

Conservation Agriculture and Breeding for Sustainable Wheat Production in Kazakhstan

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CIMMYT and Kazakhstan collaborative activities on wheat improvement are focused in the following main areas: a) Wheat germplasm enhancement: Kazakhstan-Siberian Network on Wheat Improvement (KASIB) and Shuttle Breeding “Mexico-KASIB” Programs; b) Conservation Agriculture (CA) for wheat production and crop diversification. 19 Breeding programs of Kazakhstan and Russia are united by KASIB Network and Shuttle Breeding. By 2013: more than 15,000 wheat lines and varieties involved in breeding programs of Kazakhstan and Russia; 10 varieties developed and released. The KASIB Network and Shuttle Breeding Program recognized as one of the best example of the effective regional and international cooperation in Kazakhstan and Russia. In the beginning of 2000 CIMMYT, National Agricultural Research System (NARS), the Ministry of Agriculture (MoA), FAO, World Bank in cooperation with farmers initiated large-scale activities based on Conservation Agriculture (CA) in Kazakhstan. Due the joint efforts area under CA-based practices has been increasing from virtually none to an estimated area of: 500 000 ha in 2007; 1 200 000 ha in 2008; 1 850 000 ha in 2012 with continued rapid increases in area. Kazakhstan is now included among the top ten countries with the largest areas under No-tillage in the world.

For Kazakhstan`s food security and increase its export potential the improvement of wheat production is one of the most important task and challenge. Increasing yield barrier, resistance to drought and diseases, the quality of wheat grain, shifting the breeding process to a qualitatively new level based on biotechnologies, rational use of natural resources, rehabilitation of the soil fertility have to the part of the national policy, a basis for sustainable economic development of any country and region (FAO, 2011; FAO, 2010). It is in exactly such areas of agricultural and biological sciences, as a system of Conservation Agriculture and modern effective approaches to the breeding process the cooperation between Kazakhstan and the International Maize and Wheat Improvement Center (CIMMYT) is carried out.

Wheat Germplasm Improvement

Kazakhstan-Siberian Network on Wheat Improvement (KASIB) established by CIMMYT in 2000, currently unites 19 breeding programs of Kazakhstan, Western Siberia, Ural, Altai, and Volga regions, covering the territory of more than 20 million ha of spring wheat. The main goal of KASIB is to increase efficiency and speed up the process of wheat breeding through active exchange of the best breeding materials and their

coordinated evaluation and testing in the vast territory covered by the network, as well as through exchange of experimental data, regular meetings to monitor the progress, joint publications and mutually beneficial cooperation on breeding and using the new varieties. KASIB and "Shuttle Breeding" programs for today is one of the world's best examples of the effective regional and international cooperation to accelerate breeding.

For 12 years of KASIB and "Shuttle Breeding" activities more than 15 000 lines of wheat were involved to Kazakhstan and Russia, which significantly enriched genetic resources of the countries and wheat breeding genetic basis. For this period the quality and level of the research works have been considerably improved, concrete results have been achieved and the active phase of new varieties development started, as evidenced by the increasing number of the varieties submitted to State Testing Committee. Increasing of wheat production has the highest importance to ensure food security and increasing export potential of the countries. Today this task is more and more complicated by climate change (temperature increase, drought), land degradation, new hazardous races of pathogens. Therefore priority objectives are improvement of yield potential, resistance to drought and diseases, quality of wheat grains. These objectives were and remain the KASIB and "Shuttle Breeding" programs high priorities.

In Kazakhstan, in the countries of Central Asia and the Caucasus (CAC) the International Winter Wheat Improvement Program is actively and effectively realized. Thanks to this program it is also significantly increased the level and volume of breeding activities; in Kazakhstan and other CAC countries dozens of the winter wheat varieties were developed and released.

Conservation Agriculture Adoption

The world experience shows that the traditional farming systems, even of their possible high productivity, lead to soil degradation and reduced efficiency of in input use. Negative components of the traditional farming systems are intensive tillage, returning little organic matter to the land and monoculture. Conservation Agriculture (CA) involves removing these negative components of conventional farming systems and includes three basic principles: minimal soil disturbance, permanent soil cover with crop residues and crop rotation. With these way and approach we look at and talk about CA, conventional and Conservation Agriculture are not the opposite and incompatible systems. Essentially, CA is the further development and improvement of the conventional systems, includes all of the other principles of sound crop managements, but excludes their negative components (Karabayev at al., 2013). But we must recognize that even with the apparent simplicity of such formulation, CA is a complex technology, it implies changes in a number of technological components of the existing traditional systems of agriculture. It is necessary to change two basic paradigms: the paradigm of soil tillage and the paradigm of linear knowledge flow.

Many agricultural research and extension systems are based on a linear model of knowledge flow, with new knowledge being developed in research organizations, passed on to agricultural extension agents who in turn pass on the new knowledge and information to farmers. While this model may be applied to simple technology, it does not always effectively work with complex technologies, especially when research institutes do not have the capacity to develop functional packages of multiple technological components for all farmer situations. Innovative systems on the basis of complex technologies are needed in adaptation, system development process and promotion. Innovative systems (platforms) are based on networks of multiple agents, including farmers-innovators and decision-makers, all utilizing their own knowledge, external information and policy support to help

overcome problems and develop functional systems for local farming conditions and farmer circumstances. Successful adaptation and promotion of CA in Kazakhstan can be considered as an example of this approach.

Works on adoption of Conservation Agriculture technologies in Kazakhstan (zero/minimum soil tillage, leaving crop residues in the fields, direct seeding with narrow chisel and disk openers, permanent bed-planting and furrow irrigation, etc.) were initiated in 2000. Thanks to the joint efforts of scientists and farmers, international organizations (CIMMYT, FAO, ICARDA, World Bank, etc.), support by the state and government bodies, the areas under no-till have been increasing from virtually none to an estimated area of: 500 000 ha in 2007; 1 200 000 ha in 2008; 1 850 000 ha in 2012; 2 000 000 in 2013 with continued rapid increases in the area. The utilization of CA-based technologies has become an official state policy in agriculture in Kazakhstan. Since 2008, the government of Kazakhstan has been subsidizing farmers who are adopting CA-based technologies. With this Kazakhstan is now included among the top ten countries with the largest areas under No-tillage in the world (FAO, 2009).

CIMMYT, FAO and the World Bank experts analyzed current state of CA adoption and wheat production in Kazakhstan and made the following conclusions:

- Yield of spring wheat under no-till, in average, 48 to 58% higher in comparison with the conventional technologies. The advantages of CA/No-till technologies are especially evident in the years of drought.
- In 2012 Kazakhstan was ranked first in Europe and Central Asia region, and 7th in the world for No-till adoption.
- In terms of speed of adoption during the last three years, Kazakhstan has no rivals: it appears to be the 1st.
- In severe dry 2012 year in Kazakhstan wheat production was estimated at 11.0 million tons. Wheat no-till area (only 80% of the no-till area) has produced an estimated 1.8 million tons of wheat. Incremental wheat production only because of no-till area is thus about 0.72 million tons, equivalent to around 200 million dollars.
- Increased income and food security during the last 3 years:
 - An estimated 580 million dollars incremental income;
 - Satisfied cereals requirements of about 5 million people annually.
- Climate Change mitigation: Kazakhstan contributes to the annual sequestration of about 1.3 million tons of CO₂.
- Adopted in Kazakhstan CA and No-till technologies, according to the data and characteristics, fully comply with the requirements for innovative technologies and systems.

Kazakhstan, possessing rich land resources, high research capacity and well-developed economic infrastructure, has wide opportunities for increasing agricultural production and becoming the world's leading exporter of high-quality grain and other types of agricultural production. At present, Kazakhstan is considered to be one of the world's most important regions for global food security. As per official analytical data, by 2025 the level of cereal production should reach 3 billion ton in order to feed the 8 billion of population. In order to achieve that goal, annual increase in production of wheat, the most important food crop, should amount to 2% against the existing annual increase of 1,3% (Anonymous, 2011; FAO, 2009). This increase should be achieved with the growing influence of negative factors in the background, such as decrease of water supply, drought, temperature increase, land degradation, emergence of new highly dangerous disease races, increasing use of plant products for biological fuel and livestock production. Without

doubt, successful overcoming of these negative factors and sustainable growth of agricultural production in Kazakhstan and the whole world will primarily depend on new technologies and development of research and science. In the modern world, technologies and innovations are crucial for the country's competitiveness and food security.

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