ACCELERATING ADOPTION OF CLIMATE TECHNOLOGIES IN THE AGRIFOOD SECTOR

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Session 1
ACCELERATING ADOPTION OF CLIMATE TECHNOLOGIES IN THE AGRIFOOD SECTOR – KEY RESULTS FROM THE FAO/EBRD STUDY
Background

FAO-EBRD collaboration on FINTECC

• First phase (2015-16):
  • Development of initial methodology study
  • Involvement of the International Energy Agency (IEA)
  • First pilot study in Morocco

• Second phase (2017-18):
  • Revising the methodology
  • Studies in Kazakhstan and Kyrgyz Republic
# The 5 Steps

<table>
<thead>
<tr>
<th>ANALYSIS OF EMISSIONS AND VULNERABILITIES</th>
<th>TECHNOLOGIES EVALUATED AND SCORED</th>
<th>LIST OF PRIORITISED TECHNOLOGIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adaptation priorities and mapping GHG emissions</td>
<td>Assessing technical and financial feasibility</td>
<td>Ranking and conclusions</td>
</tr>
<tr>
<td>Evaluating economy-wide impacts and sustainability</td>
<td></td>
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<tr>
<td>Evaluating support policies and barriers</td>
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</tbody>
</table>

- **Contribute to increased adaptation to climate change and to GHG emissions reduction in the agrifood sector**
- **Identify drivers to support adoption**
- **Identify technologies with significant potential**
# Objectives and criteria used for the core of the technologies assessment (Steps 2, 3 and 4)

<table>
<thead>
<tr>
<th>OBJECTIVES</th>
<th>STEP 2</th>
<th>STEP 3</th>
<th>STEP 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>TECHNICAL AND FINANCIAL</td>
<td>To identify the most technically efficient and supported technology and to maximise the returns to individual investors.</td>
<td>ECONOMIC AND ENVIRONMENTAL</td>
<td>To maximise net economic benefits</td>
</tr>
<tr>
<td>INSTITUTIONAL</td>
<td>To pursue technologies with the lowest reform threshold</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>CRITERIA</th>
<th>STEP 2</th>
<th>STEP 3</th>
<th>STEP 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance compared to best practice</td>
<td></td>
<td></td>
<td>Policy reform requirements</td>
</tr>
<tr>
<td>Maturity of technical support services</td>
<td>Potential to reduce annual GHG emissions</td>
<td>Contribution to adaptation</td>
<td></td>
</tr>
<tr>
<td>Current technology adoption rate</td>
<td>Mitigation costs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trends in gap between uptake and potential</td>
<td>Negative externalities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Financial returns</td>
<td>Positive externalities</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Assigning scores to criteria

### Technical and financial assessment (Step 2)

<table>
<thead>
<tr>
<th>STEP</th>
<th>CRITERIA</th>
<th>SCORING</th>
<th>HIGHLIGHTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>TECHNICAL &amp; FINANCIAL</td>
<td>Performance compared to best practice</td>
<td>4</td>
<td>Farmers mainly use the technology...</td>
</tr>
<tr>
<td></td>
<td>Maturity of technical support services</td>
<td>3</td>
<td>Technology....</td>
</tr>
<tr>
<td></td>
<td>Current adoption rate</td>
<td>14%</td>
<td>Potential areas ....</td>
</tr>
<tr>
<td></td>
<td>Trends in gap between uptake and potential</td>
<td>3</td>
<td>Area installed ....</td>
</tr>
<tr>
<td></td>
<td>Financial returns</td>
<td>22%</td>
<td>-NPV, -IRR, -Payback period</td>
</tr>
</tbody>
</table>
Assigning scores to criteria
Technical and financial assessment (Step 2)

<table>
<thead>
<tr>
<th>STEP</th>
<th>CRITERIA</th>
<th>SCORING</th>
<th>ABSOLUTE SCORE explained</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Performance compared to best practice</td>
<td>4</td>
<td>Qualitative: Likert scale 1 – very low to 5 – very high</td>
</tr>
<tr>
<td></td>
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<td>3</td>
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<tr>
<td></td>
<td>Current adoption rate</td>
<td>14%</td>
<td>Quantitative: estimated current adoption rate in % of technical potential</td>
</tr>
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<td>3</td>
<td>Qualitative: Likert scale 1 – very low to 5 – very high</td>
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<tr>
<td></td>
<td>Financial returns</td>
<td>22%</td>
<td>Quantitative: estimated internal rate of return (IRR) from financial models using market prices</td>
</tr>
</tbody>
</table>

Absolute scores
QUANTITATIVE or QUALITATIVE
Assigning scores to criteria
Economic and institutional assessment (Step 3 and 4)

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</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Potential to reduce annual GHG emissions</td>
<td>65 KtCO₂eq</td>
<td><strong>Quantitative:</strong> estimated absolute amount of emissions in CO₂ equivalent that could be reduced at full estimated technical adoption</td>
</tr>
<tr>
<td></td>
<td>Contribution to adaptation</td>
<td>4</td>
<td><strong>Qualitative:</strong> Likert scale 1 – very low to 5 – very high</td>
</tr>
<tr>
<td></td>
<td>Mitigation cost</td>
<td>-50 USD/tCO₂eq</td>
<td><strong>Quantitative:</strong> estimated USD per ton of CO₂ equivalent emissions where USD is based on estimated NPV of adoption</td>
</tr>
<tr>
<td></td>
<td>Negative externalities</td>
<td>3</td>
<td><strong>Qualitative:</strong> Likert scale 1 – very low to 5 – very high</td>
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<td></td>
<td>Positive externalities</td>
<td>4</td>
<td><strong>Qualitative:</strong> Likert scale 1 – very low to 5 – very high</td>
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<td>4</td>
<td>Policy reform requirements</td>
<td>2</td>
<td><strong>Qualitative:</strong> Likert scale 1 – very low to 5 – very high</td>
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</table>
Kyrgyz Republic: an important Ag sector

**Agriculture value added as % of total GDP**

**Agriculture as % of total employment**

**Important for GDP**

**Important for employment**
Agriculture value added as % of total GDP

Signs of decline but still high than international standards

Source: World Bank
Total emissions relative to total GDP

Very high country emissions to GDP, in line with the region and moderately declining

Source: FAOSTAT and World Bank
Agriculture emissions relative to Agriculture GDP
Agricultural GHG intensity value higher than region and increasing!

Source: FAOSTAT and World Bank
Value and share of agriculture emissions
Large and increasing share of Agriculture sector emissions

Source: FAOSTAT and EDGAR
Emissions intensities of key commodities
Slightly below regional averages

Source: FAOSTAT
Key emitting activities within the farm gate

Emissions from agriculture activities, thousand tCO2eq 2000-2016

- Synthetic Fertilizers
- Rice Cultivation
- Organic soils
- Manure Management
- Manure left on Pasture
- Manure applied to Soils
- Enteric Fermentation
- Cultivation of Organic Soils
- Crop Residues
- Burning - Savanna
- Burning - Crop residues

Source: FAOSTAT

95% increase in total emissions btw 2000-2002 and 2014-2016 due to livestock

+1.5 million tCO2eq
Trends in livestock numbers
Density of livestock increasing very rapidly

Density of livestock in the agricultural area, LSU/ha, 2000-2016

Evolution in stocks of major animal types in the Kyrgyz Republic, million heads, 2000-2016

Source: FAOSTAT
Livestock-output levels comparison
Above regional average (data issues?)

Yields in cow milk, average 2014-2016, kg/animal

Yields in goat and sheep milk, average 2014-2016, hg/animal

Yields in goat and sheep meat, average 2014-2016, hg/animal

Yields in cattle meat, average 2014-2016, kg/animal
Adding energy emissions to the picture (FAOSTAT data)

Stable energy emissions within farm gate and small share of total

Source: FAOSTAT
Adding energy emissions to the picture (UNSD data)
Energy related agrifood sector emissions benefiting from shift to hydro!

Emissions from energy consumption in forestry and agriculture + energy use in food and tobacco, thousand tCO2eq, 2000-2014

Electricity production from hydroelectric sources in the Kyrgyz Republic (% of total), 2000-2014

Source: UNSD

Source: World Bank
# Key findings from analysis of emissions

## Considerable growth in Ag sector emissions over past 15 years
- in absolute terms
- in value intensity: growth of 1 tCO2eq per USD 1,000 of Ag GDP since 2002
- while total country emissions relative to total GDP are approximately constant

## Main emitting activities associated with livestock (enteric fermentation and manure)
- combined account for almost 90% of total emissions from agriculture at present
- livestock sector growth accounts for 95% of emissions increase in past 15 years (around 1.4 billion tCO2eq)

## Livestock emissions evolution driven by increase in herd
- density increased significantly
- productivity stagnant with extensive systems

## Emissions from energy use within farm gate small stable (FAOSTAT)
- small share of total agriculture sector emissions (around 7%)

## Total emissions from agriculture and food industry declining (UNSD)
- mostly explained by shift to hydro and consequent decrease in emissions from electricity generation
Context of vulnerability to climate change in Kyrgyzstan

• Observed changes:
  • significant increase in average annual temperatures by of 0.0104°C/year over 1885-2010
  • precipitation changed insignificantly, but in recent years drastic changes in certain regions, both upward and downward, were observed for 1885-2010. However, downward trend in precipitation for 1990-2010
  • glacier volume decreased by approximately 15% from mid 1970s to 2000

• Existing climate projections and assessments converging towards:
  • continued increases in air temperature (1.4-2.0 °C in 2046-2065 compared to 1986-2005)
  • the annual precipitation will remain practically unchanged
  • significant reductions in glacier cover over the long run
Agriculture as a highly vulnerable sector
Main source of livelihood and food security for a large rural population

- 87% of agriculture land used as **pastures**
- 50% of pastures subject to degradation due to **overgrazing and inefficient practices**
- 12% of agriculture land used for crops
  - 75% depends on irrigation with high water losses due to poor technical conditions
  - large portions of land (50-80%) in poor condition with soil fertility problems compounded by inappropriate practices
- Sector uses 93% of country’s freshwater resources
- High susceptibility to natural disasters and unfavourable weather conditions
  - higher temperatures, shifts in cropping seasons
  - likely impact on crops and pastures yields but difficult to assess
  - natural disasters in 2016 higher than average, causing a total of USD 23 million of economic damage
Key findings from analysis of vulnerabilities

Possible shortages in water resources due to changes in surface water runoff
- increase by 10% to 55 km³/year by 2020-2025 and then decrease by about 40% by 2100
- water supply to agriculture at risk in the Kyrgyz Republic and Central-Asian region as a whole

Depletion of water resources leading to increase of arid and semi-arid areas
- from current 15% to 23-49% in 2100 (FAO GCF)

Increase in frequency and intensity of extreme climate events
- more frequent heat stress and droughts especially at low altitudes (below 1500 masl) in summer months leading to reduced water availability for livestock and additional pressure on pastures
- increased mudslides, flush floods and river floods limiting pastures accessibility
- (negative) impact of increased droughts on crop yields but difficult to determine

High expected economic losses in absence of timely adaptation in agriculture
USD 70 million per year by 2100 according to INDCs

Very high adaptation investment needs all sectors included
USD 1.9 billion according to INDCs
Climate change adaptation context

Water availability is a key concern!

Themes from key strategic documents

• Water perceived to be the most vulnerable sector
• High vulnerability of the agriculture sector with expected changes in water availability
• Irrespective of climate change there is growing pressure on resources
• High incidence of weather-related hazards
• Possibility for regional tensions due to water issues
• Hydro-power energy generation may suffer
Directions for adaptation in the country

- Increasing resilience in crops and livestock production
  - adoption of conservation tillage methods (e.g. no-till, mulching, strip till) to increase water infiltration and maintain soil moisture
  - selection of high yield drought and salt resilient crops
  - introduction of improved grazing systems and livestock management practices

- Improving the provision of water resources to agriculture
  - improved water resources management/ economic incentives for rational use
  - improved water supply efficiency (reduced water loss in existing irrigation systems through maintenance and repair and adoption of efficient irrigation technology e.g. drip irrigation)
  - rebuild existing irrigation schemes where rehabilitation not sufficient
Estimated investment size
USD 1.0 billion in base case scenario of investment needs for full adoption

USD 1.0 billion
2.9 million tCO2eq/year
Estimated simplified MACC

Pasture improvement with low mitigation cost and very high potential
Technology ranking: Mitigation-oriented
Weights, weighted scores and prioritised list

- Performance compared to best practice: 5%
- Maturity of technical support services: 5%
- Weighted scores: 0 to 100
- Financial returns: 10%
- Contribution to adaptation: 10%
- Mitigation cost: 15%
- Positive externalities: 5%
- Negative externalities: 5%
- Policy reform intensity: 5%
- Current technology adoption rate: 5%
- Trends in gap between uptake an potential: 5%
- Potential to reduce annual GHG: 30%
- Contribution to adaptation: 10%
- Financial returns: 10%
- Mitigation cost: 15%
- Positive externalities: 5%
- Negative externalities: 5%
- Policy reform intensity: 5%
- Current technology adoption rate: 5%
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Performance compared to best practice:
- PASTURE IMPROVEMENT: 64.6
- MANURE MANAGEMENT: 50.0
- DRIP IRRIGATION: 49.1
- IMPROVED GREENHOUSES: 49.0
- CONSERVATION AGRICULTURE: 47.1
- BIOGAS (BIOFERTILIZER): 41.0
- FIELD MACHINERY: 38.0
- FATTENING UNITS: 33.4
- BIOGAS: 29.2
- STEAM BOILERS: 29.1
- SOLAR WATER PUMPS: 26.3
- WIND WATER PUMPS: 19.6
Technology ranking: Adaptation-oriented
Weights, weighted scores and prioritised list

Performance compared to best practice
Maturity of technical support services
Current technology adoption rate
Trends in gap between uptake and potential
Financial returns
Potential to reduce annual GHG
Contribution to adaptation
Mitigation cost
Negative externalities
Positive externalities
Policy reform intensity
Maturity of technical support services
Performance compared to best practice

0 10 20 30 40 50 60 70

DRIP IRRIGATION 64.1
PASTURE IMPROVEMENT 60.8
IMPROVED GREENHOUSES 58.9
MANURE MANAGEMENT 57.3
CONSERVATION AGRICULTURE 54.5
BIOGAS (BIOFERTILIZER) 44.3
SOLAR WATER PUMPS 39.6
FIELD MACHINERY 39.1
WIND WATER PUMPS 32.6
FATTENING UNITS 30.7
BIOGAS 30.0
STEAM BOILERS 26.7
Technology ranking: Financial Return-oriented
Weights, weighted scores and prioritised list

![Image showing weighted scores and prioritised list of technologies]

**Performance compared to best practice** 5%
**Maturity of technical support services** 5%
**Current technology adoption rate** 5%
**Trends in gap between uptake and potential** 5%
**Policy reform intensity** 5%
**Positive externalities** 5%
**Negative externalities** 5%
**Mitigation cost** 5%
**Contribution to adaptation** 15%
**Financial returns** 30%

**Potential to reduce annual GHG** 15%
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**Negative externalities** 5%
**Positive externalities** 5%
**Policy reform intensity** 5%

**Weights**
- Financial Return: 30%
- Performance compared to best practice: 5%
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- Negative externalities: 5%
- Positive externalities: 5%
- Policy reform intensity: 5%

**Weighted scores (0 to 100)**
- **IMPROVED GREENHOUSES**: 64.7
- **DRIP IRRIGATION**: 60.5
- **BIOGAS (BIOFERTILIZER)**: 55.7
- **CONSERVATION AGRICULTURE**: 50.6
- **PASTURE IMPROVEMENT**: 48.7
- **FATTENING UNITS**: 48.2
- **MANURE MANAGEMENT**: 45.2
- **FIELD MACHINERY**: 31.9
- **STEAM BOILERS**: 30.5
- **SOLAR WATER PUMPS**: 29.6
- **BIOGAS**: 23.3
- **WIND WATER PUMPS**: 22.4
Mitigation costs, potential and weighted scores
Bubble size proportional to mitigation potential (ktCO2eq/year)
**Technology tree**

**SOLAR WATER PUMPS**
INTERESTING TECHNOLOGY BUT DIFFICULT TO DEVELOP
- Competition from cheap and low emissions electricity (hydro)
- Can be interesting in remote areas and with high value crops

**WIND WATER PUMPS**
LIMITED AREAS IN THE COUNTRY AND COMPETITION FROM CHEAP ELECTRICITY
- Very low financial returns and would need public support measures
- Only interesting in areas where access to water and grid-electricity is limited

**EFFICIENT STEAM BOILERS**
PROMISING BUT ADOPTION LINKED TO AGRIFOOD SECTOR TRANSITION
- Moderate returns but good GHG reduction per unit
- Limited by numbers of food enterprises

**BIOGAS**
VERY HIGH THEORETICAL POTENTIAL BUT VERY DIFFICULT TO DEVELOP
- Competition from cheap and low emissions electricity (hydro)
- Extensive livestock production systems not easy to modify

**EFFICIENT FATTENING UNITS**
TACKLING LIVESTOCK PRODUCTIVITY ISSUES
- Can yield high returns and support sector modernization
- Difficult to scale up with current sector structure

**DRIP IRRIGATION**
ONLY A MITIGATION TECHNOLOGY IN SPECIFIC SITUATIONS
- Solid returns and highly suitable for high value crops
- Limited current potential given country’s irrigation network

**CONSERVATION AGRICULTURE**
HIGH POTENTIAL FOR MITIGATION AND ALSO FOR ADAPTATION
- Moderate financial returns; important for long term soil quality
- Average property structure and lack of knowledge about technology are barriers

**PASTURE IMPROVEMENT**
GREAT POTENTIAL FOR CARBON SEQUESTRATION
- High priority for sustainability of livestock sector and low mitigation cost
- Public investments, organizational and technical support needed to foster adoption

**EFFICIENT FIELD MACHINERY**
GOOD POTENTIAL FOR FLEET RENOVATION
- Access to capital and availability of best technology are concerns

**IMPROVED GREENHOUSES**
MODERATE MARKET POTENTIAL BUT INTERESTING GREENING BENEFITS
- High returns but limited areas for adoption given areas under greenhouses
- Access to capital is a constraint; new greenhouses can stimulate energy consumption

**BIOGAS (BIOFERTILIZER)**
MODERATE MARKITATION POTENTIAL BUT LIMITED ADOPTION
- Solid returns and GHG reduction per unit
- Limited adoption due to highly scattered feedstock

**MANURE MANAGEMENT**
VERY GOOD MITIGATION POTENTIAL BUT COSTLY
- Good potential given livestock numbers and also important for soil quality
- Increased level of awareness on compost and public support needed

**EFFICIENT FIELD MACHINERY**
HIGH POTENTIAL FOR FLEET RENOVATION