Comparing Vegetable Yield of Conventional versus Conservation Agriculture Production Systems in Eight Countries

Presented by
Manuel ‘Manny’ Reyes, Research Professor, Kansas State University
CE SAIN Coordinator, Sustainable Intensification Innovation Lab

Regional Workshop on the Role of Mechanization in Strengthening Smallholders’ Resilience through Conservation Agriculture in Asia and the Pacific
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Comparing Vegetable Yield of Conventional versus Conservation Agriculture Production Systems in Eight Countries

Manny Reyes, Research Professor, Kansas State University
CE SAIN Coordinator, Sustainable Intensification Innovation Lab

Presented at the First International Sustainable Agricultural Intensification and Nutrition Conference, Royal University of Agriculture, Phnom Penh, Cambodia
January 10-11, 2018
Joshua Tree National Park

Lorna
Zach
Micah
‘Chickie’ Lyda’s daughter
Comparing Vegetable Yield of Conventional versus Conservation Agriculture Production Systems in Seven Countries

- Tanzania
- Ghana
- Guatemala
- Honduras
- Ethiopia
- Nepal
- USA
- Tanzania

Kansas State University
Manuel R. Reyes, Ph.D., Research Professor, Kansas State University
CE SAIN Coordinator, Sustainable Intensification Innovation Lab
FOCUS

Conservation Agriculture for Commercial Vegetable Home Gardens
What is a Commercial Vegetable Home Garden?

No more than 200 square meters
Near a home

Provides Nutritious Food

Provides Income

Commercial Vegetable
Home Garden
What is Conservation Agriculture?
Minimum soil disturbance

No tillage
Minimum soil disturbance
no-tillage
Minimum soil disturbance no-tillage

Kudos to the ASMC team look at the posture
Continuous mulch

M C D

Continuous mulch
Continuous mulch
Continuous mulch
McD
Diverse species
Diverse in time

String Beans

Kale

Tomatoes

Cucumber
Diverse in space
Diverse in space
Diverse in space
RESULTS

Paired ‘t’ test

- Conservation Agriculture
- Conventional Tilled
North Carolina Agricultural and Technical State University, Greensboro, North Carolina
North Carolina A&T State University
Yield of Pepper and Tomato in 2013 and 2014
(Edralin et al, 2015)

Table 5. Summer 2013 Vegetable Yield.

<table>
<thead>
<tr>
<th>Vegetables</th>
<th>Treatment Yield (kg m⁻²)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Conservation</td>
</tr>
<tr>
<td>Tomato *</td>
<td>9.40 a</td>
</tr>
<tr>
<td>Pepper</td>
<td>7.41</td>
</tr>
</tbody>
</table>

*Means under each vegetable having the same letters are not significantly different at 5% level of significance as indicated by Fisher’s protected LSD test.

Table 6. Summer 2014 Vegetable Yield.

<table>
<thead>
<tr>
<th>Vegetables</th>
<th>Treatment Yield (kg m⁻²)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Conservation</td>
</tr>
<tr>
<td>Tomato *</td>
<td>6.74 b</td>
</tr>
<tr>
<td>Pepper</td>
<td>1.40</td>
</tr>
</tbody>
</table>

Means under each vegetable having the same letters are not significantly different at 5% level of significance as indicated by Fisher’s protected LSD test.
CENTRAL AMERICA
Honduras
HONDURAS (International development enterprise-Honduras Zamorano University)
Guatemala
GUATEMALA (INTERNATIONAL DEVELOPMENT ENTERPRISE-HONDURAS)
### Table 1. Yield of vegetables in mulch and no-mulch treatments.

<table>
<thead>
<tr>
<th>Vegetable</th>
<th>Average yield (kg/ha)</th>
<th>Sample size n</th>
<th>Paired t-test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CA</td>
<td>CP</td>
<td>Guatemala</td>
</tr>
<tr>
<td>Broccoli</td>
<td>11955</td>
<td>5735</td>
<td>2</td>
</tr>
<tr>
<td>Chard</td>
<td>2835</td>
<td>3125</td>
<td>1</td>
</tr>
<tr>
<td>Lettuce</td>
<td>2215</td>
<td>2723</td>
<td>1</td>
</tr>
<tr>
<td>Radish</td>
<td>2748</td>
<td>2479</td>
<td>2</td>
</tr>
<tr>
<td>Bean</td>
<td>1118</td>
<td>951</td>
<td>3</td>
</tr>
<tr>
<td>Cucumber</td>
<td>17947</td>
<td>19632</td>
<td>1</td>
</tr>
<tr>
<td>Onion</td>
<td>11955</td>
<td>5735</td>
<td>4</td>
</tr>
<tr>
<td>Lettuce</td>
<td>10842</td>
<td>5538</td>
<td>4</td>
</tr>
<tr>
<td>Bean</td>
<td>3674</td>
<td>3606</td>
<td>8</td>
</tr>
<tr>
<td>Corn</td>
<td>2585</td>
<td>2540</td>
<td>2</td>
</tr>
<tr>
<td>Cucumber</td>
<td>14485</td>
<td>12319</td>
<td>7</td>
</tr>
<tr>
<td>Lettuce</td>
<td>9117</td>
<td>4975</td>
<td>5</td>
</tr>
<tr>
<td>Bean</td>
<td>2977</td>
<td>2882</td>
<td>11</td>
</tr>
<tr>
<td>Cucumber</td>
<td>14917</td>
<td>13233</td>
<td>8</td>
</tr>
</tbody>
</table>

**Note**: *statistically significant at 5% or higher

*the number in parenthesis is the probability associated with the t-test*
CONSERVATION AGRICULTURE IN COMMERCIAL VEGETABLE HOME GARDENS: A POTENTIAL CONTRIBUTION TO FOOD SECURITY IN SUB-SAHARAN AFRICA

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1. INTRODUCTION
Tanzania

INNOVATION LAB FOR SMALL SCALE IRRIGATION
TANZANIA (partner Sokoine University of Agriculture)
The average cabbage yield (Fig. 19) in CA (1.04±0.83 t/ha) was significantly lower (α = 0.05) than in CT (1.95±1.67 t/ha) (47% reduction). One of the potential reasons could be because of nitrogen stress due to the mulch cover. *(Assefa et al, in review)*

**Fig. 19**: Cabbage yields for the first cropping cycle (2016)
INNOVATION LAB FOR SMALL SCALE IRRIGATION

Ghana
GHANA (Partner International development enterprise-Ghana)
The average sweet potato yields in CA (15.90±5.59 t/ha) were significantly higher (α= 0.05) than in CT (10.14±1.96 t/ha) (57% increase).

(Assefa et al, in review)

**Fig. 20:** Sweet potato production for the first dry season (in 2016) in Ghana
Ghana

iDE Ghana has included CA as part of its practice in its scaling up projects on vegetable home gardens (Kiger 2016, email)
Ethiopia
ETHIOPIA (partner Bahir Dar University)
The average garlic and tomato yields in CA were significantly higher ($\alpha=0.01$) than in CT. No significant difference in Onion yield (Assefa et al, in review).
E thiopia

About 60 farmers are applying CA
NEPAL
NEPAL (PARTNER INTERNATIONAL DEVELOPMENT ENTERPRISE - NEPAL)
Yields significantly higher with the improved practices in comparison with the farmers (fig 1).

The benefit-cost ratios range between 2.5 and 3.5 with improved practices, indicating a high return on cash investments (fig 2).

(Sulav et al, 2018)
Nepal

Till end of December 2017, altogether there were 13,153 households are using the CA + IPM technologies. (Email: Sah 2018).
CAMBODIA
CAMBODIA (AGRICULTURAL DEVELOPMENT DENMARK ASIA)

From 15 now 100
Conservation agriculture improves yield and reduces weeding activity in sandy soils of Cambodia

Don A. Edralin¹ · Gilbert C. Sigua² · Manuel R. Reyes³ · Michael J. Mulvaney⁴ · Susan S. Andrews⁵

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Abstract The years of intensive tillage in Cambodia have caused significant decline in agriculture’s natural resources that could threaten its future of agricultural production and sustainability. Conventional tillage could cause rapid loss of soil organic matter, leading to a high potential for soil degradation and decline of environmental quality. Hence, a better and comprehensive process-based understanding of different conservation agriculture (17.1 ± 6.3 to 89.3 ± 40.2 Mg ha⁻¹) compared with conventional tillage (18.8 ± 6.4 to 63.8 ± 27.7 Mg ha⁻¹). Our results showed that manual weeding in all cropping seasons was significantly reduced by about 35% in conservation agriculture (169 ± 23 to 125 ± 18 man-day ha⁻¹), which can be attributed to existing cover crops and surface mulch. Overall, our results suggest that in smallholder commercial farming, conservation agriculture can be a sustainable alternative to tillage.
Dynamics of Soil Carbon, Nitrogen and Soil Respiration in Farmer’s Field with Conservation Agriculture, Siem Reap, Cambodia

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²United States Department of Agriculture, Agricultural Research Service, Coastal Plains Soil, Water, and Plant Research Center, Florence, SC, 29501, USA.

Authors’ contributions

This work was carried out in collaboration between all authors. Author DIAE designed the study, performed the day-to-day maintenance of the experimental plots, collected data and wrote the first draft of the manuscript. Authors GCS and MRR provided the technical advice and assistance in the overall design and management of the field study. Author GCS provided additional data analyses and assistance in revising the manuscript. Author GCS is serving as the corresponding author for the manuscript. All authors read and approved the final manuscript.
Site:

» 3 vegetable producing villages in Siem Reap

Legend:
O’ Village, Prasat Bakong District
Sratkat Village, Prasat Bakong District
Trabek Village, Soutrnikum District

Cambodia
Vegetable Yields in the fourth growing season for CA and CT, Siem Reap, Cambodia 2014. (Edralin et al, 2017)

<table>
<thead>
<tr>
<th>Village</th>
<th>Conservation agriculture</th>
<th>Conventional tillage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trabek Village</td>
<td>30.29&lt;sup&gt;a&lt;/sup&gt;</td>
<td>28.80&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>yard long bean</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Srat Village</td>
<td>30.04&lt;sup&gt;a&lt;/sup&gt;</td>
<td>23.04&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>eggplant</td>
<td></td>
<td></td>
</tr>
<tr>
<td>O Village</td>
<td>24.71&lt;sup&gt;a&lt;/sup&gt;</td>
<td>22.84&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>eggplant</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* - within each tillage treatment, means having the same letter are not significantly different at the 10% level of probability as indicated by Fisher’s protected LSD test.
ns - not significant at 10% level.
Management pValue=0.06, Irrigation pValue=0.22, CV=7.4%
Conclusion:

Conservation Agriculture on Commercial Vegetable Home Gardens

It Works!!!!

Happy! Happy! Happy! Happy! Happy! Happy! Happy! Happy! Happy! Happy!

Photo by Jenby

Photo by Jenby

Photo by Lini Sah