

ABSTRACT

of the dissertation work by Duman Zhuniskhan entitled “Ways of obtaining two or three harvests per year, in the conditions of the South of Kazakhstan”, submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy (PhD) in the educational program 8D08101 “Agronomy”

Relevance of the Research Topic. In his Address to the People of Kazakhstan dated September 8, 2025, entitled “Kazakhstan in the Era of Artificial Intelligence: Current Challenges and Their Solutions through Digital Transformation,” Kassym-Jomart Tokayev emphasized the need to elevate the agricultural sector to a new level. Long-term dynamic growth of the agro-industrial complex is no longer possible without the accelerated development of applied agricultural science. One of the key factors for the sustainable development of the agro-industrial sector is solving water-related problems. He noted that water is a strategic resource, and without water there is no life. Therefore, this sector must become one of the priority areas for agricultural development. Even now, the country is facing a shortage of natural water resources, while the level of rational water use remains insufficient. In agriculture, water-saving technologies are being introduced at an inadequate pace and without significant results. Irrigated lands and irrigation water are used inefficiently, and in many regions water-intensive crops continue to be cultivated.

To address the above-mentioned challenges, it is necessary to develop scientifically grounded approaches for the intensive use of irrigated lands and irrigation water in the irrigated zones of southern and southeastern Kazakhstan. Through the introduction of water-saving technologies and the efficient use of irrigation water, the area of irrigated land should be increased to 2.5 million hectares by 2030. On irrigated lands, many crops occupy fields for only 50–60% of the favorable growing season. The summer–autumn vegetation period, which lasts 90–120 days in the southern regions of the country, is utilized only minimally. As a result, enormous amounts of solar energy and irrigation water are irretrievably lost. Therefore, it is necessary to select suitable crops for both main and intermediate sowings and to ensure the intensive use of irrigated lands.

In connection with the above-mentioned agricultural development programs of the Republic, particularly in irrigated farming, the development and implementation of new resource-saving and water-saving innovative technologies that contribute to the efficient and intensive use of irrigated lands represent an urgent scientific and practical problem.

The hydrothermal conditions of the southern and southeastern regions of Kazakhstan, where irrigated agriculture is well developed, make it fully possible to utilize irrigated lands efficiently throughout the year. However, in practice, farmers and peasant farms do not fully exploit these opportunities. For instance, after the harvest of winter wheat and early spring crops, a considerable amount of time remains available for the cultivation of intermediate crops.

Aim of the Dissertation Research:

To determine the bioclimatic potential of the region, to study the biological characteristics of crops cultivated on irrigated lands in southern and southeastern Kazakhstan, and to identify the most suitable crops for main and intermediate sowings that ensure the guaranteed production of two to three harvests per year from the same land area.

Research Objectives:

To achieve the stated aim, the following objectives were defined:

1. To monitor the hydrothermal conditions of southern and southeastern Kazakhstan that are suitable for obtaining two to three crop harvests per year;
2. To determine the required sums of active temperatures for the maturation of agricultural crops cultivated on irrigated lands;
3. To establish a collection of main and intermediate crops and study their biological characteristics, particularly their responses to temperature conditions;
4. To investigate the growth and development features of main and intermediate crops, as well as the accumulation of plant biomass of the studied crops;
5. To disseminate knowledge and practical recommendations among farmers in southern and southeastern Kazakhstan;
6. To provide an agro-economic assessment of the technology for obtaining two to three harvests per year.

Research Methods.

During the preparation of the dissertation, both field and laboratory studies were conducted, including the following observations, measurements, and analyses: Phenological observations of plant growth and development at the main developmental stages were carried out according to generally accepted methodologies. Soil moisture reserves were determined using the thermostat-weight method. The minimum soil moisture capacity was determined using the flooded plot method. Plant density assessment, dynamics of biomass accumulation, and weed infestation monitoring were conducted according to standard methodologies. Soil sample analysis included the determination of humus content, nitrogen, and mobile forms of phosphorus and potassium. Soil bulk density was determined according to the method of A. S. Kachinsky. The structural and aggregate composition of the soil was assessed according to the method of N. I. Savvinov. Irrigation norms during the growing season were calculated using the formula of A. N. Kostyakov. Yield accounting was performed by plot-based direct combine harvesting and by the method of sampling plots. Statistical processing of yield data was conducted according to the methodology of B. A. Dospekhov. The economic efficiency of the cultivation practices for the studied crops was determined based on production costs per unit of output per hectare, in accordance with generally accepted methodologies for agrotechnical operations.

Main Provisions Submitted for Defense:

1. Monitoring of hydrothermal conditions in agroclimatic zones suitable for obtaining two to three crop harvests per year from the same field;
2. Growth and development characteristics of the main winter crops (barley, triticale, and rapeseed);
3. Growth, development, and biomass accumulation of intermediate crops (grain maize and silage maize);
4. Yield levels of the main and intermediate crops, as well as total feed unit production;
5. Specific features of growth and development of the studied crops in the extreme southern region of Kazakhstan (Maktaaral District) for obtaining two to three harvests per year;
6. Sowing and harvesting dates, as well as yield performance of the main and intermediate crops for obtaining three harvests per year from the same land area;
7. Agroeconomic assessment of the feasibility of obtaining two to three harvests per year.

Scientific Novelty. Based on the monitoring of hydrothermal conditions in southern and southeastern Kazakhstan and the study of biological characteristics of crops, a list of agricultural crops suitable for main and intermediate sowings has been identified. Approaches for obtaining two to three harvests per year from the same land area have been developed, ensuring the intensive use of irrigated lands.

Practical Significance. The implementation of the new technology makes it possible to obtain additional yields of intermediate crops, which will enable farm and peasant households to expand and strengthen both food and fodder bases. The cultivation of two to three crops per year through the sowing of intermediate crops will contribute to the rational and intensive use of irrigated lands and irrigation water throughout the growing season.

Description of the Main Research Results.

Based on the results obtained from field experiments on achieving two to three harvests per year from the same field, and taking into account the findings of other agricultural researchers, the following main recommendations can be made for farmers and peasant farms in southeastern Kazakhstan.

1. The recommended agronomic practices make it possible to obtain two to three harvests per year from the same land area. Through the use of early spring and autumn intermediate crops, it becomes possible to obtain additional production per unit area and to make fuller use of land, water resources, and solar energy.
2. To obtain two to three harvests per year, it is necessary to correctly select crops based on their biological characteristics and to establish optimal sowing and harvesting dates, as well as appropriate cultivation practices for the selected crops.
3. In the foothill zone of the Almaty region, after harvesting winter crops such as triticale and rapeseed for green biomass, it is recommended to sow maize for grain production.

4. In southern Kazakhstan, to obtain three harvests per year from the same land area, the following sequence is recommended: early cabbage harvested on May 2, followed by potato planting on May 5 with harvest on July 28, and subsequently maize for silage sown on August 1 and harvested on October 23. The implementation of these recommendations in agricultural production, as an important approach to the intensive use of irrigated lands, allows for maximum utilization of agroclimatic resources during the growing season and increases crop production per hectare.

5. Economic calculations (Experiment No. 1) showed that the highest net conditional income of 137.7–143.9 thousand KZT/ha and a profitability level of 81–84% were achieved when maize for grain was sown as an intermediate crop after harvesting winter triticale and winter rapeseed for green biomass.

6. The results of field experiments (Experiment No. 2) conducted in southern Kazakhstan demonstrated that it is possible to obtain three harvests per year from the same field. The cultivation of early cabbage, potatoes, and maize for silage within one growing season provided a high net income of 1,578 thousand KZT/ha and increased the profitability level to 92.3%.

Doctoral Candidate's Contribution to the Preparation of Each Publication.

The author of the dissertation made a full and substantial contribution to defining the research objective, formulating the research tasks, conducting the experiments, as well as summarizing and processing the obtained data.

The main results of the research have been published in 9 scientific articles, including 2 articles in journals indexed in the Scopus database, 4 articles in journals recommended by the Committee for Quality Assurance in the Field of Science and Higher Education of the Ministry of Science and Higher Education of the Republic of Kazakhstan (CQASHE MSHE RK), and 3 articles in the proceedings of international scientific and practical conferences. Based on the research results, 1 production recommendation has been issued and 3 utility model patents of the Republic of Kazakhstan have been obtained.

Compliance with Directions of Scientific Development or State Programs:

Scientific research was carried out within the framework of budget program 217 “Science Development”, subprogram 102 “Grant Funding of Scientific Research”, on the topic: “IRN: AP09259400 Selection of non-traditional crops for the intensive use of irrigated lands and the creation of a green conveyor depending on the bioclimatic potential of cultivation zones”, under an agreement concluded with the Committee of Science of the Ministry of Science and Higher Education of the Republic of Kazakhstan.

Structure and Volume of the Dissertation: The dissertation consists of an introduction, 7 chapters, a conclusion, and a list of references. It contains 28 tables and 19 figures. The total volume of the dissertation is 115 printed pages (including 91 pages of main text and 22 pages of appendices).