THE 9TH REGIONAL FORUM ON SUSTAINABLE AGRICULTURAL MECHANIZATION IN ASIA AND THE PACIFIC

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KANAT AKSHALOV
TITLE “INTENSIFICATION OF TILLAGE SYSTEM IN DRYLAND CONDITIONS OF KAZAKHSTAN: CHALLENGES, SOLUTIONS”

RESEARCH & PRODUCTION CENTER OF GRAIN FARMING NAMED AFTER A. BARAYEV

SHORTANDY, KAZAKHSTAN, 2021
WHAT IS THE SOIL - CLIMATIC CONDITIONS OF NORTH PART OF KAZAKHSTAN?
### Long-term Annual PRCP, mm (1936-2016), Shortandy, Kazakhstan

<table>
<thead>
<tr>
<th></th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>August</th>
<th>Septembe</th>
<th>October</th>
<th>November</th>
<th>December</th>
<th>Total</th>
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</thead>
<tbody>
<tr>
<td>Mean annual</td>
<td>16.2</td>
<td>13.3</td>
<td>12.9</td>
<td>20.2</td>
<td>32</td>
<td>38.4</td>
<td>56.8</td>
<td>39.4</td>
<td>24.4</td>
<td>28</td>
<td>20.6</td>
<td>19.1</td>
<td>319.7</td>
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<tr>
<td>Mean max.</td>
<td>56.5</td>
<td>48.5</td>
<td>49.3</td>
<td>94.5</td>
<td>90.9</td>
<td>104.9</td>
<td>147.1</td>
<td>150</td>
<td>86.1</td>
<td>68.4</td>
<td>58.3</td>
<td>90.5</td>
<td>476.5</td>
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<tr>
<td>Mean min.</td>
<td>2.6</td>
<td>2.2</td>
<td>2.4</td>
<td>2.4</td>
<td>1.5</td>
<td>3</td>
<td>9.9</td>
<td>5</td>
<td>1.7</td>
<td>0.4</td>
<td>4.2</td>
<td>0.9</td>
<td>141.8</td>
</tr>
</tbody>
</table>
Long-tern Annual T, °C (1936-2016 гг.). Shortandy, Kazakhstan

<table>
<thead>
<tr>
<th>Month</th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>August</th>
<th>September</th>
<th>October</th>
<th>November</th>
<th>December</th>
<th>Total</th>
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</thead>
<tbody>
<tr>
<td>Mean</td>
<td>-17.7</td>
<td>-16.4</td>
<td>-9.9</td>
<td>3.4</td>
<td>12.5</td>
<td>18.3</td>
<td>19.9</td>
<td>17.4</td>
<td>11.2</td>
<td>2.9</td>
<td>-7.4</td>
<td>-14.1</td>
<td>1.8</td>
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<tr>
<td>Absolute max.</td>
<td>2</td>
<td>3.5</td>
<td>19</td>
<td>29.8</td>
<td>37</td>
<td>39.5</td>
<td>43</td>
<td>39.5</td>
<td>37</td>
<td>25.5</td>
<td>16.8</td>
<td>3.1</td>
<td></td>
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<tr>
<td>Absolute min.</td>
<td>-44</td>
<td>-43.4</td>
<td>-37.6</td>
<td>-25.4</td>
<td>-11.8</td>
<td>-2.4</td>
<td>1</td>
<td>-3</td>
<td>-9</td>
<td>-22.7</td>
<td>-39</td>
<td>-43.5</td>
<td>-44</td>
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<tr>
<td>Mean high</td>
<td>-9.5</td>
<td>-9.5</td>
<td>-1.9</td>
<td>8.3</td>
<td>17.8</td>
<td>22.3</td>
<td>25.7</td>
<td>21.3</td>
<td>14.5</td>
<td>7.3</td>
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<td>-7</td>
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<tr>
<td>Mean low</td>
<td>-30.7</td>
<td>-25.6</td>
<td>-17.4</td>
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<td>15.2</td>
<td>14</td>
<td>4</td>
<td>-5.3</td>
<td>-16.6</td>
<td>-24.7</td>
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<tr>
<td>ITEM</td>
<td>2030 YEAR</td>
<td>2050 YEAR</td>
<td></td>
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<tr>
<td>TEMPERATURE</td>
<td>+ 2-9%</td>
<td>+ 4-15%</td>
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</tr>
<tr>
<td>SUM PRECIPITATION IN VEGETATION TIME</td>
<td>MINUS 1-10%</td>
<td>MINUS 2-14%</td>
<td></td>
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</tr>
<tr>
<td>SUM OF PRCP PER YEAR</td>
<td>ДО + 12%</td>
<td>ДО + 21%</td>
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</tbody>
</table>

It is expected increasing sum of PRCP per year due to of increasing PRCP during winter time.
CHALLENGES/ LIMITING FACTORS

- Climate Change, High Temp., High Humidity
- Decreasing of Soil & Plant Health
- Economic Factors/ World Market/ Competitiveness
- Expantion of Foreign Machines
- Soil Degradation
- High Cost of Technology (Machines, Pesticides)
CLIMATE CHANGE IS THE MAIN CHALLENGES IN KAZAKHSTAN

Expected climate change in Kazakhstan: Key Findings

- **Rise in** the seasonal and annual surface air temperature
- **Increase in** winter precipitation
- **Redistribution of** summer precipitation (more in late summer)
- An increase of precipitation **will not compensate for** increase in air temperature
- **Increased irregularity** of rainfall in time
- For all scenarios, the change trends towards **increased aridity/drought & erosion**
SOIL ZONES OF NORTH KAZAKHSTAN

Legend

- Leached fertile chernozem and meadow chernozem
- Ordinary Chernozem (Pachic Haplustolls)
- Southern chernozem (Typic Haplustolls)
- Dark Chestnut (Typic Haplustolls)

5-6 %
3-4%
2.3-3.2%
Общая площадь земель (территория) - 272.5 млн. га
в т.ч. земли с/х угодья - 221.6 млн. га
из них: пашня - 24.8 млн. га
в т.ч. орошаемые земли - 2.2 млн. га
DISTRIBUTION OF ARABLE LANDS

- С-Казахстанская: 4888.8 Th.ha
- Акмолинская: 5799.8 Th.ha
- Костанайская: 5980.4 Th.ha
- В остальных областях: 8131 Th.ha
DISTRIBUTION OF IRRIGATED AREA

- Алматинская область: 579.8 тыс.га
- Ю-Казахстанская область: 565.7 тыс.га
- Кызылординская область: 240 тыс.га
- Жамбылская область: 229.7 тыс.га
- В-Казахстанская область: 200.8 тыс.га
- В остальных областях: 352 тыс.га
Area under CA., th.ha.

Total; 5438.7 тыс. га
(21,9% от общей площади пашни)

- Посев зерновых культур стерневыми сеялками

- Уборка зерновых культур с измельчением и срабрасыванием соломы

- Посев зерновых культур с обработкой глифосатодержащими гербицидами
Area under water saving technology, th. hectares

- **Капельное орошение**
- **Дождевание**
- **Мульчирование, дискретный, подпочвенные, через борозду**

- **DRIP IRRIGATION**
- **SPRINKLING**
- **MULCHING, SUBSOIL, IRRIGATION FARROW**

Total area is 205,1 тыс. га (0,8% from arable land)
Principles of Conservation Agriculture in Kazakhstan

**No-till** – no mechanical tillage, just direct seeding

**Minimum tillage (Zero-till, reduced tillage (minimum))** – combination of mechanical & chemical treatments

**DIVERSIFICATION** – CEREALS, CASH CROPS (OIL, LEGUMES, FORAGE … CROPS)
GRAIN PRODUCTION IN NORTH KAZAKHSTAN

Canola
Flax
Sunflower
Dry pea
Corn
Barley
Oats

Check Pea
Lentil
Dry pea
Flax
Sunflower
Barley
Oats
Perennial grasses

Buckwheat
Millet
Sunflower
Perennial grasses
Check Pea
Safflower

Посев зернобобовых, масличных, зернофуражных культур и многолетних трав - повысит доходность, плодородие почвы и устойчивость производства растениеводства и животноводства.
## Area under S. Fallow in Kazakhstan & Canada

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>North Kazakhstan</td>
<td>3.0</td>
<td>3.5</td>
<td>3.0</td>
<td>3.0</td>
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<tr>
<td>Saskatchewan, Canada</td>
<td>4.7</td>
<td>1.6</td>
<td>2.4</td>
<td>1.4</td>
</tr>
</tbody>
</table>
WIND EROSION
TRANSFER OF SOIL FROM SUMMER FALLOW

PHOTO BY KANAT AKSHALOV
WATER & SOIL RUNOFF IN SPRING TIME

Photo: by Kanat Akshalov
Summer Fallow
(prepared by conventional tillage)

Summer Fallow
(prepared by No-Till)

PHOTO: BY KANAT AKSHALOV
SOIL RUNOFF FROM FALLOW FIELD

PHOTO: BY KANAT AKSHALOV
SUMMER FALLOW

Stubble

PHOTO BY KANAT AKSHALOV
CONVENTIONAL TILLAGE (SPRING TIME)
NO-TILLAGE

PHOTO BY KANAT AKSHALOV
NO-TILLAGE, MULCHING

PHOTO BY KANAT AKSHALOV
EXPERIMENTAL TRIALS AT THE BARAYEV RESEARCH & PRODUCTION OF GRAIN FARMING
DIRECT SEEDING
by “Condor 12001”
DIVERSIFICATION FLUX – IS ONE OF THE PERSPECTIVE CASH CROP
### Effects of Tillage System on Bulk Density, g/cm³

<table>
<thead>
<tr>
<th>Tillage System</th>
<th>Wheat after Fallow</th>
<th>Continuous Wheat</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Spring time</td>
<td>FALL</td>
</tr>
<tr>
<td>Conventional</td>
<td>1.09</td>
<td>1.19</td>
</tr>
<tr>
<td>No-Till</td>
<td>1.14</td>
<td>1.25</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tillage System</th>
<th>Wheat after dry pea</th>
<th>Continuous Wheat</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Spring time</td>
<td>FALL</td>
</tr>
<tr>
<td>Conventional</td>
<td>1.06</td>
<td>1.20</td>
</tr>
<tr>
<td>No-Till</td>
<td>1.13</td>
<td>1.24</td>
</tr>
</tbody>
</table>
### Soil Water Content as Affected by Tillage & Cropping System, MM

<table>
<thead>
<tr>
<th>Subsequent Crop</th>
<th>Tillage System</th>
<th>Soil Depth, CM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0-30</td>
<td>0-50</td>
</tr>
<tr>
<td><strong>Summer Fallow</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No-Till</td>
<td>42.7</td>
<td>77.1</td>
</tr>
<tr>
<td>Minimum Till</td>
<td>54.1</td>
<td>92.4</td>
</tr>
<tr>
<td><strong>Continuous Cropping (Stubble)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No-Till</td>
<td>33.2</td>
<td>66.6</td>
</tr>
<tr>
<td>Minimum Till</td>
<td>35.5</td>
<td>69.6</td>
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# PRCP Use Efficiency Under Different Cropping System

<table>
<thead>
<tr>
<th>Cropping System</th>
<th>Tillage System</th>
<th>Amount of PRCP, mm</th>
<th>PRCP Use Efficiency, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous Cropping</td>
<td>NO-TILL</td>
<td>170-180</td>
<td>50 AND ≥</td>
</tr>
<tr>
<td>Minimum</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Summer Fallow</td>
<td>NO-TILL</td>
<td>400-500</td>
<td>18-20</td>
</tr>
<tr>
<td>Minimum</td>
<td></td>
<td></td>
<td>22-25</td>
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</table>
## WATER AND SOIL RUNOFF FROM DIFFERENT CROPPING SYSTEMS

<table>
<thead>
<tr>
<th>CULTURAL PRACTICE (CROPPING SYSTEM)</th>
<th>TILLAGE SYSTEM</th>
<th>RUNOFF</th>
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<tr>
<td></td>
<td></td>
<td>WATER, M³</td>
</tr>
<tr>
<td><strong>SUMMER FALLOW</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CONVENTIONAL</td>
<td>500-600</td>
</tr>
<tr>
<td></td>
<td>NO-TILL</td>
<td>500-600</td>
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<tr>
<td><strong>CONTINUOUS CROPPING</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CONVENTIONAL</td>
<td>150-200</td>
</tr>
<tr>
<td></td>
<td>NO-TILL</td>
<td>180-250</td>
</tr>
<tr>
<td>CROP</td>
<td>TECHNOLOGY</td>
<td>YIELD, T/HA</td>
</tr>
<tr>
<td>----------</td>
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<td>-------------</td>
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<tr>
<td>CANOLA</td>
<td>MINIMUM</td>
<td>0.81</td>
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<tr>
<td></td>
<td>DIRECT SEEDING</td>
<td>1.0</td>
</tr>
<tr>
<td>FLAX</td>
<td>MINIMUM</td>
<td>1.28</td>
</tr>
<tr>
<td></td>
<td>DIRECT SEEDING</td>
<td>1.53</td>
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</table>
## ECONOMIC EVALUATION OF SEEDING TECHNOLOGY

<table>
<thead>
<tr>
<th>Seeding technology</th>
<th>Gazoline expense (liter per hectare)</th>
<th>Save, L/ra</th>
<th>Cut cost of gasoline expenses (cost of gasoline – 120 тг/л - $ 0.34)</th>
</tr>
</thead>
<tbody>
<tr>
<td>V-type drill coulter</td>
<td>5,0</td>
<td>-</td>
<td>Per hectare</td>
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<tr>
<td>Direct seeding – hoe boot «Condor 12001» - Amazone</td>
<td>3,0</td>
<td>2,0</td>
<td>$0.57</td>
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<td></td>
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<td>$570.00</td>
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## EFFICIENCY OF DIVERSIFICATION (EXAMPLE)

<table>
<thead>
<tr>
<th>CROP</th>
<th>YIELD, Т/ГА</th>
<th>CULTIVATION COST (TECHNOLOGY), $/ГА</th>
<th>COST OF PRODUCTION, $/Т</th>
<th>MARKET PRICE, $/1 Т</th>
<th>STORAGE</th>
<th>FARM PROFIT, $/ГА</th>
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</thead>
<tbody>
<tr>
<td>WHEAT</td>
<td>0,8-1,0</td>
<td>150-200</td>
<td>150-200</td>
<td>250</td>
<td></td>
<td>50.00</td>
</tr>
<tr>
<td>FLAX</td>
<td>1,0</td>
<td>200-250</td>
<td>200-250</td>
<td>500</td>
<td></td>
<td>250-300</td>
</tr>
</tbody>
</table>
YIELD OF WHEAT DEPENDS ON TECHNOLOGY, SEVERE DRY YEAR

- Wheat after fallow: 14.6
- Wheat after dry pea: 16.2
- Wheat after oats: 13.3
- Wheat after canola: 11
- Cont. wheat from 1979: 12.6

Yield, c/ha

- Traditional
- Minimum
- No-Till

Crop rotation and tillage practices significantly affect wheat yield during severe dry years.
YIELD OF WHEAT DEPENDS ON TECHNOLOGY, Growing weather

- Traditional
- Minimum
- No-Till

Yield, cent/ha

- Wheat after fallow
- Wheat after oats
- Wheat after dry pea
- Wheat after canola
- Cont. wheat from 19779

Wheat after fallow: 41.8
Wheat after oats: 36.8
Wheat after dry pea: 38.3
Wheat after canola: 29.8
Cont. wheat from 19779: 35.1

Yield range: 21.5 to 40
Based on our research & farm experience, the principle steps are needed:

- **Government strategy**

- **Long-term research on CA**

- Currently use farming system with right–angled fields and straight-lined roads on slopes doesn’t meet soil conservation requirements.

- *It is critical to develop cropping system with soil cover crop rotations and diversify root system rotation to avoid soil compaction.*

- **On – farm research on the farm level**

- **Activate extension service**

- **Use of modern technology like remote sensing and GIS technology to develop CA system with full retention of crop residues.**

- **Smart Agriculture (precision farming, remote sensing, electronic maps, etc.)**
DIRECT SEEDING of FLUX

Photo: by Kanat Akshalov
DIRECT SEEDING OF FLUX
BY «CONDOR 12001» DRILL, AMAZONE
DIRECT SEEDING OF DRY PEA

Photo: by Kanat Akshalov
DIRECT SEEDING of SPRING WHEAT

Photo: by Kanat Akshalov
DRIP IRRIGATION of COTTON
DRIP IRRIGATION
THANKS FOR YOUR ATTENTION AND FOR YOUR TIME

Photo: by Kanat Akshalov