Rational use of natural resources of land resources of the Far East using agrocenoses of grain crops

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Abstract. The article examines the structure of the cultivated areas of the Khabarovsk Territory, reveals the predominance of soybeans. For the rational use of natural resources in the Far East, the varieties of spring oats Express, Tigrovy, Premier, Marshal, Cardinal, Peredovik have been created, which are distinguished by high productivity - 4.4-6.7 t / ha. It has been established that the yield of spring wheat and spring triticale under the conditions of the Khabarovsk Territory is realized practically equally - 2.6 t/ha. It is noted that the need for heat in the sprouting-tillering phase in spring wheat and spring triticale is opposite, which indicates the need to use both crops in agrocenoses of the Far Eastern region.

1. Introduction
A significant increase in negative processes on agricultural land in Russia worsens their quality as a result of disturbance of land by water and wind erosion, salinity and alkalinity, waterlogging and waterlogging of land, the presence of land with acidic and stony soils, unsatisfactory cultural and technical state of natural pastures and hayfields. Degradation affects the entire system of agricultural landscapes in all natural zones, not only in Russia, but all over the world [1-7]. The cultivation of monoculture (soybeans) on the arable lands of the Far East leads to a violation of crop rotation, deterioration of the phytosanitary state of crops, the development of negative processes of agricultural land degradation [8]. In Europe, on the contrary, the cultivation of leguminous crops has led to the spatial division of livestock and fodder production between agricultural areas with a negative impact on the environment [9].

Increasing species diversity through crop rotation is a key approach to achieving sustainability in cropping systems [10]. Crop rotation has a positive effect on sustainable farming practices in several ways, such as improved long-term fertility, overall soil stability, and increased diversity at the landscape level, provided that compatible crop types are ordered [11-13]. Therefore, the choice of crop and variety is the main management option for optimizing crop yields [14]. The aim of the research was the rational use of natural resources of the land resources of the Far East using agrocenoses of grain crops.

2. Materials and methods
The experiments were carried out in 2016-2020 at the Far Eastern Agricultural Research Institute (Russia, Khabarovsk Territory, 135° east longitude, 48° north latitude). The object of research is samples of spring oats, spring wheat (variety Khabarovchanka), spring triticale (variety Ukro). The soil is meadow-brown podzolized gley heavy loamy. The humus content in the arable layer is 3.6-
3.8%, pHsal. - 5.1-5.3 units, hydrolytic acidity - 1.14-2.40 m-Eq. / 100 g of soil, P₂O₅ - 9.9-15.5 mg / 100 g of absolutely dry soil, K₂O - 27.7-30.4 mg / 100 g of absolutely dry soil. The predecessor is black steam. Sowing was carried out with an SSFK-7M seeder. The accounting area of the plots is 4 m², the replication is three times. The seeding rate is 5.0-5.5 million viable seeds per hectare. Counting of the harvest was carried out by the method of plot threshing with a HEGE-125 combine.

Statistical processing of the data obtained was carried out by the method of analysis of variance. Coefficient of variation (V) is a standard measure of variability expressed as a percentage and is defined as the ratio of the standard deviation to the arithmetic mean. The standard deviation (σ) is calculated as the square root of the variance of the random variable. Correlation coefficient (r) is a statistical indicator of the dependence of two random variables.

3. Results and Discussion
In the conditions of the Far East, a significant shortfall in the yield of grain crops was noted. In the structure of the cultivated areas of the Khabarovsk Territory, there is a predominance of soybeans (up to 90%) (figure 1), which indicates the high economic efficiency of the production of this crop. The use of monoculture in the region creates an unfavorable phytosanitary environment. The modern structure of the sown areas of agricultural enterprises of the region needs to be adjusted. Optimization of the grain wedge in the region will solve the problem of selling grain and providing animals with concentrated feed.

![Figure 1. Sown area of agricultural plants in the Khabarovsk Territory.](image)

Oats are widely spread among grain crops in the Far East region. In comparison with wheat and barley, due to biological characteristics, it reduces the yield to a lesser extent when placed on the worst predecessors and when sown at a later date with a protracted spring. During the period of heavy rainfall, oat grain also sprouts less on the vine, which makes it possible to obtain seeds of a higher class. These and other economically valuable characteristics predetermine its important agricultural value. The soil and climatic resources of the Khabarovsk Territory correspond to the maximum extent to the biological characteristics of this particular grain crop. In the structure of sown areas in the period from 2007-2010, 100% of all areas under oats were occupied by the Express variety of spring oats (selected by FIARI), since 2011 - the Premier spring oat variety. In 2019, a new Marshal oat variety was approved for cultivation in the Far East region.

Yield formation is a complex and multi-stage process influenced by external environmental factors. Breeding work in the region is aimed at increasing yields in combination with high resistance to adverse environmental conditions. The maximum yield values were formed by oat varieties and lines in 2019. The excess over the standard oat variety Express ranged from 2.2 to 3.1 t / ha for Marshal, Cardinal, Peredovik and for breeding lines 510-15, 318-14, 352-10, 355-10, 398-26 (table 1).

The indicator of variability of the “yield” trait in varieties and lines of oats, depending on the years of testing under the conditions of the Khabarovsk Territory, varied from low to medium (V = from 6.8 to 19.1%). Oat varieties and lines were the most stable in this trait: Marshal, Peredovik and oat breeding lines: 437-05 and 398-16, their variability index was V <10.
Table 1. Productivity of varieties and lines of spring oats bred by FIARI in comparison with wheat samples Khabarovchanka and triticale Ukro.

| Variety      | 2016 | 2017 | 2018 | 2019 | 2020 | The average | y | V, % |
|--------------|------|------|------|------|------|-------------|---|------|
| Express st   | 3.1  | 5.5  | 4.0  | 5.0  | 4.2  | 4.4         | 0.8| 19.1 |
| Tigrovy      | 4.3  | 6.3  | 4.1  | 6.1  | 5.4  | 5.2         | 0.9| 17.2 |
| Premuer      | 6.1  | 4.2  | 5.9  | 6.3  | 5.3  | 5.6         | 0.8| 13.6 |
| Marshal      | 6.2  | 6.7  | 6.0  | 7.2  | 5.5  | 6.3         | 0.6| 9.2  |
| Cardinal     | 4.9  | 5.5  | 6.5  | 7.2  | 6.4  | 6.1         | 0.7| 11.5 |
| Peredovik    | 5.5  | 6.9  | 6.5  | 7.5  | 6.9  | 6.7         | 0.7| 9.9  |
| 437-05       | 5.9  | 6.8  | 6.2  | 7.3  | 6.9  | 6.6         | 0.5| 7.6  |
| 510-15       | 5.5  | 6.1  | 5.9  | 7.5  | 6.9  | 6.4         | 0.7| 11.3 |
| 318-14       | 5.4  | 6.7  | 5.5  | 7.5  | 6.7  | 6.4         | 0.8| 12.6 |
| 352-10       | 5.8  | 6.6  | 6.2  | 8.1  | 6.5  | 6.4         | 0.8| 11.8 |
| 355-10       | 5.6  | 6.7  | 6.3  | 7.7  | 6.3  | 6.5         | 0.7| 10.6 |
| 398-16       | 6.2  | 6.9  | 6.2  | 7.2  | 6.1  | 6.5         | 0.4| 6.8  |
| Khabarovchanka| 3.0  | 1.5  | 2.3  | 3.8  | 2.3  | 2.6         | 0.9| 33.2 |
| Ukro         | 1.4  | 2.7  | 2.1  | 4.2  | 2.3  | 2.6         | 1.0| 40.0 |

Note: σ is the standard deviation; V is the coefficient of variation.

The yield of spring wheat variety Khabarovchanka and spring triticale variety Ukro under the conditions of the Khabarovsk Territory is realized virtually equally - 2.6 t / ha. The strong variability in yields for wheat and triticale (V>30) indicates an unstable harvest in the region. Each stage in the development of spring wheat and triticale plants is characterized by specific requirements for growing conditions. The limiting factors of the formation of high yields of wheat and triticale in the Far East are meteorological conditions. Calculation of the correlation coefficients between the yield of wheat cultivar Khabarovchanka and triticale cultivar Ukro and the sum of temperatures of the surface layer of air during the germination-tillering period indicates a high degree of dependence (table 2). At the same time, it was found that the need for heat in the germination-tillering phase in spring wheat and spring triticale is opposite.

Table 2. Correlation coefficients between the yield of the Khabarovchanka wheat variety and the Ukro triticale variety and meteorological conditions in the main phases of the growing season.

| Conditions | Variety      | sowing-seedlings | seedlings-tillering | tillering-out into the tube | ear tube exit | earing-wax ripeness |
|------------|--------------|------------------|---------------------|-----------------------------|--------------|---------------------|
| Air temperature sums, °C | Triticale Ukro | -0.446           | 0.623               | -0.222                      | -0.837       | -0.129              |
|             | Wheat        | 0.428            | -0.827              | 0.514                       | 0.284        | 0.115               |
|             | Khabarovchanka |                  |                     |                             |              |                     |
| Credibility (p) | Triticale Ukro | 0.174            | 0.028               | 0.214                       | 0.066        | 0.403               |
| Amount of precipitation, mm | Wheat        | -0.331           | -0.335              | -0.225                      | 0.257        | -0.417              |
| Credibility (p) | Khabarovchanka | 0.456            | 0.247               | 0.271                       | -0.290       | -0.619              |
|              |              |                  |                     |                             |              |                     |

Thus, the conditions for the formation of high yields of spring wheat in the region do not develop every year; therefore, it is necessary to grow spring triticale as an insurance crop for wheat.
4. Conclusion
There is a tendency to decrease the acreage of grain crops in the Khabarovsk Territory in comparison with soybeans. For the rational use of natural resources of agricultural land in the Far East region, there have been created crop varieties of spring oats: Express, Tigrovy, Premier, Marshal, Cardinal, Peredovik. Since the opposite reaction of spring wheat and spring triticale plants to meteorological conditions during critical growing periods has been established, in order to obtain stable productivity in the region, it is necessary to use both crops in agrocenoses of the Far East.

References
[1] Kosolapov V M, Trofimov I A, Trofimova L S and Akovleva E P 2018 Rational nature management and fodder production in Russian’s agriculturale (Moscow) 132
[2] Johanness Wilhelmus, Maria Pullens, Peter Sorensen, Bo Melander and Jorgen Eiving Olesen 2021 European Journal of Agronomy 122 126-169
[3] Rachel A Wieme, Lynne A Carpenter-Boggs, David W Crowder, Kevin M Murpy and John P Reganold 2020 Agricultural Systems 177 102709
[4] Moritz Recklihg, Goran Bergkvist, Christine A Watson, Frederick L Stoddard and Johann Bacchinder 2020 European Journal of Agronomy 112 125951
[5] Dengpan Xiao, De Li Liu, Puyu Feng, Bin Wang, Cathy Waters, Yajun Shen, Yongqing Qi, Huizi Bai and Jianzhao Tang 2021 Agricultural Water Management 246 106685
[6] Jacob M Jungers, Lee H DeHaan, David J Mulla, Craig C Sheaffer and Donald L Wyze 2019 Agriculturale, Ecosystems & Environment 272 63-73
[7] Daniel Plaza-Bonilla, Irene Nogue-Serra, Difier Raffiaillac, Carlios Cantero-Martines and Eric Jastes 2018 Agricultural System 167 92-102
[8] Samarina Yu, Postovitenko K and Knyazeva E 2018 Agricultural sciences 20 3-7
[9] Machele Monti, Antonio Pellicano, Aurelio Pristeri, Giuseppe Badaglicca, Giovanni Preiti and Antonio Gelsimono 2019 Field Crops Research 240 23-33
[10] Alireza Houshmandtar, Noboru Ota, Kadambot H M Siddique and Michael Tausz 2019 Agricultural and Forest Meteorology 275 277-282
[11] Dawit Ashenafi Ayalew, Detlef Deumlich and Borivoj Sarapatka 2021 European Journal of Agronomy 123 126203
[12] Ruiyuan Li, Miaoqing Xu, Ziyue Chen, Bingbo Gao, Jun Cai, Feixue Shen, Xianglin He, Yan Zhuang and Danlu Chen 2021 Soil and Tillage Research 206 104838
[13] Lindsay A Chamberlin, Marian L Bolton, Madison S Cox, Garret Suen, Shawn P Conley and Jean-Michel Ane 2020 Applied Soil Ecology 154 103603
[14] Sara Minoli, Dennis B Egli, Susanne Rolfinski and Christoph Muller 2019 Global and Planetary Change 174 35-46