Use of Conservation Agriculture in Crop-Livestock Systems (CLCA) in the Drylands for Enhanced Water Use Efficiency, Soil Fertility and Productivity in NEN and LAC Countries

Tunisia CLCA Project: Socio-economic activities

Tunis, March 5th, 2020
How to deal with complex systems?

**Farming systems**
- Farmers' behaviors
- Economic context
- Environmental mutation
- Societal exigences

**Resources:**
- (land, water, soil, energy, ...)  

**Society:**
- (markets, technologies, institutions, policies, ...)  

**Agricultural systems:**
- (crops-livestock-mixed system, capital, labor,)

**Indicators**
- Products
- Costs
- Externalities (+/-)
- Income

**Policy decisions**
- Public engagement
- Stakeholders involvement
- Civil society and NGOs

**Assessment**
- Participatory methods
- Mathematic programming
- Cost-benefit analysis
- Multi criteria analysis

**Sustainability**
Where we are right now?

• **Achievement:**
  - Assessment of constraints to the Adoption of Conservation Agriculture
  - Assessment of farmers perceptions of extension services
  - Quantification of crops residues + BBN model + typology of crop residues patterns.
  - Cost benefit assessment 79 ha... methodology + some results.
  - Presentation of Farm Design model,

• **Ongoing activities:**
  - Stakeholders perception of extension services
  - Spatial Extended cost benefit assessment .
  - Suitability map for sustainable CA adoption
Activities of socioeconomic teams

Participatory approach & Socio-economic surveys → stakeholders & farmers perception on CA adoption/ extension techniques
(20 surveys with farmers & 16 with researchers)

• Socio-economic survey → mathematical programming & optimization (farm typology
(150 surveys and 5 farm type surveys)

• Socio-economic survey → Spatial extended cost benefit analysis (survey design and testing)

• Spatial analysis → Generation of suitability map for sustainable CA adoption
Perception of constraints on CA adoption

Researchers & farmers Scoring results (means and range)

Correlation map, Kendall test
Effectiveness of agricultural extension

Effectiveness of the Extension methods

Factors influencing effectiveness of Extension methods

Potential impacts of Extension on the Livelihood of CA adopters
Assessment of trade-offs (1)

• The objective is to characterize trade-offs related to the use of crop residues in the small cereal-sheep farms of North West Tunisia (152 farms of the region of Siliana).
  • Calculated the quantity of cereal residues left on the soil after the harvest and the summer grazing (HI).
  • Analyzed the complex relationships of factors influencing farmer’s choices regarding crop residues allocation using a Bayesian Belief Network (BBN) model.
  • Typology analysis of farms based on their patterns of residue management in addition to other structural variables.

\[
CR_{left \ on \ the \ soil} = AGM_{ij} - (TQG_{ij} + SS_{ij} + GY_{ij})
\]

Conditional probability for CR patterns drivers:

\[
P(X_1, ...X_n) = \prod P\left(\frac{X_i}{\Pi_i}\right)
\]
Results:

- 74% of farmers in our sample are keeping less than 200 kg/ha of crop residue as mulch.

- This is especially relevant for the smallest farms with limited grazing opportunities and financial capacities to complement their animals with concentrates feed.

- The residue management is especially influenced by the share of livestock income, livestock herds, cost of livestock feed, barley area, and available grazing area.
Generation of suitability map for sustainable CA adoption

Step 1: Pre-selection of potential sites

Step 2: Sustainability Composite Index (SCI)
- Economic indicators
- Social indicators
- Environmental indicators

Step 3: Generation of the potential areas
- Land use
- Slope
- Stream network
- Others

Step 4: Spatial integration of SCI and feasibility maps

Source: Bahri et al., 2019

Suitability map for sustainable CA adoption
Extended spatial Cost Benefit Analysis

Potential suitable map for sustainable CA adoption
Net Present value of CA on different locations

Financial aspects (cost & benefit) and environmental aspects (preventing water erosion and enhancing soil fertility)

Extended CBA (12%)

\[
NPV = \sum_{t=0}^{n} \frac{(Benefits - Costs)_t}{(1 + r)^t}
\]

where:
- \( r \) = discount rate
- \( t \) = year
- \( n \) = analytic horizon (in years)

Preliminary results

<table>
<thead>
<tr>
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<th>Financial CBA (12%)</th>
<th>Extended CBA (12%)</th>
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<tbody>
<tr>
<td>NPV/Ha</td>
<td>374 DNT</td>
<td>746 DNT</td>
</tr>
<tr>
<td>IRR</td>
<td>16.15%</td>
<td>20.40%</td>
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Farm area: 73 ha
Investment cost: Seeder, Tractor and land preparation
Thank you !