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CROP YIELD IN RAINFED AREAS USING RAINWATER AND FLOOD WATERS

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Today, dryland areas worldwide cover 1.4 billion hectares, or 85–87% of all agricultural lands. These areas exist in arid desert and semi-arid regions across nearly all continents. Dryland areas make up 95% of agricultural lands in the Sahara Desert, 75% in the Middle East and North Africa, 65% in East Asia, and 60% in South Asia.[1]

Growing agricultural crops in these areas is considered a guaranteed solution to ensuring food security.

The total dryland area currently used and brought into agricultural use in the Republic of Uzbekistan amounts to 938,100 hectares. These lands are distributed at altitudes ranging from 200 to 1,500–1,800 meters above sea level depending on the region, and annual precipitation in these areas ranges from 250 to 700 mm. Dryland areas are divided into 4 zones based on their soil and climatic conditions and elevation above sea level, and a specific farming system is applied in each zone. Due to relatively low precipitation (200–600 mm), a sharply continental climate, cold winters or long dry summers, and the fact that 60–65% of precipitation falls in winter and early spring, the second half of the growing season of autumn grain crops (heading–ripening) takes place under conditions of soil and atmospheric drought.

One of the key tasks of today is the rational use of available resources to elevate agriculture to a higher level, introducing scientifically based, resource-saving, and improved agrotechnologies for crop cultivation, and achieving high-quality yields at minimal cost. The Decrees of the President of the Republic of Uzbekistan No. PF-5742 dated June 18, 2019, and No. PF-5853 dated October 23, 2019, emphasize increasing soil fertility of irrigated and dryland areas, mountain and foothill regions, and desert-pasture territories, efficient use of water and other natural resources. Resolution No. PQ-201 dated May 25, 2026, "On measures to ensure efficient use of mudflow and flood waters," highlights the importance of organizing scientific research competitions related to efficiently using spring-summer mudflow and flood waters, developing new jobs through reclamation of additional land areas, expanding agricultural production, and developing and implementing scientifically based effective technologies for using dryland areas.

Analysis of Climatic Conditions of Uzbekistan's Dryland Areas over 45 Years (1980–2025) at the Research Institute of Dryland Farming shows that weather changes frequently during autumn-winter and spring months in dryland areas due to cold air masses arriving from the north and warm tropical air flows from the southwest.

According to long-term data, the average annual precipitation norm during the growing season of autumn grain crops (October–June) in this dryland region is 354.9 mm, distributed as follows: during the autumn sowing season (October) — 21.2 mm (6.0%); in late autumn and

[1] https://www.fao.org/3/i1688r/i1688r.pdf

winter (November–February) — 169.7 mm (47.8%); in spring months (March–May) — 155.1 mm (43.7%); and in summer (June) — 8.0 mm (2.2%).

One of the most urgent tasks is growing cereal, legume, and other dryland crops under unfavorable soil and weather conditions using resource-saving agrotechnologies, which forms the basis for producing stable high yields under any weather conditions in dryland areas.

In years when precipitation in the semi-humid hilly dryland zone was close to the long-term norm (354.9 mm), uniform distribution of rainfall in late autumn, winter, and spring allowed soil moisture at 0–100 cm depth to reach 5.8–10.2% in autumn and 9.5–10.8% in spring. This helped mitigate the negative effects of atmospheric drought during critical growth phases (flowering and milk-wax ripening) of autumn grain crops. Wheat yield in unfertilized plots was 11.0–14.7 c/ha, and with N40P40 fertilization — 15.5–21.8 c/ha.

In high-rainfall years (466–488 mm and 501–542 mm), rainfall of 36.3–104.9 mm in late autumn (November), winter, and spring months — particularly in May — led to soil moisture reaching depths of 0–160 cm. Such soil moisture naturally creates favorable conditions for the growth, development, and high yield accumulation of autumn grain crops. In these years, soil moisture was 10.2–13.8% in autumn and 15.8–12.8% in spring; wheat yield in unfertilized plots was 11.8–19.4 c/ha, and with N40P40 — 14.9–29.4 c/ha.

In mountainous dryland regions in 2023–2024 (322 mm precipitation), experiments were conducted on moderately washed dark-grey soils studying agrotechnological measures that allow efficient use of atmospheric precipitation, minimizing water erosion processes in the soil, and obtaining high yields from grain and legume crops.

Field experiments were conducted on mountainous dryland lands belonging to the Bakhmal Scientific Experimental Station of the Research Institute of Rainfed Agriculture in Bakhmal district, Jizzakh region, at an altitude of 1,358 meters above sea level.

The experiments included autumn wheat variety "Nushkent," pea variety "Guliston," and fodder pea variety "Vostok 84," sown along the slope direction (control, slope gradient 9–12 degrees) and across the slope after cross-slope tillage.

Phenological observations showed that autumn wheat sown along the slope (top to bottom, control variant) germinated 2–3 days later compared to variants with cross-slope tillage and sowing.

Soil moisture in wheat plots varied significantly depending on tillage and sowing direction. During the tillering phase (April) at 0–20 cm depth, the control variant had average moisture of 10.2% (259.1 m³/ha); during heading (May) — 9.2% (242.9 m³/ha); during full ripening (July) — 7.1% (180.3 m³/ha). In cross-slope tillage and sowing variants, these figures were 10.8% (248.9 m³/ha), 9.5% (241.3 m³/ha), and 8.5% (215.9 m³/ha), respectively.

Yields of grain and legume crops sown on foothill slopes during the experimental years varied depending on tillage and sowing direction. The highest additional yield compared to the control — 3.1–4.5 c/ha — was obtained in variants where seeds were sown after cross-slope tillage.

Resolution No. PQ-144 dated March 1, 2022, "On further improving measures for implementing water-saving technologies in agriculture," notes that in recent years, special attention has been paid to increasing the efficiency of agricultural lands in the country, including through the use of water-saving technologies.

It is aimed at eliminating existing shortcomings and problems in implementing water-saving technologies, mitigating the negative impact of water shortages observed in the region, and achieving more efficient use of water resources in growing agricultural crops.

Regarding water conservation alone, the Development Strategy of New Uzbekistan for 2022–2026 sets a target of saving 7 billion cubic meters of water.

According to data, today approximately 1.1 billion people on Earth suffer from water shortages of varying degrees. As a result of global climate change, glaciers in Central Asia alone have shrunk by approximately 30% over the last 50–60 years.

By using rainwater, one person can save up to 71 liters of drinking water per day. Currently, average daily water consumption per person is 130 liters. If production processes, household activities, car washing, and similar uses that currently consume clean drinking water were met by rainwater, a significant amount of clean drinking water could be saved across the country.

For example, in Turkey, the collection of rainwater is mandatory in multi-story buildings of more than 2,000 square meters and newly constructed buildings. In Germany, rainwater collected at Frankfurt Airport enables irrigation of 60% of the airport's green areas and replaces technical water needs. In Australia, rainwater meets 9% of urban and 63% of rural water demand.

When studying the effect of various agrotechnical measures on wheat yield through efficient use of rainwater and small flood waters, atmospheric precipitation in 2025 amounted to 320.5 mm. Yield of the soft wheat variety "Qizil don" varied from 3.3 to 5.2 c/ha depending on agrotechnical measures applied: unfertilized control — 3.3 c/ha; P40 variant — 3.9 c/ha; P40+N40 — 4.3 c/ha; P40+N40+suspension — 4.6 c/ha; unfertilized + sprinkler irrigation in May (using rainwater and small flood waters collected in artificial reservoirs) — 9.0 c/ha. The highest yield of 15.2 c/ha was obtained in the P40+N40+suspension+sprinkler irrigation in May variant, combining both conventional fertilization and one-time sprinkler irrigation. The additional grain yield in this variant exceeded the unfertilized control and the unfertilized+sprinkler irrigation variant by 6.2–12.1 c/ha, or 272.7–353.4%. The P40+N40+suspension variant without irrigation yielded 10.9 c/ha less than the variant with sprinkler irrigation.

Conclusions

1. One of the factors limiting the yield of grain and other crops in the republic's dryland areas is the decline in soil fertility due to water erosion.

2. Cross-slope tillage and sowing on highly sloped foothill dryland lands with moderate to severe water erosion increases the yield of autumn wheat and other crops by an average of 31–34%.

3. For efficient use of atmospheric precipitation in dryland areas, collecting rainwater and small flood waters for one-time sprinkler irrigation of grain crops in May produces effective results.

4. Collecting rainwater and small flood waters for use during the growing season ensures stable high yields for farmers in mountainous and foothill dryland areas under any weather conditions.

5. Through the introduction of new technologies and efficient use of rainwater and flood waters, productivity of the existing 938,100 hectares of dryland area in the republic — currently averaging 5–6 c/ha — can be increased 3–4 times, achieving a total harvest of 1.5–2.0 million tonnes.

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