# ECONOMIC IMPACT ASSESSMENT ON SANREM

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SANREM CRSP
Sustainable Agriculture and Natural Resource Manage
Collaborative Research Support Program

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# Objectives of Economic Impact Assessment Program on SANREM

To identify:

1) Costs and benefits of CA practices
2) Optimal CA practices in target cropping systems, and optimal sequencing of CAPS elements
3) Broader economic and social impacts of CA adoption
4) Policy changes to encourage CAPS adoption

# Structure of Impact Assessment

- The Impact Assessment cross-cutting research program has interacted with regional programs, as economic analyses take place in both the impact assessment program and the regional programs



# Collaboration with regional programs

- Regional programs have conducted baseline surveys and many have summarized and compared available input cost and yield data
- Regional programs (Lesotho, Mozambique, Ecuador, Uganda, Ghana) have conducted analyses of factors affecting  adoption of CA practices
- Regional programs in Ecuador and Nepal have assessed optimal CAPs
- Regional programs (Uganda and Ecuador) have assessed value farmers place on traits such as erosion control

# Analysis in Ghana of 3 years of cost of production data (by Tim Dalton and student at Kansas State)

## Example (2009): (a) Nyoli with conventional versus no-till

| Costs (GH¢/ha) | Maize | | Soybeans | |
|---|---|---|---|---|
| | CT+NPK | NT+NPK | CT | NT |
| **Labour** | 88.00 | 88.00 | 163.80 | 163.80 |
| **Purchased input** | 463.00 | 352.00 | 150.00 | 39.00 |
| **Total variable cost** | 551.00 | 440.00 | 313.80 | 202.80 |
| | | | | |
| **Yield (ton/ha)** | 0.27 | 0.20 | 1.11 | 1.00 |
| **Revenue(GH¢/ha)** | 140.19 | 103.38 | 579.18 | 521.14 |
| **Gross margin(GH¢/ha)** | -410.81 | -336.62 | 265.38 | 318.34 |
| **B/C ratio** | 0.75 | 0.77 | 0.85 | 1.57 |
| **Returns to labour** | 1.59 | 1.18 | 3.54 | 3.18 |
| **labour productivity(Kg/Mndys)** | 4.49 | 3.31 | 18.56 | 16.70 |

## (b) Busa-Tangzu with conventional versus no-till

| *Costs(GH¢/ha)* | *Treatments* | | | |
|---|---|---|---|---|
| | ***CT+NPK*** | ***NT-NPK*** | ***NT+NPK*** | ***NT+P*** |
| ***Labour*** | *184.40* | *182.40* | *182.40* | *182.40* |
| ***Tractor use*** | *150.00* | *0.00* | *0.00* | *0.00* |
| ***Fertilizer*** | *125.00* | *0.00* | *125.00* | *170.20* |
| ***Herbicide*** | *0.00* | *39.00* | *39.00* | *39.00* |
| ***Total variable cost*** | *459.40* | *221.40* | *346.40* | *391.60* |
| | | | | |
| ***Yield (ton/ha)*** | *0.95* | *0.61* | *0.85* | *0.81* |
| ***Revenue(GH¢/ha)*** | *683.71* | *442.22* | *612.14* | *585.50* |
| ***Gross margin(GH¢/ha)*** | *224.31* | *220.82* | *265.74* | *193.90* |
| ***B/C ratio*** | *0.49* | *0.99* | *0.77* | *0.49* |
| ***Returns to labour*** | *3.71* | *2.42* | *3.36* | *3.21* |
| ***labour productivity(Kg/Mndys)*** | *15.83* | *10.24* | *14.17* | *13.55* |

# Ghana – Partial budgets for trials

(C) Nandom maize trials with flat, tied ridges, and tied ridges plus grass strips treatments

| | TREATMENTS | | |
|---|---|---|---|
| ***Costs(GH¢/ha)*** | ***FLAT*** | ***TIED RIDGES*** | ***TR + GRASS STRIPS*** |
| ***Labour*** | *182.00* | *186.00* | *188.00* |
| ***Fertilizer*** | *385.00* | *385.00* | *385.00* |
| ***TVC*** | *567.00* | *571.00* | *573.00* |
| | | | |
| ***Yield (ton/ha)*** | *2.8* | *2.3* | *3.1* |
| ***Revenue(GH¢/ha)*** | *1326.60* | *1099.80* | *1474.20* |
| ***Gross margin(GH¢/ha)*** | *759.60* | *528.80* | *901.20* |
| ***B/C ratio*** | *1.34* | *0.93* | *1.57* |
| ***Returns to labour*** | *7.29* | *5.91* | *7.84* |
| ***labour productivity(Kg/Mndys)*** | *46.10* | *38.20* | *51.20* |

See several more budgets (for 2010 and 2011) and results from baseline survey in T. Dalton, I, Yahaya, and J. Naab "Perceptions And Performance of Conservation Agriculture Practices in Northwestern Ghana," *Agriculture, Ecosystems, and Environment*, 187 (April 2014): 65-71.

**Net benefits positive (except for maize in Nyoli) but varied substantially over the years**

# Nepal: Enterprise budgets
# (from Paudel, Halbrendt, and other at Hawaii)

## Cost of production (CoP), labor requirement and revenue

| Systems | $COP_{BLC}$($)/ha | Labor (person. days/ha) | Labor cost ($/hr) | Revenue ($) | $Profit_{BLC}$ ($) | $Profit_{ALC}$ labor $ |
|---|---|---|---|---|---|---|
| FT Maize-->Millet | 203 | 516 | 1146 | 1314 | 1111 | -35 |
| FT Maize-->BG | 209 | 514 | 1143 | 2248 | 2039 | 897 |
| FT Maize-->Cp | 203 | 461 | 1025 | 2190 | 1987 | 962 |
| FT Maize-->Mi+BG | 210 | 633 | 1406 | 1821 | 1611 | 206 |
| FT Maize-->Mi+Cp | 207 | 686 | 1524 | 2040 | 1833 | 309 |
| ST Maize-->Mi+BG | 210 | 608 | 1351 | 1822 | 1612 | 261 |
| ST Maize-->Mi+Cp | 207 | 633 | 1408 | 1934 | 1727 | 319 |

**NOTE: BLC = before labor cost, ALC = after labor cost, FT = full tillage, ST = Strip tillage; Mi+BG = millet and blackgram intercrop; Mi+Cp = millet and cowpea intercrop**
**--> sign indicate preceding crop was followed by the succeeding crop in second season**

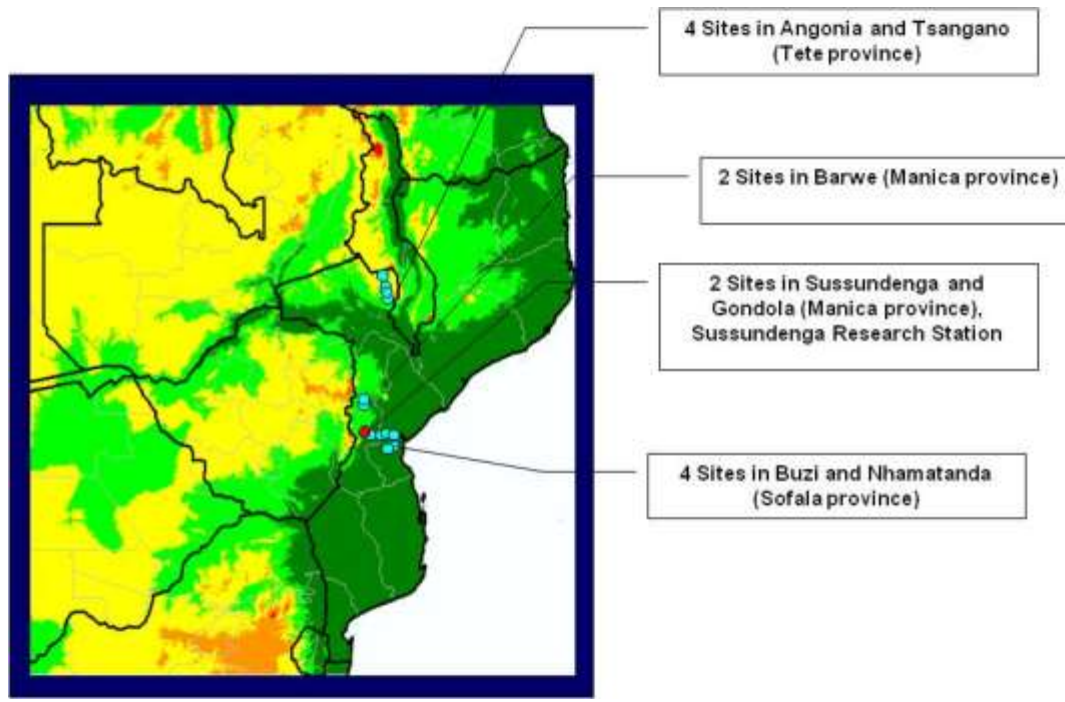
# Mozambique Budgets (from Dayton Lambert at Tennessee)

Jab planter

Basins ("likoti")

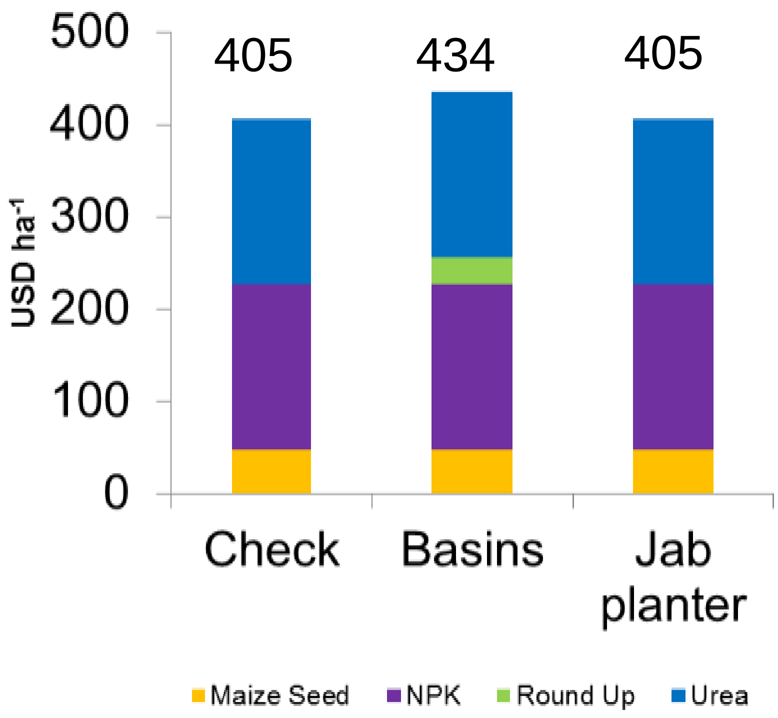
Tete, Manica, and Sofala Provinces, Mozambique 2008 – 2011

- Check, Basins, Jab planter
- Maize/cowpea rotations
- N = 638 farmers, 22 villages
- NPK/Urea (all plots)
- Herbicide on CA plots

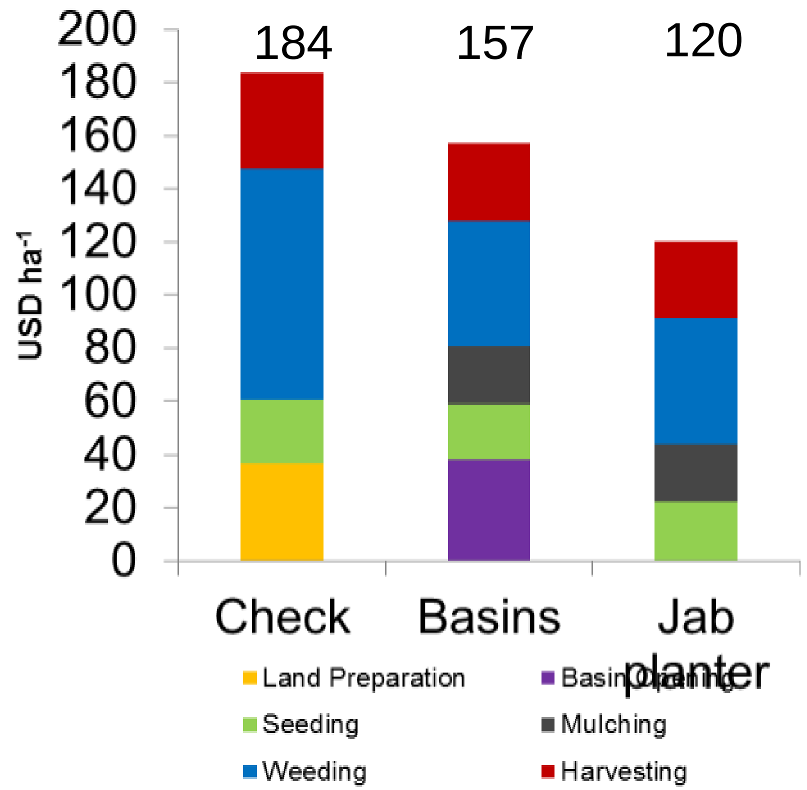


# Average input and labor costs for maize: Mozambique (2008 – 2011)

Input costs




Labor costs



# Net returns: conventional tillage treatments and CA planting technologies for maize, Mozambique, 2008 – 2011 (N = 631 farms)

| Net returns (USD $ha^{-1}$) | Control | Basin | Jab planter |
|---|---|---|---|
| Mean | 104 | 148 | 195 |
| Std. Dev. | 452 | 478 | 499 |
| CV | 435 | 323 | 257 |
| ----$H_0$: distributions not different*---- | | | |
| Control | | 0.07 (0.0776) | 0.12 (0.0002) |

*Kolmogorov-Smirnoff test; D-statistic (p-value)

# Field production survey: Butha Buthe, Lesotho

- Survey data
- Compared management of *No till* and *Conventional fields*
- 728 field-level observations
- Maize production (summer, 2010)
- 553 conventional/51 no-till (usable)
- Fertilizer (NPK), labor, maize production, labor/input costs, plot size, seeding rate, maize prices

# Field level inputs and production (Lesotho, 2010)

| Variable | Mean | N | Mean | N |
|---|---|---|---|---|
| | -----CA------ | | ----Conventional--- | |
| Field area (ha) | **0.48** | 51 | **0.76** | 553 |
| Seed (kg) | **4.25** | 44 | **7.90** | 478 |
| Fertilizer (kg) | **7.02** | 44 | **26.55** | 478 |
| Hired labor (person days) | **2.70** | 51 | **10.19** | 553 |
| Maize production (kg) | **145.23** | 51 | **256.33** | 553 |

*Bold entries are different at the 5% level (t test)

# Example: Linear programming analysis (Ecuador) (from A. Nguema at Virginia Tech)

Developed production coefficients and constraints based on:

- Initial survey of 286 farms
- Expert interviews with agronomists, economists, and soil scientists
- Follow-up farmer survey with 45 participants from the upper watershed and 43 from the lower watershed

# Results: Upper Watershed

- Optimal solution for typical farm household
  - 1180 square meters of:

    (potatoes, fallow land, fava beans, fallow land rotation; conventional tillage; no deviation ditches; no cover crop)
  - 1078 square meters of:

    (potatoes, oats-vetch, barley, fava beans rotation; conventional tillage; no deviation ditches; removal of cover crop)
  - 864 square meters of:

    (potatoes, oats-vetch, barley, oats-vetch rotation; conventional tillage; no deviation ditches; incorporation of cover crop)

Total of 3122 Square meters of crops per farm household

# Results: Upper Watershed

- Net revenue per farm: $2280
- Deviation ditches not profitable
- Conventional tillage more profitable than reduced tillage

# Results: Lower Watershed

- Optimal solution per farm household: 8,286 meters of
  - corn, oats-vetch, beans, oats-vetch rotation; reduced tillage; manual weeding; removal of cover crop
- Net revenue per farm: $7700
- Reduced tillage more profitable than conventional tillage
- Incorporation of cover crop not profitable

# Aggregate Benefits of CAPS through Economic Surplus Analysis

- Countries: Lesotho, Ecuador  and Nepal
- Crops: maize, beans, potatoes, millet, and cowpeas
- Data required:
  - Input cost and yield data from the regional projects
  - Supply and demand elasticity estimates
  - Price and quantity data
  - Adoption rates (projecting benefits for 1%, 3%, 5% adoption)
  - Research costs

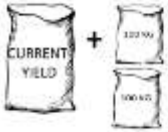
# Examples of aggregate impact results

- With 1% adoption over 12 years (discounted at 5%)
  - Ecuador: Net present value (NPV) of at least $15 to $18 million in maize, none in potato, and minimal in beans
  - Nepal: $13 million for maize/cowpeas/millet
  - Lesotho Lekoti system with maize: $12 million

# Information for policy analysis

- Knowing how much farmers would be willing to pay for attributes of conservation agriculture, gives an indication of how likely farmers will be to adopt conservation agriculture with or without a payment-for-environmental-services and what the payment might have to be.
- Kate Vaiknoras completed a **choice experiment** survey and analysis to assess the value that farmers in Tororo and Kapchorwa districts in Uganda place on the attributes of Conservation Agriculture

# Example of survey question

| | EXAMPLE QUESTION | | | |
|---|---|---|---|---|
| | YIELD | EROSION | LAND PREPARATION LABOR | INPUT COSTS |
| OPTION A |  |  |  | CURRENT COSTS |
| OPTION B |  |  |  | CURRENT COSTS +<br>30,000 30,000 |
| OPTION C |  |  |  | CURRENT COSTS |

# Sample size and model

- 400 farmers surveyed (200 in each district) after pilot testing
- 10 enumerators used in each district who were trained on the survey and conducted interviews in local languages
- Kate used a mixed logit model to arrive at value placed on traits associated with cover crops, minimum tillage, and cover crops

# Results

- For most of the models estimated, farmers had a positive and significant willingness to pay for increases in yield as well as reductions in erosion.
  - Labor savings were less of an incentive for farmers to adopt CA.
  - **See Kate's poster for details.**

# Other studies

- **Choice experiment in Ecuador** on value placed by farmers on conservation agriculture traits (Michael Barrowclough with assistance from undergraduate interns who conducted survey of 230 farmers in June 2013).
- **Risk analysis** conducted in Uganda to assess willingness of maize farmers to accept potential risk associated with new CA farming practices.
  - Based on survey and analysis with 400 farmers in Tororo and Kapchorwa, poorest farmers were just as willing to accept risk as better off farmers (**See poster by Barry Weiler-Landis for details**).

# Poverty effects of CAPS

- Analysis of poverty estimates for the Eastern Ugandan district of Tororo and assessing the size of average treatment (yield and income) effect that would need to be obtained from CAPS to have a measurable impact on poverty in the district.
  - Uses both World Bank Ugandan national survey data and local survey data from Tororo
  - Compare this impact with preliminary estimates of average treatment effects of CAPS (Jarrad Farris study currently underway)

# Conclusions

- Positive benefits from Conservation Agriculture in each region studied. Earlier economic surplus analyses, not reported on here, found that results vary widely among treatments and crops:
  - Some non-profitable economic outcomes, but others indicated 10's to 100's of millions of potential economic benefits over 12 years even with relatively low levels of adoption in some settings
- Farmers willing to pay not just for traits such as yield but for erosion benefits as well

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