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HISTORICAL EXPERIENCE AND ADAPTIVE WAYS OF MANAGEMENT OF NATURAL RESOURCES IN ARID REGIONS OF RUSSIA AND KAZAKHSTAN

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Abstract

The characteristics and stages of development of agricultural production in the semidesert and dry steppe regions of Russia and Kazakhstan over a century of development of the social system are described. It has been shown that government subsidies into outdated agricultural technology with uncontrolled increase of population density is a dead-end. The necessity of compliance with human and biological resources using innovative agricultural technologies with adaptive ways of management of natural resources in arid regions has been shown.

Key words: arid regions, rural population, adaptive management, natural resources

1. INTRODUCTION

Sustainable land management is the most important condition for the development of society, suggesting the sustainable use of soil, water, flora and fauna in the production of goods that meet the changing needs and demands of the people. At the same time, it should provide the long-term maintenance of production potential of these resources and the preservation of their ecological functions.

The most challenging is the development of sustainable land management in arid and semi-arid regions, where water deficiency and high insolation restrict the intensification of production and regulate human resources and manufacturing resources as per unit area. Besides, the system of farming in arid regions of Russia and Kazakhstan has undergone significant changes during historical time. During the last century, the changes in socio-political system caused the changes in farming, which, in its turn, resulted in the radical change of environmental management. This paper is focused on the specificities of those changes and proposes a conceptual model of a modern adaptive sustainable land management.

2. MATERIAL AND METHODS

The goal of the study is to identify trends in the formation of the modern agrarian market in the dryland of Russia and Kazakhstan, and to develop new approaches to environmentally secure, cost-effective and sustainable land management with the use of innovative technologies.

The object of the study is the status and the prospects of land management in the dryland for the purpose of sustainable nature management and improvement in rural livelihoods.

In Russia and Kazakhstan, the most area of dry steppes and semideserts is not very favourable for agriculture due to high continentality of climate (temperature range from -40°C to +40°C), small amount of annual precipitation (200-350 mm), and high potential evaporation (more than 800-1000 mm). At the same time, the growing season is characterized by inconsistent rainfall, frequent dry winds and droughts repeating one time in several years or even each year, especially in the recent years (Rode and Polskii 1961; Biogeocenotic… 1974; Sizemskaya and Sapanov 2008).

Here, the soil cover is represented by moderately and slightly fertile chestnut soils (from nonsaline dark chestnut to saline light chestnut soil) and brown arid soils in combination with strongly saline solonetzes occupying 20-50% of the total area. However, the fertile intrazonal meadow chestnut soils and local depressions with the lenses of fresh ground water occupying up to 10% of the total area are found ubiquitously.

In such a severe environment, it can be anticipated that the growth of population should be limited to the profit from agricultural production. Meanwhile, these proportions are strongly violated due to frequent changes in social order.

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3. RESULTS

In the recent past, the studied area has gone through the several stages of agricultural development.

Pre-revolutionary period (before 1917). Individual farms in the pre-revolutionary period (until 1917) were the most adapted to the natural conditions. For example, the marginal (low productive) lands were used for shifting grazing whereas the highly productive lands were used for growing grain and melons/watermelons, and sometimes, for horticulture (Increasing the productivity ... 1989; Yuzhakova 2006).

This period was characterized by market self-regulation of population and social welfare. In other words, the population of a certain area was closely related to the food resources, from one hand, and to the area of lands available for agriculture, from other hand. For example, in the Volga - Ural interfluve, the nomads of Bukeyev Khanate grazed a record amount of cattle (about 1 million heads) (Zimanov 1982). On average, in this arid region, one head of small livestock (e.g., sheep, goat) per hectare could be fed in the years with sufficient fodder (Gordeeva and Larin 1965). However, a natural regulator of the number of animals (and people) here was not only the productivity of pastures, but also periodic dzhuts (from Turkic, winter starvation), which could dramatically reduce the cattle stock by one order of magnitude or more.

Farmers cultivated here only fertile lands, such as meadow chestnut soils in mesodepressions (padinas) with the lenses of available fresh ground water. They received a guaranteed yield of grain and melons/watermelons that was sufficient for their personal use and for small sale (Gordeeva and Larin 1965; Zimanov 1982; Bolshakov et al. 1983).

Thus, the positive side of this extensive period in the development of arid lands was the self-regulation of population density, while the negative side was the "inhumane" way to achieve such an equilibrium, when a severe drought and / or death of animals forced the population to migrate to more favorable regions and cities.

Socialist period (1917-1992). This period was marked by centralization of production with the advent of collective and state farms. Marginal (low productive) lands were involved in the crop rotation by the consolidation of agricultural fields (up to 500-600 ha). The stabling of livestock expanded due to the decrease in the area of rangelands. The most impressive event of that period was the widescale agricultural development of virgin land for growing cereal crops (over 40 million hectares of virgin land were plowed) beginning from 1954 and the construction of numerous watering and irrigation systems since the mid-1970s to increase forage production (millions of hectares of land were irrigated).

The positive side of such a policy was the growth of stability in regional increase of agricultural production, almost independent on the crop failure and market conditions. The population increased drastically and was no longer dependent on the natural fertility of the land (Increasing the productivity ... 1989; Belyakova and Barmin 2008).

At the same time, these activities increased costs and cost per unit of agricultural products and required the governmental subsidies. This result was primarily due to loss of productivity of one unit of acreage due to enlargement of fields up to 500-600 hectares, which caused the inevitable involvement in the crop rotation the unproductive saline solonetzes and slightly saline light chestnut and chestnut soils composing the soil cover of the studied region. On average, cereal yields fell down below the level of profitability from 3000 kg/ha to 600-800 kg/ha. In cattle farming, this period also caused an increase in costs mainly due to the stabling of livestock (Bolshakov et al. 1983; Sotneva 2006).

Thus, the positive side of the transition from extensive to intensive development of the region was a stabilization of agricultural production and the growth of population, supported by the governmental grants and subsidies. During this period, the ratio of productive forces and the fertility of the land ceased to be governed by market mechanisms

Modern period (from the beginning of the 1990s). Currently, the development is now back on track of market relations. The new regulatory mechanism of the productive forces destroyed the socialist method of management and caused the collapse of the integrated (collective) farms. At this stage, there has been a sharp decrease in production of crops and livestock products resulting in the widespread weed growth in arable land, the destruction and the total loss of protective forest plantations, increased erosion, annual uncontrolled fires and other unwanted processes. Rural population is rapidly shrinking due to migration into large towns or aging (Braga 2011).

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The significant area of land is little used or not used at all. Survived farmers mainly use the “shepherd’s points” with a centralized power grid and located near sparse open reservoirs and / or wells. Attempts made by these households to conduct the production via "socialist" manner by producing crops at large areas with unproductive soils fail over and over again. In other words, agricultural reform (or rather, self-regulation) is spontaneous and unsystematic, and now more than ever, a well-defined government program aimed at improvement of environmental management in this region is of vital importance (Volkov 2009; Voronin 2011).

However, even in this scenario of agricultural development, the positive outputs from returning to extensive land use practices can be indicated. An example is a return to the natural regulation of the population in this area, as well as a decrease in governmental support of unpromising obsolete technologies and production (through insurance, subsidies and other mechanisms), which is not always effective and justified due to lack of incentive to modernization (Zavodov and Imshenetskaya 2007; Dmitrieva et al. 2011).

Thus, the analysis of the agricultural development in arid regions of Central Eurasia during the last century demonstrated the positive and negative aspects of different scenarios of environmental management. It is worth noting that in the world such drylands are used with maximum adaptation of agricultural techniques to natural conditions. The closest analogue are the farms of America and Western Europe, successfully operating through the creation of many small isolated farms, and concerning the development of advanced technologies in the drylands – the farms of Israel, China and Australia. In general, small farms use fertile land for crops, the poor lands are used for by grazing the cattle. If freshwater is sufficient, the irrigation is organized, mainly by drip method.

4. DISCUSSION

Prospects for the development of arid lands through the use of new technologies.

The historical experience and the results of scientific research show that the welfare of the local population can be improved through the creation of modern agricultural systems. The land use in the drylands should be based on the respect for the renewable natural resources such as water and soil fertility. These areas are easily subjected to anthropogenic desertification especially when the balance in the functioning of natural ecosystems is broken due to overgrazing, cultivation of monoculture, irrigation of saline soils and other industries (Sizemskaya and Sapanov 2008, 2010).

In other words, the technologies should be socially relevant, environmentally secure, and if in the market conditions, more functionally necessary, cost-effective and profitable. These conditions can be met if small profitable farms distributed sparsely over the territory and applying energy saving technologies are created.

The basis of such farms located far from open water bodies should be autonomous cattle farms, in which electricity is produced by solar and wind energy and fresh water is taken from boreholes and wells. Number of livestock on free grazing must be proportionate to the productivity of pastures and the debit of wells. To ensure the insurance fund of forage it is possible to grow cereal crops and perennial grasses in long-living agroforestry systems, which are based on narrow-band snow-retaining forest shelterbelts with agricultural fields between them. Each field must have a total width of about 200 m, where the extra water in the form of snow is retained thanks to one-row shelterbelts of trees or shrubs planted along the length of the field every 40-60 m between them. Such fields must be located at least 500 m from each other. In a similar manner, it is also possible to create the long-living and narrow-band tree plantations and small isolated plantations from trees and shrubs for silvopastoral purposes (Bolshakov et al. 1983; Sapanov 2003; Sizemskaya and Sapanov 2005; Sapanov et al. 2005).

Besides, the natural shallow depressions with the intrazonal fertile meadow-chestnut soils with the lenses of fresh ground water can be the places for rainfed orchards, berry farms and even for small tree plantations for the personal needs. It is also possible to arrange the small irrigated plots under drip irrigation (Recommendations… 1988).

The analogue of the proposed model of the development of drylands is the agroforestry oasis of the Dzhanybek Research station of the Institute of Forest Science RAS, which is located in the Northern Caspian semidesert in the Volga – Ural interfluve. This station was created (Fig. 1) so as to maximally adapt to rainfed (non- irrigated) arid conditions so that the man-made ecosystems (agroforestry and silvopastoral systems, orchards and berry fields, tree plantations, etc.) were in optimal conditions in terms of moistening thanks to redistribution of water flows including snow masses, spring runoff of melting water and sustainable use of fresh ground water.

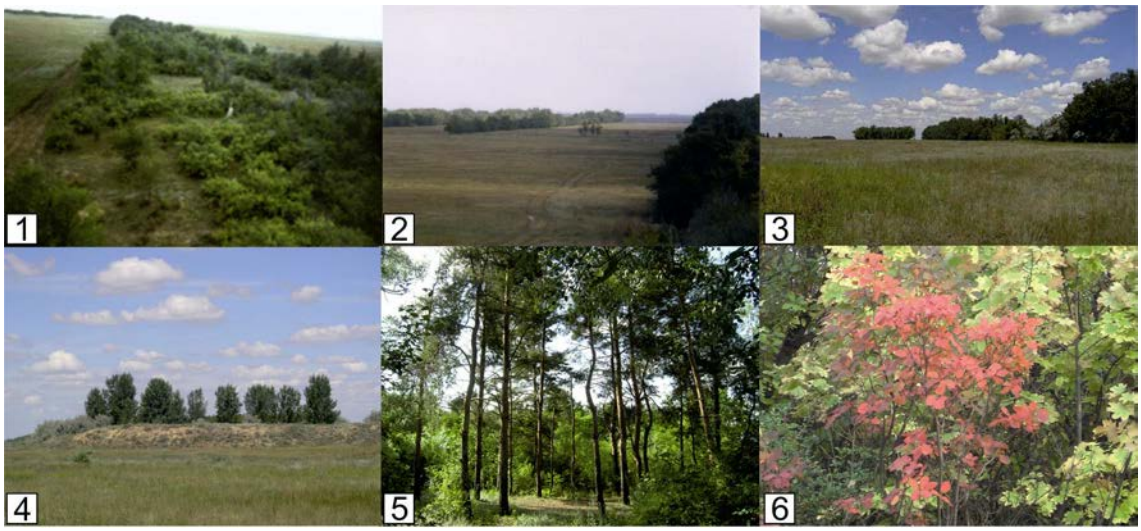


Fig.1. Silvopastoral (1), field-protecting (2), massive (3), small isolated (4), and recreational (5, 6) tree plantations at the Dzhanybek research station in semidesert of the Northern Caspian region

Successful 60-year operation of this agroforestry system can be recommended as a model of environmental evidence-based adaptive management in arid regions characterized by patterned soil and vegetation cover.

5. CONCLUSION

The historical experience of development of arid areas of Russia and Kazakhstan showed to be promising the development of cattle farming in this region. An example of the optimal environmental management in such harsh arid conditions is the 60-year-old Dzhanybek research station of the Institute of Forest Science RAS, with its diverse ecosystems (agroforestry systems, orchads, berry fields, tree plantations, etc.), which was awarded by the Russian government (Decree number 719 of 16 June 1997) with the status of Natural monument of federal importance. A new concept of adaptive environmental management based on the creation of agroforestry systems was suggested for arid regions of Russia and Kazakhstan. Such innovative approach includes the environmentally adjusted technological processes of planning, creatiion, protecting and management of socially significant, low-cost, functionally necessary artificial forest plantations in arid regions. Our approach can be applied in similar natural and socio-economic conditions of the world.

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