No-Till
A Climate Smart Agriculture Solution for Kazakhstan

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Turi Fileccia (FAO)

Washington, DC. April 22, 2013
Outline

1. Agriculture and forestry are a major component of the climate change problem
2. But agriculture and forestry are also part of the solution
3. Carbon in soils – Conservation Agriculture/No-Till
4. The example of Kazakhstan
5. The Agricultural Competitiveness Project
CO2 basics...

- Plants utilize Carbon Dioxide (CO$_2$) and water to produce carbohydrates which converts atmospheric CO$_2$ into an organic form.
- Burning plants/trees releases CO$_2$.
- Soils store large quantities of organic matter (more carbon is stored in soils than atmosphere and living vegetation together).
- Changing organic matter in soils releases/sequesters CO$_2$ into/from the atmosphere.

That is why deforestation and desertification (loss of soil organic matter) are a major sources of Green House Gases (GHGs).
Not only CO2...

Two Green House Gases (GHGs) other than CO₂ are important in agriculture:

• **Methane (CH₄):** 21 times more climate impact than CO₂
• **Nitrous Oxide (N₂O):** 310 times more climate impact than CO₂

*Agriculture contributes about 47% and 58% of total anthropogenic emissions of Methane (CH₄) and Nitrous Oxide (N₂O):*

• Enteric fermentation in cattle, manure decomposition and rice cultivation release Methane (CH₄)
• Soils, fertilizer applications, and livestock release Nitrous Oxide (N₂O)
IPCC estimates of global anthropogenic GHG emissions

Indeed according to FAO, livestock alone contributes to 18% of global emissions.

Forestry is short - but wrong - for Land Use, Land Use Change, and Forestry (LULUCF).

The new IPCC 5 assessment will merge Agriculture, Forestry, and Land Use.
The annual CO$_2$ variations are due to carbon absorption by plants during spring and summer due to the fact that the land area in the northern hemisphere is much wider than in the southern hemisphere. This proves the massive role of vegetation in sequestering CO$_2$.
What truth??

A most inconvenient truth

...what Al Gore neglected to mention
CC Impact on Agriculture

Regionally variability with many uncertainties:

Negative impact in warmer regions where water limits productivity of rain-fed crops (i.e., most of Turkey, southern Kazakhstan and the rest of Central Asia)

- Decreased water availability (reduced average precipitations, increased average temperatures, glaciers melting)
- Increased climatic variability (more droughts or floods)
- Changes in pests and weeds

Some Positive impacts in colder regions (north Kaz.):

- Improved farming season thanks to increased temperatures (in colder climates)
- CO2 fertilization
CC impact on Agriculture

Projected impacts from climate change in different EU regions

↑ winter rainfall (floods)
↑ sea levels
↑ hotter and drier summers
↑ crop yields, range

↑ temperature
↓ annual rainfall, water availability
↑ drought risk, heat stress
↓ crop yields
↓ suitable crop areas

↑ sea / lake levels
↑ storms, floods
↑ hotter and drier summers
↑ growing seasons
↑ crop potential
↑ pests
↑ permafrost thaw

↑ winter rainfall (floods)
↓ summer rainfall
↑ drought risks
↑ Soil erosion risk
↑ growing season length
↑ crop yields and range
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Agriculture has a role in both Mitigation & Adaptation

• **Mitigation - Avoid the unmanageable**
  - Reforestation (implemented in Turkey, but without carbon trading)
  - Soil Management
  - Livestock Waste Management

• **Adaptation - Manage the unavoidable**
  - Improved water resources management
  - Development of new varieties for crops and pastures (shorter cycles)
  - Increased use of insurances to mitigate climatic extremes
  - Control new/stronger pests/weeds and animal diseases
  - Improved farming technologies
Agriculture and Forestry jointly have more mitigation potential than energy

Global Economic Mitigation Potential for Different Sectors by 2030
(IPCC Estimations)
Ag.: Lower Mitigation Cost than Energy

Global GHG abatement cost curve beyond business-as-usual – 2030

Agricultural potential underlined in red
Forestry potential underlined in green

Note: The curve presents an estimate of the maximum potential of all technical GHG abatement measures below €60 per tCO₂e if each lever was pursued aggressively. It is not a forecast of what role different abatement measures and technologies will play.

Source: Global GHG Abatement Cost Curve v2.0
Practices to increase soil carbon

Avoid burning harvest residues

Improve soil fertility and plant biomass production

Improve arable soil management: Reduce/no tillage

From Martial Bernoux, Institut de Recherche pour le Développement (IRD)
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Conservation Agriculture Definition

**FAO definition:**
1. **Minimal Soil Disturbance/No Till**: the tilled area must be less than 15 cm wide or 25% of the cropped area (whichever is lower)
2. **Soil cover**: Ground cover must be more than 30%
3. **Crop rotation**: Rotation should ideally involve at least 3 different crops. However, monocropping is not an exclusion factor

From Martial Bernoux, Institut de Recherche pour le Développement (IRD)
Conservation Agriculture (CA)

AGRICULTURE

No-Till: the Quiet Revolution

The age-old practice of turning the soil before planting a new crop is a leading cause of farmland degradation. Many farmers are thus looking to make plowing a thing of the past.

By David R. Huggins and John P. Reganold

From Scientific American, 2008
The limits of ploughing

Ploughing used to be essential to control weeds, but it causes soil erosion and consequent loss of fertility (with variations according to local conditions).

CA/NT increases soil organic matter with the following benefits: reduced soil erosion, improved soil structure, reduced leaching, increased water infiltration, earthworms proliferation which creates channels that foster root growth.
CA/NT and Soil Carbon sequestration

Impact of adoption of conservation agriculture on soil carbon stocks

CA also promotes economy of fossil fuel consumption (permanent benefit)

From Martial Bernoux, Institut de Recherche pour le Développement (IRD)
World Bank Report
Carbon Sequestration in Agricultural Soils

By Ademola Braimoh
abraimoh@worldbank.org
Soil Carbon Sequestration Website

CA/NT for adaptation

CA/NT

Conventional

Source: Sandra Corsi (IFAD) from Des McGarry in Cina
CA/NT Increases Water Infiltration

- Mulch insulates extreme temperatures
- Better soil structure increases rainfall efficiency
- Studies prove that CA/NT increases rainfall infiltration

<table>
<thead>
<tr>
<th>Canada</th>
<th>13 Year No-Till</th>
<th>Conv. Till (Wheat/Fallow)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organic Matter (%)</td>
<td>5.1</td>
<td>2.7</td>
</tr>
<tr>
<td>Infiltration (mm/hr)</td>
<td>69</td>
<td>38</td>
</tr>
</tbody>
</table>

Total of 80 mm of water applied in 1 hour.
CA/NT Increases Soil Moisture

Soil moisture in 0-20cm soil depth:
CA: Conservation Agriculture TT: Traditional Tillage
China, March 2009
CA/NT Effects on Soil Structure

Traditional Tillage

52 years CA/NT

20 feet apart samples in Ohio

http://www.youtube.com/watch?v=q1aR5OLgcc0
Short Term Benefit: Planting Immediately after Harvesting
CA Triple Win-Win

**Economic/Financial benefits**
- Increased profitability by reducing soil preparation costs
- Possibility to have two crops/catch crops (in warmer climates)
- Reduced soil erosion

**Climate Change Adaptation**
- Improving rainfall efficiency and soil moisture storing
- Increased soil organic matter, biodiversity and fertility

**Climate Change Mitigation**
- Reduced green house gas emissions
Conservation Agriculture Adoption

Global adoption in 2010/12: ~125 Million ha (9% of arable land)

From Martial Bernoux (IRD) on data from Derpsch and Friedrich (FAO), and *Roberts and Johnston, 2009
Obstacles to Adoption

- More benefits when technology is applied for several years
- Challenging technological changes and steep learning curve
- New weed management approach
- Increased cost for herbicides (at least initially)
- Challenges to update farm machinery
- Difficulty to handle crop residues

Adoption is easier in larger farms, and more challenging (but not impossible nor less beneficial) in smaller farms. That is why adoption takes time
CA Adoption Takes Time

Sales of CA equipment in Australia
CA/NT History

History and Development

Global CA area (million ha)

- 1974: First farmer adoption in Brazil
- 1976: FAO involvement in Latin America
- 1980: CA revolution in Latin America
- 1990: Start of FAO CA work
- 1996: First CA congress in Central Asia
- 2000: Increased global interest in CA
- 2010: Current status

European Regional Conference (ERC) 2012: “Save and Grow” and promotion of Conservation Agriculture, Baku, Azerbaijan
Production Increase
**EX-Ante Carbon-balance Tool (EX-ACT)**

**One tool, several potentials**

- Helping policy decision-making
- Putting forward externalities
- Helping to get additional funding
- Strengthening value chains

**EX-ACT main objective**

Estimating the possible mitigation benefits of an investment project/programme

**EX-ACT in few words**

- Set of linked Microsoft Excel sheets (19)
- Based on land use and management practices
- Using IPCC default values (Tier 1) and/or *ad hoc* coefficients (Tier2)
- Comparing a situation without project and a situation with project
- Upgradable over time
- Possible up-scaling (watershed, national, regional levels)

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Kazakhstan is a major wheat exporter

Wheat production and exports (2008-2012)

- **Production (1000 MT)**
- **Exports (1000 MT)**
- **Domestic Consumption (1000 MT)**
- **Linear (Exports (1000 MT))**

<table>
<thead>
<tr>
<th>Year</th>
<th>Production</th>
<th>Exports</th>
<th>Domestic Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>12,538</td>
<td>6,152</td>
<td>6,185</td>
</tr>
<tr>
<td>2009</td>
<td>17,051</td>
<td>7,600</td>
<td>7,600</td>
</tr>
<tr>
<td>2010</td>
<td>9,638</td>
<td>6,200</td>
<td>6,200</td>
</tr>
<tr>
<td>2011</td>
<td>22,732</td>
<td>7,400</td>
<td>7,400</td>
</tr>
<tr>
<td>2012</td>
<td>11,844</td>
<td>6,800</td>
<td>6,800</td>
</tr>
</tbody>
</table>

Exports / Production (2008-2012): 5% to 60%
RUK is challenging the US as the largest wheat exporter in the world.
Wheat is produced mostly in the northern part of Kazakhstan

Ranks 9 place all over the world in the area extent. Around 20 mln ha is used for crop production, mainly for wheat – 14 mln ha. Mostly spring wheat, planted in spring and harvested in autumn because winters are too cold.
Rainfed wheat with limited precipitation

- 250-300 mm, rainfed
- 350-400 mm, rainfed
- 250 mm, rainfed
- 250-300 mm, rainfed
- 300-350 mm, irrigated, rainfed
The importance of stubble

- 50% of yield depends on soil moisture
- Snow 30-40 % of all precipitations
- Snow is taken away by the strong wind of the steppe or through runoff (causing erosion)
- Stubbles of preceding crop trap snow
- Snow melts more gradually and more water becomes available to growing crop
- The higher the stubble the better (35 to 40-45 cm for best results)
Snow trapping
CA/NT Adoption in Kazakhstan

- Kazakhstan together with Russia has the highest adoption in ECA
- The area has grown more than 200% during the last 5 years
- Now it is practiced on at least 1.85 million ha (CIMMYT, 2012 based on a rigorous new assessment)
- The country is ranked 9th in the world
CA/NT area in Kazakhstan

2007: 600 '000 hectares
2010: 1,220 '000 hectares
2011: 1,440 '000 hectares
2012: 1,850 '000 hectares
In terms of speed of adoption, during the last three years, Kazakhstan shares the 1st position with China.
A good business for farmers

Graph 2: Financial Benefits of Conservation Agriculture in Wheat Production in Northern Kazakhstan (F-IRR = 28%)
# Global Adoption of TA/No Till

## Table 1: General overview of CA/No-till Adoption in the World

<table>
<thead>
<tr>
<th>Rank</th>
<th>Country</th>
<th>Conservation agriculture area (1000 ha)</th>
<th>Conservation agriculture area as % of cultivated area (%)</th>
<th>Ranking Order</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>United States of America</td>
<td>26,500</td>
<td>16</td>
<td>9</td>
</tr>
<tr>
<td>2</td>
<td>Argentina</td>
<td>25,553</td>
<td>80</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>Brazil</td>
<td>25,502</td>
<td>37</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>Australia</td>
<td>17,000</td>
<td>36</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>Canada</td>
<td>13,481</td>
<td>26</td>
<td>7</td>
</tr>
<tr>
<td>6</td>
<td>Russia</td>
<td>4,500</td>
<td>4</td>
<td>16</td>
</tr>
<tr>
<td>7</td>
<td>China</td>
<td>3,100</td>
<td>2</td>
<td>17</td>
</tr>
<tr>
<td>8</td>
<td>Paraguay</td>
<td>2,400</td>
<td>62</td>
<td>2</td>
</tr>
<tr>
<td>9</td>
<td>Kazakhstan</td>
<td>1,850</td>
<td>7</td>
<td>13</td>
</tr>
<tr>
<td>10</td>
<td>Bolivia</td>
<td>706</td>
<td>18</td>
<td>8</td>
</tr>
<tr>
<td>11</td>
<td>Uruguay</td>
<td>655</td>
<td>34</td>
<td>5</td>
</tr>
<tr>
<td>12</td>
<td>Spain</td>
<td>650</td>
<td>4</td>
<td>15</td>
</tr>
<tr>
<td>13</td>
<td>Ukraine</td>
<td>600</td>
<td>2</td>
<td>19</td>
</tr>
<tr>
<td>14</td>
<td>South Africa</td>
<td>368</td>
<td>2</td>
<td>18</td>
</tr>
<tr>
<td>15</td>
<td>Venezuela</td>
<td>300</td>
<td>9</td>
<td>11</td>
</tr>
<tr>
<td>16</td>
<td>France</td>
<td>200</td>
<td>1</td>
<td>20</td>
</tr>
<tr>
<td>17</td>
<td>Zambia</td>
<td>200</td>
<td>6</td>
<td>14</td>
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<tr>
<td>18</td>
<td>Chile</td>
<td>180</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>19</td>
<td>New Zealand</td>
<td>162</td>
<td>30</td>
<td>6</td>
</tr>
<tr>
<td>20</td>
<td>Finland</td>
<td>160</td>
<td>7</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td><strong>TOTAL</strong></td>
<td><strong>124,067</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Others</strong></td>
<td><strong>1,000</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: FAO Aquastat, 2012; Mission update for Kazakhstan
Wheat production is estimated to be 10.7 million tons

*Wheat 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 0.7 million tons, equivalent to around 220 million dollars

Kazakhstan - Yield Increases

- Traditional technology (t/ha)
- No till technology (t/ha)

Wheat Productivity

<table>
<thead>
<tr>
<th>Year</th>
<th>Traditional technology</th>
<th>No till technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>0.65</td>
<td>1.02</td>
</tr>
<tr>
<td>2011</td>
<td>1.58</td>
<td>2.34</td>
</tr>
<tr>
<td>2012</td>
<td>0.83</td>
<td>1.23</td>
</tr>
</tbody>
</table>
National Benefits from CA/NT Adoption - Wheat only

**Thousand ton**

- 2010: 364
- 2011: 883
- 2012: 717

**US$ million**

- 2010: $75.0
- 2011: $282.6
- 2012: $218.9

**Percent of Total Production**

- 2010: 4%
- 2011: 4%
- 2012: 7%

**Million People Fed**

- 2010: 3
- 2011: 6
- 2012: 5
Kazakhstan - Impact of CA/NT

• Increased income and food security during the last three 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 equivalent to the emissions of 270,000 cars
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The Agricultural Competitiveness Project (ACP)

- 42 out of 585 Competitive Grants awarded for no-till/minimum tillage activities.
- Beneficiary farmers have expanded the technology to the rest of their farm areas (about 45,000 ha)
- Extension activities of KazAgroInnovation contributed to further expansion through seminars in knowledge centers, direct consultancies and call centers. High demand topic
ACP Contribution

• Due to replication effect, extrapolation can be made for the entire country which would allow the assumption that some 350,000-400,000 ha of NT area have been promoted thanks to ACP

• Strengthened links between research centers and farmers reduced failures

• ACP supported the CIMMYT assessment
Kazakhstan – CA/NT State of art and needs

- **GOK** and the national research system have done a lot: policy, incentives, investment, R&D
- **The private sector** has invested (specifically) over 200 million dollars
- CA/NT specialized **machinery companies are expanding**, but farmers depend excessively on machinery suppliers
- Some farmers **reversed adoption** because of organizational challenges
- To enable further expansion and avoid reversals **more investment is required**
- More farm/business specific **R&D, Knowledge Dissemination, and expert advice**
... a good start, but still a work in progress!!
Thanks!