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Increasing the efficiency of former agricultural land using

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Abstract. Research an attempt was made to develop a system of economic measures aimed at minimizing damage from a reduction in the area of agricultural land. Lands excluded from agricultural use are divided into 2 groups. The first group includes areas overgrown with woody vegetation. Here it is planned to conduct forestry aimed at growing highly productive sustainable plantings for targeted purposes. The second group consisted of areas where undergrowth taxation indicators do not allow them to be transferred to lands covered with forest vegetation, it is planned to conduct farming taking into account effective soil fertility. If the potential soil fertility does not provide the yield of grain crops equal to the average for the region over the past 3-5 years, this site is recommended to be used to create forest plantations from fast-growing species. In particular, from *Larix Sukaczewii* Dyl. which at the age of 60 provides a stock of stem wood up to 740 m³/ha. Plots with soil fertility that allows to grow grain crops equal to and above the average for the region for the last 3–5 years are subjected to cleaning of woody vegetation and involvement in agricultural turnover.

1. Introduction

The transition of the Russian Federation to market relations in the nineties of the last century has significantly changed the situation in agricultural. Many collective and state forms whose lands were located in the taiga zone went bankrupt. The latter results in termination of agricultural use on a significant area of arable land, hayfields and pastures. According to a number of authors in the period from 2001 to 2011 alone, more than 17 million ha of arable land have been removed from active agricultural use [1].

Most of the former agricultural lands began to be intensively overgrown first with weedy herbaceous and then tree shrub vegetation [2]. The species composition and productivity of created on the former agricultural lands of free and shrub vegetation differ significantly depending on the natural and geographic conditions, on the type used, size of the plot, the physical, chemical and hydrological properties of the soil, the taxation indicators of the adjacent tree stands as well as some other factors. For all this it should be noted that the taxation indicators of the emerging plantations are not always optimal from an economic point of view and therefore there is a need to develop a system of economic measures aimed at activity increasing of former agricultural land utilization in view to minimize damage from their use termination for their intended purposes. This determined the purpose and directions of our research.



2. Methods and Materials

The study is based on the indicator plot method (IPM) with the establishment of the main taxation indicator being formed on former agricultural land [3]. When determining the degree of agricultural land overgrowing with woody vegetation the requirements of the current regulatory documents of reforestation were used [4].

The studies carried out showed that depending on the age of the termination, all former agricultural lands can be divided into 2 groups. The first group includes arable lands hayfields and pastures on which plantations have already been formed, that is in, accordance with regulatory documents, the plots can be transferred to the lands covered with forest vegetation. As a rule, these plantations are represented by mixed stands of seed origin. The average age of the forest stands exceed 20 years and therefore the return of the plots to the original state is associated with significant material costs. Abandoned in the first place agricultural overgrown with wood vegetation are most often characterized by considerable remoteness from small settlements, by fine contour, low soil fertility. When subjected to their return to the agricultural turnover, in addition to stubbing, relgeling of cut out small sized wood and combing out the roots, it will be necessary to take measures to increase soil fertility – i.l. liming and introducing of organic and mineral fertilizers. Taking into account the livestock reduction and the high cost of fertilizers the possibility of these measures performing by agricultural producers is highly doubtful.

A more viable option on former agricultural lands is wood growing. It is necessary at the same time to make an inventory of these lands with drawing up a forest development project. The project must take into account the specifics of the plot location and the inventory indicators of the plantings. So, in particular, on a number of sites located nearby settlements, it is advisable to plan the implementation of recreational activity. In plantations with the participation of small leaved linden (*Tilia cordata* Mill) it is reasonable to plan the placement of apiaries, that is to organize harvesting and collection of non-timber forest resources. The latter unclad the collection of mushrooms, the yield of which on plantations formed on arable land is most often significantly higher than chat in natural plantings of a similar age formed on logged and burned out areas.

In plantations intended for wood growing, a system of thinning should be provided to ensure the cultivation of highly productive sustainable plantations of targeted species composition. Taking into account the seed origin and high quality of soft deciduous wood, it is advisable to plan in the future a selective form of farming [5]. This will make possible to increase overall productivity of plantings.

On former agricultural land plots where undergrowth inventory does not provide a transfer to the lands covered with forest vegetation when planning the use it is advisable to take into account the effective fertility of the soil. By the latter we understand the average potential yield of grain crops. In such a case the calculation is carried out in 2 stages. At first it is established the overase yield of grain crops in the region for the last 3–5 years. Then on the basis of the soil chemical analysis, the potential yield of the soil overgrown with woody vegetation of the site is established. It the potential soil fertility ensures a grain yield below the average in the region over the past 3–5 years, it is not advisable to use the site as an agricultural land. The return of these plots into an arable land will require not only the cost of cleaning it from existing woody vegetation but also for measures to increase soil fertility. In such a case low potential fertility question cost recovery.

It is economically more justified to grow on these plots forest plantations from fast growing tree species. The latter is explained by the fact that woody plants are less demanding for soil fertility than agricultural ones.

3. Results and Discussion

The studies carried out have shown that the artificial plantations of larch (*Larix sukaczewii* Dyl.) at the age of 60 allows to obtain 740 m³/ha of stem wood on the former arable land (table 1).

Table 1. Taxation indicators of artificial 60-year-old larch forest stands on former arable land.

№ plots	Composition	Average		Stand density, pcs/ha	Fullness		Deposit, m ³ /ha
		height, m	DBH, cm		absolute, m ² /ha	relative	
1	100% Larix	28.0	23.2	1272	53.8	1.16	740
2	100% Larix	27.2	25.4	908	45.9	1.01	650
3	100% Larix and single Betula	26.5	23.2	1087	45.8	1.01	630
4	100% Larix and single Betula	27.5	22.9	800	32.9	0.73	450
5	100% Larix	26.9	22.8	1000	40.7	0.90	560

The materials of table 1 indicate that the productivity of artificial larch plantations depends on the density of forest plantations. All indicator plots are characterized by the 1st forest quality index with an average growth of wood from 7.5 to 12.3 m³/ha per year. The stands of all indicator plots are characterized by a good sanitary state and the first class of marketability (figure 1).

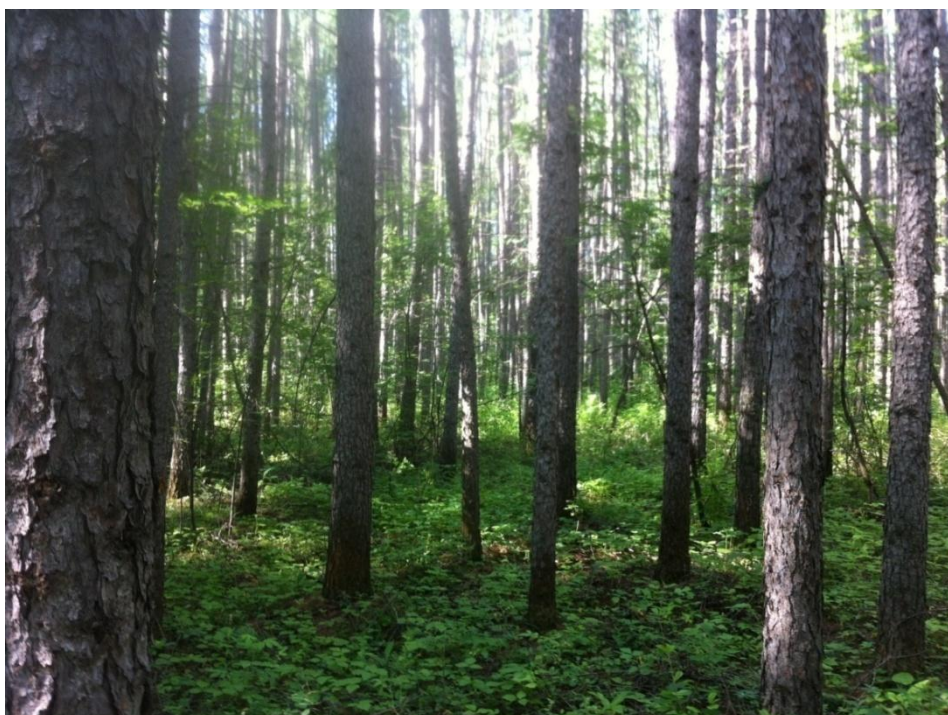


Figure 1. Appearance of an artificial larch plantations on the former arable land (IPM-2).

The main disadvantage of creating artificial plantations on former arable land is the risk of developing foci of root sponges (*Heterobasidion annosum* (Fr.) Brefs. Str.). The latter is due to the forma of a dense plow bottom under the arable horizon which is practically impenetrable for the roots of coniferous tree species. As a result in artificial stands on old arable lands, surface root system is formed. The latter results in coalescence of roots and rapid spreading of root pathogens.

To minimize the danger of root sponge spreading it is advisable use a short feeling turnover which is the most acceptable for plantation forest cultivation. In addition cultivation of mixed stands and rare thinning regime carrying out helps to minimize the risk the foci of root sponge formation. So, we have

surveyed artificial pine plantations of 140-years old that have been formed on the former arable land (table 2).

Table 2. Inventory indicators of 140-years old artificial pine stands created on the former arable land.

№ plots	Composition	Average		Stand density, pcs/ha	Fullness		Deposit, m ³ /ha
		height, m	DBH, cm		absolute, m ² /ha	relative	
1	96% Pinus	32.1	40.6	500	64.7		880
	4% Betula	17.6	13.5	250	3.6		30
	Total			750	68.3	1.7	910
2	98 % Pinus	33.8	39.2	500	60.2		890
	2 % Betula	15.1	12.9	190	2.5		20
	Total			690	62.7	1.6	910

Materials of table 2 indicate a stock of artificial pine stand which is two times higher than that of natural pine forests. At the age of 140 artificial pine plantations created on arable lands are characterized by the first forest class of quality, excellent sanitary conation and the first class of marketability (figure 2).



Figure 2. The appearance of a 140-years old artificial pine plantation created on arable land.

Naturally it is economically inexpedient to grow pine plantations on the former arable land for 140 years. However, the data shown in table 2 indicate the possibility of durable high performance plantations on arable lands.

As woody plants for plantation cultivation on the former arable lands it is ad visible to deciduous species with a short felling turnover. In particular poplars. However we were not succeeded in finding objects of this kind in the middle Urals which testifies to the relevance of lagging out experimental

and experience production plantations of deciduous species types, including forms and varieties of poplars. Plantation cultivation of poplars will allow growing assortments in a very short period in particular deciduous pulpwood. The creation of plantations from silver birch with the aim of growing deciduous pulpwood and plywood raw materials deserves attention. At the same time, the balance can be obtained in the process of thinning and plywood during the felling of mature and over mature stands.

On areas overgrown with woody vegetation in addition to forest plantations it is possible to plan the cultivation of planting material as well as fruits, berries, ornamental and medicinal plants [6]. If farmers have financial capabilities to carry out measures to improve soil fertility then agricultural land overgrown with woody vegetation can be cleared and returned to its original state, that is for growing crops.

On former agricultural lands with effective soil fertility providing grain yield equal or higher than the average grain yield in the region for the last 3–5 years it is advisable to carry out work on cleaning the existing woody vegetation with the subsequent use of agricultural land for its intended purpose.

An individual approach to the use of former agricultural land will make it possible rationally use the vacant lands taking into account their potential fertility, taxation indicators of available tree vegetation and the financial capabilities of agricultural producers. In other words, the proposed option for the use of former agricultural land will ensure minimization of the negative consequences from reduction in the area of agricultural use. Additionally it can be noted that cultivation of both natural and artificial plantings on former agricultural land will allow to obtain a significant amount of demanded wood timber forest products, prevent soil erosions and will also contribute to the deposition of carbon dioxide reducing the danger of greenhouse effect. The last is especially relevant in modern reality.

4. Summary

1. In the Russian Federation there are significant areas of former agricultural land in different stages of overgrowth with woody vegetation.

2. In order to minimize the economical damage from the reduction of agricultural land area, it is advisable to develop a management system taking into account the potential fertility of soils and available woody vegetation.

3. In areas where the inventory of forest stands allows them to be transferred to the lands covered with forest vegetation, it is advisable to form high performance sustainable plantings for the purpose by thinning.

4. On areas overgrown with woody vegetation the ones with low effective soil fertility it is advisable to create forest plantations from fastgrowing species, in particular from *Larix Sukaczewii* Dyl.

5. Plots with soil fertility providing the yield of grain crops above the average yield values for those in the region over the past 3–5 years should be cleared from woody vegetation and involved in agricultural turnover.

6. As for the middle Urals it is necessary to conduct research on the selection of promising types, forms, hardwood varieties for plantation cultivation on former agricultural land.

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