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Creation of an Agricultural Security System: An Effective Model of Sustainable Land Use

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Abstract

The article discusses the effective use of degraded foothill lands of the Kamashy district of the Kashkadarya region of Uzbekistan. Sustainable land use in the arid lands of the foothill zone, due to water conservation, growing seedlings of nut and fruit trees, growing fodder crops in row spacing, allows local livestock breeders to create a rational model of agroforestry system of land use. The organization and development of agroforestry will ensure sustainable land use, create additional jobs, increase household incomes and improve the standard of living of the population.

Keywords

Agroforestry, Foothills, Arid Lands, Drought-Resistant, *Juglansregia*, *Prunusdulcis*, *Ziziphus jujube*, *Pistaceavera*, *Kochia prostrata*, *Ceratoideseversmanniana*, *Aelleniasubaphylla*, *Ferula*, Pasture Plants

1. Introduction

The arid foothills of the Kamyshy district, as well as other districts of the Kashkadarya region, are mainly used for growing grain crops on safflower and cattle grazing. Due to frequent droughts, crop yields are declining. Farmers end the year with a profit only when the grain is sown in a favorable season, which happens once every 3 - 5 years. In other years, farmers barely cover their expenses, and often at the end of the year, farmers suffer losses. At the same time, due to the inefficient use of land as pastures, the land is degraded [1] [2].

Such methods of land use damage soil fertility and the ecosystem as a whole. A small amount of wheat harvested from such lands can also be obtained due to a slight increase in grain yields on irrigated lands. A number of projects to improve the efficiency of animal husbandry are also being implemented in this

zone [1] [3]. At the same time, alternative methods of farming, in the conditions of climate change, on the one hand, should bring income to the rural population and be more profitable, and on the other hand, be useful for nature, *i.e.* a normal ecosystem of arid areas should serve to restore their condition and further use.

This sustainable use of tree crops, along with food crops and animal husbandry, is called agroforestry. Some types of trees also grow in ecologically difficult conditions, such as drought and salinity, preventing erosion, enriching the soil with nutrients and fertility, including improving microclimatic conditions and increasing soil moisture. Local residents of Uzbekistan have been using various agroforestry systems based on fruit and nut crops since ancient times [1] [3].

2. Purpose and Objectives

- Support of the local community by introducing the best practices of sustainable land use in order to organize the effective use and restoration of degraded territories and pasture ecosystems of the foothills;
- Improving the livelihoods and well-being of the rural population, sustainable land use on arid lands, through water conservation, growing seedlings of walnut and fruit trees, growing forage crops in row spacing, creating a rational model of agroforestry system of land use;
- Expansion of additional environmental benefits at the local, national and global levels.

3. Material and Methods of Research

Sowing of forage plants and planting of tree crops was carried out according to the generally accepted method, that is, the sowing of forage plants such as *Aelleniasubaphylla* was carried out at the rate of 12 kg per 1 ha, *Ceratoideseversmanniana*, 10 kg per 1 ha, *Kochia prostrata* 10 kg per 1 ha [4] [5], and the planting of tree crops was carried out according to the garden type with a scheme of 6 × 5 meters at the rate of 320 pieces per 1 ha, and the sowing of seeds and planting pistachio seedlings in the Kamashy forestry were carried out according to the scheme of 8 × 8 and 8 × 7 meters at the rate of 156 - 178 seats per 1 hectare [1] [6].

Identification of pasture types and determination of the yield of fodder mass on the test areas by seasons. Assessment of the degree of degradation of the vegetation cover of pastures [3] [4] [5].

To determine plant species, the "Determinant of plants of Central Asia" in 10 volumes (1968-1992) and "Flora of Uzbekistan" in 6 volumes (1951-1962) are used. Latin names of plant species are given according to the summary "Vascular plants of Russia and neighboring states within the former USSR" [7].

Research Area

With the support of the Food and Agriculture Organization of the United Nations (FAO), the project "Integrated management of natural resources in arid

and saline agricultural landscapes of Central Asia and Turkey" was implemented in the arid foothills of the Kamashy district of Kashkadarya region [1]. In order to organize the effective use of degraded foothills, the best practices of sustainable land use were applied in the following areas:

- In order to prevent the degradation of pasture lands, work has been carried out to increase their productivity and restore and maintain the production activities of landscape ecosystems, as well as to improve environmental protection in the region;
- Forest reclamation measures were carried out by creating nut and fruit trees against water and soil erosion in the arid lands of the foothill zone;
- Increasing the productivity of pastures in the foothills by planting grasses for livestock feed between rows of trees, as well as sowing medicinal plants—ferula is an additional source of income;
- Opportunities have been created for the implementation of multi-purpose economic activities in the foothills of arid lands, increasing the incomes of farms and solving accumulated socio-economic problems.

4. Results and Discussion

The project organized a model section of agroforestry on the territory of the farm "OltynbayevYeri" of the Kamashy district. This farm has 105 hectares of arable land, which is mainly used for growing wheat and barley. The yield of pastures depends on weather conditions, in years with heavy rainfall, the yield is good, but in years with little precipitation, the yield is low, and in some dry years, such as 2020 and 2021, there was no forage harvest at all (**Figures 1-4**).

The farmer built a 50 cubic meter pool on his plot for watering fruit trees. Planted in 2017-2018 according to the 6 × 5 m scheme, almond trees and linear plantings of Ulmusdensa and *Halóxylonammodéndron* have taken root and are in good condition and have entered fruiting for 4 years. In 2019, new experimental plantings of *Prunusdulcis*, *Ziziphusjujube* and *Vítisvinífera* were laid on

Figure 1. Concrete pool for watering.

Figure 2. Fodder plants.

Figure 3. Fruit-bearing *Prunus dulcis* trees.

Figure 4. Fruit-bearing *Ziziphus jujube* trees.

an area of more than 0.5. They proved to be resistant to drought and in these conditions took root by almost 100 percent.

In 2019-2020, the trees were watered with fresh water, which was delivered by water carriers from fresh water sources. In 2021, a well was drilled to fill the pool on the territory, a pump was installed and irrigation of planted trees was carried out with this water from a depth of 125 meters. It should be noted that when studying the composition of groundwater, the presence of 6 - 8 g of mineralization in 1 liter of water was determined. Water is used for watering animals and watering planted trees. But no negative effects on plants and animals were noticed.

As a rule, most varieties of *Prunus dulcis* yield up to 10 quintals per hectare by the 8th year of vegetation. The yield increases from year to year. In 10 years, the trees will enter full yield [1] [6]. If almond orchards are laid on these lands in accordance with agrotechnical rules, there is no doubt that in 7 - 8 years the farmer will receive a significant income.

Calculations show that when planting almond seedlings and other trees according to the 6 × 5 meter scheme, 333 almond seedlings will be planted on 1 hectare. (1 hectare is equal to 10,000 m^2 of area, the almond planting scheme is 6 by 5 meters, while dividing 100 meters by 6 meters we get 16 trees, dividing the rest by 5 meters we get 20 trees. When multiplying 16 × 20 = 320 trees per 1 ha). If you water each tree every 5 - 6 days, starting in May, and use 2 buckets (20 liters) of water per 1 tree for each watering, then 100 liters of water will be consumed per 1 tree per month. 320 trees consume 32,000 liters or 32.0 cubic meters of water. If we count the period of drought from May to October, then in just 6 months about 200 cubic meters of water are spent on irrigation of trees. With the introduction of the technology of mulching and drip irrigation of trees, the consumption of irrigation water will be reduced by 50% - 60% [8].

It should be noted that when using these lands for agricultural crops, high yields can be obtained only in years with good precipitation, and when using these lands for planting nut crops together with agricultural crops such as *Prunus dulcis* and *Ziziphus jujube*, high yields can be harvested. For example, the lowest price for 1 kg of almonds in the markets is on average $ 8-10. If 8 quintals of fruit are harvested from 1 hectare of almond plantations, the income will amount to 6 - 8 thousand US dollars. If it takes about 30% - 40% or 1.8 - 2.4 thousand dollars to cover expenses, then 4.2 - 5.6 thousand dollars is net income and is spent on the development of economic activity of the farm.

The problem of land degradation and desertification in this area is largely related to the plowing of significant areas for rain-fed crops of grain, which in this zone have low and unstable yields and very low profitability. This form of agriculture, without taking into account natural conditions, although partially provides the region with grain, but has the most negative environmental consequences and is ultimately economically unprofitable. Animal husbandry is the main source of livelihood and well-being of the population living here, the in-

come from which in the family budget is from 75% and above, the efficiency and condition of animal husbandry is directly dependent on the condition of pastures.

The monitoring of pastures in the Kamyshy district in 2015-2021 revealed that the productivity of pastures is low and averages about 0.05 - 0.25 t/ha over the years. Unsystematic, unregulated grazing, excessive concentration of livestock per unit area and inefficient extensive methods of keeping livestock are the main causes of degradation of pastures in the region. In these regions, overgrazing can lead to complete destruction of vegetation cover. The inability to preserve the traditional pasture turnover and seasonal transitions from one pasture to another, led to a strong degree of overgrazing and degradation of pastures near villages, damage to slopes and areas that could be used more productively (**Figure 5** and **Figure 6**).

In the vegetation cover there are such valuable forage species as *Poa bulbosa*, *Bromus tectorum*, in places there is *Carex pachystulis*, *Agropyrum orientale*. Pastures are narrow-zone forage lands used in the spring and summer period. From coarse-stemmed forage plants on pastures there are such species as *Alhagi pseudalhagi*, *Cousinia resinosa*, *Prosopis farcta*, ferula species *Ferula tadshikorum*.

Figure 5. Grazing.

Figure 6. Natural pasture.

However, their numbers in the herbage are rare, and their forage value increases in the summer season of the year.

In the most favorable climatic conditions in 2019 and 2020, the height of herbaceous plants in 2019 averaged 41.0 - 47.3 cm, in 2020 41.3, and in arid 2021 25.0 cm. The pasture yield was 1.3 - 1.8 kg/ha in 2019-2020, slightly lower in 2021 than in 2020 and averaged 1.43 kg/ha. The average sheep capacity in 2019-2020 is 0.16 heads/ha, and in 2021, with a yield of 0.11 t/ha, 0.12 heads per 1 ha of pasture territory. For the needs of 1 head of sheep, up to 8 - 9 hectares of natural pastures are needed.

Therefore, when using the recommended technology and land use model, it is possible to obtain products for another 1.5 - 2.0 thousand dollars of income from growing perennial drought-resistant pasture plants planted among almond rows. Local non-invasive species of long-term drought-resistant highly productive forage species are sown from the *Kochia prostrata* and *Ceratoideseversmanniana* seeds, which will be used to increase the productivity of pastures. These plants as a result of anthropogenic impact fell out of the herbage of this zone. It should be noted that they grew well in the conditions of drought of 2020/2021, forming seeds and yields of up to 1.0 - 1.5 tons per hectare, spread throughout the site. When receiving such a feed mass, it is possible to keep 1.7 heads of sheep per 1 hectare or to harvest insurance stocks of feed for the winter period.

When mowing twice a year, you can use the feed mass in the spring and prepare well-eaten hay for the winter period in the fall, given that, in the autumn-winter period of the year, there is no foot feed for livestock on the pastures around the farm. At the same time, grazing should be prohibited for two years after sowing, since animals can bleed young seedlings of pasture plants together with the root system [3] [4].

In addition, winter and summer koshars for 50 - 60 heads of small cattle (sheep, lambs) have been built on the territory of the farm, manure from which, in turn, is annually brought directly into the field. Organic fertilizers improve the structure of the soil, increase its fertility, and increase the growth and productivity of planted trees (**Figure 7** and **Figure 8**).

The introduction of sustainable land management means their continuous use for many years in the production of goods and other products to meet human needs without disturbing the ecological balance. In mountainous and foothill areas, the main activities of the local population are animal husbandry and agriculture, but they have limited access to water sources and, accordingly, high yields. Therefore, depending on the conditions of the region, it is necessary to find alternative ways to profit from farming on irrigated lands through the development of other areas of agriculture. In this case, one of the alternative methods is sowing and planting nut-bearing, fruit species and grapes that do not require abundant watering, resistant to local climatic conditions, as well as laying medicinal plants in the aisles, including ferula species and forage plants that can be used for haymaking.

Figure 7. *Aelleniasubaphylla*.

Figure 8. *Ceratoideseversmanniana*.

In the Kamashy state forestry, it is planned to increase revenues by sowing ferula between rows of pistachios, on an area of more than 2000 hectares. Plots of 88 hectares have been allocated to the local population, where ferula seeds have been sown. 4 - 5 years after sowing, gum resin is harvested from the plants, which is a very large source of income for local residents. One *ferula p*lant can produce 70 grams of gum resin per year, the price of 1 kg varies depending on its chemical composition and quality, in 2021 the average price of 1 kg was 150 - 250 US dollars. Additional costs for growing ferula are not required, only in the first year seeds are purchased according to the quota. Up to 2000 ferula plants can be grown on one hectare, if 50 grams of gum resin can be obtained from 1000 individuals in the fifth year, or 50 kg from the entire plot. The price of 1 kg gum resin is 200 US dollars, the cost of 50 kg is 10.0 thousand dollars. If 30 percent of this income is spent on quotas, seed collection, sowing, protection and gum resin collection, the net profit will be 7.0 thousand dollars [1] [9] (**Figure 9** and **Figure 10**).

To propagate *ferula*, it is recommended to prepare seeds ripe in summer, dig holes 5 - 10 cm deep in autumn, sow 3 - 5 pieces of seeds and cover the surface with soil [1]. The study showed that with 1 hectare of *Pistaceavera* plantations, using this technology, you can get ten times more profit than with traditional land use, since 18 years after the *Pistaceavera* plantation enters fruiting, you can

Figure 9. Flowering ferula bush.

Figure 10. Ferula seeds.

get up to 25.6 thousand dollars in profit. It is noted that growing pistachios is 50 times more profitable than growing wheat on these arid lands. Pistachio fruits begin to ripen 18 - 25 years after planting and bear fruit for 100 years [2]. As soon as the harvest is harvested from the grafted *Pistaceavera*, the incomes of the local population will grow, and their living conditions will improve.

5. Conclusions

1) It is advisable to replenish the dried trees on the site by planting additional seedlings and expanding the areas of *Prunusdulcis*, *Pistaceavera* and *Ziziphus-jujube*.

2) Laying *Pistaceavera* on arid pasture lands of the foothill zone and growing medicinal and fodder plants of reintroducers such as *Kochia prostrate Ceratoi-deseversmanniana* and *Aelleniasubaphylla* in the aisles is the best model form of creating a system of agroforestry and sustainable land management and creating a solid fodder base for animal husbandry.

3) The implementation of multi-purpose economic activities increases the incomes of farms and solves accumulated socio-economic problems. Multi-purpose

land use provides for the "diversification" of production and reduction of risks associated with natural and climatic conditions. In other words, multi-purpose land use is an effective measure against natural disasters.

4) The organization and development of agroforestry in agriculture will ensure the rational use of land, the creation of additional jobs, an increase in household incomes and an increase in the standard of living of the population.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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