# 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*
*18-20 April 2018, Phnom Penh, Cambodia*

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

Manny Reyes, Research Professor, Kansas State University
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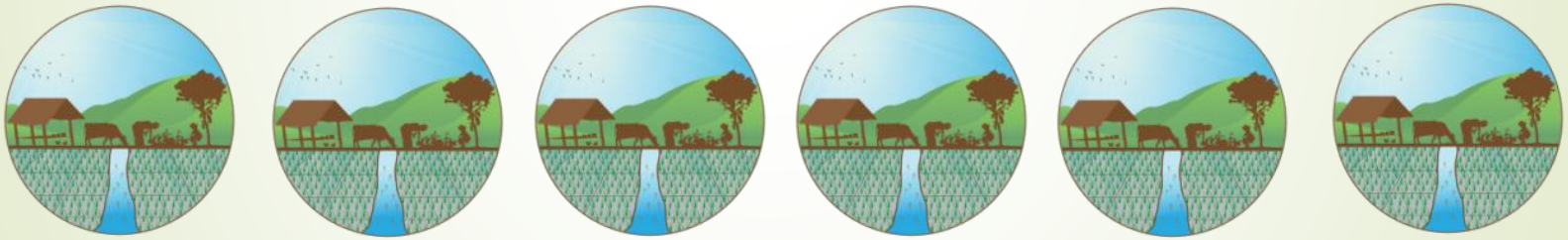

Presented at the First International Sustainable Agricultural Intensification and Nutrition Conference, Royal University of Agriculture, Phnom Penh, Cambodia
January 10-11, 2018

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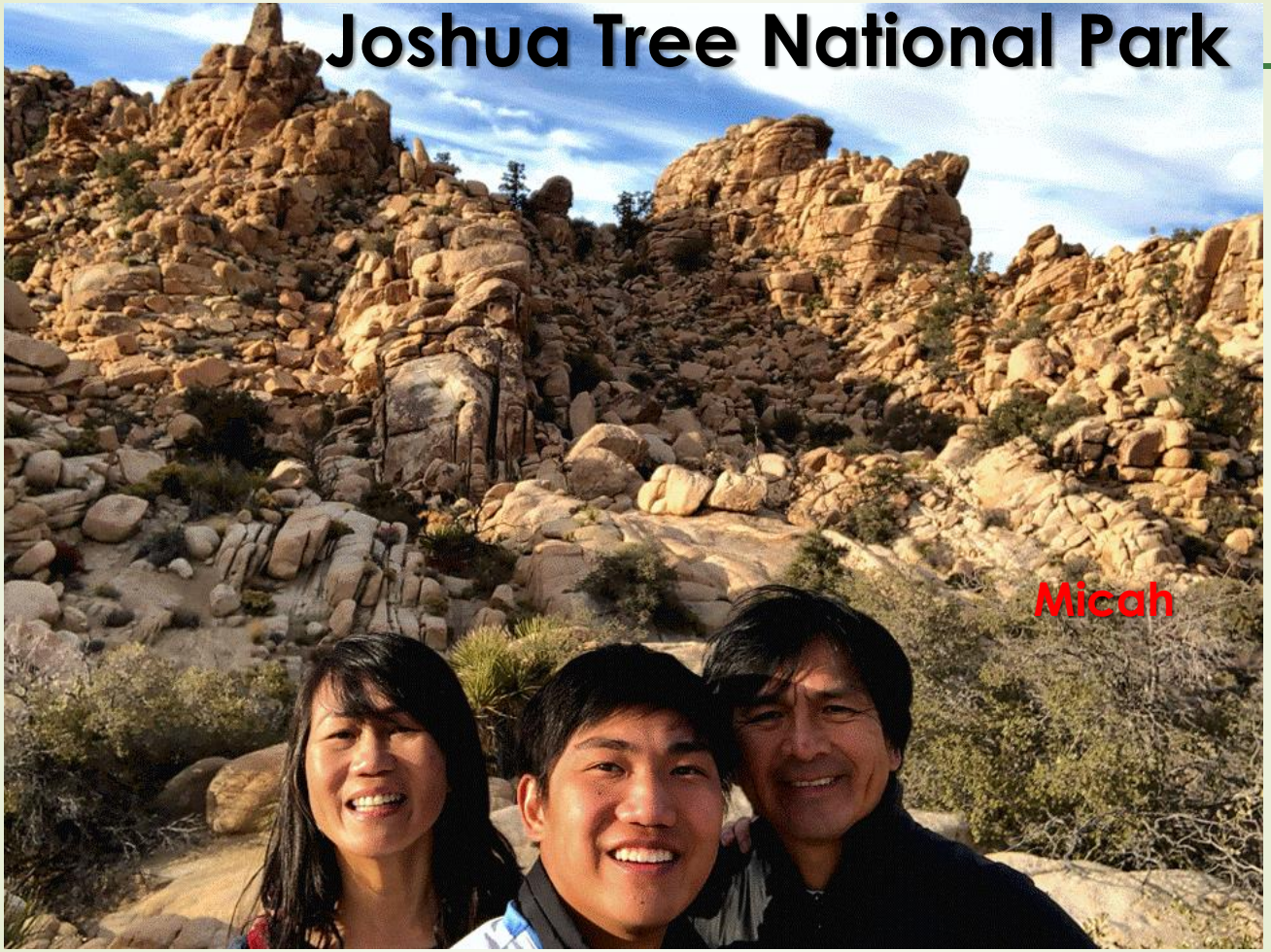
# Joshua Tree National Park




Lorna Zach

# ‘Chickie’ Lyda’s daughter

# Global Studies funded by:







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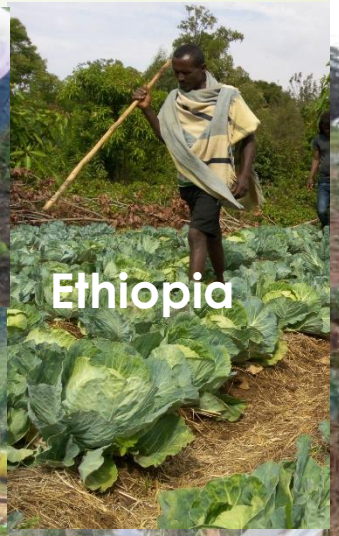







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# FOCUS

# Conservation Agriculture for Commercial Vegetable Home Gardens

# What is a Commercial Vegetable Home Garden?

## No more than 200 square meters


Provides Nutritious Food
Near a home
Provides Income
Commercial Vegetable Home Garden

# What is Conservation Agriculture?

# MCD

# MCD

**M**inimum soil disturbance

**No tillage**

# Minimum soil disturbance no-tillage

**Minimum soil disturbance no-tillage**

**Kudos to the ASMC team look at the posture**

# MCD

## Continuous mulch


Continuous mulch


Continuous mulch

# Continuous mulch

# mcD

# Diverse species

# Diverse in time


String Beans

Tomatoes


Kale


Cucumber


Diverse in space


Diverse in space
04:45


Diverse in space

# RESULTS

## Paired 't' test

- Conservation Agriculture
- Conventional Tilled


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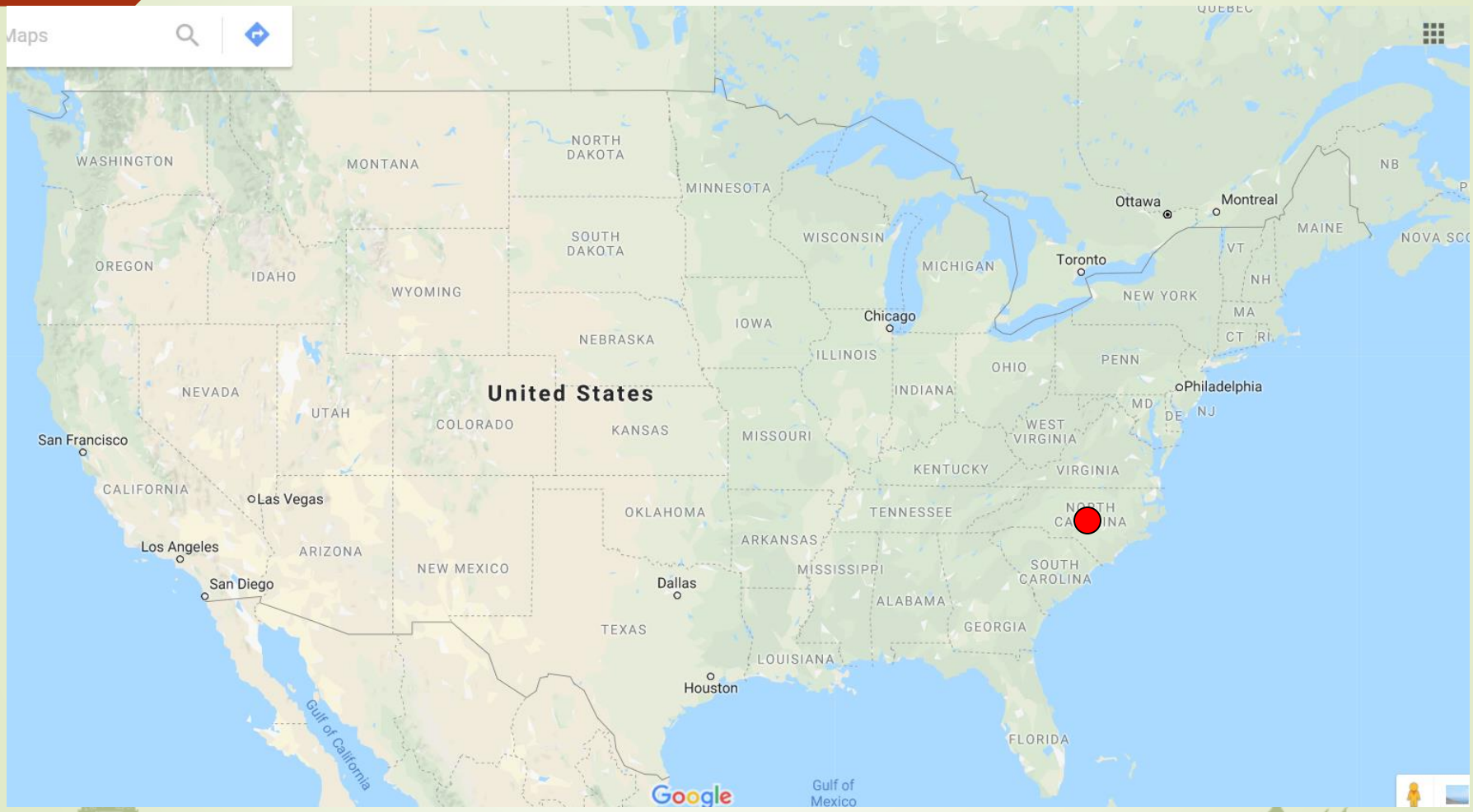
# AMERICAS

# United States of America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NEVADA
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# 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.

| Vegetables | Treatment Yield (kg $m^{-2}$) | | |
|---|---|---|---|
| | Conservation Agric Winter | No - till | Tilled |
| Tomato * | 9.40 [a] | 6.67 [b] | 6.43 [b] |
| Pepper | 7.41 | 6.47 | 5.85 |

[+]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.

| Vegetables | Treatment Yield (kg $m^{-2}$) | | |
|---|---|---|---|
| | Conservation Agric Winter | No - till | Tilled |
| Tomato * | 6.74[b] | 8.87[a] | 9.14[a] |
| Pepper | 1.40 | 0.94 | 1.14 |

[+]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.

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# CENTRAL AMERICA

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# Honduras


ARKANSAS
NEW MEXICO
San Diego
Dallas
MISSISSIPPI
SOUTH CAROLINA
ALABAMA
TEXAS
GEORGIA
LOUISIANA
Houston
Gulf of California
FLORIDA
Gulf of Mexico
Mexico
Cuba
Mexico City
Dominican Republic
Puerto Rico
Honduras
Caribbean Sea
Caracas
Costa Rica
Panama
Venezuela
Bogotá
French Guiana
Guyana
Calio
Colombia
Suriname


La Esperanza
La Paz
Cane
CA5
CA7
Marcala
El Rodeo
Teupasenti
Valle de Angeles
Comayaguela
Tegucigalpa
Zamorano
Danli
CA6
CA5
Perquin
7
Aguanqueterique
Ojojona
Yuscaran
Guinope
El Paraiso
Sabana Grande
Ciudad Barrios
3
San Francisco Gotera
Santa María
6
Santa Rosa de Lima
El Amatillo
53
Ocotal
CA5
15
Liure
CA1
1

# HONDURAS (international development enterprise-Honduras Zamorano University)

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# Guatemala


ARKANSAS
NEW MEXICO
San Diego
Dallas
MISSISSIPPI
SOUTH CAROLINA
ALABAMA
TEXAS
GEORGIA
LOUISIANA
Houston
Gulf of California
FLORIDA
Gulf of Mexico
Mexico
Cuba
Mexico City
Dominican Republic
Puerto Rico
Guatemala
Caribbean Sea
Nicaragua
Caracas
Costa Rica
Panama
Venezuela
Bogotá
French Guiana
Guyana
Calio
Colombia
Suriname


Montaña Peña Blanca
Todos Santos Cuchumatan
Biosfera Visis Cabá
Lancetillo La Parroquia
El Porvenir
Cuilco
Nebaj
Cobán
Motozintla
Chiantla
Huehuetenango
Uspantan
Cunén
Sacapulas
Santa Catalina la Tinta
Villa Comaltitlán
Tacaná
Canillá
Huixtla
Comitancillo
Cubulco
Rabinal
Salama
San Jerónimo
Momostenango
Santa Cruz del Quiché
Joyabaj
San Marcos
San Agustín Acasaguastlán
Tapachula
Malacatán
Totonicapán
Quetzaltenango
Guastatoya
Area de Uso Multiple Cuenca de Lago Atitlán
Puerto Chiapas
Ciudad Hidalgo
Coatepeque
Chimaltenango
CA1
CA2
CA14
CA19
211
229
225
200
5
18

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# GUATEMALA (INTERNATIONAL DEVELOPMENT ENTERPRISE-HONDURAS)

# HONDURAS AND GUATEMALA

(Reyes, 2014)

**Table 1. Yield of vegetables in mulch and no-mulch treatments.**

| Vegetable | Average yield (kg/ha) | | Sample size n | Paired t-test | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Guatemala | Honduras | Guatemala | Honduras | Two countries |
| | CA | CP | | CA vs CP | CA vs CP | CA vs CP | CA vs CP | CA vs CP |
| Broccoli | 11955 | 5735 | 2 | ns(0.723) | | ns(0.642) n = 10 | | *(0.001) n=35 |
| Chard | 2835 | 3125 | 1 | | | | | |
| Lettuce | 2215 | 2723 | 1 | | | | | |
| Radish | 2748 | 2479 | 2 | ns(0.500) | | | | |
| Bean | 1118 | 951 | 3 | ns(0.367) | | | | |
| Cucumber | 17947 | 19632 | 1 | | | | | |
| Onion | 11955 | 5735 | 4 | | ns(0.052) | | *(0.0001) n=25 | |
| Lettuce | 10842 | 5538 | 4 | | ns(0.068) | | | |
| Bean | 3674 | 3606 | 8 | | ns(0.816) | | | |
| Corn | 2585 | 2540 | 2 | | ns(0.500) | | | |
| Cucumber | 14485 | 12319 | 7 | | ns(0.052) | | | |
| Lettuce | 9117 | 4975 | 5 | | | ns(0.092) | | |
| Bean | 2977 | 2882 | 11 | | | ns(0.651) | | |
| Cucumber | 14917 | 13233 | 8 | | | ns(0.107) | | |

**Note** * statistically significant at 5%

the number in parenthesis is the probability associated with the t-test

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# AFRICA

# Paper under review for journal publication:

1 **CONSERVATION AGRICULTURE IN COMMERCIAL VEGETABLE**
2 **HOME GARDENS: A POTENTIAL CONTRIBUTION TO FOOD**
3 **SECURITY IN SUB-SAHARAN AFRICA**

75


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77 (corresponding author). E-mail: ttaffese@gmail.com
78 [2]**Manoj. K. Jha,** Associate Professor, Department of Civil Engineering, North Carolina A & T State University, North Carolina, USA. E-mail: mkjha@ncat.edu
79 [3]**Manuel. R. Reyes,** Research Professor, Sustainable Intensification Innovation Lab (SIIL), Kansas State University, Kansas, USA. E-mail:
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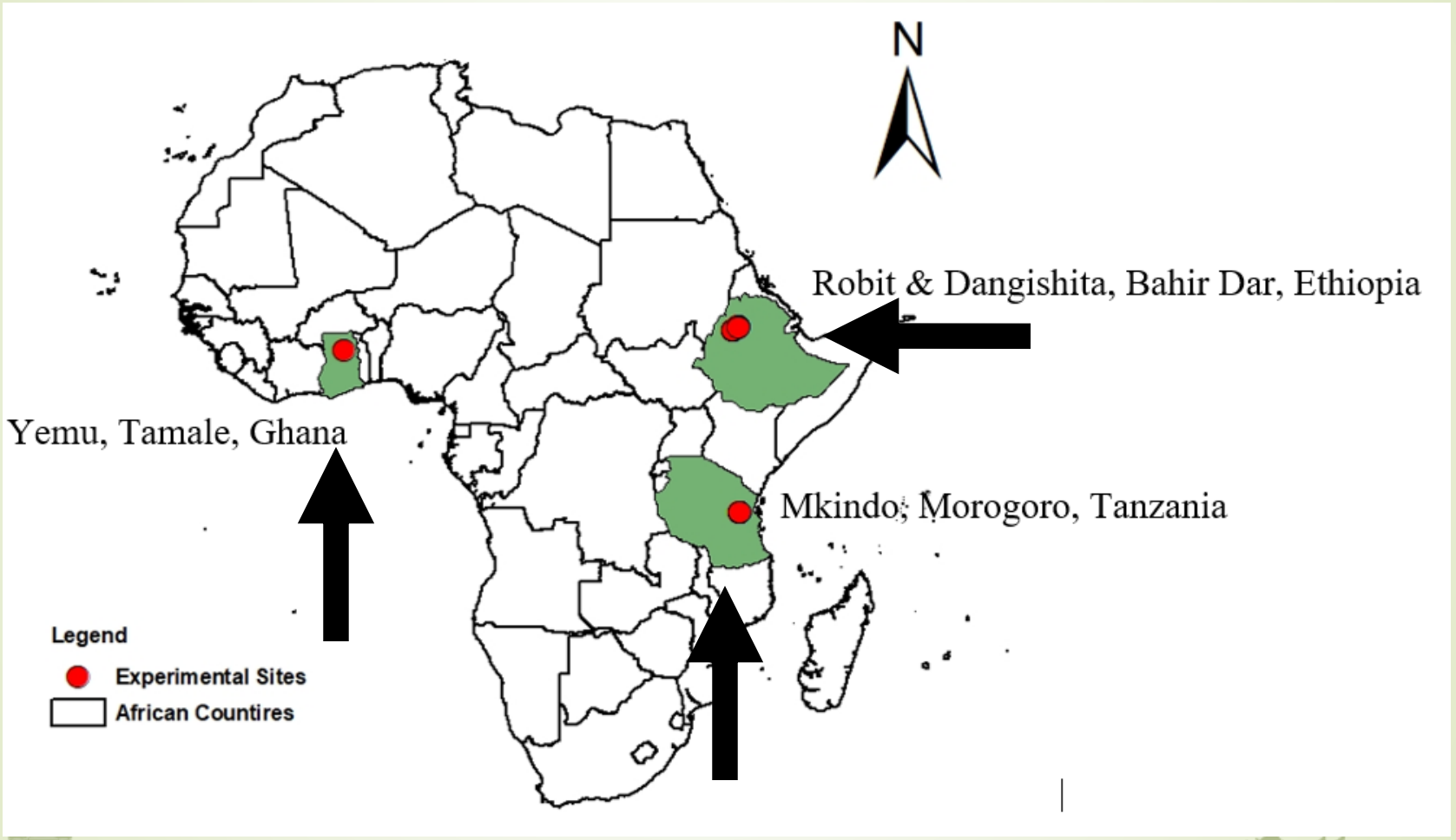
81 [4]**Seifu A. Tilahun,** Associate Professor, Department of Civil and Water Resource Engineering, Bahir Dar University, Bahir Dar, Ethiopia. E-mail:
82 sat86@cornell.edu


83 **1. INTRODUCTION**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Robit & Dangishita, Bahir Dar, Ethiopia
Yemu, Tamale, Ghana
Mkindo, Morogoro, Tanzania
Legend
Experimental Sites
African Countires

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# Tanzania

# 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)**

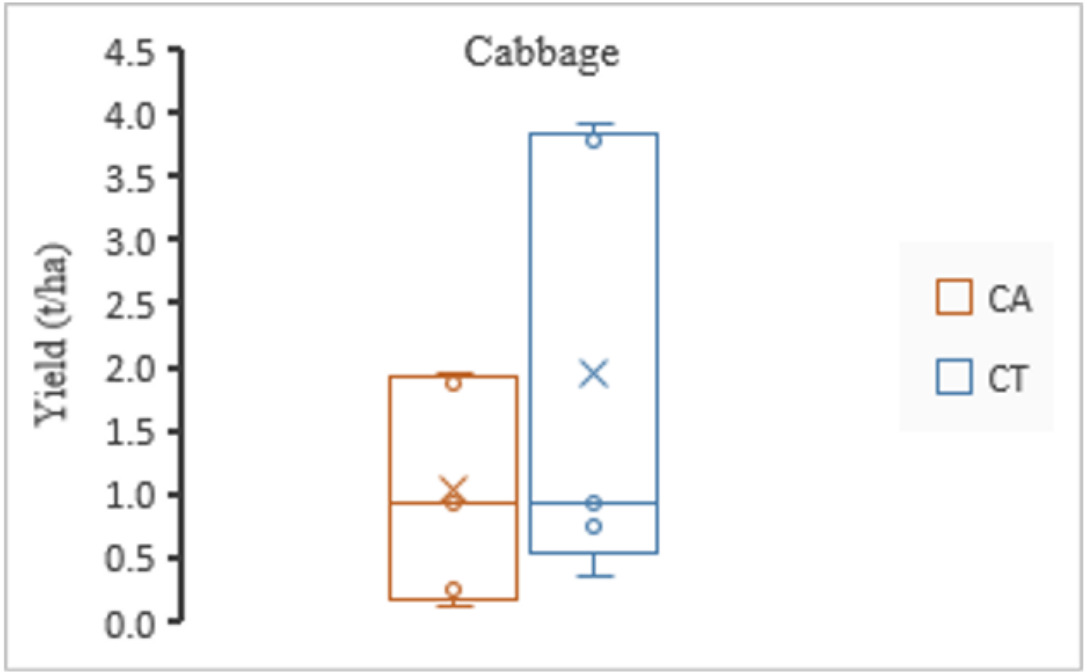


**Fig. 19**: Cabbage yields for the first cropping cycle (2016)

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# 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)**

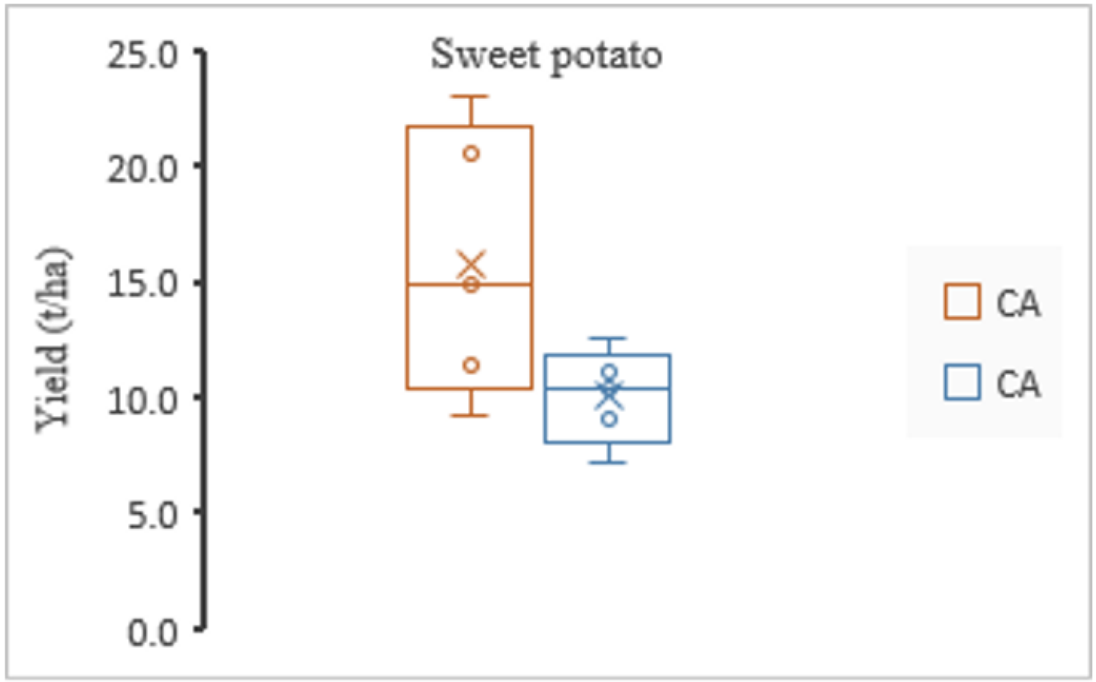


**Fig. 20**: Sweet potato production for the first dry season (in 2016) in Ghana

# Ghana

**iDE Ghana has included CA as part of its practice in its scaling up projects on vegetable home gardens** (Kiger 2016, email)

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# Ethiopia

# ETHIOPIA (partner Bahir Dar University)

The average garlic and tomato yields in CA were significantly higher (α= 0.01) than in CT. No significant difference in Onion yield **(Assefa et al, in review).**

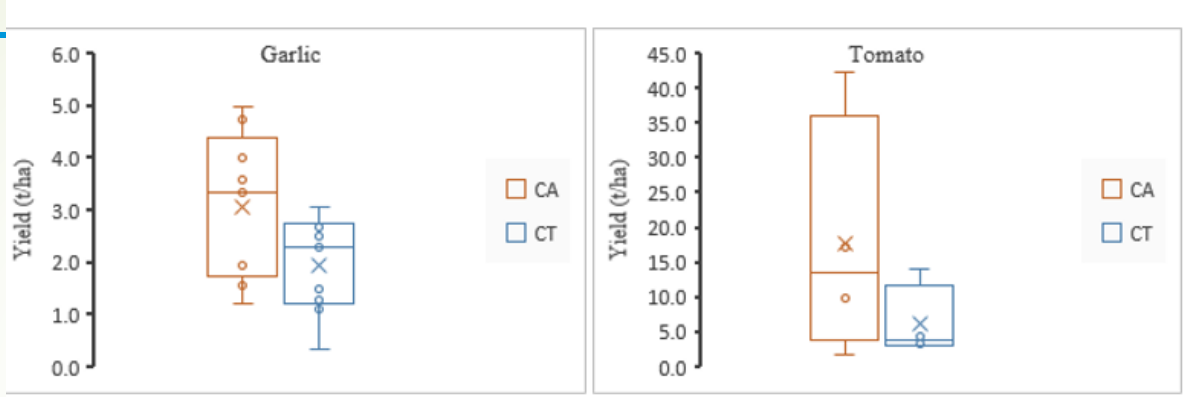


**Fig. 12**: Garlic (Dangishita and Robit) and Tomato (Robit) yields (harvested in 2016)

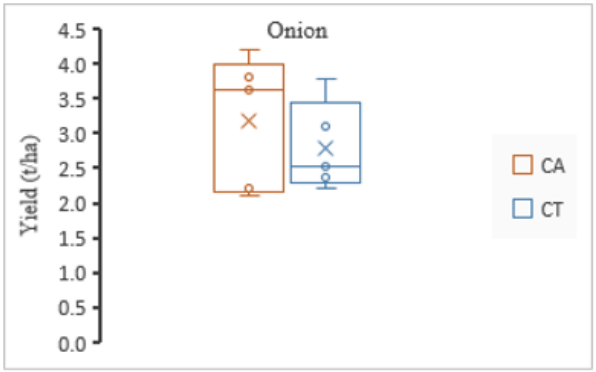


**Fig. 13**: Onion (Dangishita) yields for the second cropping cycle (harvested in 2016)

# E thiopia

## About 60 farmers are applying CA

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# ASIA

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# NEPAL

# NEPAL (PARTNER INTERNATIONAL DEVELOPMENT ENTERPRISE-NEPAL)

## i) Crop yield

- 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).

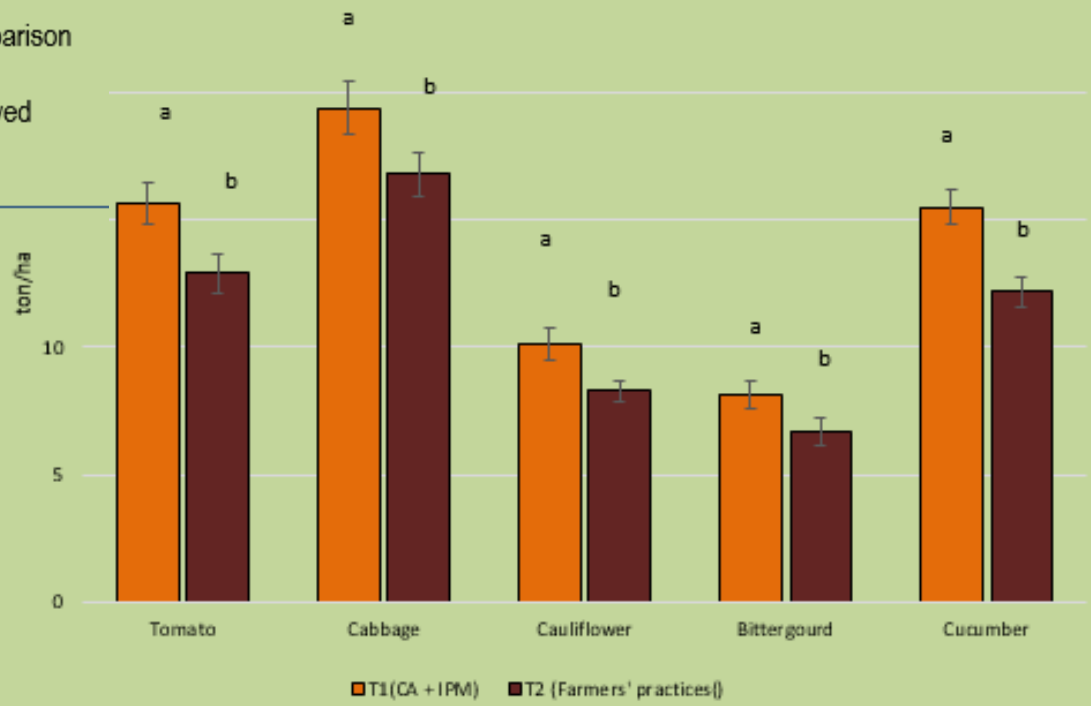


Fig 1: Yields (ton/ha) differences between improved and farmers' practices

**(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).

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# CAMBODIA

# CAMBODIA (AGRICULTURAL DEVELOPMENT DENMARK ASIA)

Agron. Sustain. Dev. (2017) 37:52
DOI 10.1007/s13593-017-0461-7

RESEARCH ARTICLE

# Conservation agriculture improves yield and reduces weeding activity in sandy soils of Cambodia

**Don A. Edralin[1] · Gilbert C. Sigua[2] · Manuel R. Reyes[3] · Michael J. Mulvaney[4] · Susan S. Andrews[5]**

Accepted: 22 September 2017


**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 commer-


*International Journal of Plant & Soil Science*
*11(1): 1-13, 2016; Article no.IJPSS.25339*
*ISSN: 2320-7035*

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# Dynamics of Soil Carbon, Nitrogen and Soil Respiration in Famer's Field with Conservation Agriculture, Siem Reap, Cambodia

**Don Immanuel A. Edralin[1], Gilbert C. Sigua[2*] and Manuel R. Reyes[1]**

*[1]North Carolina Agricultural and Technical State University, Greensboro, NC, USA.*
*[2]United 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


Cambodia

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

| Village | Conservation agriculture | Conventional tillage |
|---|---|---|
| | ----------Mg ha$^{-1}$ ---------- | |
| Trabek Village *yard long bean* | 30.29[a] | 28.80[b] |
| Srat Village *eggplant* | 30.04[a] | 23.04[b] |
| O Village *eggplant* | 24.71[a] | 22.84[b] |

* - 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!!!!

Manuel R. Reyes
Kansas State University

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




No till. mulch. diversity. no till. mulch. diversity


No till.mulch.diversity.no till. mulch.diversity.no till.mulch.diversity