Scholarly Publisher
RS Global Sp. z O.O.
ISNI: 0000 0004 8495 2390

Dolna 17, Warsaw, Poland 00-773
Tel: +48 226 0 227 03
Email: editorial_office@rsglobal.pl

JOURNAL	International Journal of Innovative Technologies in Economy
p-ISSN	2412-8368
e-ISSN	2414-1305
PUBLISHER	RS Global Sp. z O.O., Poland

ARTICLE TITLE	CULTIVABLE LAND WATER SUPPLY AND A PERSPECTIVE VIEW OF AGRICULTURAL CROPS YIELD
AUTHOR(S)	Solomon Pavliashvili, David Gubeladze
ARTICLE INFO	Solomon Pavliashvili, David Gubeladze. (2021) Cultivable Land Water Supply and a Perspective View of Agricultural Crops Yield. International Journal of Innovative Technologies in Economy. 4(36). doi: 10.31435/rsglobal_ijite/30122021/7712
DOI	https://doi.org/10.31435/rsglobal_ijite/30122021/7712
RECEIVED	27 September 2021
ACCEPTED	19 December 2021
PUBLISHED	24 December 2021
LICENSE	This work is licensed under a **Creative Commons Attribution 4.0 International License.**

CULTIVABLE LAND WATER SUPPLY AND A PERSPECTIVE VIEW OF AGRICULTURAL CROPS YIELD

Solomon Pavliashvili, *Academy Member, Georgian National Academy of Sciences, Doctor of Economics, Professor of Georgian Technical University; Tbilisi, Georgia, ORCID ID: https://orcid.org/0000-0002-9006-1039*
David Gubeladze, *Doctor of Technical Sciences, Professor of Georgian Technical University, Faculty of Agrarian, Sciences and Biosystems Engineering, Tbilisi, Georgia, ORCID ID: https://orcid.org/0000-0002-8332-3694*

DOI: https://doi.org/10.31435/rsglobal_ijite/30122021/7712

ARTICLE INFO

Received 27 September 2021
Accepted 19 December 2021
Published 24 December 2021

KEYWORDS

irrigation, agricultural crops, financial resources, water supply, microbiological processes, agricultural activities, effective agricultural policy.

ABSTRACT

The maximum use of the potential of Georgia's agriculture and the targeted use of natural resources is vital for the development of the sectoral economy. The main guarantee of achieving a positive result for the country is the implementation of a clearly defined, effective agricultural policy aimed at competitive production, assistance in attracting financial resources, and encouragement of agricultural activities, conducting agrotechnical measures during the growing season of agricultural crops and determining the norms and terms of irrigation.

Citation: Solomon Pavliashvili, David Gubeladze. (2021) Cultivable Land Water Supply and a Perspective View of Agricultural Crops Yield. *International Journal of Innovative Technologies in Economy*. 4(36). doi: 10.31435/rsglobal_ijite/30122021/7712

Introduction. Optimal use of water resources and the supply of irrigation water to agricultural land lead to a maximum increase in yields and high-quality agricultural products. Watering is all the more important the drier the area. In addition, watering has a higher effect, the shallower the root system of the plant (e.g. vegetables) is spread, since the topsoil dries relatively early and a plant with a short root system begins to wilt earlier than a plant with a deep root system. In this case, the deeply rooted plant enjoys the moisture from the deeper layers.

Raise a point. When working on agricultural land, during the period of plant development and during the growing season, the accuracy of the choice of the irrigation period is of particular importance. Failure to adhere to the watering schedule will not do any good other than degrading soil properties, and studies show can significantly reduce the yield of the next crop.

Irrigation affects not only the amount of the crop, but also its quality, which, in turn, affects the microbiological processes occurring in the soil. In normally irrigated soil, the growth of microorganisms occurs more intensively, since water is one of the main factors in the development of microorganisms.

The nitrification process takes place intensively when soil moisture is about 60 percent of the total water content. In general, excess moisture has a worse effect on the nitrification process than dryness. This explains the fact that the process of nitrification on irrigated areas in the irrigated zone occurs especially in spring and autumn, and gradually slows down in summer. The process of nitrification on irrigated land lasts all summer long [1, 5, 6].

Priority zones for agricultural activities, taking into account climatic factors, can be conditionally divided as follows: 1. Lower Kartli (Marneuli and Gardabani regions, Upper Samgori massif); 2. Part of Kakheti region (southern part of Gurjaani district, Sighnaghi and Dedoplistskaro districts; 3. The rest of Kakheti region (northern part of Gurjaani district, Sagarejo, Kvareli, Lagodekhi and Telavi districts), Part of Lower Kartli (Bolnisi and Dmanisi districts) and Tetritskaro district; 4. Part of Kartli region (Khashuri district, Samachablo) and Mtskheta-Mtianeti (Mtskheta and Dusheti districts); 5. Southern Georgia, Adigeni, Akhaltsikhe, Aspindza and Akhalkalaki districts; 6. The rest of Imereti, Irrigation systems of Guria and Samegrelo regions.

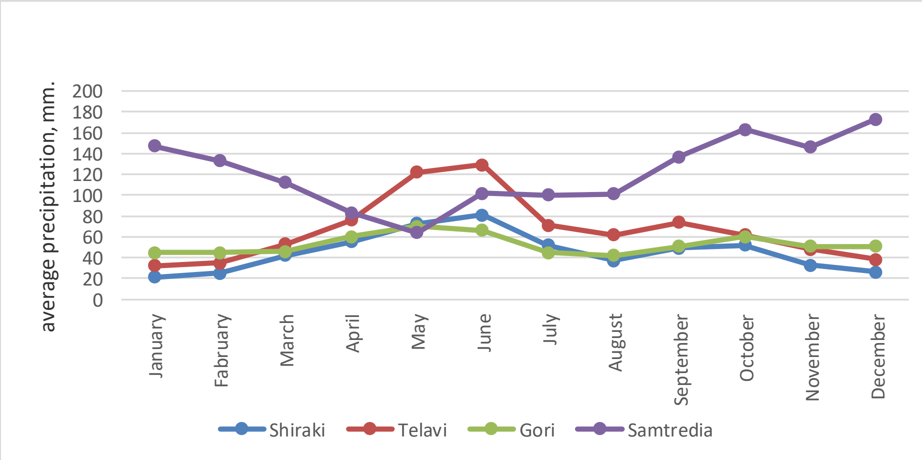

Fig. 1. Average monthly precipitation by region (average precipitation, mm)

The total water consumption by a plant (transpiration and evaporation from the topsoil) under conditions of optimal humidity in the irrigated area for optimal water consumption losses with rational use mainly depends on the lack of water in the air. As this deficit increases, so does the plant's total water consumption.

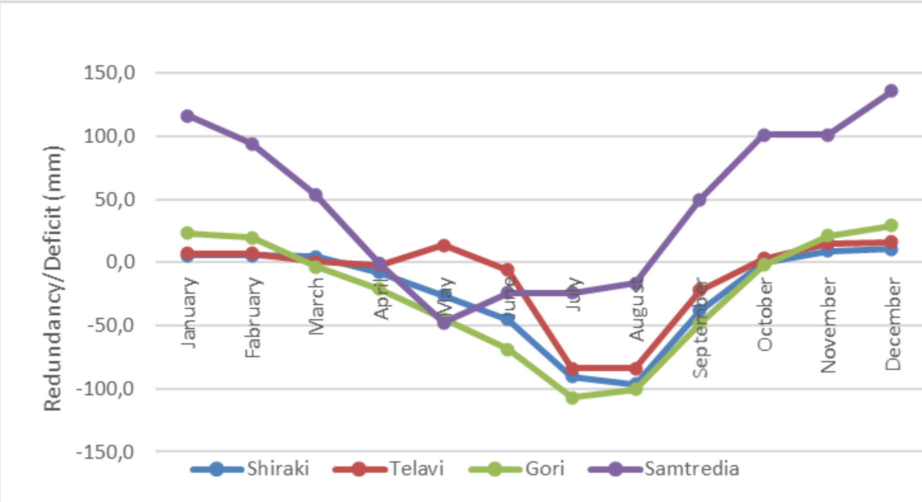

Fig. 2. Monthly water deficit for agricultural crops by region by month (surplus / deficit)

It is known that precipitation during the growing season often does not provide the above ratio between water deficit in the air and total consumption, and in fact, sometimes there is a noticeable difference between them.

The goal of watering is to minimize this difference, which requires accurate watering norms and timing.

Main part. The irrigation rate is determined by the amount of water that one hectare should receive during the next irrigation. It is clear that soil moisture changes during these periods of time. Its goal: to maintain an optimal state of moisture as long as possible and maintain it in the soil for a long time; Never reduce soil moisture to physiological limits; The duration of watering and the calendar period should be combined with further agrotechnical measures.

Irrigation should establish the desired water and air regime for the plant in the active layer of the soil (R), i.e. In the layer where the main mass of the plant's root system is spread.

The active layer depends both on the crop itself and on the intensity and depth of soil moisture. The active layer can be small due to wetting at a shallow depth. It is undesirable to artificially reduce the depth of the root system, as this will reduce the volume of soil used for the plant, and at the same time the supply of nutrients.

0.3–0.5 m for vegetable plants; 0.6–0.8 m for field plants; 0.7–0.8 m for perennial crops; Under normal moisture conditions, the main active part of the root system of fruit trees is located in a layer of 0.5 m. An active layer of 0.8 m is required for vines in Kakheti. We got an active layer of 0.75-0.80 m for perennials.

In the same plant, the active layer changes in accordance with the phases of development and for the individual culture obtained by us, the active layer is characteristic of the period of maximum development. In addition, the question arises whether it is necessary to moisten the soil deep into the active layer during watering, taking into account that part of the root system that goes deep into the active layer. Some advocate wetting the 1.0 m layer during irrigation, regardless of the crop, and even deeper. For this, in our conditions, watering of perennial plants and grasses in autumn-winter or early spring is quite enough, with an increased rate of watering, with a moisture content of about 1.2 m.

As for annual crops, they are provided with the necessary watering before sowing, taking into account the moisture of the active layer characteristic of each crop, which is quite enough for the deep layer, since during spring sowing of agricultural crops, a kind of water supply usually accumulates in the soil. In addition to watering immediately after sowing, additional precipitation is added to autumn crops during sowing, in winter and early spring (before the start of vegetative irrigation) [1, 2, 3].

Watering norms can be determined in several ways. If the soil has a certain amount of water and the maximum moisture characteristic for this soil is known, their difference will give us the irrigation norm.

The maximum moisture content is the limiting water content, which sometimes reaches 90% of the total moisture capacity. Thus,

$$m = W_{\max} - W_0 , \quad (1)$$

where m – irrigation norm m^3 / ha;

W_{max} – The maximum amount of moisture, m^3;

W_0 – Water supply in soil, m^3.

The limiting moisture capacity of the soil is r_L = 26%, the water supply of the soil is r0 = 18%, and the Volumetric weight of soil $\alpha = 1{,}3$ and active layer of this soil is $H = 0{,}8$ m, m = r_{LC} - r_0 = 26% - 18% = 8% so:

$$m = 100 H r \alpha = 100 \times 0.8 \times 8 \times 1.3 = 832 \ m^3$$

The minimum moisture content in the soil is the wilting coefficient, i.e., the amount of moisture below which water supply is not available to the plant is physiologically useless. A decrease in water supply in the soil to the wilting coefficient is not allowed, it must always exceed 70% of the maximum moisture content for an agricultural crop.

In general:

$$m = r_{LC} - rdm \quad (2)$$

where r_{LC} is the limiting water capacity;

rdm – is the desired minimum.

The desired minimum moisture content per plant ranges from 70% to 90–95% of the water limit. The desired minimum for winter wheat is 80% of the water limit.

$$m = 100 H \alpha \, K(r_{LC} - r_{LC\,80\%}) \quad L / s \ ha \quad (3)$$

Watering rates also affect the location of groundwater. If the latter is located close to the soil surface and irrigation is expected to provide and consolidate groundwater, which could lead to waterlogging (especially in the eastern part of the Alazani Valley), In this case, it is necessary to artificially reduce the watering rate. The irrigation rate must be artificially reduced also in cases where the soil and the lower part of the active layer or the layer immediately below it have a strong light texture, since such a layer cannot hold the calculated amount of water and will uselessly go into the depth.

$$M = m_1 + m_2 + m_3 + \cdots + m_n , \quad (4)$$

where n – is the number of waterings

The watering norm should be reduced, even if the bottom layer is very salty. The irrigation rate should be reduced in the sense that water does not reach this salty layer and, in addition, salts dissolved as a result of evaporation do not accumulate in the upper layer.

The irrigation norm should be increased when the active layer is salty. With an increased irrigation rate, temporary washing out of salts from the lower layers is possible. This is especially necessary during the germination period, if salts have accumulated in the upper layer.

The irrigation rate established by the above rule, if it is not affected by the proximity to groundwater or salt, does not need to be increased at all in the conditions of Georgia. This is due to the following circumstances: in most of our cases, soils with a heavy texture are characterized by a relatively slow fluid loss and a given irrigation rate does not reach a given depth in time, most of them remain in the upper layer with a relatively high moisture content. As a result, the bottom layer remains less moist and sometimes the water cannot reach it completely.

Therefore, taking into account this circumstance, from the very beginning we give 10-15% more water, that is, we introduce a correction factor into the formula for the calculated irrigation rate and the formula itself takes the following form:

The irrigation rate should be increased even when the theoretically calculated rate is very low (400-500 m^3) due to the limited amount of water. Irrigation at such an irrigation rate is very difficult for irrigation, requires more labor and, as we will see later, the elements of irrigation technique require unfavorable changes;

In addition to the irrigation rate, the irrigation rate is also known, which shows the amount of water consumed per hectare for the entire growing season. Depending on how many times a particular crop is irrigated, the irrigation rate also differs. The irrigation rate is equal to:

Where n is the number of irrigations

The discussed rates represent a kind of optimal rates, which often differ greatly from the actual irrigation rates in a particular area. Actual irrigation rates will depend on local conditions, available water supplies and especially the irrigation equipment.

The presence of irrigation norms allows you to efficiently use the amount of irrigation water from the water intake source.

Determination of the actual watering rates for plants and bringing them to optimal rates depends on the irrigation technique and the improvement of agrotechnical measures in general. Self-improving irrigation methods cannot be introduced if they do not match other agricultural technologies.

Table 1. Corn harvest according to irrigation rate and quantity of irrigations

Number of irrigations	Irrigation norm m^3	Harvest	
		C / ha	In%
3	1481	30,6	100,00
4	1220	47,0	153,88
6	872	55,1	180,29
9	527	67,3	220,05

Irrigation in all zones leads to higher yields, but in arid and very arid regions it is almost impossible to harvest and conduct more or less efficient agricultural production.

In addition, watering has a higher effect, the shallower the root system of the plant (e.g. vegetables) is spread, since the topsoil dries relatively early and a plant with a short root system begins to wilt earlier than a plant with a deep root system. In this case, the deeply rooted plant enjoys the moisture from the deeper layers [3, 4].

Watering rates can be determined in several ways; As the amount of water increases, the yield increases within certain limits.

Irrigation affects not only the quantity of the crop, but also its quality. It also affects the microbiological processes in the soil. The growth of microorganisms occurs more intensively in normally irrigated soil, since water is one of the main factors influencing the situation on the part of microorganisms.

One of the vital processes of microorganisms in the soil is nitrification, that is, the biological oxidation of ammonia oxygen in nitrite, followed by the oxidation of these nitrites to nitrates - nitrifying bacteria act in the soil, decomposing organic matter.

Table 2. Percentage increase in productivity as a result of water supply planning.

Zone names	Percentage increase in yield efficiency		
	Vegetables %	The rest of the crops, %	Cereals %
Moist (regions of Samegrelo, Adjara, Guria, high-mountainous regions of Imereti);	25	20	10
Moderate drought (part of the regions of Western Georgia, in the Imereti Valley);	100	70	50
Drought (Inner Kartli region, Mtskheta, Dusheti);	230	150	100
Severe drought (Telavi, Gurjaani, Kaspi, Tetritskaro, Bolnisi districts)	550	300	230

As can be seen from Table 2, in arid and very arid regions, without irrigation, it is almost impossible to harvest and conduct more or less efficient agricultural production. It should also be borne in mind that at present most of the additional agricultural products obtained as a result of irrigation in Georgia are produced on private farms, peasants, this is often not directly reflected in the country's budget, although this does not diminish its importance in providing the population with agricultural products for local agricultural production and economic development of the country as a whole [4, 5].

Table 3. Water consumption required for irrigation, depending on the texture and slope of the soil.

The mechanical composition of the soil	Slope	Consumption per meter of width in l / s
1. Heavy mechanical composition;	0,001–0,01	1,5–2,0
	>0,01	1,0–1,5
2. Average mechanical composition;	0,001–0,01	2,0–2,5
	>0,01	1,5–2,0
3. Light mechanical composition.	0,001–0,01	2,5–3,0
	>0,01	2,0–2,5

This explains the fact that the process of nitrification on irrigated areas in the irrigated zone occurs especially in spring and autumn, and gradually slows down in summer. The process of nitrification on irrigated land lasts all summer long. The nitrification process takes place intensively when soil moisture is about 60 percent of the total water content. In general, excess moisture has a worse effect on the nitrification process than dryness.

Conclusions. With the improvement of agrotechnical measures, our irrigation technique also improves, and at the same time the actual irrigation norm approaches the optimal one. The water consumption required for irrigation is taken into account depending on the texture and slope of the soil. Against the background of the general development of the economy, the irrigation water service in Georgia is gradually strengthening, and the percentage of increase in yields as a result of the planning of the water service in agriculture, it is expected that collection of payments by water users will improve accordingly and government funding will decrease. However, this depends on whether the structure involved receives the assistance needed to provide adequate services to water users in the future.

REFERENCES

1. Pavliashvili S., Gubeladze D. (2020). The Economic Challenges in Times of Covid-19, Circular Labor Migration, the Necessity to Switch from a Linear to a Circular Economy and Business Opportunities; Social and Economic Aspects of Education in Modern Society (Scientific and Practical Conference) ISBN 978-83-958980-6-8, Vol.1, p.3, December 25, Publisher – RS Global Sp. z O.O., Warsaw, Poland;
2. Pavliashvili S., Gubeladze D. (2020). Agriculture, economic efficiency management and circular economics, Manual, "Mwignobari" Publishing House, Tbilisi.
3. Gubeladze D. (2019). Methods of engineering solution for river flow regulation, "Publishing House", Georgian Technical University, Tbilisi.
4. Gubeladze D., Xaraishvili O. (2020). Handbook of Agricultural Hydromelioration, Tbilisi. p. 650.
5. Retrieved from http://gtu.ge/ScienceDep/Pdf/Angarishi_2017/ANGARISHI_samecn_STU_Gaertianebuli_2017_Print.pdf
6. Retrieved from https://mepa.gov.ge/Ge/Files/Download/21971