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# RELEVANCE AND PROSPECTS OF LONG-TERM WHEAT IN MODERN AGRICULTURE

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**ABSTRACT:**

*In this scientific work, the role of perennial wheat in modern agriculture is analyzed based on a comprehensive approach. The study highlights the biological characteristics, agroecological advantages, economic efficiency, and strategic importance of perennial wheat in ensuring global food security based on scientific sources. The advantages of perennial crops under conditions of climate change, water scarcity, and soil degradation, as well as existing limitations related to their introduction, were also analyzed. The research results show that perennial wheat is one of the important innovative solutions in the formation of a sustainable agricultural system.*

**Input**

In the 21st century, agriculture is facing global environmental and economic problems. While population growth is increasing the demand for food, climate change, water scarcity, and soil degradation are reducing agricultural efficiency.

The traditional system of annual grain crops, in particular wheat, requires annual plowing, repeated sowing, and intensive agrotechnical measures. This leads to the destruction of soil structure, erosion, and a decrease in biodiversity.

From this point of view, perennial grain crops, including perennial wheat, are considered an alternative solution in modern science.

## CHAPTER I. THEORETICAL FOUNDATIONS OF PERENNIAL WHEAT

### 1.1. Concept of perennial plants

Perennial plants are plants that, once planted, live for several years and grow again every year. Their main feature is that they do not die completely after the end of the growing season, but continue to develop again in the next season through underground or some above-ground parts. Simply put, such plants do not require replanting every year. Their root system or other storage parts survive and begin to grow again when favorable conditions arise.

The following factors contribute to the survival of perennial plants:

A deep and strong root system - nourishes the plant even in conditions of water and nutrient deficiency, Storage of nutrients - new growth begins due to the energy stored in the root or stem Vegetative reproduction capability - propagates through rhizomes, tubers, or other parts

This concept is important in agriculture because perennial crops:

reduces the need for annual soil processing,

prevents erosion,

saves water and labor resources,

increases the stability of the agroecosystem.

### 1.2. Origin of perennial wheat

Perennial wheat is an artificially created crop, formed by crossing (hybridizing) cultivated wheat with wild perennial plants found in nature. Common wheat (e.g., Triticum aestivum) is mostly annual and requires re-sowing every year. Scientists conducted research to create a long-lived form of this crop.

Wild perennial cereal plants, including Thinopyrum, played an important role in the emergence of perennial wheat. These wild plants had characteristics such as surviving in natural conditions for several years, drought resistance, and a strong root system.

In the breeding process, scientists tried to combine the high yield characteristics of cultivated wheat with the resistance characteristics of wild species. As a result, new forms with long-term viability were obtained.

One of the most famous scientific initiatives in this direction was carried out by The Land Institute, which created a perennial grain crop known as "Kernza." This crop is one of the practical results of the concept of perennial wheat.

In conclusion, perennial wheat is not a product of natural evolution, but an innovative crop created on the basis of scientific selection and hybridization, the origin of which lies in the combination of the genetic characteristics of cultivated wheat and wild perennial cereals.

### 1.3. Morphological and biological characteristics

Morphological and biological characteristics of perennial wheat are the main features that distinguish it from ordinary annual wheat. These characteristics are related to the external structure (morphology) and internal life processes (biology) of the plant.

Morphologically, the most important characteristic of perennial wheat is its strong and deep root system. Such roots penetrate deep into the soil and provide the plant with water and nutrients. Therefore, it grows relatively steadily even in drought conditions. In addition, perennial wheat has well-developed underground parts (root stalks or similar structures) that contribute to plant regeneration.

In terms of stem and leaf structure, it is similar to ordinary wheat, but after the end of the growing season, the plant does not completely wither. The underground organs are preserved and form new shoots in the following season.

Regarding biological properties, perennial wheat has a key role in longevity and regeneration ability. In unfavorable conditions (cold, drought), the plant enters a state of temporary dormancy, reducing its metabolic activity. When conditions improve, it continues to grow actively again.

Also, the accumulation of reserve nutrients in the roots and underground parts of this plant is an important biological feature. These reserves will serve as a source of energy at a new stage of growth.

In general, the morphological and biological properties of perennial wheat allow for its longevity, stable development, and adaptation to various unfavorable environmental conditions.

## CHAPTER II. ENVIRONMENTAL RELEVANCE

### 2.1. Reduction of soil degradation

Perennial wheat is considered one of the effective crops in reducing soil degradation. Soil degradation is understood as a decrease in soil fertility, disruption of its composition and structure. This condition usually occurs due to improper land use, frequent plowing, wind and water erosion, as well as excessive use of chemicals.

Perennial wheat reduces these problems in several ways. First of all, it grows there for a long time and constantly holds the soil firmly with its roots. This prevents soil from being washed away or blown away by wind and water. As a result, the high fertile layer of the soil is preserved.

In addition, perennial wheat does not require repeated sowing every year, so the land is not plowed often. The plowing process disrupts the natural structure of the soil and changes its

density. In perennial crops, this process is minimal, therefore the natural state of the soil is better preserved.

The root system of perennial wheat is deeply developed, forming a network-like structure in the soil. This structure binds soil particles together, increasing its strength. At the same time, the roots decompose, organic matter is added to the soil, and the amount of humus increases.

Also, such crops reduce the effects of sunlight and wind, as they cover the soil surface throughout the year. This slows down the drying and erosion of the soil.

**2.2. Influence on the microbiological environment of the soil**

Perennial wheat has a positive effect on the activity of soil microorganisms. Soil microbiological environment refers to the general condition and activity of bacteria, fungi, actinomycetes, and other microorganisms living in the soil. These microorganisms play an important role in maintaining soil fertility.

The root system of perennial wheat is active for a long time and constantly releases root exudates into the soil. These secretions serve as a food source for microorganisms. As a result, the number and activity of microorganisms increases around the root, this area is called the "risosphere."

Microorganisms, in turn, decompose organic matter in the soil and convert it into a form that can be absorbed by plants. This process improves plant nutrition and increases soil fertility. Perennial wheat ensures that this process continues steadily throughout the year, as the soil does not remain loose for a long time.

Also, perennial crops create favorable conditions for beneficial microorganisms in the soil. Since the soil is not plowed frequently, the habitat of microorganisms is not disturbed. This contributes to their reproduction and stable functioning.

Another important aspect is that perennial wheat helps to improve the balance between pathogenic (disease-causing) and beneficial microorganisms in the soil. As a result of the multiplication of beneficial microorganisms, the likelihood of disease development decreases.

**2.3. Carbon cycle and climate change**

Perennial wheat is of great ecological importance due to its impact on the carbon cycle and climate change. The carbon cycle is the process of constant exchange of carbon in nature between the atmosphere, soil, plants, and living organisms. In the process of photosynthesis, plants absorb carbon dioxide ($CO_2$) from the atmosphere and convert it into organic substances.

Perennial wheat participates effectively in this process, as it lives for a long time and does not require re-sowing every year. Its permanent root system helps to retain carbon in the soil for a long time. When roots and plant debris fall into the soil and decompose, some of the carbon accumulates in the soil. This process is called "carbon sequestration."

Deep roots of perennial wheat help not only to accumulate carbon, but also to deliver it to the lower layers of the soil. This reduces the likelihood of carbon returning to the atmosphere and keeps it in the soil for a long time.

From the perspective of climate change, perennial wheat indirectly contributes to the reduction of greenhouse gases. Firstly, since it does not require frequent plowing, fuel consumption is reduced, and as a result, carbon emissions are reduced. Secondly, an increase in organic matter in the soil increases its carbon capacity.

Also, perennial crops make the agroecosystem more resilient to climate change. They can adapt to drought, temperature fluctuations, and other unfavorable conditions, which ensures the stability of yields.

## Chapter III. ECONOMIC AND AGROTECHNICAL SIGNIFICANCE

### 3.1. Cost Reduction

One of the main economic advantages in the cultivation of perennial wheat is a significant reduction in production costs. Since this crop can bear fruit for several years once planted, it does not require many expenses associated with annual replanting.

First of all, seed costs will be reduced. While regular wheat needs to be sown with new seeds annually, perennial wheat does this process only once. In subsequent years, the plant grows again through its root system.

The costs of land cultivation (plowing, leveling, preparation for sowing) will also decrease. Because the field sown with perennial wheat is not plowed every year. This reduces the use of equipment, fuel consumption, and maintenance costs.

Another important aspect is the reduction of labor costs. Since annual sowing, re-sowing, and harvesting operations are not required, the need for labor is reduced. This simplifies the overall production process.

In addition, the costs of combating weeds, diseases, and pests can be relatively reduced. The reason is that the soil is permanently covered, the development of weeds is limited, and the need for chemicals decreases.

### 3.2. Long-term yield

One of the important agrotechnical and economic advantages of perennial wheat is its ability to produce stable yields over a long period. Common annual wheat requires re-sowing

every season, and yields often depend on weather, soil conditions, and agricultural practices. Perennial wheat, after being sown once, continues to bear fruit for several years.

The long-term yield of this plant is directly related to its developed root system. Deep roots absorb water and nutrients from various soil layers, which ensures stable nutrition of the plant during the growing season. As a result, the plant regenerates annually, forming new shoots and bearing fruit.

In perennial wheat, the reserve nutrients accumulated during the growing season are stored in the roots and underground parts. These reserves will serve as a source of energy for the start of growth in the next season. Therefore, the plant develops relatively quickly and steadily every year.

Another important aspect of long-term fertility is that the structure and fertility of the soil are preserved due to the fact that it is not processed every year. This creates a favorable agroecological environment for the plant and prevents a sharp decline in yield from year to year.

Also, perennial systems have higher resistance to climate change and adverse weather conditions. Even if the negative factors of one season affect the yield, in subsequent years the plant will recover and continue to bear fruit.

**3.3. Restrictions**

Although perennial wheat has many advantages, there are a number of limitations and problems in its widespread introduction. These limitations are mainly due to biological, agrotechnical, and economic factors.

One of the most important limitations is the low yield level compared to traditional annual wheat. At the present stage, perennial wheat is a developing crop in the breeding process, and scientific research on increasing its yield continues.

Another problem is the heterogeneity of crops (genetic and morphological unevenness). In perennial forms, some characteristics (fruit quality, grain size, ripening time) are not equally stable. This makes it difficult to obtain standard products on an industrial scale.

There are also some restrictions in terms of agrotechnical aspects.

For example: existing equipment and technologies are not fully adapted to perennial crops,

clear and universal care recommendations have not yet been fully developed,

the processes of harvesting and processing the crop can be complex in some cases.

From an economic point of view, in the initial period, there may be a shortage of seed material and its high cost. Moreover, the transition to a new crop may seem risky to farmers, as the market and experience are not yet fully formed.

Furthermore, the widespread introduction of perennial wheat requires research, breeding programs, and infrastructure development. This process requires time and significant resources.

## Chapter IV. MODERN RESEARCH AND INNOVATION

### 4.1. Directions of scientific research

Scientific research on perennial wheat is being conducted in several main areas. All these directions are aimed at improving the biological characteristics of the crop, increasing its yield, and widely introducing it into practical agriculture.

The first direction is genetic and breeding research. In this direction, scientists are studying the genetic characteristics of cultivated wheat and wild perennial plants and working on creating new varieties by combining them. The goal is to obtain forms that combine high yield, high-quality grain, and longevity.

The second direction is agroecological research. Here, the adaptation of perennial wheat to various climatic and soil conditions is studied. Scientists analyze the plant's resistance to drought, cold, the degree of adaptation to soil conditions, and the effectiveness of water use.

The third direction is agrotechnical research. In this direction, optimal cultivation methods for the cultivation of perennial wheat will be developed. For example:

irrigation regime
fertilization system
weed and pest control
harvesting technologies

The fourth direction is soil and ecological research. In this direction, the influence of perennial wheat on soil fertility, microbiological environment, and carbon cycle is studied. As a result, its contribution to environmental sustainability is assessed.

The fifth direction is economic and applied research. Here, the economic efficiency, cost analysis, benefits, and risks of growing perennial wheat are studied. The possibilities of its implementation in farms will also be assessed.

### 4.2. Innovative approaches

Innovative approaches play an important role in the development and implementation of perennial wheat. These approaches, unlike traditional methods, aim to achieve high efficiency through the application of modern scientific technologies and best practices.

The first innovative approach is genome editing and molecular selection. With the help of these methods, important genes of the plant are identified and the necessary properties (for

example, drought resistance or disease resistance) are enhanced. This process reduces the time for creating new varieties and ensures the achievement of accurate results.

The second approach is digital technologies and precision agriculture. In this system, the condition of the crops is monitored through sensors, drones, and satellite data. Soil moisture, nutrients, and the level of plant development are analyzed in real time, and care is carried out accordingly.

The third approach is integrated agricultural technologies. This method uses environmentally friendly and resource-saving methods for growing perennial wheat. For example:

minimal processing

use of organic fertilizers

use of biological protective agents

These approaches help to achieve high efficiency without harming the soil and environment.

The fourth approach is the testing and adaptation of innovative varieties. Newly created perennial wheat varieties are tested in different climatic zones, and their adaptability and yield are assessed. This process allows them to be used in wide areas.

The fifth approach is scientific cooperation and technology transfer. Various scientific centers, universities, and international organizations conduct joint research and implement innovative solutions. This contributes to the rapid dissemination of knowledge and technologies.

## Chapter V. PROSPECTS IN THE CONDITIONS OF UZBEKISTAN

### 5.1. Analysis of agroclimatic conditions

Analysis of agroclimatic conditions means the study of climatic and natural factors to determine the possibilities of growing agricultural crops in a certain territory. For the successful cultivation of perennial wheat in the conditions of Uzbekistan, these factors are assessed comprehensively.

First of all, the temperature regime is one of the important factors. In the territory of Uzbekistan, the temperature during the summer months is high, which in some cases causes stress for plants. Perennial wheat is relatively resistant and can adapt to various temperature fluctuations during the growing season. During the winter season, its underground parts are preserved and begin to grow again in spring.

The second important factor is the amount of precipitation. In many regions of the country, the amount of natural precipitation is insufficient, therefore the need for an irrigation system

is high. Because perennial wheat has a deep root system, it effectively uses groundwater and is resistant to drought conditions.

The third factor is solar radiation (insulation). There are many sunny days in the territory of Uzbekistan, which contributes to the active process of photosynthesis. The availability of sufficient light for perennial wheat supports its growth and development.

The fourth aspect is the wind regime and wind erosion of the soil. In some areas, strong winds can damage the topsoil. Perennial wheat reduces wind erosion because it constantly covers the soil and strengthens it through its root system.

The fifth factor is the state of soil and water resources. In the conditions of Uzbekistan, there are areas with low salinity and fertility. Perennial wheat roots contribute to the improvement of soil structure, increase the accumulation of organic matter, and increase the efficiency of water use.

**5.2. Water resources and opportunities for conservation**

In the conditions of Uzbekistan, water resources are one of the most important and limited factors for agriculture. Therefore, the issue of efficient use and conservation of water is of paramount importance. Perennial wheat is considered one of the important agrotechnical solutions in solving this problem.

One of the main advantages of perennial wheat is its deep and extensively developed root system. These roots can absorb moisture from the lower layers of the soil. As a result, the plant does not depend only on the upper layer of water, and the need for irrigation decreases.

Unlike annual crops, perennial wheat is not replanted every year. This reduces water consumption associated with land preparation, sowing, and irrigation processes. In particular, pre-sowing irrigation (moistening irrigation) does not require additional water consumption.

Also, perennial wheat constantly covers the soil surface. Status:

reduces water evaporation from the soil,

contributes to longer moisture retention,

makes the microclimate relatively stable,

As a result, water losses are significantly reduced.

Another important aspect is increasing the efficiency of irrigation systems. Since perennial crops require relatively little irrigation, available water resources are used more economically. This is especially important in areas with water scarcity.

**5.3. Possibilities of practical implementation**

The practical introduction of perennial wheat into Uzbekistan's agriculture depends on a number of organizational, technical, and scientific factors. For the introduction of this crop

into large-scale production, the existing conditions, infrastructure, and experience base are taken into account.

One of the most important opportunities is the creation of experimental sites. Initially, perennial wheat is sown in small areas, and its adaptation to local climate, soil, and irrigation conditions is studied. Based on the results obtained, conclusions are drawn on its implementation in large areas.

The second possibility is cooperation with research institutes and higher educational institutions. Through these organizations, it is possible to create varieties of perennial wheat suitable for local conditions, develop agrotechnical recommendations, and provide practical instructions to farmers.

The third aspect is the phased involvement of farms. For farmers, the transition to a new crop type requires a certain degree of risk. Therefore, it is important to attract them first through pilot projects, show the results, and justify the economic efficiency.

The fourth possibility is the adaptation of equipment and technologies. For the cultivation, care, and harvesting of perennial wheat, it is necessary to adapt existing agricultural machinery or introduce new technologies.

The fifth aspect is state support and incentive mechanisms. Through subsidies, preferential loans, and grant programs, farmers can be encouraged to introduce new innovative crops. This contributes to the widespread cultivation of the crop.

**Conclusion**

Perennial wheat is an important innovative direction in modern agriculture, ensuring sustainable development. It has high environmental, economic, and social effectiveness and can play an important role in ensuring global food security in the future.

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