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## **STRATEGY OF DEVELOPMENT AND IMPLEMENTATION OF CROP ROTATIONS IN UKRAINE (PART 1)**

**Introduction of problem.** Changes of farming systems in the historical context of their development and improvement were determined by changes in industrial relations and hydrothermal conditions of those periods. The extensive farming system is ineffective and does not prevent the degradation of soil fertility and enhancing both water and wind erosion.

Taking into account all positive achievements of old farming systems the strategy of development of modern farming systems need to be based on the new approaches to land use. In particular, it is essential to take into account its specific agricultural and environmental features in the production of agricultural products depended to its quality and quantity for environmentally and economically effectiveness in accordance with market requirements, logistical and natural resources, agricultural landscapes. Each subsequent farming system characterized by the increased energy consumption, which is also characteristic for modern farming systems, with their high scientific and technical level. Recently, in the science and practice many terms have appeared that determine the characteristics of agriculture systems. The modern farming systems include industrial (intensive), soil protective, environmental, biological (organic), no-till system and so on.

Modern farming systems provide growth of crops productivity, restoring, preserving and improving of soil fertility by means of measures and intensification of agriculture – rational use of crop acreage structure and intensive crop rotation, high-productive crops and their varieties, advanced methods of soil cultivation, use of fertilizers, weeds, diseases and pests control preparations, the implementation of soil and the environment protection from destruction and pollution, introduction of new equipment and technologies, intensive cultivation techniques of crops. The main task of modern

agriculture is to provide the population with quality and safe human food, animal - feed, and industry – with raw materials. Therefore, farming systems should be energy-efficient, low-cost, environmentally safe, soil protective and high productive.

At the end of the second and beginning of the third millennium in most countries more and more attention is paid to the development of alternative environmentally friendly farming. It's strategy requires the development, improvement, further development and innovation of individual units zonal farming systems. Among them, one of the major components are crop rotation.

The role of crop rotation in modern agriculture due to the biological characteristics of field crops. Various plants or group of similar crops require varying conditions of water or soil nutrient regimes, while affecting the properties of the latters. The technological importance of crop rotation is correct alternation of different biological requirements of its plants, in which the best conditions are created for growth of each culture, it's development and high productivity.

Crop rotation provides a dual impact. Due to the rotation the crop can better used not only nutrients but also moisture, because plant roots penetrate to different depths. In addition, some cultures, for example beans, are able to provide the soil with nitrogen – after these crops the soil is not depleted, and vice versa – fertile. One of the major objectives of the rotation – to provide a particular crop the best conditions for growth and development and establish the conditions for growing the next culture.

At the same time the permanent crop growing dramatically reduces productivity, soil fertility, affects the phytosanitary status of soils and crops when comparing with the inclusion of crops into rotation. Introduction to rotation the crops, which differ in terms of sowing and harvesting, development character, different ways of care techniques, promotes uniform distribution during the year and rational use of means and labor. Properly prepared and introduced crop rotation is important for improving the farming culture, increasing crop yields and profitability of agriculture.

**Analysis of recent researches and publications.** The analysis of yields of major crops, including cereals, for the past 20 years shows that the biological potential of varieties and hybrids realized only by 40-75% because the varieties or hybrids of some crops content only biological productivity potential of a particular culture, and implement it is only possible in the real field conditions due to optimized cultivation techniques based on soil and climatic resources [4, 7, 14, 16, 18].

The current level of farming and market production conditions require the placement of crops in rotations that would lead to increased productivity of every field crop, stabilization of soil fertility, improving phytosanitary condition of soil and crops, to satisfy the needs of the market, did not violate the environmental sphere [1 2, 3, 6, 8, 13, 15, 17].

Of course, it is difficult for the manufacturer to determine what crops will be grown in rotation and the method they rotate. But there are general principles that can help him at an early stage. In particular, crop rotation sequence without efficient or desired interval between crop fields become an obstacle to change the types of pests, diseases and weeds and minimize the possibility of developing resistant, tolerant or adapted species, since each species has its own “survival strategy”; the development of livestock becomes easier to diversify crop rotations through the use of feed and forage crops, and occupied fallow that increases the possibility of controlling the intensity of crop rotation; rotation should be dynamic, combined and scientifically based. Used crop rotation should be dynamic and change as changing market, environment, soil, climate and economic conditions. You can create many variations of rotation, but the reasons are always needed in their implementation [5, 9, 10, 11, 12]. Since the agrometeorological conditions of cultivation of field crops experienced changes with climate changes, so it is important to assess the impact of conditions of vegetation on productivity and gross yield of each crop depending on its place in rotations with different duration.

**Goals, objectives and methods of research.** The purpose of research is the development, improvement and innovation of agro-ecological and biological basis of efficiency increase of scientifically based crop rotations with different duration depending on soil and climatic conditions with different saturation, ratio and placement of cereals, industrial and forage crops. These principles would promote to increase and stabilize soil fertility; increase the level of quality, diversified crop production by reducing the cost of its production and achieving ecological safety of the environment.

Many years - researches were performed in the field of long stationary experiments on typical chernozem on zone of unstable humidity at former Drabiv experimental station and Panfily experimental station NSC “Institute of Agriculture NAAS.” In addition, due to the land reform and the creation of new groups in the agricultural sector of Ukraine (public, rent and private) in the late twentieth and early twenty-first century. Scientific institutions were

focused on keeping fixed research, the focus of which was to study on different soil and climatic zones efficiency of crop rotations with different duration, including specialized crop rotations with short rotations and impact on soil fertility and efficient use of arable land.

Implementation of research programs took place in accordance with the methods [3], making it possible to obtain reliable data and depending on the crop acreage in rotation structure, their type and kind, soil fertility, phytosanitary soil and crop conditions and productivity of crops and some agrophytocenoses and rotation.

**Results.** On typical chernozem at Cherkassy experimental station of NSC “Institute of Agriculture NAAS” 10-fields rotation with cereals saturation 70%, including 30% of winter wheat, 20% peas or soybeans, 20% corn and 20% of sugar beet, 10% corn silage provides grain yield 5.0 t / ha, 10.4 t / ha of fodder units, 0.76 t / ha digestible protein. Net income is 2.9 thousand. UAH. / ha, profitability 106% .

A highly intensive crop rotation consists of 5 fields and is saturated by cereals to 80% (20% of winter wheat, 20 peas or soybeans, 40 – maize and 20% of sugar beet. Grain yield is 6.0 t per 1 ha of arable land, 10.0 t / ha of fodder units and 0.62 t / ha digestible protein. Conventionally net profit reached 3.0 thousand. UAH. / ha, 137.4% profitability.

The 4-fields grain-crop rotation is noteworthy with 50% saturation of grain (25% winter wheat and the same, 25% maize), 25% of sugar beet and annual grasses. It provides grain yield 6.04 t / ha, 10.46 t / ha of fodder units, 0.83 t / ha of digestible protein, 2.5 thousand UAH, conditional net income, profitability on 88.3% .

The high yield of grain crops on Panfyly Experimental Station of NSC “Institute of Agriculture NAAS” was achieved in 4-fields rotation with 100% saturation of grain (25% peas or soybeans, the same for winter wheat, corn and barley) – 5,03-5,28 t / ha. Here conventionally net profit reached 5.1 thousand UAH./ha. Priority for these indices belongs to three-field crop rotation with 100% saturation of cereals (66.7% and 33.3% soya), which received the highest yield of forage grains – 4.90 t / ha. However, the lowest productivity and economic efficiency were obtained at two-field rotation.

For farms with different directions of specialization there are developed 7-10-field crop rotation saturated by grain crop to 60-100% , providing a yield of cereals 5,0-6,1 t/ha, 2,3-3,2 thousand UAH/ ha net profit and 87-112% profitability. In rotations with short duration 3-4-5-field with 40-100% saturation by cereals yield of grain is 6,0-

6,5 t / ha, net profit 2,5-2,9 thousand USH / ha, rate of profitability 88, 3-137,4%. Food units yield reaches 10,5-11,0 t / ha, digestible protein – 0,75-0,90 t / ha. Saturation of rotation to 40% maize on grain, 20% sunflower, rape and soybeans both – 20% increased energy efficiency ratio to 5,3-5,5 units. Among rotations with short duration on typical chernozem the advantage remains at 4-5- fields of crop rotations where 80-100% is maize and three-field crop rotation with soybeans and maize.

Placing crops after the best predecessors is complicated in specialized crop rotations, which are characterized by a high concentration of certain cultures. In such cases, it is appropriate reasonable compromise that will provide stable agrosystem productivity: limited saturation, guaranteeing acceptable rotation frequency of demanding crops, the right mix for their compatibility, additional techniques that improve alternation (intermediate crops, mineral fertilizers, green manure and others). When the need for rotation we can have 75-100% cereals, properly combining of winter crops (20-30%), maize, barley, oats, soybeans, canola and other crops without reducing their productivity. Illegal is over-saturation of crop rotations by self-incompatible sensitive crops such as sunflower, flax, lupine, which demand for optimal return period.

Summary of studies in different soil and climatic zones of Ukraine shows that when the terms of the optimal parameters rotation saturation by cereals, technical and forage crops and rational placement after predecessors are done, yield of crops depends on the set (particles) in their rotation, and the ratio in groups of crops, different on their biological properties and cultivation technology on the basis of crop interchange.

The optimal level of saturation crop rotation by cereals, considering the need for growing another crops (technical – sugar beet, sunflower, oil – canola, flax, soybean, forage – perennial and annual grasses etc.) in the Steppe and Forest-steppe is to 60% (30% of winter wheat and 30% of spring cereals, legumes and maize), in Polyssya – 50-55% (30-35% of winter cereals, 20% of spring cereals, legumes and maize). In Steppe and Forest-steppe saturation by specialized crop rotation crops can reach 70-80-100% due to an increase in the Steppe area of maize, soybeans, barley, the Forest-steppe – maize, barley and soybeans. The share of crop rotations in winter is 20-30%; maize – 30-40, legumes – 20-30, barley 20-30%). In the Steppe rotation saturation by wheat to 40% is possible if there is it's placement after the best precursors (black

and full fallows, legumes), and 50% with the presence in rotation of two black fallow fields and one field of full fallow. Based on years of researches there were recommended for industrial and farm production scientifically based principles of rotations constructing of both types, and different types and sorts of crop rotations (from 3-5 to 6-10-fields). They respond appropriately to account for land reform and consider zoning areas: Steppe, Forest-steppe, Polyssya, areas of the Carpathians, Transcarpathia, Crimea lowlands, including irrigation and drained lands. They paid enough attention to crop rotation with vegetable crops, soil and crop protective rotations, optimizing structure of crop acreage and crop rotation system through mathematical designing. Developed and recommended rotations with different duration types and systems for appropriate crop rotation systems and structure of crop acreage, a different set, and placement ratio that produces high quality products (grain, oil, raw material of sugar beet, fodder) and leads to high productivity of arable land. There are recommended cereal – fallow – row tilled crops rotation for farms in Steppe and north-east Forest-steppe of grain specialization; cereal, cereal-row tilled crops, crop interchanging, row tilled crops rotations – for farms with livestock and grain developed specialization in all areas of Ukraine.

It should be noted that considering the soil and climatic conditions of Ukraine zoning, adaptive farming systems have to be developed and implemented, which provide not only efficient use of arable land, but any and all farmland. A characteristic feature of such farming systems is their high technological level, the widespread use of intensive crop rotation, high productive crops and their varieties, advanced tillage technologies, fertilization, weed control measures, plant protection of diseases and pests, environment protection from destruction and pollution, soil conservation, introduction of new equipment and techniques of intensive crops cultivation.

The organization of the farm land and crop rotation should be the basis that integrates all parts of any farming system together. In different areas of the country, depending on soil and climatic conditions the fixed ratio between the areas of land (arable land, meadows, pastures, forests, water, etc.) is not the same. In the southern part with high level of plowed land the arable land dominated, while in the northern part there are not substantial benefits of this component against forest, natural feeding grounds.

*Розглянуто стратегію розроблення й інновації різноротаційних сівозмін, обґрунтовано відповідну структуру посівних площ з урахуванням ґрунтово-кліматичних умов та спеціалізації господарств України. Наведено окремі ефективні принципові схеми сівозмін різної ротації, що відповідають сучасним системам землеробства і запроваджуються в господарствах, які стали найефективнішими за показниками виробництва. Визначено перспективи подальших досліджень у напрямі поглиблення основ розроблення сівозмін.*

**Ключові слова:** сучасні системи землеробства, різноротаційні сівозміни, структура посівних площ, чергування культур, різне насичення, інновації, форми господарювання.

*Рассмотрено стратегию разработки и инновации разноротационных севооборотов, обосновано соответствующую структуру посевных площадей с учетом почвенно-климатических условий и специализации хозяйств Украины. Приведены некоторые эффективные принципиальные схемы севооборотов различных ротаций, соответствующих современным системам земледелия и внедряемых в хозяйствах, которые стали наиболее эффективными по всем производственным показателям. Определено перспективы дальнейших исследований, дано предложение по улучшению форм хозяйственной деятельности.*

**Ключевые слова:** современные системы земледелия, разноротационные севообороты, структура посевных площадей, чередование культур, разное насыщение, инновации, формы хозяйствования.

*The strategy of development and innovation of crop rotations with different durations, the satisfying structure of sown areas regarding soil and climatic conditions and farms specialization in Ukraine are examined. There are shown some effective principle crop rotation schemes of different duration met the modern agricultural systems and introduced in the farms which had achieved the most effective productive parameters. The prospects of further studies are determined on the direction of deepening the researches of crop rotations development.*

**Keywords:** modern farming systems, crop rotations with different durations, structure acreage, crop rotation, different saturation, innovation, forms of management.

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