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ԲԱՐՁՐ ՏԵԽՆՈԼՈԳԻԱՆԵՐԻ ՏԵՂԵԿԱԳԻՐ
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Տեղեկագիրը հրատարակվում է Ակադեմիկոս Ի.Վ.Եղիազարովի ջրային հիմնահարցերի և հիդրոտեխնիկայի ինստիտուտի, Հիդրավլիկական հետազոտությունների հայկական ազգային ասոցիացիայի, Երևանի կապի միջոցների գիտահետազոտական ինստիտուտի և Շուշիի տեխնոլոգիական համալսարանի կողմից: Հիմնադրվել է 2016թ.: Լույս է տեսնում տարեկան 4 անգամ:

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INCREASE OF SOIL MOISTURE CONTENT BY APPLYING POLYMER-MINERAL MATERIAL

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The paper presents the results of using polymer-mineral material (PMM) to retain water in the soil (substrate) in order to increase its moisture content. The substrate, presented by Timiryazev Academy, is a mixture of soil with additives of manure and peat for growing fruit tree seedlings. Various experiments were carried out to determine the moisture content in such a substrate both without additives of PMM and with its addition in various proportions and in different ways. The dynamics of decreasing the moisture content in containers due to filtration and evaporation was measured. Containers with such mixtures were filled with water until the substrate reached its maximum amount then it was analyzed how much water flows from the holes at the bottom of the container and how much evaporates from the surface of this substrate over time. As a result of the experiments, the possibility of obtaining an additional amount of water in the substrate surpassing its moisture content was revealed and it is also shown how this additional amount of water is stored for a long time in comparison with the substrate without PMM which allows not only to accumulate additional moisture but also to reduce the coefficients of filtration and evaporation of the soil.

Key words: water, irrigation, plant, ground, filtration, polymer, additive.

Introduction

Plants will be grown for quite a long time under natural conditions in agriculture often without additional irrigation, so the efficient use of solar energy and moisture from rainfall and groundwater are the most important tasks in many arid regions of the Earth, particularly in Armenia. For normal growth the plants also need water, nutrients, air in addition to light and heat which they receive from the soil and the environment. In particular, solar energy and nutrients in the soil are quite enough for the regions of Armenia, but water problems often arise here. Additional water for plants is necessary not only for more growth and high yield but also just for survival.

High yield of cultivated crops is the most important characteristic of agriculture which influences on their cost price and increases the competitiveness of agricultural production. Water and air in cultivated structural soil provide all the vital processes in plants and the vital activity of great number of microorganisms as well which are in the plants and provide the necessary technological processes for their growing. Therefore, due to lack of water, the productivity of many plant species under rain fed conditions is significantly lower than that in irrigated soils of the same region.

Rain fed lands (rain fed fields, rain fed agriculture) – are lands in the zone of irrigated agriculture on which crops are cultivated without artificial irrigation, i.e. they mainly use moisture which the soil gets in spring. Mostly these lands are located in foothill plains and margins of oases where drought-resistant corn, food and garden plants are grown.

Therefore, in the territories of land where crops are cultivated without artificial irrigation, the use of polymer-mineral material (PMM) will improve the water regime which may lead to increased yields by reducing the root system of grown plants and reducing the coefficients of filtration and soil evaporation. In particular, the use of polymer-mineral material in soil under rainfed conditions will ensure the rapid growth of trees and increase their viability.

Thus, when growing plants are in rainfed conditions, the main reason of the low yield is water shortage, therefore, in the regions of Armenia, where annual rainfall is 250-450 mm, agriculture is carried out by using artificial irrigation. In foothill and mid-mountain zones where the average annual

precipitation is 450-650 mm, agriculture is carried out mainly without artificial irrigation. However, often recurring natural disasters such as drought, hail and others, cause serious damage to agriculture, creating the danger of desertification of lands.

The reason for the decrease of moisture in soil in natural conditions is not only the high temperature of the environment and small amount of precipitation, but also human anthropogenic impact. The increase in the capacity of agricultural machinery, the intensity of agriculture, the depth of cultivation and intensified loosening and traditional furrow turning create conditions for soil degradation and thereby difficult conditions for the survival and growth of plants. In this regard, minimal and zero tillage is of great importance using effective agro technical activities such as scientifically based crop rotation, the use of organic fertilizers and ameliorants which not only allow the plant to survive but also produce high yields. At different times, specialists of agriculture often made attempts to quickly improve the physical properties of the soil with the help of various ameliorants in addition to traditional methods [1-6]. The authors of this study consider purposeful to use polymer-mineral material (PMM) as ameliorant which is created by Research Institute of Mechanics of Moscow State University after M.V. Lomonosov.

Conflict settings

The aim of the study is to increase the moisture content of the soil and the possibility of retaining sufficient amount of additional water collected from precipitation and groundwater long before for the purpose of irrigation or sharply reduced irrigation regime of plant growth. The effects obtained from PMM can be used in the cultivation of various plants and will help to increase the productivity, to reduce production costs and to regulate the regime of water in the soil under rain-fed conditions.

Research results

The fertility of the soil depends on its structure, porosity, moisture content and absorption capacity which in its turn depends on the presence of colloidal particles (size 0,0001 mm or less) of organic and mineral origin. The more such particles, the greater the absorption capacity of the soil. Consequently, water and dissolved salts and gases are retained in the soil until the plant picks them up as its nutrition through its root system. A plant inevitably gradually dies in the soil in conditions of water and air deficit despite having a sufficient amount of nutrients. Therefore, it is necessary to provide a sufficient amount of water and air to the pores, which, depending on the type of soil, occupy about half of its volume determined by its moisture content (moisture content is the ability of the soil to accept and retain a certain amount of precipitation water in its fiber holes not allowing the latter to drain).

Moisture content determines the amount of water in substrate at the moment of measuring.

For effective farming medium sized pores (less than 3-5 mm) are desirable in the soil. Then in moist soil water will be stored in small pores and the air which is necessary for respiration of the root system of plants and microorganisms will be kept in large ones. The type of vegetation growing in the soil, relief, the processing system, the presence of winds, surrounding temperature etc. affect the level of soil moisture.

The rate of soil filtration which is characterized by a parameter - the filtration coefficient, also has a significant effect on the level of soil fertility.

Filtration coefficient is a characteristic of soil permeability in relation to certain filtered water; in case of the linear law of filtration it is equal to the rate of water filtration with a unit pressure gradient.

Precipitation fallen to the surface of the earth is absorbed into the soil through large pores and then it is filtered inland through small pores and capillaries surrounding the particles of the earth. In sandy soils the filtration rate is much higher than in alumina. If the soil is rich in calcic compounds, then small particles, especially colloidal ones, stick together with each other forming sufficiently

strong porous grains that resist water erosion processes longer. Under natural conditions, medium-sized pores are formed between the grains and such alumina acquire good filtration characteristics. The greater the porosity of the soil is, the more water is placed in it. This amount of water meets the criterion of soil moisture content which should be distinguished from the concept of water-holding ability of soil determined by the content of moisture remaining in the soil after complete water saturation until the final free squeeze.

The property of the soil to retain water by absorption and capillary forces is called water retention capacity. The quantitative characteristics of water holding capacity are the moisture content and potential of soil moisture. The formation of productive moisture content in the soil is associated with water-holding ability. There is always moisture storage in the soil but not all of it is available for plants.

Such important indicators as evaporation, buoyancy force of the soil etc. are also important for cultivated plants.

So, all the physicochemical and biological properties of the soil are important for the growth of various plants which acquire their best indicators in structural soils where there is a sufficient amount of water and air at the same time.

Restoration and preservation of the soil structure is carried out by agro - technical methods and by introducing artificial structure-forming agents into the soil. Agro - technical methods for improving soil structure include: sowing perennial grass, cultivation of ripening soil, liming acidic soils, gypsum treatment of saline soils and applying mineral and especially organic fertilizers.

Traditional methods of preserving soil structure are based on deep tillage using intensive loosening, furrow turning and applying crop rotation and also using fertilizers, treating acid soils with calcic and gypsum treatment of saline soils. However, deep tillage of the soil with the use of intensive loosening and furrow turning leads to its rapid degradation. Nowadays the best conditions for both maintaining and improving soil structure and increasing fertility are created with minimal and zero tillage using scientifically based crop rotation and ameliorants and fertilizers as well.

Therefore, in order to improve the physical properties of the soil for increasing yield and reducing cost price and improving the characteristics of cultivated plants in rainfed conditions as well, the task is set to regulate the water regime in the soil using ameliorants, particularly PMM material. The obtained results can be guaranteed.

Taking into account that it is difficult to ensure equal conditions for experiments in the field conditions, therefore, for obtaining reliable results the studies were carried out indoors at room temperature and humidity (wind, sun and temperature changes can significantly affect the speed of evaporation under natural conditions).

Depending on the method and amount of the ameliorant, the following were determined: soil moisture content and the amount of accumulated water in the substrate over time. The experiments were conducted with soil without vegetation in order to exclude flow of one of the components of the fluid, namely, the moisture consumption by plants for their growth and surviving. In this case only two components were analyzed that affect the dynamics of the accumulated water in the substrate, associated with evaporation and leakage from the bottom of the container with many holes into which the substrate with PMM was placed.

To determine the moisture content of the substrate a container with a mixture of PMM was placed in a bath tube of water to be filled to the maximum limit. The “dry substrate” was weighed in advance. The time for filling fluctuated from 15 minutes to a day. Further the container was placed on a solid surface with holes for out flowing of additional water after which it was weighed according to the difference between the results of measuring the mass of the dry mixture and thus the quantity of maximum (additionally) collected water was determined by soaked mixture.

For example, if a container with a “dry” substrate weighed 315 g in which 15 g is the weight of the container and 300 g is the weight of either a pure substrate or a mixture of a substrate with PMM, then after soaking in a bath tube the container could weigh 450 g. So, the additionally collected water

in this case will be 450 - 315 = 135 g. Next, daily measurements of the mass of such substrate in the container were carried out and observations were made until the indicator on the scales again showed a mass approaching the dimension corresponding to the mass of the container with the mixture before the experiment began. The experiments were repeated several times. Below we bring the average measurement indicators that demonstrate the effect of the use of PMM in the substrate.

Let us enumerate the basic variants of mixing the substrate with PMM.

1. Pure substrate without PMM for controlling the measurement of various variants of mixture.
2. Definite amount of PMM equally mixed with substrate by the proportion of 1 to 4 (75 g PMM and 225 g substrate summing up the total weight of 300 g).
3. On the bottom of the container 0,5 or 1 cm layer of PMM was put for reducing the water filtration (the layer of PMM thicker than 2 cm is a good isolator and practically doesn't let water out).
4. Two layered amount: on the bottom of the container we put the layer of substrate mixed with PMM and on the top we put pure substrate without PMM.
5. Multi layered (three layered) packing: on the bottom and top we put the substrate mixed with PMM and between them the pure substrate which provides reduced filtration and evaporation (fluid is poorly evaporated when soaked in PMM).
6. «Slices» (rods made of PMM) with diameter of 0,5 - 1 cm and depth up to 10 cm into the substrate filled with PMM. The amount and sizes of rods are determined by the amount of PMM which is necessary to insert into the substrate for collecting additional badly evaporated water (particularly, 1 g. PMM absorbs up to 1,5 liter water). Diameter of the rod is limited such a way the bigger it is the slower the absorption of moisture is into PMM. Increasing the amount of rods in their optimal fixed diameter leads to the increase of the surface for water absorption. On the top the rods are covered by the layer of substrate.

Let us note that the mixture of the substrate with PMM has the property of multiple use and is not washed out with water (repeatedly watering or growing of new plants is possible in this mixture), a small concentration of PMM in the substrate should not lead to fading of the plant due to extra moisture, pores must be left in the substrate for air (minimum watering).

Results of experiments

Amount of water accumulated by the substrate in the container is determined as difference between the mass of the container with substrate at the time of measuring and the mass of the container before starting its soaking into the water in bath tube.

Relative moisture content in the container is calculated as the relation of water amount to initial "dry" mass of substrate before it is wetted in the bath tube which is shown in percents.

1 experiment

300 g pure substrate is wetted at room temperature in the bath tube during 10-15 min. Total weight of accumulated water with soil comprised 430 g i.e. we additionally have 130 g of water. The results of the experiment are shown in Table 1.

Table 1

Days	0	1	2	3	4	5	6	14	17	18	20
Water amount, g	130	100	90	85	80	75	70	40	30	25	0
Relative moisture content, %	43,33	33,33	30,00	28,33	26,67	25,00	23,33	13,33	10,00	8,33	0,00

Conclusion 1: The substrate absorbed an additional 130 g. water to the one that was before the experiment. The water completely evaporated and flowed out of the container in about 20 days (measurement accuracy of 1 gram, measurements were rounded to 5 grams). Obviously, in a container with a seedling, the amount of water would have decreased faster due to consumption for its life.

2 experiment

A container weighing 20 g filled with a mixture of a total mass of 300 g, containing a substrate of 225 g mixed with 75 g PMM, after wetting in a bath tube with water for 15 minutes weighed 470 g, hence, the mass of additionally collected water is: 470 - 300 - 20 = 150 g. Thus, compared with experiment 1, 75 g PMM replacing 75 g substrate absorbed 20 g more water. The results of experiment are shown in Table 2.

Table 2

Days	0	1	2	3	4	5	6	14	17	18	20
Water amount, g	150	135	130	125	120	115	110	65	50	45	40
Relative moisture content, %	50,00	45,00	43,33	41,67	40,00	38,33	36,67	21,67	16,67	15,00	13,33

Conclusion 2: Mixture of substrate with PMM collected 20 g water more than without PMM and then after 20 days it kept 40 g more water which is badly evaporated and may be used for nourishing the plants.

3 experiment

We take two containers, put 25 g PMM on the bottom of the first container (approximately 0,5 cm thick layer) and a substrate of 275 g was poured on top (total weight is 300 g.), weight of container is 15 g (total weight is 315 g. before watering) and put 50 g PMM on the bottom of the second container (layer is about 1 cm thick). Then both containers were placed in a bath tube with water. The results of the experiment are shown in Tables 3 and 4.

Table 3

Days	0	1	2	3	4	5	6	14	17	18	20
Water amount, g	130	115	110	108	105	100	95	70	60	55	50
Relative moisture content, %	43,33	38,33	36,67	36,00	35,00	33,33	31,67	23,33	20,00	18,33	16,67

Table 4

Days	0	1	2	3	4	5	6	14	17	18	20
Water amount, g	145	125	120	115	110	105	100	70	60	55	50
Relative moisture content, %	48,33	41,67	40,00	38,33	36,67	35,00	33,33	23,33	20,00	18,33	16,67

Conclusion 3: The size of the PMM layer of 0,5 cm or 1 cm practically does not affect the amount of stored water at the end (50 g.) and in order to save PMM it can be put even less. Besides, at the beginning more water was collected where there was a layer of 1 cm. This is due to a decrease in filtration. The evaporation process prevailed over the process of filtration and water changes in the first and second cases over time mainly depended on evaporation and they turned out to be equal. Comparing these results with the first and second experiments, we can conclude that a relatively small amount of PMM laid on the bottom (25 and 50 g) allows us to save more water for longer time (50 g) than 75 g PMM mixed with a substrate (40 gr. water). For saving in the costs for PMM, we can put its even thinner layer with thickness of 1 to 3 mm. (for example, in the form of a cartridge of PMM between two layers of paper laid on the bottom of the container).

4 experiment

40 g PMM mixed with 120 g substrate (total 160 g.) was put on the bottom of the container and 150 g substrate was poured on top (weight of the mass is 310 g, weight of container is 20 g), total weight is 330 g which is the weight of the container with the mixture before irrigation. The container

was placed in a bath tube filled with water for 15 minutes. The weight of the container was 465 g from which 135 g is the amount of additional water. The results of the experiment are shown in Table 5.

Table 5

Days	0	1	2	3	4	5	6	14	17	18	20
Water amount, g	135	120	115	110	105	100	95	70	60	55	50
Relative moisture content, %	45,00	40,00	38,33	36,67	35,00	33,33	31,67	23,33	20,00	18,33	16,67

Conclusion 4: Two-layer substrate (bottom layer of a mixture of PMM and substrate in a ratio of 1: 4 and top layer of a substrate of 150 g) allows us to collect additional water on one hand and reduces the filtration coefficient on the other hand compared to options 2 and 4 and allows us to save the amount of PMM and save an additional 50 g water even after 20 days.

5 experiment

Three-layer substrate: 40 g PMM is mixed with 120 g substrate and the resulting mixture is laid at the bottom and on the top inside the container for 80 g each layer and between them there is a layer of 150 g substrate. Before watering the weight of the container is 330 g 20 g of which is the weight of the container and 310 g mass of the mixture. After soaking, the weight of the container was 480 g 150 g of which is added water. The results of the experiment are shown in Table 6.

Table 6

Days	0	1	2	3	4	5	6	14	17	18	20
Water amount, g	150	125	120	115	110	105	100	75	65	65	60
Relative moisture content, %	50,00	41,67	40,00	38,33	36,67	35,00	33,33	25,00	21,67	21,67	20,00

Conclusion 5: Three-layer mixture is obtained where the bottom and top layer of the mixture with PMM allows us to collect more water, to reduce evaporation and filtration and after 20 days save an additional 60 g water at the same waste of PMM (40 g).

6 experiment

520 g substrate is put in the container weighing 45 g where PMM is put in four slices of 80 g with 0,5 cm diameter (20 g each). Total weight of the container is 645 g. After filling it with water during 15 minutes the weight becomes 980 g from which the weight of added water is 335 g. The results of the experiment is shown in Table 7.

Table 7

Days	0	1	2	3	4	5	6	14	17	18	20
Water amount, g	335	290	275	260	245	225	215	120	90	70	65
Relative moisture content, %	55,83	48,33	45,83	43,33	40,83	37,5	35,83	20	15	11,67	10,83

Conclusion 6: The version of the container with 80 g PMM with four holes after 20 days retained an additional 65 g. water and around the holes the substrate is almost dry as before the experiment. This option can be used for already planted trees or perennials by making holes in the ground or in a container with PMM holes.

Conclusion

Mixing PMM with the substrate and laying it on the bottom of the container and in the holes inside the substrate as well allows us to save more water thereby increasing moisture content, to reduce evaporation from the surface of the substrate and filtration through the bottom of the container.

These experiments must be carried out together with various plants which will allow to determine the optimal amount of PMM for a particular plant taking into account the possibility of irrigation or rainfall and other climatic conditions for its growth both indoors and in natural conditions.

References

1. Качинский Н.А. О влажности почвы и методах её изучения /М:, «Новая деревня», 1923, 40с.
2. Tokmajyan V.H., Markosyan A.Kh., Khalatyan A.A., Khachatryan N.B. The Perspectives Of Providing The Storage Of Irrigation Water In The Case Of Using Water Collecting Additives In The Ground // Bulletin of high technology, Shushi , N 2 (6) /2018, p. 9-14.
3. Danilova T.N., Regulation of the water regime of grainy sandy loam soils and moisture supply of plants with the help of water-absorbing polymers. Agro physics, 2016, № 1, p. 8-16.
4. Hydrogel and plants //floweryvale.ru/houseplants/hydrogel-and-plants.html
5. Forms of water in the soil //http://mse-online.ru/pochva/formy-vody-v-pochve.html
6. Terleev V.V., Topaj A.G., Mirshel V., Gourin P.D., Modeling of water-retaining capacity of soil on the basis of concepts of capillary hysteresis and lognormal pore size distribution //theory of Agro physics, S.P. (b), 2014, N1(13), p. 9-18.

References

1. Kachinskiy N.A., About the humidity of the soil and the methods of its study /M:, «New village», 1923, 40 p.
2. Tokmajyan V.H., Markosyan A.Kh., Khalatyan A.A., Khachatryan N.B. The perspectives of providing the storage of irrigation water in the case of using water collecting additives in the ground // Bulletin of high technology, Shushi , N 2 (6) /2018, p. 9-14.
3. Danilova T.N., Regulation of the water regime of grainy sandy loam soils and moisture supply of plants with the help of water-absorbing polymers. Agro physics, 2016, № 1, p. 8-16.
4. Hydrogel and plants //floweryvale.ru/houseplants/hydrogel-and-plants.html
5. Forms of water in the soil //http://mse-online.ru/pochva/formy-vody-v-pochve.html
6. Terleev V.V., Topaj A.G., Mirshel V., Gourin P.D., Modeling of water-retaining capacity of soil on the basis of concepts of capillary hysteresis and lognormal pore size distribution //theory of Agro physics, S.P. (b), 2014, N1(13), p. 9-18.

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Ա.Հ. Վարդանյան[1], Ա.Ա. Շահնազարով[1], Վ.Հ. Թոքմաջյան[2], Ա.Ա. Սարուխանյան[3]
[1]Լոմոնոսովի անվան Մոսկվայի պետական համալսարան
[2]Շուշիի տեխնոլոգիական համալսարան
[3]Ճարտարապետության և շինարարության Հայաստանի ազգային համալսարան

Հոդվածում բերվում են հողի ջրատարողունակության բարձրացման նպատակով, պոլիմերահանքային նյութի օգտագործման միջոցով ջուրը այնտեղ պահելուն ուղղված հետազոտությունների արդյունքները: Տիմիրյազևյան ակադեմիայի կողմից ներկայացված, մրգատու ծառերի տնկիների աճեցման սուբստրատը՝ հողի, օրգանական պարարտանյութի (գոմաղբ) և տորֆի խառնուրդ է: Իրականացվել են բազմաթիվ փորձեր, այդպիսի սուբստրատի ջրատարողունակության որոշման ուղղությամբ, ինչպես պոլիմերահանքային նյութի, տարբեր

չափերով և եղանակներով, օգտագործմամբ, այնպես էլ՝ առանց դրա: Բեռնարկղերում չափվել է սուստրատում ջրի քանակի վրա, ֆիլտրացիայի և գոլորշիացման ազդեցության դինամիկան: Բեռնարկղերը հագեցվում էին ջրով, մինչև սուբստրատի առավելագույն ծավալի ստացումը, այնուհետև վերլուծվում էր, թե ինչքան ջուր է հոսել բեռնարկղի հատակի անցքերից և ժամանակի ընթացքում, ինչքան է կազմում գոլորշիացումը: Կատարված հետազոտությունների արդյունքում, բացահայտվել է, սուբստրատում, պոլիմերահանքային նյութի օգտագործման դեպքում, ջրի լրացուցիչ ծավալ կուտակելու և ըստ ժամանակի, դրա պահպանման հնարավորությունը: Պոլիմերահանքային նյութի օգտագործման հետևանքով, նաև փոքրանում է հողի ֆիլտրացիայի գործակիցը և գոլորշիացման ծավալը:

Բանալի բառեր. ջուր, ոռոգում, բույս, հող, ֆիլտրացիա, պոլիմեր, լցանյութ:

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УВЕЛИЧЕНИЕ ВЛАГОЕМКОСТИ ПОЧВЫ С ПОМОЩЬЮ ПОЛИМЕРНО-МИНЕРАЛЬНОГО МАТЕРИАЛА

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В работе приведены результаты использования полимерно-минерального материала (ПММ) для удержания воды в почве (субстрате) с целью повышения его влагоемкости. Субстрат для выращивания саженцев фруктовых деревьев, предоставленный Тимирязевской академией, представляет собой смесь из почвы с добавками навоза и торфа. Проводились различные эксперименты по определению влагоемкости воды в таком субстрате, как без добавок ПММ, так и с его добавлением в различных пропорциях и разными способами. Измерялась динамика уменьшения влагосодержания в контейнерах за счет фильтрации и испарения. Контейнеры с такими смесями наполнялись водой, до достижения субстратом максимального объема, далее анализировалось сколько воды вытекает из отверстий на дне контейнера и сколько испаряется с поверхности этого субстрата во времени. В результате проведенных экспериментов выявлена возможность получения дополнительного объема воды в субстрате сверх его влагоемкости, а также показано как этот дополнительный объем воды сохраняется продолжительное время, по сравнения с субстратом без ПММ, который позволяет не только аккумулировать дополнительную влагу, но и понизить коэффициенты фильтрации и испарения почвы.

Ключевые слова: вода, орошение, растение, грунт, фильтрация, полимер, добавка.

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THE REGULATION OF WATER REGIME OF FIELD CROPS AND DECORATIVE WOODY PLANTS IN NATURAL CONDITIONS BY APPLYING POLYMER-MINERAL RAW MATERIAL

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The efficient use of solar energy to synthesize organic matter has ever been and still remains the main task of agriculture. In addition to the light and heat from the sun which are the main and only way for the plants to function normally, water, nutrients and air (CO_2 lL O_2) which the plants get from soil and surrounding atmosphere are needed for the continuation of this process along with the natural activity of plants. Among the mentioned factors, water is the criterion of crop yield in those regions of Armenia having insufficient and unstable humidity. This article offers solutions for providing water regime in the soil.

Key words: agriculture, harvest, raw material, organic substance, ameliorant, rain-fed soils.

Introduction

The vital processes of plants, the activity of microorganisms as well as the technological properties of the soil, specific resistance, processing time and other issues are due to water content in the soil. In any case, crops grow and develop normally in cultivated agricultural lands which contain water and air simultaneously.

Attempts have been made in various periods to rapidly improve the physical properties of the soil in addition to the existing traditional means of using various ameliorants [1-3].

Conflict settings

The aim of the work is to apply the polymer mining raw materials created by the Institute of Mechanics of the Moscow State University after M.V. Lomonosov as ameliorants to reduce the costs on unit product, to increase the yield, to regulate water regime in soybean nurseries of decorative use and other corns among them winter wheat and sainfoin which is used as animal feed rich in proteins and carotene gaining new circulation in the republic in rain-fed agricultural conditions of Artsakh and Armenia.

Research results

Autumn wheat which is considered to be the main food crop, is one of the most valuable and high-yield plants. In all cultivation areas the average yield is significantly higher than the spring wheat crop as it has good use of autumn and spring moisture. Autumn wheat has a well-developed root system that penetrates deep into the soil due to which it absorbs nutrients well and suffers little from drought. It protects itself from drought and sandstorm due to its early maturation. The high value of autumn wheat lies in the fact that having the same nutritional value as spring wheat it is more valuable from management and economic point of view. Winter crop and relatively early harvesting, compared to spring wheat, allows the full and balanced use of labor and production facilities.

The second crop that is another topic for research is sainfoin which as papilionaceous feed plant is the first in its distribution and meaning prevailing in our country (the second is alfalfa which is cultivated in irrigated lands).

The sainfoin exceeds clover and alfalfa by its total caloric value of corn (1 kg of grass contains 0,54 feed units) and the amount of digestible protein is close to alfalfa (10,6% in grass). It is cultivated for getting grass, grass flour and green mass which all kinds of animals eat with pleasure. Unlike other

papilionaceous flowers, tympanic disease does not occur when feeding animals with green sainfoin. Sainfoin has a relatively high yield and often exceeds alfalfa and clover in its main cultivation areas. Sainfoin is an excellent honey plant. It provides 80-100 kg or more of honey per 1 hectare. The agro-technical significance of sainfoin is also great. It enriches the soil with organic matter and nitrogen. In the case of 50-60 c/ha of harvest for two years sainfoin leaves 100-120 kg of nitrogen in the root and stubble remnants in plowland.

The southern species of the tree of life belonging to the family of cypress are the third object of the study, they are trees and shrubs of xerofite properties and are widely used in greening the environment, gardening and forestry.

The first two objects which are distinguished by the plasticity of adaptation to different soil and climatic conditions and the best nutritional and food features, are considered to be strategically important crops in the agricultural economy of the republic. Therefore, in the current conditions of increasing environmental stress it is necessary to ensure high yields at the lowest possible cost by developing various agro-technical measures and investing in production.

The factor of minimized yield is water in Armenia and Artsakh in conditions of insufficient and unstable humidity. Therefore, in the lowland zone where the annual precipitation is 250-450 mm, the cultivation is carried out mostly in irrigated conditions and in the foothills and middle mountain zones where the average annual precipitation varies between 450-650 mm and it is carried out mainly by rain-fed conditions. However, frequent droughts and hailstorms in recent years have caused great damage to agriculture threatening desertification.

In natural conditions (without irrigation), as the results of many studies show, the reason for moisture deficit does not depend only on the increase in temperature and the decrease in precipitation. One of the reasons for the decrease in soil moisture is the anthropogenic factor. With the increase in the power of machinery and tools, the increase in cultivation depth, the intensive mellowing of arable land with traditional furrow turn accompanied by an increase in the number of operations and the intensification of agriculture create favorable conditions for such negative phenomena as degradation of soil aggregates, acceleration of dissolving rates of organic substances, pulverization of plowland, loss of moisture, acceleration of erosion and increase in labor and material costs etc.

In order to prevent soil degradation, it is important to have minimal and zero tillage, to use such agronomic measures as the use of scientifically justified crop rotations, fertilization with organic fertilizers as well as rapid improvement of agro physical properties of soil with various ameliorants.

Fertility is the main and important feature of the soil which in its turn depends on a number of other properties. One of the most important of these features is its absorbency. It is highly dependent on colloidal (less than 0,0001 mm) particles of mineral, organic and organic –mineral origin. The more these particles are, the better the soil absorption is and therefore the greater the amount of water and soluble salts and gases is absorbed by it and retained by certain forces. Absorbed substances are not absorbed by the soil forever. They are only stored until the amount of water increases and the plants require them through their root system. If soil moisture increases, some of the substances will undoubtedly return to the soil solution.

If there are enough nutrients in the soil but there is lack of water and air, the plants die. Therefore, care must be taken to ensure that there is always water and air in the soil along with nutrients. They are located in soil pores and cracks which occupy in average 50% of the total land area.

It is preferable to make pores for crops in the soil (from several mm to tens and hundreds of mm). In this case even big pores of the soil will contain air which is necessary for respiration of soil inhabitants and plant root system and even the smallest pores contain water.

One of the main elements of soil fertility is its water permeability index. The water falling in the form of precipitation on the surface of the soil under the influence of gravity, is absorbed by large pores in it and is absorbed by thin pores or capillaries surrounding the soil particles with a wide layer. The larger the soil particles (for example, in sand) are, the larger the holes between them are and the

easier is water penetration in such soil. In contrast to clay soils which are rich in smallest particles, the holes between them are very small and the water penetrates relatively slowly.

However, this applies not only to non-structural clay soils. If such soil is rich in humus and lime compounds, the individual smallest particles, especially the colloidal particle coagulate, soften and are stuck to each other in it forming porous grains and particles which are quite strong in the presence of humus and lime and withstand prolonged water washing. In natural conditions middle-sized holes appear between the grains and particles as in sand and such structural clay obtains good water permeability. The more porous the soil is, the more water there is in it. This amount of water corresponds to the soil water permeability index. It is clear that the water permeability of the soil is equal in volume to its porosity. However, water permeability must be distinguished from soil moisture. Soil moisture is the moisture retained by it that remains in it after complete wetting and free squeezing with the pores directed downwards or sideways according to the slope.

The properties of the soil include the evaporating properties of the soil, the water-raising force and so on.

All the properties of the soil are important for the growth and development of crops and find their best expression in the agricultural lands which contain water and air at the same time.

According to the principles of the traditional soil cultivation system, the methods of maintaining soil structure are: deep tillage by traditional furrow turn, introduction of meadow crops, application of organic and mineral fertilizers, fertilization of acid soils, gypsum of saline soils etc. However, centuries of experience in agriculture have shown that this is not so. As t is mentioned above, the deep loosening of the soil by furrow turn and the increase in the number of cultivations are the cause of all the negative effects that lead to accelerated soil degradation. According to current ideas, both the best conditions for maintaining and improving the structure and the other properties of the soil that create the total fertility are created by the minimum and zero continuous cultivation of the soil scientifically based on the use of crop rotations, fertilizers and ameliorants to improve the plowland of the soil quickly.

Based on the above mentioned and guided by the requirements of basic and applied sciences, we set ourselves the task to determine the impact of the application of polymer mineral raw materials created by Moscow State University after M.V. Lomonosov on the regulation of water regimes of field crops and woody plants through vegetation and field experiments in rain-fed conditions.

We call water regime all the processes that take place in the soil related to water penetration, movement and distribution through certain horizons and its storage and waste as well.

Field experiments should be carried out in dark chestnut gravel weak carbonated soils in the foothills of the republic at an altitude of 600 m above sea level. In the natural conditions of this zone the main source of moisture in the soil is atmospheric precipitation and deep water. In addition to precipitation and deep water, the soil moisture is affected by the nature of the vegetation, the relief, the cultivation system, the presence of winds etc. The average annual precipitation in the zone is 524 mm and the average annual air temperature is 11,8^{o}.

For field crops such as wheat and sainfain the ameliorant will be put into the soil and mixed with the 7-8 cm layer of cultivated soil taking into account the production capacity. It is also worth noting that the plot of land intended for the experiment which has a weak slope to its eastern parts, is cultivated continuously in a minimal method for 12 years.

Conclusion

In order to improve the properties of degraded lands, to regulate water and food regimes of crops, to reduce the cost price of production it is necessary to carry out laboratory, field and vegetation experiments by means of studies to reveal the impact of different amounts of polymer-mineral raw materials invented by Research Institute of Mechanics of Moscow State University after M.V.Lomonosov and their application methods on soil improvement, regulation of water and food regimes and as a result on economic efficiency of crops and decorative trees.

References

1. Tokmajyan V.H., Markosyan A.Kh., Khalatyan A.A., Khachatryan N.B., The perspectives of providing the storage of irrigation water in case of using water collecting additives in the ground // Bulletin of high technology, Shushi , N 2 (6) /2018, p. 9-14.
2. Danilova T.N., Regulation of the water regime of grainy sandy loam soils and moisture supply of plants with the help of water-absorbing polymers. Agro physics, 2016, № 1, p. 8-16.
3. Hydrogel and plants //floweryvale.ru/houseplants/hydrogel-and-plants.html

ՀՏԴ - 635:556:631.51

ԲՆԱԿԱՆ ՊԱՅՄԱՆՆԵՐՈՒՄ ԴԱՇՏԱՅԻՆ ՄՇԱԿԱԲՈՒՅՍԵՐԻ ԵՎ ԴԵԿՈՐԱՏԻՎ ԾԱՌԱԲՈՒՅՍԵՐԻ ՋՐԱՅԻՆ ՌԵԺԻՄԻ ԿԱՐԳԱՎՈՐՈՒՄԸ ՊՈԼԻՄԵՐԱՀԱՆՔԱՅԻՆ ՀՈՒՄՔԻ ԿԻՐԱՌՄԱՄԲ

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Երկրագործության հիմնական խնդիրն եղել և մնում է օրգանական նյութ սինթեզելու համար արեգակնային էներգիայի արդյունավետ օգտագործումը: Այդ գործընթացը ապահովող գլխավոր և միակ միջոցի՝ բույսերի բնականոն գործունեության համար բացի արեգակից ստացվող լույսից ու ջերմությունից անհրաժեշտ է նաև ջուր, սննդանյութեր, օդ (CO_2 և O_2), որոնք բույսերն ստանում են հողից և հողամերձ մթնոլորտից: Նշված գործոններից՝ ջուրը Հայաստանի անբավարար ու անկայուն խոնավություն ունեցող շրջաններում մշակաբույսերի բերքատվության չափորոշիչն է: Սույն հոդվածում առաջարկվում են լուծումներ՝ հողում ջրային ռեժիմի ապահովման համար:

Բանալի բառեր. երկրագործություն, բերք, հումք, օրգանական նյութ, մելիորանտ, անջրդի հողեր:

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ПРИМЕНЕНИЕ ПОЛИМЕРНО-МИНЕРАЛЬНОГО МАТЕРИАЛА ДЛЯ РЕГУЛИРОВАНИЯ ВОДНОГО РЕЖИМА ПОЛЕВЫХ РАСТЕНИЙ И ДЕКОРАТИВНЫХ ДЕРЕВЬЕВ В ЕСТЕСТВЕННЫХ УСЛОВИЯХ

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Основной задачей земледелия в естественных условиях является эффективное использование солнечной энергии для синтеза органического вещества. Для обеспечения нормальной деятельности растений, кроме света и тепла, также необходимы вода, питательные вещества, воздух (CO_2 и O_2), которые растения получают из почвы и окружающей среды. Из отмеченных составляющих, для регионов Армении с недостаточной и неустойчивой

влажностью, вода является важным фактором урожайности возделываемых культур. В статье предлагаются решения для обеспечения водного режима в почве.

Ключевые слова: земледелье, урожай, сырье, органическое вещество, мелиорант, неорошаемые земли.

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THE IMPACT OF CULTIVATION METHODS ON SOIL FERTILITY ELEMENTS AND WINTER CROP

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In the conditions of dry agriculture of lowland zone of the Republic of Artsakh the effects of traditional deep tillage with furrow turn and minimum cultivation on soil humus content, humidity, nutrients, agrophysical properties and the yield of winter crop were compared.

It has been found out that in dark cinnamonic gravel soils of Askeran region humus and mineral nutrients are distributed at different depths of the plowland depending on the main method of soil tillage, soil moisture content during vegetation is higher after different precursors in minimum cultivation which helps to decrease the interval of change of soil density during vegetation, to preserve optimal density and to increase the yield of winter crop.

Key words: winter crop, soil density, water supply, nutrient distribution, crop**.**

Introduction

The intensification of traditional agriculture which has been accompanied by a significant increase in the capacity and productivity of soil-cultivating machines and tools in the tillage system by increasing the depth of soil cultivation, the intensive mellowing of soil, the increase in the number of cultivation activities has produced such negative effects as decomposition of soil aggregates, acceleration of the tempos of solution of organic materials, powdering of cultivated layer, loss of moisture, increased labor and material costs etc. [5].

Unlike the traditional soil cultivation, the minimal land cultivation system whose main and decisive link is soil cultivation by turning furrow based on the reduction of cultivated layer, reduction of the number of operations and the principle of creation of vegetation residues on its surface for its protection excludes such negative events [5].

Based on the above mentioned, our task is to identify the agronomic, environmental and economic advantages of the traditional land cultivation system through field experiments and laboratory studies.

Conflict setting

Field experiments have been made in dark cinnamonic, gravel, in some places carbonated, medium strong, weak humus soils of Ivanyan, Askeran region for 4 times with 4 repetition.

Based on the circumstance that winter tillage is mainly done in clean fallow or after winter crops, the following versions have been developed as

1. Precursor clean fallow with traditional soil cultivation,
2. Precursor winter corn with traditional soil cultivation,
3. Precursor clean fallow with minimum soil cultivation,
4. Precursor winter corn with minimum soil cultivation.

The precursor was done in clean fallows versions with early fallow which was done PLN-35 plough in one case (the first version) in 23-25 cm depth and in the other case (the third version) with heavy disc plough in 7-8 cm depth.

In precursor winter corn versions the main soil cultivation was done after harvest with the same tools.

Initial cultivation in all variants was done in the first ten days of November and sowing was done after 2–3 days with the norm of 5 million germinated grains of “Krasnodarski 99” sort per hectare.

During the research period (2015–2017) the dynamics of humus and plant nutrients, soil mass density, change in moisture content depending on type of soil cultivation and the precursor was determined in soil samples taken from different depths of the tillage layer by the appropriate method.

Phenological observations and biometric measurements were performed during vegetation. The crop yield was determined by combining and weighing the crop field. Prior to harvesting, samples were taken to determine the structure of elements of wheat harvest [2].

Research results

The results of the analysis of the soil samples selected from the experiment field (Table 1) showed that the humic substances and mineral nutrients in the plowland are distributed at different depths of the soil depending on the cultivation method. In the case of furrow turn of fallow they are mainly concentrated in the layer of 15-30 cm and in the case of minimal cultivation in 0-15 cm layer. There are some viewpoints that such differentiation of fertility of the layer is generally dangerous while applying shallow cultivation and particularly during drought as drying of the top layer (0-15 cm) of the plowland does not allow plants to use the fertility factors distributed there [6].

Table 1

The dynamics of change of humus and nutrients available for plants in plowland depending on the method of soil cultivation and the previous (2015-2017)

The main method of soil cultivation and the previous	Depth of plowland, cm	Humus content in plowland, %			Nutrient content in plowland mg in 100 g soil								
					2015			2016			2017		
		2015	2016	2017	N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O
Tillage clean fallow	0-15	3,75	3,75	3,41	4,33	2,44	32,2	4,03	2,40	30,5	3,96	2,38	30,18
	15-30	3,18	3,18	3,47	3,01	2,14	20,8	3,12	2,11	21,1	3,11	2,12	20,70
	0-30	3,46	3,46	3,44	3,67	22,9	26,5	3,57	2,25	25,8	3,53	2,25	25,44
Tillage corn	0-15	3,61	3,61	3,65	2,82	2,05	28	2,67	2,1	27,1	2,71	2,15	27,11
	15-30	3,58	3,58	3,48	2,56	2,00	24,2	2,70	2,07	24,10	2,64	2,00	23,98
	0-30	3,59	3,59	3,56	2,69	2,02	26,1	2,68	2,08	25,6	2,67	2,07	25,54
Shallow cultivation clean fallow	0-15	3,78	3,78	3,82	3,15	2,48	32,9	3,01	3,15	32,9	3,11	3,18	32,95
	15-30	3,18	3,18	3,14	2,12	1,65	25,2	2,00	2,11	25,6	2,08	2,11	25,58
	0-30	3,48	3,48	3,48	2,63	2,06	29	2,50	2,63	29,3	2,59	2,64	29,26
Shallow cultivation corn	0-15	3,82	3,82	3,75	2,96	2,35	30,7	2,98	3,14	31,1	3,12	3,16	31,13
	15-30	3,14	3,12	3,28	1,92	1,93	23,1	1,87	2,07	24,1	1,68	2,12	24,07
	0-30	3,48	3,47	3,51	2,44	2,14	26,9	2,42	2,60	27,6	2,40	2,64	27,60

But attempts have proved the contrary: in both wet and especially dry seasons the crop yields are higher by shallow cultivation than by traditional crop cultivation. Differentiation of plowland according to the degree of fertility is considered to be one of the conditions for increasing the yield during minimum cultivation [3; 1].

In case of a furrow turn of fallow, deep covering of the surface layer of soil results in its rapid loss of already created activity and slow activation of the newly formed upper layer. However, the next tillage averts the desired differentiation mentioned above.

It can also be seen from the data in Table 1, in case of shallow cultivation there is a decrease in movable nitrogen in the first years depending on the decrease in humus decomposition rates. On the contrary, soil phosphorus and potassium regimes are improving and this should be taken into account when developing a fertilizing system.

Describing the process of land-accumulation and the factors conditioning it P.A. Kostichev (1949) set the physical properties of the soil and especially its mass volume into the first place [5].

Many scientists believe that frequent cultivation in the system of furrow turn in fallow leads to deterioration of soil composition and structure and against the conditions created are to fight with more frequent tillage.

Table 2

Dynamics of change of mass amount in plowland depending on the method of soil cultivation and the precursor (g/cm³) average in 2015-2017

Main method of soil cultivation and the precursor	Plowland depth, cm	Observation stages					Average according to the depth	Average in 0- 40 cm layer
		Before tillage	Stooling, pipeline	Earing	Ripening	Before harvest		
Tillage clean fallow	0-10	1,09	1,11	1,12	1,13	1,44	1,17	1,21
	10-20	1,16	1,00	1,15	1,17	1,64	1,22	
	20-30	1,17	1,01	1,15	1,15	1,56	1,20	
	30-40	1,15	1,28	1,18	1,19	1,63	1,28	
Tillage corn	0-10	0,61	1,11	1,11	1,18	1,38	1,07	1,18
	10-20	0,65	1,03	1,07	1,15	1,66	1,11	
	20-30	0,95	1,17	1,15	1,24	1,52	1,20	
	30-40	1,28	1,27	1,28	1,29	1,58	1,34	
Shallow cultivation clean fallow	0-10	1,01	1,16	1,16	1,09	1,3	1,14	1,19
	10-20	1,19	1,00	1,12	1,14	1,4	1,17	
	20-30	1,23	1,07	1,13	1,15	1,45	1,20	
	30-40	1,24	1,27	1,25	1,25	1,4	1,28	
Shallow cultivation corn	0-10	1,05	1,12	1,13	1,15	1,46	1,18	1,22
	10-20	1,16	1,01	1,15	1,17	1,47	1,19	
	20-30	1,15	1,15	1,14	1,16	1,52	1,22	
	30-40	1,19	1,25	1,26	1,28	1,55	1,30	

Our laboratory studies on the dynamics of soil size amount at different stages of vegetation and at different depths of the arable land (Table 2) show that in the case of a tillage of furrow turn the density of the soil is small compared to the minimum cultivation only immediately after planting. During other period of the year the 5-10 cm soil layer is 10-20% denser when fallowed than when cultivating the soil with the minimum cultivation. It should also be noted that the range of density change in the lower case is greater and ranges from 0,61 to 1,63 g/cm^3 while during the minimum cultivation the same rate was 1,01 - 1,55 g/cm^3. According to the average data of three years the highest density was observed in the 40 cm layer of soil, the precursor was autumn corn in the version of minimal cultivation with 1,22 g/cm^3 and the lowest was the previous winter corn in the traditional soil cultivation version with 1,18 g/cm^3.

Based on the above mentioned, we can conclude in comparison with the minimum cultivation the fallow leads to excessive soil fragility, which, however, at the time of tillage crops is equal with its density to the minimum density. In addition, when preparing the soil for winter wheat crop with a breast plow excessive porosity of the sowing layer may occur due to which the conditions for seed germination deteriorate depending on the rapid loss of moisture and weak contact of seed and soil [4].

The soil cultivator can accumulate, preserve and provide nutrients and precipitation and subsoil waters to the plants by proper cultivation of the soil. Minimal tillage of the soil, combined with the stubble and the remnants of the stubble along with its mulching, improves the water regime of the soil. This is due to the role of the snow accumulating role of stubble as well as the reduction of water evaporation from the soil surface due to the plant mulch.

Table 3

Dynamics of moisture change in plowland (%)
2015-2017 average data

Main method of soil cultivation and the precursor	Depth of precursor, cm	Observation stages					Average density due to the depths	Average in 0-40 cm
		Before tillage	Stooling, pipeline	Earing	Ripening	Before harvest		
Tillage clean fallow	0-10	18,35	21,17	16,22	4,53	14,75	15,00	20,23
	10-20	25,96	22,74	23,98	21,01	16,22	21,98	
	20-30	26,82	20,90	24,6	25,86	15,77	22,79	
	30-40	24,38	20,11	23,28	24,23	13,77	21,15	
Tillage corn	0-10	11,19	21,7	21,17	9,58	14,78	15,68	18,02
	10-20	22,95	22,90	22,74	14,85	13,43	19,37	
	20-30	21,38	20,80	20,90	15,92	15,2	18,84	
	30-40	20,16	20,15	20,17	15,41	15,15	18,2	
Shallow cultivation, clean fallow	0-10	18,03	21,18	21,26	13,62	12,98	17,41	20,41
	10-20	25,61	23,11	23,28	27,08	15,38	20,89	
	20-30	27,25	20,90	24,27	27,56	15,85	23,16	
	30-40	25,21	20,12	21,35	18,00	16,31	20,19	
Shallow cultivation, corn	0-10	17,45	20,48	20,62	8,34	15,12	16,4	19,15
	10-20	24,45	22,98	22,59	15,84	14,21	20,01	
	20-30	27,91	19,76	23,49	17,53	15,75	20,89	
	30-40	26,18	18,40	20,78	17,05	14,12	19,30	

Hence, minimal cultivation ensures the differentiation of plowland according to its fertility, the concentration of fertility elements in the soil of 0-15 cm layer, creation of favorable soil density, moisture accumulation, preservation and efficient use which has a significant impact on plant growth and development. The seeds sown in the biologically active layer germinate harmoniously, their field germination is high, the expiration dates of the initial stage of plant development are accelerated, the energy of the stooling is high, winter tillage is well matured in the initial winter period and withstands unfavorable winter conditions.

The highest yields in our surveys, on average for three years (Table 4), were obtained in the minimal cultivation-clean fallow version (42,5 c/ha) and the lowest in the non-fallow precursor traditional tillage version with 25,8 c/ha.

Table 4

Yield of autumn wheat and gluten content in a grain depending the main method of soil cultivation and precursor (2015-2017)

Main soil cultivation	Precursor	Yield, c/ha	Additives, c/ha		Gluten content, %	Additives, %	
			Precursor	Cultivation method		Precursor	Cultivation method
Tillage	Clean fallow	41,6	15,8/ 7,9	-	23,3	1,2	0,8
	Corn	25,8	-	-	22,1	-	1,1
Shallow cultivation	Clean fallow	42,5	14,3/7,1	0,9	22,5	1,5	-
	Corn	28,2	-	2,4	21,0	-	-
AET $_{05}$			1,7			0,5	

The increase in yield was calculated depending on the precursor and the method of tillage. As data in the table show, the increase in yield in the traditional cultivation-clean fallow version was 15,8 c/ha or 7,9 c/ha per year depending on the precursor, in clean fallow-minimal cultivation version 14,3 c/ha or 7,1 c/ha annually and depending on the method of soil cultivation, the yield increase was observed in clean fallow-minimal cultivation version. 0,9 c/ ha to clean fallow-traditional cultivation version and 2,4 c/ha in the non fallow-precursor-minimal cultivation version to non fallow-precursor-traditional cultivation version were obtained.

References

1. Գալստյան Ս.Բ., Ալեքսանյան Վ.Ա., Հողում արդյունավետ խոնավության կուտակումն ու աշնանացան ցորենի բերքատվությունը՝ կախված դրա մշակման եղանակից: Ագրոգիտություն, 2012, № 1-2, էջ 57:
2. Խաչատրյան Ա.Ռ. Ագրոնոմիական հետազոտությունների մեթոդներ Երևան 2002, 237 էջ:
3. Галстян С.Б., Эффективность поверхностной обработки почвы в посевах овощных культур. Известия Национального аграрного университета Армении, 2014, № 2, 8-10с.
4. Гилев С.Б., Цыбаленко И.Н., Курлов А.П., Русакова И.В. Технология прямого посева и микробиологическая активность чернозема выщелоченного / Земледелие, 2015, №3, 28-30с.
5. Курдюмов Н.И., Мастерство плодородия. 2007, 130с.
6. Моргун Ф.Т., Шикула Н.К., Почвозащитное бесплужное земледелие. М.: «Колос» 1984, 276с.

References

1. Galstyan S.B., Alexanyan V.A., Accumulation of efficient moisture in soil and winter wheat harvest depending on its cultivation method. Agriscience, 2012, № 1-2, p. 57
2. Khachaturyan A.R., Methods of agrichemical research, Yerevan, 2002, 237 p.
3. Galstyan C.B., The efficiency of shallow cultivation of soil in tillage of vegetables, Bulletin of Armenian National Agrarian University, 2014, № 2, 8-10p.
4. Gilev S. B., Tsibalenko I.N., Kurlov A.P., Rusakova I.V., Technology of direct tillage and microbiological activeness of dark chestnut soils/Soil science, 2015, №3, p. 28-30
5. Kurdyumov N.I., Art of fertility, 2007, p. 130
6. Morgun F.T., Shikula N.K., Soil preservation plougless cultivation, M., «Kolos», 1984, 276 p.

ՀՏԴ - 633.11:631.434

ՄՇԱԿՄԱՆ ԵՂԱՆԱԿՆԵՐԻ ԱԶԴԵՑՈՒԹՅՈՒՆԸ ՀՈՂԻ ԲԵՐՐԻՈՒԹՅԱՆ ՏԱՐՐԵՐԻ ԵՎ ԱՇՆԱՆԱՑԱՆ ՑՈՐԵՆԻ ԲԵՐՔԱՏՎՈՒԹՅԱՆ ՎՐԱ

Ս.Բ. Գալստյան, Վ.Ս. Ադամյան, Վ.Ա. Ալեքսանյան, Ա.Վ. Ավագիմյան
Շուշիի տեխնոլոգիական համալսարան

Արցախի հանրապետության ցածրադիր գոտու անջրդի երկրագործության պայմաններում համեմատվել են ավանդական առի շրջմամբ խորը վարի և նվազագույն մշակման ազդեցությունը հողի հումոսայնության, սննդային տարրերի, խոնավապահովածություն, ագրոֆիզիկական հատկունների և աշնանացան ցորենի բերքատվության վրա:

Պարզվել է, որ Ասկերանի շրջանի մուգ շագանակագույն խճաքարային հողերում՝ կախված հողի հիմնական մշակման եղանակից, հումոսային նյութերն ու հանքային սննդատարրերը տեղաբաշխվում են վարելաշերտի տարբեր խորություններում, հողի խոնավությունը վեգետացիայի ընթացքում տարբեր նախորդներից հետո բարձր է լինում նվազագույն մշակման դեպքում, որը նպաստում է վեգետացիայի ընթացքում հողի խտության փոփոխման միջակայքի նվազեցմանը, օպտիմալ խտության պահպանմանը և աշնանացան ցորենի բերքատվության ավելացմանը:

Բանալի բառեր. աշնանացան ցորեն, հողի խտություն, ջրապահովածություն, սննդատարրերի տեղաբաշխում, բերք:

УДК - 633.11:631.434

ВЛИЯНИЕ СПОСОБОВ ОБРАБОТКИ НА ЭЛЕМЕНТЫ ПЛОДОРОДИЯ ПОЧВЫ И НА ПРОДУКТИВНОСТЬ ОЗИМОЙ ПШЕНИЦЫ

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В условиях богарного земледелия в низменной зоне Республики Арцах было сравнено влияние традиционной - глубокой отвальной вспашки и минимальной обработки на гумусность, питательные элементы, влагообеспеченность, агрофизические свойство и урожайность озимой пшеницы.

Выяснилось, что в темно-коричневых, щебенно - каменных почвах Аскеранского района, в зависимости от типа основной обработки почвы, гумусовые вещества и минерально питательные элементы располагаются на разных глубинах пахотного слоя почвы. Во время вегетации при минимальной обработке влажность почвы оставалась высокой, что также способствовало снижению диапазона изменению плотности почвы во время вегетации и сохранению оптимальной плотности и увеличению урожайности озимой пшеницы.

Ключевые слова: озимая пшеница, плотность почвы, водообеспеченность, распределение питательных элементов, урожай.

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THE IMPACT OF THE CONTENT OF NUTRIENTS IN POTATO LEAVES ON THE GROWTH AND YIELD OF THE PLANT

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The method of determining the content of nutrients in plant leaves (chemical analysis of plants) is considered to be a method of determining the requirement for fertilization and providing nutrients.

The aim of the study was to find out the relation between NPK content, yield, supply of nutrients and efficiency of using fertilizers in the plant. These studies allow us to determine the content of NPK, the need of usage of fertilizers and their dasages through leaf analysis. The results of these studies are summarized in Tables 4 and 5.

Studies have been carried out on «Impala» sort which is a high-yield, edible and early grown sort. Nitrogen, phosphorus and potassium content in the leaves of the plant was determined by Kieldal method for nitrogen, phosphorus by colorimetric and potassium by the flame photometer method.

Key words: leaf, chemical analyses, nutrients, fetilizer, plant, potato.

Introduction

Determination of the dosage of fertilizers of crops is of major economic and environmental importance. Various methods have been developed to settle this important issue. The method of determining the content of nutrients available to plants in the soil is the most common [1, 2, 4, 6, 18].

An important method of determining the nutrient requirement and fertilization of plants is also the method of determination of nutrients content in the leaves of the plant (method of chemical analysis of plants). It is based on the fact that there is a definite link between the chemical composition of the plant such as nitrogen, phosphorus and potassium (other nutrients as well) and the supply of plant nutrients [3, 7, 8, 9]. It should be noted that the method of chemical analysis of plants is more widely used in European countries, the USA, Japan etc. [3, 7, 8, 17]. In many countries the «optimal» amounts of nutrients of certain crops are determined on the basis of this method. These are those amounts when the plants are considered to be well supplied with nutrients and do not need fertilization [11, 17, 22, 23].

The irreplacable role of each nutrient in plant growth and crop formation is known. In particular, the nitrogen supply of the plant determines the growth and the amount of crops. Phosphorus contributes to the growth of the root system reducing the amount of water consumed to obtain a single harvest. Potassium increases the efficiency of photosynthesis and cellular turgor and increases the viability of tubers. Calcium promotes root growth and wall thickening of plant cell which allows to withstand many diseases and pests. It is established that the plant gets 5,4-6,0 kg N, 2,0-2,4 kg P_2O_5, 9,1-10,5 kg K_2O, 3,5 - 3,6 kg Ca and 2,0-2,1 kg Mg for harvesting 1 tonne of tuber yield. The plant of potato is very sensitive to the deficiency of nitrogen: the haulms turn yellow, the crop declines and in the case of rise of nitrogen there is a strong growth of the haulms, plant growth is delayed and crop declines. The deficiency of potassium and phosphorus reduces the efficiency of photosynthesis, yield and quality of tubers [11, 13].

It is proved that the chemical composition of the leaves and roots of potato, including nitrogen, phosphorus and potassium content, largely depends on soil and climatic conditions, stage of plant growth and nutrient availability. Such relation allows to determine the supply of nutrients (NPK, etc.) of potato and the need for fertilization based on the determination of the chemical composition of the leaves.

It is proved that the active nutrient absorption of plants occurs during its rapid growth which coincides with the stages of leaf foliage, buttoning and flowering [16, 21, 28, 36]. During the further growth of the plant the absorbtion of nutrients out from the soil significantly decreases but the plant still uses organic agents and nutrients accumulated in the stems, leaves and roots (13, 18, 20). As a result during the natural death of haulms the main content of nutrients in the mentioned parts minimizes. The plant of potato uses 27-28% of nitrogen, 22-23% of phosphorus and 20-21% of potassium during the period of buttoning and during the period of flowering when the overground part of the plant is already formed, the plant uses 67% of nitrogen, 75% of phosphorus and 80% of potassium and during the active period of tuber formation these rates reach correspondingly to 91, 95 and 98% [13, 18]. These rates show that fertilization should be done in such periods when the plant is provided with necessary nutrients. While fertilizing the nutrition of early sorts of potato is done within uncomparably shorter time than that of late grown crops which should be taken into account [18, 20].

The fluctuations of potato nutrition were proved to have a greater effect on the content of nitrogen, phosphorus, potassium and other elements in the leaves. Consequently, this relation enables to determine the supply of NPK of the plant and to determine the need for nutrition and the amount of application of fertilizers based on the determination of these elements. Unstable nutrition not only affects plant growth and viability but also reflects the nutritional status of the plant which the plant growth, yield, tuber quality and resistance to disease and partly to pests depend on [5, 10, 12, 14, 19].

Conflict setting

Field studies and laboratory observations were done in 2011-2015 in Qrasni village of RA Askeran region by the following schemes:

Experiement № 1	Experiment № 2
1. Without fertilizing (tester)	1. Without fertilizing (tester)
2. $N_{90}P_{90}K_{90}$	2. $N_{90}P_{90}K_{90}$ (KCl)
3. Manure 30 t/ha	3. $N_{90}P_{90}K_{90}$ (RDT) 600 kg/ha
4. $N_{90}P_{90}K_{90}$ + manure 30t/ha	4. $N_{90}P_{90}K_{90}$ (RDT) 600 kg/ha + MM
5. $N_{90}P_{90}K_{90}$ + manure 30t/ha	5. $N_{90}P_{90}K_{90}$ (KCl) + bentonite 300 kg/ha
6. $N_{90}P_{90}K_{90}$ + manure 30t/ha	6. $N_{90}P_{90}K_{90}$ (KCl) + gypsum 300 kg/ha

As it is seen from the schemes of the experiments, during the first experiment manure and mineral fertilizers were applied separately and mixed and during the second experiment the impact of ameliorators and mineral fertilizers on the content of nitrogen, phosphorus and potassium dynamics in potato leaves and the yield of tuber was revealed. Relation was established between the content of NPK in the leaves and the supply and yield of the plant connected with these nutrients. Those «optimal» amounts of nitrogen, phosphorus and potassium in the leaves were stated on the basis of studies when the plant is privided by all these nutrients and there is no need for fertilization.

Experiments were held thrise, the dimension of one experimental row is $105m^2$ (3.5m x 30m = $105m^2$) and feeding surface of one plant is $0.21m^2$ (0,7m x 0,3m). All the observations, biometric measurements and crop amount accounting were done repeatedly.

Studies have been carried out on “Impala” sort which is a high-yield, edible and early grown sort. The tubers are oval shaped, the sarcocarp is partially yellowish and medium. The resistance of haulms is medium to phytophtora and the plant is resistant to eelworm.

“MM” biofertilizer was obtained by the Institute of Biochemistry of the National Academy of Sciences of the Republic of Armenia and it contains various useful microorganisms and also micro-elements. It is used for soaking the seeds, watering the soil and providing extra nourishment.

Recycled dacite tuff (RDT) is a complex fertilizer containing potassium, calcium, magnesium, phosphorus and amorphous silicon dioxide. It is obtained by thermochemical treatment of rich potassium (up to 9,5-15,1%) dacite tuff. The method of obtaining was developed by the Institute of

General and Inorganic Chemistry of NAS RA and ANAU. Fertilizer also has indirect positive properties which makes it more effective compared to KCl [21].

During vegetation the stages of the growth and development of the plant were determined: germination, buttoning, flowering and natural death of haulms by visual method and plant height by linear measurement method.

Nitrogen, phosphorus and potassium content in the leaves of plants were determined at the stages of germination, buttoning, flowering and natural death of the haulms: nitrogen by the Kieldall, phosphorus by the method of colorimetric and potassium by the flame photometer method.

Pieces of land were cut for soil characterization (N 1 and 2) and were described, then soil samples were taken from genetic horizons and their agrochemical and agrophysical properties were determined. Humus was determined by Turin method, pH was determined by pH-meter, water-solvent salts were determined by ultrameter, carbonates - by calcimeter and mechanical composition was determined by pipette method.

Nitrogen which is available to plants was determined by Thurin-Cononova solvent extract, phosphorus by Machigin and potassium by Machigin solution extracts [24].

Tuber crop was calculated according to the experimental rows, then data was recalculated by c/ha. The data of yield were subjected to mathematical processing. The most significant difference between variants (SM) and experimental error (Sx%) was calculated (34).

Research results

Field studies were done on forest brown soils [25] and the agrochemical rates of experimental soils were summarized in Table 1.

Table 1

Agrochemical characteristics of experimental soils

The site of taking soil sample and the experiment	Depth of taking soil sample, cm	Humus content, %	pH in water intake	Content of water solvent salts, %	Carbonates, $CaCO_3$, %	Physical clay, %	Available nutrients, mg, 100 g soil		
							N	P_2O_5	K_2O
Experiment N=1 Cutting N=1	0-19	4.29	7.1	0.116	3.60	58.9	4.5	3.80	55.1
	19-44	3.71	7.3	0.091	4.70	56.6	3.6	3.10	48.6
Experiment N=2 Cutting N=2	0-22	3.18	6.8	0.108	0.12	61.2	4.6	0.78	45.5
	22-49	2.06	6.9	0.081	1.21	60.4	2.8	0.49	39.5

The data of the table show that they are significantly different from each other. Humus content in the upper layer of the soil of the experimental site is 4,29%, reaction is neutral, the content of solvent salts is permitted within 0,116%, carbonates comprise 3,6%, mechanical composition is heavy clay, i.e. physical clay is 58,9%.

According to soil sample number 1 of ANAU branch of scientific centre of Soil Science, Agrichemistry and Amelioration after H. Petrosyan, it is considered to be weak in nitrogen, medium in phosphorus and strong in potassium.

The soil sample number 2 is poor in nutrients and humus available for plants. In the upper layer the content of humus comprises 3,18%, pH is 68, water solvent salts is 0,108, carbonates comprise 0,12% and physical clay is 61,2%.

It is poorly supplied by nitrogen and phosphorus and well supplied by potassium (Table 1).

Taking into consideration that numerous studies have linked the content of nitrogen, phosphorus and the content of potassium and in four stages of the growth of potato (germination, blossomig, flowering, natural death of haulms) the content of these nutrients was determined in the leaves which enabled us to define the optimal amount of these elements when the plant does not need any fertilization. The obtained results are summarized in Tables 2 and 3.

According to the data presented in these tables, the NPK content in the leaves gradually decreases during vegetation reaching to a minimum at the end of vegetation. However, the amount of reduction depends on the fertilization.

As in Experiment 1, nitrogen content in leaves of potatoes during blooming period was 4,75%, 4,47% at flowering stage, 3,61% at the end of flowering stage and 0,93% at the beginning of natural death of haulms (Table 2). Only in the fertilized versions ($N_{90}P_{90}K_{90}$) the nitrogen content was about as much as it was in the checker that is 4,67% and at the end of vegetation it is 0,95%.

Table 2

The impact of fertilizers on the content of nutrients in potato leaves (2012-2015 average), % Experiment №1

Versions		Germimnation			Buttonning			End of flowering			Beginning of natural death of haulms		
		N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O
1	Without fertilization	4,75	0,61	5,01	4,47	0,58	4,65	3,61	0,39	3,90	0,93	0,15	0,95
2	$N_{90}P_{90}K_{90}$	4,67	0,70	5,18	4,41	0,70	4,92	3,82	0,50	4,32	0,95	0,23	1,13
3	Manure 30t/ha	5,04	0,70	5,14	4,50	0,62	4,90	3,70	0,44	4,35	1,12	0,30	1,24
4	$N_{90}P_{90}K_{90}$ + manure 30t/ha	4,90	0,78	5,30	4,42	0,82	5,02	4,01	0,63	4,65	1,24	0,35	1,30
5	$N_{120}P_{90}K_{90}$ + manure 30t/ha	4,95	0,75	5,31	4,50	0,79	5,09	4,12	0,60	4,67	1,30	0,35	1,29
6	$N_{150}P_{90}K_{90}$ + manure 30t/hha	4,96	0,76	5,28	4,53	0,81	5,10	4,35	0,57	4,64	1,37	0,31	1,28

This is due to the fact that nitrogen feeding was performed later in the stage of blooming-flowering of the plant and as a result, the nitrogen content had increased at the end of flowering to a certain extent compared to the tester but further decreased again to the level of the tester. This fact indicates that 90 kg/ha of nitrogen in $N_{90}P_{90}K_{90}$ system did not meet the plant requirement for that element.

Only in the version which had received organic fertilizer (manure 30 t/ha), nitrogen content (germination) was 5,04% at the beginning of vegetation, 4,50% at the blooming stage and 3,70% and 1,12% at the end of flowering and at the beginning of natural death of haulms respectively. Nitrogen content in the leaves was maintained at higher levels and varied from 4,90 to 1,24% and from 4,95 to 1,30% respectively during the whole vegetation period in the system of (NPK) fertilizers and 30t/ha manure in the versions of N_{90} and N_{120} (versions 4 and 5). The sharp reduction of nitrogen content at the end of plant flowering and later on is due to the rapid growth of the plant that time which requires large amounts of nitrogen and other nutrients as it has been proven by other researchers [19]. Higher nitrogen content in leaves was preserved in the version where the maximum amount of nitrogen fertilizer was applied with manure (version 6).

In case of sufficient quantities of essential nutrients they have contributed to both increased crop yields and improved tuber quality.

Hence, by examining the effect of fertilizer application on the dynamics of nitrogen, phosphorus and potassium content in potato leaves, it was found out that their quantities decrease gradually along with the stages of growth and less amounts are preserved during the natural death of haulms which is conditioned by the biological peculiarities of potato.

Table 3

Impact of fertilizers and ameliorators on the dynamics of nutrient content in potato leaves (NPK) (2012-2015), % Experiment №2

Versions		Germination			Buttoning			End of flowering			Beginning of natural death of haulms		
		N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O
1	Without fertilizer (tester)	3,65	0,37	4,12	3,54	0,31	3,72	2,94	0,25	3,14	0,67	0,10	0,65
2	$N_{90}P_{90}K_{90}$ (KCl)	3,66	0,36	4,10	3,48	0,48	4,15	3,58	0,31	3,62	0,78	0,16	0,87
3	$N_{90}P_{90}K_{90}$ (RDT) 600 kg/ha	3,71	0,35	4,26	3,78	0,60	4,75	3,73	0,42	3,95	0,86	0,38	0,95
4	$N_{90}P_{90}K_{90}$ (RDT) 600 kg/ha + MM	3,63	0,38	4,29	3,68	0,69	4,73	3,71	0,50	4,04	1,06	0,38	1,08
5	$N_{90}P_{90}K_{90}$ (KCl) + bentonit 300 kg/ha	3,61	0,36	4,12	3,45	0,39	4,12	3,41	0,32	3,57	0,75	0,16	0,79
6	$N_{90}P_{90}K_{90}$ (KCl) + gypsum 300 kg/ha	3,68	0,35	4,15	3,60	0,39	4,33	3,35	0,30	3,63	0,80	0,26	0,89

At the end of vegetation most of the nutrients and organic substances accumulated from the upper mass flow into the tubers (storage organs) [26]. Despite this, the content of nutrients (NPK) in the leaves is conditioned by the supply of these elements in the leaves: the higher the plant is provided with these nutrients, the higher the content of the nutrient is and this allows the chemical analysis of the leaves to determine the degree of provision of the specified elements of potato and also the need for fertilization.

It should be noted that many countries with developed agriculture have defined “optimal amounts” of nitrogen, phosphorus, potassium and other nutrients in the leaves (varieties) according to the stages of plant growth and crop varieties when the plants are considered to be fully provided with nutrients and yield a good harvest typical of the certain sort.

According to the results of our research, at the end of the flowering stage of “Impala” sort of potato 4,01 - 4,12% of nitrogen, 0,44 - 0,63% of phosphorus and 4,32 - 4,64% potassium in the leaves can be considered as “optimal" quantities”.

Table 3 presents the results obtained in Experiment 2 which concern the impact of using mineral fertilizers, biofertilizer “MM” and ameliorators on the dynamics of nitrogen, phosphorus and potassium contents in potato leaves. The data show that as in Experiment 1, the nutrients are gradually decreasing during the vegetation process here starting from the buttoning stage the extent of which is entirely conditioned by fertilization (plant nutrition).

The nitrogen, phosphorus and potassium content is less in the tester the amount of which declines sharply during vegetation and at the end of flowering and the natural death of the haulms they reach the minimum amounts. While NPK content was relatively high in fertilized versions, their size still depends on fertilization. Thus, the application of $N_{90}P_{90}K_{90}$ (KCl) increased the nitrogen, phosphorus and potassium amounts in the leaves at all stages of plant growth and the use of bentonite or gypsum (versions 5,6) had no effect on the NPK content in this case, so we can conclude that it did not affect the nutritional process of the plant. Whereas when KCl was replaced by dacitic tuff (RDT) in NPK system and biofertilizer “MM” was applied in this case, the NPK content in leaves increased significantly compared with tester and $N_{90}P_{90}K_{90}$ (KCl) version. Especially in the case of increased nitrogen this phenomenon is conditioned by the fact that RDT prevents nitrogen loss from the soil and fertilizers which the plants use. The use of “MM” biofertilizer contributes to the accumulation of biological nitrogen in soil as it also contains nitrogen fixing bacteria among other bacteria [20]. This fertilizer also mitigates the development of diseases. The increase of phosphorus is conditioned by certain amount of phosphorus in RDT and with increasing hard solubility of phosphorus compounds in the soil [21]. The increase of potassium in leaves influenced by RDT is again conditioned by the positive effect of fertilizer contributing to the increase of absorption of potassium by the plant which has been stated by other researchers [12, 14].

As it was mentioned, the purpose of the study was to determine the relation between NPK content in potato leaves, crop yield, nutrient availability and efficiency of fertilizer application. These

studies allow to determine NPK content in the plant, the need and application of fertilizers through leaf analysis. The results of these studies are summarized in Tables 4 and 5.

The data from these tables show that applying fertilizers has a significant effect on both the potato yield and NPK content of the leaves. But their size depends on the fertilizing system. Hence, according to the data of Experiment 1 (Table 4), the tuber harvest in the tester (average of 3 years) was 145 c/ha and in fertilized versions it was 172-218 c/ha. The highest yield (203-218 c/ha) was obtained in the places where manure was applied with mineral fertilizers (variants $N_{120}P_{90}K_{90}N$ + manure 30 t/ha, + manure 30 t/ha and $N_{120}P_{90}K_{90}N$ + manure 30 t/ha). In these versions the NPK content in leaves is also significantly higher, nitrogen – 4,01 - 4,35%, phosphorus is 0,57 – 0,63% and potassium is 4,64 -4,67%. However, the yield of tubers in tester was 145 c/ha, nitrogen in leaves – 3,61%, phosphorus – 0,39% and potassium – 3,90%.

Table 4

The impact of fertilizers on NPK content and yield of tubers in potato leaves (experiment №1)

№	Versions	Tuber yield for years, c/ha			Average yield of tuber, c/ha	Content in leaves, %		
		2012	2013	2014		N	P_2O_5	K_2O
1	Without fertilizer (tester)	148	127	160	145	3,61	0,39	3,90
2	$N_{90}P_{90}K_{90}$	174	147	195	172	3,82	0,50	4,32
3	Manure 30t/ha	193	164	216	191	3,70	0,44	4,35
4	$N_{90}P_{90}K_{90}$ + manure 30t/ha	206	175	228	203	4,01	0,63	4,65
5	$N_{90}P_{90}K_{90}$ + manure 30t/ha	223	193	238	218	4,12	0,60	4,67
6	$N_{90}P_{90}K_{90}$ + manure 30t/ha	209	176	230	205	4,35	0,57	4,64

DSM 05 = 7,5 c/ha Sx% = 1,3%

Similar regularity between the yield, efficiency of fertilzing and NPK content in leaves is regarded also in Experiment 2 (Table 5). Therefore, more harvest and more efficicnecy of fertilizers was obtained in those versions where the nitrogen content comprised 3,71 – 3,73%, phosphorus was 0,4 2- 0,50 and potassium was 3,95 – 4,04%, whereas the crop in tester was 157c/ha, nitrogen in leaves comprised 2,94%, phosphorus 0,25% and potassium 3,14%.

Table 5

The impact of fertilizers and ameliorators on the yield of tuber and NPK content in potato leaves (experiment №2)

№	Versions	Tuber crop for years, c/ha			Average crop of tuber, c/ha	Content in leaves, %		
		2012	2013	2014		N	P_2O_5	K_2O
1	Without fertilization (tester)	195	140	136	157	2,94	0,25	3,14
2	$N_{90}P_{90}K_{90}$ (KCl)	201	174	195	190	3,58	0.31	3.62
3	$N_{90}P_{90}K_{90}$ (RDT) 600 kg/ha	231	193	230	218	3,73	0,42	3,95
4	$N_{90}P_{90}K_{90}$ (RDT) 600 kg/ha + MM	252	217	254	241	3,71	0,50	4,04
5	$N_{90}P_{90}K_{90}$ (KCl) + bentonite 300կq/hա	220	180	221	207	3,41	0.32	3,57
6	$N_{90}P_{90}K_{90}$ (KCl) + gypsum 300 kg/ha	204	160	194	186	3,35	0,30	3,63

DSM = 22,3 c/ha Sx% = 3,6%

Conclusion

Field studies and laboratory experiments show that during the observations in 2011-2015 in forest dark brown crop fields of Askeran region of the Republic of Artsakh these soils differ greatly in terms of agrochemical and agrophysical properties and also in terms of fertility.

1. The plants are weakly provided with available nitrogen, medium or weak by phosphorus and medium or good by potassium. Hence the use of fertilizers is an important agri-technical activity.

2. By creating favorable conditions for potato nourishing through efficient system of fertilization the absolute and relative amounts of nitrogen, phosphorus and potassium in potato leaves fluctuate within certain limit of dimension. It enables to determine the “optimal” amounts of NPK supply of the plant.
3. According to the results of the experiments in the end of flowering stage of Impala sort the “optimal” amount of nitrogen in the leaves comprises 3,71 – 4,01%, phosphorus is 0,32 – 0,62% and potassium is 3,57 – 4,64%.
4. More crop was obtained in experimental site number 1 as 203-2018 c/ha where the amount of nitrogen comprises 4,01 - 4,35% in the leaves of potato under the influence of fertilizers, phosphorus comprised 0,57 – 0,63% and potassium was 4, 64 – 4,67% respectively. In the second experiment we have obtained more crop as 218 – 241 c/ha as a result of those versions of fertilization where the amount of nitrogen in leaves comprised 3,71 – 3,73%, phosphorus was 0,42 – 0,50% and potassium 3,95 – 4,04% respectively.

References

1. Ավագյան Հ.Հ. – Հանձնարարականներ պարարտանյութերի կիրառման վերաբերյալ, Երևան, Հայաստան հրատ., 1987, 155 էջ
2. Агрохимические методы исследования почв.подрод. А.В. Соколова М., Наука 1875, 656с.
3. Боулд К. Использование анализа листьев для определения потребности яблони и некоторых овощных культур в удобрениях Вкн. "Анализ растений и проблемы удобрения перев.с. англ. Т.Л. Чебоновой М. 1964, с. 25-39
4. Державин И.П., Кулюкин А.Н. Агрохимические основа системи удобрения овощных и плодовых культур, М. Агропромиздат, 1988, 270с.
5. Кружилин А.С., Шведская З.М. Устойчивость растений к болезням. В.кн. физиология сельскохозяйственный растений. М. Изд-во "Московского университета" 1970, Том 8, с. 142-147
6. Пискунов А.С. Методы агрохимических исследований М. "Колос" 2004, 312 с.
7. Прево П., Олланье М. Применение листовой диагностики.Физиология растений, 1956 т.3, вып. 6, с.36-42
8. Хаулелетт ф. Изменчивость состава листьев некоторых овощных культур, В.кн. Анализ растений и проблемы удобрения. Перевод с англ. Т.Л. Чебоновой. М. 1964, с. 317-346
9. Церлинг В.В. Об управлении минеральным питанием растений. Земледение 1987 №4, с. 27-30
10. Лимантова Е.М., Лапа В.В. Роль удобрений в форуровании урожая картофеля и его качества. Почвеведение и агрохимия. Сборник научных трудов. Выт. 25, Минск,урожай, 1989, с. 100-104
11. Магницкий К.П. Контроль питания полевых и овощных культур. М. из-ва. Московский рабочий" 1972, 271с.
12. Матыченков В.В., Богарникова Е.А., Аммосова Я.М., Влияние кремновых удобрений на растение и почву, Агрохимия 2001, №12, с. 30-37
13. Минеев В.Г. Агрогимия, М. Колос, 2004, 719с.
14. Самсонова Н.Е., Кремний в почве и растениях, Агрохимия 2005, №6, с. 76-86
15. Саргсян А., Саргсян О., Мадоян Р., Геворкян Р., Биоудобрение ММ на основе микроорганизмов и минеральных композитов, Образование и наука Арцаха, 2013, №=1-2, с. 101-104
16. Справочник картофелавода под ред А.И. Замотаева, М. "Агропромиздат" 1987, 352с.
17. Васильев А.А. Листовая подкоршка картофеля эффективна. Картофель и овощи №9, 213с. 24

18. Власенко Н.Е. удобрение картофеля М, "Агропромиздат" 1987, 224с.
19. Крамининник Н.В. Рекомендации по технилогии возделивания картофеля от "АПХ" групп "Рус".Картофель и овощи №2, 2010, с. 20-23
20. Магницкий К.П. Контроль питания полевый и овощных культур. М., "Моковский рабочий", 1964, 304с.
21. Խաչատրյան Վ.Ս., Երիցյան Ս.Կ., Բարթիկյան Պ.Մ., Կալիումով հարուստ վերամշակված դացիտային տուֆի ազդեցությունը մշակաբույսերի բերքատվության վրա ՀՀ տարբեր հողակլիմայական պայմաններում, Ագրոգիտություն, Երևան, 1996, №9-10, էջ 601-607
22. Хорошкин А.Б. Листовые подкоршки картофеля (краткый обзор). Картофель и овощи, 2015, №11, с. 25-26
23. Церлинг В.В. Диагностика питания сельскохозяйственных культур. Справочник, М., Агропромиздат", 1990, 235с.
24. Ягодин Б.А. Практикум по агрохимии. М., "Агропромиздат" 1987, 512с.
25. Լեռնային Ղարաբաղի Հանրապետության ԱՏԼԱՍ Երևան, Գեոդեզիայի և քարտեզագրության կենտրոն, 2009, 95 էջ
26. Вавилов П.П., Гриценко В.В.м Кузнецов В.С. асиениеводство, Издание: 5-е, перераб. И доп. , Москва, 1986, «Агропомиздат» 512 с.

References

1. Avagyan H.H., Tasks on how to use fertilizers, Yerevan, Armenia publishing house, 1987, 155 p.
2. Agrichemical methods of soil study, ed. By A. V. Sokolov, M., Nauka, 1875, 656 p.
3. Boald K., Application of study of leaves for determination the needs of apple tree and several vegetables for fertilizers, “Analyses of plants and problems of fertilization, translated from English by T.L. Chebonova, M., 1964, p. 25-39
4. Derjavin I.P., Kulyukin A.N., Agrichemical basis of the fertilization system of vegetables and fruits, M., Agripromizdat, 1988, 270 p.
5. Krujilin A.S., Shvedskaya Z.M., Resistance of plants to diseases, Physiology of agricultural plants, M., publishing house “Moscow University”, 1970, vol. 8, p. 142-147
6. Piskunov A.S., Methods of agrichemical research, M., “Kolos”, 2004, 312 p.
7. Prevo P., Allagne M., Application of leaf diagnosis. Physiology of plants, 1956, vol.3, ed. 6, p. 36-42
8. Houlelett F., Diversity of leaf composition of some vegetables, Analysis of plants and problems of fertilization, trans. into English by T. L. Chebanova, M., 1964, p. 317-346
9. Tserling V.V., Management of mineral nutrition of plants. Soil cultivation, 1987, №4, p. 27-30
10. Limantova E.M., Lapa V.V., The role of fertilization and potato crop fluioridation and its quality, Soil study and agri-chemistry. Bulletin of scientific papers, ed. 25, Minsk, Harvest, 1989, p. 100-104
11. Magnitskiy K.P., Control of nutrition of field and vegetable crops, M., publishing house “Moscow worker”, 1972, 271 p.
12. Matichenkov V.V., Bogarnikova E.A., Ammasova Ya.M., Influence of silicon fertilizers on the plants and soil, Agri-chemistry, 2001, №12, p. 30-37
13. Minaev V.G., Agri-chemistry, M., Kolos, 2004, 719 p.
14. Samsonova N. E., Silicon in soil and plants, Agri-chemistry, 2005, №6, p. 76-86
15. Sargsyan A., Sargsyan O., Madoyan R., Gevorgyan R., Bio fertilization MM on the basis of microorganisms amd mineral composites, Education and science in Artsakh, 2013, №=1-2, p. 101-104
16. Bulletin of potato cultivator, edited by A. I. Zamoteva, M., “Agropromizdat”, 1987, 352 p.

17. Vasileva A.A., Leaf dressing of potato, Potato and veggies №9, 213, p. 24
18. Vlasenko N.E., Fertilization of potato, M., “Agropromizdat”, 1987, 224 p.
19. Kremennik N.V., Recommendations on technologies of potato cultivation, «АПХ» group «Rus», Potato and veggies №2, 2010, p. 20-23
20. Magnitskiy K.P., Control of nutrition of field and vegetable crops, M., publishing house “Moscow worker”, 1964, 304 p.
21. Khachatryan V.S., Yeritsyan S.K., Bartikyan P.M., The impact of reprocessed dacite tuff rich in potassium on the yield of crops in different soil and climatic conditions of RA, Agri-science,Yerevan, 1996, №9-10, p. 601-607
22. Khoroshkin A.B., Leaf dressing of potato (short glimpse), Potato and veggies, 2015, №11, p. 25-26
23. Tserling V.V., Diagnosis of nutrition of agricultural crops, Guidebook, M., “Agropromizdat”, 1990, 235 p.
24. Yagodin B.A., Practice on agri-chemistry, “Agropromizdat”, 1987, 512 p.
25. ATLAS of the Republic of Nagorno Karabakh, Yerevan, Centre of Geodesy and mapping, 2009, 95 p.
26. Vavilov P.P., Gritsenko V.V., Kuznetsov V.S., Plant growing, Ed. 5, suppl. M., “Agropromizdat”, 1986, 512 p.

ՀՏԴ - 631.81.033

ԿԱՐՏՈՖԻԼԻ ՏԵՐԵՎՆԵՐՈՒՄ ՍՆՆԴԱՏԱՐՐԵՐԻ ՊԱՐՈՒՆԱԿՈՒԹՅԱՆ ԱԶԴԵՑՈՒԹՅՈՒՆԸ ԲՈՒՅՍԻ ԱՃԻ ՈՒ ԲԵՐՔԱՏՎՈՒԹՅԱՆ ՎՐԱ

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Բույսի տերևներում սննդատարրերի պարունակության որոշման մեթոդը (բույսի քիմիական անալիզ) հանդիսանում է, որպես պարարտացման պահանջի որոշման և սննդատարրերով ապահովված մեթոդ:

Հետազոտության նպատակն է եղել պարզել կարտոֆիլի տերևներում NPK-ի պարունակության, բերքատվության, բույսի այդ սննդատարրերով ապահովվածության և պարարտանյութերի կիրառման արդյունավետության միջև եղած կապը: Այդ ուսումնասիրությունները հնարավորություն են տալիս տերևների անալիզի միջոցով որոշել բույսի NPK-ով ապահովվածությունը, պարարտանյութերի կիրառման անհրաժեշտությունը և չափաքանակները: Այս կապակցությամբ կատարված ուսումնասիրությունների արդյունքներն ամփոփված են թիվ 4 և 5 աղյուսակներում:

Ուսումնասիրությունները կատարվել են «Իմպալա» սորտի վրա, որը գերվաղահաս, սեղանի, բարձր բերքատու սորտ է: Բույսի տերևներում ազոտի, ֆոսֆորի և կալիումի պարունակությունը որոշվել է ազոտը՝ Կյելդալի, ֆոսֆորը՝ գունաչափական, կալիումը՝ բոցային ֆոտոմետրի մեթոդով:

Բանալի բառեր. տերև, քիմիական անալիզ, սննդատարրեր, պարարտանյութ, բույս, կարտոֆիլ:

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ВЛИЯНИЕ СОДЕРЖАНИЯ ПИТАТЕЛЬНЫХ ВЕЩЕСТВ В ЛИСТЬЯХ КАРТОФЕЛЯ НА РОСТ И УРОЖАЙНОСТЬ РАСТЕНИЯ

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Метод определения содержания питательных веществ в листьх растения (химический анали), является метод определения необходимости удобрения и обеспеченности питательными веществами.

Цель исследования – выяснить содержание NPK в листьях картофеля, урожайность, обеспеченность этими элементами растения и связь между применением удобрений и эффективностью. Исследования дают возможность с помощью анализа листьев определить обеспеченность растения NPK, необходимость применеия удобрений и определения их количества. Результаты проведенных исследований обобщены в таблицах 4 и 5.

Исследования проведены на ранеспелом, высокоурожайном сорте картофеля Импала. В листьях растения содержание азота, фосфора и калия определили: азот-методом Кейдаля, фосфор-колориметрическим методом, калий-методом пламенного фотометра.

Ключевые слова: лист, химический анализ, питательное вещесво, растение, картофель.

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Գրախոսման է ուղարկվել՝ 07.02.2020թ.
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MOIST ABSORPTION PROPERTIES OF FRUIT AND VEGETABLE CHIPS, THE CONDITIONS OF THEIR PRESERVATION AND RATES OF SENSITIVITY

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The moist absorption property of apricots, the preservation conditions of apples and rates of sensitivity of apricots and apples have been studied during the experiments. As a result of the research it became clear that the study enables to determine the duration of the further technological processes which is extremely vital for the organization of the processes of chips production. The description of the durations of those processes allows to state that the packaging of the chips during 2-3 hours after their thermal treatment, final production after their flavoring with food additives is of great importance.

Nowadays the packaging materials are very various in food production, for example, the varnished polypropylene napkins which enable to keep the packaged food from 1-2 weeks to 12 months.

Key words: fruit and vegetable chips, fruit and vegetable chips packaging, preservation, relative moisture, physical-chemical properties.

Introduction

In the process of producing fruit and vegetable chips, the vegetable and fruit raw material undergoes various stages of thermal treatment causing its physico-chemical properties to change. They cause changes in the moisture-absorbing properties of the raw materials and especially in the properties of moist absorption from the environment. Their storage and packaging technologies are conditioned by the latter and to reveal the regulations of these technologies experiments were done.

Conflict setting

The moisture-absorbing properties, storage conditions and sensitivity properties of fruit and vegetable chips have not been fully studied. In particular, data on the drying of these raw materials are missing which require special investigations. The aim was to study the moisture absorption properties of Shalakh and Satin apricot chips and apple chips and to clarify their storage conditions and rates of sensitivity.

Research results

The results of half finished apricot chips are shown in Table 1.

Table 1

Change of moisture during the preservation of apricot half finished chips depending on the environment

Preservation period, day	Relative moisture of environment, φ %								
	10	20	30	40	50	60	70	80	90
1	4,2	6,7	6,8	6,9	7,1	7,2	8,9	10,1	12,
2	4,6	8,0	8,1	8,3	8,5	8,7	10,9	13,7	15,3
4	4,6	8,3	9,2	9,4	9,8	10,2	11,5	14,5	17,1
6	4,6	8,3	9,4	10,1	10,5	10,7	12,0	15,3	18,6
8	4,6	8,3	9,4	10,1	10,9	11,2	12,5	15,8	19,9
10	4,6	8,3	9,4	10,1	10,9	11,5	13,1	16,4	20,6
12	4,6	8,3	9,4	10,1	10,9	11,8	13,5	17,0	21,2
14	4,6	8,3	9,4	10,1	10,9	11,8	13,5	17,3	21,7
16	4,6	8,3	9,4	10,1	10,9	11,8	13,5	17,3	22,1

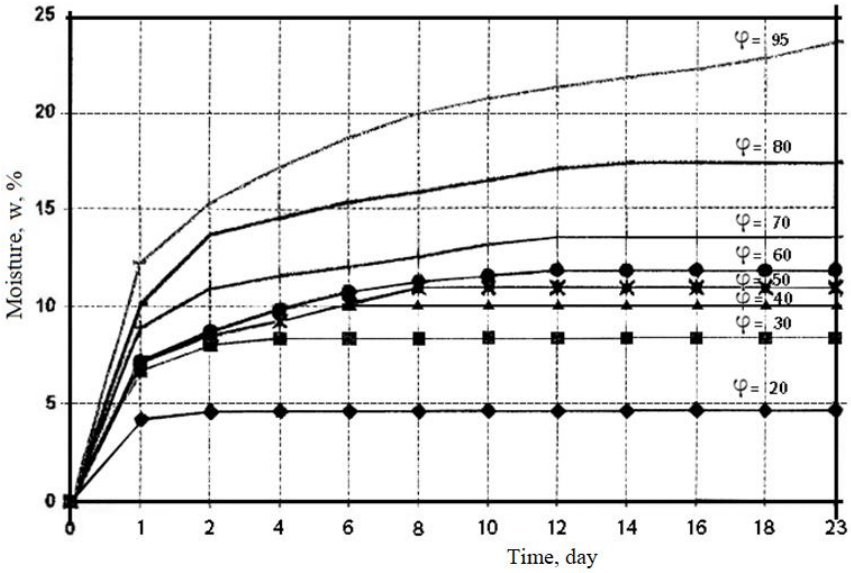

Fig. 1 Change of moisture of half finished product depending on the moisture φ – of environment

The graphs in Figure 1 show that parallel to the increase of surrounding air humidity the moisture content of the half-finished product increases, resulting in intensified biochemical processes in the sample, which, at some point, also result in spoilage of the raw material and in the case of φ = 80% also in mucorales.

Half–finished chips products which consist of proteins and carbohydrates whose atomic groups act as active centers and in co-operation with water molecules, absorb moisture into the inner layers of the material.

To determine the type of dry materials and fluid relationship in the apricot sample, the isotherm of moistening the test sample was made according to the results of Table 1 (Fig. 2).

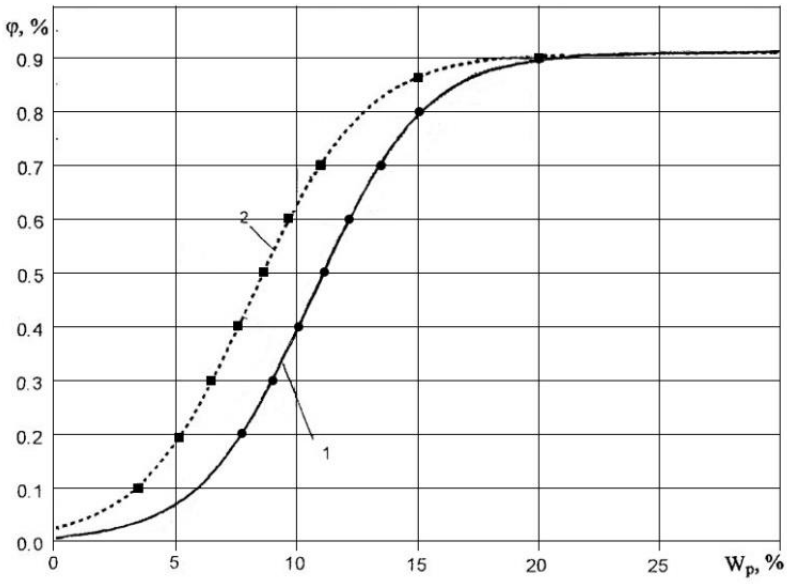

Fig. 2 Moistening isotherm of apricot half-finished chips

The moistening isotherm of half-finished product shown in Figure 2 coinsides with the regularities adopted in the thoery by appearance [1,5] which prove that the material of our experiment (half-finished product of apricot) is typical colloid, porous body. It also shows that molecules of the material are connected with the molecules of the water passing through thermal processing. The

obtained results also show that in the conditions of φ=60-70% of the store the moist content of the sample fluctuates between 13,5 % - 9,8 % which is necessary to take into account while developing the normative – technical documents of the production of half-finished chips.

Experiments have shown that the thermal treatment of the half finished chips which is done for the final product results in a substantial increase in the specific surface area of the sample as the sample is dehydrated. The high temperatures used during the thermal treatment of sample lead to a distort of its balanced moisture content which results in moisture on the surface of the sample occurred from the environment.

The long lasting contact of the chips with the surrounding air is accompanied by the loss of chip crunching and the stickiness of the surface as well, in other words, by altering the organoleptic properties of the chips [3]. Therefore great attention should be paid to the moisture content of the chips before packaging.

Experimental studies were carried out at t = 20°C air temperature and φ = 60% air humidity with dynamic study of chip weight changes at different time intervals to get the answer.The results of these experiments of two varieties of apricot chips are presented in Table 2. The analysis of the data in Table 2 shows that apricot chips actively absorb air moisture by increasing their weight. Thus, Satin apricot chips absorb such amount of humidity in the room with 60% humidity during four hours that the increase of moisture content is 5.4% and Shalakh apricot chips moisture in the same conditions comprises 12.5%. For comparison it turns out that if the rates of the same comparisons for Satin chips are 11.8%, then for Shalakh chips they are 9.5%.

Table 2

The picture of absorbing water vapors from the air of Shalakh and Saten apricot chips having thermal treatment in the conditions of t=20°C temperature and φ=60 % relative humidity

Sample	Rate	Duration of sample staying in the open air and time				
Saten apricot chips	-	0,5	1,0	5	10	24
	Weight, g	3,5	3,7	3,9	3,93	3,97
	Increase of weight, g	-	0,2	0,4	0,43	0,47
	Increase of weight mass, %	-	5,4	10,3	10,9	11,8
Shalakh apricot chips	Weight, g	4,2	4,8	5,1	5,25	5,8
	Increase of weight, g	-	0,6	0,3	0,15	0,55
	Increase of weight mass, %	-	12,5	5,9	2,86	9,5

The chips in these very conditions, as the results of experimental research show, started to soften during five hours.

In the end of computer processing of the results of experiments it turned out that the relation of time and humidity may be expressed by simple mathematical model as

$$W = \frac{a + b\tau}{c + \tau} \quad (1)$$

where W- is the moisture of the chips, %; τ - is the time, a, b and c – are the coefficients of correlations of the function equal to 0,995 a=3,67; b=3,9; c=9,28.

The results of the experiments are shown in Figures 3 and 4 the first of which is the graph of moisture absorption and the second is the speed of absorption.

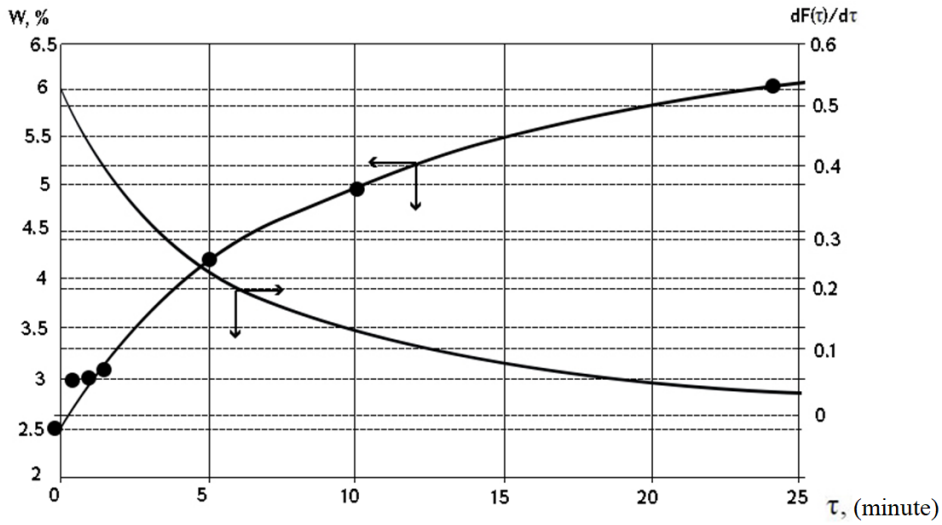

Fig. 3 The graph of moisture absorption of Saten apricot chips

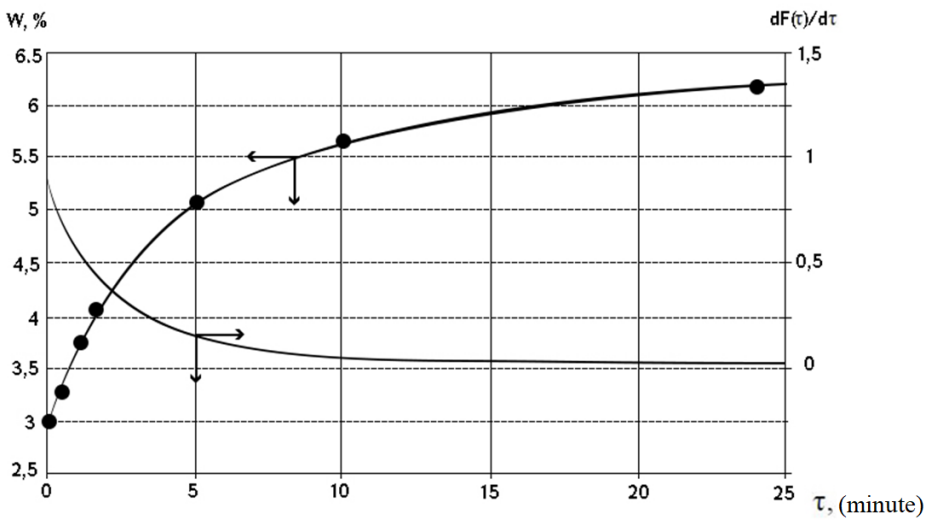

Fig. 4 The graph of moisture absorption of Shalakh apricot chips

The analysis of graphs 3 and 4 shows that the research allows to determine the duration of subsequent technological processes which is very important for the organization of the processes of chips production. The characteristics of the duration of these processes allows to state that it is very important to pack them within 2-3 hours after thermal treatment, formation as well as enrichment with food additives of the chips.

For the development of the technology of preservation and packaging of fruit and vegetable chips we have considered it appropriate to observe the technological details of preserving and packaging apple chips since chips made from this fruit have similarities to other fruits and can be common for them too.

For example, the solar drying process of apples usually lasts 2-3 days if the epicarp of the fruit is removed. During this drying it is necessary to turn the apple pieces being dried from time to time (once in 1-2 hours). Experiments have shown that if apple round pieces are dried for 3 to 6 days with removed epicarp, the rings with non-removed epicarp dry for 8-12 days.

In the drying process, the evaporation of liquid from the apple rings is accompanied by an increase in the concentration of sugar in them which makes them sweeter and tasty which in turn impedes the drying process and takes longer time for the raw material to dry.

Due to high levels of amino acids and high concentration of sugar in the apple in order to make the drying process quick the application of high temperatures leads to caramelization and occurring of melanid as a result of which the taste properties of the raw materials are significantly deteriorated, the

color is darkened, the organoleptic properties of the food are also worsened which should be taken into account when choosing drying modes of apple slices. For this purpose it should be remembered that the results of numerous studies to avoid caramelization and melanids in chips during apple drying the preference should be given to sour and sour sweet apple sorts which are late autumn and early winter sorts. To orient in this easily, let us be introduced to the chemical composition of fresh and dried apple chips [2, 4, 6].

Table 3

Chemical indicators of fresh apple, dried and chips «slices»

Indicators	Drying unit /100 grams/	Fresh apple	Dried apple	Apple chips
Solvent dry substance	g	15,5	80,0	97,0
Proteins	g	0,26	2,2	2,6
Lipids	g	0,17	0,1	1,14
Carbohydrates	g	13,81	59,0	92,38
Vitamin C	mkg	4,60	2,0	1,66
Ca	mg	6,0	31,0	37,6
P	mg	11,0	56,8	68,87
K	mg	107,0	552,26	669,6
Na	mg	1,0	12,0	14,55
Mg	mg	5,0	30,0	33,45
Fe	mg	3,3	6,0	22,08

The data of Table 3 show that apple chips and generally chips of drupes from the point of view of their nutritional values and chemical composition are preferred to other fresh and dry fruits mainly due to their high content of dry substances. The content of vitamin C in apple chips is comparatively low the main reason of which is high temperature during primary dehydration of apples.

To determine the rates of sensitivity of fruit and vegetable chips we found it comfortable to observe apple and apricot chips. For this purpose apple and apricot chips were prepared by two different technologies. The results are shown in Tables 4 and 5.

Table 4

Relative rating assessment of sensitivity of dried apricot

Indicators	Rates of sensitivity of dry apricot	
	Convective drying	Convective microwave drying (chips)
Appearance and structure	The slices are complete, strong, with surface main frame, slightly slicy in the cutting	The slices are complete, dry, slightly crispy, thin, surface frame, slightly porous in the cutting
Color	Dark yellow, heterogeneous, unsaturated, yellow reddish shades	Light yellow, homogeneous typical to fresh apricot, bright saturated
Taste and smell	Typical taste and smell to dried apricot	Typical taste and smell to fresh apricot

Table 5

Relative rating assessment of sensitivity of dried apple

Indicators	Rates of sensitivity of dry apricot	
	Convective drying	Convective microwave drying (chips)
Appearance and structure	The slices are complete, strong, with surface main frame, slightly slicy in the cutting	The slices are complete, dry, slightly crispy, thin, surface frame, slightly porous in the cutting
Color	Dark milky, heterogeneous, unsaturated, dark brown shade	Dark milky, homogeneous typical to fresh apple, bright saturated
Taste and smell	Typical taste and smell to dried apple	Typical taste and smell to fresh apricot

Conclusion

So, as a result of analysis of rates corresponding to high quality product, we can conclude that the best method for drying chip half finished products is the convective-microwave drying method.

Fruit and vegetable chips are a type of food whose moisture is lower than the balanced humidity of the surrounding air. For this reason, this variety of food should first of all be protected from moisture which can lead to its rapid spoilage. The fluctuations in moisture content in packaged chips are almost unacceptable and their packaging must be so perfect to exclude such event. At the same time, the loss of odorants from the chips should also be excluded which is almost always accompanied by occurring other odors and flavors in the package. The desired result can be achieved by making the package multilayer (2-3 layers), one or two of which will become opaque and the chips will also be protected from the harmful effects of light.

Currently packaging materials are extremely diverse in the food industry. For example, the varnished polypropylene napkins which enable to keep the packaged food from 1-2 weeks to 12 months.

References

1. Гинзбург А.С. Основы теории и техники сушки пищевых продуктов. - М.: Пищевая промышленность, 1973. - 528 с.
2. Гореньков, Э.С. Технология консервирования растительного сырья [Текст] / Э. С. Гореньков, А. Н. Горенькова, О. И. Кутина, Т. В. Шленская – СПб.: ГИОРД, 2014. – 320с.qqqДжаийлс, Н. Рост производства снэков и новый образ питания видоизменяют процесс упаковки// Тара и упаковка - № 1 – 2004
3. Королёв, А.А. Испытания линии комбинированной сушки яблок. / Материалы международной практической конференции «Плодоовощные консервы - технология, оборудование, качество, безопасность» - М.: 2009 С. 146 -152
4. Лыков А.В. Теория сушки. – М.: Энергия.- 1968. – 470с
5. Патент РФ 2268617, МГЖ А23 L 1/212, А23 В 7/02 Способ производства пищевого продукта из яблок / Гуревич А.В., Королев А.А., Пенто В.Б., Явчуновский В.Я.-№ 2005102852/13, заявлен 07.02.2005; опубл. 27.01.2006 Бюл. №4. - 8с.

References

1. Ginsburgh A. S., Basics of theory and techniques of drying food, M., Food industry, 1973, 528 p.
2. Gorenkov E.S., Technology of canning vegetable raw material / E. S. Gorenkov, A. N. Gorenkova, O. I. Kutina, T. V. Shlenskaya, GIORD, 2014, 320 p., Jailiss N., Rise of production of snacks and new way of feeding change process of packaging, /Containers and packages, № 1 – 2004
3. Korolyov A. A., Experience of drying apples / Materials of international practical conference «Fruit and vegetable cans- technologies, equipment, quality, safety» , M., 2009, p. 146 -152.
4. Lkov A. V., Theory of drying, M., Energy, 1968, 470 p.
5. Patent of RF 2268617, МГЖ А23 L 1/212, А23 В 7/02 Method of producing food products from apples / Gurevich A. V., Korolyov A. A., Pento v. B., Yavchunovskiy V. Ya., № 2005102852/13, submitted 07.02.2005; published 27.01.2006, bulletin №4, 8 p.

ՀՏԴ - 612.392.72:635.075:641

ՊՏՈՒՂԲԱՆՋԱՐԵՂԵՆԱՅԻՆ ՉԻՊՍԵՐԻ ԽՈՆԱՎԱԿԼԱՆԻՉ ՀԱՏԿՈՒԹՅՈՒՆՆԵՐԸ, ՊԱՀՊԱՆՈՒԹՅԱՆ ՊԱՅՄԱՆՆԵՐԸ ԵՎ ԶԳԱՅԱԲԱՆԱԿԱՆ ՑՈՒՑԱՆԻՇՆԵՐԸ

Վ.Ա. Կարապետյան
Հայաստանի ազգային ագրարային համալսարան

Փորձերի ընթացքում ուսումնասիրվել է ծիրանի պտուղների խոնավակլանիչ հատկությունները, խնձորի պտուղների պահպանման պայմանները, ինչպես նաև ծիրանի և խնձորի պտուղների զգայաբանական ցուցանիշները:

Ուսումնասիրությունից հետո պարզ է դարձել, որ կատարված հետազոտությունը թույլ է տալիս որոշել հաջորդող տեխնոլոգիական գործընթացների տևողությունը, ինչը խիստ կարևոր է չիպսերի արտադրական պրոցեսների կազմակերպման համար: Այդ գործընթացների տևողությունների բնութագիրը թույլ է տալիս պնդել, որ ջերմային մշակումից ու չիպսերի ձևավորումից, ինչպես նաև նրանց սննդահամային հավելումներով հարստացումից հետո խիստ կարևոր է 2-3 ժամվա ընթացքում իրականացնել նրանց փաթեթավորումը:

Ներկայումս փաթեթավորման նյութերը սննդարդյունաբերությունում խիստ բազմազան են: Օրինակ՝ լաքապատված պոլիպրոպիլենային թաղանթապատումը, որը թույլ է տալիս փաթեթավորված մթերքը պահպանել 1-2 շաբաթից մինչև 12 ամիս:

Բանալի բառեր. պտուղբանջարեղենայինչիպսեր, պտուղբանջարեղենայինչիպսերի փաթեթավորում, պտուղբանջարեղենայինչիպսերի պահպանում, հարաբերականխոնավություն, ֆիզիկա - քիմիական հատկություններ:

УДК - 612.392.72:635.075:641

ВЛАГОПОГЛОЩАЮЩИЕ СВОЙСТВА ПЛОДООВОЩНЫХ ЧИПСОВ, ИХ ОРГАНОЛЕПТИЧЕСКИЕ СВОЙСТВА И УСЛОВИЯ ХРАНЕНИЯ

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Во время опытных исследований изучались влагопоглощающие и органолептические свойства и условия хранения чипсов из яблок и абрикосов. Проведенные исследования позволяют определить продолжительность последующих технологических процессов, что необходимо для правильной организации производства чипсов. Определение временного интервала технологических процессов позволяет утверждать, что после формирования и тепловой обработки чипсов, а также после обогащения их пищевыми добавками необходимо в течении 2-3-х часов произвести упаковку.

В настоящее время в промышленности используют много видов упаковок, например лакированные полипропиленовые пленочные упаковки, которые позволяют хранить в них продукт от 1-2-х недель до 12-ти месяцев.

Ключевые слова: плодоовощные чипсы, упаковка плодоовощных чипсов, хранение плодоовощных чипсов, относительная влажность, физико-химические свойства.

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STUDY OF CIRCUIT PARAMETERS OBTAINED USING ALGORITHMS FOR DETECTING AND CORRECTING ERRORS

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Software errors and constantly reducing technologies have paved the way for the creation of software algorithms for detecting and correcting errors in embedded systems. The quality of the algorithm for detecting and correcting errors in such systems depends to a great extent on the behavioral description of this algorithm. Each algorithm for detecting and correcting errors is more efficient than the other. In this paper, two of the most common detector algorithms were studied, the circuit described by these algorithms was synthesized by SAED 14 and SAED 32 nanometer libraries and the parameters were evaluated.

Key words: integrated circuit, device description language, codeword, logical synthesis.

Introduction

Accurate data transmission and storage are of extreme importance nowadays. Hardware and software issues are the cause of data corruption. Unlike hardware problems which are similarly important, software problems may occur due to noise and radiation particles, which can lead to inaccurate data transmission and storage. Since these issues are impossible to avoid, circuits developed using algorithms for detecting and correcting errors which have been already used during data transmission for several decades [1]. The complexity of this task is that the circuits developed by these algorithms should work while the program is running, maintaining the smooth operation of systems such as automation systems, medical equipment, space stations and all systems that use data transmission.

The importance of accurate data transmission in information systems

Data is transmitted between two or more remote points through the transmitting channel, using the digital system. Noise in the transmission channel has a major impact on the quality, reliability, and accuracy of data (Fig. 1). To avoid the following issues, telecommunications systems use algorithms for correcting corrupted data [2]. The main issue is that even in the case of a software error, it is possible to save the data correctly. The data is stored in memory or transferred to another memory. Since these circuits should be used in such areas as automation, medical equipment and space stations, then accurate data transmission is of major importance (Fig. 2). Multiply developed algorithms, such as Hamming, Reed-Solomon, and Bose-Chaudhuri-Hocquenghem algorithms [3-4], are used to transmit and store data accurately. The rationale for this algorithm lies in the fact that when data is transmitted incorrectly, it should be detected and corrected while the program is running. It has been studied that the Reed-Solomon algorithm functions more effectively during data transmission compared to the Hamming one due to its simpler description of hardware. With the results obtained in this paper, we compare the parameters of the circuits obtained by the Reed-Solomon and Bose-Chaudhuri-Hocquenghem algorithms described in the hardware description language [5].

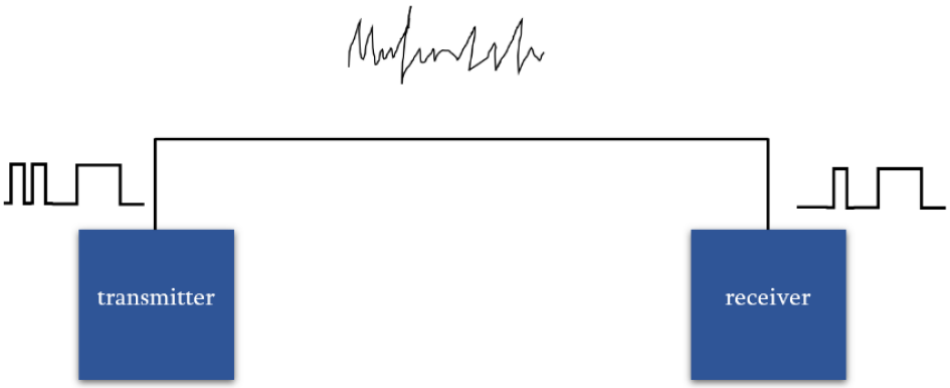

Fig. 1 The impact of noise during data transmission

The Reed-Solomon algorithm

The Reed-Solomon code is an error correction code introduced by Irving Reed and Gustav Solomon in 1960. It is widely used for correcting errors in mass memory systems. The Reed-Solomon code is the main component of the CD. There are two main forms of Reed-Solomon: the original one and the Bose-Chaudhuri-Hocquenghem (BCH) one. The appearance of the BCH is more generalized since decoders function faster and do not require large volumes. There are different procedures for encoding the Reed-Solomon code, that is, different ways to describe the codeword. Each codeword in the original code is represented as a sequence of functions. The codeword is obtained by presenting the message as follows:

$C=(p(a_1) ,p(a_2) , p(a_3),\ldots, p(a_n))$, where p is a polynomial of a degree less than k.

There are different forms of encoding. In the original X structure, the Reed-Solomon message (1960) is described by the coefficient of the polynomial p, and in the subsequent structure, the message is described by the values $a_1, a_2, \ldots, a_k$ of the polynomial and the interpolation of the latter produces the p polynomial. Subsequent procedural encoding, although less efficient, still provides a systematic advantage of encoding in that the message is always contained in subsequent keywords.

Simple encoding procedure

Message as a sequence of coefficients. In the original structure, the Reed-Solomon message (1960) x= $(x_1, x_2, \ldots x_k)$ is modified into the polynomial p_x :

$$p_x(a) = \sum_{i=1}^{k} x_i a^{i-1} \tag{1}$$

the codeword is p_x expressing itself in points of the Gaussian distribution $(a_1, \ldots a_n)$.

$$C_x = (p_x(a_1), \ldots p_x(a_n)) \tag{2}$$

The resulting C function is a linear transformation that satisfies $C_x = x * A$

$$A= \begin{bmatrix} 1 & \ldots & 1 & \ldots & 1 \\ a_1 & \ldots & a_k & \ldots & a_n \\ a_1^2 & \ldots & a_k^2 & \ldots & a_n^2 \\ \vdots & \ldots & \vdots & \ldots & \vdots \\ a_1^{k-1} & \ldots & a_k^{k-1} & \ldots & a_n^{k-1} \end{bmatrix} \tag{3}$$

A simple procedure for encoding the generated matrix.

Systematic coding procedure

A message as an initial sequence of values. In this procedure, the format of the polynomial p_x message is performed in a different way. The polynomial p_x is defined as a polynomial less than k.

$$p_x(a_i) = x_i \quad i \in \{1, \ldots, k\}$$

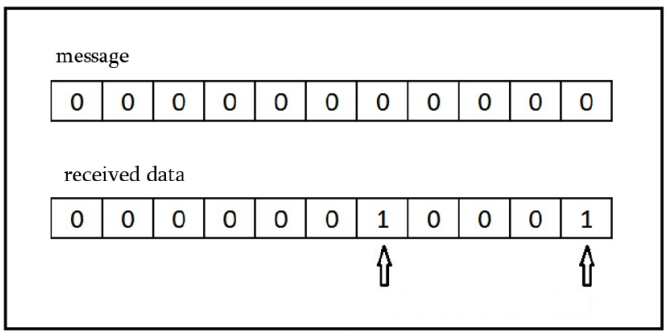

Fig. 2 The simple example of an error message received

Using Lagrange interpolation, we can calculate the polynomial p_x and express it in points of the Gaussian distribution: $a_{k+1}, \dots a_n$ we obtain the function C.

$$C_x = (p_x(a_1), \dots p_x(a_n))$$

Since Lagrange interpolation is a linear transformation, C is also linear C_x = x*G

$$G = \begin{bmatrix} 1 & 0 & 0 & \cdots & 0 & g_{1,k+1} & \cdots & g_{1,n} \\ 0 & 1 & 0 & \cdots & 0 & g_{2,k+1} & \cdots & g_{2,n} \\ 0 & 0 & 1 & \cdots & 0 & g_{3,k+1} & \cdots & g_{3,n} \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ 0 & \cdots & 0 & \cdots & 1 & g_{k,k+1} & \cdots & g_{k,n} \end{bmatrix} \quad (4)$$

G is the generated matrix of the system encoding procedure.

Reed-Solomon decoder

When transmitting, there will be a distortion of the transmitted message, a distortion of the codeword, due to noise.

$$R_x = C_x + E_x \quad (5)$$

C_x is a codeword and E_x is errors in it

$$E_x = e_{n-1}x^{n-1} + e_{n-2}x^{n-2} + \dots + e_1x^1 + e_0 \quad (6)$$

Bose-Chaudhuri-Hocquenghem algorithm

The decoder described by the Bose-Chaudhuri-Hocquenghem algorithm operated in the following sequence of steps: it calculates the distortion from the received codeword, from which the error locator polynomial is obtained, and the latter is used to correct corrupted bits. (Fig. 3).

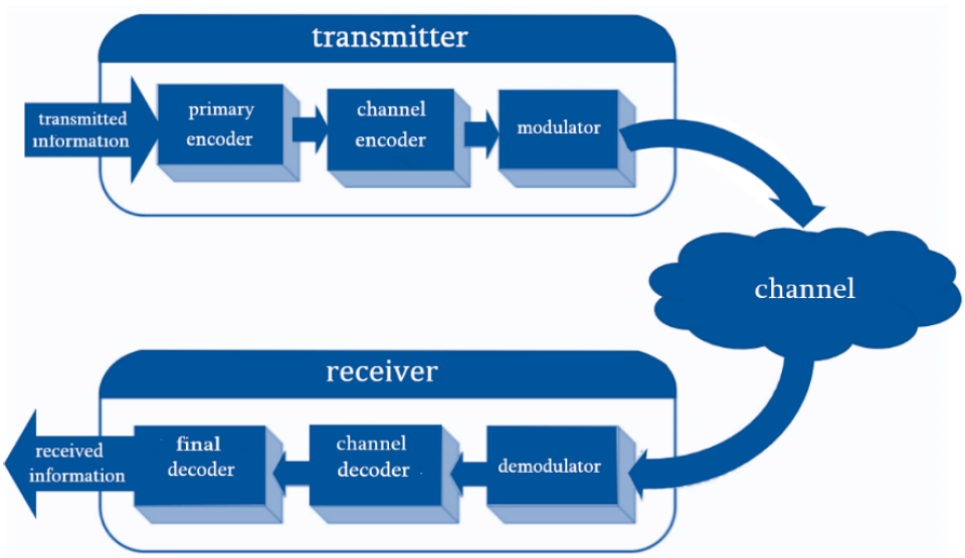

Fig. 3 Route of the Bose-Chaudhuri-Hocquenghem algorithm

Results and Discussion

In the course of the work using the description of algorithms presented in the hardware description language and in the Verilog language, a logical synthesis was performed using ready-made libraries of standard digital cells. Based on the outcomes, algorithms for detecting and correcting errors were evaluated and compared with various input data transmitted by the bitstream. Table 1 shows the expected results on the surface, expressed in μm^2, SAED 14 and 32 nanometers for the process [6-7].

Table 1

Area values of circuits

Bit	SAED 14 nm technology		SAED 32 nm technology	
	Reed-Solomon	Bose-Chaudhuri-Hocquenghem	Reed-Solomon	Bose-Chaudhuri-Hocquenghem
8	1,741.5	602.6	5,466.18	1,995.8
16	3,105.7	1,077.4	9,871.3	3,860.7
32	5,488	1,981.6	18,044.8	7,581.6
64	10,391.8	3,869.8	37,104.8	13,488.5

The table shows that the circuits developed using the Bose-Chaudhuri-Hocquenghem algorithm have approximately 2.7 times the smaller surface area.

Fig. 4 and 5 show the power of circuits synthesized by 14 and 32 nanometer process libraries, respectively which proves that the power consumed when using the Bose-Chaudhuri-Hocquenghem algorithm is 30% more efficient.

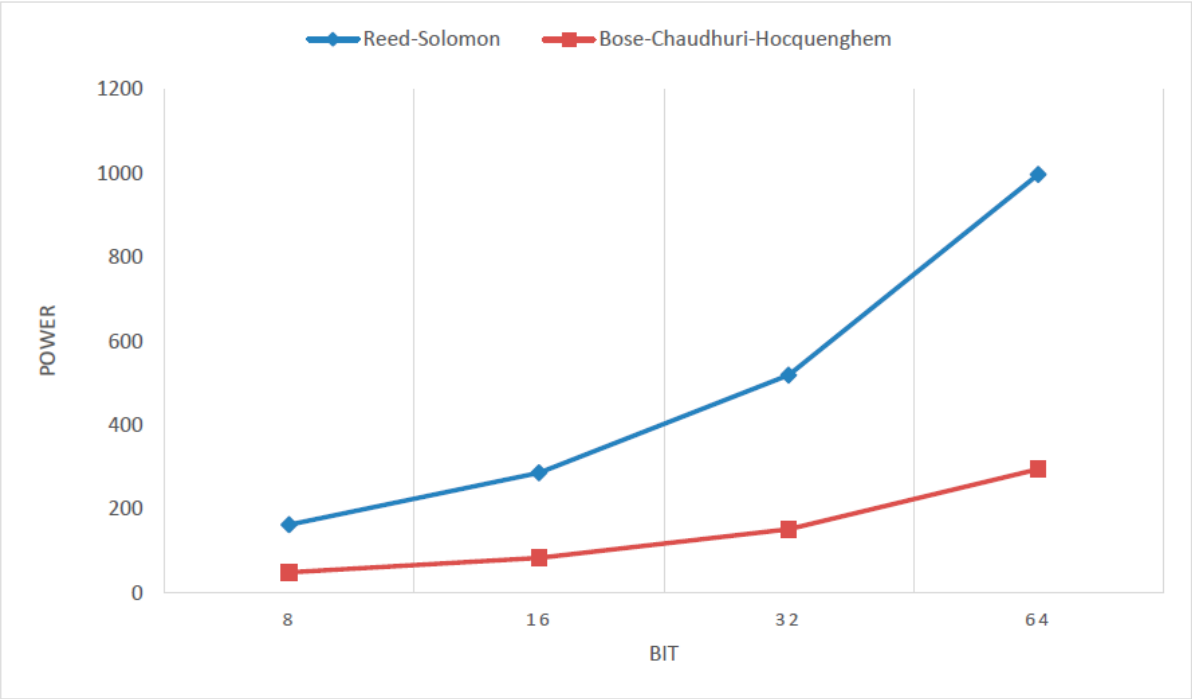

Fig. 4 The power values using 14 nm SAED technology

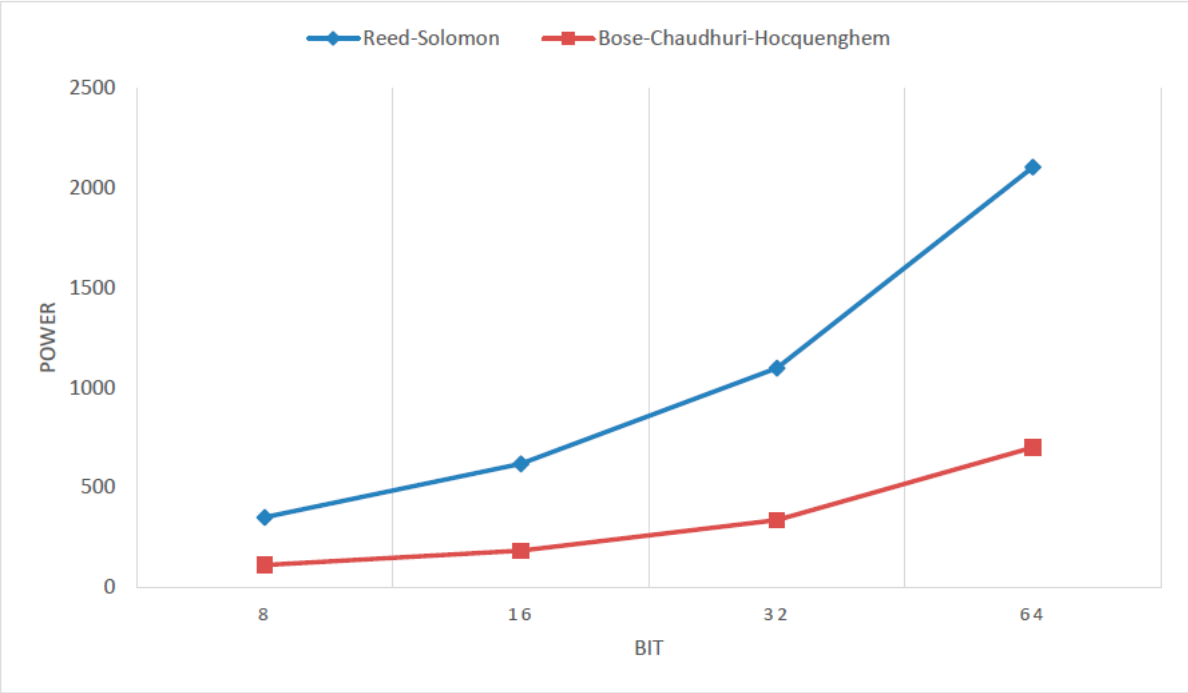

Fig. 5 The power values using 32 nm SAED technology

Conclusion

The purpose of this paper was to study two well-known algorithms for detecting errors, the Reed-Solomon on and the Bose-Chaudhuri-Hocquenghe one as well as to study their application in data transmission systems. The result shows that, in contrast to the Reed-Solomon algorithm, the circuit described by the Bose-Chaudhuri-Hocquenghe algorithm occupies a smaller surface area and consumes less energy due to the data decoder.

References

1. Lee H.P., Chang H.C., Lin T.C., Truong T.K. A Weight Method of Decoding the Binary BCH Code // IEEE - 2008. - P. 545-548.
2. Abildgren R., Moullenc Y., Analyzing and Implementing a Reed-Solomon Decoder for Forward Error Correction in ADSL // Aalborg University - 2007. P. 45-53.
3. Okeke C., Eng M., A Comparative Study between Hamming Code and Reed-Solomon Code in Byte Error Detection and Correction // IJRASET - 2015. P. 34-38.
4. Lone F. R., Puri A., Kumar S. Performance Comparison of Reed Solomon Code and BCH Code over Rayleigh Fading Channel // IEEE - 2013. P. 23-26.
5. Chang H., Cheng C. Reed-Solomon Decoder using Decomposed Euclidean Algorithm // IEEE - 2000. P. 262-265.
6. Melikyan V., Martirosyan M., Melikyan A., Piliposyan G. 14nm Educational Design Kit: Capabilities, Deployment and Future // Small Systems Simulation Symposium Niš, Serbia, - February, 2018. - P. 37-41.
7. Goldman R., Bartleson K., Wood T., Kranen K., Melikyan V., Babayan E. 32/28nm Educational Design Kit // Capabilities, deployment and future, Asia Pacific Conference on Postgraduate Research in Microelectronics and Electronics (PrimeAsia), IEEE, - 2013.

ՀՏԴ - 519.688:004.42

ՍԽԱԼԻ ՀԱՅՏՆԱԲԵՐՄԱՆ ԵՎ ՈՒՂՂՄԱՆ ԱԼԳՈՐԻԹՄՆԵՐՈՎ ՍՏԱՑՎԱԾ ՍԽԵՄԱՆԵՐԻ ՊԱՐԱՄԵՏՐԵՐԻ ՈՒՍՈՒՄՆԱՍԻՐՈՒԹՅՈՒՆ

Ն.Վ. Մելիքյան, Ա.Մ. Դանիելյան, Ա.Գ. Մանուկյան, Ա.Ա. Գալստյան
Հայաստանի ազգային պոլիտեխնիկական համալսարան

Ծրագրային սխալները և անընդհատ փոքրացող տեխնոլոգիաները ճանապարհ են հարթել ծրագրային սխալների հայտնաբերման և ուղղման ալգորիթմների ստեղծմանը ներդրված համակարգերում: Այդպիսի համակարգերում սխալների հայտնաբերման և ուղղման ալգորիթմի բարդության աստիճանը կախված է դրա վարքային նկարագրությունից: Աշխատանքում ուսումնասիրվել է ամենատարածված դետեկտորային ալգորիթմներից երկուսը, կատարվել է այդ ալգորիթմների նկարագրությամբ ՍԱՈՒԴ 14 և 32 նանոմետրանոց տեխնոլոգիական գրադարաններով սինթեզված սխեմաների ուսումնասիրություն, պարամետրերի գնահատում և համեմատում:

Բանալի բառեր. ինտեգրալ սխեմա, սարքակազմի նկարագրման լեզու, ինտերպոլացիա, բառ-կոդ, տրամաբանական սինթեզ:

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ИЗУЧЕНИЕ ПАРАМЕТРОВ СХЕМ ПОЛУЧЕННЫХ С АЛГОРИТМАМИ ОБНАРУЖЕНИЯ И ИСПРАВЛЕНИЯ ОШИБКИ

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Программные ошибки и постоянно уменьшающиеся технологии проложили путь к созданию алгоритмов обнаружения и исправления программных ошибок во встроенных системах. Степень сложности алгоритма обнаружения и исправления ошибок в таких системах зависит от его поведенческого описания. В данной работе были изучены два из наиболее распространенных алгоритмов детектирования, проведено исследование схем с описанием этих алгоритмов, синтезированных для технологий САУД 14нм и САУД 32нм, оценка и сравнение параметров.

Ключевые слова: интегральные схемы, язык описания аппаратуры, интерполяция, кодовое слово, логический синтез.

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TECHNOLOGY AND LABORATORY RESEARCH ON FLEXIBLE STONES

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In laboratory conditions, flexible stone preparation, flexibility testing and efficiency of the results obtained were carried out. As a result of the experiments and tests, a flexible stone has been obtained which enables the structure to be covered. When facing the interior and exterior curved surfaces of buildings and structures, problems arise that require a great deal of time and effort. By saving time as a result of the use of flexible stone the work is done faster and more efficiently. This stone allows us to show a design approach while using various types of tuff stone while saving the natural raw materials resources of the tuff.

Key words: flexible stone, tuff, external coating, fine crushed stone, internal coating.

Introduction

Depending on the rock resources of the country, different types of fine crushed stones are used [1]. Flexible stone is widely produced and used in Poland, the Russian Federation and Kazakhstan.

For the first time in “Good Stone” company launched the production of flexible stone the Russian Federation that was able to be used in both cold and hot weathers. It was first tested in 2012 using quartz and marble gravel.

As a result of numerous experiments and trials, the efficiency of the product was increased and the self cost was decreased. The experiments were carried out by the students in the laboratory of the department of Construction Production Management of the NUACA.

Conflict setting

The experiment was carried out in the laboratory of the department of Construction Production Management of the NUACA. The experiment began with mould making using a 1000x1000 mm plywood board and 18 mm square wooden rods (Fig. 1).

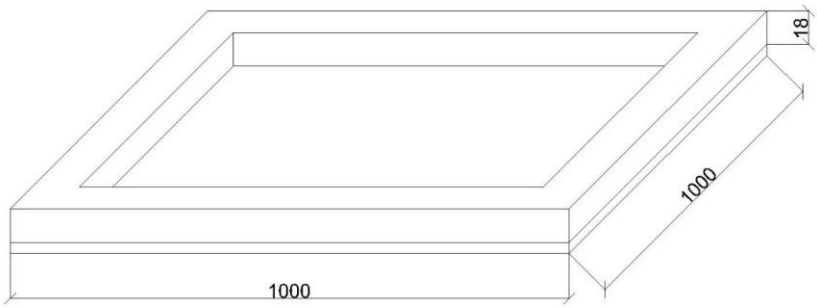

Fig. 1 Structure and dimensions of the mould

After moulding, the tuff stone was crushed which resulted in fine crushed stone of different sizes. In the next step, the fine crushed stone was passed through the screen, first through a screen having a diameter of 2 mm, then through a screen having a diameter of 0.8 mm (Fig. 2). As a result of that, we have fine crushed stone with the size of 0.8-2mm. In addition to the natural colors of tuff, it is possible to color the crushed stone with different color pigments for a more attractive and aesthetic texture.

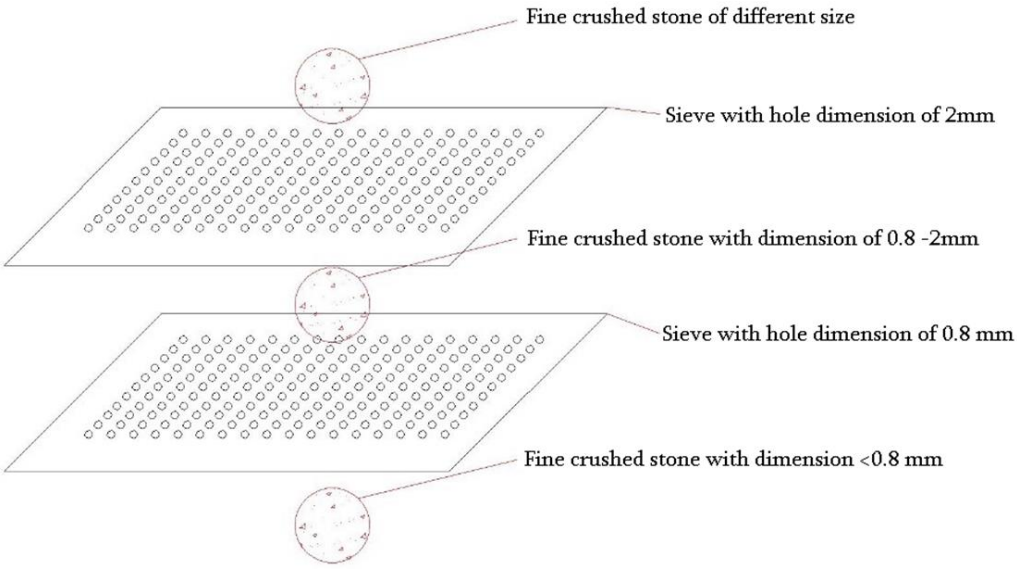

Fig. 2 Scheme describing the sscreening process

If both colored and non colored fine crushed stones are filled into the mould together, we will get any texture to make it look even more attractive and interesting (Fig. 3).

Fig. 3 Mould filled with fine crushed stone

In the next step we cut a section with diameters of 1000x1000mm from the waterproof fabric to which the binding material is added [2] (Fig. 4).

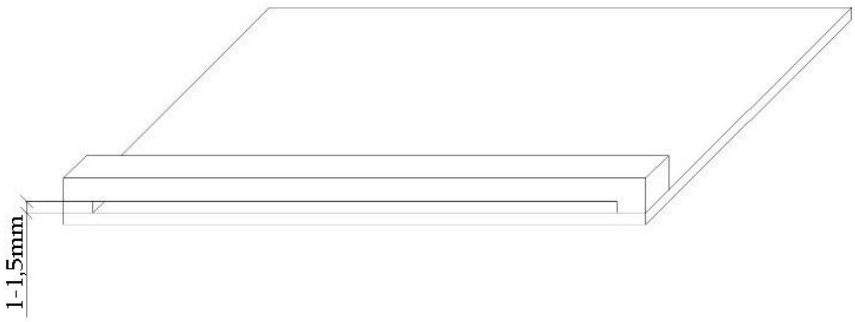

Fig. 4 Facility for adding the binding material

After adding the binding material, the waterproof [3] fabric is installed on the crushed stone in the mould and is compressed with paint roller (Fig. 5).

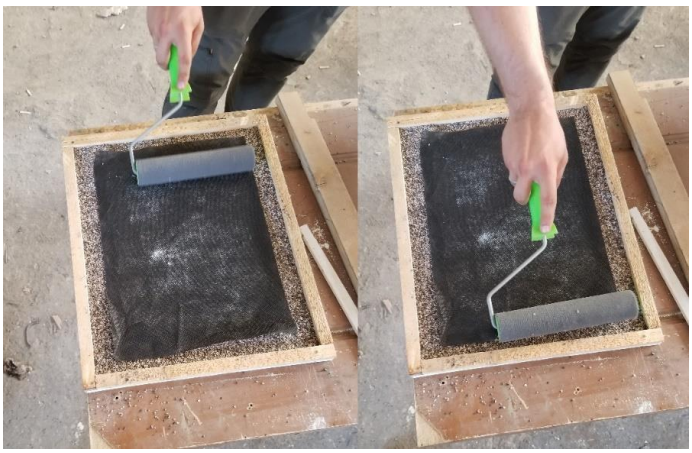

Fig. 5 Compressing process of waterproof fabric

After compressing with paint roller, we take the waterproof fabric and move to a dryer. The temperature and the moisture content of the dryer vary depending on the type of binding material. The result remains in the dryer for up to 24 hours (Fig. 6).

Fig. 6 Drying process

After drying, a protective layer is added to the material, which is then cut to the dimensions of 550x340mm and get the final result (Fig. 7, 8). The final thickness of the flexible stone is 2-3 mm.

Fig. 7 Final result of the flexible stone

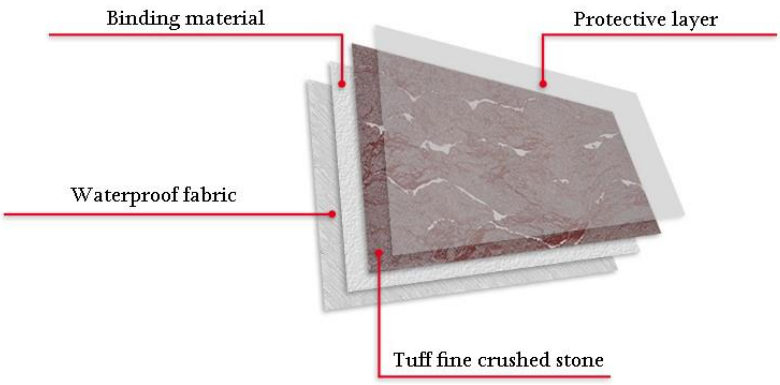

Fig. 8 Structure of the flexible stone

Research results

As a result of experiments, depending on the binding material and the thickness of the binding material [4], we obtained flexible stones of varying degrees of flexibility from which the most optimal version was resulted by using the binding material with the thickness of 1mm. During the interior finishing works, a flexible binding material for wallpaper is used for the reinforcing the flexible stone and a waterproof and heat resistant binding material is used for the exterior coating.

In order to obtain higher thermal insulation during interior finishing works, the flexible stone is glued to the foam plastic and then fixed to the wall (Fig. 9).

Fig. 9 Foam plastic tile with flexible stone

The main features of the flexible stones are:

- Water resistance
- Simplicity and ease of installation due to plasticity and slimness
- vapor resistance
- Fire resistance
- Small mass

Conclusion

The analysis of the results of the studies allows us to conclude that due to the main properties, the flexible stone can be used for both external and internal coating irrespective of the weather conditions.

The resulting flexible stone almost doubles the duration of the works for the interior and exterior curved surfaces of buildings and structures. By comparing the volume of the stone used for flexible stone with the volume of the used stone during the facing, we get a saving of 90% of natural resources.

References

1. Վիկտոր Համբարձումյան. Հայկական Սովետական Հանրագիտարան, հատոր 12 – Երևան «Հայ սովետական հանրագիտարան» հրատակչություն 1986թ. էջ 424
2. Петрова А. П. Клеящие материалы. Справочник, ЗАО «Редакция журнала «Каучук и резина». Москва. 2002 – С. 14-15
3. Самойлов В. С. Крыши и кровли. — М.: Литературный бульвар, 2010. С. 282-292.
4. Նյութաբանություն շինարարների համար / Պ.Հ.Տեր-Պետրոսյան, Ա.Մ.Ասիրյան, Է.Ա.Մովսիսյան, Գ.Վ.Հովհաննիսյան, Է.Ռ.Սահակյան, Վ.Վ.Պողոսյան. - Երևան: «Նաիրի»,2005. - 614 էջ:

References

1. Viktor Hambardzumyan (1986) Armenian Soviet Encyclopedia, volume 12 [Armenian Soviet Encyclopedia, Volume 12] – Yerevan «Armenian Soviet Encyclopedia » Publ., 424 p. (in Armenian)
2. Petrova A. P. (2002) [Adhesive materials. Directory] – Moscow, ZAO Edition of the magazine «Rubber and gum elastic» Publ., p. 14-15. (in Russian)
3. Samoylov V. S.(2010) Roofs and tops, [Roofs and housetop]– Moscow Literary boulevard Publ., p.282-292 (in Russian)
4. Ter-Petrosyan, P.H., Asiryan, A.M., Movsisyan, E.A., Hovhannisyan, G.V., Sahakyan, E.R., Poghosyan, V.V. (2005), [Materialism for Builders]. Yerevan, «Nairi» Publ., 614 p. (in Armenian)

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ՃԿՈՒՆ ՔԱՐԵՐԻ ՊԱՏՐԱՍՏՄԱՆ ՏԵԽՆՈԼՈԳԻԱ ԵՎ ԼԱԲԱՐԱՏՈՐ ՀԵՏԱԶՈՏՈՒԹՅՈՒՆ

Ա.Ի. Վասիլեվա, Ս.Ե. Պետրոսյան
Ճարտարապետության և շինարարության Հայաստանի ազգային համալսարան, ՀՀ, ք. Երևան

Լաբարատոր պայմաններում իրականացվել է ճկուն քարի պատրաստում, ճկունության ստուգում և ստացված արդյունքի արդյունավետության ստուգում: Արված փորձերի և փորձարկումների արդյունքում ստացվել է ճկուն քար, որի շնորհիվ հնարավորություն է տրվում երեսապատել կառույցը: Շենքերի և շինությունների ներքին և արտաքին կոր մակերևույթների երեսապատման ժամանակ, առաջանում են խնդիրներ, որի լուծման համար պահանջվում է երկար ժամանակ և ջանք: Ճկուն քարի օգտագործման արդյունքում խնայելով ժամանակը, աշխատանքները կատարվում են ավելի արագ և արդյունավետ: Այդ քարը մեզ թույլ է տալիս ցուցաբերել դիզայներական մոտեցում՝ օգտագործելով միաժամանակ տուֆ քարի տարբեր տեսակներ, խնայելով տուֆի բնական հումքային պաշարները:

Բանալի բառեր. ճկուն քար, տուֆ, արտաքին երեսապատում, մանրախճաքար, ներքին երեսապատում:

УДК - 691.273:69.001.5

ТЕХНОЛОГИЯ ИЗГОТОВЛЕНИЯ ГИБКИХ КАМНЕЙ И ЛАБОРАТОРНЫЕ ИССЛЕДОВАНИЯ

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В лабораторных условиях было произведено приготовление гибкого камня, проверка гибкости и проверка эффективности готового результата. В итоге опытов и экспериментов получился гибкий камень, благодаря которому мы получили возможность покрыть здание. При покрытии внутренних и внешних кривых покрытий зданий и строений выявляются некоторые

проблемы, для решения которых необходимо много усилий и времени. Экономя время благодаря использованию гибкого камня, работы ведуться быстрее и эффективнее. Данный вид камня даёт нам возможность проявить дизайнерский подход при использовании одновременно разные виды камня туф, сэкономив природные сирьевые запасы.

Ключевые слова: гибкий камень, туф, внешнее покрытие, мелкий щебень, внутреннее покрытие.

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CROSS STONE ART AS INSEPARABLE PART OF DEVELOPMENT OF MEDIEVAL ARCHITECTURE OF ARTSAKH

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Nagorno Karabakh is the homeland of Artsakh school of Armenian architecture where many significant values of the Armenian architectural heritage have been created: churches, monastery complexes, fortifications, engineering structures, outstanding works of cross stone art, obelisks, palaces, notable folk houses many of which have their honorable place not only in the treasury of the Armenian people but also in the treasury of universal architecture and culture.

The architectural school established in Nagorno Karabakh has gone through the same main stages of development as the other schools of pan-Armenian architecture. It began to develop in the pre-Christian period in the fourth century with the adoption of Christianity passing through the flourishing period of the Midddle Ages. Having peculiarities coming from local conditions and traditions, the generality of Artsakhi architecture with pan-Armenian architecture is clearly reflected in the layout and spatial composition of the buildings, in design solutions, construction techniques, traditional building materials, proportions, ornaments, cross art etc.

During the medieval period the church architecture was mainly developed in Artsakh: churches, temples, chapels and monasteries were mainly built. At that time, literature and cross stone art were also developing rapidly.

The cross stones are very typical of medieval Armenian monuments in Artsakh. The cross stones are the symbol of the originality of the Armenian medieval culture.

Key words: architectural heritage, Middle Ages, structure, church, obelisk, monastery, Artsakh school, culture, monument, cross stone art.

Introduction

Cross stone art is an inseparable part of Artsakhi architecture. These cross stones with numerous and varied illustrations are scattered everywhere in the territory of Artsakh, in the yards of monasteries and churches, in the free environment of nature, in cemeteries, they are built in the walls of religious structures, in enclosures and elsewhere. As a rule, they are works of high mastery, enriching, aesthetically evaluating and making colorful the historical - cultural environment. Especially cross stones of Khatravank, Koshik Anapat, Gandzasar, Dadivank and others are bearers of decoration and high sculptural art.

Conflict settings

The aim of this article is to observe the process of formation and development of the medieval Artsakh School of Architecture with the pan-Armenian architecture. The topic of the article is the discovery of the process of formation and development of architecture in the Middle Ages in Artsakh School of Architecture using cross stone art.

Research results

The path of formation, development and improvement which the Armenian cross stone art had passed is clearly visible in the example of Artsakh cross stones. Here the earliest cross stones (VIII-IX centuries) often have irregular, prolonged, rectangular and circular forms sometimes directly attached to the ground or on a pedestal that almost does not rise above the ground. They still do not have the composition typical of further cross stones, they are far from stable and regulated forms, moreover, it is difficult to differ the concepts of cross stone and cross sculptures and they are out of date and inscriptions. The most important thing in the early cross stones is their specific practical significance,

the artistic decoration is modest and assimilated with the composition, the stone retains its materiality. The texture is still rough and the monumentality is accentuated. Some scholars consider the issue of relating the origins of cross stones to the earliest ninth century very suspectable. And also B. Ulubabyan stated: «And we think that the researchers who think that the well-known cross stone originated and developed only in the 9th century are wrong» [47, p. 38].

The earliest Armenian cross stones date back to the 9th century, there are 8 cross stones 2 of which are located in Artsakh, one in the Metsarants Monastery in Kolatak village (only the cross stone pedestal built by monastery's bishop Solomon in 853 still stay) and the other is granite cross stone-memorial preserved in Vaghuhas village dated in 866.The literature includes a significant number of ancient undated cross stones from Ghushchi, Nakhijevan, Syunik and also from Artsakh (Noragyugh, Khutavank) which are dated to the VIII century or the first half of the IX century. Early examples of cross stones attempted to preserve and strengthen the Christian faith (which were very necessary in the threat of assimilation). The main element of artistic decoration and the bearer of the idea of goodwill or wish is the cross with a variety of simple drawings, often schematic, with edge curves or in or out of the background with total size with equal wings or small differences in the lengths of wings length. Early cross stones are found mainly in places having rich cultural traditions of the early Middle Ages and outside the plains in Syunik, Artsakh, Lori, Tavush and elsewhere.

In the second half of the 19th century there were cross stones having rising leaf wings from lower wings («Flower Cross»), cross stones with simple plant and animal sculptures. A number of sculptural ornaments were adopted on ancient monuments, basilica churches and other structures (almond leaves, pomegranate, olive, palm leaves sculptures etc.) in connection with pagan and early Christian beliefs. As a rule, the cross wings have hemispheres at the two-branched ends extending outwards and in the center, some of which are covered with longitudinal linear excavations. The stepped pedestals have not been formed yet, the geometric drawing is lacking both in cross stones and in individual elements in general. The elegant decoration and the iconography typical of the early medieval art are simplified and generalized. The sculptures are significantly softer and smaller. In the 10th century inscriptions on cross stones were often engraved. The inscriptions cover not only the backs of the cross stones but also the faces, the gaps between the cross sculptures and even the ribs. The goals and motives for standing cross stones are incomparably expanding and cross stones become more and more popular monuments in the coming centuries.

A. Yacobson wrote about the development of Armenian cross stones: «The twelfth century is noted as a new stage in the artistic carving of cross stones which is a flourishing stage of Armenian stone plastics, which at that time, especially in the 13th century, reached exceptional perfection. The cross stones serve as a shining addition to the architectural works of the time in which they are often placed» [48, p. 217].

XII-XIII centuries are the period of flourishing of cross stone art in Artsakh and in Armenia in general. Folk and household sculptural art in which the themes of war, agriculture, hunting, the abundant depiction of weapons, household items and costumes occupy a large place become especially popular. Their value is further enhanced by the fact that they are usually accompanied by protocols. Presenting the secular motives of cross stones in Khachen, H. Orbely concludes that «cross stones with human images were first found in this part of Armenia, in Khachen, where it is generally a favorite occupation to decorate and carve high sculptures, where you can see wide scenes of high sculpture in addition to the usual titular sculptures you may meet in other places of Armenia» [8, p. 196]. (From what H. Orbely said, it may seem probable from the abundance of cross stones in Khachen that the origin of the place name Khachen is connected with the name of cross). Sculptures related to everyday life and activity and high-tech sculptures depict episodes in the history of Artsakhi life, for example, on more than one and a half dozen cross stones the scenes of war, soldiers and horse riders are depicted in Koshiki Anapat.

The cross stones of Dadivank are highly valued. «The two cross stones of Dadivank are one of the unique monuments of ancient Armenian art. And even if they are not considered the most beautiful in their appearance, it is impossible to show any other more perfect than they are» [49, p. 19].

The foreigner said: «I was lucky to see hundreds of cross stones» - writes G. Anokhin visiting Dadivank, - «but these two are incomparable with their unimaginable tiny and various laces» [50, p. 14]. Many cross stones connected with the names of Prince Hassan Jalali and his wife, Arzukhatuni, cross stones in Khaghbakyans family cemetery in Havaptuk Monastery, in Khatravank built by Sophia and in Koshik Anapat are very highly appreciated. Within certain limits of likeliness, each of the thousands of Armenian cross stones including those from Artsakh, has its own peculiarity of composition and its own scale of ornaments. They show the infinity of imagination, high taste and dedication of building masters.

The image of the cross forming core is explained as the «cross of light» (Agatangeghos), «the sun» (Kaghankatvatsi), the tree of life, the idea of God’s crusification and resurrection. Artsakhi people always being in the conditions of attacks and oppression of foreign dictatorship felt the need of God's support the most and most often addressed the cross stone, as N. Mar said, «that closest recorder» which was the best intercessor between God and Armenian». It seems that Ed. Mezelaytis said especially about Artsakhi cross stone: «Cross stone is an Armenian phenomenon, a unique symbol of Armenia. The stone carved on the stone symbolizes the suffering, the blood and the sacrifices which cruel history forced on this small number of ancient people. And the vegetation that covers the entire background of the slab symbolizes the vital force of those people whom disasters, death and genocide were powerless to» (Pravda, July 2, 1983).

The spirit of national unity and commonality, the essence of cultural heritage and the sequence of events are also evidently manifested in Artsakh cross stone art. Many expressions and manifestations of artistic perceptions, inventive tricks and elements are visible in the cross stone art of Mother Armenia and its Artsakh part which is the birth of the same roots and prehistory, base of development, the result of national commonality and unity.

Conclusion

Monuments of memorial architecture of Artsakh (cross stones, monuments) are closely related to the stylistic features of other regions of Armenia, especially to the memorial structures of Syunik, the wall-cross monuments the best examples of which are those located in the complex of Bri Yeghtsi Monastery.

Medieval Armenian cross stone art of Artsakh has influenced the formation and development of Artsakh School of Architecture.

References

1. Ուլուբաբյան Մ. Խաչքար //Եր. «Գարուն», 1985, N3, էջ 36-46
2. Якобсон А., Об армянских хачкарах //ՊԲՀ, Եր. 1978, N1, стр.215-224
3. Орбели И. А. Избранные труды АН Армении //Ер., 1963, с.196
4. Ուլուբաբյան Բ., Հասրաթյան Մ. Դադիվանք //«Հայկական հայագիտական հանդես», “Պեյրութ”, 1980, էջ 7-54
5. Հակոբյան Հր., Արցախի միջնադարյան արվեստը, Պարբերական, Ե., 1991, էջ՝ 14

References

1. Ulubabyan M., Cross stone // Yerevan, «Garun», 1985, N3, p. 36-46
2. Yakobson A., About Armenian cross stones //HPM, Yerevan, 1978, N1, p. 215-224
3. Orbely I., The unique works of Armenia//Yerevan, 1963, p. 196
4. Ulubayan B., Hasratyan M., Dadivank //«Armenian Armenological magazine», «Beirut», 1980, p. 7-54
5. Hakobyan Hr., Medieval art of Artsakh, Regular newspaper, Yerevan, 1991, p. 14

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ԽԱՉՔԱՐԱՅԻՆ ԱՐՎԵՍՏԸ ՄԻՋՆԱԴԱՐՅԱՆ ԱՐՑԱԽՅԱՆ ՃԱՐՏԱՐԱՊԵՏՈՒԹՅԱՆ ԶԱՐԳԱՑՄԱՆ ԱՆԲԱԺԱՆ ՄԱՍ

Ն.Ա. Միքայելյան
Շուշիի տեխնոլոգիական համալսարան

Լեռնային Ղարաբաղը հայկականն ճարտարապետության արցախյան դպրոցի հայրենիքն է, որտեղ ստեղծվել են հայ ճարտարապետական ժառանգության նշանակալից շատ արժեքներ՝ եկեղեցիներ, վանական համալիրներ, ամրաշինական, ինժեներական կառույցներ, խաչքարային արվեստի աչքի ընկնող գործեր, կողոթներ, մելիքական ապարանքներ, ժողովրդական տների ուշագրավ օրինակներ, որոնցից շատերը տեղ են գրավում ոչ միայն հայ ժողովրդի, այլև համընդհանուր ճարտարապետության և մշակույթի գանձարանում:

Լեռնային Ղարաբաղում ստեղծված ճարտարապետական դպրոցը անցել է զարգացման այն նույն հիմնական փուլերով, ինչպես համահայկական ճարտարապետության մնացած դպրոցները: Այն սկսել է զարգանալ նախաքրիստոնեական շրջանում, այնուհետև անցնելով չորրորդ դարում քրիստոնեության ընդունմամբ և միջնադարյան ծաղկուն շրջանի միջով: Ունենալով տեղական պայմաններից և ավանդույթներից բխող յուրահատկություններ, համահայկական ճարտարապետության հետ Արցախի ճարտարապետության ընդհանրությունը ակնհայտորեն արտահայտում է շինությունների հատակագծային և ծավալատարածական հորինվածքներում, կոնստրուկտիվ լուծումներում, շինարարական տեխնիկայում, ավանդական շինանյութերի կիրառման ձևերում, համաչափություններում, զարդամոտիվներում, խաչքարային արվեստում և այլն:

Միջնադարյան շրջանում Արցախում հիմնականում զարգացած է եղել եկեղեցական ճարտարապետությունը՝ եկեղեցիներ, տաճարներ, մատուռներ և վանքեր: Այդ ժամանակաշրջանում բուռն զարգացում էր ապրում նաև գրագրությունը և խաչքարային արվեստը:

Արցախում միջնադարյան հայկական հուշարձաններից շատ տիպական և տարածված են խաչքարերը: Խաչքարերը հանդիսանում են հայ միջնադարյան մշակույթի ինքնատիպության խորհրդանիշ:

Բանալի բառեր. ճարտարապետական ժառանգություն, միջնադար, կառույց, եկեղեցի, կոթող, վանք, Արցախյան դպրոց, մշակույթ, հուշարձան, խաչքարային արվեստ:

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ХАЧКАРНОЕ ИСКУССТВО КАК НЕОТЪЕМЛЕМАЯ ЧАСТЬ РАЗВИТИЯ АРЦАХСКОЙ АРХИТЕКТУРЫ СРЕДНЕВЕКОВЬЯ

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Нагорный Карабах являается родиной арцахской школы армянской архитектуры, где создавались многие значимые ценности армянского архитектурного наследия: церкви, монастыри, комплексы, оборонительные и инженерные строения, выдающиеся произведения

хачкарного мастерства, монументы, меликские особняки, интересные примеры народных жилых домов, многие из которых занимают достойное место не только в архитектурной и культурной сокровищнице армянского народа, но и в мировой.

Созданная в Карабахе архитектурная школа прошла те же основные этапы развития, что и другие общармянские архитектурные школы. Она зародилась в дохристианскую эпоху, пройдя затем сквозь принятие христианства в четвертом веке и расцвет средневекового периода. Обладая особенностями, обусловленными местностью и традициями, всеобщность Арцахской и общармянской архитектуры проявляется в объемно-пространственных строениях, в планировке, в конструктивных решениях, в технике строения, в использовании традиционных строительных материалов, в пропорциях, в форме, в хачкарном искусстве и т.д.

В средневековье в Арцахе в основном развивалась церковная архитектура – церкви, храмы, часовни, монастыри. В тот же время также активно развивалась писменность и хачкарное искусство. Хачкары в Арцахе являются самыми типичными и распространенными средневековыми армянскими памятниками. Хачкары являются символами самобытности армянской средневековой культуры.

Ключевые слова: Нагорный Карабах, архитектурное наследие, средневековье, сооружения, церкви, монумент, монастыри, Арцахская школа, культура, памятники, хачкарное искусство.

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USING 3D PANELS IN SHORT-TERM BUILDINGS AS EXTERNAL CONSTRUCTIONS

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3D panels are considered to be up-to-date external structures with certain important features.

The article first presents what 3D panels are, why they should be used and then methods of panel erection. We refer to their thermal resistance and present the advantages and disadvantages of using 3D panels.

Key words: 3D panels, structure, construction, construction construction technologies, foamed concrete, short creating.

Introduction

Under present-day conditions of technological development new demands are required from science. Particularly it concerns the introduction of technological achievements in the construction sector. Before launching them into the construction process, they go through many stages: processing, testing and commissioning. The main challenge of construction sector of the 20th century was to reduce construction period and costs.

There is currently a crisis of fundamental innovation around the world and in many areas. For example, not more than 7% of the natural raw material extracted in technologies for converting materials and energy is consumed in the finished product and the rest is wasted or used in vain. The current situation has led to new trends in the development of construction:

- Transition from discrete (cycle) technologies to continuous (intranet) production processes as the most efficient and rational.
- Introduction of non-waste technology cycles into production as it is more environmentally friendly [1].

3D panels used in short-term buildings is one such environmentally friendly and affordable technology.

Conflict setting

The technology of 3D panels is based on polystyrene foam and the use of shotcreting method. This advanced technology is unique in its simplicity and profitability; it reduces energy consumption and allows reducing both construction costs and time spent on the construction.

3D panel is a versatile element used to create almost all basic building elements and infrastructures (foundation, floors, walls, partitions, roof, stairs).

3D panel is a spatial structure consisting of a expanded polystyrene plate both sides of which are fixed wire fabrics made of high strength wire. The mesh fabrics are connected by penetrating metal rods [2]. Mesh fabrics are welded at an angle; it gives a spatial rigidity to the structure and simultaneously prevents expanded polystyrene core shifting.

Main advantages and disadvantages of 3D panels compared to traditional building structures:

3D panel consists of three-dimensional metal frame and expanded polystyrene foam light core.

The strength of this structure is additionally provided by diagonal cross rods attached to the mesh on all sides.

Standard panel with dimensions of 3x1.2 m weighs about 20 kg.

The advantages of 3D panels are:

1. strength;
2. simplicity of structure;
3. the possibility to quickly and easily install with hands;
4. energy and heat savings;
5. absence of strict foundation requirements.

As it has been already mentioned, the second component of 3D panels is expanded polystyrene which means that 3D panels have an organic structure. Expanded polystyrene has the following major disadvantages:

1. susceptible to UV degradation (corrosion);
2. low resistance to mechanical shock.

These two disadvantages of expanded polystyrene indicate that 3D panels with expanded polystyrene are not suitable for long-term buildings.

Given the fact that the 3D panel is considered an organic material, its core deteriorates over the years (25-30 years) and becomes a sandlike mass. It follows that after deterioration of the core two layers of foam concrete remain and the air between the layers, resulting in a complete change of thermal resistance and an adverse effect, as the thermal resistance of the air layer is quite low. Therefore, when calculating the durability of 3D panels, it is also necessary to calculate the thermal resistance.

The thermal resistance is calculated by the following formula:

$$K = \frac{1}{\sum R} = \frac{1}{\frac{1}{\alpha_i} + \frac{\delta_1}{\lambda_1} + \frac{\delta_2}{\lambda_2} + \dots + \frac{\delta_n}{\lambda_n} + \frac{1}{\alpha_o}} \quad (1)$$

where:

λ – coefficient of thermal conductivity
δ – layer thickness
K – heat transfer coefficient
R – heat transfer resistance

Using formula 1, we will have in our example:

$$K = \frac{1}{\sum R} = \frac{1}{\frac{1}{\alpha_i} + \frac{\delta_1}{\lambda_1} + \frac{\delta_2}{\lambda_2} + \frac{\delta_3}{\lambda_1} + \frac{1}{\alpha_o}} = \frac{1}{\frac{1}{8.7} + \frac{0.035}{1.5} + \frac{0.07}{0.05} + \frac{0.04}{1.5} + \frac{1}{23}} = 0.61 \mathrm{W/m^2{}^\circ C}$$

where:

δ_1 = 35mm thickness of the first layer
δ_2 = 70mm thickness of the second layer
δ_3 = 40mm thickness of the third layer
λ_1 = 1.5 W/m°C the first and the third layers coefficient of thermal conductivity
λ_2 = 0.05W/m°C the second layer coefficient of thermal conductivity

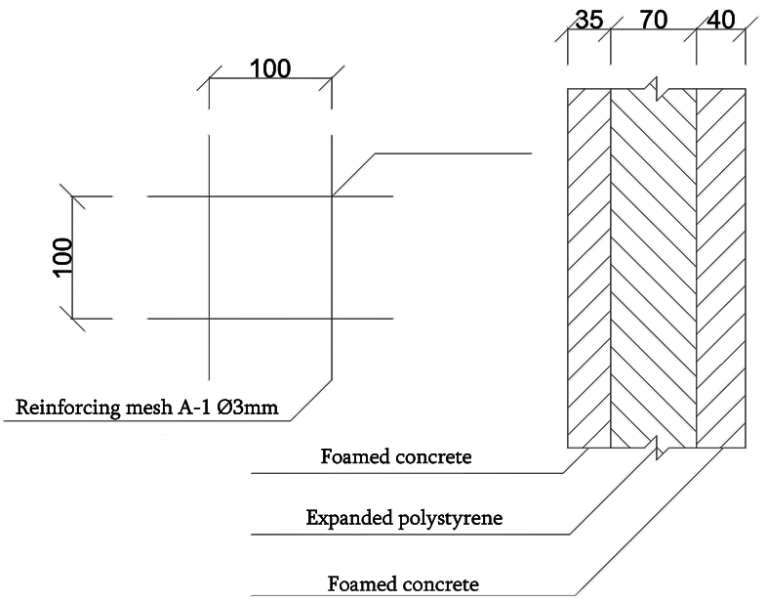

Fig. 1 Schematic structure of 3D panel

Features of erecting 3D panels

Now let us discuss the technology of assembly of elements and general installation more detailed. The 3D panel is a spatial branched structure consisted of high quality wire fastening meshes and rods which are welded at an angle with polystyrene foam and are held by fire rod (Fig.2).

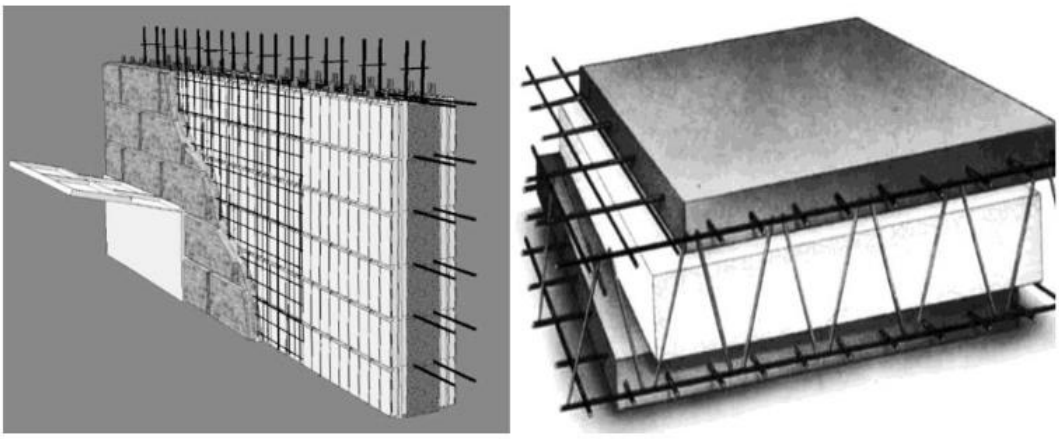

Fig. 2 Structure of 3D panels

Shotcreting is one of the most important stages of erecting 3D. This is a method of applying concrete layer or other mortar (plaster, clay) to the surface of concrete or reinforced concrete structures. This is a coating with foamed concrete. Shotcreting is applied under the compressed air pressure as a result of which the cement particles interact closely with the surface of the structure filling even the cracks and small pores (Fig. 3) [3].

Fig. 3 Shotcreting process

Fast-hardening cement is used when a method of shotcreting with foamed concrete is applied. The panel is coated with 4-5cm thick foamed concrete layer from the outside and with 3-4 cm thick layer – from the inside.

3D panels can be applied to any building if the service life of the building and the heat-resistance calculation match [4].

3D panels are also used for internal walls. To ensure surface roughness the installation of panels starts at the corner of the building and they are successively fixed with reinforcing bars ensuring them with a soft wire. Installation of panels in one of the floors takes an average two-three days.

Fig. 4 Window and door parts installation

Installation of utilities is another important point in the building erection. The advantage of this technology is that it is quite easy to install all communications or initially to identify them considering the correct technological sequence of work. After all the steps are completed, proceed to the next design - the roof. 3D panels allow you to get any angle the most convenient for the roof.

Smooth surface allows to apply absolutely any type of coating [5].

Research results

The use of 3D panels provides the most rationality in economic terms. Compared to other traditional building structures, the cost of 3D panels is reduced by 60-70%. In addition, any method of interior decoration can be used: paints, wallpapers, tiles etc.

Combining correctly all structures we can obtain an appropriate reinforced concrete structure where the 3D panels are completed with reinforced concrete mesh.

The result is a building with fairly simple construction method.

Conclusion

Consequently as a result of our research we realized that 3D panels are one of the contemporary construction innovations and are widely used abroad. They are especially important when used in the short-term buildings.

An important advantage of 3D panels is that they are efficient. Compared to traditional constructions, 3D panels have a low cost threshold. However, in addition to the advantages, 3D panels have disadvantages making them suitable for buildings with short-term maintenance as due to air temperature fluctuations they will be corroded and the building will become unreliable.

Hence, these studies allow to realize that for meeting current construction requirements, the infrastructures or structures with features complying all the proposed construction requirements like 3D panels shall be used.

References

1. Бадьин Г.М. Б15 Современные технологии строительства и реконструкции зданий / Петербург, 2013. 153 с.
2. 3D–панели. [Электронный ресурс]. Режим доступа: http://3dcomplect.com/3d-paneli/ (дата обращения: 20.04.2019).

3. Калугина Ю.Е., Бабанов В.В., Современная технология строительства домов с применением 3d-панелей, Современные инновации № 2(30) 2018, с. 23.
4. Строительство своими руками дома из 3D панелей и технология торкретирования.[Электронный ресурс]. Режим доступа: http://kak-svoimi-rukami.com/2012/09/stroitelstvo-svoimi-rukami-doma-iz-3d-panelej-i-texnologiya-torkretirovaniya/ (дата обращения: 21.04.2019).
5. Юдина А.Ф. Строительство жилых и общественных зданий : учебник для студ. учреждений сред. проф. образования / А.Ф. Юдина. М.: Издательский центр «Академия», 2011. 10-20 с.

References

1. Badyin G.M., B15 Modern technologies for the construction and reconstruction of buildings / Petersburg: Petersburg, 2013, p. 153.
2. 3D panels. [Electronic resource]. Access mode: http://3dcomplect.com/3d-paneli/ (accessed date: 04/20/2019).
3. Kalugina Yu.E., Babanov V.V., Modern technology for building houses using 3d panels, Modern innovations No. 2 (30) 2018, p. 23.
4. DIY construction of houses from 3D panels and shotcrete technology. [Electronic resource]. Access mode: http://kak-svoimi-rukami.com/2012/09/stroitelstvo-svoimi-rukami-doma-iz-3d-panelej-i-texnologiya-torkretirovaniya/ (accessed: 04/21/2019).
5. Yudina A.F., Construction of residential and public buildings: a textbook for students. institutions environments. prof. education / Publishing Center “Academy”, 2011, 10-20 p.

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3D ՊԱՆԵԼՆԵՐԻ ՕԳՏԱԳՈՐԾՈՒՄԸ ԿԱՐՃԱԺԱՄԿԵՏ ՇԻՆՈՒԹՅՈՒՆՆԵՐՈՒՄ ՈՐՊԵՍ ԱՐՏԱՔԻՆ ԿՈՆՍՏՐՈՒԿՑԻԱ

Ս. Ե. Պետրոսյան, Ս. Կ. Պետրոսյան
Ճարտարապետության և շինարարության Հայաստանի ազգային համալսարան, ՀՀ, ք. Երևան

3D պանելները համարվում են ժամանակակից շինարարական արտաքին կոնստրուկցիա, որոնք ունեն որոշակի կարևոր առանձնահատկություններ:

Հոդվածում նախ ներկայացվում է, թե ինչ են իրենցից ներկայացնում 3D պանելները, ինչի համար է անհրաժեշտ դրանց կիրառությունը, որից հետո ներկայացվում է, թե ինչ մեթոդներով է այն մոնտաժվում: Անդրադառնում ենք նրա ջերմային դիմադրողականությանը: Ներկայացվում են նաև 3D պանելների կիրառման առավելություններն ու թերությունները:

Բանալի բառեր. 3D պանելներ, կոնստրուկցիա, շինարարություն, շինարարական տեխնոլոգիաներ, փրփրաբետոն, տորկրետավորում:

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ИСПОЛЬЗОВАНИЕ 3D-ПАНЕЛЕЙ В НЕДОЛГОВЕЧНЫХ СООРУЖЕНИЙ В КОЧЕСТВЕ НАРУЖНЫХ КОНСТРУКЦИЙ

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3D панели считаются современными внешними стороительными конструкциями, которые имеют некоторые важные своиствия.

В статье сперва говориться что из себя представляют 3D панели, для чего важны ихние использывание, а так же говориться как эти конструкции монтажируеться. Мы ссылаемся на его тепловое сопротивление. Также представлены преимущества и недостатки использования 3D панелей.

Ключевые слова: 3D панели, строительство, строительные технологии, пенобетон, кладка, торкретирование.

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UDC - 556:627.1:34.1

THE STATE OF UTILIZATION OF WATER RESOURCES OF THE REPUBLIC OF ARMENIA AND RELATED ISSUES

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The current state of development of the events shows that the fight for the use of water resources and other resources will intensify both in the world and in the Republic of Armenia which can be compared to the fierce struggle for hydrocarbon fuel. We note only one difference. If oil has substitutes and activities for the wider use of alternative fuels do not stop, then water remains the only and exclusive resource that is not replaced by another alternative. Under such conditions, the issues of water use and conservation become increasingly urgent which are particularly important in the Republic of Armenia as it is impossible to develop the economy without water resources as well as to meet the growing demands of the population for this indispensable resource.

Key words: water resources, water crisis, water offer and demand, water intake, water utilization, surface and underground water resources, regenerating water resources**.**

Introduction

In almost all countries around the world issues about water utilization are very significant so most states have both short-term and long-term strategies for using them. The Republic of Armenia is included in a group of countries with a high level of water crisis according to the current classification of water resource crises which obliges to pay more attention to identifying ways of increasing the efficiency of utilization of water resources in the republic both today and in the future.

Conflict setting

The authors cover a brief description of the RA water resources, the general picture of water distribution and and water utilization, freshwater renewable resources, water losses and other indicators characterizing the utilization of water resources presenting the economic potential which can make possible the exporting of water. From this point of view, it was important to identify export-related issues and discuss ways to solve them.

By World Resource Institute which investigates the natural resources (water, energetics, forestry etc) and climatic changes, the data on provision of water supplies of all the countries of the world had been published which definitely vary from the visions about water resources of RA existing up to now. The researchers of the institute underline that particularly water crises become usual and typical to many countries about which such approaches have not been formed yet.

The causes of the water crises are not only limited by droughts but are also due to increased demand for water around the world noting that demand has more than doubled since the 1960s.

Researchers from all countries of the world have been divided into five groups classified by the severity of crises of water resource. Thus, in 17 countries which are in extreme crisis (12 of which are the Middle East and North African countries), one quarter of the world population lives and in average each year 80% of available water resources of those countries is produced for irrigated agriculture, industry and domestic use.

The other group consisting of twenty-seven countries, including the Republic of Armenia, is characterized as a group of countries with a high level of water crisis where each year more than 40% of available water resources is produced. The countries with the highest water resource crisis are: Chile, Cyprus, Yemen, Andorra, Morocco, Belgium, Mexico, Uzbekistan, Greece, Afghanistan, Spain,

Algeria, Tunisia, Syria, Turkey, Albania, Armenia, Burkina-Fasone, Jibuty, Namibia, Kyrgyzstan, Niger, Nepal, Portugal, Iraq, Egypt and Italy where one third of the world's population live together.

Other countries are grouped in this way:

- Countries having higher than average rate of water crisis where 24 countries are included (among them China, Kazakhistan, Tajikistan and Azerbaijan),
- Countries having lower than average rate of water crisis where 32 countries are included (among them the USA, Ukraine, Georgia, the Russian Federation and Moldova),
- Countries having low rate of water crisis where 64 countries are included (among them Canada, Finland, Norway, New Zealand, Belorus) [1].

The global crisis of water resources has many impacts on livelihoods and economies of people posing serious threats to the lives, living standards and sustainable operation of economic entities. With the increase in population and the socio-economic development of countries, demand for water tends to increase while climate change makes precipitation, weather forecasting and the formation of renewable water resources more unpredictable.

The survey by World Resource Institute also identifies the main ways to overcome the water crisis. First of all, the focus should be on increasing the efficiency of agriculture which means that every amount of water should support the growth of plants. In particular, the main emphasis may be on the use of such seeds that require less water and the use of irrigation systems that allow the use of the exact amount of water required without overcrowding and wasteful flooding of cultivated areas. In order to have an efficient agriculture, it is also important to make capital investments aimed at increasing water productivity.

The second direction which is mentioned by the specialists of the institute, is the investments in “gray” and “green” infrastructures. The analysis also shows that the indicators of the water resource crisis can vary greatly throughout the year. “Green” infrastructure built in the form of new pipelines and treatment plants can simultaneously solve issues of both water supply and water quality.

Water recycling and re-utilization is the third area that will help to cope with the water crisis. Recommendations in this regard are to treat wastewater as a “new” source of water after recycling [1].

Among the factors contributing to the socio-economic development of any country including labor, capital and entrepreneurial experience and skills are the importance of both natural resources and conditions and their inclusion in the economic circulation and the efficient management and organization of these processes.

Moreover, it is possible to achieve the improvement of such important indicators characterizing the level of development of the country as national wealth, which, being one of the main macroeconomic indicators, essentially describes the level of capitalization of the economy of the country. It is currently characterized by four components - manufactured, natural, human capital and the dimension of net external assets. It is sufficient to note that according to World Bank estimations, national wealth was totally US $ 52894 per capita including 15451 produced capital, 12702 natural capital, 27329 human capital and US $ -2588 net assets [2 , p. 226-233].

The negative dimension of trade balance was characteristic for all the years of the third Republic of Armenia. Thus, the export of Armenia amounted to USD 270,9 million in 1995, import - USD 673,9 million, the negative balance of foreign trade amounted to -403,0 million USD. In 2000 these figures were like this: exports - $ 300,5 million, imports - $ 884,7 million and the negative balance - $ 584,2 million, in 2005 – 973,9, 1801,7 and -827,8, in 2010 – 1041,1, 3748,9 and -2707,8, in 2015 – 1485,3, 3239,2 and -1753,9, in 2016 – 1791,7, 3273,5 and -1481,8 respectively. In 2018 exports amounted to $ 2412,4 million, imports - $ 4975,5 million and negative balance - $ 2563,1 million [3].

The negative balance of foreign trade led to the negative balance of payments balance of the republic which led to the increase of the external debt of the Republic of Armenia (which amounted to USD 5536,4 million in 2018) [3], whose further increase is due to serious socio-economic and political problems.

Taking into account the above mentioned and many other circumstances, it is important to identify and use new sources of revenue growth in the country among which we believe that water resources are important. And if we notice that a significant portion of these resources are not used in the country and are flowing to neighboring countries, then it will become clear that one of the most valuable natural resources in the world, water, is "exported" from the country at zero cost. If in the basis of the exchange value of any commodity the consumption value of that commodity is primarily (but not exclusively) set, then water is the only commodity that is indispensable (as opposed to, for example, oil that can be replaced by many other alternatives).

Research results

Brief description of water supplies of the Republic of Armenia. Water resources of Armenia are formed mainly from the regional atmospheric precipitation and from the water flows of border rivers the Araks and the Akhuryan. Though most part of researchers has one opinion on the sources of formation of water resources of Armenia , however, various dimensions are presented during the estimation of their storages [4, p. 45, 5, p. 27 and 34, 6, 7, 8, p. 84 and 278, 9, 10, p. 63-67, 11].

Even for an index such as the average long term surface water flow which is relatively stable (determined on the basis of averaged data of 75–80 years), the conclusions are very different. There are also significant differences between the indices of groundwater characterization, in particular, in terms of the use of their storages (or, as previously assumed, "operation"). Thus, water resources (both surface and underground) are estimated to range from 11,7 km^3 to 9,0 km^3 and even 7 km^3, respectively [12, p. 59].

Average annual precipitation in Armenia was 592 mm. and in 2017 it was 481,0 mm in 1961-1990. (The 2017 precipitation deviation was – 111,0 mm compared to that of 1961-1990) [13, p. 118]. Unlike 2017 and 2018, such deviation has had a positive effect. The average annual precipitation was 606,3 mm. in 2018 which is 14,3 mm higher than the long term norm of 1961-1990 [14, p. 132].

Over 80% of the total river flow is formed (excluding Lake Sevan) in the Republic of Armenia. Much of the leftover surface flow forms the transit flow of border rivers of the Araks and the Akhuryan [15, p. 5]. Borderline river influx is estimated equally as 0,9 billion cubic meters per year. The difference between groundwater influx and outflow is positive, about 0,1 billion cubic meters per year. The current evaporation is 11,5 billion cubic meters and the continuous flow of inner rivers is 6,3 billion cubic meters. The renewing storages of surface waters comprise 7,2 billion cubic meters per year. About 2,3 billion cubic meters of this water are used (originally 4 billion cubic meters), 2 billion cubic meters of which (previously 3 billion cubic meters) are used for irrigation and provision for other production areas and 430,0 million cubic meters (previously 550 million cubic meters) for drinking and domestic purposes [16, p. 5-6].

The study of the data in Table 1 allows to observe the above-mentioned patterns summarizing of which we can note that all indicators of water intake and water utilization decreased in 2018 compared to 1990 with the total volume of water intake by 31,1%, water intake from groundwater sources decreased by 10,1%, total water use by 44,9%, drinking and domestic water use by 70,8%, water utilization for industrial, utility and construction purposes by 65,2% and water utilization in agriculture, fish production and forestry by 34,9 %.

Table 1

Water intake and water utilization in the Republic of Armenia in 1990-2018, mln. cube meters

	1990	1995	2000	2005	2010	2015	2016	2017	2018
1	2	3	4	5	6	7	8	9	10
Water intake, totally	3942.0	2531.0	1871.2	2770.6	2126.4	3271.7	3181.9	2865.4	2714.4
Among them from underground waters	1325.4	851.0	533.0	803.0	1005.2	1304.4	1136.3	1154.5	1191.6

1	2	3	4	5	6	7	8	9	10
Totally used water	3497.0	1478.0	1046.0	1905.0	1341.2	2533.1	2470.0	2040.0	1926.5
Including for needs									
Drinking *	634.0	527.0	107.0	69.0	67.1	96.5	107.7	107.6	185.1
Industry, household and construction	406.0	209.0	42.0	70.0	121.4	153.3	145.4	225.2	141.4
Agriculture, fish industry and forestry	2457.0	742.0	897.0	1766.0	1152.7	2283.3	2216.8	1707.2	1600.0

* Up to 2000 included for drinking and domestic needs
Source by data base of RA statistical service of the department of "Water resources", statistical annual of Armenia of 2019, RA Statistical committee, 2019, p. 216, RA Statistical committee, 2011, RA NSS, 2011, p. 217, statistical annual of Armenia of 2007, RA NSS, 2007, p. 190, statistical annual of Armenia of 2002, RA NSS, 2002, p. 217, statistical annual of Armenia of 2001, RA NSS, 2001, p. 173, statistical annual of Armenia of 1993-1994, RA NSS, (https://www.armstat.am/am/?nid=586&year=1994), p. 69

Table 2 presents the data on renewable freshwater resources in the Republic of Armenia for the years 1990-2018 as well as the average values of long term observations which can be compared with the deviations for each year from the "normal" values.

Table 2

The renewing resources of freshwater in RA in 1990-2018, the rates, mln. cube meters

	Average long term values	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
Precipitation	16710	15794	15407	11264	12516	17761	18595	15287	18714	16658	19221
Summative evaporation	9851	10426	10526	9032	9750	10930	10997	10531	11320	11081	11367
Influx	6859	5368	4881	2232	2766	6831	7598	4756	7394	5577	7854
Surface and underground influx	910	1442	1189	641	557	1062	1086	1546	1063	1157	1513
Renewing water resources	7769	6810	6070	2873	3323	7893	8684	6302	8457	6734	9367

Continued

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Precipitation	13378	17713	19447	19579	15997	16310	16493	18506	19012	14335	18059
Summative evaporation	9840	10674	12549	11066	10816	10773	11432	12827	12928	10382	12120
Influx	3538	7039	6898	8512	5181	5537	5061	5678	6084	3953	5939
Surface and underground influx	901	1294	1783	773	641	842	471	763	798	710	632.4
Renewing water resources	4439	8333	8681	9285	5822	6379	5532	6441	6882	4663	6571

Information source by data base of the department of "Water resources" of RA statistical committee

The current state of utilization of water supply of the Republic of Armenia

Data of freshwater intake and water utilization (by classification of economic activity) studied in 2011-2018 in the RA shows that water intake increased by 11,3% in 2018 compared to 2011 (from 2438,3 million m^3 in 2011 to 2714,4 million m^3 in 2018). The largest volume of water intake was observed in 2015 – 3271,7 million cubic meters. A study of water utilization indicators shows that it increased by 10,8% in 2018 compared to 2011 (from 1738,1 million cubic meters in 2011 to 1926,5 million cubic meters in 2018) and the highest rate of water utilization was also in 2015 – 2533,1 million cubic meters (Table 3).

According to classification of economic activity the largest water intake implementers were the spheres of water supply, sewerage, waste management and recycling with a share of total water intake from 65,8% in 2011 decreasing to 70,7% in 2018 with water utilization indicators comprising 9,5% and 12,3% respectively. Irrigation occupies the first place in the water utilization index with the share of total water use rate reaching 49,3% from 2011 to 55,3% in 2018. The water intake and water utilization for the purpose of fish industry is also significant, the water intake for these purposes was only 20,5% in 2011 and 18,1% in 2018 and water utilization 28,7% and 25,4% respectively (Table 3).

Table 3

Freshwater intake and utilization (according to the types of economic activities) in 2011-2018, mln. m^3

	2011		2012		2013		2014		2015		2016		2017		2018	
	Intake	Utilization	Intake	Utilization	Intake	Utilization	Intake	Utilization	Intake	Utilization	Intake	Utilization	Intake	Utilization	Intake	Utilization
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Total RA	2438.3	1738.1	2941.2	2187.2	2955.1	2089.1	2860.5	2112.8	3271.7	2533.1	3181.9	2470.0	2865.4	2040.0	2714.4	1926.5
Agriculture, forestry and fish industry	627.5	1367.7	790.9	1793.2	1362.8	1845.9	921.3	1748.1	1097.7	2269.9	896.6	2191.6	961.4	1751.6	660.4	1553.8
Irrigation	127.5	867.7	178.7	1181.1	561.1	1044.5	224.9	1051.7	357.6	1519.1	227.3	1522.3	446.3	1236.6	167.8	1064.6
Forestry	0.3	0.2	0.4	0.4	0.6	0.5	0.5	0.5	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0
Fishing/ fish industry	499.7	499.7	611.8	611.7	801.1	800.9	695.9	695.9	740.1	750.1	669.3	669.3	515.1	515.0	492.6	489.2
Mining industry and open mine exploitation	54.9	54.9	152.3	152.2	58.4	58.3	101.9	133.8	44.0	88.1	81.6	81.5	83.9	83.9	84.0	84.0
Processing industry	93.6	9.4	45.9	4.5	41.7	4.1	38.0	4.2	41.1	4.2	5.9	6.0	7.7	7.7	17.1	17.1
Electricity, gas, steam and good quality electricity provision	40.9	38.3	33.5	32.1	23.1	22.2	27.9	27.8	24.2	24.2	21.6	21.4	27.2	27.2	28.9	28.9
Water supply, sewage, waste management and recycling	1603.2	165.4	1902.3	147.6	1456.8	113.1	1744.2	147.8	2060.7	119.1	2166.0	123.2	1747.7	132.1	1919.1	237.8
Water supply (water collection, processing, distribution)	1602.0	164.3	1902.2	147.4	1444.9	111.2	1743.8	147.5	2050.7	97.2	2165.7	122.7	1744.4	128.8	1805.7	124.4

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
from which for irrigation	1017.7	-	1317.6	-	927.9	-	1221.7	-	1574.9	-	1645.9	-	1165.2	-	1221.6	-
Construction	0.7	0.7	0.5	0.5	0.2	0.2	4.7	4.7	0.1	0.1	0.1	0.1	3.6	3.6	0.2	0.2
Other types of economic activity	17.4	101.7	15.8	57.1	12.2	45.3	22.5	46.4	3.2	27.5	10.1	46.5	33.9	33.9	4.7	4.7
GDP, mln. USD (PPP, equivalent value, 2011)	-	20192.6	-	21646.5	-	22360.8	-	23165.8	-	23907.1	-	2395.9	-	25751.6	-	27090.6
Water utilization by GDP 1000 USD (PPP, purchasing value, 2011), mln.m ^{2}/1000 USD	-	86.1	-	101.0	-	93.4	-	91.2	-	106.0	-	103.1	-	79.2	-	71.1

Information by data base of RA statistical committee «Water resources» department
Citation http://armstatbank.am/pxweb/hy/ArmStatBank/?rxid=002cc9e9-1bc8-4ae6-aaa3-40c0e377450a

The dimension of the indicator of water utilization depends on the technological as well as anthropogenic and other factors of individual types of economic activity. Table 4 presents the water utilization of the Republic of Armenia in 2015-2018 by main economic activity types of water utilization. From the above mentioned data it follows that water utilization for 1000 AMD of GDP of Armenia in 2015-2018 differ significantly from each other. Thus, if the index in 2018 was the highest in the water supply, sewage, waste management and recycling sector comprising 8,10 and for certain types of activity it stood around 0,0 in construction and in recycling industry it comprised about 0,03. Totally, the water utilization for 1000 AMD of GDP produced in the RA comprised 0,32 m^3 in 2018 and it decreased (0,50) compared to 2015 while the average for the years studied (2015-2018) was 0,42 m^3.

Table 4

Water utilization for 1000 AMD in RA GDP in 2015-2018 according to main types of economic activities of water users

	GDP, mln. AMD				Water utilization, mln. m^3				Water utilization for 1000 AMD of GDP (current prices), m ^{3}/1000 AMD				
	2015	2016	2017	2018	2015	2016	2017	2018	2015	2016	2017	2018	Average 2015-2018
1	2	3	4	5	6	7	8	9	10	11	12	13	14
Agriculture, forestry and fish industry	868,671.0	830,553.4	834,354.6	822,444.4	2,533.1	2,470.0	2,040.0	1,926.5	2.92	2.97	2.45	2.34	2.67
Mining industry and open mine exploitation	107,717.5	130,835.2	185,510.3	173,213.2	88.1	81.5	83.9	84.0	0.82	0.62	0.45	0.48	0.59
Processing industry	464,325.5	521,153.4	591,568.3	679,030.0	4.2	6.0	7.7	17.1	0.01	0.01	0.01	0.03	0.01
Electricity, gas, steam and good quality air provision	231,279.0	227,107.8	226,849.4	220,860.0	24.2	21.4	27.2	28.9	0.10	0.09	0.12	0.13	0.11

1	2	3	4	5	6	7	8	9	10	11	12	13	14
Water supply, sewage, waste management and recycling	19,223.5	23,795.6	27,839.0	29,340.4	119.1	123.2	132.1	237.8	6.20	5.18	4.75	8.10	6.06
Construction	474,107.0	393,176.4	404,402.7	397,824.6	0.1	0.1	3.6	0.2	0.00	0.00	0.01	0.00	0.00
Other types of economic activities	2,878,309.7	2,940,671.7	3,293,969.0	3,682,345.5	27.5	46.5	33.9	4.7	0.01	0.02	0.01	0.00	0.01
Total (gross domestic product or water utilization)	5,043,633.2	5,067,293.5	5,564,493.3	6,005,058.1	2,533.1	2,470.0	2,040.0	1,926.5	0.50	0.49	0.37	0.32	0.42

Source by statistical annual of Armenia 2019, p. 236, 247-248, data base of RA statistical committee «Water resources»
Citation by http://armstatbank.am/pxweb/hy/ArmStatBank/?rxid=002cc9e9-1bc8-4ae6-aaa3-40c0e377450a

Let us note that freshwater of Armenia differs with its high quality and part of it being «formed» contain those useful mineral substances necessary for human beings (Table 5).

Table 5

Freshwater intake (surface and underground), according to their indicators and years, mln. m ^{3}

	1990	1995	2000	2005	2010	2015	2016	2017	2018
1. Water intake (Totally 2+3), mln.m^3	3942.0	2531.0	1871.2	2770.6	2126.4	3271.7	3181.9	2865.4	2714.4
2. Water intake from surface springs, mln. m^3	2616.6	1680.0	1338.2	1967.6	1250.6	1967.3	2045.6	1710.9	1522.8
3. Water intake from underground springs, mln.m^3	1325.4	851.0	533.0	803.0	875.8	1304.4	1136.3	1154.5	1191.6
4. Renewing water resources, mln.m^3 annually	7769.0	6070.0	2873.0	8457.0	8681.0	6441.0	6882.0	4663.0	6571.4
5. The index of exploitation of water resources (WREI), %	50.7	32.6	24.1	35.7	27.4	42.1	41.0	36.9	34.9

Source by data base of RA statistical committee «Water resources»
Citation http://armstatbank.am/pxweb/hy/ArmStatBank/?rxid=002cc9e9-1bc8-4ae6-aaa3-40c0e377450a

Losses of water resources

The study of statistical data shows that there are still significant losses of water resources in the Republic of Armenia. It should be noted that the water losses in 2011-2018 did not decrease but increased reaching from 700,1 million cubic meters in 2011 to 787,9 million cubic meters in 2018. The highest loss was in 2013 (866,0 million cubic meters). In other words, if in 2011 the loss of water resources to total water intake (2438,3 million cubic meters) was 28,7%, then in 2018 it comprised 29,0%. In terms of storage the largest loss of water resources was recorded in the water supply, sewerage, waste management and recycling sectors where the share of total losses was 99,6% in 2011 and 95,8% in 2018 (Table 6).

Table 6

Water losses (according to the types of classification of economic activities) in 2011-2018, mln. m^3

	2011	2012	2013	2014	2015	2016	2017	2018
Total RA	700.1	754.0	866.0	747.4	738.6	711.9	825.4	787.9
Agriculture, forestry and fishing	0.1	0.1	0.2	0.2	0.0	0.0	0.0	33.1
Irrigation	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
Forestry	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0
Fishing /fish industry	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0
Mining industry and open mine exploitation	0.0	0.1	0.1	0.1	0.0	0.1	0.0	0.0
Processing industry	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Electricity, steam, gas and good air provision	2.5	1.4	0.9	0.0	0.0	0.2	0.0	0.0
Water supply, sewage, waste management and recycling	697.5	752.4	864.8	747.1	738.6	711.7	825.4	754.8
Water supply (water collection, processing, distribution)	697.5	752.4	854.8	747.1	738.5	711.7	825.4	754.8
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other types of economic activity	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Source by data base of RA statistical committee «Water resources»
Citation http://armstatbank.am/pxweb/hy/ArmStatBank/?rxid=002cc9e9-1bc8-4ae6-aaa3-40c0e377450a

If we consider the coefficient of efficiency of water resources in the Republic of Armenia (water utilization ratio to water intake), then we find it appropriate to consider it at two levels: a) the rate of final water utilization in water intake; and b) the rate of final water utilization of water utilization in the territory of the Republic of Armenia (we take them as 10 km^3 or 10 billion cubic meters per year). In this case, we will have the following picture: in 2011, the coefficient of the efficiency of utilization of water made up for a) 71,3%, water utilization made up 1738,1 mln. m^3) and for b) 17,4% and water resources loss comprised 8261,9 million cubic meters, in 2017 respectively for a) 71,2%, water utilization comprised 2040,0 million cubic meters and b) 20,4% and water resources loss comprised 7960,0 million cubic meters.The estimated utility coefficient for 2018 will be a) 71,0% , water utilization comprised 1926,5 million cubic meters and b) 19,3% and loss of water resources comprised 8073,5 million cubic meters.

In other words, every 4- 8 years (38,21 km^3/7,96 km^3) the Republic of Armenia “loses” one Lake Sevan. Thus, it turns out that the most expensive resource “exported” from the Republic of Armenia, fresh water is “exported” to the neighboring country at zero cost. It follows that radical reforms are needed in the country to improve the state of water utilization and increase the efficiency of utilization of water resources.

Exporting and importing rates of natural or artificial mineral waters and soft drinks in RA. It can be seen from the data in Table 7 that the sizes of export and import of natural or artificial mineral water and soft drinks are insignificant which does not correspond to the potential and capacity of the RA water resources. Hence there is a strong need to sharply increase the export volumes of the above mentioned products.

Table 7

Exporting and importing rates of natural or artificial mineral waters and soft drinks in RA in 2005-2018

Goods	Date	Export (tonne)	Export (1000 USD)	Import (tonne)	Import (1000 USD)
1. Waters (natural or artificial mineral waters) and drinks (without sugar)	2019*	17424.2	6603.0	411.9	291.1
	2018	18391.4	7430.4	585.8	364.3
	2017	16905.3	7333.3	1022.4	652.5
	2016	15039.8	6055.7	345.9	186.7
	2015	14702.6	5997.6	543.2	184.3
	2010	12771.1	5341.1	288.5	197.5
	2005	6342.2	1661.6	50.3	30.6
2. Mineral water and soft drink (with sugar)	2019*	4164.3	2401.5	44808.7	12447.3
	2018	25526.5	2611.6	20018.5	11456.1
	2017	4353.4	2980.0	18191.1	11555.1
	2016	5638.4	3661.9	70162.9	9305.3
	2015	3844.9	2848.3	14832.8	9105.6
	2010	2006.1	2025.9	20494.9	14639.4
	2005	1384.3	805.8	7526.5	3964.5
Total (1 + 2)	2019*	21588.5	9004.5	45220.6	12738.4
	2018	43917.9	10042	20604.3	11820.4
	2017	21258.7	10313.3	19213.5	12207.6
	2016	20678.2	9717.7	70508.8	9492.0
	2015	18547.6	8845.9	15375.9	9289.8
	2010	14777.2	7367.0	20783.4	14836.9
	2005	7726.5	2467.4	7576.9	3995.1

* Indices of 10 months of 2019

Information by data base of «Foreign trade» of RA statistical committee and «Data base of foreign trade according to the 4th classification of goods list appellation»

Citation https://www.armstat.am/am/?nid=148

Drinking water as product of international trade

The study of individual products and services of world market shows that deep and comprehensive changes have taken place in the field over the last 20-30 years. Depending on demand, new products have emerged and on the contrary, due to lack of the demand, some of them are gradually "leaving" the market.

One of the important products of the world market in recent years is drinking water which is gradually attracting more and more sizes and sectors in the export and import turnover of different countries. We can also surely say that the volumes of drinking water will increase significantly in the near future. Obviously, meeting the needs of the population for drinking water in individual countries is extremely problematic and these countries are looking for different ways to solve this problem. For example, it was mentioned about Antarctica icebergs in the ways to satisfy the demand for potable water in Arab countries in 1970s which were pushed to the Arabic Peninsula and bottled to the population. On the other hand, the countries that are rich in drinking water can take advantage of the situation on the world market and receive foreign exchange revenues which is needed to reduce the negative foreign trade balance of the country.

From the point of view of expanding the export of potable water from the Republic of Armenia, it is important to present its developments in global market and discuss the dynamics of consumption of bottled water as well. With the rise of global urbanization and environmental pollution, the problem of drinking water is increasingly sharpened worldwide today as a result of which bottled water becomes a demanded product and its production becomes a profitable and promising business. Drinking water is one of the rare resources that our country is rich in.

Production of drinking water, especially bottled water in our country is starting to gain new scale and quality. There has been a sharp increase in competition in this segment of the market lately with new players emerging, leading to increased market saturation. However, we still have an unsolved problem of distributing bottled water to the world market which is particularly important in the context of a rapidly changing context of world market.

The growing interest in bottled water in the world is also evidenced by the amount of bottled water consumption compared to other beverages. In particular, according to statistics in the largest bottled water market in the United States in the last decade, consumption of this product appeared in the second place among beverages whereas it was the 5th only 10 years ago. Over the years, bottled water has surpassed beer, coffee and milk and currently only rebates carbonated soft drinks. So in 2000 the United States consumed 57 billion liters of carbonated soft drinks which comprised 28% of all beverages while bottled water was only 9% or 18 billion liters. According to the results in 2008, the consumption of carbonated soft drinks has decreased to 53 billion liters, while the consumption of bottled water has reached 33 billion liters (about 15% of total drinks consumption). There are clearly shaped market giants in the global bottled water market including Nestle, Danone, Coca-Cola and Pepsi Cola. The latter together account for more than 35% of world turnover. The leader is Nestle with 12%, the second is Danone with 8,5%. According to expert estimatations, in the next five years these multifunctional food companies will focus on water production issues which in turn will contribute to increasing their role and market concentration in the global market. In total, 8 of the world's top 10 brands in terms of sales belong to “Big Four”, 3 to Danone and Nestle each, 2 to Coca-Cola and Pepsi Cola each. The top five best-selling brands in the world are Aqua (Danone), Pure, Lile (Nestle), Wahaha (Danone) and Aquafina (Pepsi Cola).

Chart 1 shows the countries with the largest amounts of bottled water sales in 2015 and the projected sales volumes of those countries in 2020. Figures indicate that China will remain the world leader in sales of bottled water which provided a 17% share of that product in 2015.

According to the results of research conducted by The Business Research Company, the global bottled water market has grown by more than $ 200 billion providing a 9% annual increase due to concerns over the threat of contaminated water consumption from 2014 to 2017. In addition to concerns over health threats, the increase in bottled water consumption has also contributed substantially to the increase in disposable income of the population of Asia and the Pacific region as the largest bottled water consumers [17].

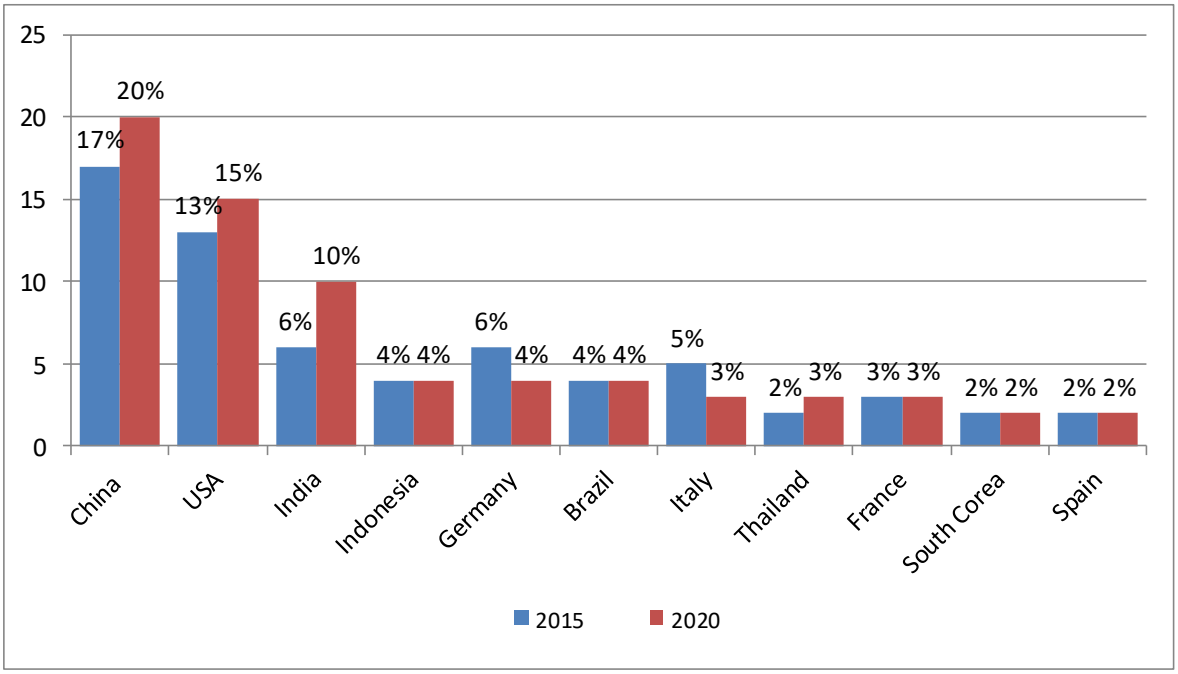

Chart 1. The largest sizes of sale of bottled water in the world in 2015 and forecasting for 2020 (%)
Source by https://www.statista.com/statistics/252208/global-bottled-water-volume-share-by-region/

Revenues in bottled water market worldwide totaled $ 286,2 billion in 2019 and this market is expected to grow at a very high rate with an average annual growth of 6,4% for 2020-2023 (Chart 2). At the same time, the largest part of the income of this sector in the world was formed in the USA, it was 67,6 billion USD in 2019. The income per capita in bottled water production totaled $ 38,84 in 2019 with average consumption of per capita 61,5 liters in 2019 [18].

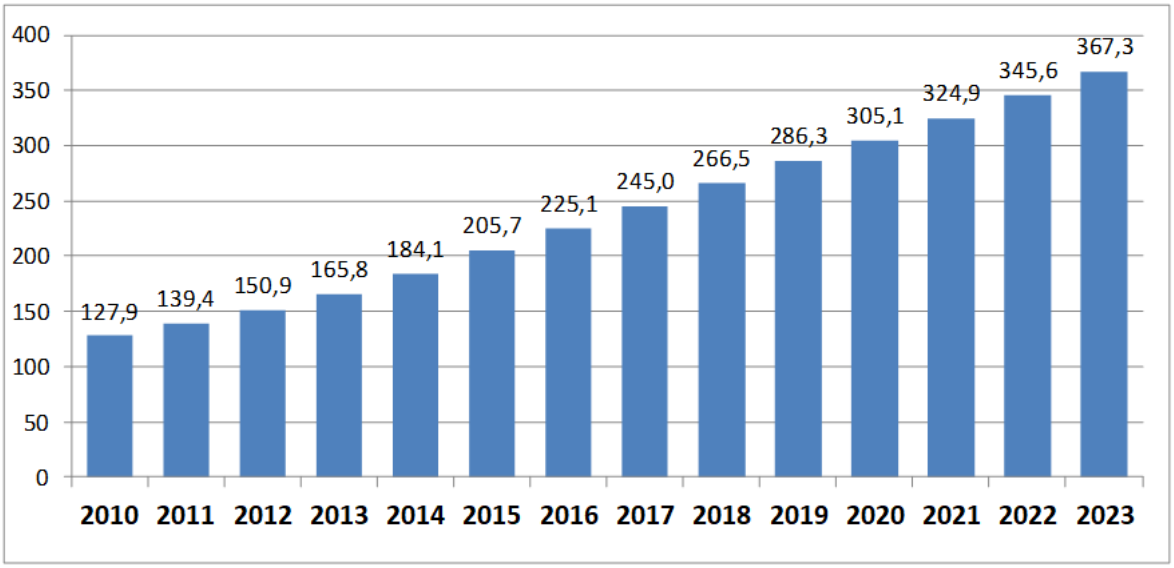

Chart 2. The revenues in bottled water sphere in 2010-2019 and the predictions utill 2023, billion USD

Source by https://www.statista.com/outlook/20010000/100/bottled-water/worldwide#market-revenue

If we admit that one liter of drinking water exported from Armenia can be sold for $ 0,37 in the world market (let us note that the value of one liter of drinking water in the world market is almost equal to the value of one liter of oil which has risen significantly in the recent period, comprising 0,5 USD on October 22, 2018) [19], it is easy to see that the revenue from the export of one million liters (1000 cubic meters) of drinking water will amount to $ 370 million USD, exporting 10 million cubic meters we will get $ 3,7 billion which exceeds the amount of exports from Armenia in 2017 more than three times. Such a quantity of water can be taken from Lake Sevan and exported mainly through the shoreline to the Persian Gulf. It is also important to note that the amount of water can also be delivered to the countries of the region by gravity, knowing that Armenia is 700 meters higher above sea level than the countries of Persian Gulf by its geographical location which would significantly reduce the costs of transporting drinking water. By the way, for the implementation of this project it is advisable to create a consortium at the expense of those countries that would like to use the drinking water of the RA as they did in the neighboring Azerbaijan during the export of oil and gas.

Conclusion

Since independence the whole vision of scientifically-based and consistently implemented natural (including water) resource management has not been formulated in the Republic of Armenia for the long-term development of the economy of the country which would set out a systematic action plan for sector development. Such a package should take the utmost account of geopolitical, national security, resource, socio-psychological issues, the formation of new culture of utilization of natural resources, comparative advantages of foreign trade and other features.

No matter how limited the resources are, there are always standards for their poor, good or better utilization and possible solutions. The subprojects providing access to the objectives set in the national interest are diverse (in the fields of agriculture, energy, information technology, education,

health) and include a comprehensive water resource utilization program in this list followed by detailed elaboration and step-by-step implementation.

Therefore, taking into account the unique significance of water resources in the development of the Republic of Armenia and its economy, it is necessary to develop and approve integrated development plans in the form of laws for the use of the water resources of the Republic of Armenia for at least 15-20 years by five years term, three years term and yearly term phases.

References

1. "17 Countries, Home to One-Quarter of the World's Population, Face Extremely High Water Stress", by Rutger Willem Hofste, Paul Reig and Leah Schleifer, August 06, 2019, Internet source (as of 25 December 2019): https://www.wri.org/blog/2019/08/17-countries-home-one-quarter-world-population-face-extremely-high-water-stress
2. The Changing Wealth of Nations 2018. Building a Sustainable Future, 235 pages
3. ՀՀ վիճակագրական կոմիտեի պաշտոնական՝ www.armstat.am կայքի «Ժամանակագրական շարքեր» բաժինը
4. Оганян К.О. Реки и озера Армянской ССР, Ереван, 1961, Советский Союз. Географическое описание в 22 томах, т. Армения, М., 1966
5. Баграмян Г.А., Повышение эффективности комплексного использования водных ресурсов Армянской ССР, Ереван, 1973
6. Подземные воды СССР, обзор подземных вод Армянской ССР, т.1, 1980
7. Экономические вопросы использования водных ресурсов Армянской ССР (материалы научно-технического совещания), Ереван, 1975
8. Комплексная программа НТП СССР на 1986-2005гг., М., 1983
9. Ресурсы поверхностных и подземных вод, их использование и качество, Л., 1986
10. Армянская советская энциклопедия, т. Советакан Айастан, Ереван, 1987
11. Аветисян В.А., Давтян Д.Е., Животворные подземные воды, Ереван, 1987
12. Մովսիսյան Վ. «Հայաստանի Հանրապետության ջրային պաշարների կանխատեսումը, գնահատումը և համալիր կառավարումը», Եր., «Գիտություն» հրատարակչություն, 2003, 206 էջ
13. «Հայաստանի Հանրապետության սոցիալ-տնտեսական վիճակը 2018 թվականի հունվարին», Եր., ՀՀ վիճակագրական կոմիտե, 2018թ., www.armstat.am
14. «Հայաստանի Հանրապետության սոցիալ-տնտեսական վիճակը 2019 թվականի հունվարին», Եր., ՀՀ վիճակագրական կոմիտե, 2019թ., www.armstat.am
15. Չիլինգարյան Լ.Ա., Մնացականյան Բ.Պ., Աղաբաբյան Կ.Ա., Թոքմաջյան Հ.Վ. «Հայաստանի գետերի ու լճերի ջրագրությունը», Ջրային հիմնահարցերի և հիդրոտեխնիկայի ինստիտուտ, Ագրոպրես ՊՓԲԸ, Երևան, 2002թ.
16. «Հայաստանի Հանրապետության ջրային տնտեսության համակարգի բարեփոխումների ու զարգացման մասին ՀՀ կառավարության որոշումներ և ծրագրեր», Երևան, մայիս 2001թ.
17. https://blog.marketresearch.com/the-global-bottled-water-market-expert-insights-statistics
18. https://www.statista.com/outlook/20010000/100/bottled-water/worldwide
19. https://news.yandex.ru/quotes/1006.html

References

1. “17 Countries, Home to One-Quarter of the World's Population, Face Extremely High Water Stress", by Rutger Willem Hofste, Paul Reig and Leah Schleifer, August 06, 2019, Internet source (as of 25 December 2019): https://www.wri.org/blog/2019/08/17-countries-home-one-quarter-world-population-face-extremely-high-water-stress
2. The Changing Wealth of Nations 2018. Building a Sustainable Future, 235 pages.

3. The official site of RA statistical committee www.armstat.am department of «Chronology»
4. Ohanyan K.O., Rivers and lakes of Armenian SSR, Yerevan, 1961, Soviet Union, Geographical description in 22 volumes, vol. Armenia, M., 1966
5. Baghramyan G.A., Increasing the efficiency of complex use of water resources of Armenian SSR, Yerevan, 1973
6. Underground waters of the USSR, study of the underground waters of Armenian SSR, vol.1, 1980
7. Economic issues of utilization of water resources of Armenian SSR (materials of scientific-technical conference), Yerevan, 1975
8. Complex program of NEP USSR of 1986-2005, M., 1983
9. Resources of surface and underground waters, their utilization and quality, L., 1986
10. Armenian Soviet Encyclopedy, vol. Sovetakan Hayastan, Yerevan, 1987
11. Avetisyan V.A., Davtyan D.E., Vital underground waters, Yerevan, 1987
12. Movsisyan V., «Forecasting, estoamtion and complex management of water resources of the Republic of Armenia», Yerevan, «Science» publishing house, 2003, 206 p.
13. Social-economic condition of the Republic of Armenia in January 2019», Yerevan, RA statistical committee, 2018, www.armstat.am
14. «Social-economic condition of the Republic of Armenia in January 2019», Yerevan, RA statistical committee, 2019, www.armstat.am
15. Chilingaryan L.A., Mnatsakayan B.P., Aghababyan K.A., Tokmajyan H.V., «Hydrology rivers and lakes of Armenia», Institute of water problems and hydrology, Agropres SCJSC, 2002
16. «Decrees and programs of RA Government on reforms and development of water economy of the Republic of Armenia», Yerevan, May 2001
17. https://blog.marketresearch.com/the-global-bottled-water-market-expert-insights-statistics
18. https://www.statista.com/outlook/20010000/100/bottled-water/worldwide
19. https://news.yandex.ru/quotes/1006.html

ՀՏԴ - 556:627.1:34.1

ՀԱՅԱՍՏԱՆԻ ՀԱՆՐԱՊԵՏՈՒԹՅԱՆ ՋՐԱՅԻՆ ՌԵՍՈՒՐՍՆԵՐԻ ՕԳՏԱԳՈՐԾՄԱՆ ՎԻՃԱԿԸ ԵՎ ՀԻՄՆԱԽՆԴԻՐՆԵՐԸ

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Իրադարձությունների զարգացման ներկայիս վիճակը ցույց է տալիս, որ ինչպես ողջ աշխարհում, այնպես էլ Հայաստանի Հանրապետությունում սրվելու է ջրային ռեսուրսների և այդ ռեսուրսների օգտագործման համար ընթացող պայքարը, որը կարելի է համեմատել աշխաջրածնային վառելիքի համար մղվող թեժ պայքարի հետ: Միայն մեկ տարբերությամբ: Եթե նավթն ունի փոխարինիչներ, իսկ վառելիքի այլընտրանքային տեսակների ավելի լայն կիրառման համար աշխատանքները չեն դադարում, ապա ջուրը շարունակում է մնալ որպես միակ և բացառիկ ռեսուրս, որը չի փոխարինվում մեկ այլ այլընտրանքով: Նման պայմաններում խիստ արդիական են դառնում ջրային ռեսուրսների օգտագարծման, պահպանման հիմնախնդիրները, որոնք հատկապես կարևորվում են ՀՀ-ում, քանի որ առանց ջրային ռեսուրսների անհնար է

զարգացնել տնտեսությունը, ինչպես նաև բավարարել բնակչության հարաճուն պահանջմունքներն այդ անփոխարինելի ռեսուրսի նկատմամբ:

Բանալի բառեր. ջրային ռեսուրսներ, ջրային ճգնաժամ, ջրի առաջարկ և պահանջարկ, ջրառ, ջրօգտագործում, մակերևութային և ստորերկրյա ջրային ռեսուրսներ, վերականգնվող ջրային ռեսուրսներ:

УДК - 556:627.1:34.1

СОСТОЯНИЕ И ПРОБЛЕМЫ ИСПОЛЬЗОВАНИЯ ВОДНЫХ РЕСУРСОВ РЕСПУБЛИКИ АРМЕНИЯ

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Нынешнее положение дел и прогнозы развития показывают, что борьба за водные ресурсы и их использование будет обостряться. Притом эти тенденции замечаются как во всем мире, так и в Республике Армения, и в мировом масштабе сравнимы с борьбой за углеводородные энергетические ресурсы. Существенную роль играет одно отличие. Если у нефти есть заменители, а работы по нахождению и более широкому использованию альтернативных видов топлива не прекращаются, то вода остается единственным и исключительным ресурсом, который не имеет заменителей. В таких условиях вопросы водопользования и охраны водных ресурсов становятся все более актуальными, что имеет особое значение для Республики Армения, поскольку невозможно развивать экономику без водных ресурсов, а также удовлетворить растущие потребности населения в этом незаменимом ресурсе.

Ключевые слова: водные ресурсы, кризис водных ресурсов, предложение и спрос на воду, водозабор, водопользование, поверхностные и подземные водные ресурсы, возобновляемые водные ресурсы.

Ներկայացվել է՝ 08.01.2020թ.
Գրախոսման է ուղարկվել՝ 08.01.2020թ.
Երաշխավորվել է տպագրության՝ 18.03.2020թ.

UDC - 556:627.1:34.1

THE MAIN METHODS OF IMPROVING THE MANAGEMENT OF WATER RESOURCES OF THE REPUBLIC OF ARMENIA

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Water resources are an important part of the natural resources of the Republic of Armenia. The study of the economic-legal system for regulating water relations, adopted in the early 2000s, shows that there are numerous shortcomings and gaps in the field occurred mainly from the violation of the requirements of the existing legal system. At the same time unnecessary changes and additions to the constitutional laws have actually worsened the state of the utilization of water resources in the Republic of Armenia. This has posed a challenge to the country which requires immediate correction of deficiencies and shortcomings in water relations, the creation of modern economic-legal system that takes into account the harmonization of both the state (as the owner of water resources) and the public interests thus ensuring effective partnership. The latter particularly implies the expansion of frameworks of state-private sector partnership and the application of various methods of such partnership.

Key words: water resources, improvement of management of water resources, water code, corporation of water consumers, state-private sector cooperation, accreditation management, trade organization, renting, concession, free use of property.

Introduction

Water resources are the most important state resources and the rights of their disposing, possessing and using are defined by the RA Water Code (adopted by the National Assembly of the Republic of Armenia on June 4, 2002 along with the RA Law on Corporations of water consumers and Associations of water consumers).

The Water Code of the Republic of Armenia, adopted on June 4, 2002, founded the new legal-economic and organizational system of water relations of the Republic, which, in addition to the above mentioned Code, includes the following three constitutive laws: Laws of the Republic of Armenia on «Companies of Water consumers and Unions of Water consumers», «Fundamentals of national water policy» and «National program of water».

Conflict setting

Taking into account that the aforementioned legal acts are systematic documents in the field of water relations and more than 17 years were required after they had come into force and there are still many shortcomings and gaps in the field, first of all let us try to analyze and evaluate the legal status of these documents realizing the need for sectoral reforms which will serve as a basis for meaningful changes in further reforms as well.

However, as the analysis shows, after the adoption of the Water Code, the activity of the system did not improve at all, but on the contrary, the costs and debts of the system increased while the efficiency of management decreased. One of the reasons of such a situation is the number of settlements left out of the services of supplying drinking water (one reason is also that out of the five forms of water consumption defined by the RA Water Code only the right of free utilization of water systems has been applied so far and the remaining four which should implement new ways of investment and management in the water systems and in water consumer- companies – state relations remain on paper. An exception to this rule is the service of supplying drinking water provided by the

renter, but which also cannot be considered as highly effective especially when we take into account the high level of drinking water losses (about 570 settlements).

Thus, most of the irrigation water pipelines in Armenia were built during the Soviet era and have a high degree of fatigue. The water supply systems of the Republic of Armenia have been in operation for 15-50 years, most of which are technically inadequate and currently the losses in the water supply system make up 80%.

Hence all water consumers, the companies of the system and aslo the state are now dissatisfied from the acting system.

Research results

Water Code of the Republic of Armenia. The RA Water Code can be considered as one of the most important codes of the third republic without exaggeration as it regulates perhaps the most valuable and indispensable resource of the Republic of Armenia such as water without which not only the economy of the country, but also the population of the country and its economy can not survive. In other words, the relations regulated by the Code refer to the vital activity of the whole republic.

The purpose of the RA Water Code (Article 6) is: the protection of national water resources, satisfaction of the needs of citizens and the economy through effective management of consumable water resources, ensurance of the environmental sustainability and the provision of legal bases to solve the issues of the Code. Based on this purpose the Water Code was designed as a firm set of interconnected parts (chapters) whose implementation and application had to proceed in an organic and logical unity especially over time.

However, as the study of amendments and supplements to the Water Code shows (Table 1), they are numerous and in many cases have not only violated the timeliness of the implementation of the Water Code, but have significantly reduced the effectiveness of the measures provided by the Code.

Table 1

The amendments and supplements to the Water Code of the Republic of Armenia (adopted on June 4, 2002 by the National assembly of RA)

N	Date of amendments and supplements	Total	From which			
			Number	Article (s)	Number	Article (s)
1	2	3	4	5	6	7
1	31.03.2003	2	1	121	1	121
2	04.11.2003	1	-	-	1	121
3	18.11.2003	1	1	121	-	-
4	25.12.2003	8	7	38, 39, 43, 44, 46, 79, 14, 121	1	79.1
5	22.11.2004	1	1	121	-	-
6	08.12.2004	1	1	121	-	-
7	08.12.2004	5	5	121	-	-
8	20.05.2005	1	1	121	-	-
9	20.05.2005	3	2	121	1	121
10	21.02.2007	1	-	-	1	79.1
11	16.11.2009	1	1	33	-	-
12	03.10.2011	2	1	33	1	8
13	24.10.2011	11	4	Title of 13th, 61th and 9th chapters, 71	7	1, 14, 49, 55.1, 61.1, 61.2, 71.1
14	19.06.2013	1	1	33	-	-
15	23.06.2015	36	31	1, 5, 12, 14, 19, 20, 36, 38-43, chapter 5.1 (47.1-47.3), 48, 56, 57, 58, 59, 62, 73, 78, 79, 79.1, 114, 118, 121	5	1, 47.1, 47.2, 47.3, 121

1	2	3	4	5	6	7
16	21.12.2015	16	6	1, 8, 10, 19, 30, 33	10	19.1, 19.2, 25.1, 30.1, 30.2, 32, 34, 37.1, 37.2, 37.3
17	29.06.2016	1	1	78	-	-
18	17.11.2017	3	2	10, 37.1	1	37.1
19	23.03.2018	3	3	63, 64, 64	-	-
20	02.03.2018	16	13	1, 4, 113, 14, 19.1, 25.1, 39, 68, 75, 78, 101, 103, 104	3	62.1, 62.2, 62.3
21	21.03.2018	1	-	-	1	10
22	16.12.2016	1	1	93	-	-
23	23.03.2018	3	1	12	2	1.1, 3
24	19.06.2019	3	2	30.2, 92	1	1
25	28.06.2019	2	1	33	1	30.1

The study of amendments and supplememnts made show that the most amendments and supplements had been made in Article 121 of the code (Transitional theses). Though it is foreseen by the first part of the Article that till July 1, 2004 the legal acts containing legal norms in water relations should be correspondent to the Code, but before these acts are correspondent to the Code in water relations, they are implemented as long as they are not contradicting to the law, however, according to transitional theses, almost all legal acts supporting the operation of the Code, had been admitted with unnecessary noticable delays of deadlines and postpones or had not been adopted at all thus making the Water Code “invalid”. Let us bring several examples only.

Hence, according to the 4th part of the Article 121 on basics of national water policy the bill of RA Law should have been presented to the National Assembly of RA by the RA Government during six months but the RA Law on basics of national water policy was adopted only on May 3, 2005. According to the same Article of Water Code, the discussion of the bill on national program of water should be held during one year, but RA Law on national program of water was adopted November 27, 2006. And the bill on drinking water according to the 4th part of Article 121 of RA Water Code had to be presented to the discussion of National Assembly of RA during two years (later the date was changed into 4 years), has not been adopted up to now.

The 6th Chapter of RA Water Code is of separate importance and topic of discussion which runs about the 5 following ways foreseen in the Law on consumption of water resources and their management which are state property:

1) by accreditation management (which is regulated by Articles 50-52 of the Code and by the Government Decree N 81-N of January 9, 2003 which describes the procedure for accreditation of water systems);

2) by an agrement of concession (regulated by Article 53 of the Code and the procedure for signing agreements of concession on water systems by the decree of the Government of the Republic of Armenia N 245-N of January 30, 2003);

3) by creating trade organization (regulated by Article 54 of the Code),

4) by renting (regulated by Article 55 of the Code and by the decree of RA Government N 243-N of January 30, 2003 on enabling the private business entities to rent the water systems),

5) by agreement of free utilization of property (regulated by Article 55.1 of the Code).

The variety of ways of utilization water systems mentioned above was aimed at providing the water sector with advanced methods of management and opportunities for managers to increase responsibility for fulfilling their tasks thus attracting investment resources in this area as well. All of these has not been implemented in practice and, in fact, the implementation of 4 of the 5 forms of water management in Chapter 6 of the RA Water Code was distorted and mainly the free use of water systems management was being preferred which was not envisaged at the time of the adoption of the

RA Water Code (2002) (the first 4 forms mentioned above were envisaged). This form of transfer of the rights of property was augmented by a supplement to the RA Water Code (SL-273-N) on October 24, 2011 when the first part of Article 49 of the Code was amended by new paragraph 5 which provides signing contracts for free use of property of water systems. In this case it is unclear how the water systems were managed for over ten years unless the methods provided by the Code of Water Systems Management were applied.

The above mentioned process of transferring the rights of utilization of water systems, how strange it may seem, has been "implemented" by the Government of the Republic of Armenia. Thus, the decrees of N 81-N of the Government of the Republic of Armenia of January 9, 2003 on "Approval of the regulation of assigning the state-owned water system to the accreditation management " and N 243-N on "Approval of procedure of transfer by renting according to the rights of utilization of state-owned water systems" on January 30, 2003 of the Government of the Republic of Armenia and in all three Decisions N 245-N of the Government of the Republic of Armenia of January 30, 2003 on the Procedure for transferring the rights of utilization of state-owned water systems by concession agreement" were adopted for implementation of the RA Water Code. There was paragraph 2 in all three decrees stipulating that the Chairman of the State Committee of Water Economy by the Government of the Republic of Armenia was to submit to the Government of the Republic of Armenia the list of state-owned water systems (their parts) apt to accredited management, renting or concession agreement within 4 months thus classifying them by priority.

However, instead of making the above classification and submitting recommendations to the Government of the Republic of Armenia, by the decree of Government Decision N 9-N, adopted on 15 January 2004 the 2nd paragraphs of those three decrees were recognized as invalid leaving much uncertainty in the decision-making process and in this way essentially demonstrated the reality which excludes the use of progressive ways of transfer and management of the rights of utilization of water systems.

Hence, we can certainly insist that an absolute state monopoly has been established in the field of water utilization and management which has led to inefficient use and management of these systems excluding the use of progressive ways of management. And if we consider that water resources are the exclusive property of the state, we believe that the diversity of water systems utilization and management is a tool that can significantly improve the efficiency and use of management of water resources.

Therefore, by preserving the diversity of utilization of state-owned water systems and their management under the RA Water Code, their practical application should be continued by correcting governmental errors in this area as well as allowing private capital to be incorporated into these systems and the application of new forms of management. For this purpose it is proposed to add to the RA Water Code new forms of rights of transfer of water systems (6): building - ownership -operation - transfer (BOOT) for realizing programs and (7): building – ownership – operation or building – renting - mastering that will ensure improved governance, access to private property to these systems thereby ensuring competition which can significantly improve the situation.

The reform of the use and management of state-owned water systems can be substantially promoted by the Law on State-Private Partnership adopted on June 28, 2019, and according to the peculiarities of utilization and management o water systems, if necessary, they should be mentioned in the Water Code as well. In such cases, the government may define the peculiarities of state-private partnerships depending on the nuances of the particular transaction.

The proposed approach will contribute to the elimination of the state-owned monopoly on water systems management which reminds us of Spanish playwright Lopez de Vega's work "The Dog on the Grass". As for the different forms of use and management of water systems (including the transfer to communities), this will be decided in practice as the legislative changes already adopted and proposed by us allow the application of these forms within the limits established by RA laws and other legal acts.

RA Law on «Companies and unions of companies of water consumers»

Formation and activities of CWCs. According to the RA Law on «Companies and unions of companies of water consumers» stated in 2002 aimed at improving the irrigation systems of RA based on the idea of hydrounit about 50 companies of water consumers had been crated in the republic.

54 water consumption companies (CWUs) were formed on a voluntary basis in the Republic of Armenia with the support of the World Bank in 2003-2004. As a result of optimalization of institutional reforms in the field of irrigation, the companies have been reorganized in several phases as a result of which 15 CWCs are currently in operation. Unlike the drinking water supply system, the primary and secondary water supply functions are carried out by different organizations in irrigation system.

CWCs play an important role in irrigation water management. In particular, the operation and maintenance of inter-economic and intra-economic systems as well as the preservation of small pumping stations and reservoirs have already been transferred to CWCs.

According to RA Government Decree N 422-N on 22.04.2015, the powers of the Executive Body of the Board of Regulators of RA CWCs and UWCs have been authorized to the State Committee of Water Economy (currently the Water Committee of the Ministry of Territorial Administration and Infrastructure). The management bodies of the CWC are the General Meeting of the Company and the Administration Council.The CWC is headed by an elected executive director.

CWCs were formed mainly on the basis of the indivisibility of one hydrounit operating about 1700 km of inter-economic and about 16 thousand km. km of inland canals, over 55 small and medium reservoirs, pumping stations and about 650 deep wells 90 of which are self-fountaining in over 600 communities for the provision of irrigation water supply services to about 180 thousand water users.

According to the Land Cadastre of the Republic of Armenia, the irrigated land in Armenia is about 210 thousand ha 190 thousand ha of cadastral irrigated land are in the service area of CWCs. In recent years, CWCs have actually irrigated about 90 thousand hectare of land (Chart 1).

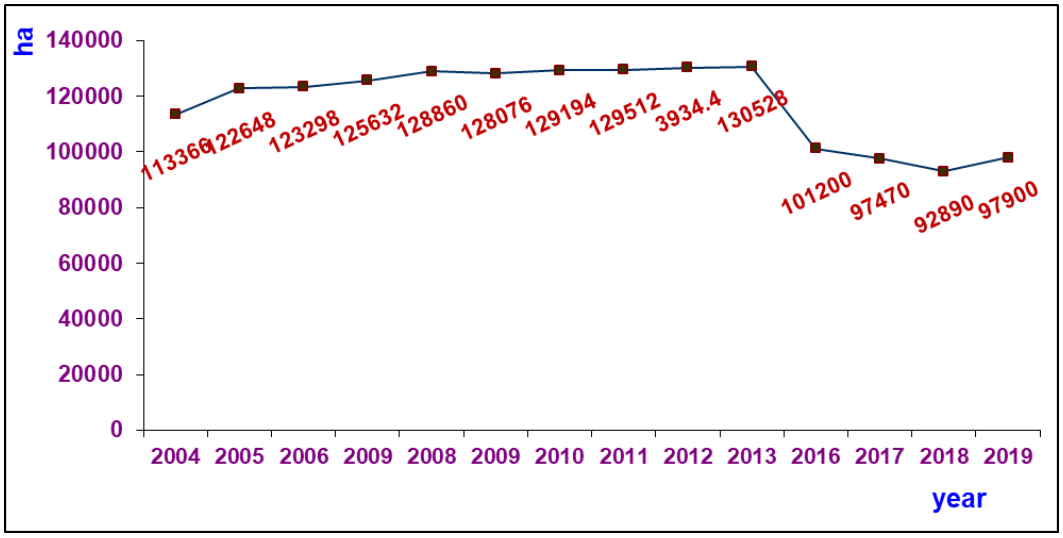

Chart 1. Factually irrigated areas by water consumption companies for years

The studies show that the costs of water consumption companies increase year by year and at the same time the percentage of tax costs of water consumption companies decrease. Hence, the rates of the last five years show that the percentage of fees sharply decreased comprising 81,5% in 2014, 81,2% in 2015, 75,5% in 2016, 63,5% in 2017 and 48% in 2018. According to separate CWC water distribution, the income of the companies and data on the fees and the structure of the rates in 2018 are presented in Table 2.

Table 2

The rates and structure of RA CWCs water distribution, income and toll and toll rate in 2018

N/N	Name of CWC	Water distribution th.m ^{3}	Income th. AMd	Toll th. AMD	Rate of toll %
1	Yerevan	24,019.80	264,217.80	172,324.00	65.0
	% to the total	4.32	4.05	5.25	
2	Artashat	71,595.90	787,554.90	519,506.90	66.0
	% to the total	12.88	12.06	15.82	
3	Ararat	32,677.90	357,374.80	339,069.10	94.9
	% to the total	5.88	5.47	10.33	
4	Armavir	140,205.20	1,542,257.20	502,429.00	32.6
	% to the total	25.22	23.61	15.30	
5	Ejmiatsin	101,358.00	1,114,938.00	346,760.00	31.1
	% to the total	18.23	17.07	10.56	
6	Shenik	34,523.20	709,755.00	333,239.70	47.0
	% to the total	6.21	10.87	10.15	
7	Aragatsotn	62,563.40	688,197.40	303,500.00	44.1
	% to the total	11.25	10.54	9.24	
8	Talin	20,733.00	228,063.00	114,271.00	50.1
	% to the total	3.73	3.49	3.48	
9	Kotayq	30,639.00	406,869.00	291,698.50	71.7
	% to the total	5.51	6.23	8.88	
10	Gegharquniq	7,094.00	78,034.00	52,203.60	66.9
	% to the total	1.28	1.19	1.59	
11	Shirak	6,310.00	69,410.00	65,451.80	94.3
	% to the total	1.13	1.06	1.99	
12	Tavush	6,514.90	71,664.10	70,085.00	97.1
	% to the total	1.17	1.10	2.13	
13	Lori	1,736.10	31,993.20	29,972.40	93.7
	% to the total	0.31	0.49	0.91	
14	Yeghegnazor	10,345.50	117,817.00	119,952.00	101.8
	% to the total	1.86	1.80	3.65	
15	Syuniq	5,704.60	63,211.50	22,750.00	36.0
	% to the total	1.03	0.97	0.69	
	Total	556,020.50	6,531,356.92	3,283,213.40	50.2
		100.0	100.0	100.0	

Table was drawn on the data of RA Water Comittee of Ministry of Territorial Management and Infrastructures

Current tariffs for irrigation water supply mainly cover current costs for operating and maintenance. The most part of these expenditures is financed by state subsidies and credits and grant funds (Table 3).

Survey of irrigation system indicators also shows that in the period between 2006 and August 1, 2018 actually irrigated hectares decreased by 2,4% in average, but the subsidies by RA state budget to irrigation system organizations (CWCs and «Jrar CJSC») increased by 23,2% in average with increasing 3,5% in average to CWCs and 43% to «Jrar» CJSC. Operating costs per hectare increased by an average of 4,4% against 2,4% reduction in actual irrigated hectares, if, for example, the operating costs per hectare were 66,7 thousand in 2006. In 2017 these expenses raised to 103,3 thousand AMD or the actual growth in 2006 was 35%.

Table 4 presents the main indicators of the irrigation sector of the Republic of Armenia in 2006-2018.

Table 3

RA subsidies for irrigation systems, debts and RA state budget, mln. AMD

	2013		2014		2015		2016		2017		2018		2019
	Debt by 01.01.2013	2013 RA budgetary allocations	Debt by 01.01.2014	2014 RA budgetary allocations	Debt by 01.01.2015	2015 RA budgetary allocations	Debt by 01.01.2016	2016 RA budgetary allocations	Debt by 01.01.2017	2017 RA budgetary allocations	Debt by 01.01.2018	2018 RA budgetary allocations	Debt by 01.01.2019
Total	1793.9	5374.2	1945.5	5491.8	2298.8	5585.4	3725.3	7077.2	2947.8	5207.5	5556.9	4922.0	9371.7
From which													
1.Electricity	267.0		214.7		659.4		1506.4		1588.3		3071.0		11.3
2. Water intake	475.5	Other current grants	978.9	Other current grants	815.4	Other current grants	1330.6	Other current grants	486.9	Other current grants	1365.2	Other current grants 466,8 and programm financial recovery 260,2	2056.8
3. Spring preparatory	65.5		29.2		107.1		136.9		256.7		324.1		423.7
4. Salary	94.6		105.2		181.4		282.7		242.4		406.4		538.9
5.Taxes and fines	56.5		57.5		27.0		38.0		109.5		109.1		241.3
6.Loan and credit	743.3		452.2		390.0		337.8		229.9		107.0		5886.8
7.Other expenses	91.5		107.8		118.5		93.9		34.2		174.1		212.9

Table was drawn on the data of RA Water Comittee of Ministry of Territorial Management and Infrastructures

Table 4

Main indices of RA irrigation system in 2006-2018

№	Rates	Measure	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Average rate
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	Irrigated areas , cadastrial	Hectare	194,036	194,036	194,036	194,036	194,036	194,036	194,036	194,036	194,036	198,283	198,283	198,283	198,283	195,343
2	Irrigated areas, factual	Hectare	123,298	126,819	128,860	128,076	128,767	129,417	130,527	130,280	130,942	115,769	101,214	97,473	92,890	120,342
3	Irrigated areas factual (growth or decrease compared to the previous year)	%		2.9%	1.6%	-0.6%	0.5%	0.5%	0.9%	-0.2%	0.5%	-11.6%	-12.6%	-3.7%	-4.7%	-2.21%
4	Costst of general exploitation of the sphere	Mln. AMD	8,222.0	8,219.0	9,685.4	8,232.6	8,538.0	8,593.3	8,794.4	9,217.0	10,487.0	10,967.0	10,227.0	10,466.3	10,711.2	9,404.6
5	Costs of exploitation for one hectare (average)	AMD	66,684.3	64,809.0	75,162.5	64,279.0	66,305.9	66,400.5	67,376.2	70,747.6	80,089.1	94,731.8	101,043.3	107,377.0	115,311.0	79,790.3

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
6	Costs of exploitation for one hectare (growth or decline compared to the previous year)	%		-2.8%	16.0%	-14.5%	3.2%	0.1%	1.5%	5.0%	13.2%	18.3%	6.7%	2.3%	2.3%	4.28%
7	Used electricity	Mln. kWt/hour	104.4	96.2	115.2	80.3	79.0	88.0	109.0	106.2	118.1	115.2	94.6	119.6	168.2	106.7
8	Supplied water	Mln..m^3	574.8	521.0	575.2	412.0	448.7	414.6	471.8	472.0	461.2	473.7	454.2	450.6	626.6	487.4
9	Tariff for used water	AMD/m^3	7.0	8.0	9.0	9.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	10.1
10	Current fixed income	Mln AMD	4,023.3	4,168.3	5,177.0	3,708.3	4,935.7	4,560.8	5,092.0	5,179.9	5,050.1	5,198.7	4,987.8	4,956.8	6,891.6	4,900.7
11	Current income for one hectare (average)	AMD	32,631.1	32,868.2	40,175.4	28,953.6	38,330.2	35,241.4	39,011.1	39,760.0	38,567.2	44,905.4	49,279.6	50,853.3	74,190.9	41,716.4
12	Costs of exploitation for one hectare (growth or decline compared to the previous year)	%		0.7%	22.2%	-27.9%	32.4%	-8.1%	10.7%	1.9%	-3.0%	16.4%	9.7%	3.2%	45.9%	8.68%
13	Sum of money from current income	Mln AMD	3,093.9	2,399.1	3,117.1	2,875.7	3,200.0	3,430.0	4,026.0	4,439.1	4,109.8	3,875.7	3,870.9	3,407.8	3,284.0	3,460.7
14	Collected money for one hectare (average)	AMD	25,092.7	18,917.4	24,189.8	22,453.4	24,851.4	26,503.6	30,844.2	34,073.3	31,386.7	33,477.6	38,244.8	34,961.5	35,354.1	29,136.7
15	Comparison of collected sum with income	%	76.9%	57.6%	60.2%	77.5%	64.8%	75.2%	79.1%	85.7%	81.4%	74.6%	77.6%	68.7%	47.7%	71.31%
16	State subsidies to CWCs	Mnl. AMD	3,715.4	5,420.0	4,952.3	5,250.4	4,756.0	4,179.5	3,934.4	5,372.8	5,491.7	5,580.9	7,077.2	5,253.1	4,762.6	5,056.9
17	State subsidies to CWC (growth or decline compared to the previous years)	%	-0.7%	45.9%	-8.6%	6.0%	-9.4%	-12.1%	-5.9%	36.6%	2.2%	1.6%	26.8%	-25.8%	-9.3%	3.64%
18	State subsidies to water intake	Mln. AMD	0	0	0	0	0	583,700	583,700	578,894	2,782,962	1,717,739	1,213,284	1,131,617	1,178,000	750,981
19	State subsidies to water intake (growth or decline compared to the previous years)	%							0.0%	-0.8%	380.7%	-38.3%	-29.4%	-6.7%	4.1%	44.23%

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
20	Sum of state subsidies for one hectare (average)	AMD	30,133.5	42,738.1	38,431.6	40,994.5	36,934.9	32,294.9	30,142.7	41,240.5	41,969.1	48,203.9	69,919.9	53,892.3	51,271.5	42,925.7
21	Sum of state subsidies for one hectare (growth or decline compared to the previous years)	%		41.8%	-10.1%	6.7%	-9.9%	-12.6%	-6.7%	36.8%	1.8%	14.9%	45.1%	-22.9%	-4.9%	6.67%
22	Debet debth of the sphere	Mln AMD	5,805.4	6,346.8	7,982.7	8,052.1	8,956.3	7,599.0	8,247.2	9,204.0	10,631.0	11,661.0	13,044.0	13,044.5	20,104.4	9,992.4
23	Credit depth of the sphere	Mln. AMD	1,359.7	1,310.8	1,867.6	1,713.0	1,494.5	1,239.3	1,793.9	1,945.5	2,298.8	3,725.3	2,947.8	5,556.9	9,371.7	2,804.2

Source by «Reform of «harmful» subsidies of irrigation system of Armenia» final project of report, December, 2018, p. 56-57 (data of 2006-2016) and data of RA Water Comittee of Ministry of Territorial Management and Infrastructures (2017-2018)

Taking into account the circumstance that the RA Law on “Companies of Water Consumers and Unions of Water Consumers with the new title and new edition of “Water User Associations” was developed in the framework of USAID's Program of Participatory and Effective Use of Water Resources (“Urban” Sustainable Development Foundation, “National Water Partnership” NGO with the participation of YSU Environmental Law Research Center), we have not discussed this law separately.

Without underestimating the importance and significance of the work done, we believe that such an approach to problem solving is fragmentary and incomplete. Changes in water system management essentially cannot fundamentally change the state of affairs as they do not namely relate to the deep strengthening of ownership and property responsibility, the increase in the interest and economic interest of water users in the sector of water consumption.

By the way, the results of the above-mentioned sociological survey also show that 61% of the population think that the head of their community is the person who is able to solve the problems of irrigation and drinking water in their community. In the second place is the council of trustees (51%) and in the third place is the population (40%). Then 38% of population are inclined to trust CWCs and then the governor (35%). Residents do not believe that the Ministry of the Environment or other governmental authorities, NGOs or international organizations are able to solve water issues in their community. According to the survey, most of the population of Ararat Valley (96% or more) are not actively involved in processes of water resources management nor have they received relevant information or participated in training courses of water resources management. The overwhelming majority of population (69%) indicated that they would participate in discussions about drinking or irrigation water in their community if such discussions were held.

In other words, it is clearly necessary to introduce economic competition in the field of water relations, to apply a flexible tariff policy for irrigation water as well as a system that will allow to invest private equality and private management methods, tools and best practices in this area. A separate topic for discussion could be the transfer of part of the existing water systems (local area network) to the communities which will allow to increase the efficiency of water use in this way.

Thus, even after the proposed amendments to the new RA Law on Companies of Water Consumers, these companies will continue to act as “unsuccessful” NGOs which is unacceptable in the economic system of water relations.

Solving complex and multifaceted problems in the field of water relations cannot be limited to the development of a new law on water use companies, sector reforms require a complex approach which need to be referred from both economic and organizational viewpoint with new legal acts as well as by organizing public discussions.

RA Law on «Fundamentals of national policy of water»

Within the logic of the Water Code of the Republic of Armenia, it was assumed and expected that the Law of the Republic of Armenia on the Fundamentals of National Policy of Water would define and regulate the developments of the water sector for the next 10-15 years, the measures implemented and the expected results. However, the current RA Law on Fundamentals of National Water Policy does not meet these requirements, it is more theoretical in nature and therefore needs to be edited depending on the demands of the long-term requirements of prospective-complex development of the sector**.**

RA Law on «National program of water of the Republic of Armenia»

The current Law of the Republic of Armenia on National Water Program of the Republic of Armenia also does not meet the requirements of water sector development and program of relationship management and it is of more theoretical than practical importance. One of the main reasons is that the requirement to submit a report on project implementation has been replaced by a report to the National Assembly ("The Government submits an annual report on the implementation of the National Water Program and any amendments made there to the National Assembly by May 15 of the following year") which does not cause any legal consequences thus weakening the responsibility for the implementation of the National Water Program and the levers of control by the National Assembly of the Republic of Armenia.

To make the National Water Program more targeted and practical, it also needs to make a number of primary changes and additions, in particular concerning water management, regulation of water resource flow, flood risk assessment and management.

Besides, Article 11 of the RA Law on National Water Program of the Republic of Armenia states that: "1. State-owned water systems defined by the National Water Program are state-owned and are not subjected to privatization". [1] Such an approach is unacceptable, firstly because of Article 171 of the RA Civil Code ("Privatization of State Property") states: "The state may transfer the property under its ownership to the ownership of citizens and legal entities in accordance with the law on privatization (de-privatization) of state property". [2] In addition to the fact that the note was made in the Civil Code of the Republic of Armenia, this provision also contradicted the RA Law on Legal Acts which had come into force at the time of the adoption of the RA Water Code and the National Water Program and stipulated that: "All other laws of the Republic of Armenia in the field of legal regulation of the Code shall comply with the Codes" [3], i.e. it confirmed the subordination of legal acts.

One more fundamental of RA Law on «Legal acts» (Article 24: «Suborditaion of legal acts of the Repblic of Armenia») defines that: «New legal act stated by the same body should not contradict the legal acts stated before which have equal legal power. When contradictions occur between legal acts having equal legal power the early acted norms of legal acts come into force except for the case of the second paragraph of the fourth part of Article 94 of the Law» [3].

Second, restrictions of state property privatization have been (and currently are) defined by state property privatization (ownership) programs which have always been adopted in the form of RA laws. In particular, in accordance with Article 4 of the Law of the Republic of Armenia "On State Property Privatization Program 2017-2020" ("Sectors and Spheres of Economy in which no privatization is provided") «1. According to this plan, the following are not subjected to privatization:

1) sites of civil defense and mobilization and military structures,

2) companies with state-owned stake holders performing preservation of mapping, geodetic, hydro-meteorological spheres and also maintenance of environmental and natural resources,

3) objects of storage economy of state reserves and mobilization resources;

4) companies providing state-owned standardization with stake holdings and measurement services;

5) interstate and republican railways and highways; Yerevan subway; train and air flight security services and military marches;

6) state non trade organizations.

2. Areas that are subjected to privatization will not be privatized and will be separated from the property if they are distributed:

1) in engineering structures, communication routes (bridges, tunnels, dams, undergrounds etc.) and in engineering areas nearby such as railway stations, social and cultural facilities (educational establishments, cultural facilities);

2) in areas of protection and security importance and in the areas adjacent.

3. In the cases provided in paragraph 2 of this Article where privatization of the site is not permitted, it may be used on a lease basis in accordance with the legislation of the Republic of Armenia [4].

Third, Article 13 of the RA Law on National Water Program of the Republic of Armenia states that: "2. State-owned special water systems, first and second-class water systems are considered to be strategically important water systems for which funds have been deposited in the state budget of the Republic of Armenia to prevent emergencies. The list of water systems of special state importance shall be defined by this Law".

3. Tertiary water systems which were not built by private investment, can be given to communities by ownership.

4. 4th class water systems which were not built through private investment, can be owned by communities, water user companies, their associations and other public service organizations.

5. 5th class water systems may be subjected to privatization.

6. "The legal, organizational, economic and other regimes of state-owned water systems and the requirements for their protection and operation also apply to those water systems built by private investors that meet the requirements of state-owned water systems in their characteristics. The dissemination of state water systems regimes on water systems built by private investors does not entail any change in their ownership rights".

And according to the RA Water Code (Article 61.1. "State and Community Owned Irrigation System" supplemented by RA Water Code AC-273-N of 24.10.2011): "The irrigation system by functional significance is classified into:

1) highway irrigation system - a system of supplying irrigation water to inter-community, economic or intereconomic irrigation systems originating from a water source (first class (main) water pipes and pumping stations, main canals etc);

2) Intercommunity irrigation system - a system of supplying irrigation water to irrigated lands of more than one community originating from the highway irrigation system (second class canals and pumping stations);

3) Economic Irrigation System - a system that provides irrigation water originating from highway or inter-economic irrigation systems and providing irrigation water to irrigated land of only one community (tertiary canals);

4) Interfarming irrigation system - a system of distribution of irrigation water (fourth-class canals or distribution networks) originating from farming irrigation systems as well as local water springs and irrigated land of only one community.

State-owned and second class irrigation systems are not subjected to privatization. They may be transferred only to water suppliers with the right of use in the way prescribed by this Code.

State-owned tertiary irrigation systems which were not built by private investment can be transferred to the community by ownership.

Fourth class state-owned irrigation systems which were not built by private investment, can be granted to the community and water suppliers by the decree of the Government of RA". [5]

State – Private partnership in water infrastructures

State-Private partnership (SPP) with the participation of private companies is a way of primarily infrastructural development and service provision (including state and public) that implements resources and incentives of private sector into the sphere of infrastructures and services but at the same time requires the presence of the government as contracting party and/or regulatory authority as competition in the infrastructure sector being limited and the economic development of society from the perspective of development is significant in the country.

In general, the SPP characteristics is the long-term and/or short-term cooperation between the state and private sectors when the private sector finances and/or manages the construction and development of infrastructure facilities as well as the provision of services for the needs of the state. The emergence and development of various forms of contractual relations within the SPP is due to the use of effective models preferred by the sectors.

Due to the specificity of the related sector, the right choice of SPP models depends on the efficiency of the transaction, which will meet the needs of both the state and the private sector and society. SPP contracts are viewed not only as a means of financing public infrastructure, but also as a tool for improving the efficiency and quality of public services.

Some of the ways of directions impacting on the reduction of costs of Infrastructure development and government expenditure are:

- Provision of aditional financing,
- Introduction of new methods of management,
- Creation of VAT for consumers and society,
- Better determination of needs and optimal use of resources whose applied efficiency is higher within the framework of SPP especially in the case of choosing the right model.

International experience shows that several main models of SPP are widely applied depending on the way of participation, way of infrastructure ownership, distribution of risks and duration of partnership.

The agreement of outsourcing of accreditation management is simpler form of SPP which does not suppose investment responsibilities**.** Ownership and investment decisions remain in the hands of the state while the private company is solely responsible for management and therefore only takes the transaction risks. This form of contract is typically applied where private investment is not possible because prices are traditionally lower than costs and the government is not in favor of setting tariffs that will cover costs. These types of contracts help to increase productivity, improve management and improve the quality of provided services. At the same time, these contracts are concluded for a short period and may not need to increase productivity and to improve efficiency which may not be mentioned there.

During signing the contract of the private sector leases state assets and provides services. However, the private sector also does not undertake investment commitments in this model.

In the case of a **concession agreement**, the private partner (operator) takes over the management and maintenance of the facility on a charged basis. During the period specified in the contract, he is obliged to invest for the acquisition of new equipment or the construction of an infrastructure facility. Thus, this form assumes that the private company takes over trade (commercial) risks while the property remains in the hands of the state. For this reason, the set level of tariffs is not essential as it may be related to the rental fee (i.e. if the tariff is insufficient to cover costs, the rental fee may be reduced), but the revenues should offset the long-term costs of providing services and give an opportunity to make a reasonable profit. This model is mainly applicable in those areas where project implementation takes a long time. It may also be applied in cases where the transfer of property rights is impossible for legal and political considerations**.**

The projects implemented from **«Green field» (from zero level)** assume that private company or mixed company (private and state) builds and operates new facility withinn the time period foreseen in the contract. After the deadline the facility either is transfered to the state or becomes the own

property of the company according to the conditions mentioned in the agreement. More widely distributed ways of «Green field» project are:

1) Acording to Building-Ownership-Operation-Transfer project (BOOT) the private sector invests in the construction of the facility after which owns and operates it within the time limit fixed in the agreement. After the deadline mentioned in the agreement the whole property is transferred to the state.

2) In Building-Management-Ownership and Building-Leasing-Ownership projects the private company is responsible for financing and management of infrastructure facility. Unlike BOOT project, the company becomes the owner of the very facility and he does not transfer it to the state. However, the economic activity of private company can be regulated by defining the tariffs for services using certain restrictions in the field of management. These costs suppose long term cooperation between state and private sector (more than 30 years) which are impacts for efficient and high quality construction and optimalization of management costs and keeping it in act and neat condition. This way of contract also supposes that private sector overtakes all market risks connected with construction and management.

Conclusion

The law regulating SPP relations in the Republic of Armenia ("State-Private Partnership") was adopted by the National Assembly of the Republic of Armenia on June 28, 2019 and came into force on January 1, 2020. [6] It provides a firm and reliable economic and legal basis, in particular for the change and improvement of the RA water relations system which is linked to the inflow of private capital in the management of water systems. The importance of establishing a clear SPP economic and legal field is due to the fact that the water sector itself needs huge investment, and these relationships, having remained state-owned for the last 20 years, have been inefficient and "absorbed" huge state resources without being maintained adequate ((financial and social) compensation.

The above mentioned law defines the concept of a SPP contract according to which: "SPP contract – is a contract between a state partner and a private partner for the purpose of implementing the SPP program as stipulated by this Law, including a concession". The procedures and rules applicable to the implementation of SPP programs are set by the decree of the Government of the Republic of Armenia [6, Article 2].

The RA Water Code should provide for the application of the above forms of SPP in the water infrastructure. It is proposed to apply the fundamentals of the RA Law on State-Private Partnership, adopted by the National Assembly of the Republic of Armenia on June 28, 2019 in water sector management and to use the procedures following the Law where appropriate and if necessary, to define other features of state-private sector partnership.

References

1. «Հայաստանի Հանրապետության ջրի ազգային ծրագրի մասին» ՀՀ օրենք, ընդունվել է ՀՀ Ազգային ժողովի կողմից 2006 թվականի նոյեմբերի 27-ին, ՀՕ-232-Ն, փոփոխություններով և լրացումներով տարբերակը Հայաստանի իրավական տեղեկատվական համակարգի պաշտոնական www.arlis.am կայքում:
2. «Հայաստանի Հանրապետության քաղաքացիական օրենսգիրք»-ը, ընդունվել է ՀՀ Ազգային ժողովի կողմից 1998 թվականի մայիսի 5-ին, փոփոխություններով և լրացումներով տարբերակը Հայաստանի իրավական տեղեկատվական համակարգի պաշտոնական www.arlis.am կայքում:
3. «Իրավական ակտերի մասին» ՀՀ օրենքը (Հոդված 9, մաս 6), ընդունվել է ՀՀ Ազգային ժողովի կողմից 2002 թվականի ապրիլի 3-ին (ներկայումս չի գործում), տե՛ս Հայաստանի իրավական տեղեկատվական համակարգի պաշտոնական www.arlis.am կայքում:

4. «Պետական գույքի մասնավորեցման 2017-2020 թվականների ծրագրի մասին» ՀՀ օրենքը, ընդունվել է ՀՀ Ազգային ժողովի կողմից 2017 թվականի հունիսի 9-ին, փոփոխություններով և լրացումներով տարբերակը Հայաստանի իրավական տեղեկատվական համակարգի պաշտոնական www.arlis.am կայքում:
5. «Հայաստանի Հանրապետության ջրային օրենսգիրք», ընդունվել է ՀՀ Ազգային ժողովի կողմից 2002 թվականի հունիսի 4-ին, փոփոխություններով և լրացումներով տարբերակը Հայաստանի իրավական տեղեկատվական համակարգի պաշտոնական www.arlis.am կայքում:
6. «Պետություն-մասնավոր գործընկերության մասին») ՀՀ օրենքը, ընդունվել է ՀՀ Ազգային ժողովի կողմից 2019թ.-ի հունիսի 28-ին (ՀՕ-113-Ն), տե՛ս Հայաստանի իրավական տեղեկատվական համակարգի պաշտոնական www.arlis.am կայքում:

References

1. The RA «Law on National Water Program of the Republic of Armenia», adopted by the National Assembly of the Republic of Armenia on November 27, 2006, TC-232-N, with the amended version of the Legal Information System of Armenia at official website www.arlis.am
2. «The Civil Code of the Republic of Armenia», adopted by the National Assembly of the Republic of Armenia on May 5, 1998, amended and supplemented in the Legal Information System of the Republic of Armenia at official website www.arlis.am
3. Law of the Republic of Armenia on «Legal Acts» (Article 9, Part 6), adopted by the National Assembly of the Republic of Armenia on April 3, 2002 (currently not in force), see in Legal Information System of Armenia at official website www.arlis.am
4. RA Law «On Program of Privatization of State Property 2017-2020», adopted by the National Assembly of the Republic of Armenia on June 9, 2017, amended and supplemented in the Legal Information System of the Republic of Armenia at official website www.arlis.am
5. «Water Code of the Republic of Armenia», adopted by RA National Assembly, amended and supplemented in Legal Information System of the Republic of Armenia at official website www.arlis.am
6. RA Law on «State – Private Partnership», adopted by RA National Assembly on June 28, 2019, (TC-113-N), see in Legal Information System of the Republic of Armenia at official website www.arlis.am

ՀՏԴ - 556:627.1:34.1

ՀԱՅԱՍՏԱՆԻ ՀԱՆՐԱՊԵՏՈՒԹՅԱՆ ՋՐԱՅԻՆ ՌԵՍՈՒՐՍՆԵՐԻ ԿԱՌԱՎԱՐՄԱՆ ԲԱՐԵԼԱՎՄԱՆ ՀԻՄՆԱԿԱՆ ՈՒՂԻՆԵՐԸ

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[2]Շուշիի տեխնոլոգիական համալսարան
[3]Եվրոպական համալսարան

Հայաստանի Հանրապետության բնական ռեսուրսների կարևոր մասն են կազմում ջրային ռեսուրսները: Դեռևս 2000-ական թվականների սկզբին ընդունված ջրային հարաբերությունների կարգավորման տնտեսա-իրավական դաշտի քննական վերլուծությունը վկայում է, որ ոլորտում տեղ են գտել բազմաթիվ թերություններ և բացթողումներ, որոնք առաջացել են հիմնականում գործող իրավական դաշտի պահանջները հաշվի չառնելու հետևանքով: Միևնույն ժամանակ,

հիմնադիր օրենքների անհարկի փոփոխություններն ու լրացումները, ըստ էության, ավելի են վատացրել ՀՀ-ում ջրային ռեսուրսների օգտագործման վիճակը: Այդ հանգամանքը երկիրը կանգնեցրել է այնպիսի մարտահրավերի առջև, որոնք պահանջում են ջրային հարաբերություններում տեղ գտած թերությունների և բացթողումների շուտափույթ շտկում, ժամանակի պահանջներին համապատասխանող տնտեսա-իրավական համակարգի ստեղծում, որը հաշվի կառնի ինչպես պետության (որպես ջրային պաշարների սեփականատիրոջ) հանրային շահերն, այնպես էլ տարբեր ջրօգտագործողների շահերի ներդաշնակեցումը, և այդպիսով արդյունավետ գործընկերության ապահովմանը: Վերջին հանգամանքը ենթադրում է, հատկապես, պետություն-մասնավոր գործընկերության շրջանակների ընդլայնում և այդպիսի գործընկերության տարբեր եղանակների կիրառում:

Բանալի բառեր. ջրային ռեսուրսներ, ջրային ռեսուրսների կառավարման բարելավում, ջրային օրենսգիրք, ջրօգտագործողների ընկերություն, պետություն-մասնավոր գործընկերություն, հավատարմագրային կառավարում, առևտրային կազմակերպություն, վարձակալություն, կոնցեսիա, գույքի անհատույց օգտագործում:

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ОСНОВНЫЕ ПУТИ УЛУЧШЕНИЯ УПРАВЛЕНИЯ ВОДНЫМИ РЕСУРСАМИ РЕСПУБЛИКИ АРМЕНИЯ

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Водные ресурсы являются важной частью природных ресурсов Республики Армения. Изучение экономико-правовых основ регулирования водных отношений, основанных в начале 2000-х годов, показывает, что в этой области имеются многочисленные недостатки и упущения, возникшие в основном из-за несоблюдения требований существующей правовой базы. В то же время необоснованные изменения и дополнения, введённые в Водный кодекс РА, фактически имели обратный эффект - ухудшили состояние водопользования в Республике Армения. Проблемы, возникшие вследствие этого требуют безотлагательного решения, в частности - исправления недостатков в сфере водных отношений, создания современной экономико-правовой системы (основы), которая будет учитывать как общественные интересы государства (владельца водных ресурсов), так и интересы различных водопользователей и их гармонизацию. Последнее подразумевает, в частности, внедрение практики государственно-частного партнерства, расширение рамок и осуществление различных форм такого партнерства.

Ключевые слова: водные ресурсы, совершенствование управления водными ресурсами, водный кодекс, ассоциация водопользователей, государственно-частное партнерство, доверительное управление, коммерческая организация, аренда, концессия, безвозмездное пользование имуществом.

Ներկայացվել է՝ 08.01.2020թ.
Գրախոսման է ուղարկվել՝ 08.01.2020թ.
Երաշխավորվել է տպագրության՝ 11.03.2020թ.

UDC - 631.316.031

THE STUDY OF INTERACTION OF WORKING ORGAN OF SOIL CULTIVATING MACHINE WORKING ON SLOPE AND THE SOIL

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The field cultivation processes in the mountain farming of the RA and AR are mainly carried out by such machines and mechanisms designed for lowland conditions without taking into account the specificities of mountain farming. As a result, the slope soil is subjected to erosion. Taking into account this factor, the interaction between the soil and working organ of soil cultivating machine working on slopes was theoretically studied and the relative motion of the soil on the working surface of the working organ was determined. The resulting statements will help to identify the mechanism of soil erosion during slope soil cultivation and to develop preventive measures.

Key words: slope, working organ, furrow, soil erosion, trajectory, wedge, motion.

Introduction

The current level of mechanization of the mountain agriculture of the Republic of Armenia is quite low, it does not exceed 15% on average and some of the existing machines carry out technological processes with incomplete, low productivity and insufficient quality. Therefore, the mechanization of cultivation processes in mountain conditions is carried out by such methods and machines which are designed for lowland conditions without taking into account the specificities of mountain farming. As a result, slope lands are subjected to intensive erosion and if appropriate measures are not taken, these lands can become non arable causing significant economic harm to agriculture.

For the best cultivation of slope soil as well as for increasing the efficiency of agricultural machinery operation we need a multifaceted study and justification of the interaction between the soil cultivating aggregates and their working organs and between the working organ and soil as well based on modern agro-technical requirements.

Conflict setting

In slopes due to lateral forces, the working organs of the soil cultivating machine deviate from the set direction which also changes the trajectory of relative movement of the soil over the working surface of the working organ [1,2,3,4,5,6,7].

During the process of slope soil cultivation normal pressure force N, impact lateral force Q directed to down slope and contact force F (Fig. 1) [3,4,8,9,10] influence on the furrow cut by working organ. During slope cultivation the soil particles begin to move in the direction of the equilibrium forces. The contact force of these forces does not affect the relative motion of the soil. It is therefore necessary to determine the trajectory of relative motion of slope soil due to the normal pressure N and lateral Q forces.

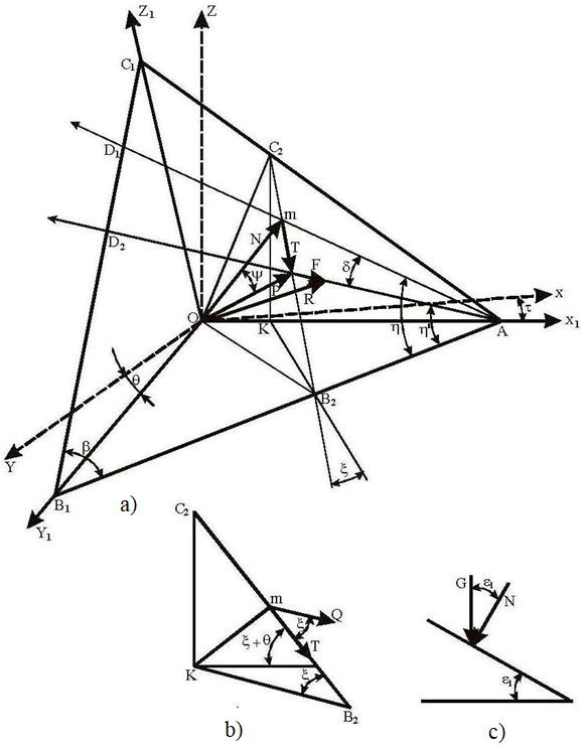

Fig. 1 The scheme of determining the deviation angle of the trajectory of relative motion of slope soil (δ)

Research results

Lateral Q force is located on KB_2C_2 plane parallel to slope and the component is in ABC plane (Fig.1,a).

$$T = Q\cos\xi = G\sin\theta\cos\xi, \tag{1}$$

where ξ- is the angle of B_2C_2 line and AOB_1 plane down the wedge on the working surface of trihedral wedge. It is dependent both on wedge parameters and motion direction of machine-tractor aggregates (MTA) to horizontal (τ) (Fig.2).

Considering that T component of Q force is directed to CE we will get the following according to Fig. 2

$$tg\,\xi = \frac{OC}{OE} = \frac{OC}{OD}\cos(\gamma - \tau) = tg\,\varepsilon\cos(\gamma - \tau) \tag{2}$$

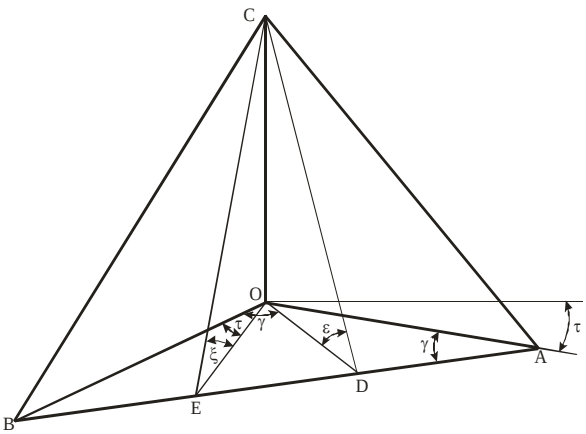

Fig. 2 Determining scheme of ξ angle formed by AOB plane down the wedge and EC line stretching down the slope

From the analysis of obtained (2) expression and $\xi = f(\tau)$ graph (Fig. 3) we see that

1. when soil cultivating MTA moves towards the field horizontals $(\tau = 0)$, then

$$tg\xi = tg\varepsilon\cos\gamma = tg\beta \ , \tag{3}$$

i.e. here $\xi = \beta$,

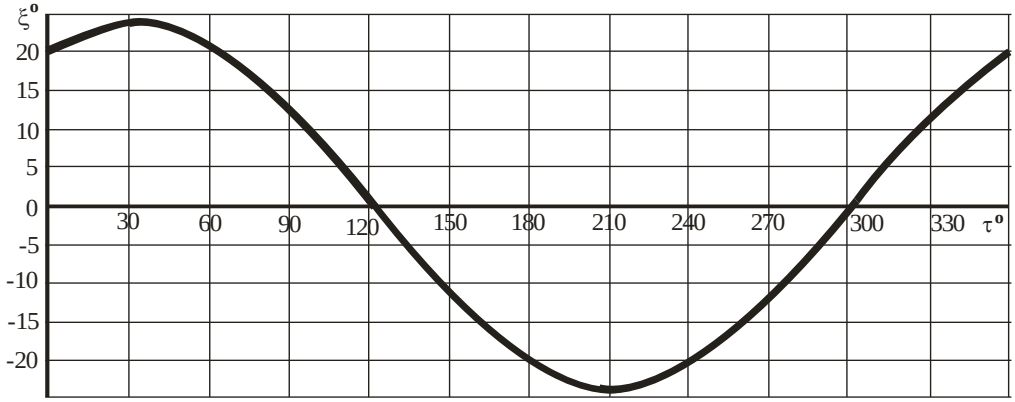

Fig. 3 The graph of change of the ξ angle by EC line stretching down the slope and AOB plane down the wedge depending on direction of MTA motion $\gamma = 32°, \varepsilon = 23,5°$

2. when MTA moves down the slope ($\tau = 90°$), then

$$tg\xi = tg\varepsilon\cos(\gamma - 90°) = tg\varepsilon\gamma\sin = \mathrm{tg}\alpha, \tag{4}$$

i.e. $\xi = \alpha$,

3. when $\tau = \gamma$, $tg\xi = tg\varepsilon$, (5)

i.e. $\xi = \varepsilon$

for arrow paw breast up the slop ξ angle will be

$$tg\xi = tg\varepsilon\cos(\gamma + \tau) \tag{6}$$

According to (2) and (6) expressions the formula for determining ξ angle will generally have the following form

$$tg\xi = tg\varepsilon\cos(\gamma \pm \tau) \ , \tag{7}$$

where + corresponds to breast of arrow paw to upper slope, - to the breast of down the slope.

T component of lateral Q force, normal pressure N force and their equilibrium P force are in OB_2C_2 plane (Fig.1, a). The angle ψ by N and P forces will be determined from the following expression

$$tg\psi = \frac{T}{N} \tag{8}$$

Normal pressure N force is determined by Fig.1, c- $N = G\cos\varepsilon_1$,

where ε_1 is the angle of working surface with horizontal plane

consequently,

$$tg\psi = \frac{G\sin\theta\cos\xi}{G\cos\varepsilon_1} = \frac{\sin\theta\cos\xi}{\cos\varepsilon_1} \tag{9}$$

Influenced by T component of lateral force the trajectory of the relative movemet of soil over working surface of wedge deviates by δ angle forming η′ angle to cutting edge (Fig. 1, a)

$$\eta' = \eta \pm \delta, \tag{10}$$

where η is the angle by the trajectory of relative motion of the soil over the working surface of wedge to the cutting edge working in horizontal plane. + corresponds to breast of arrow paw to upper slope, - to the breast of down the slope.

In Fig. 4 we see the boundary positions AD_2' and AD_2' of trajectory of relative movement of furrow and AD_1 trajectory corresponds to the case when lateral forces are absent (plane).

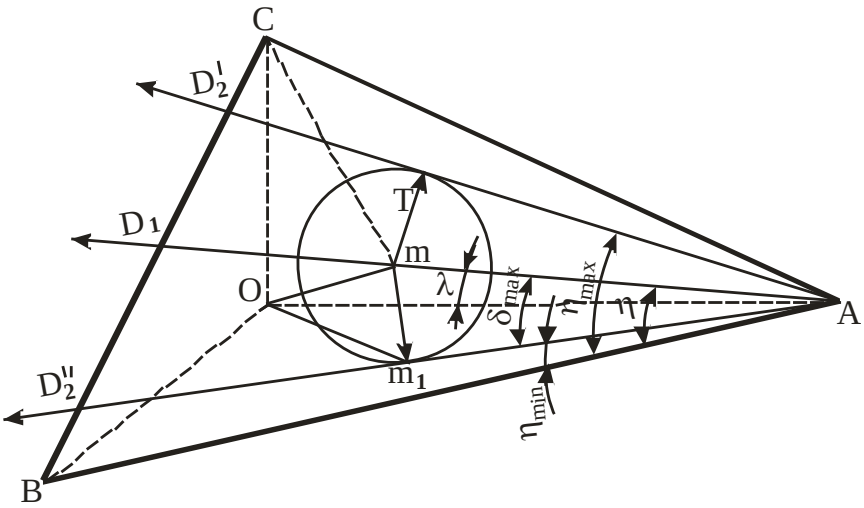

Fig. 4 Scheme of determining the dimension of deviation of trajectory of relative motion of soil over the working surface of working organ

The deviation of the trajectory of relative motion of the furrow on the same slopes (δ) is dependent on the direction of MTA movement. When the slope coincides with mm_1 line, the trajectory of relative movement of furrow will be AD_2' having the maximum deviation. In this case the working organ will be deviated towards horizontal by $\theta = \eta_r$ angle. i.e. the projection of AD_1 trajectory on the horizontal plane and the direction of movement of MTA coincide. We can observe Omm_1 and Amm_1 rectangular triangles for this case which have the same mm_1 leg (Fig. 4). According to these triangles we can write

$$Om\, tg\psi = Am\, sin\delta_{max}, \quad \text{where}$$

$$sin\delta_{max} = \frac{Om}{Am} tg\psi = tg\lambda\, tg\psi, \tag{11}$$

where λ is the angle of the direction of movement of MTA and AD_1 trajectory.

Taking into account that the trajectory of relative movement of soil over working surface of wedge is proposed by the η angle with cutting edge of plough and, according to L. V. Gyachev [3], it satisfies the following condition $tg\eta = tg\gamma \cos\varepsilon$,

$\cos\lambda \cos\eta = \cos\gamma$, $\sin\gamma \sin\varepsilon = \sin\lambda$,

where γ is the angle to the direction of movement and cutting edge of the wedge.

From the last expressions we can write

$$tg\lambda = \frac{sin\gamma sin\varepsilon cos\eta}{cos\gamma}, \quad \text{or}$$

$$tg\lambda = tg\gamma sin\varepsilon cos\eta \tag{12}$$

Considering (9) and (12), (11) will have the following form

$$sin\delta_{max} = \frac{tg\gamma sin\varepsilon cos\,\eta sin\,\theta\, cos\,\xi}{cos\varepsilon_1} \quad (13)$$

Current values of δ angle will be determined by multiplying the obtained expression with cos(θ$\pm\eta_г$)

$$sin\delta = \frac{tg\gamma sin\varepsilon\, cos\,\eta\, sin\,\theta\ cos\,\xi \cos(\theta \pm \eta_г)}{cos\varepsilon_1} \quad (14)$$

where $\eta_г$ angle by horizontal projection of the direction of furrow movement and movement is determined by the following expression [11]

$$tg\,\eta_г = \frac{tg\gamma - cos\varepsilon \cdot tg\eta}{1 + tg\gamma \cdot tg\eta \cdot cos\varepsilon} \quad (15)$$

Inserting the calculated value of δ in (10) expression the trajectory of relative movement of furrow over working surface of working organ on slope depending on the impact of lateral forces is determined.

Conclusion

1. As a result of study of interaction of soil and working organs of soil cultivators on the slopes the expressions were obtained determining the trajectory of relative movement of furrow over the working surface of working organ depending on the impact of lateral forces and the change of technological parameters of working organ.
2. The obtained expressions will allow to reveal the soil erosion mechanism during slope soil cultivation and to develop preventive actions.

References

1. Горячкин В.П. Собрание сочинений: Т.2. – М., 1965. – 459 с.
2. Синеоков Г.Н., Панов И.М. Теория и расчет почвообрабатывающих машин. – М.: Машиностроение, 1977. – 328 с.
3. Гячев Л.В. Теория лемешно-отвальной поверхности / Тр.АЧИМСХ; Вып.13. – Зерноград, 1961. – 317с.
4. Бледных В.В. Сущность появления механической эрозии почв при обработке склонов / Бледных В.В., Рахимов З.С.// Сб. науч. тр. факультета механизации сельского хозяйства, посвященный 50-летию факультета – Уфа: БГАУ, 2001. – С. 80-87.
5. Свечников П.Г. Модернизация почвообрабатывающих рабочих органов на основе исследования процесса их взаимодействия с почвой: автореф. дис. докт. техн. наук: Челябинск, 2013. – 43с.
6. Тураев Л.Д. Динамика плуга. – Харьков: Изд-во Харьковского университета, 1973. – 161с.
7. Шаршак В.К. Плужные каналокопатели. Рекомендации проектированию рабочих органов. – Новочеркасск, 1972. – 66с.
8. Буряков А.С. Исследование перемещения почвы по лапе плоскорежущего рабочего органа // Вопросы механизации почвозащитного земледелия. – Целиноград, 1976. – С.11-20.
9. Котов П.М. Экспериментальное исследование перемещения почвы по крылу стрельчатой лапы // Труды ОмСХИ; Т.114. 1973. – с. 69-71.

10. Пигулевский М.Х. Основы и методы изучения почвенных деформаций// Теория, конструкция и производство сельскохозяйственных машин. – М.: Сельхозгиз, 1936. Т.2. – С. 421-528/
11. Tonapetyan P.A.Gasparyan P.Yu. The Estimation of mechanical removal of slope soil. Bulletin of high technology 3(10) Shushi-2019, p. 15-22.

References

1. Goryachkin V. P., Collected works, vol. 2, Moscow, 1965, 459 p.
2. Sinekov G.N., Panov I.M., Theory and calculation of soil cultivation machines, M., Machine industry, 1977, 328 p.
3. Gyachev L.V., Theory of plough-breast surface / Tr. AChEIMI, Ed. 13, Zernograd, 1961, 317 p.
4. Blednikh V.V., The essence of mechanical erosion of soils during the slope cultivation/ Blednikh V.V., Rakhimov Z.S.// Collection of proceedings of the faculty of Mechanization of agriculture dedicated to the 50th anniversary of the Department, Ufa, BSAU, 2001, p. 80-87.
5. Svechnikov P.G., Modernization of soil cultivating working organs on the basis of research of their interaction with soil, abstract of dissertation for Doctor of Technical Sciences, Chelyabinsk, 2013, 43 p.
6. Turaev L.D., Dynamics of plough, Kharkiv, ed. of Kharkiv University, 1973, 161 p.
7. Sharshak V.K., Plough canal diggers, Recomendations of projecting of working organs, Novocherkassk, 1972, 66 p.
8. Buryakov A.S., Study of soil erosion on the paw of cuttng edge of working organ// Issues on mechanization of soil preservation agriculture, Tselinograd, 1976, p.11-20.
9. Kotov P.M., Experimental research of soil erosion over the arrow paw// Works of OAI, vol.114, 1973, p. 69-71.
10. Pigulevski M.Kh., Basics and methods of studying the soil deformations//, Theory, construction and production of farm machinery, M., Agricultural publishing, 1936, vol. 2, p. 421-528
11. Tonapetyan P.A., Gasparyan P.Yu. The Estimation of mechanical removal of slope soil. Bulletin of high technology 3(10) Shushi-2019, p. 15-22.

ՀՏԴ - 631.316.031

ԼԱՆՋՈՎ ԱՇԽԱՏՈՂ ՀՈՂԱՄՇԱԿ ՄԵՔԵՆԱՅԻ ԲԱՆՈՂ ՕՐԳԱՆԻ ԵՎ ՀՈՂԻ ՓՈԽԱԶԴԵՑՈՒԹՅԱՆ ՈՒՍՈՒՄՆԱՍԻՐՈՒԹՅՈՒՆԸ

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[2]Շուշիի տեխնոլոգիական համալսարան

ՀՀ և ԱՀ լեռնային երկրագործությունում դաշտավարության գործընթացներն հիմնականում իրականացվում են այնպիսի մեքենաներով և մեխանիզմներով, որոնք նախատեսված են հարթավայրային պայմանների համար՝ հաշվի չառնելով լեռնային երկրագործության առանձնահատկությունները: Արդյունքում լանջերի հողը ենթարկվում է հողատարման: Հաշվի առնելով այդ հանգամանքը տեսականորեն ուսումնասիրվել է լանջերում հողամշակ մեքենայի բանող օրգանի և հողի փոխազդեցությունը, որոշվել բանող օրգանի աշխատանքային մակերևույթով հողի հարաբերական շարժման հետագիծը: Ստացված արտահայտությունները

թույլ կտան բացահայտելու լանջերի հողերի մշակման ժամանակ հողատարման մեխանիզմը և մշակել կանխարգելիչ միջոցառումներ:

Բանալի բառեր. լանջ, բանող օրգան, առ, հողատարում, հետագիծ, սեպ, տեղաշարժ:

УДК - 631.316.031

ИССЛЕДОВАНИЕ ВЗАИМОДЕЙСТВИЯ РАБОЧЕГО ОРГАНА ПОЧВООБРАБАТЫВАЮЩЕЙ МАШИНЫ, РАБОТАЮЩЕЙ ПО СКЛОНУ, С ПОЧВОЙ

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В горном земледелии РА и Республики Арцах процессы полеводства в основном осуществляются машинами и механизмами, предназначенными для равнинных условий, без учета особенностей горного земледелия. В результате почвы на склонах подвергаются эрозии. Учитывая это обстоятельство, теоретически было изучено взаимодействие рабочего органа почвообрабатывающей машины с почвой на склонах, определена относительная траектория движения почвы по рабочей поверхности рабочего органа. Полученные утверждения позволят выявить механизм эрозии при обработке земель склонов и разработать профилактические мероприятия.

Ключевые слова: склон, рабочий орган, пласт земли, эрозия почвы, траектория, клин, перемещение.

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Երաշխավորվել է տպագրության՝ 02.04.2020թ.

UDC - 621.867.014

SCREW CONVEYOR FOR LOADING - UNLOADING SHIFTING CARGO

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In many studies devoted to loading, transportation and unloading processes of shifting cargo with screw conveyor the load is considered as a single material point that is transferred to the surface of the auger. The process of moving the cargo from the load box to the screw wings is not yet fully explored, although the processes taking place in that area have a significant impact on the operation of the screw conveyors.

Theoretical research has been done and it has been found that in order to increase the efficiency of loading activities of shifting cargo with screw conveyors, it is necessary to move the cargo from the load box to the maximum speed. Otherwise the material may be clogged in the coils in front of and behind the screw. As a result, a new structure of screw conveyor has been developed the application of which will reduce the energy costs of loading, transportation and unloading the shifting cargo.

Key words: cargo, shifting, auger, conveyor, screw, regime, mass.

Introduction

Numerous studies have been conducted by both CIC and other foreign authors on the processes of loading, transporting and unloading of shifting cargoes with screw conveyors. Among such researches are the works of L.M. Alexander, D.N. Bashkatov, A.M. Grigoryev, E.M. Gutyar, B.A. Katanov etc, in many of which the transported cargo is considered to be one material point which is transferred to the surface of the auger [1,2,3,4,5,6]. Such an approach can be considered justified only because the volume of transported shifting cargo is not widely studied although some work has been done in that direction. The process of moving the cargo from the load cell to the screw wings is not fully studied yet although the processes taking place in that area have a significant impact on the operation of the screw conveyors.

In case of unsuccessful structure of the load box of screw conveyor, the screw may not catch the load but throw it which undoubtedly affects the productivity and energy costs of the conveyor.Therefore, we can argue that the process of loading, transporting and unloading the cargo with screw conveyor requires further research.

It is not possible to accurately calculate the parameters and modes of operation of the auger with existing formulas and the required values are usually determined experimentally as the application of computational values leads to contradictory results for 20-60%.

At present when calculating the power required for the work of the auger, its productivity and other parameters, the speed of the auger is determined instead of the speed of the material transported by it. However, the velocity of the transported mass changes its size as the material interacts with the surface of the auger coils.

Conflict setting

While transporting shifting cargoes the peculiarity of vertical auger is the presence of some critical angular speed of screw in case of its low position the auger does not give motion to the material vertically.

The axial v_0 and perimetric v_c speeds of particles at the distane of R from auger axis will be equal to

$$v_0 = \frac{Sn}{60}\left(\cos^2\alpha - tg\varphi\cos\alpha\right), \qquad (1)$$

$$v_c = \frac{Sn}{60}\left(\cos\alpha \sin\alpha + tg\varphi \cos^2\alpha\right), \tag{2}$$

where S is auger step, n is the rolling number of shaft, φ is angle of the vector slope of absolute speed of the particles to the norm on the screw surface, α is the angle of rise of screw line.

To determine the slope angle of absolute speed to screw normal the differential equation system of the movement of the point in the screw surface edge is used. For cylinder coordinate system Dalamber equation is written as follows:

$$\left.\begin{aligned} &M\left[\frac{d^2R}{dt^2} - R\left(\frac{d\varepsilon}{dt}\right)^2\right] = -N_2, \\ &M\frac{1}{R}\frac{d}{dt}\left(R^2\varepsilon\right) = F_1\cos\alpha + N_1\sin\alpha + F_2\sin(\alpha+\varphi), \\ &M = \frac{d^2Z}{dt^2} = N_1\cos\alpha - G - F_1\sin\alpha - F_2\cos(\alpha+\varphi): \end{aligned}\right\} \tag{3}$$

M is the forces on load particles (Fig.1), normal reaction of auger screw is N_1 which with OZ axis forms α angle, normal reaction of auger cover is N_2 which is directed to the radius, $F_1 = N_1 f$ is contact force of the particles with screw surface where f is the contact coefficient of contact forces of particles with screw surface. F_1 contact force is directed against the rolling of the screw over screw surface. $F_2 = N_2 f_1$ where f_1 is the coefficient of the particles with auger cover.

Solution of (3) equation system after installing the reactions of forces and relations in it can be presented as follows:

$$\frac{S^2n^2}{gR60^2}\left(f_1 f\cos\varphi - f_1\sin\varphi\right)\cos^2\alpha\left(\sin\alpha + tg\varphi\cos\alpha\right)^2 = -\sin\alpha - f\cos\alpha \tag{4}$$

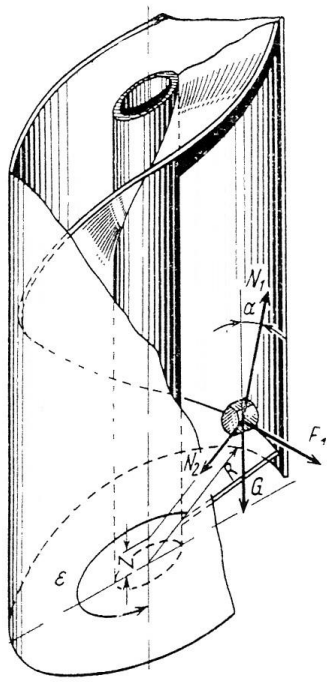

Fig. 1 Scheme of forces on material particle in vertical auger

Let us observe $\lambda = \frac{Sn^2}{g}$ coefficient which describes cinematic regime of auger. Solving (4) equation to the coefficient of cinematic regime we will get

$$\lambda = \frac{60^2}{2\pi f_1} \cdot \frac{\sin\alpha + f\cos\alpha}{\sin\alpha\cos\alpha(\sin\varphi - f\cos\varphi)(\sin\alpha + tg\varphi\cos\alpha)^2} \quad (5)$$

To screw line rising α angle of external edge of auger corresponds certain relation of external edge of step and coil $t_0 = \frac{S}{2R_0}$ which is connected with α angle by $\alpha = arctg\frac{t_0}{\pi}$ dependence. We can see from (5) relation that φ angle is depended on t_0 relation of structural parameters, f and f_1 contact coefficients and S step of screw.

The rising angle of screw line also effects the dimension of pressure force of the load on conveyer cover. The latter depends on centrifuge force ($F_ц$), gravity force (G) and contact force of load with screw ($F_{тр.ш.}$) (Fig. 2).

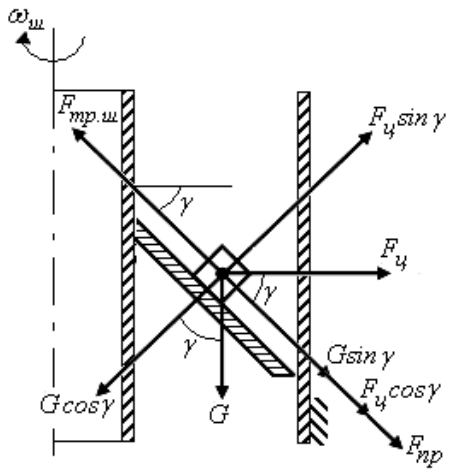

Fig. 2 Scheme of forces on material point on screw line

According to calculation scheme in Fig. 2 we obtained pressure force on conveyer cover:

$$F_{пр} = m \cdot \left[\omega_ш^2 R(\cos\gamma + \sin\gamma \cdot f_ш) + g(\sin\gamma - \cos\gamma \cdot f_ш)\right], \quad (6)$$

where γ is slope angle of screw line to screw axis.

Obtained (6) expression enables us to determine the dependence of γ angle on load transported by conveyer and screw contact coefficient.

Thus, as in (6) expression the first component is not dependent on γ angle within 5-20°, then pressure force of load on the cover will be equal to 0, if $\sin\gamma = \cos\gamma \cdot f_ш$ from which we can write

$$\gamma = arc\ tg\gamma \cdot f_ш : \quad (7)$$

Taking into account that while preparing the screw its working surface is well processed then the contact coefficient between load and screw can be chosen within 0,2-0,3. Consequently, the slope angle to screw axis should be taken within $\gamma = 10 - 15^0$.

Research results

Theoretical research has shown that in order to increase the efficiency of loading cargo with screw conveyors it is necessary to move the cargo from the load box with the maximum speed. Otherwise, the material may be clogged in the coils in front of the screw and later in other coils.

To solve the problem it is recommended to increase the number of screw coils which will proportionally increase the speed of load transfer from the load box to the screw coils.

For this purpose we suggest to use advanced conveyer (Fig.3) made of screw (1), one input coils (2) and cover (3). On the bottom of screw there is a tip (4) with two coils (main and auxiliary), indeed the main screw (5) stretches from along all the length of the tip and the auxiliary screw (6) is somehow shorter from the main one.

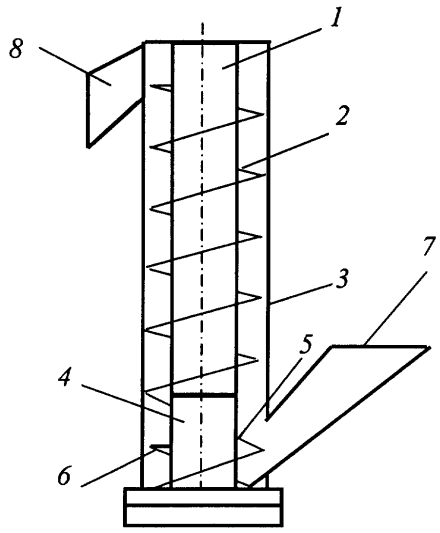

Fig. 3 Scheme of advanced screw conveyer

Screw conveyer has loading (7) and unloading (8) facilities.

The working principle of the suggested screw conveyer is simple, it works this way: shifting cargo fills into the space between the tip coils (4) from load box and transports to the main screw (5) by auxiliary screw from which it is transferred to spiral part (2) of screw conveyer (1) and thus raising reaches unloading facility.

Conclusions

1. Theoretical research revealed that during transporting shifting cargo we can provide maximum productivity when rising angle of screw line makes 10-15^0 to screw axis which corresponds to the dimensions of 1.2-1.4 of coil step according to external coils and 150-200 turn/min of screw rotation.
2. Theoretical research has shown that in order to increase the efficiency of loading cargo with screw conveyors it is necessary to move the cargo from the load box with maximum speed. Otherwise, the material may be clogged in the coils in front of the screw and later in other coils.
3. A new structure of screw conveyer was developed using which the energy costs of loading, transportation and unloading of shifting cargoes will significantly decrease.

References

1. Атоян С.В. Автоматизированные методы расчета шнековых устройств для транспортирования и уплотнения порошкообразных материалов: МГУИ, 1999. - 176 с.
2. Байбара С.Н. Вертикальный шнековый конвейер; Межвуз. сб. науч. тр. Проблемы машиностроения и технического обслуживания в сфере сервиса. Радиоэлектроника, телекоммуникации и информационные технологии. 2005.
3. Катанов Б.А., Кузнецов В.И. Определение закономерностей движения. одиночной частицы по шнеку., Изв. вузов. Горный журнал- 1972. -№2.-с. 125-131.

4. Корн Г. Справочник по математике для научных работников и инженеров., М.: Наука, 1977.- 760 с.
5. Пухов Ю.С. Транспортирующие машины М.: Недра 1987, 232 с.
6. Соколов М.В. Клинков А.С. , Ефремов О.В. Автоматизированное проектирование и расчет шнековых машин М.: Машиностроение-1, 2007
7. Тополиди К.Г., Васильев В.К. ,. Монастырский Д.Ш. Справочник по расчету и проектированию транспортирующих устройств предприятий текстильной и легкой промышленности. -М. Легкая и пищевая промышленность, 1983.192 с.

References

1. Atoyan S.V., Automated methods of calculation of screw devices for transporting and compression of powder materials. MSUE, 1999, 176 p.
2. Baybora S.N., Vertical screw conveyer, InterHEI, Proceedings, Issues of machinery and technical service in the service sector. Radio electronics, telecommunications and information technologies, 2005.
3. Katanov B.A., Kuznetsov V.I., Determination of the regularities of movement, single particles along the screw, bulletin of HEI, Gorniy Journal, 1972. -№2, p.125-131.
4. Corn G., Mathematical guidebook for scientific workers and engineers, M., Science, 1977, 760 p.
5. Pukhov Yu. S., Transporting machines, M., Nedra, 1987, 232 p.
6. Sokolov M.B., Klinkov A., S., Yefremov O.V., Automated projecting and calculation of screw machines, M., Machinery -1, 2007
7. Topolidi K.G., Vasilyev V.K., Monasterskiy D. Sh., Guidebook of calculations and projecting of transporting facilities of textile and light industry plants, M., Light and food industry, 1983, 192 p.

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ՍՈՐՈՒՆ ԲԵՌՆԵՐԻ ԲԵՌՆՄԱՆ-ԲԵՌՆԱԹԱՓՄԱՆ ՊՏՈՒՏԱԿԱՎՈՐ ՓՈԽԱԿՐԻՉ

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Սորուն բեռների պտուտակավոր փոխակրիչներով բեռնման, փոխադրման և բեռնաթափման գործընթացներին նվիրված բազմաթիվ հետազոտություններում, բեռը դիտարկվում է որպես մեկ նյութական կետ, որը տեղափոխվում է շնեկի պարուրակի մակերևույթով: Դեռևս լիարժեք ուսումնասիրված չեն բեռնման խցիծ դեպի պտուտակի թևերը բեռի տեղափոխման գործընթացը, չնայած, որ այդ գոտում տեղի ունեցող գործընթացները էական ազդեցություն են թողնում պտուտակավոր փոխակրիչների աշխատանքի վրա:

Կատարվել է տեսական հետազոտություններ և պարզվել, որ պտուտակավոր փոխակրիչներով սորուն բեռների բեռնման աշխատանքների արդյունավետության բարձրացման նպատակով անհրաժեշտ է, որպեսզի բեռնման խցից փոխադրվող բեռը տեղափոխվի առավելագույն արագությամբ: Հակառակ դեպքում կարող է փոխադրվող նյութը խցանվել պտուտակի առջևի և այնուհետև մնացած գալարներում: Արդյունքում մշակվել է պտուտակավոր

փոխակրիչի նոր կառուցվածք, որի կիրառման դեպքում կնվազի սորուն բեռների բեռնման, փոխադրման, բեռնաթափման էներգածախսերը:

Բանալի բառեր. բեռ, սորուն, շնեկ, փոխակրիչ, պտուտակ, ռեժիմ, զանգված:

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ПОГРУЗОЧНО-РАЗГРУЗОЧНЫЙ ВИНТОВОЙ КОНВЕЙЕР ДЛЯ СЫПУЧИХ ГРУЗОВ

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В многочисленных исследованиях, посвященных процессам погрузки, транспортировки и разгрузки сыпучих грузов винтовыми конвейерами, груз рассматривается как одна материальная точка, перемещающаяся по винтовой поверхности шнека. Процесс перемещения груза из загрузочной камеры к лопастям винта еще полностью не изучен, несмотря на то, что процессы, происходящие в этой зоне, оказывают существенное влияние на работу винтовых конвейеров.

В ходе проведенных теоретических исследований было установлено, что для повышения эффективности работ по погрузке сыпучих грузов винтовыми конвейерами необходимо, чтобы из загрузочной камеры груз перемещался на максимальной скорости. В противном случае транспортируемый материал может закупориться в передних, а затем в оставшихся спиралях шнека. В результате была разработана новая структура винтового конвейера, в случае применения которой снизятся энергозатраты на погрузку, транспортировку и разгрузку сыпучих грузов.

Ключевые слова: груз, сыпучий, шнек, конвейер, винт, режим, масса.

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The article copyright Submission Format Requirements

Articles can be submitted in Armenian, English or Russian up to 14 p. (titled “Economic” up to 24 p).
Sheet format A4, margins up , down, left , right 18 mm.
The fonts: Armenian – Unicode /GHEA Grapalat/, Russian, English – Times New Roman.
The space between the lines – 1,15

1. The title of the article is given in the article’s submitted language, in capital letters, in Armenian 11, Russian and English 12 bold font size at the right bottom of the page.
2. Universal Decimal Classification consisting of 6 symbols at least is given in the left corner of the next page.
3. A line down, in the middle, the article’s submitted language, the title, capital letters, in Armenian 12, Russian and English 14 bold font size.
4. Two lines down, from the left, in the article’s submitted language, the review of the author’s name and surname, initial affiliation, in Armenian 11, Russian and English 12 bold font size
5. Aline, from the left, in the article’s submitted language, (Italic) is given the name of the organization, in Armenian 9, Russian and English 10 font size.
6. Disabling text in horizontal solid line, from the left corner of the page are given the Key Words (up to 5-8 words), in Armenian 10, Russian and English 11 font size
7. Two lines down, in the article’s submitted language, in the middle, (Italic), is written summery of the article., 10-20 lines, in Armenian 9, Russian and English 10 font size
8. Two lines down is given the main text of the article, in Armenian 10, Russian and English 11 font size.The paragraphs begin from new line, 10 mm from the depths. The expound of the theme are guaranteed of the following scheme: “Introduction”, “conflict settings”, “Research results”, “Conclusion”. In case of need can also be other section with corresponding titles.
9. The formulas are presented in separated lines, in the middle and are numbered on the right, in brackets. The formulas, as well as math’s symbols and expressions are given in the text in Microsoft Equation, Italic 10 font size.
10. There can be found pictures, diagrams, graphs and tables in texts. The pictures and diagrams are numbered by transit numbering by sign “pic”. The description of pictures, diagrams, the names of pictures, diagrams graphs and the signs of description are given below. They can be placed vertical or horizontal in Armenian 9, Russian and English 10 bold font. Tables are numbered by “pic” transit numbering. The names of tables, sign description are given above. They could be placed vertical or horizontal. If the table can’t be placed on a single page, it must be transferred to the other page and mentioned as condonation. In table column must not be left free lines, there must be put dash or write “not” (“determined”).
11. Pictures, diagrams graphs in electronic version are colored as a rule.
12. At the end of the article, two lines down, from 10 mm left corner is typed “lietarture” Armenian 11, Russian and English 12 bold font. A line down is presented the list of literature numbered by link sequence. In list the sources must be marked […] and include the authors last name and the first letter of name, full names of theme, publishing dates, (place publishing,town, year, tom and pages). Official information as well as a-mail computer programs, reports, commands, copyrights patents, in case of patents are given the whole details. The sources are given in an original languages. At the same time Armenian and Russian sources are given in latin fonts.
13. On separate pages is given the translation of the article headquarters and summary. (beseides article presented language), Armenian , Russian (resume) and English (summary).
14. The Articles should be sent to the info@bulletin.am.
15. The published and corrected version of the text are submitted with author(s).
16. On a separate sheet of paper are given the information about the authors (surname, name, affiliation (the whole), picture, academic degree, address, telephon, organization, position, e-mail.

Հոդվածների հեղինակային օրինակների ձևակերպման համար ներկայացվող պահանջներ

Հոդվածները կարելի է ներկայացնել հայերենով, ռուսերենով և անգլերենով՝ մինչև 14 էջի (“Էկոնոմիկա” խորագրով՝ մինչև 24 էջի) սահմաններում.
Էջի ֆորմատը՝ A4, լուսանցքները՝ վերևից, ներքևից, աջից և ձախից՝ 18 մմ.
Տառատեսակը հայերեն՝ Unicode /GHEA Grapalat/, ռուսերեն և անգլերեն՝ Times New Roman.
Միջտողային հեռավորությունը՝ 1,15:

1. Էջի վերին աջ անկյունում, հոդվածի ներկայացման լեզվով, գլխատառերով՝, հայերեն՝ 11, ռուսերեն և անգլերեն՝ 12 **bold** տառաչափով տրվում է հոդվածի խորագիրը:
2. Հաջորդ տողի էջի ձախ անկյունում տրվում է ՀՏԴ-ն՝ առնվազն վեցանիշ թվով:
3. Դրանից մեկ տող ներքև, մեջտեղում, հոդվածի ներկայացման լեզվով գլխատառերով դրվում է վերնագիրը՝ հայերեն՝ 12 **bold**, ռուսերեն և անգլերեն՝ 14 **bold** տառաչափով:
4. Երկու տող ներքև, ձախից, հոդվածի ներկայացման լեզվով, հեղինակի (հեղինակների, որոնց թիվը, որպես կանոն, չի կարող գերազանցել 4-ը) Անվան, Հայրանվան սկզբնատառերը և Ազգանունը՝ հայերեն՝ 11, ռուսերեն և անգլերեն՝ 12 **bold** տառաչափով:
5. Մեկ տող ներքև, ձախից, հոդվածի ներկայացման լեզվով, շեղատառերով (*Italic*) տրվում է կազմակերպության (կազմակերպությունների) անվանումը՝ հայերեն՝ 9, ռուսերեն և անգլերեն՝ 10 տառաչափով:
6. Անջատելով տեքստը հորիզոնական հոծ գծով՝ էջի ձախ անկյունից, հոդվածի ներկայացման լեզվով, տրվում են Բանալի բառերը (5-8 բառ)՝ հայերեն՝ 10, ռուսերեն և անգլերեն՝ 11 տառաչափով:
7. Երկու տող ներքև, հոդվածի ներկայացման լեզվով, մեջտեղում, շեղատառերով (*Italic*), գրվում է հոդվածի համառոտագիրը՝ 10-20 տող՝ հայերեն՝ 9, ռուսերեն և անգլերեն՝ 10 տառաչափով:
8. Երկու տող ներքև ներկայացվում է հոդվածի հիմնական տեքստը՝ հայերեն՝ 10, ռուսերեն և անգլերեն՝ 11 տառաչափով: Պարբերությունները սկսվում են նոր տողից՝ 10 մմ խորքից: Երաշխավորվում է նյութի շարադրման հետևյալ սխեման. «***Ներածություն***», «***Խնդրի դրվածքը***», «***Հետազոտության արդյունքները***», «***Եզրակացություն***»: Անհրաժեշտության դեպքում կարող են լինել նաև այլ բաժիններ՝ համապատասխան վերնագրերով:
9. Բանաձևերը ներկայացվում են առանձին տողով, մեջտեղում և համարակալվում են աջ մասում, փակագծերի մեջ: Բանաձևերը, ինչպես նաև տեքստում տեղադրվող մաթեմատիկական սիմվոլներն ու արտահայտությունները տրվում են Microsoft Equation-ով, Italic՝ 10 տառաչափով:
10. Տեքստում կարող են լինել նկարներ, գծապատկերներ, գծագրեր և աղյուսակներ: Նկարները և գծապատկերները համարակալվում են միջանցիկ համարակալմամբ՝ «**Նկ.**» նմուշառմամբ: Նկարների, գծապատկերների, գծագրերի անվանումները, նշանակումների բացատրությունները տրվում են ներքևում: Դրանք կարելի է տեղադրել ուղղաձիգ կամ հորիզոնական դիրքով՝ հայերեն՝ 9, ռուսերեն և անգլերեն՝ 10 **bold** տառաչափով: Աղյուսակները համարակալվում են միջանցիկ համարակալմամբ՝ «**Աղ.**» նմուշառմամբ: Աղյուսակների անվանումները, նշանակումների բացատրությունները տրվում են վերևում: Դրանք կարելի է տեղադրել ուղղաձիգ կամ հորիզոնական դիրքով: Եթե մեկ թերթի վրա աղյուսակը չի տեղավորվում, պետք է շարունակել մյուս թերթի վրա՝ նշելով, որ շարունակությունն է: Աղյուսակի սյունյակներում ազատ տեղեր չպետք է մնան. պետք է դնել գծիկ կամ գրել «չկա» («չի որոշված»):
11. Նկարները, գծապատկերները, գծագրերը էլեկտրոնային տարբերակով, որպես օրենք, տրվում են գունավոր տարբերակով:
12. Հոդվածի վերջում, երկու տող ներքև, ձախից՝ 10 մմ խորքից տպագրվում է «**Գրականություն**»՝ հայերեն՝ 11, ռուսերեն և անգլերեն՝ 12 **bold** տառաչափով: Մեկ տող ներքև ներկայացվում է գրականության ցանկը՝ համարակալված ըստ հղումների հերթականության: Ցանկում աղբյուրները պետք է նշվեն [...] տեսքով և ընդգրկեն՝ հեղինակի/ների/ ազգանունը և անվան /Հայրանունի/ առաջին տառը /երը/, նյութերի լրիվ անվանումը, հրատարակության տվյալները /տեղը, հրատարակչությունը, քաղաքը, տարեթիվը, հատորը, էջերը/: Տեղեկատվական պաշտոնական, այդ թվում՝ էլեկտրոնային աղբյուրների, համակարգչային ծրագրերի, հաշվետվությունների, հրահանգների, հեղինակային իրավունքի արտոնագրերի, պատենտների դեպքում ներկայացվում են լրիվ տվյալները: Աղբյուրները բերվում են բնօրինակի լեզվով: Միևնույն ժամանակ, հայերեն և ռուսերեն աղբյուրները ներկայացվում են նաև լատինատառ շարվածքով:
13. Առանձին էջերի վրա տրվում է հոդվածի գլխամասի և համառոտագրի թարգմանությունը (բացի հոդվածի ներկայացման լեզվի)՝ հայերեն, ռուսերեն (Резюме) և անգլերեն լեզուներով (Summary):
14. Հոդվածները պետք է ուղարկել info@bulletin.am էլ. հասցեով:
15. Տեքստի խմբագրված և սրբագրված տարբերակը համաձայնեցվում է հեղինակ(ներ)ի հետ:
16. Առանձին թղթի վրա տրվում է հեղինակների մասին տվյալները (Ազգանուն, Անուն, Հայրանուն (լրիվ), լուսանկարը, գիտական աստիճանը, գիտական կոչումը, հասցեն, հեռախոսը, կազմակերպությունը, զբաղեցրած պաշտոնը, էլեկտրոնային հասցեն):

Требования, предъявляемые к оформлению авторских образцов статей

Статьи можно представить на армянском, русском и английском языках объемом до 14 страниц (статьи под рубрикой "Экономика" до 24 страниц)
Формат страницы: А4, поля сверху, снизу, справа и слева по 18 мм
Шрифт армянский - Unicode/GHEA Grapalat/, русский и английский - Times New Roman.
Междустрочное расстояние - 1,15

1. В верхнем правом углу страницы заглавными буквами (на языке статьи) записывается название рубруки по шрифту: армянский – 11 **bold**, русский и английский - 12 **bold**.
2. На следующей строке в верхнем левом углу страницы записывается УДК (минимум шестизначное число).
3. На следующей строке набирается заголовок статьи заглавными буквами по центру по шрифту: армянский – 12 **bold**, русский и английский - 14 **bold**.
4. Две строки ниже, слева, на языке статьи набирается фамилия и инициалы автора (соавторов, как правило, не более 4 человек) по шрифту: армянский – 11 **bold**, русский и английский - 12 **bold**.
5. На следующей строке, слева, на языке статьи курсивом (*Italic*) дается название организации (организаций) по шрифту: армянский - 9, русский и английский - 10.
6. Отделив текст горизонтальной выделенной линией, слева даются ключевые слова (5-8 слов) по шрифту: армянский - 10, русский и английский - 11.
7. Две строки ниже, на языке статьи, по центру курсивом (*Italic*) дается аннотация (10-20 строк) по шрифту: армянский - 9, русский и английский - 10.
8. Две строки ниже, дается основной текст статьи по шрифту: армянский - 10, русский и английский - 11. Абзацы начинаются с новой строки с отступом 10 мм. Рекомендуется следующая схема изложения материала: "Введение", "Постановка задачи", "Результаты исследования", "Заключение". В случае необходимости могут быть также другие разделы с соответствующими названиями.
9. Формулы располагаются отдельной строкой по центру и нумеруются в правой части в скобках. Формулы, а также математические символы и выражения приводятся по “Microsoft Equation”, курсивом (*Italic*) по шрифту - 10.
10. В тексте могут быть рисунки, графики, чертежи и таблицы. Рисунки и графики нумеруются по порядку - "Рис.". Названия рисунков, графиков, чертежей, объяснения обозначений приводятся снизу. Их можно расположить в вертикальном или горизонтальном положении по шрифту: армянский - 9 **bold**, русский и английский - 10 **bold**. Таблицы нумеруются по порядку - "Таб.". Названия таблиц, объяснения обозначений приводятся сверху. Их можно расположить в вертикальном или горизонтальном положении. Если таблица не помещается на одной странице, нужно продолжить ее на следующей странице, отметив, что это продолжение данной таблицы. В таблице не должно быть свободных столбцов, в этом случае нужно поставить черточку или написать "нет" ("не определено").
11. Рисунки, графики и чертежи в электронной версии, как правило, приводятся в цветном варианте.
12. В конце статьи, через две строки, с отступом слева 10 мм печатается "Литература" по шрифту: армянский - 11 **bold**, русский и английский - 12 **bold**. На следующей строке приводится список использованной литературы, пронумерованный по последовательности ссылок. В списке источники должны указываться в виде [...] и включать фамилию и инициалы автора (авторов), полное название статьи (материала), данные публикации (место, издательство, город, год, том, страницы). В случае официальной информации, в том числе электронных источников, компьютерных программ, отчетов, инструкций, сертификатов об авторских правах, патентов, приводятся полные данные. Источники приводятся на языке оригинала. В то же время армянские и русские источники печатаются также латинскими буквами.
13. На отдельных листках дается перевод названия статьи, фамилии и инициалов автора (авторов), названия организации (организаций), ключевых слов и аннотации (кроме языка статьи) на армянский язык (Ամփոփում), русский язык (Резюме) и английский язык (Summary).
14. Статьи нужно отправить на почту info@bulletin.am.
15. Отредактированная версия текста согласовывается с автором (авторами).
16. На отдельном листе приводятся сведения об авторах (Фамилия, Имя, Отчество (полностью), фотография, ученая степень, ученое звание, адрес, номер телефона, организация, занимаемая должность, адрес электронной почты).

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