Conservation Agriculture for Food Security in Cambodia and the Philippines

Manny Reyes
Spokesperson Southeast Asia Team

Cambodia flat with basic soils
The Philippines sloping with acidic soils

North Carolina Agricultural and Technical State University
Thanks to my wife

Geyser Yellowstone National Park

Lorna
Micah, North Carolina State University, BS and MS; an engineer designing sailboat parts; no girlfriend @ 28 years old. I have been telling him, “I want to be a granddad,” He has been telling me not yet Dad!!!
Thanks to my son Zach

Zach kissing an ancient smiling face in Angkor Wat, Cambodia

2011 12 years old

2012 13 years old
Thanks to my son Zach

Zach still wearing blue shirt

Angkor Wat, Cambodia

2013

14 years old
Funding for Study

United States Agency for International Development (USAID)

Sanrem Innovation Lab
Feed the Future Innovation Lab for Collaborative Research on Sustainable Agriculture and Natural Resource Management

French Agency for International Development (AFD)

Centre International de Recherche sur l'Alimentation (CIRAD)
Flags of Red White and Blue +
Brazil
Strong Partnership
Thanks to the many who are involved (please stand if you are here)
• Osei Yeboah, Co-Principal Investigator, Interim Director, North Carolina A&T State University International Trade Center
• Rada Kong  host country coordinator
  Cambodia
• Stephane ‘macho’ Boulakia - CIRAD Scientist, former host country coordinator, Cambodia
• Victor Ella, Philippines host country coordinator, Professor, University of the Philippines at Los Baños
• Agustin Mercado, World Agroforestry Scientist and Philippines site coordinator
• Ma. Elena Javier, Gender specialist, De La Salle University, Philippines
• Susan Andrews, USDA-NRCS, National Leader, Soil Quality and Ecosystems
• Gilbert Sigua, USDA-ARS, Soil Scientist, Florence, South Carolina. Congratulations:!! ASA Fellow 2012
• Mike Mulvaney, CIMMYT
• Maria Elisa Christie and team VT
• Mary Harman Parks, Virginia Tech
Daniel Sumner, Virginia Tech
João Carlos de Moraes Sá
University of Ponta Grossa
Brazil
• Florent Tivet, CIRAD
Magnificent Three Ph.D. Graduate Students

Michael Williams
USA

Lyda Hok
Cambodia

Don Edralin
Philippines
Cambodian Conservation Agriculture Extension Staff
Ph.D. and M.S. University of the Philippines at Los Baños graduate students
Farmers and audience, did we, Southeast Asia team succeed?
Did we succeed?
Did we succeed?

Cambodia
Problem
Cambodia
Flat slope in basic soils
In Cambodia, after the restoration of peace, the area of annual upland crops soared from 120,000 ha in 2000 to about 800,000 ha in 2012.
Twelve years 680,000 hectares (1.65 million acres) of forest gone
Did we succeed?

Cambodia

*French and Brazilian partners*

2004, SANREM came 2010
A holistic approach of Conservation Agriculture that unites engineering, research, on-farm demonstration and extension in Cambodia

S. Boulakia, R. Kong, O. Husson, V. Leng, V. Sar, K. Soeurng, B. Thy, L. Huot, S. Nhjem, S. Pheav, M. Reyes, F. Tivet, L. Séguy

Contextual objective

In Cambodia, after the restoration of peace, the area of annual cropland crops shrank from 120,000 ha in 2000 to about 800,000 ha in 2012. This development has been generated by migration from populated central areas to less populated peripheral regions, the illegal clearing of forests, and strong regional demand for rice, cassava and soybean. Today, the production of annual cash crops (i.e., soybean, maize, cassava) is an important dimension in the development of smallholder agriculture on the western and northern provinces. In combination with the fertilizer increase and high rate of soil organic matter (SOM) mineralization, mechanized farming accelerated the problem of soil degradation. Maintaining productive capacity of the soil is a critical element for long-term improvement of livelihoods. In 2009, the Cambodia Ministry of Agriculture and Forestry has hosted a research and development program led by North Carolina A&T, CIRAD and funded by the USAID through the Feed the Future Innovation Lab for Collaborative Research on Sustainable Agriculture and Natural Resources Management (SANREM), directed at local smallholders and based on Conservation Agriculture (CA) and diversified direct seeding multi-cropped (DMS) systems.

A Holistic Approach based on Diagnostic, Design, Assessment, Training and Extension (DATE)

DATE is a multi-scale, multi-stakeholder participatory approach, integrating scientific and local knowledge. This approach outlines new innovation through experiential prototyping, ranging the range of possible options in a step by step design, favouring adaptation and learning universes. DATE is built on four main components: a diagnosis and three tools of coping system design. The diagnosis provides a multi-scale analysis of the agricultural systems. On this basis, a large range of coping system are designed and tested at different scales, with three successive learning loops (Husson et al., forthcoming).

Experimental units for diversified DMS systems

The first loop is conducted by agronomists and researchers, in experimental plots. A large range of high biomass-C input under DMS systems (i.e., cassava/crops succeeded, associations, rotations and different levels of intercropping) is assessed to anticipate market changes.

On-farm assessment

The second loop takes place in farmers’ fields where the most promising systems are tested by farmers in interaction with researchers. Precisely, information on practicability and management principles are developed. A process of on-farm assessment is used to match DMS systems to smallholder conditions and strategies. Feedback from the smallholders is recorded throughout the process, so that in every constraint can be taken into account during the experimental phases.

Networks of extension

The third loop takes place through a network of pre-extension, managed by extension agents with agronomists and researchers backstopping. At this stage, a detailed record of cost, labour requirements and economic performances is made on a sub-sample of representative farms. The changes in economic and economic performances are assessed in real conditions and the constraints to adoption are reviewed, to identify and test measures to facilitate the dissemination process.

The integration of these three loops into a holistic innovation approach feeds the overall learning by doing process. At all levels, multiple-evaluation feeds back into the successive loops of technical adjustment and improvement.

The DATE approach was implemented since 2004 (Kampot Cham), starting with experiments in controlled conditions and demonstration plots (first and second loop). Although the rural development project was associated to this research, a pilot extension network was created in 2009 (third loop). In Kramskao (Battambang province), this network covered 4 villages and involved 64 households, applying DMS systems on 20% ha (39% of spontaneous diffusion) in 2012.
A holistic approach of Conservation Agriculture that unites engineering, research, on-farm demonstration and extension in Cambodia

S. Boukalá, R. Kong, O. Husson, V. Leng, V. Sar, K. Soeurung, B. Thy, I. Huot, S. Nhâm, S. Pheav, M. Reyes, F. Tivet, L. Séguy

Context and objective

In Cambodia, after the restoration of peace, the area of annual upland crops climbed from 120,000 ha in 2009 to about 800,000 ha in 2012. This development has been accompanied by migration from populated central regions to the peri-urban periphery (i.e., kroms and cassava) is an important dimension in the development of smallholder agriculture on the western and northern provinces. In combination with the recent climate and high rate of soil organic carbon (SOC) mineralization, mechanized farming exacerbates the problem of soil degradation. Maintaining productive capacity of the soil is a critical element for long-term improvement of livelihoods. In 2009, the Cambodian Ministry of Agriculture and Forestry has hosted a research and development program led by North Carolina A&T, CIRAD and funded by the USAID through the Feed the Future Innovation Lab for Collaborative Research on Sustainable Agriculture and Natural Resources Management (SANREM), directed at small-scale farmers based on conservation agriculture (CA) and identified direct-seeding mulch-based cropping (DMC) systems.

A Holistic Approach based on Diagnostic, Design, Assessment, Training and Extension (DATE)

DATE is a multi-scale, multi-stakeholder participatory approach, integrating scientific and local knowledge. This approach translates the most advanced agricultural practices into a series of participatory design processes. DATE is built on four main components: a diagnosis and three tools of coping system design. The diagnosis provides a multi-scale analysis of the agricultural systems. On this basis, a large range of cropping system are designed and tested at different scales, with three successive learning loops (Hyten et al., forthcoming).

Experimental units for diversified DMC systems

The first loop is conducted by agronomists and researchers, in experimental plots. A large range of high biomass-C input under DMC systems (i.e., cover/crop successions, associations, rotations and different levels of intensification) is assessed to anticipate market changes.

On-farm assessment

The second loop takes place in farmers' fields where the most promising systems are tested by farmers in interaction with researchers. Previous information on practicability and management principles are developed. A process of on-farm assessment is used to match DMC systems to smallholder conditions and strategies. Feedback from the smallholders is recorded throughout the process, so that every constraint can be taken into account during the experimental phases.

Networks of pre-adoption

The third loop takes place through a network of pre-adoption, managed by extension agents with agronomists and researchers. At this stage, a detailed record of on-farm requirements and economic performances is made on a sub-sample of representative farms. The changes in farmers' and extension performances are assessed in real conditions and the constraints to adoption are reviewed, to identify and test measures to facilitate the dissemination process. The integration of these three loops into a holistic innovation approach feeds the overall learning by doing process. At all levels, multi-criteria evaluation feeds back into the successive loops of technical adjustment and improvement.

The DATE approach was implemented since 2004 (Kampong Cham), starting with experiments in controlled conditions and demonstration plots (first and second loop). Although no rural development project was associated to this research, a pilot extension network was initiated in 2009 (third loop). In Krating Kandal (Kratong province), this network covered 4 villages and involved 66 households, applying DMC systems on 20 ha (30% of spontaneous agriculture) in 2012.

Kong Rada and Lyda Hok had a DATE with you Cambodia. They are ready and have been trained.
Did we succeed?
Cambodia
Testing Maize
We tested several hybrid corn for CA application and found some promising ones.
Did we succeed?

Cambodia

Cover crop
germplasm
We have amassed more than 500 cover crop germplasms for you Cambodia. We know this living ‘gold’ mine you will maintain.
We built three pillars of conservation agriculture in Cambodia. Now there is a government department for CA and CA dedicated research station land.
The name of the Department is: Conservation Agriculture Service Center. And some plots in the center are in CA for 8 years now.
Oh yes, we have trained at least 20 Cambodians who can apply pillars of conservation agriculture.
Oh yes, Ph.D. dude student ‘Lyda’ found from one plot at the CA station that there was soil carbon build-up from CA and soil carbon loss from tilled.
A poster reported maize yield in CA higher than tilled, that black line.
2013.

Oh Rada, what an exciting rise in CA adoption in 2012, but then a drop in 2013.
One of many interesting findings of that Virginia Tech student, Daniel. Gosh he flew all the way from the USA to join us in Cambodia. I heard he was trained by Gender guru Maria Elisa. Morally it is very important we emphasize gender equality.
In Daniel’s poster he relayed that:

80% of women and 77% men indicated that CA reduced their labor burden in annual cash crop production land preparation and implementation.
Oh I almost forgot, there is another dude Ph.D. student named Don. He is Filipino but doing research in Cambodia. He loves Cambodia. And you know what he found, CA and drip for vegetable production increases income for women in Cambodia.
Did we succeed in Cambodia?

Women of Siem Reap
Did we succeed?

Philippines
Problem
Philippines
Steep slope acidic soils
Rainforest - Mindanao

http://www.flickr.com/photos/30369673@N06/8231531320/sizes/k/in/photostream/
Rainforest replaced!!!!
Rainforest replaced!!!!
Rainforest replaced!!!!
Rainforest replaced!!!!
Pineapple
This is what happens?

Claveria, Philippines
The estimated annual replacement cost of eroded nutrients is $1000 per hectare per year.
Did we succeed?
Philippines
In 2010, SANREM funded a team of scientists in the Philippines to get CA training in Cambodia.
Do you remember, Philippine team first time seeing a CA plot in Cambodia?
Do you remember, when we mapped out the CA treatments for the Philippines overlooking the Mekong River?
Did we succeed?
Philippines
Soil erosion control?
From SANREM-Philippines site

Conservation Agriculture

Maize

Arachis pintoi
Residual moisture:

Did we succeed?
Profit
Gross Profit Margin
Researcher Managed

Conservation Agriculture (Year 3)

Arachis pintoi: $1,627

Tilled: $205
Residual moisture:

Did we succeed?
Climate change resilience
Residual moisture
Residual moisture:

Volumetric moisture content (%)

CAPS
Arachis pintoi

Tilled
Did we succeed?
Soil Organic Matter
Soil Organic Matter:

Did we succeed?

Tilled

Soil organic matter at 0-5 cm

CAPS

Arachis pintoi
Did we succeed?

*Arachis pintoi* for livestock
Did we succeed?

Pigs like *Arachis pintoi*
Did we succeed?

*Arachis pintoi* for carabao and cattle?
Did we succeed?

*Arachis pintoi* for fish
Did we succeed?

Conservation Agriculture

seeding/planting
Animal Drawn
Single Moldboard
Plow
Animal pulled one row seeder
Fitarelli two row seeder
Best seeder is Bolo
Did we succeed, Philippines? Rainwater Harvesters
Developed a technology to build ponds for rainwater harvesting using animals with a video too.
Did we succeed, Philippines?
Gender
Labor reductions experienced through reduced weeding for Filipinas (women) and no till for Filipinos (men)
Did we succeed?

because of SANREM we applied Conservation Agriculture in the United States
VEGETABLE PRODUCTION IN URBAN LANDSCAPES using Conservation Agriculture Technology USDA funded
With Small farmer in NC

Charles
With Community Garden in Greensboro
Post Doctoral NCA&T Trainee from Indonesia
Ph.D. Graduate Student from Vietnam

Soil test training to Early STEM College

Harvesting at Page summer 2013
Undergraduate Students at NCA&T
N.C. A&T Campus

Turf lawn, Sockwell Hall, 2011  Oasissofa Study, Fall 2011

Oasissofa Study: summer 2012 (left) and summer 2013 (right)
Conservation agriculture, summer 2013
Sunn hemp, summer cover crop 2012
Pigeon pea (summer 2013 cover crop)
N.C. A&T extended Conservation Agriculture experiments in K-12 campuses with K-12 students involved.
High School Faculty from NC
High School Students from NC
Middle School Students in Durham, NC
General Greene Elementary School. NC

Planting peppers

Staking tomatoes & peppers
Did we succeed?

Conservation Agriculture Application in the United States High School Campuses
N.C. A&T Early STEM College
**Yield Summer 2013 (lbs)**

<table>
<thead>
<tr>
<th>Varieties</th>
<th>Peppers</th>
<th>Tomatoes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total</strong></td>
<td>291</td>
<td>332</td>
</tr>
<tr>
<td><strong>Lbs/bed</strong></td>
<td>24</td>
<td>28</td>
</tr>
</tbody>
</table>

Bed is a size of a sofa 6 feet by 3 feet hence oasissofas. Oasis in the midst of a food desert.
Smith High School, Greensboro
Yield Summer 2013 (lbs)

<table>
<thead>
<tr>
<th>Varieties</th>
<th>Peppers</th>
<th>Tomatoes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>235</td>
<td>205</td>
</tr>
<tr>
<td>Lbs/bed</td>
<td>20</td>
<td>17</td>
</tr>
</tbody>
</table>

Bed is a size of a sofa 6 feet by 3 feet hence oasissofas. Oasis in the midst of a food desert.
Andrews High School, Greensboro
## Yield Summer 2013 (lbs)

<table>
<thead>
<tr>
<th>Varieties</th>
<th>Peppers</th>
<th>Tomatoes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total</strong></td>
<td>240</td>
<td>357</td>
</tr>
<tr>
<td><strong>Lbs/bed</strong></td>
<td>20</td>
<td>30</td>
</tr>
</tbody>
</table>

Bed is a size of a sofa 6 feet by 3 feet hence oasisspace. Oasis in the midst of a food desert.
Dudley High School, Greensboro
## Yield Summer 2013 (lbs)

<table>
<thead>
<tr>
<th>Varieties</th>
<th>Peppers</th>
<th>Tomatoes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>315</td>
<td>480</td>
</tr>
<tr>
<td>Lbs/bed</td>
<td>26</td>
<td>40</td>
</tr>
</tbody>
</table>

Bed is a size of a sofa 6 feet by 3 feet hence oasissofas. Oasis in the midst of a food desert.
Page High School, Greensboro
# Yield Summer 2013 (lbs)

<table>
<thead>
<tr>
<th>Varieties</th>
<th>Peppers</th>
<th>Tomatoes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total</strong></td>
<td>341</td>
<td>420</td>
</tr>
<tr>
<td><strong>Lbs/bed</strong></td>
<td>28</td>
<td>35</td>
</tr>
</tbody>
</table>

Bed is a size of a sofa 6 feet by 3 feet hence oassissofas. Oasis in the midst of a food desert.
Southeast Guilford High School, Greensboro
Yield Summer 2013 (lbs)

<table>
<thead>
<tr>
<th>Varieties</th>
<th>Peppers</th>
<th>Tomatoes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>184</td>
<td>334</td>
</tr>
<tr>
<td>Lbs/bed</td>
<td>15</td>
<td>28</td>
</tr>
</tbody>
</table>

Bed is a size of a sofa 6 feet by 3 feet hence oasissofas. Oasis in the midst of a food desert.
Southern High School of Energy and Sustainability, Durham
<table>
<thead>
<tr>
<th>Varieties</th>
<th>Peppers</th>
<th>Tomatoes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>215</td>
<td>30</td>
</tr>
<tr>
<td>Lbs/bed</td>
<td>18</td>
<td>3</td>
</tr>
</tbody>
</table>

Bed is a size of a sofa 6 feet by 3 feet hence oasisssofas. Oasis in the midst of a food desert.
Scale School, Greensboro
Yield Summer 2013 (lbs)

<table>
<thead>
<tr>
<th>Varieties</th>
<th>Tomatoes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>166</td>
</tr>
<tr>
<td>Lbs/bed</td>
<td>21</td>
</tr>
</tbody>
</table>

Bed is a size of a sofa 6 feet by 3 feet hence oasisspace. Oasis in the midst of a food desert.
Neal Middle School, Durham
Yield Summer 2013 (lbs)

<table>
<thead>
<tr>
<th>Varieties</th>
<th>Peppers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>253</td>
</tr>
<tr>
<td>Lbs/bed</td>
<td>32</td>
</tr>
</tbody>
</table>

Bed is a size of a sofa 6 feet by 3 feet hence oasissosofas. Oasis in the midst of a food desert.
General Greene Elementary School, Greensboro
### Yield Summer 2013 (lbs)

<table>
<thead>
<tr>
<th>Varieties</th>
<th>Peppers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>128</td>
</tr>
<tr>
<td>Lbs/bed</td>
<td>11</td>
</tr>
</tbody>
</table>
At least **4000** pounds of healthy locally produced vegetables grown in K-12 campuses most in Conservation Agriculture technology
Did we succeed?
Capacity Building
Lyda Hok

- Ph.D. student A&T
- Committee members are from Brazil, France and USA
- Traveled to Brazil, Cambodia and the USA
- Just got engaged
Don Immanuel Edralin

- Ph.D. student A&T
- Committee members are from CIMMYT, USDA ARS, USDA-NRCS, and NCA&T, USA
- Traveled to Cambodia
- Just got married a week ago
Michael Williams

- Ph.D. student, NCA&T
- Adopted African American Southeast Asian
- Formerly from Urban New York City
- Currently in the Philippines
- Next stint Cambodia
Victor Ella

- SANREM Philippine Coordinator
- Professor, University of the Philippines Los Baños
- Learned about Conservation Agriculture through SANREM
Did we succeed?
Capacity Building
Conservation Agriculture Centers
Cambodia

Conservation Agriculture Service Center was established under the Ministry of Agriculture, Fisheries, and Forestry
Philippines

Feed the Future
SANREM Innovation Lab
Conservation Agriculture with Trees Center was established

Watch video in
https://www.youtube.com/watch?v=s8_-Z5Q It-c
USAID & Virginia Tech
Thanks for SANREM
Did the Southeast Asia team succeed?
Questions