Direct sowing of spring wheat in Northern Kazakhstan (Photo courtesy of CIMMYT-Kazakhstan office)

Conservation Agriculture for cereal production in rainfed areas of Kazakhstan

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Conservation Agriculture for cereals production in rainfed agriculture lands

Conservation agriculture applied in Northern Kazakhstan is based on no-tillage direct sowing of cereals into the soil permanently covered by crop residues. It contributes to reverse soil degradation, enhance water use efficiency, increase crop productivity in the rainfed lands.

The cropping system in Northern Kazakhstan is based mainly on continuous wheat production using conventional technologies. Negative components of this system are intensive tillage, returning little organic matter to the land and monoculture. This system has led to soil degradation (wind and water erosion), soil fertility loss, boost-up of diseases, weed infestation and other problems.

Conservation Agriculture (CA) involves removing these negative components of conventional farming systems and includes three basic principles: 1) minimal soil disturbance, 2) permanent soil cover with crop residues and 3) crop rotation.
In accordance with these principles,

Conservation Agriculture technology includes 3 main operations:
1. Sowing with simultaneously soil fertilization using direct seeder.
2. Post-sowing (after 1-2 days) treatment by non-selective herbicide
3. Harvesting combined with simultaneous plant residues chopping and spreading

For comparison Conventional technology includes 7 operations:
1. Deep fall soil tillage (25 cm).
2. Early spring soil treatment.
4. Pre-sowing soil treatment.
5. Sowing with simultaneously soil fertilization using conventional seeder.
6. Selective herbicide application 2,4-Dichlorophenoxyacetic acid (2-4-D).
7. Harvesting.

The CA technology was applied in four farms in Akmola and North-Kazakhstan oblasts:
1.Farm “DARYN”, village Valikhanovo, Zharkainsky rayon, Akmola oblast, Kazakhstan.
2.Farm “Surayev”, village Vishnevka, Arshalinsky rayon, Akmola oblast, Kazakhstan.
3.Farm “Dostyk”, village Astrahanovka, Arshalinsky rayon, Akmola oblast, Kazakhstan.
4. Farm “Cherezdanov”, village Smirnovo, Akkayinskii rayon, Northern Kazakhstan oblast, Kazakhstan.

Depending on the capability of these four farms in total 330 ha agricultural land were allocated for the testing and adaptation of the technology. On each farm, field trials under equal conditions (soil, temperature, humidity, landscape, etc.) were conducted and included 2 treatments: Conventional (7 operations) and Conservation Agriculture (3 operations).
Analysis of 2002-2004 trials data demonstrated that yield of wheat and other cereals under CA technology was in average 15-25% higher in comparison with the conventional technology. The advantages of CA technology are especially evident in the years of drought (up to 40% in dry 2004 year). Economic evaluation of the technology made by two independent experts from Kazakhstan (Kazakh Research Institute for Grain Farming) and USA (Idaho State University) suggested that costs of labor, fuel, repairs and spare parts as well as machinery and equipment wearing-out under the Conservation Agriculture technologies is significantly lower as compared to those of traditional technology. In general, it is important to emphasize that the experience of the CA adaptation in North Kazakhstan helped farmers/land-users:
•To determine the appropriate level of tillage in a cropping system that is feasible with direct sowing and CA technology requirements as a potential goal.
•To retain sufficient residue on the soil surface to reduce soil erosion, enhance crop/water productivity, improve soil fertility (because of plant organic material bioprocessing in the soil)

: Smirnovo village, Akkayin district, Northern Kazakhstan region; Valikhanovo village, Zharkainsk district, Akmola region; Astrahanovka village, Astrahanskyi district, Akmola region; 4) Vishnevka village, Arshalinsky district, Akmola region, Northern Kazakhstan: Akmola and North Kazakhstan regions (provinces),

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and better ensure long term, sustainable production.
•Employ economically viable, diversified crop rotations that can improve cropping system productivity and offer farmers new options to reduce risk that is extremely important for the conditions of Northern Kazakhstan relating to the area of risk farming.

The introduction of the technology for cereal production in the rainfed areas of Kazakhstan was realized within the framework of the FAO/TCP/KAZ/2801 (T) Project "Conservation Agriculture for Sustainable Crop Production in Northern Kazakhstan", under active cooperation with counterparts: Ministry of Agriculture of the Republic of Kazakhstan (MoA RK), FAO, CIMMYT, Union of Farmers of Kazakhstan (UFK), national agriculture research organizations.

Direct sowed winter rye after spring wheat, North Kazakhstan (Muratbek Karabayev)

Direct sowed spring wheat after barley, North Kazakhstan (Muratbek Karabayev)

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- : loss of soil fertility due to wind and water erosion

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Sequence of main operations and elements of the technology implemented:

1) Direct sowing of wheat with seeder SZS 6.12 equipped with brazil disk openers and cutting discs, and simultaneous ammophos application at the rate of P20
2) Herbicide treatment (Glyphosate 360) with sprayer OP-2000, 3.0 l/ha after wheat planting
3) Direct sowing spring wheat
4) Harvesting with chopping and overspreading of the straw

Technical specifications, dimensions, spacing of the experimental plots:

The total land area under the technology - 330 ha for 4 farms: «Cherezdanov», «Dostyk 06», «Suraev», «Daryn» (20 plots , 16.5 ha each)
1 plot - 16.5 ha (length - 702 m, width - 235 m)

Species used: wheat, barely, rye, oat. Different seed rates of spring wheat are used at the farms: from 105 kg/ha to 140 kg/ha.

Author: Muratbek Karabayev

- (**330 ha**)
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- ( ) 1 USD =
- 22 USD

CA technology shows some clear economic advantages compared to the traditional system. Production costs for CA are slightly higher, associated primarily with the cost of glyphosate. But they are partially reimbursed by lower costs fot labor, fuel and ownership costs associated with a slight reduction in equipment use. However, additional revenue associated with the higher yields experienced for CA compensates for the higher production costs.

1. Snow Retention (/ : Dec-Feb)
2. Herbicides (Glyphosate) Application (/ : May)
3. Direct sowing, fertilizing (/ : May)
4. Herbicide Application (/ : June)
5. Harvest and Hauling (/ : Aug-Sep)

			( )	( )	%
Permanent and seasonal workers	person-days	242,7	22,0	5339,4	
Fuel	liter	5374,28	0,35	1881,0	
Modification of seeders and sprayers		2,0	1240,8	2481,6	
Machinery Depreciation (7 Unit of equipment)		7,0	1427,5	9992,5	100,0
Machinery Interest (7 Unit of equipment)		7,0	646,4	4524,8	100,0
Wheat Seed	kg	40764,7	0,17	6930,0	
Fertilizer: Ammonium Phosphate	kg	33000,0	0,1	3300,0	
Herbicide: Broadleaf	liter	330,0	5,5	1815,0	
Herbicide: Glyphosate	liter	990,0	6,5	6435,0	
Land	ha	330,0	12,88	4250,4	100,0
				46'949.7	
				46'949.7	

1. Snow Retention (/ : Dec-Feb)
2. Herbicides (Glyphosate) Application (/ : May)
3. Direct sowing, fertilizing (/ : May)
4. Herbicide Application (/ : June)
5. Harvest and Hauling (/ : Aug-Sep)

					%

			( )	( )	
Permanent and Seasonal Workers	person/days	242,7	22,0	5339,4	
Fuel	liter	5374,28	0,35	1881,0	
Equipment repairs and service		2,0	1240,8	2481,6	
Machinery Depreciation (7 Unit of equipment)		7,0	1427,5	9992,5	100,0
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Fertilizer: Ammonium Phosphate	kg	33000,0	0,1	3300,0	
Herbicide: Broadleaf	liter	330,0	5,5	1815,0	
Herbicide: Glyphosate	liter	825,0	6,5	5362,5	
Land	ha	330,0	12,88	4250,4	100,0
				45'877.2	
				45'877.2	

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3,001-4,000
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Short growing period, low rainfall during the growing period, frequent droughts, early and late frosts

"KazHydroMet" National State Organization

Farm "Cherezdanov", Smirnovo village, Akkayinskii rayon, Northern Kazakhstan oblast: mean annual rainfall, mm - 333,4; mean annual temperature (degrees Celsius) - +1,6;
Farm "Dostyk 06", Astrahanovka village, Astrahanskyi rayon, Akmola oblast: mean annual rainfall, mm - 319,6; mean annual temperature (degrees Celsius) - +1,6;
Farm "Surayev", Arshalinsky rayon, Akmola oblast: mean annual rainfall, mm - 312,8; mean annual temperature (degrees Celsius) - +2,4;
Farm "Daryn", Valikhanovo village, Zharkainsky rayon, Akmola oblast: mean annual rainfall, mm - 253,4; mean annual temperature (degrees Celsius) - +2,5

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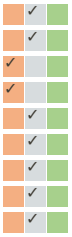

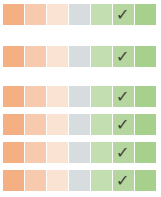

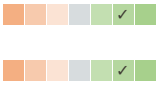

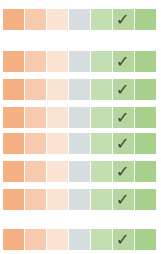

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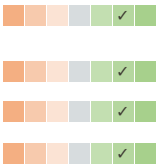

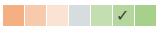

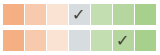

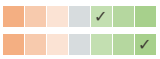

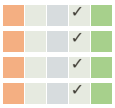

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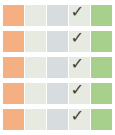

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about 3 mln ha under Conservation Agriculture in Kazakhstan now

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- A special advantage of Conservation Agriculture is observed in extremely dry conditions. It allows to consider this technology as water-conserving, which is critical for risky farming area in Kazakhstan.
- Conservation Agriculture is not inferior to traditional technologies and is competitive in the regional cereal production system and promising given their role in soil fertility recovery, cost reduction, increase in labor productivity and positive effect on the environment.
- The wide-scale use of Conservation Agriculture in Kazakhstan, shift of farms to modern cropping systems are realistic and promising.

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- High costs at the 1st stage of technology implementation State support programs or land user cooperation needed
- Weed control problems Weed control is one aspect that needs further research. Herbicides are costly in Kazakhstan, especially when compared to depressed grain prices. Options for weed control with different weed spectra and these different conditions must be available. One of the ways to combat is the crop rotation. Potential for more diversified systems in northern Kazakhstan exists. Policy emphasis should be placed on market development for alternative crops.

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- Based on the data on yield, ecological, soil and agronomic parameters and economic analysis, the Conservation Agriculture can be considered as effective and promising for the region. It will allow for farmers to switch to modern farming systems based on diversified crop production, minimal soil treatment, stubble retention, and direct seeding.
- The modified local seeders, in general, performed well and can be used under production conditions. The possibility to locally produce direct seeders and well-established herbicide and fertilizer production suggest feasible wide-scale application of CA technology for crop production in the country.
- Under current conditions, it is extremely important to intensify collaboration between national agricultural systems and international organizations and research centers. They actively use their large international expertise, modern technologies, rich genetic pool to facilitate a rapid integration of a country’s agrarian sector into the world system.
- Equipment availability for resource-poor farmers There are many inexpensive models of direct seeders and other equipment for CA in the world market. Farmers need in marketing services, technical consultations. Subsidizing purchase of CA equipment by government can help farmers to advance the process of CA adoption in country and region.
- Delayed effect (it takes time to get all the benefits of the technology) Provision of long-term low interest loans
- The problem of farmers' awareness of technology, its features and benefits Awareness needs to be raised

Editors

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: 4 2020 : 5 2020

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https://qcat.wocat.net/km/wocat/technologies/view/technologies_5673/

SLM

Approaches: Awareness Raising for SLM Using Conservation Agriculture https://qcat.wocat.net/km/wocat/approaches/view/approaches_5677/

- Kazakh Research Institute for Livestock and Fodder Production (Kazakh Research Institute for Livestock and Fodder Production) -

- Integrated natural resources management in drought-prone and salt-affected agricultural production landscapes in Central Asia and Turkey ((CACILM-2))

- 1.Karabaev M., Vasko I., Matyushkov M., Bektemirov A., Kenzhebekov A., Bakhman T., Friedrich T., Makus L., Morgunov A., Darinov A., Sagimbaev M., Suraev V., Perezdanov V ., Rodionov A., Wall P. Zero-processing and direct sowing technologies for the cultivation of grain crops in Northern Kazakhstan. 2005. FAO-SIMMIT, 64 p. (in Russian):
- 2.Shpigun S., Karabayev M.No-till and direct seeding technologies for cereals in North Kazakhstan. - Practical recommendations for farmers. Astana, Kazakhstan, 2007, 15 p.:
- 3.Karabayev M., Yuschenko N., Akramkhanov A., and Shpigun S.Forage crops production in dry areas with an allowance for ecological risks. - Methods of seeding and growing of perennial and annual grasses. Astana, Kazakhstan, 2007, 112 p.:
- 4.CIMMYT Wheat Improvement Program for Kazakhstan. Together in 21st Century. - 2008, CIMMYT, 56 p.:
- 5.Yushenko N., Iskakov Z., Karabayev M., Shpigun S., Yushenko D., Shaushekov T., Baitassov A. Perennial grasses cropping in abandoned lands of Central Kazakhstan based on Conservation Agriculture. – Drylands Management, World Bank-GEF-MOEP Kazakhstan, 2008, p.38-43.:
- 6.No-Till with Soil Cover and Crop Rotation: A Basis for Policy Support to Conservation Agriculture for Sustainable Production Intensification. – Proceedings of the International Consultation Conference, 8-10 July, 2009, Astana-Shortandy, Kazakhstan. CIMMYT, FAO, Ministry of Agriculture, Kazakhstan, 2009, p. 350.:
- 7.Commonwealth Agricultural Bureaux International (CABI). 2011. Climate Change and Crop Production. Oxfordshire, UK: CABI, 292 p.:
- 8.FAO (Food and Agriculture Organization of the United Nations). 2011. Save and Grow: A Policymaker's Guide to the Sustainable Intensification of Smallholder Crop Production. Rome, Italy: FAO.:
- 9.Ospanbayev Zh., Koishibayev M., Karabayev M., Zhapayev R., Bedoshvili D., Zhunusov K. 2010. Winter wheat direct seeding technology on rainfed lands. Recommendations for farmers, Almaty, Kazakhstan, 13 p.:
- 10.Karabayev M., Ushenko N., Baitassov A., Ushenko D., Ishmukhanbetov S. 2011. Conservation agriculture for hayfields and pastures under agricultural landscapes of Central Kazakhstan // INAT-AGRO, GEF, UNDP, CIMMYT. Astana, Kazakhstan, 39 p.:
- 11.Ushenko N., Ushenko D., Baitassov A. 2011. Adaptation of no till and direct seeding of cereals in agricultural landscapes of Central Kazakhstan // CIMMYT, ACP, Astana, Kazakhstan, 22 p.:
- 12.Advancement and impact of conservation agriculture/no-till technology adoption in Kazakhstan. FAO Investment Centre, Information Note, December 6, 2012:
- 13.Karabayev M., P.Wall., K.Sayre, R.Zhapayev, A.Morgounov, V.Dvurechenski, N.Yushenko, T.Friedrich, T.Fillecia, A.Jumabayeva, M.Guadagni. Adoption of Conservation Agriculture in Kazakhstan // Soil-Water Journal. 2013, Vol. 2, # 2, p. 2003-2006.:
- 14.Zhapayev R., K.Iskandarova, M.Karabayev, K.Toderich. Ecological testing of the sorghum genotypes in South-East Kazakhstan // Agroecological bases of improvement the productivity and sustainability of Agriculture in the XXI century. 2013, Kazakhstan, p. 124-127.:
- 15.Karabayev M., V.Dvurechenski, P.Wall, K.Sayre, T.Friedrich, N.Yushenko, Zh.Ospanbayev, R.Zhapayev, A.Morgounov, A.Darinov, A.Nazarenko, E.Gossen, T.Fillecia, M.Guadagni. Conservation Agriculture in Kazakhstan // CIMMYT-Kazakhstan, 2013, 32 p.:
- 16.Karabayev M., A.Morgounov, P.Wall, K.Sayre, Y.Zelenskiy, R.Zhapayev, V.Dvurechenskii, A.Akhmetova, T.Friedrich, T.Fileccia, M.Guadagni. Conservation Agriculture and breeding for sustainable wheat production in Kazakhstan // Journal of Bahri Dagdas Crop Research, 2014, (1-2), 50-53 p.:
- 17.Nurbekov A., A.Akramkhanov, J.Lamers, A.Kassam, T.Friedrich, R.Gupta, H.Muminjanov, M.Karabayev, D.Sydyk, J.Turok, M.Bekenov. Conservation Agriculture in Central Asia (chapter) // Conservation Agriculture. Global prospects and challenges. CABI (CAB Int.), 2014, UK-USA, p.223-248.:
- 18.Karabayev M., A.Morgounov, H.-J.Braun, P.Wall, K.Sayre, Yu.Zelenskiy, R.Zhapayev, A.Akhmetova, V.Dvurechenskii, K.Iskandarova, T.Friedrich, T.Fileccia, M.Guadagni. Effective approaches to wheat improvement in Kazakhstan: Breeding and Conservation Agriculture // Journal of Agricultural Science and Technology, USA, 2014, v.4, #10, p.761-765.:
- 19.Goddard T., Basch G., Derpsh R., Hongwen L., Jin H., Karabayev M., Moriya K., Peiretti R., Smith H. Institutional and policy support for CA uptake // Advances in Conservation Agriculture, Volume 1: Systems and Science, Burleigh Dodds Science Publishing, Cambridge, UK, 2020, (ISBN: 978 1 78676 264 1; www.bdspublishing.com), 52 p.:

- No-Till: A Climate Smart Agriculture Solution for Kazakhstan (World Bank): http://www.worldbank.org/en/results/2013/08/08/no-till-climate-smart-agriculture-solution-for-kazakhstan