Investigation of Rain-Fed Horticulture Productivity in the Namangan Region, Uzbekistan

water

Brief Report

Investigation of Rain-Fed Horticulture Productivity in the Namangan Region, Uzbekistan

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Abstract: With the limited availability of water, rain-fed horticulture is important anywhere in the world, especially in countries with arid climates. Therefore, experimental analysis is necessary to see the impact of rain-fed horticulture. Thus, it can be popularized among agricultural people if the strategies achieve better outcomes. This study aims to create a garden without irrigation in the lower regions of the Namangan hills in Uzbekistan using agrotechnical measures based on collecting natural moisture and its long-term storage due to the natural growth of some wild fruits. Soil moisture is the most important factor for plant development in arid and warm regions. The experiments were analyzed from 2013 to 2019 and promising results were found. The plant growth rate after a few years was comparable with that of irrigated agricultural lands. In addition, the yield in non-irrigated gardens was comparable with that of irrigated farms. However, a slight reduction in fruit sizes was observed (10–20%). Furthermore, the terracing and plastic and organic mulching method's efficiency is higher than terracing and organic mulching due to maintaining long-term soil moisture that can be absorbed by the plants (For May 2019, 12.7%, 7.7%, and 6.1% soil moisture levels were found in plastic and organic mulching, organic mulching, and unmulched areas). Overcoming the challenges in rain-fed horticulture experiments requires a holistic approach that integrates scientific knowledge, technological advancements, and sustainable farming practices. Collaboration between researchers, farmers, and policymakers is crucial to develop and disseminate effective strategies that address these challenges and promote resilient rain-fed horticulture systems. Therefore, this study shows the practical possibility of rain-fed horticulture in the northeastern hills in the Namangan region of Uzbekistan. Furthermore, this study provides possible agrotechnologies to practice horticulture without irrigation, which is beneficial for planners, engineers, farm managers, and agribusiness controllers.

Keywords: arid climate; mulching; rain-fed horticulture; plant growth rate; soil moisture content; terracing; water-free gardening

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1. Introduction

Identification of techniques to operate water-free agriculture and a garden running with finite water are essential worldwide, not limited to countries with arid and semi-arid climates [1]. Due to increased water scarcity and increased drought conditions, the productivity of agricultural lands and crop yields decreases [2–5]. Although water is an essential input for agriculture, some plants can grow with limited water supply in arid environments [6]. Therefore, soil moisture conservation should be a highly concerned point in some areas, such as Uzbekistan, Africa, the Middle East, and the western part of the United States of America [7–10]. Therefore, farming with a minimum amount of water or without irrigation is required due to the reduction in water accessibility with the increasing population and several other issues. Choosing the right type of plants, seasonal gardening, using compost at least once a year, improving the soil, mulching the soil, terracing hilly areas, creating proper irrigation systems, considering xeriscape, and using tools to retain water are some of the methods to improve an agricultural field with minimal water usage [11–13]. Soil moisture, which exhibits a significant correlation between precipitation, surface water, groundwater, and crop water in an ecosystem, is the major eco-hydrological variable in the soil–plant–atmosphere continuum and plays a major role in material transport and energy transfer [14,15]. Due to the impact of climate, geography, crop type, properties of soil, etc., soil moisture content exhibits temporal and spatial variability [16]. Conservation and efficient use of water is also highlighted in the United Nations Sustainable Development Goals (SDG) as zero hunger (Goal 2), clean water and sanitation (Goal 6), and climate action (Goal 13). Therefore, conservation agriculture is prioritized in arid areas.

A major advantage of conservation agriculture in dryland farming is enhanced water-use efficiency by increased infiltration and decreased evaporation from the soil surface, which is associated with declined runoff and soil erosion [17]. Generally, mulching is used to mitigate the water stress conditions in agriculture. It is essential to conserve soil moisture, lower soil temperature, and minimize soil evaporation, which influences crop growth and yield [18]. Mulching with organic materials such as plant residues (leaf clippings, plant stems, straw, etc.), livestock residues (rotten manure), and wood industry residues (wood shavings (sawdust)) is considered organic mulching [19]. Organic mulching has several positive properties. In particular, it preserves soil moisture, and roots in the soil, enriches it with organic fertilizers, increases the porosity of the soil, and improves the aeration process [20–22]. The most important difference between organic mulching and mulching with plastic materials (film) is that organic mulches allow the atmospheric precipitations that have been applied after mulching to be easily absorbed into the soil and do not prevent the soil moisture from increasing even after mulching [23]. At the same time, it seriously hinders the process of evaporation and preserves soil moisture for a long time. However, organic mulching cannot effectively maintain soil moisture [24,25]. Plastic mulch materials strongly protect existing soil moisture from evaporation and preserve it for a long time, but the atmosphere created after mulching prevents rainwater from absorbing into the soil, which does not allow moisture to increase [26].

Difficulties and challenges in rain-fed horticulture experiments can be addressed through various strategies and approaches. Water availability and variability, drought stress, soil moisture management, crop selection and adaptation, nutrient management, erosion and runoff, and climate change impacts are some challenges. The implementation of water conservation techniques such as mulching (which helps retain soil moisture and reduce evaporation); adapting rainwater harvesting techniques to capture and store rainwater; selecting crop varieties that are adapted to drought conditions and have better water-use efficiency; using plastic mulching to reduce water loss from plant surfaces during drought periods; improving soil structure and water-holding capacity through practices such as organic matter addition, cover cropping, and minimum tillage; using techniques such as contour plowing, terracing, or bunding to minimize runoff and enhance water infiltration into the soil; adopting conservation practices, such as contour plowing or cover cropping, to reduce nutrient runoff and leaching; and implementing erosion control measures such as contour plowing, terracing, or strip cropping to minimize soil erosion are some ways to overcome these challenges.

The benefits of terracing for soil management and controlling moisture levels were documented in detail [27,28]. In the past, large-scale agricultural activities were carried out by creating a surface water flow from occasional rainfall in areas with an arid climate [29].

Here, the agricultural plots have been prepared by constructing staircases of terraces in the areas where there is a slope near the rivers flowing through the mountain valleys [30–32]. As an example, in Uzbekistan, long-term irrigation farming has been practiced in the Syrdarya River's terraces. Most of the time, the terraces created in arid regions were constructed using stones and soil and were gathered as "dry stone terraces" and "earth embankments". These units focused to make even the valley floors and to soothe their slope to broaden the surface runoff to the greatest width of the valleys to meet with adequate irrigation [33]. Hamidov et al., 2020 [34] indicate a general decrease in water table depths throughout the region over time, as per the results of the Mann-Kendall trend test from 1.72 m in 2050 to 1.77 m by 2100 and the linear regression model from 1.75 m in 2050 to 1.79 m by 2100. Conversely, the salinity level is projected to increase from 1.72 $g \cdot L^{-1}$ in 2050 to 1.85 $g \cdot L^{-1}$ by 2100 based on the Mann-Kendall trend test and from 1.97 $g \cdot L^{-1}$ in 2050 to 2.1 $g \cdot L^{-1}$ by 2100 according to the linear regression model.

The Aral Sea Basin (ASB), which covers parts of Uzbekistan, Kazakhstan, Turkmenistan, Kyrgyzstan, Tajikistan, and Afghanistan is considered a region with minimal croplands [35]. The population increased by 70.5% within the period 1990 to 2016 in this region, and domestic gardening (home gardening) is the primary occupation for most of the rural population [36]. Irrigated agriculture significantly contributes to Uzbekistan's economy, comprising 30% of the overall gross domestic product (GDP) [37]. However, water availability in the region decreases due to climate change, increased population growth, and poor water management and usage [38,39]. The water capacity of the Aral Sea decreased by more than 90% from 1960 to 2018 due to the improper management of water in the Amudarya and Syrdarya rivers for cotton cultivation [40–42]. It was reported that around 35–50% of water and other resources were recently saved through implementing water-saving agrotechnologies in Uzbekistan [43]. Land utilization can be practiced efficiently, and the fruit requirement of the population is fulfilled by implementing grape and other fruit cultivation in mountain and foothill areas [43]. Approximately 90% of the water resources in Uzbekistan are consumed for agricultural practices; 81% of this amount is used during the growing season [43].

Therefore, water resources are a highly important factor in the rural economy of Uzbekistan. The country has already started discussions on water-efficient agriculture, and the discussion must move to rural areas. Thus, non-irrigated gardening can be effectively managed. However, some of the lower regions of hilly areas in Uzbekistan showcase issues in developing dryland horticulture due to minimal accumulation of natural moisture. Therefore, this experimental study is carried out to investigate the possibility of developing rain-fed horticulture in these hilly areas. The experimental work was carried out by creating a non-irrigated garden of several types of fruit trees using agrotechnical measures based on collecting natural moisture and its long-term storage due to the natural growth of some wild fruits in the regions where irrigation is not applied.

2. Materials and Methods

2.1. Experiment Site

The experiments were carried out in the Northern part of the Uychi district in the Namangan region hills (Adyr foothills) of Uzbekistan (Figure 1). The Namangan region is located between the latitude 40°38′53″ N to 41°32′39″ N and longitude 70°20′23″ E to 72°10′48″ E, which is in the southern Fergana Valley. It covers an area of around 7440 km^2. The mountainous areas, which are situated more than 1000 m above mean sea level (MSL), in this region receive annual rainfalls of 600–700 mm [7]. Lower regions in these hilly areas with elevations of 500–1000 m above MSL receive annual rainfalls of 200–300 mm. The location of the experiment site is shown in Figure 1.

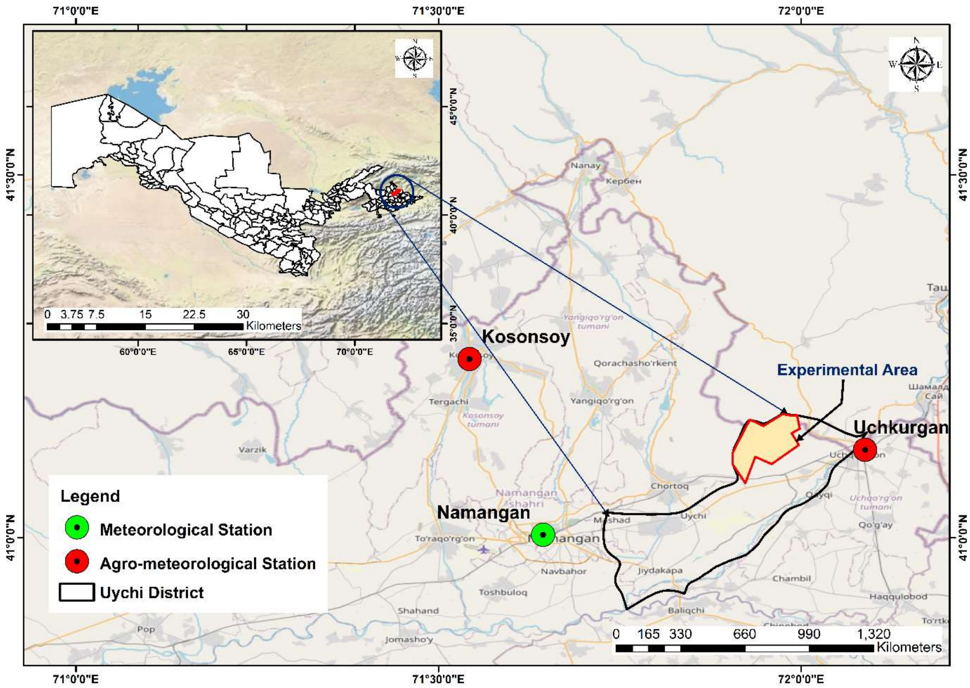

Figure 1. The location of the experiment site.

2.2. Experimental Design

Two sites of 500 m^2 were selected for this experiment (Figure 2a). The first experiment was carried out at Site A without irrigation in 2013. This site was in the territory of the Uychi Sohibkor Bostoni agricultural company. The site is in a hilly area of 500–550 m above MSL. The next site (Site B) was initiated in 2014, and the seedlings were planted in an area of 500 m^2. A total of 10 apricot seedlings, 5 apple seedlings, and 1 peach seedling were planted in March 2013 at the site A. On the day of planting, each tree was covered with cellophane in a circle with a radius of 80–100 cm to prevent evaporation (Figure 2b). The covered cellophane was covered with 3–5 cm of soil to prevent the soil temperature from rising. Along the border of the covered cellophane, a 30 cm deep ditch was dug in a circle to collect rainwater and increase soil moisture (Figure 2c).

After the dry and hot days of the summer months, the cellophane used for mulching around the trees was removed in the first days of autumn (early September 2013). After that, the sides of the seedlings in a radius of 1 m were softened. All other attributes were similar to the watered trees. However, 1 apple seedling was withered, and the germination rate of non-irrigated seedlings was much lower than that of irrigated seedlings. The experiment was continued using the same procedure in 2014. There were 5 each apricot, cherry, plum, and quince saplings, 15 apple saplings, and 10 peach saplings in site B (altogether 45 fruit saplings). At the end of the 2014 experiment, all seedlings planted in the 2013 experiment completed their growing season. Of the newly planted seedlings in 2014, 2 apricot, cherry, and plum seedlings were dried up.

Having thoroughly analyzed all events and processes that occurred during the observation process of the experiment, as well as the results of the experiment, it was concluded that it is necessary to further improve the experimental technology in order to obtain more effective results. For this purpose, several additional measures were introduced into the experimental technology as a novelty, not only to provide the experimental fruit trees with moisture throughout the growing season by mulching around the seedlings but also to collect atmospheric precipitation from the surrounding area and preserve it for a long time. As one such measure, the mulching part of the seedlings planted in the fall of 2015 in a radius of 1 m can be made into the appearance of small stairs, i.e., the process of terracing, which can be shown as an example (Figure 3). Due to the high slope of the hills, on average, 60–70% of the spring rain runs off, and, on top of that, the fertile layer of the soil is washed away (soil erosion), so there was very little moisture in the soil. By introducing the practice of terracing the slopes, it was possible to achieve a high accumulation of moisture in the soil and the prevention of soil erosion.

(**a**)

(**b**)

(**c**)

Figure 2. Experimental orchards: (**a**) sites A and B, (**b**) planted area covered by cellophane layer, and (**c**) soil cover on top of the cellophane cover.

Figure 3. Sketch of a natural hillside and a terraced hillside.

Experimental work was continued in 2016. This year, a slight change was made to the technology of the experiment. In particular, in early spring, the upper part of the terraced surface around the seedling was smoothed and slightly compacted. Then, films 1–1.5 m long and 1.5–2 m wide were laid on the surface. This allowed rainfall that fell on the slope to flow onto the terraces without allowing it to soak into the soil (Figure 4). These films were laid in early March and removed in early May.

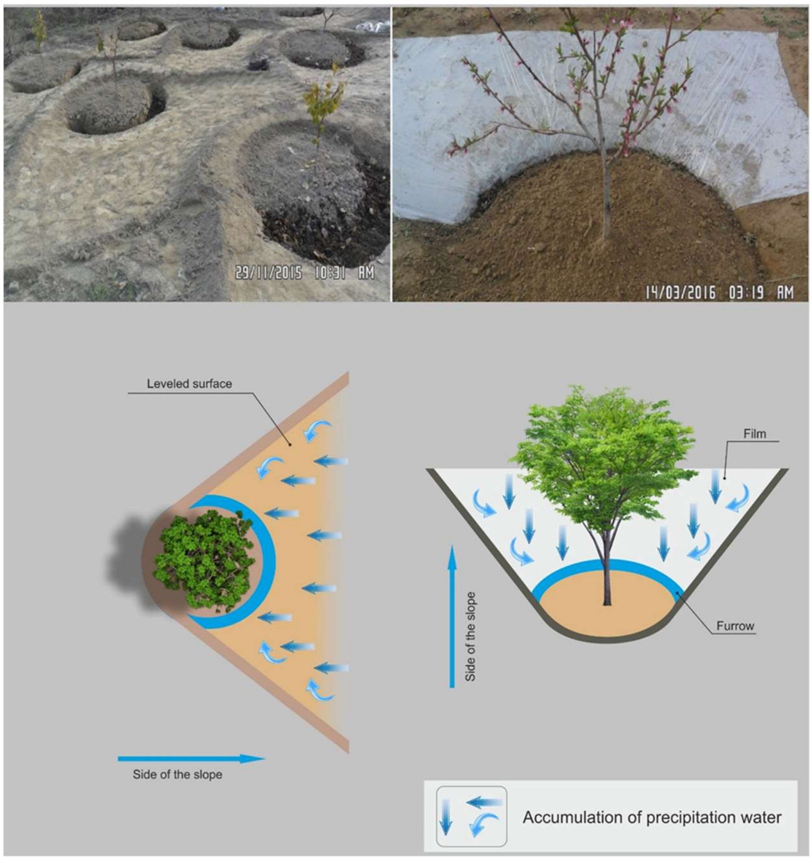

Figure 4. Terracing the slope, creating a rain-collecting surface, laying a film on the surface, and digging a ditch around the seedling.

March and April are the wettest months in the hills of the Namangan region. Therefore, the films were kept lying on the slope in March and April. All other processes in the experimental technology were carried out in their place and within the specified time, as in previous years. It should be added that every year in early spring, experimental seedlings were formed. In 2017–2018, no changes were made to the experimental work, and work was organized according to the 2016 procedure.

Based on the preliminary observation in the process of experiments, the next stages were further improved. Additionally, organic mulching and plastic mulching were carried out separately during the growing season of the plants. The mulching was not carried out during the summer months as it can decrease soil moisture due to sunny days, increased temperatures, and higher winds. Therefore, mulching was carried out in the end months of winter and early spring of 2019. Initially, in the last months of the winter season, humus was applied to the terraced and plowed surfaces with a thickness of 3–5 cm (Figure 5). This helped to slow down the smelting of snow and then to easily absorb the water into the soil. Additionally, the insect larvae, if they are in compost, can be easily controlled due to strong cold conditions. Furthermore, humus manure increases soil fertility in an environmentally friendly organic way.

The soil layer was automatically protected from direct sunlight and wind by the leaves of the plants. This helped to preserve the moisture that accumulated in the soil for a long time throughout the winter. At the same time, it ensured that the rainwater of the spring season was easily absorbed into the soil. Then, the plastic mulching was carried out around the seedlings using a film in mid-May (end of the spring rains). The films were mulched over the leaf hazons laid out on the terraces and buried underneath soil 3–5 cm thick. From September, the mulched films were collected, and the composted manure and leaf litter under the film were mixed into the soil. This concluded the experiment carried out with fruit trees.

(**a**) (**b**)

Figure 5. (**a**) Applying compost to the terraced and plowed surface around the seedlings; (**b**) mulching by laying plant leaves on humus.

2.3. Measurements Carried Out

2.3.1. Precipitation and Air Temperature

Meteorological observations are highly important in agriculture. However, meteorological observations were not carried out in the hilly area where the trial works on the establishment of a garden without irrigation, they were carried out in the northeastern part of the Namangan region. Therefore, the climate coverage of the experiment area was carried out based on the last 10 years' (2010–2019) data of the Namangan meteorological station and Kosonsoy and Uchkurgan agrometeorological stations located at the closest distance to the experiment site (Figure 1).

2.3.2. Soil Moisture Content

The soil moisture data during the active growing season of plants in March–September 2013–2019 were collected from the Namangan weather station. This was under an irrigated field. Therefore, measurements in the winter months, March, and early April were taken before irrigation to show the naturally accumulated moisture. In addition, the soil moisture data at the experiment site were measured for the same period. These measurements were carried out in order to determine the natural moisture accumulated in the soil layers, its changes during the growing season of plants, and the effectiveness of the measures taken to maintain soil moisture for a long time in the experimental area for creating a garden without irrigation.

Initial measurements determining soil moisture were carried out in March 2013 in order to determine the natural moisture accumulated in 1 m thick soil layers of the non-irrigated experimental garden in the plowed and non-plowed areas. The next experiments on measuring soil moisture were conducted in March, April, and May 2018. Soil samples were taken from the ditches dug around the experimental seedlings to collect atmospheric precipitation, as well as from the field under natural conditions (Figure 6a,b). The next set of measurements was carried out in 2019. The experiments were performed according to 3 options. Option 1 was not mulched, option 2 was organically mulched, and option 3 was a film layer over organic mulch, plastic mulch. These measurements were taken every 15 days from March to September.

Soil moisture was determined using the thermal method. The thermal method is a method of measuring soil moisture based on the difference between the weight of wet and dry soil by drying the soil samples under the influence of the high temperature of the thermostat. Two pits with a depth of 1 m were dug in the initially plowed and unplowed areas. Then, the soil samples were taken at 10 cm, 30 cm, 50 cm, 70 cm, and 90 cm depths from the dug pits. The soil samples from the experiment area were weighed on an electronic scale. Then, they were dried for 4–6 h in a thermostat at 105–110 °C heat and weighed again. The soil sample was dried a second time for 2 h and weighed to obtain more accurate data. The order of recording the data during the analysis was the same as the order of the hygroscopic moisture determination table. Soil moisture was calculated based on mass balance.

(**a**) (**b**)

Figure 6. (**a**) Taking soil samples under the trenches dug (**b**) from the field under natural conditions.

3. Results and Discussion

3.1. Meteorological Observation and Impact of Weather Patterns to the Crops

The average monthly air temperatures for the 2010–2019 period are shown in Figure 7a. Apart from a few years, the average monthly temperature has positive values in most winter months. For example, in the years 2010, 2015, 2016, 2017, and 2019, the average January temperature was completely positive in the Namangan, Kosonsoy, and Uchkurgan regions. The lowest average temperature was −1.9 °C in Uchkurgan in 2017, and the highest was 4.8 °C in Kosonsoy in 2010. Negative January temperatures were observed in all regions only in 2012 and 2013. In 2018, it was −1.1 °C in the Kosonsoy district. In February, cold (negative) weather prevailed in all regions in 2012 and 2014. In the rest of the year, no negative temperatures were observed in this month. The average monthly temperature in December was −0.5 °C in Namangan and −0.6 °C in Uchkurgan in 2012 and −0.2 °C in Kosonsoy in 2013. Positive temperatures were observed in all other years and regions. Thus, between 2010 and 2019, the winter months were quite warm. This could be due to the changing climate patterns throughout the world. The precipitation received in autumn and winter months could be easily absorbed. Thus, more moisture can be expected in the soil compared with soft soil. A difference of 15–20 days can be observed in the leaf-falling periods (yellowing of leaves in autumn) in these non-irrigated trees compared with the irrigated fruit trees.

Figure 7b presents the maximum air temperature in the regions. The maximum air temperature of the Namangan weather station and Kosonsoy and Uchkurgan agrometeorological stations over the years shows that in December 2010, the maximum temperature in Kosonsoy rose to 20.0 °C. Additionally, in 2010 and 2016, the maximum temperature in Kosonsoy in January rose to 19.0 °C, and in February 2016 it rose to 22.0 °C in Uchkurgan, to 25.0 °C in Kosonsoy, and to 25.4 °C in Namangan. Therefore, from February 2016, the plants started the early vegetation period. Along with this, experimental seedlings also began to bloom in February. For example, an apricot fruit tree planted in 2013 started flowering on 26 February. However, some of the young experimental seedlings planted were dried in 2018–2019 due to high summer temperatures. Droughts can be seen for 20 continuous days or more during 2018 and 2019.

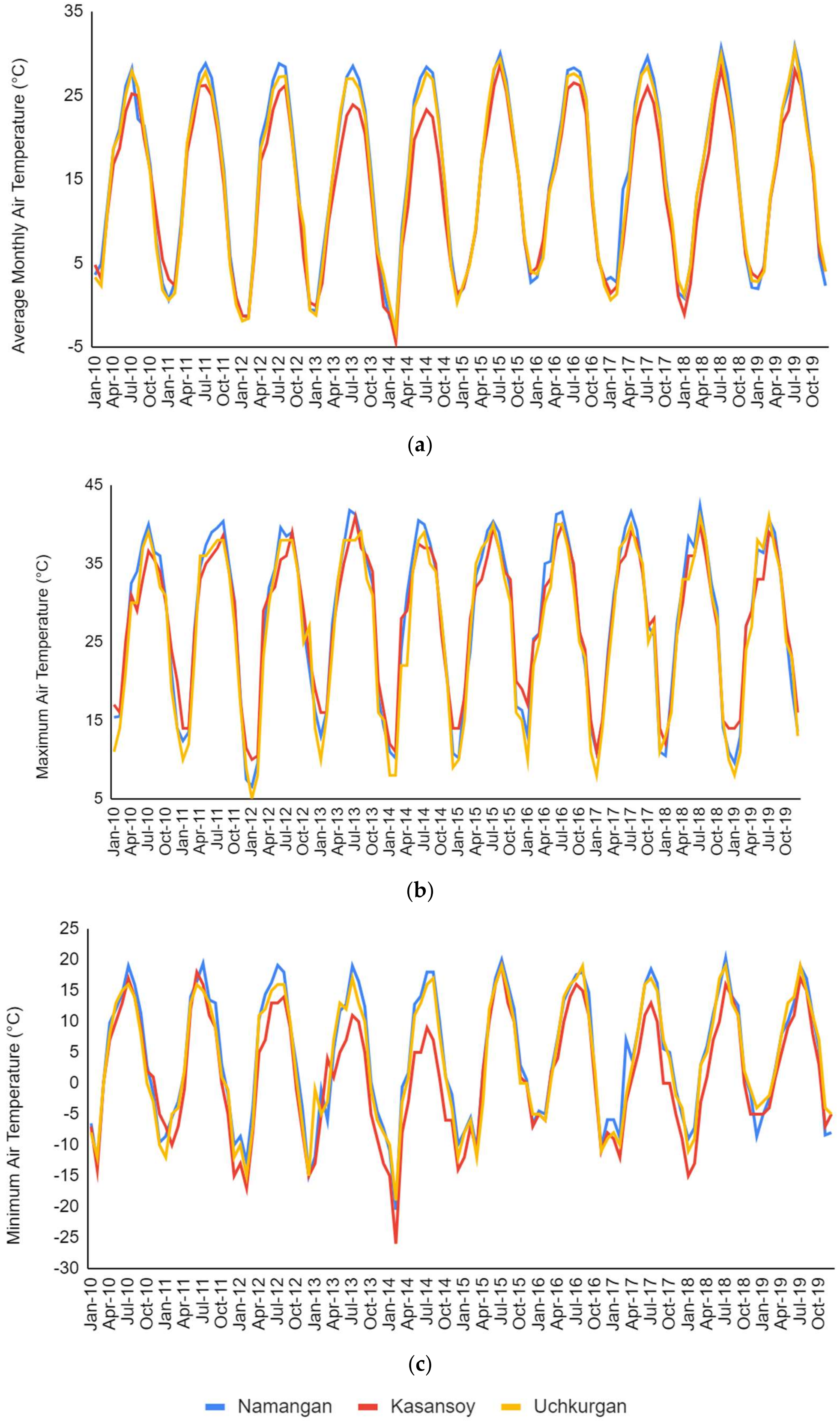

Figure 7. Temperature variation. (**a**) Average monthly air temperature; (**b**) maximum air temperature; (**c**) minimum air temperature.

Considering the minimum air temperature, it was reported that in some of the years, severe cold weather was experienced in the spring season (Figure 7c). The temperatures were 10.7 °C in Namangan, −11 °C in Kasansay, and −12 °C in Uchkurgan in March 2015. This situation was very harmful to all plants that started the growing season and seriously damaged the formation of the crop. The sharp cooling observed at the end of March 2015 is a clear example of black frost (Figure 8).

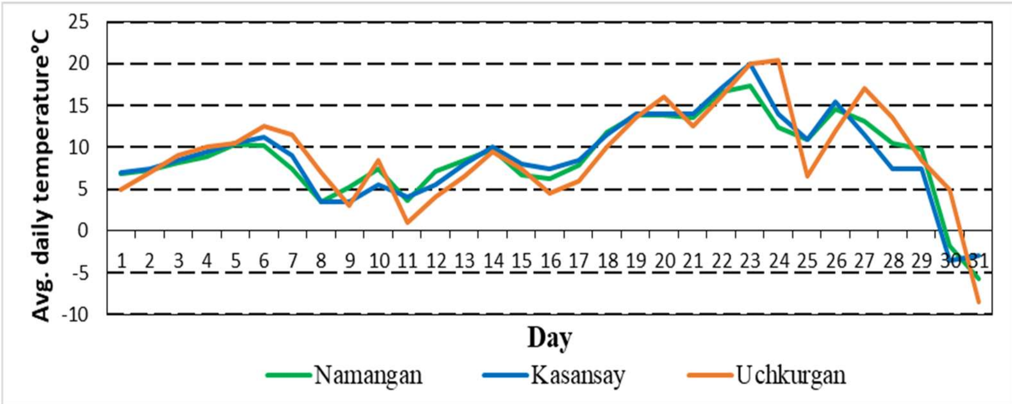

Figure 8. Daily temperature variation in March.

As shown in Figure 8, the average daily temperature in early and mid-March 2015 was quite warm. The temperature increased to 20 °C in Kasansay and Uchkurgan on 23 March. As a result, many fruit trees have started their growing season, flowering and leafing. By the end of March, (31 of March), the average daily temperature has reduced significantly (−3 °C in Kasansay, −5.7 °C in Namangan, −8.5 °C in Uchkurgan). As a result, agricultural crops as well as experimental seedlings were seriously damaged. The warming patterns in Central Asia exhibit greater prominence in the flat regions at lower altitudes and the valleys between mountains compared with higher elevated areas [44]. Based on certain climate scenarios, Central Asia is anticipated to experience a rise of 2.5 °C in summer temperatures by the conclusion of this century [45]. Additionally, the average annual precipitation in Central Asia is projected to steadily rise by approximately 14.51% (ranging from 8.11% to 16.9%) by the end of the 21st century. Notably, the majority of this increased precipitation is expected to occur outside the typical crop-growing period, spanning from November to March [46]. Over a decade, Uzbekistan witnessed a gradual temperature rise at a rate of 0.27 °C [47].

Recorded precipitation for Namagan, Kasansay, and Uchkurgan is given in Figure 9. This is one of the most important climatic parameters under investigation in this research work. The average annual rainfall of this area during the 2010–2019 period was 302.6 mm. The lowest rainfall was recorded in 2018 (163.9 mm) whereas the highest was in 2015 (394.7 mm). It can be clearly seen that this precipitation is not healthy for sound agriculture, and therefore, the need for this research is highly justified.

Relative humidity is another important factor that determines the conditions for agriculture. Relative humidity also affects the rate of evaporation from the soil surface. When relative humidity is low and the air is drier, evaporation rates increase, leading to faster moisture loss from the soil. This can contribute to water stress in crops and increase irrigation demands. Table 1 shows the measured relative humidity at the Namangan weather station for 10 years. The lowest relative humidity was observed in July 2018 and 2019, 31% and 33%, respectively. In addition, some lower values can be seen in other months as well. However, higher relative humidity can be observed in the winter months (varying from 61% to 84%). Most of the crops are better in relative humidity between 50 to 75%. Therefore, agriculture in Namangan is challenging.

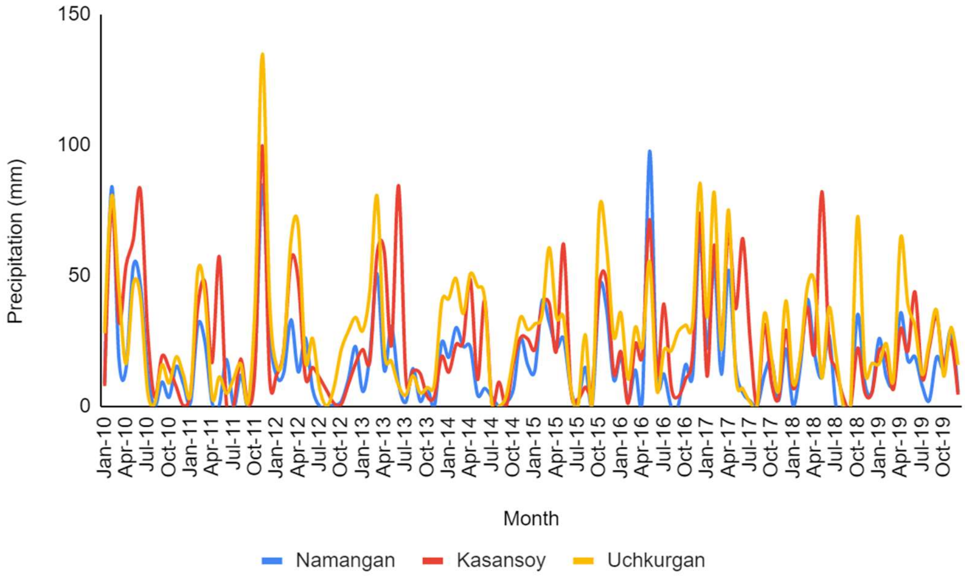

Figure 9. Temporal variation of precipitation.

Table 1. Average relative humidity of Namangan (%).

Months	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
January	73	75	81	81	83	78	75	78	76	73
February	84	77	76	69	76	79	55	73	61	62
March	67	63	69	68	62	66	60	67	61	51
April	59	46	53	67	56	56	57	59	56	62
May	65	44	51	48	40	53	58	47	46	39
June	60	39	44	41	44	35	43	39	41	40
July	51	35	39	41	39	40	44	41	31	33
August	43	43	42	51	46	44	42	42	39	37
September	47	49	47	45	48	49	45	46	41	45
October	53	61	51	58	66	64	61	58	55	54
November	74	86	69	60	77	77	69	61	69	68
December	65	84	80	81	72	71	83	76	73	76
Yearly	62	59	59	59	59	59	58	57	54	53

3.2. Soil Moisture Levels

The 1 m thick soil moisture measured at the experiment site in March 2013 is presented in Table 2. It was observed that the water content of the soil in a 50 cm^3 cup collected from the plowed land was 8.1 g, while the sample collected from the unplowed land was 6.8 g. Thus, at the beginning of the experiment (15 March 2013), there was 162 mm of water in the plowed soil of 1 m thickness and 137 mm of water in the unplowed soil of the same thickness. On 18 March of the same year, 193 mm of moisture was accumulated in a 1 m thick soil layer at the experiment site of the Namangan weather station. Higher slopes might have adversely impacted the holding capacity of the soil moisture content. In addition, it was understood that rainfall collection activities around seedlings significantly increased soil moisture. The soil moisture levels during the rainy months were higher.

Table 3 presents the moisture in 1 m of soil layer for four cases: terraced organic and plastic mulched, terraced and organic mulched, unmulched, and irrigated areas. It can be well understood that the mulched soil can retain more water compared with the unmulched cases. However, among mulched areas, a combination of organic and plastic mulched soil showcased the best water-holding capacity. Nevertheless, higher moisture content can be observed in the irrigated area, except on the 15 July. A higher moisture level was expected, as the area was irrigated.

Table 2. Soil moisture measured at the experiment site in March 2013.

Depths (cm)	Soil Moisture (g)	Soil Moisture (%)	Soil Moisture (g)	Soil Moisture (%)
	Cultivated Soil		Uncultivated Soil	
10	16.2	20.6	7.4	10.4
30	9.4	11.3	9	12.2
50	5.6	7.5	8.1	10.9
70	4	5.5	7.4	10.3
90	5.2	6.8	2.3	3.1

Table 3. The moisture content in a 1 m thick soil layer during the growing season of plants in 2019.

Day	Terraced and Organic and Plastic Mulched (mm)	Terraced and Organic Mulched (mm)	Unmulched (mm)	Irrigated Area (mm)
31 Mar.	NM	172	130	NM
15 Apr.	NM	176	120	NM
30 Apr.	NM	184	136	NM
15 May	158	146	92	206
31 May	156	146	102	NM
15 Jun.	144	120	104	169
1 Jul.	142	128	110	NM
15 Jul.	156	132	110	140
1 Aug.	134	116	104	151
1 Sep.	126	108	96	160

NM—not measured.

In addition, higher moisture contents were observed in the ditches dug to accumulate precipitation. Therefore, the proposed techniques illustrate better results. Table 4 presents the comparison of soil moisture availability with the wilting moisture content for the crops. It can be clearly seen that the mulched areas have enough moisture content to keep the plants from wilting. The unmulched areas showcased water scarcity in the months of May to September where the area is without much precipitation. The positive results obtained during the experimental test work on the establishment of a garden without irrigation since 2013 can be scientifically substantiated by comparing the below-mentioned climatic observation results. Therefore, these findings again justify the techniques that were used in this research work.

Table 4. Comparison of plants' wilting moisture and soil moisture in 2019 (%).

Month	Wilting Moisture of Plants on Irrigated Light Gray Soils, % [48]		Terraced and Organic and Plastic Mulched		Terraced and Organically Mulched		Unmulched		Irrigated Are	
	0–30 cm	30–90 cm	0–30 cm	30–90 cm	0–30 cm	30–90 cm	0–30 cm	30–90 cm	0–30 cm	30–90 cm
March					15.2	15.3	11.3	9.03	13.7	16.3
April					15.3	15.4	9.8	9.6	18.3	19.6
May			12.7	12.03	7.7	13.1	6.1	7.3	18.5	19.5
June	8.6	10.2	9.5	11.7	9.5	10	8.6	7.8	16.3	17.3
July			11.8	11.2	10.5	9.6	9.6	8.6	12.3	15.7
August			11.3	10.4	9.4	8.7	7	8.2	13.4	16.9
September			9.5	9.6	7.8	8.5	5.8	7.9	12.9	16.6

3.3. Growth Rate of Plants

The experimental work without irrigation began in 2013 and continued until the end of 2019. The work after 2020 was not properly coordinated due to the COVID-19 pandemic situation. However, the experiment was improved annually from the initial learnings. The phenological observations were recorded from the day the seedlings were planted. Table 5 illustrates the phenological observations recorded for experiment 1 (10 apricot trees, 5 apple trees, and 1 peach tree in 500 m^2) during their growing season.

Table 5. Phenological observations recorded for experiment 1 in 2013.

	Apricot	Peach	Apple
Fruit tree variety	White Apricot	Morettini jyolty ranniy	Renet Simirenko
Planting day	22/3	29/3	29/3
Day mulched with film	22/3	29/3	29/3
The number of seedlings planted	10	1	5
The day when flowering begins	2/4	-	-
A day of full bloom	5/4	-	-
The day the seedlings begin to leaf out	2/4	5/4	5/4
The day when fruit formation begins	The fruit did not form.	The fruit did not form.	The fruit did not form.
The day the leaves start to turn yellow	20/9	15/9	10/10
The day the leaves begin to fall	7/8	29/10	5/11
The day the leaf shedding ends	26/11	10/11	26/11
The average height of the seedling at the beginning of vegetation	80–100 cm	50 cm	60–80 cm
Seedling height at the end of vegetation	150–100 cm	80 cm	100–110 cm
The number of seedlings withered by the end of the growing season	0	0	1

The best results were observed in apricot seedlings. During the growing season, they produced new shoots and branches up to 50 cm long. They bloomed in the first year of planting, but the fruits were not buds. Lower results were observed in apple seedlings, some of which produced new shoots up to 40 cm long, while others were limited to producing shoots smaller than 10 cm. One apple tree dried up during the process. A peach seedling planted with only one bush had 30 cm long branches throughout the year. Nevertheless, these results are lower than the observations recorded in irrigated seedlings in the vicinity. The new shoots of irrigated seedlings grew up to 100–150 cm during the growing season.

The results of the phenological observation conducted in 2014 on seedlings planted in 2013 are summarized in Table 6. The development of seedlings planted in 2013 in 2014 was relatively higher in apricot seedlings. In the remaining seedlings, no significant changes were observed compared with the development indicators in 2013. This year, only apricot seedlings bloomed, but no fruit was produced. In the summer months when the temperature was high, at midday, the leaves of the seedlings faded slightly, and the phenomenon of plasmolysis was observed. In the evening, after the temperature decreased, the turgor condition of the leaves was restored and deplasmolysis occurred. This year as well, the period of autumn leaf shedding started 15–20 days earlier compared with irrigated seedlings. However, in 2014, not a single seedling dried up and completed its vegetation.

Table 6. Phenological observations recorded for experiment 1 in 2014 of seedlings planted in 2013.

Seedling Name	Apricot	Peach	Apple
Fruit tree varieties	10	1	4
Day mulched with film	16/3	16/3	16/3
The day when flowering begins	30/3	-	-
A day of full bloom	5/4	-	-
The day the seedlings begin to leaf out	6/4	5/4	7/4
The day when fruit formation begins	the fruit did not form	the fruit did not form	the fruit did not form
The day the leaf starts to turn yellow	15/9	15/9	10/10
The day the leaves begin to fall	1/10	10/10	1/11
The day the leaf shedding ends	16/11	1/11	26/11
The average height of the seedling at the beginning of vegetation	100–110 cm	70 cm	90–100 cm
Seedling height at the end of vegetation	150–200 cm	100 cm	110–120 cm
The number of seedlings withered by the end of the growing season	0	0	0

As stated in the methodology section, a second site (500 m^2) was experimented in with 45 plants in 2014. This was carried out to understand the mistakes and faults that occurred in the 2013 experiment. Results were found with slight variations but similar to experiment 1. Slight variations were observed due to different types of fruit seedlings (peach, quince, cherry, and plum) compared with experiment 1. The observations recordings were severely affected in March 2015 due to black frost.

Observations in 2016 were interesting due to the sudden increase in temperature. The experimental seedlings, along with all the plants, started the vegetation period earlier than in previous years. Therefore, apricot seedlings began to bloom at the end of February, and other fruit seedlings began to bloom in early spring. Peach seedlings had more flowers than other fruit seedlings. In some peach and cherry seedlings (despite the small height of the seedlings), more than 100 flower buds bloomed, and in quince seedlings, less than 5 flower buds were observed. The process by which seedlings flower and set fruit is different for each fruit plant and has changed over time. In particular, it was noted that peach seedlings comprised almost 70% of the total flower buds and set fruit. However, only 5 to 25 peaches remained and ripened per tree where it had 30 to 70 flowers. Similar observations were seen in other types of fruits. This important but scientifically difficult-to-prove observation was identified. Ripened peaches and apricots in the experimental garden were sweeter than in the irrigated field. However, the opposite was observed in cherries. Nevertheless, these observations about taste cannot be scientifically proven. In addition, the sizes of ripened peaches, apricots, and cherries in the experimental garden were almost the same as the size of the irrigated ones. Only the quince fruit was 1.5–2 times smaller compared with irrigated quince fruit.

The best results were seen in 2017. Fruit seedlings produced more fruit, produced more branches, and grew taller than in previous years. More than 100 flower buds bloomed on 5 apricot seedlings from the experimental seedlings planted in 2013. Out of them, 60–70% were brought into fruits. Two bushes of apricot seedlings dropped their fruit before ripening. On average, 25–30 apricot fruits ripened in 3 apricot bushes. In addition, the apricot seedlings grew on average 1.5–2 m and were almost the same as irrigated apricot trees. A good fruit harvest was observed in other fruit trees too.

In all experimental seedlings planted in 2013 and 2014, the phenological processes occurred on time, almost as in the irrigated seedlings in 2018. This may be due to the well-grown root system. Even in hot and dry periods of summer, plasmolysis was rarely observed in experimental seedlings. Seedlings produced more branches. However, only one quince sapling dried up due to plant disease (plant blight).

Table 7 presents the yield indicators obtained in 2018 and 2019. As per the results shown in the table, there was no significant damage to the harvest due to non-irrigation. However, the sizes of the fruits were slightly smaller (10–20%) than the fruits from irrigated farms. Therefore, this brought an adaptation strategy to agriculture in water scarcity areas.

Table 7. The yield indicators obtained from experimental seedlings.

Fruit	Year of Planting	Total Number of Seedlings	The Number of Seedlings that Bore Fruit	The Number of Seedlings that Did Not Produce	Maximum Yield per One Tree (kg)	The Minimum Yield per One Tree (kg)	Average Yield (kg)
For 2018							
Apricot	2013	9	7	2	15	1	6
Apricot	2014	3	3	0	15	6	8
Peach		8	8	0	6	1	3
Cherry		2	2	0	2	0.5	0.8
Quince		4	2	2	2	0.5	1
Plum		3	2	1	0.2	0.1	0.15
Apple		15	8	7	7	0.5	3

Table 7. *Cont.*

Fruit	Year of Planting	Total Number of Seedlings	The Number of Seedlings that Bore Fruit	The Number of Seedlings that Did Not Produce	Maximum Yield per One Tree (kg)	The Minimum Yield per One Tree (kg)	Average Yield (kg)
For 2019							
Apricot	2013	9	8	1	20	2	10
Apricot	2014	3	3	0	20	10	10
Peach		8	8	0	7	2	4
Cherry		2	2	0	2	0.5	0.8
Quince		4	4	0	8	0.5	3
Plum		3	2	0	0.5	0.2	0.3
Apple		15	10	5	10	0.5	4

4. Conclusions

Soil moisture conservation techniques are essential for horticultural work, especially in arid countries such as Uzbekistan. Soil moisture conservation techniques help optimize water use and minimize wastage, ensuring that the available water is used efficiently for horticultural production. Water requirements for horticultural practices can be gained by collecting rainwater in an efficient way without irrigation. This study developed experimental dryland horticulture in the lower regions of the Namangan hills in Uzbekistan by investigating the possibility of creating a non-irrigated garden of many types of fruit trees using agrotechnical measures based on collecting natural moisture. In addition, the impacts in the long term on fruits are discussed regarding the adapted techniques used for the first time in the context of Uzbekistan.

Despite the severe damage that occurred due to black frost, the experiment showcased some interesting results. All fruit types were adapted to the non-irrigation techniques and an acceptable yield was received in a few years. Initially, a reduced growth rate in plants was observed; however, after a few years, it returned to the usual phase. The growth rate after 2–3 years was comparable to the similar type of crops in the vicinity that were irrigated. In addition, the yield was acceptable and comparable even though the size of the fruit in non-irrigated farms showcased slight reductions. Therefore, the experiments illustrated an acceptable and sound approach to be considered among farming people. It is possible to have a larger-scale non-irrigated farm in the northeastern hills of the Namangan region as a pilot project to see the outcome.

Results of the experiment also indicated that the combination of organic and plastic mulching produces a better approach. Therefore, this is highly recommended to introduce into a pilot study. The experimental work that was carried out in this research can be highly rewarding in other arid countries for the adaptation strategies in changing climates. Soil moisture conservation techniques play a vital role in horticulture in arid countries by mitigating water scarcity, improving plant resilience to drought, optimizing water-use efficiency, enhancing soil health, and promoting sustainable agricultural practices. By implementing these techniques, arid regions can achieve better horticultural production, reduce the pressure on water resources, and ensure long-term agricultural sustainability. Future research can be oriented toward climate adaptation strategies while moving with the technology to enhance crop quality.

Conducting experiments at different locations in Uzbekistan to validate the effectiveness of soil moisture conservation techniques; conducting long-term studies to provide more accurate insights into the sustained benefits of soil moisture conservation practices; conducting experiments in various soil types and multiple climatic conditions to obtain a broader range of scenarios; implementing irrigation scheduling, nutrient management, and crop spacing to optimize the benefits of soil moisture conservation techniques; and conducting cost–benefit analyses to evaluate the economic viability of adopting these practices on a larger scale are some limitations of and recommendations for experimental soil moisture conservation techniques.

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References

1. Zhang, L.; Yu, Y.; Malik, I.; Wistuba, M.; Sun, L.; Yang, M.; Wang, Q.; Yu, R. Water Resources Evaluation in Arid Areas Based on Agricultural Water Footprint—A Case Study on the Edge of the Taklimakan Desert. *Atmosphere* **2023**, *14*, 67. [CrossRef]
2. Döös, B.R. Population Growth and Loss of Arable Land. *Glob. Environ. Chang.* **2002**, *12*, 303–311. [CrossRef]
3. Rosegrant, M.W.; Cai, X. Global Water Demand and Supply Projections: Part 2. Results and Prospects to 2025. *Water Int.* **2002**, *27*, 170–182. [CrossRef]
4. Gleick, P.H.; Palaniappan, M. Peak Water Limits to Freshwater Withdrawal and Use. *Proc. Natl. Acad. Sci. USA* **2010**, *107*, 11155–11162. [CrossRef]
5. Bodirsky, B.L.; Rolinski, S.; Biewald, A.; Weindl, I.; Popp, A.; Lotze-Campen, H. Global Food Demand Scenarios for the 21st Century. *PLoS ONE* **2015**, *10*, e0139201. [CrossRef]
6. Kirschner, G.K.; Xiao, T.T.; Blilou, I. Rooting in the Desert: A Developmental Overview on Desert Plants. *Genes* **2021**, *12*, 709. [CrossRef]
7. Chathuranika, I.; Khaniya, B.; Neupane, K.; Rustamjonovich, K.M.; Rathnayake, U. Implementation of water-saving agro-technologies and irrigation methods in agriculture of Uzbekistan on a large scale as an urgent issue. *Sustain. Water Resour. Manag.* **2022**, *8*, 155. [CrossRef]
8. Nyamekye, C.; Thiel, M.; Schönbrodt-Stitt, S.; Zoungrana, B.J.-B.; Amekudzi, L.K. Soil and Water Conservation in Burkina Faso, West Africa. *Sustainability* **2018**, *10*, 3182. [CrossRef]
9. Diop, M.; Chirinda, N.; Beniaich, A.; El Gharous, M.; El Mejahed, K. Soil and Water Conservation in Africa: State of Play and Potential Role in Tackling Soil Degradation and Building Soil Health in Agricultural Lands. *Sustainability* **2022**, *14*, 13425. [CrossRef]
10. Abdo, G.; Abdin, M.; Abdulmohsen, A.-S. Water conservation in the Arab region: A must for survival. *Sci. Cold Arid. Reg.* **2013**, *5*. [CrossRef]
11. Harik, G.; Alameddine, I.; Zurayk, R.; El-Fadel, M. An integrated socio-economic agent-based modeling framework towards assessing farmers' decision making under water scarcity and varying utility functions. *J. Environ. Manag.* **2023**, *329*, 117055. [CrossRef] [PubMed]
12. Kelly, T.D.; Foster, T.; Schultz, D.M. Assessing the value of adapting irrigation strategies within the season. *Agric. Water Manag.* **2023**, *275*, 107986. [CrossRef]
13. Samimi, M.; Mirchi, A.; Moriasi, D.; Sheng, Z.; Gutzler, D.; Taghvaeian, S.; Hargrove, W. Adapting irrigated agriculture in the Middle Rio Grande to a warm-dry future. *J. Hydrol. Reg. Stud.* **2023**, *45*, 101307. [CrossRef]
14. Wang, C.; Fu, B.; Zhang, L.; Xu, Z. Soil moisture–plant interactions: An ecohydrological review. *J. Soils Sediments* **2019**, *19*, 1–9. [CrossRef]
15. Wang, C.; Wang, S.; Fu, B.; Zhang, L.; Lu, N.; Jiao, L. Stochastic soil moisture dynamic modelling: A case study in the Loess Plateau, China. *Earth Environ. Sci. Trans. R. Soc. Edinb.* **2018**, *109*, 437–444. [CrossRef]
16. Lin, P.F.; Zhu, X.; He, Z.B.; Du, J.; Chen, L.F. Research progress on soil moisture temporal stability. *Acta Ecol. Sin.* **2018**, *38*, 3403–3413.
17. Thierfelder, C.; Wall, P.C. Effects of conservation agriculture techniques on infiltration and soil water content in Zambia and Zimbabwe. *Soil Tillage Res.* **2009**, *217–227*, 105. [CrossRef]
18. Kader, M.A.; Singha, A.; Begum, M.A.; Jewel, A.; Khan, F.H.; Khan, N.I. Mulching as water-saving technique in dryland agriculture: Review article. *Bull. Natl. Res. Cent.* **2019**, *43*, 147. [CrossRef]
19. Cabrera-Pérez, C.; Valencia-Gredilla, F.; Royo-Esnal, A.; Recasens, J. Organic Mulches as an Alternative to Conventional Under-Vine Weed Management in Mediterranean Irrigated Vineyards. *Plants* **2022**, *11*, 2785. [CrossRef]
20. Davies, W.J.; Zhang, J.; Yang, J.; Dodd, I.C. Novel crop science to improve yield and resource use efficiency in water-limited agriculture. *J. Agric. Sci.* **2011**, *149*, 123–131. [CrossRef]

21. López-Urrea, R.; Sánchez, J.M.; Montoro, A.; Mañas, F.; Intrigliolo, D.S. Effect of using pruning waste as an organic mulching on a drip-irrigated vineyard evapotranspiration under a semi-arid climate. *Agric. For. Meteorol.* **2020**, *291*, 108064. [CrossRef]
22. Varga, P.; Májer, J. The use of organic wastes for soil-covering of vineyards. *Acta Hortic.* **2004**, *652*, 191–197. [CrossRef]
23. Li, R.; Li, Q.; Pan, L. Review of organic mulching effects on soil and water loss. *Arch. Agron. Soil Sci.* **2020**, *67*, 136–151. [CrossRef]
24. Tuovinen, T.; Kikas, A.; Tolonen, T.; Kivijärvi, P. Organic mulches vs. black plastic in organic strawberry: Does it make a difference for ground beetles (Col., Carabidae)? *J. Appl. Entomol.* **2006**, *130*, 495–503. [CrossRef]
25. Narayan, S.; Makhdoomi, M.I.; Malik, A.; Nabi, A.; Hussain, K.; Khan, F.A. Influence of Plastic and organic mulching on productivity, growth and weed density in chilli (*Capsicum annuum* L.). *J. Pharmacogn. Phytochem.* **2017**, *6*, 1733–1735.
26. Shah, F.; Wu, W. Use of plastic mulch in agriculture and strategies to mitigate the associated environmental concerns. *Adv. Agron.* **2020**, *164*, 231–287. [CrossRef]
27. Grove, D.; Rackham, O. *The Nature of Mediterranean Europe: An Ecological History*; Yale University Press: New Haven, CT, USA; London, UK, 2001.
28. Turner, S.; Kinnaird, T.; Varinlioğlu, G.; Şerifoğlu, T.; Koparal, E.; Demirciler, V.; Athanasoulis, D.; Odegard, K.; Crow, J.; Jackson, M.; et al. Agricultural terraces in the Mediterranean: Medieval intensification revealed by OSL profiling and dating. *Antiquity* **2021**, *95*, 773–790. [CrossRef]
29. Avni, Y. The Emergence of Terrace Farming in the Arid Zone of the Levant—Past Perspectives and Future Implications. *Land* **2022**, *11*, 1798. [CrossRef]
30. Barker, G.W.W.; Gilbertson, D.D.; Jones, B.; Mattingly, D. *Farming the Desert. The UNESCO Libyan Valleys Archaeological Survey*; UNESCO: Paris, French; Department of Antiquities: Tripoli, Libya; Society for Libyan Studies: London, UK, 1996; 404p.
31. Tarolli, P.; Preti, F.; Romano, N. Terraced landscapes: From an old best practice to a potential hazard for soil degradation due to land abandonment. *Anthropocene* **2014**, *6*, 10–25. [CrossRef]
32. Tarolli, P. Agricultural Terraces Special Issue Preface. *Land Degrad. Dev.* **2018**, *29*, 3544–3548. [CrossRef]
33. Spencer, J.E.; Hale, G.A. Origin, nature and distribution of agricultural terracing. *Pac. Viewp.* **1961**, *2*, 1–40. [CrossRef]
34. Hamidov, A.; Khamidov, M.; Ishchanov, J. Impact of Climate Change on Groundwater Management in the Northwestern Part of Uzbekistan. *Agronomy* **2020**, *10*, 1173. [CrossRef]
35. Löw, F.; Prishchepov, A.V.; Waldner, F.; Dubovyk, O.; Akramkhanov, A.; Biradar, C.; Lamers, J.P.A. Mapping Cropland Abandonment in the Aral Sea Basin with MODIS Time Series. *Remote Sens.* **2018**, *10*, 159. [CrossRef]
36. Qadir, M.; Noble, A.D.; Qureshi, A.S.; Gupta, R.K.; Yuldashev, T.; Karimov, A. Salt induced land and water degradation in the Aral Sea basin: A challenge to sustainable agriculture in Central Asia. *Nat. Resour. Forum* **2009**, *33*, 134–149. [CrossRef]
37. World Bank. *Agriculture Modernization in Uzbekistan*; World Bank: Washington, DC, USA, 2020.
38. Chathuranika, I.M.; Gunathilake, M.B.; Azamathulla, H.M.; Rathnayake, U. Evaluation of Future Streamflow in the Upper Part of the Nilwala River Basin (Sri Lanka) under Climate Change. *Hydrology* **2022**, *9*, 48. [CrossRef]
39. Hamidov, A.; Kasymov, U.; Djumaboev, K.; Paul, C. Rebound Effects in Irrigated Agriculture in Uzbekistan: A Stakeholder-Based Assessment. *Sustainability* **2022**, *14*, 8375. [CrossRef]
40. Kasymov, U.; Hamidov, A. Comparative Analysis of Nature-Related Transactions and Governance Structures in Pasture Use and Irrigation Water in Central Asia. *Sustainability* **2017**, *9*, 1633. [CrossRef]
41. Khamraev, S.; Mukhamednazarov, L.; Sokolov, V.; Gayfulin, I. *Irrigation and Drainage in Republic of Uzbekistan: History and Modern State*; Ministry of Water Resources of the Republic of Uzbekistan: Tashkent, Uzbekistan, 2020; p. 27.
42. Hamidov, A.; Daedlow, K.; Webber, H.; Hussein, H.; Abdurahmanov, I.; Dolidudko, A.; Seerat, A.Y.; Solieva, U.; Woldeyohanes, T.; Helming, K. Operationalizing water-energy-food nexus research for sustainable development in social-ecological systems: An interdisciplinary learning case in Central Asia. *Ecol. Soc.* **2022**, *27*, 12. [CrossRef]
43. Musinovich, S.M.; Khaitmuratovich, K.I.; Tulkunovna, U.Z. Application of Water-Saving Technologies in Gardening Uzbekistan. *Am. J. Agric. Biomed. Eng.* **2021**, *3*, 1–8. [CrossRef]
44. Unger-Shayesteh, K.; Vorogushyn, S.; Farinotti, D.; Gafurov, A.; Duethmann, D.; Mandychev, A.; Merz, B. What do we know about past changes in the water cycle of Central Asian headwaters? A review. *Glob. Planet Chang.* **2013**, *110*, 4–25. [CrossRef]
45. Reyer, C.P.O.; Otto, I.M.; Adams, S.; Albrecht, T.; Baarsch, F.; Cartsburg, M.; Coumou, D.; Eden, A.; Ludi, E.; Marcus, R.; et al. Climate change impacts in Central Asia and their implications for development. *Reg. Environ. Chang.* **2017**, *17*, 1639–1650. [CrossRef]
46. Jie, J.; Tianjun, Z.; Xiaolong, C.; Lixia, Z. Future changes in precipitation over Central Asia based on CMIP6 projections. *Environ. Res. Lett.* **2020**, *15*, 054009.
47. Chub, V.E.; Spectorman, T.Y. Climate Trends in Uzbekistan. In *Climate Change, Reasons, Impacts and Response Measures*; Bulletin: Tashkent, Uzbekistan, 2016; pp. 5–16.
48. Turapov, I.; Kamilov, B.S.; Qodirova, D.A.; Saidova, M.E.; Namozov, N.C.; Burxanova, D.U. *Soil Physics (Tuproq fizikasi in Written in Uzbek Language)*; Tashkent State Agrarian University Publishing House: Tashkent, Uzbekistan, 2014. Available online: https://lib.nspi.uz/book/62 (accessed on 29 March 2023).