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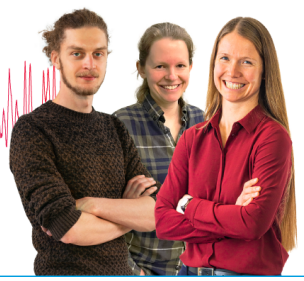
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Efficient use of Water Resources in Aral Sea Region in Context of Global Climate Change and Water Scarcity

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Abstract. Global climate change is becoming a factor that can have a significant impact on all areas of human activity. In many parts of the world, it has a negative impact on the environment, human life, and health in various sectors of the economy. The impact of climate change, especially on agriculture, is so huge, as agriculture is one of the main sectors of the economy that depends on the weather. Climate change will lead to a 10-15% increase in surface water evaporation and a 10-20% increase in water consumption due to increased plant transpiration and irrigation. In this regard, the purpose of the study was to study the effectiveness of subirrigation irrigation of winter wheat from major crops in the Aral Sea region in the context of water scarcity, to develop technology for its application, for which the following tasks were performed: determine the effect of irrigation regime on the growth, development, yield, and quality of winter wheat. Observations, measurements, and analysis in research "Methods of conducting field experiments" adopted at the Research Institute of Cotton Breeding, Seed Production and Agrotechnology (RICBSPA) and the accuracy and reliability of the data obtained were analyzed mathematically and statistically using a computer program. The experiments created optimal irrigation regimes and favorable reclamation conditions for the growth and development of winter wheat while maintaining 80% of the limited field moisture capacity(BFMC) before the irrigation of winter wheat. At the same time, winter wheat is irrigated 6 times in the 2-3-1 system according to the growth phases; the irrigation norm is 492-517 m3 / ha, the seasonal irrigation norm is 3032-3038 m3 / ha, 1831-2706 m3 of water is saved compared to river water with surface irrigation.

04 August 2025 08:59:01

Keywords. Climate change, water resources, agriculture, transpiration, irrigation method, subirrigation, winter wheat, irrigation rate, irrigation regime, efficiency.

INTRODUCTION

As a result of global climate change, the area of glaciers in Central Asia has shrunk by about 30 percent over the past 50-60 years. According to the Center for Hydrometeorological Service (UZHYDROMET) scenario, there will be no significant changes in water resources in the Amudarya and Syrdarya basins by 2030. By 2050, water resources in the Syrdarya basin will decrease by 5% and 15% in the Amudarya basin. In the new period of 2015, the total water shortage in Uzbekistan will exceed 3 billion m^3, and by 2050 may reach 15 billion m^3 (Agaltseva N.) [1].

In the current conditions of irrigated lands, climate change will inevitably lead to an increase in water shortages. It can also pose serious challenges to meeting the water needs of other sectors of the economy. Over the next 15 years, the water supply per capita decreased from 3,048 m^3 to 1,589 m^3. At the same time, the average annual population growth in the country is 650-700 thousand people, and by 2030, their demand for quality water will increase from 2.3 billion m^3 to 2.7-3.0 billion m^3, or 18-20%. In recent years, the industrial and energy sectors have been developing rapidly. Their demand for water is increasing year by year. The total annual water consumption of these sectors will increase 1.8 times from today's 1.9 billion m^3 to 2030 to 3.5 billion m^3 (Bezborodov G.A., Toshmatov M.N., Shamsiev A.S.; Methods of agrochemical, agrophysical and microbiological studies in irrigated cotton areas.) [6, 15].

Global climate change is becoming a factor that can have a significant impact on all areas of human activity. It has a negative impact on the environment in many parts of the planet, as well as on the lives and health of the population in various sectors of the economy. The impact of climate change on agriculture, in particular, is high, as

agriculture is one of the most weather-dependent sectors of the economy. Climate change will lead to 10-15% evaporation of water from water surfaces and 10-20% more water consumption due to increased plant transpiration and irrigation standards. This leads to an average 18% increase in non-renewable water consumption (Bekmirzaev, G., Hamidov, A., Khamidov, M., Ishchanov, J., Gubanov Ya.V., Ivanov N.I. [4, 9, 10]. Assessing the possible increase in water consumption on irrigated lands due to climate change (water consumption of various crops, losses, changes in land reclamation) is a topical issue today.

None of the climate scenarios considered in terms of global warming predicts an increase in available water resources; an increase in total evaporation under expected global warming will increase water loss from irrigated areas, which will require additional water consumption. As a result of climate change, Uzbekistan is projected to experience a significant increase in water scarcity and drought due to declining river flows and rapid population growth, increasing demand for water in all sectors of the economy. The lower reaches of the Amudarya will have a negative impact on the Khorezm region and the Republic of Karakalpakstan of the Republic of Uzbekistan in the Aral Sea region [4].

The irrigated area of the republic is 4.329 million hectares, and per hectare, an average of 90-91% of the total water resources are in agriculture, 4.5% in public utilities, 1.4% in industry, 1.2% in fisheries, 0.5% in thermal energy, and 1% in the economy which used in other industries (Methods of agrochemical, agrophysical and microbiological studies in irrigated cotton areas.) [15].

One of the solutions to the problem of water scarcity in irrigated agriculture is the widespread use of water-saving irrigation methods. In the country, agricultural crops are irrigated mainly by traditional methods - the land, the level of land leveling with lasers equipped with laser equipment remains very low. In 2019, a new system of state support for water-saving irrigation technologies was introduced. As a result, drip irrigation was introduced on 77,470 hectares, rainfall on 1,123 hectares, and discrete irrigation technologies were introduced on 2,000 hectares. At the same time, the share of the area where this modern irrigation technology has been introduced remains low (6 percent). As a result, water consumption per hectare and per complex is 10,690 m^3, which is higher than in developed countries.

Water is necessary for the formation of organic matter in the plant body. Biochemical processes take place in its presence. Water maintains a stable state in the cell and plant body. Cell division increases, photosynthesis the respiration of the injured plant works to maintain turgor. Photosynthesis is a public attachment to the area of water in a leaf, along with the opening of the leaf axils of the injured plant. A decrease in water in the plant body accelerates its respiration, the process of photosynthesis slows down, carbohydrates are reduced, and the plant begins to dry out. When water evaporates from a plant, heat is dissipated, resulting in a decrease in its body temperature and protection from the negative effects of heat (Alekseev A.M.) [2].

According to Academician Mirziyoev Sh.M. [16], plants under normal living conditions receive nutrients in dilute solutions with an osmotic pressure of 1-2 atmospheres. In any case, the soil moisture before irrigation should not be less than 65-70% relative to the limited field moisture capacity (BFMC). In soils prone to salinization, the humidity should be 75% relative to BFMC in order to reduce the concentration of the soil solution. Thus, the physiologically scarce soil moisture is 30–35% relative to BFMC.

One of the key issues to be addressed during the study of the irrigation regime and the development of recommendations for its application is the pre-irrigation moisture of the soil for the crop, which is the moisture required to carry out the next irrigation. Plants consume different amounts of water during the irrigation period, so a specific irrigation schedule is established for each transition phase of their development, taking into account soil conditions.

S.N. Ryzhov (Ryzhov SN [17] theoretically substantiated the determination of the norm of irrigation of cotton. He found that the main root mass of the cotton was spread out to about one meter and that most of the water was taken from a depth of 30-90 cm for transpiration.

N.F Bespalov [5], as a result of many years of observations, showed that the optimal pre-irrigation moisture regime in non-saline soils is 70 (85) -75–65% compared to BFMC (limited field moisture capacity). In saline soils, pre-irrigation should be carried out when the soil moisture is 75-80-65% relative to BFMC.

Scientific sources show that wheat is a very demanding plant in terms of the water, air, and nutrient regimes of the soil, and during the growth and development period, these factors are treated differently, especially in terms of the water regime. The results of research conducted by Y.V.Gubanov and N.I. Ivanov [9] shows that in irrigated lands for the purpose of collecting moisture, the main roots of winter wheat are 1 m and more, and the side roots are 50-60 cm reaches a depth of when the soil moisture is low, it is 25–30 cm. layer, which leads to deterioration of plant growth and reduced productivity.

04 August 2025 08:59:01

MATERIALS AND METHODS

The study aimed to study the conditions of alluvial, mechanically heavy sandy soils of the Khorezm region in the Aral Sea region, where global climate change and water scarcity are observed, with a groundwater level of 1.5-2.0 m and a mineralization of 1.0-3.0 g/l. a scientifically based irrigation procedure for wheat subirrigation and its impact on the growth, development, yield, and quality of winter wheat. The following tasks were performed to achieve the objectives of the study:

- to determine the soil conditions (type, mechanical composition, water-physical properties, and fertility) of experimental fields;
- to determine the hydrogeological and reclamation conditions of experimental fields;
- Determining a scientifically based irrigation regime for winter wheat by subirrigation;
- To determine the impact of a scientifically based irrigation regime of winter wheat subirrigation on soil water and physical properties, salinity, changes in groundwater level and mineralization, growth, development, yield, and quality of winter wheat;
- Determination of total water consumption by subirrigation irrigation of winter wheat

Observations, measurements, and analyses in field research were carried out using the guidelines "Methods of conducting field experiments" (Dospekhov B.A.) [7], "Methods of agrochemical, agrophysical and microbiological studies in irrigated cotton areas", «Field observational methods» [8; 15]. The accuracy and reliability of the data obtained were analyzed mathematically and statistically using the multivariate method of B.A. Dospekhov and the computer program SPSS (Statistical Package for Social Science) (Dospekhov B.A.) [7]. All data obtained were within the allowable deviations defined in the methodologies.

Research on determining the order of irrigation of winter wheat by the method of subirrigation was carried out in 3 variants on the alluvial, mechanically heavy sandy soils of the meadow Shavat district of Khorezm region. In this case, the first option - irrigation technology as a control option, the second option - subirrigation irrigation soil moisture before irrigation was 70% of ChDNS, and the third option - subirrigation irrigation soil moisture before irrigation was 80% of ChDNS. The experiments were performed in three repetitions. The area of the variants (length 60 m, width 40 m) was 2400 m2, and the fragments were placed one after the other in a tier. The experiments were carried out in three repetitions. The option area (60 m long, 40 m wide) was 2400 m2, and the pieces were placed in a row on one tier.

04 August 2025 08:59:01

RESULTS

The soil composition of the experimental field planted with winter wheat was determined under laboratory conditions in samples taken by genetic strata (Table 1). According to laboratory analysis, the mechanical composition of the experimental field soil is heavy sand according to N. Kachinsky (the method of N. Kachinsky; by Order of the Federal Agency for Technical Regulation and Metrology of December 12, 2014 No. 2022-st, the interstate standard GOST 12536–2014 was put into effect as the National Standard of the Russian Federation from July 1, 2015) [11]. Its downward slope is important in the use of groundwater by plants.

TABLE 1. Mechanical composition of experimental field soil.

Layers, cm	> 0.25	0.25-0.1	0.1-0.05	0.05-0.01	0.01-0.005	0.005-0.001	< 0.001	< 0.01	According to N.Kachinsky
0-37	0.68	3.67	13.60	32.18	11.99	20.46	14.31	46.58	heavy sand
37-86	0.52	3.54	16.25	38.44	10.65	19.57	11.69	48.10	heavy sand
86-122	0.25	2.99	12.88	31.32	14.72	20.26	15.24	39.50	medium sand
122-165	0.28	3.11	17.25	29.98	11.17	13.61	10.56	34.41	medium sand
165-182	0.40	3.05	15.12	30.77	9.59	16.22	11.38	28.53	light sand

According to agrochemical analyses to assess soil fertility in the winter wheat experimental field (Table 2), the humus content in the tillage layer of the experimental field was 1.28%, total nitrogen 0.094%, and total phosphorus 0.255%, as well as mobile nitrogen 18.9 mg/kg, phosphorus, was 35.2 mg/kg, and potassium was 148.6 mg/kg. Given that these soils are insufficient in nitrogen content, average in phosphorus, and insufficient in potassium, it was necessary to use more nitrogen and potassium fertilizers to grow high-quality wheat.

TABLE 2. Agrochemical parameters of experimental field soils.

Layers, cm	Humus %	General reserve,%		On the move, mg/kg		
		Nitrogen	phosphorus	$N\text{-}N0_3$	$P_2 0_5$	$K_2 0$
0-37	1.28	0.094	0.255	18.9	35.2	148.6
37-86	0.89	0.068	0.236	16.6	34.8	150.2
86-122	0.56	0.057	0.202	13.8	34.1	153.3
122-165	0.45	0.042	0.198	10.1	32.2	136.7
165-182	0.36	0.033	0.154	6.7	25.8	129.5

One of the main indicators determining the structure of the soil driving layer is its volumetric weight [17]. At the beginning of the growing season in the experimental field, the volumetric weight of the soil was 1.34-1.36 g / cm^3 in the 0-30 cm layer, 1.42 g / cm^3 in the subsoil (30-50 cm) layer and 1.40 in the 0-100 cm layer. 1.41 g / cm^3. Towards the end of the growing season, the preparation of the field for planting, sowing, agronomic measures, irrigation methods, and procedures had a different effect on soil compaction. In all variants, there was an increase in the bulk density of the soil. Towards the end of the vegetation, in Option 3, the bulk density of the soil was 1.35–1.36 g / cm^3 in the 0–30 cm layer to be plowed, 1.44 g / cm^3 in the subsoil (30–50 cm) layer, and 1 in the 0–100 cm layer. Was 41–1.42 g / cm^3 and increased by a small amount compared to other options: 0.01–0.02 g / cm^3.

The water permeability of the experimental field soil was 956-1004 m^3 / ha or 0.266-0.279 mm/min for 6 hours at the beginning of the growing season. At the end of the vegetation period, in option 3, the water permeability of the soil for 6 hours was 828-900 m^3 / ha or 0.230-0.250 mm/min, and the decrease compared to other options was minimal 0.029-0.036 mm/min.

In the experiments, the irrigation regime was studied based on the analysis of the literature on the following 4 main types of winter wheat vegetation: germination-accumulation periods, tubing periods, germination-flowering periods, and milk-wax, full ripening periods (Alekseev A.M.; Armor B.A.; Ryzhov S.N.) [2, 3, 15, 19].

In the subirrigation irrigation method, winter wheat was irrigated 6 times in variant 3 with pre-irrigation soil moisture of 80% relative to BFMC. Irrigation norms for winter wheat germination and harvesting were 504-517 m^3/ha for irrigation, 492-515 m^3/ha for tubing and flowering, and 493-497 m^3 / ha for milk-wax and full ripening. Seasonal irrigation norms were 3032-3038 m^3/ha, which was 1831-2706 m^3/ha less than the control option.

To determine changes in groundwater depth and mineralization in the experimental field, observation wells were drilled at a distance of 25 m, 50 m, 100 m, and 150 m from the primary ditch at a depth of 3.0 m perpendicular to it, with a diameter of 40 mm and a length of ¾. Groundwater levels were measured every 10 days, and water samples were chemically analyzed.

The groundwater table was found to be 151-176 cm deep above the ground during the sowing of winter wheat. The main reason for the location of groundwater at such depths is the completion of irrigation of agricultural crops in September, the impact of collector-drainage networks, and the rapid evaporation of moisture from irrigated fields. In the experimental field where subirrigation was applied, the average depth of groundwater over the years was 130-174 cm. During the growing season in the winter wheat experimental field, the groundwater level was controlled using a dam structure installed in the primary ditch and kept at an average of around 97-114 cm (fig. 1).

In the conditions of alluvial soils of meadows with a groundwater level of 1-2 m in the Khorezm region, the application of irrigation criteria for winter wheat by subirrigation, pre-irrigation humidity in the order of 80% relative to BFMC and moisture deficit will prevent deterioration of their quality. In this variant, the chlorine ion content at the end of the vegetation was at least 0.438-0.440 g / l compared to the other variants. In the control variant, as a result of irrigation of winter wheat with large irrigation standards, excess water consumption, and leaching of salts and other toxic substances from the soil into groundwater, their mineralization was 0.148-0.152 g / l higher than other options.

In the 0-30 cm layer of plowing of the experimental field soil, the chlorine ion content was 0.011-0.012% relative to the soil weight at the beginning of the growing season and 0.017-0.019% at the end of the growing season. In the 0–70 cm layer, it was 0.009–0.010% and 0.013–0.014%, respectively. In the plowed layer, the dry residue at the beginning of the vegetation was 0.190-0.195%, and at the end of the vegetation, it was 0.240-0.252%, while in the 0-100 cm layer, it was 0.158-0.166% and 0.217-0.220%, respectively. The seasonal salt accumulation coefficient was 1.40–1.44 for the chloride ion in the 0–70 cm layer and 1.33–1.37 for the dry residue.

04 August 2025 08:59:01

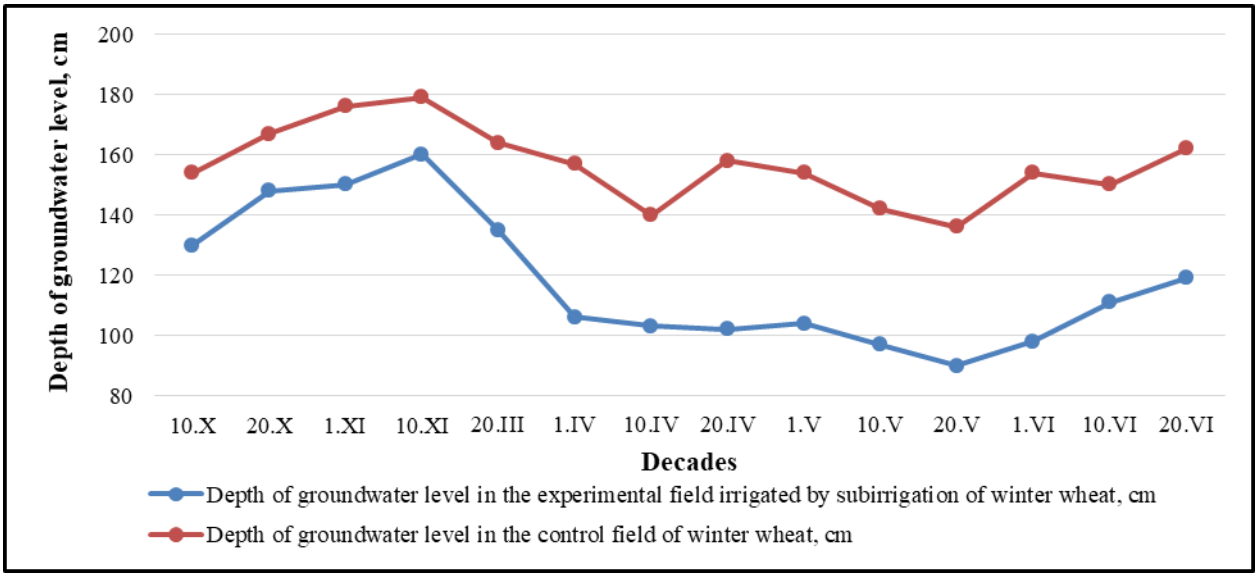


FIGURE 1. Groundwater level dynamics in experimental field.

The highest morphological characteristics of winter wheat were recorded in variant 3 of the experiment, in the variant where the pre-irrigation soil moisture in the subirrigation irrigation method was 80% relative to the BFMC. In the years of the experiment, the length of the stem in the ripening phase of winter wheat grain was 90.0-92.3 cm. The number of productive stems is 340.0-356.0 pieces / m^3, the length of the spike is 8.6-9.2 cm, the number of grains in the spike is 33.8-34.3 pieces, the weight of grain in one spike is 1.36-1.38 gram, the grain weight per 1000 grains is 40.2-40.4 grams, the number of productive stalks compared to the 1st control variant is 6.7-8 pieces / m^2, the length of the spike is 0.6-0.7 cm, the grains per spike the number was 0.8-1.0 pieces and the weight of 1000 grains was 1.6-1.7 grams higher. In this variant, 62.8-64.5 river water was used to grow one quintal of grain, and 47.1-48.3 ts/ha of grain and 60.5-61.4 ts/ha of straw were harvested, which is 3.9 times more than in the control variant. -4.1 ts/ha more grain and 5.7-5.8 ts/ha more straw were grown.

Data obtained from the study of the quality of winter wheat grain showed that relatively high protein and gluten content was recorded in option 2 of 12.35-12.47% and 27.37-27.48%, respectively. In the 1st control variant of the experiment, these figures were 11.43-11.82% and 25.46-25.63%, respectively.

DISCUSSION

Z.Tajiev [18] In the years of water shortage in the Khorezm region, the use of nitrogen, phosphorus, and potassium fertilizers in the amount of 240, 170, 120 kg/ha in the years of "Polovchanka" at a rate of 60-60-60% compared to BMFC 3290.6 m3/ ha during the growing season, the average yield was 47.8 t / ha, 3-times in the 1-1-1 system and 42.3 t / ha of grain was obtained from the Chillaki variety.

According to G.A.Bezborodov, M.N.Toshmatov, A.S.Shamsiev [6], many years of research have shown that in the alluvial soils of the meadows of Khorezm region, the pre-irrigation moisture content of winter wheat is maintained at 75-75-60% relative to BMFC and 4 times irrigation, seasonal irrigation norm will be 4100 m^3/ha and winter wheat yield will be 46.9 ts/ha.

B.Sh.Matyakubov [14] studied the irrigation regime of the "Kupava" variety of winter wheat in the Khorezm region, and based on the results of 3-years of experience, the norms of irrigation of wheat 5 times in 2-2-2 system 553-763 m^3/ha and the norm of seasonal irrigation 3197 m^3/ha. When irrigated in this irrigation regime, it is possible to get a grain yield of 58.2 quintals per hectare.

According to Sh.Yu. Kadirov, I.G. Masharipov, U.K. Abdurakhimov, with the increase in moisture content of winter wheat in the alluvial-meadow soils of Khorezm region, the effectiveness of nitrogen fertilizers has also increased (Khamraev Sh.R.) [12, 13]. The highest grain yield was formed at 74 ts/ha, soil moisture at 70% relative to BMFC, and nitrogen fertilizer at 180 kg/ha.

04 August 2025 08:59:01

The scientific results of the above scientists obtained during the irrigation of autumn steam on traditional land confirmed that the results obtained with the use of 250-1000 m^3/ha more water, less than 1.4-6.0 ts/ha, and the optimal reclamation condition by subirrigation irrigation.

CONCLUSION

Grassland in the Khorezm region, located in the Aral Sea region, where global climate change and water scarcity are observed scientifically based on irrigation regime and its impact on the growth, development, yield, and quality of winter wheat due to optimal irrigation regime and favorable meliorative conditions for the growth and development of winter wheat by subirrigation of winter wheat, pre-irrigation soil moisture in all growth phases it is created when it is held at 80% relative to the BMFC. It is recommended to irrigate winter wheat 6 times during the growing season in the 2-1-2-1 system by growth phases, with irrigation norms of 492-517 m^3 / ha and seasonal irrigation norms of 3032-3038 m^3 / ha.

The optimal irrigation regime for winter wheat in the subirrigation method has a better effect on the water-physical properties of the soil than other options, and at the end of the growing season: the volume weight of the soil in the 0-100 cm layer is 1.41-1.42 g / cm^3, Increased to 01-0.02 g / cm^3; The water permeability of the soil for 6 hours was 828-900 m^3 / ha or 0.230-0.250 mm/min, and the decrease compared to other options was minimal - 0.029-0.036 mm/min.

In the field where subirrigation was applied, it was found that the groundwater level during the growing season should be controlled by means of a dam installed in the primary ditch and kept at an average of 100-115 cm.

In the cultivation of winter wheat by subirrigation irrigation, the coefficient of seasonal salt accumulation in the 0-70 cm layer was 1.40-1.44 for chlorine ion and 1.33-1.37 for dry residue, which was 32-48% lower than other options.

62.8-64.5 m^3 of river water was used to grow one quintal of grain in the variant with pre-irrigation soil moisture of 80% compared to BMFC by subirrigation irrigation method and 47.1-48.3 ts/ha of grain and 60.5-61.4 ts/ha of straw and 3.9-4.1 ts/ha of grain and 5.7-5.8 ts/ha of straw compared to the control option.

The relatively high protein and gluten content of winter wheat grain was 12.35-12.47% and 27.37-27.48% in variant 2 of the experiment, which was 0.65-0.92% and 1, respectively, compared to the control variant, which was 85-1.91% higher.

The results of the study show that in the conditions of water scarcity, the groundwater table with a mineralization of 1.0-3.0 g / l during the vegetation period of winter wheat is managed using a dam built in the primary ditch and kept at an average of 100-115 cm which allows you to get. Due to the recurrence of drought years with high water shortages in the country every 3-4 years, a comprehensive study of the use of subirrigation irrigation for the use of groundwater as an additional source of water in the irrigation of major crops such as cotton and others will reduce the negative effects of water shortages.

04 August 2025 08:59:01

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04 August 2025 08:59:01