

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

A photograph of a man and a woman posing together in front of a geyser. The woman, on the left, is wearing sunglasses and a dark jacket. The man, on the right, is wearing sunglasses and a dark jacket with "THE NORTH FACE" and "FLIGHT SERIES" logos. They are both smiling. The background shows a geyser with a vibrant turquoise and green mineral pool, surrounded by rocky terrain and a wooden walkway.

Lorna



Thanks to my son Micah

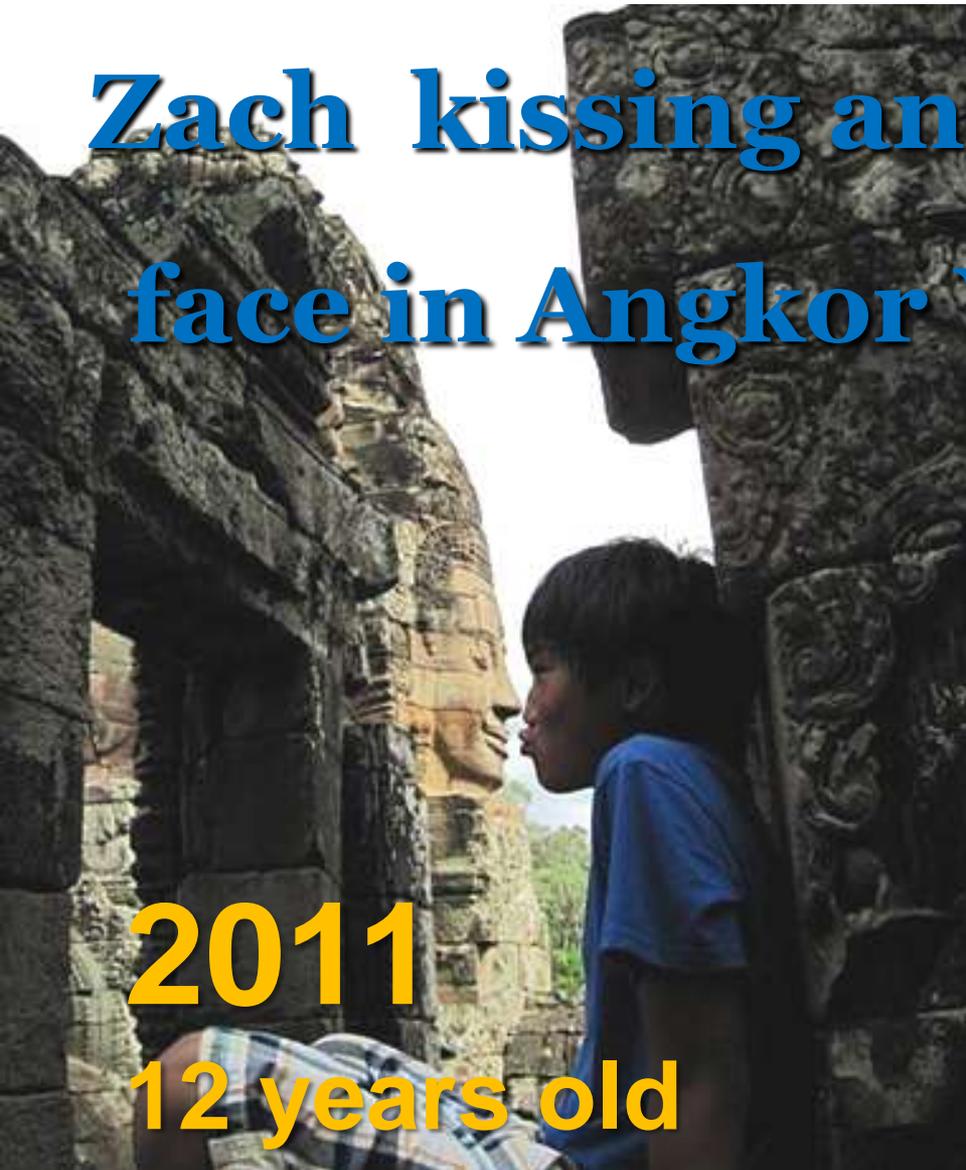
Micah, North Carolina State University, BS and MS; an engineer designing sailboat parts; no girlfriend @ 28 years old. I have been telling him, “I want to be a granddad,” He has been telling me not yet Dad!!!





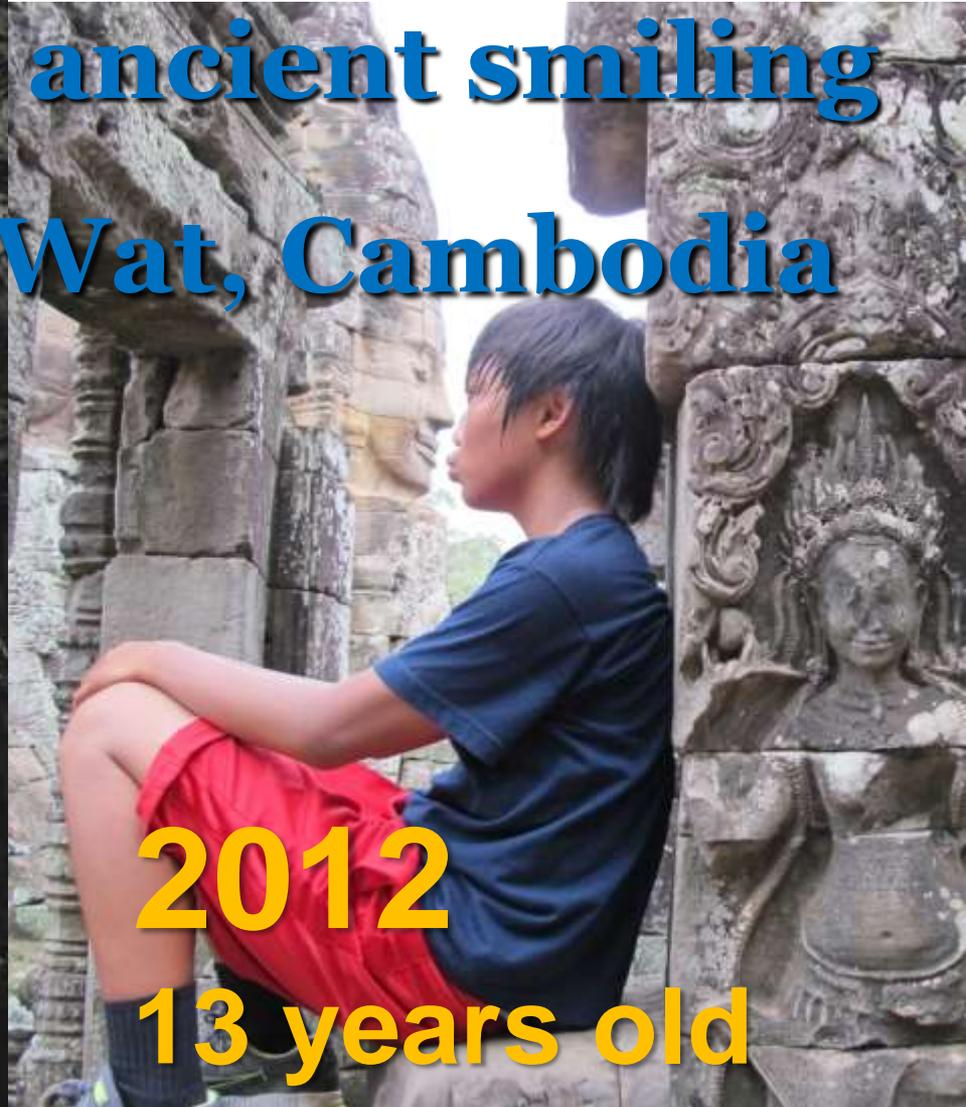
Thanks to my son Zach

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



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SANREM INNOVATION LAB
Feed the Future Innovation Lab for Collaborative Research
on Sustainable Agriculture and Natural Resource Management



**French Agency
for
International
Development**





Flags of Red White and Blue +



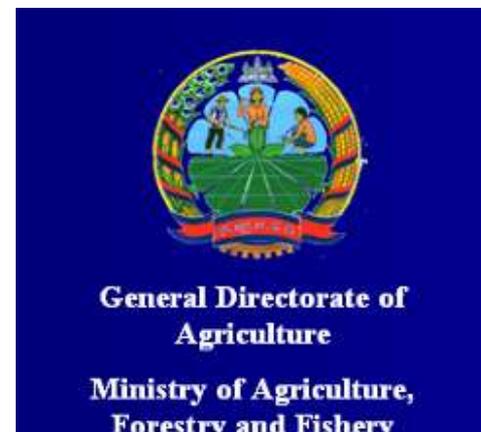


Brazil



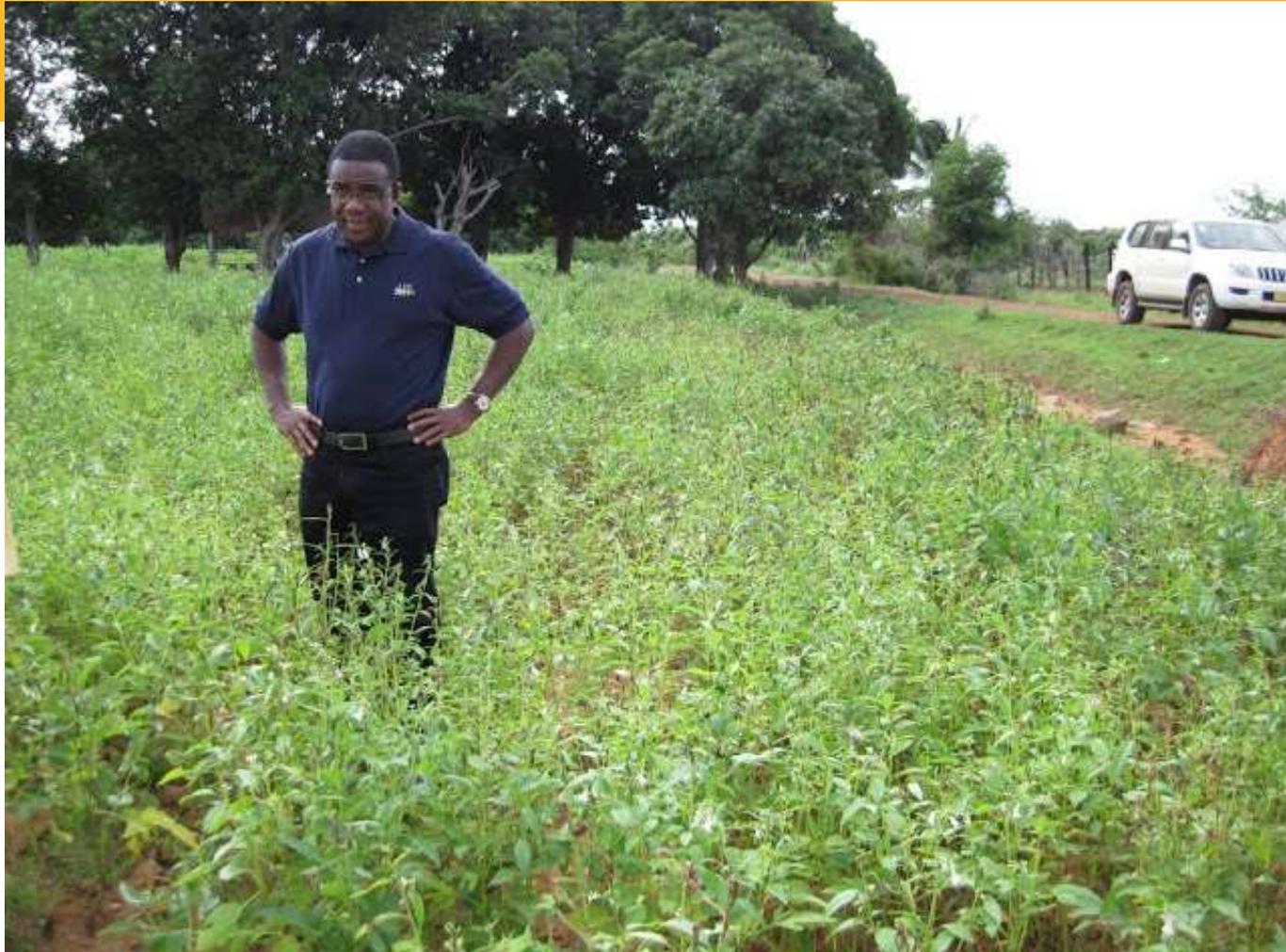


Strong Partnership





**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**



Ellen

- **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

- **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**



WOMEN
MEN



**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. Nhem, S. Pheav, M. Reyes, F. Tivet, L. Séguy

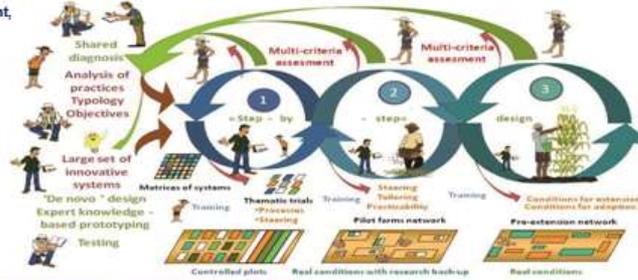


Context and objective

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. This development has been promoted by migration from populated central regions to forested peripheral regions, the illegal clearing of forests, and strong regional demand for maize, 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 harsh climate, and high rate of soil organic carbon (SOC) mineralization, mechanized farming exacerbated the problem of soil degradation. Maintaining productive capacity of the soil is a crucial 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 local smallholders and based on conservation agriculture (CA) and diversified 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 tacit knowledge. The approach combines *de novo* innovation through expert-based prototyping, keeping the range of possible options wide open, and a step-by-step design, favouring adaptation and learning processes. DATE is built on four main components: a diagnosis and three loops of cropping system design. The diagnosis provides a multi-scale analysis of the agricultural systems. On this basis, a large range of cropping systems are designed and tested at different scales, with three successive learning loops (Husson 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/crelay crops successions, associations, rotations and different levels of intensification) are 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. Precious information on practicability and management principles are developed. A process of on-farm assessment is used to match DMC systems to smallholders' conditions and strategies. Feed-back from the smallholders is recorded throughout the process, so that every constraint can be taken into account during the experimental phase.



Network of pre-extension

The third loop takes place through a network of pre-extension, managed by extension agents with agronomists/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 technical 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, 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 loops). Although no rural development project was associated to this research, a pilot extension network was initiated in 2009 (third loop). In Ratanak Mondul (Battambang province), this network covered 4 villages and involved 64 households, applying DMC systems on 200 ha (35 ha of spontaneous diffusion) in 2012.

We had a DATE Cambodia. Conservation Agriculture Design, Assessment, Training and Extension approach



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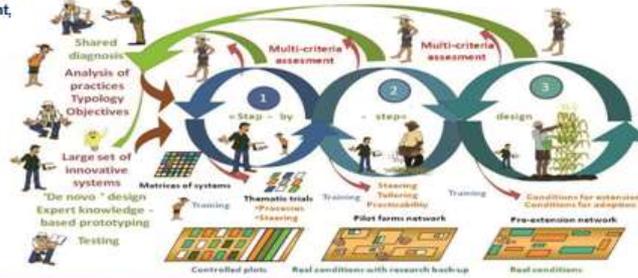


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Kong Rada
and Lyda
Hok had a
DATE with
you
Cambodia.
They are
ready and
have been
trained.



SANREM INNOVATION LAB



USAID
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Did we succeed?
Cambodia
Testing Maize



Recommendation of hybrid corn on Mollisols of Western upland areas in Cambodia



R. Kong, V. Sar, K. Soueng, B. Thy, S. Boulakia, V. Leng, L. Huot, S. Nhem, S. Pheav, M. Reyes, F. Tivet, L. Séguy



Context, objective and methodology

Hybrid of corn are widely grown since early 2000s by smallholders in the western areas of Cambodia. A large number of hybrids are available on the market. However, few information are delivered regarding the yield potentialities, tolerance to drought and to low soil fertility, among others criteria. Through the Feed the Future Innovation Lab for Collaborative Research on Sustainable Agriculture and Natural Resources Management (SANREM) funded by USAID, a number of trials of registered hybrids were carried-out on several locations (Bonbo I: BB-I) and Bonbo II: BB-II) since 2010 on Mollisols in Rattanak Mondul, Battambang province. They aim at assessing the yield to recommend the more appropriate cultivars to farmers. The experimental design is based on a tested collection with one control (cv. CP888) replicated and each hybrid was tested on 40m² with two fertilization levels F1 (70N-30P₂O₅-30K₂O) and F2 (116N-65P₂O₅-60K₂O) under conventional plow-based cropping (CT) and direct seeding mulch based cropping (DMC) systems (i.e., no-tillage, diversified crop sequence, cover/relay crops).

Corn yield under DMC and CT management

Yield was significantly higher ($p < 0.05$) under DMC than that under CT management. On average, the increase under DMC was 1.5 Mg ha⁻¹ and 2.5 Mg ha⁻¹ in 2012 and 2013, respectively (Fig. 1 and Fig. 2). When comparing the effect of fertilization, the difference between F1 and F2 ranged from 1 Mg ha⁻¹ to 1.5 Mg ha⁻¹ under DMC and CT management, respectively. By contrast, the gain in yield due to mineral fertilizers can reach almost zero on rich soil like the Red Oxisol on basalt in Chamcar Leur, Kampong Cham province.



Fig. 1: Annual rainfall (mm month⁻¹) 2010-2013

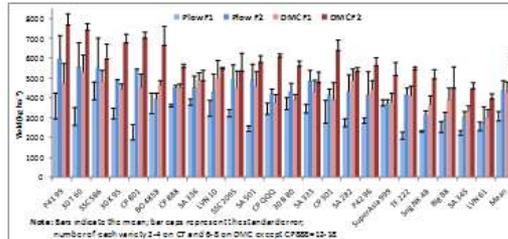


Fig. 2: Hybrid yields under DMC and CT management 2012-2013

DMC corn yield as compared with the control CP888

- In 2010, CPAAA, CPQQQ, and 30B80 produced higher yield than other hybrids, the yield was in average 38%, 31%, and 21% higher than CP888, respectively.
- In 2011, CPQQQ, 30Y87, and 30B80 were the first top three hybrids, with a yield 30-to-40% higher than CP888.
- In 2012, due to drought higher yield was observed with CP888. Only three hybrids showed similar yields than CP888: 30B80, P4296, and SA336.
- In 2013, higher yields were observed for SA282, SA336, 30T60, and SA501, 20-30% higher than CP888.

During this year, significant difference were recorded, and yield performance varied drastically with given biophysical environment, and climatic conditions. The hybrids 30T60, P4296, SA282, and SA336 showed more stable yields when compared with the others hybrids. Additional trials may confirm these first results.

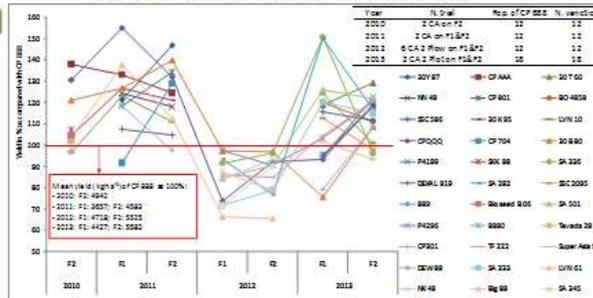


Fig. 3: Comparison of hybrid yield between CP888 (control) and the others hybrids (2010-2013)

We tested several hybrid corn for CA application and found some promising ones.



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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.





Enhancing ecological processes under diversified direct seeding mulch-based cropping systems in Cambodia

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



From 3 pillars...

We built three pillars of conservation agriculture in Cambodia. Now there is a government department for CA and CA dedicated research station land.



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Enhancing ecological processes under diversified direct seeding mulch-based cropping systems in Cambodia

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Minimum soil disturbance



Permanent soil cover



To high and diversified biomass-C inputs from crops and key cover crops ...



... to continuous C flux, above and belowground ...



Diversified crop rotations + cover/relay crops



... to SOC sequestration, nutrients cycling, soil fauna and microbial functional diversity



The name of the Department is: Conservation Agriculture Service Center. And some plots in the center are in CA for 8 years now.



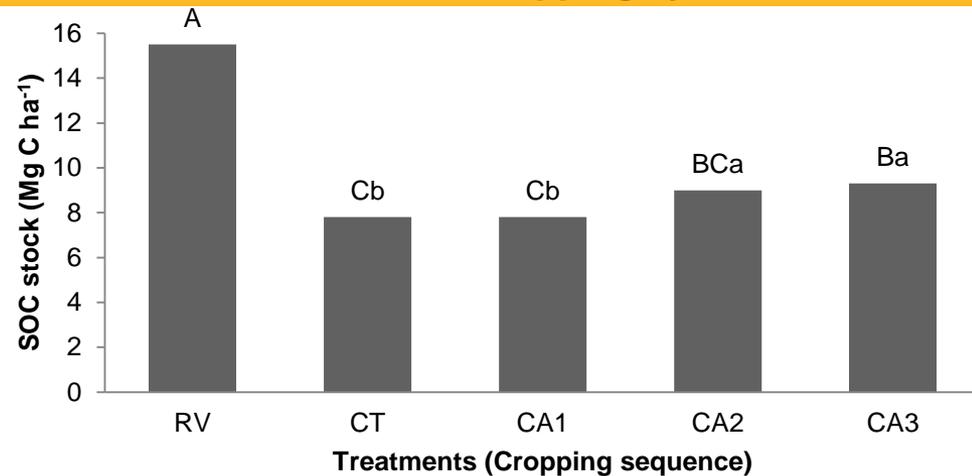
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Oh yes, we have trained at least 20 Cambodians who can apply pillars of conservation agriculture



Cassava-based cropping systems



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.



Diversified direct seeding maize-based cropping systems for Western Cambodia

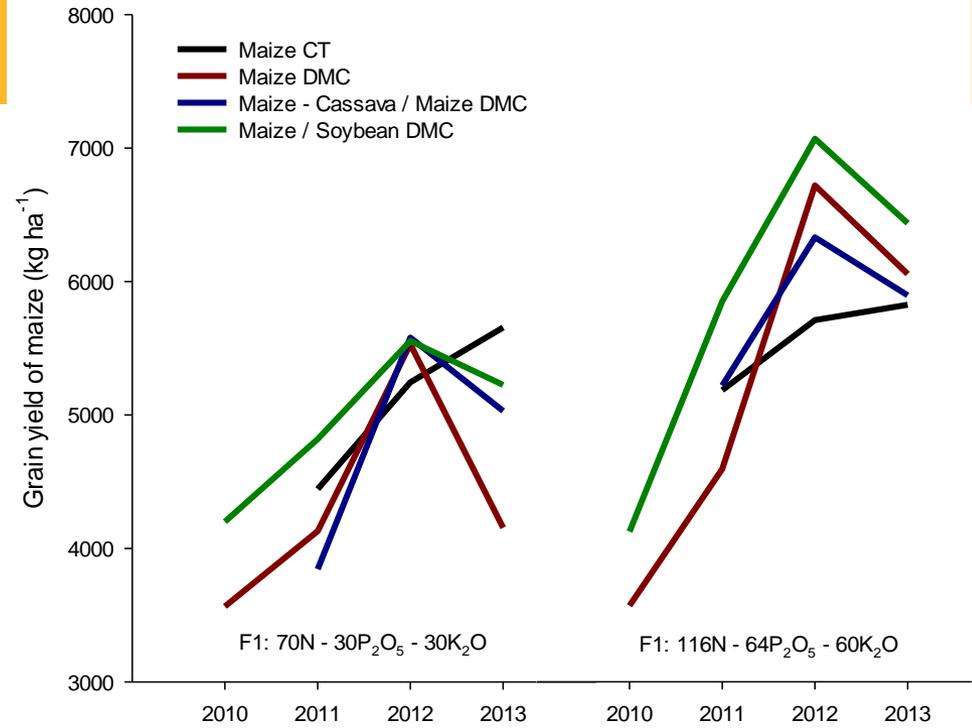
S. Bouali, V. Sir, B. Thy, K. Soumy, R. Kong, V. Long, S. Phras, M. Reyes, F. Tivet, L. Seguy

Context and objective
 The Western province of Cambodia (i.e., Banteay Meanchey, Pursat, Kampong Speu, and Takeo) is one of the main maize production areas in Cambodia. Maize and rice are the main crops. A sustainable maize production system for the 2030s (2010-2030) has to be developed. This requires a maize-based cropping system that is resilient to climate change, that allows a higher maize yield and a higher maize yield stability over time, and that allows a higher maize yield stability over time, and that allows a higher maize yield stability over time.

Engineering of diversified no-till cropping systems
 Innovative systems in conjunction with conventional practices were introduced in two maize structures (improved (Rorik village, Banteay Meanchey province, Banteay Meanchey) in representative situations of the local maize-based cropping systems. Different intercropping systems, associations and rotations are tested under CT and DMC management, and the fertilization levels, maize yield and gross profit margin (GPM) of the following cropping systems are presented:

- CT Maize monoculture
- DMC Maize + Finger millet (P)
- Sorghum (Sg) + Soybean (Sb) + Maize + P + Soybean + Sg under DMC, a two-year rotation sequence of maize and soybean with different sowing dates (Sg and Sb are sown at the beginning of the rainy season and controlled after 70 days). Two weeks later, sowing of maize in association with Pp as relay crop.
- Maize + Finger millet (P) + Sb + Cassava + Maize + Pp under DMC. Early maize (May - September) associated with Pp + Sb. After maize harvest, planting of dry season cassava (October - July), followed by a winter season maize + Pp.

Results and discussion
 The average yield of maize ranged from 5.1 (P) to 6.7 (Sg + Sb) kg ha⁻¹ (P) under CT management (Fig. 1). Under F1, the yield under DMC ranged from 4.6 to 6.2 kg ha⁻¹. It ranged from 5.1 to 6.7 kg ha⁻¹ under DMC, which was higher than those obtained under CT and ranged from 5.8 to 6.4 kg ha⁻¹. Under both fertilization levels, higher yields were obtained in the maize + soybean + sorghum rotation. In 2010, the gross of maize was highest (Table 1), resulting in a dramatic decrease of the GPM under maize CT and maize DMC (Fig. 2). The diversification with soybean and the cassava production under DMC represent promising alternatives for this region. Smallholders in Cambodia need strong constraints to access to credit and inputs, thus strategy should focus on enhancing nutrient cycling through continuous biomass-C inputs under DMC systems plus a combination of actions to reduce nutrient removal from cassava fields through limitation of stems exportation.



A poster reported maize yield in CA higher than tilled, that black line.



Potentials and challenges of Conservation Agriculture in the western upland areas of Cambodia. A case study in Rattanak Mondul, Battambang province



R. Kong, S. Boulakia, V. Sar, K. Soeurng, B. Thy, V. Leng, L. Huot, S. Nhem, S. Pheav, M. Reyes, F. Tivet, L. Ségué



Context and objective

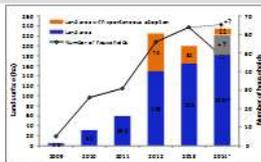
Rattanak Mondul is one of the last Khmer Rouge stronghold areas in the western Cambodia, where 440,000 ha of forest lands have been reclaimed in a decade after the full peace establishment on all national territory in 1998. The ever increasing market demand, the available agricultural inputs and private services for plowing, induced drastic changes in smallholders habits. Small scale subsistence farming, based on upland rice and peanut, quickly shifted to commercial farming based on soybean (2003), corn (2005) and cassava productions. Intensive plow-based tillage and ridging with cassava monoculture have induced a marked soil fertility depletion and soil degradation. Coupling with climate change impacts (drought and flooding) and higher production costs (chemical fertilizers and chemical weedicides control), this development scheme has jeopardized the agronomic and economic performances of the farms. On-farm assessment and network of pre-extension have been used since 2009 through the Feed the Future Innovation Lab for Collaborative Research on Sustainable Agriculture and Natural Resources Management (SANREM) to introduce direct seeding mulch-based cropping systems (DMC) for sustainably intensification and diversification.

Proposed cropping systems and evolution of DMC adoption

Pigeon pea (*Cajanus cajan*) is successfully tested as cover crop for corn to replace Stylo (*Stylosanthes guianensis*) on this highly-alkaline Mollisols soil with pH 6.5-8.0. For its possible competition, especially on poor soils with low fertilization, pigeon pea is sown 10-15 days after corn sowing in the inter-row. The network of pre-extension increased from 2 target villages, few households and hectares in 2009, to 4 villages, 200 ha and 64 household in 2013, even facing yield damage due to long drought span in 2012, and ending with the 300USD ha⁻¹ free-interest credit on inputs and services. The farmers are convinced by no-till on crop residues, saving the cost of soil preparation, higher flexibility regarding the sowing date, and soil restoration improvement. However, they are still reluctant to investing additional labor for sowing of pigeon pea.

Yield performance and gross profit margin (GPM)

In spite of the years of DMC practice, the yield of corn under DMC management was similar to those observed under conventional management, expected under higher fertilizer level (70N-30P₂O₅-30K₂O) where higher yields were observed under DMC. As a result, the GPM of DMC plots were lower than those under conventional plow-based management (CT), except in 2013.

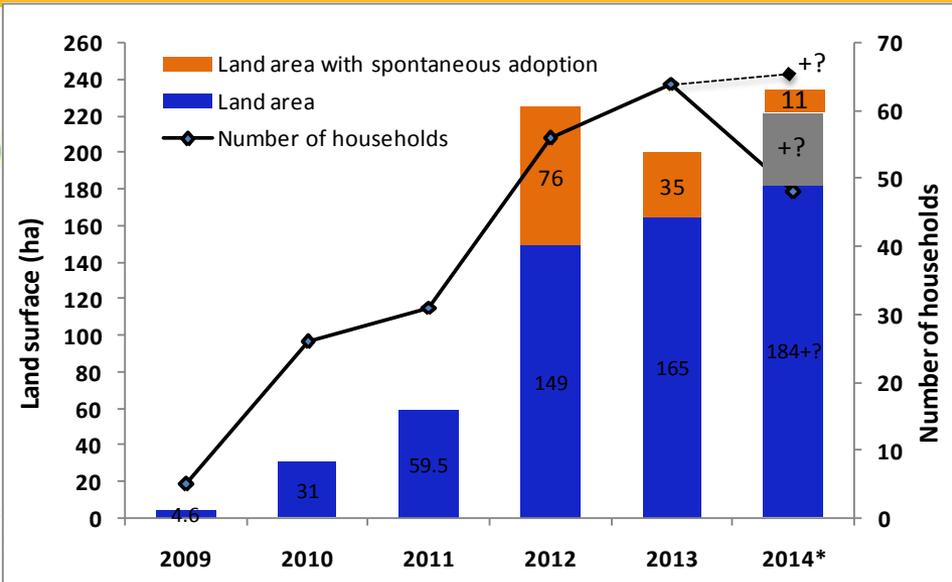


Conclusions

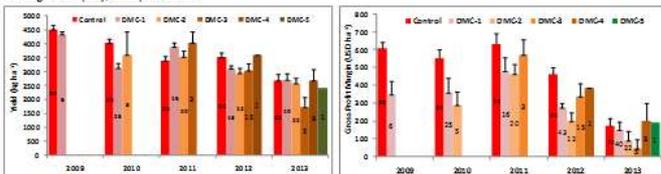
- Farmers are convinced by no-till sowing on crop residues, to save cost and to preserve the soil potentialities. However, any additional cost or labour input impair the use of cover/re lay crops, such as no-till sowing of mungbean or pigeon pea.

- Training and communication are also one of the main issues to promoting DMC cropping systems. Improvement in know-how and skills of both smallholders and extension agents is needed.

- Giving additional value to the cover/re lay crops (ash and/or animal feeding), facilitating the access to credit with low interest rate (subsidy for payment for environmental services) through farmer cooperative will boost the adoption of DMC cropping systems.



Oh Rada, what an exciting rise in CA adoption in 2012, but then a drop in 2013.



Note: Bars indicate the mean; Number inside the bar is number plot; bar caps represent the standard error; DMC-1 means 1 year DMC practice

Potentials and challenges for adoption and scaling up

The proposed DMC based cropping systems are compatible with the operations conducted by the private contractors, generally involved in machinery, pesticides and fertilizers supply. The farmers are curious for innovative technologies that could reduce labor and production cost, while sustaining the crop productivity. Some farmers already invested in a 4-row and 2-row direct seeders. Pigeon pea could be used for cattle and pig fattening which is being promoted by NGOs in the region. Additional engineering and research works should be conducted to assess the best combination of density and sowing date of pigeon pea with corn to reduce water competition that could occur. Other legumes species that could be eventually broadcasted (reducing labor requirement) should be evaluated on these alkaline soils. Access to specific DMC equipments (Machine Auto Part Co., Ltd, Thailand), fertilizers, and cover crops are today facilitated, but the lack of financial support represents one of the main constraint to the extension of DMC cropping systems. Developing DMC systems for cassava (after chiseling for furrow opening), in rotation with corn or soybean integrating a nutrient cycling strategy (limiting stem removal of cassava), represent one of the main challenge in Cambodia.



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Gendered livelihoods and conservation agriculture: Space, decision-making, and access

¹Daniel Sumner, ²Dr. Maria Elisa Christie, ³Dr. Manuel Reyes, ⁴Dr. Stephane Boulakia

¹Office of International Research, Education, and Development, Virginia Tech, Blacksburg, Virginia USA
²Department of Natural Resources and Environmental Science, North Carolina A&T, Greensboro, North Carolina, USA

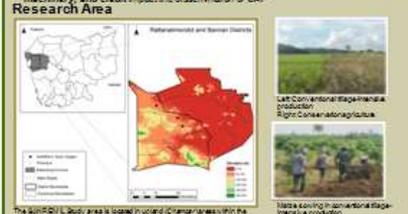


Abstract: Interactions on Researcher-Apprentice social development. This poster investigates gender-based constraints and opportunities to the dissemination of conservation agriculture based on a case study with smallholder farmers in the village of Pichangya, Ratanak Kiri District, Battambang Province, Cambodia. A mixed-methods approach was used, including focus group discussions, semi-structured interviews, household surveys, and participatory mapping, to explore the effect of conservation agriculture on men's and women's allocation of labor, gendered power relations in intra-household negotiations, and access to resources and information. We found that conservation agriculture has the potential to decrease men's and women's workload and productivity in cash crop production and generates opportunities for other work. This may contribute to an increase in women's "triple workload" as they invest part of this "extra" time into additional domestic and community activities. We also found that gender intersects with other factors to limit men's and women's access to information and participation in household negotiations. These findings could have implications on smallholder farmers' introduction of conservation agriculture.



Research Objectives

- How does CA implementation affect men's and women's allocation of labor to different productive, reproductive, and community activities?
- How do men and women access agricultural support services and information about CA?
- How are gendered livelihood practices linked to men's and women's participation in intra-household decision-making and the implementation of CA?
- How could gender-based differences in access to and control over land, agricultural machinery, and credit impact the dissemination of CA?



Methods: Focus Group Discussions and Household Visits

Two FGDs held separately with men and women (5 men and women interviewed separately)



How does CA implementation affect men's and women's allocation of labor to different productive, reproductive, and community activities?

- 50% of women and 77% men indicated that CA reduced their labor burden in annual cash crop production, land preparation and implementation.
- When my family was plowing... my whole family had to help during land preparation but with CA my wife and children no longer have to sow the maize seed or apply the fertilizer (Male farmer).
- Men and women able to allocate more labor to household cash crop and subsistence agriculture.
- Men and women have more "extra" time to reallocate, but there is little change in their perceived roles and responsibilities.

How do men and women access agricultural support services and information about CA?

- Distance affects men's and women's ability to attend meetings and seminar trainings.
- Men and women are commonly listed as members, but more men reported that they attended a farmer association/producer group meeting or seminar training.
- There was more equity in BANRBM meeting participation.
- Women cannot go on to field trainings because of their obligations in managing the household and reported, "men cannot take care of children when the women are gone." (Female Farmer)
- Field trainings focus on technical knowledge and field activities and thus perceived as men's domain.

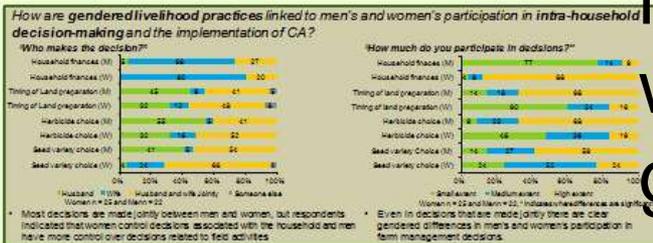
	Yes	No	No knowledge of group
Farmer Association/producer group	Men: 45%, Women: 35%	Men: 35%, Women: 55%	-
BANRBM IL Farmer Association	Men: 60%, Women: 55%	Men: 41%, Women: 44%	-

Example of a man's participatory map:

- Men discuss CA with other men when they are working on their plot or visiting a neighbor's plot.
- Women discuss CA in a greater variety of spaces including household gardens, pagodas, and markets.

Example of a woman's participatory map:

- I share mostly with men because men control the upland cultivation and have the information and know about the supplies that are needed (Male farmer)
- I talk about CA mostly with women because it's mostly women at the Pochek market (Female farmer)



How could gender-based differences in access to and control over land, credit, and agricultural machinery impact the dissemination of CA?

Access to land: Men's and Women's Reported Land Ownership

Ownership	Men	Women
Joint	17%	10%
Men	77%	89%
Women	6%	1%

Access to credit:

- Micro-finance institutions
- Local intermediary
- BANRBM
- ... my husband takes out the loan, but I'm not concerned with clearing the debt (Female farmer)

Access to and control over agricultural machinery:

- Increasing mechanization within the study area
- Status symbol and identity
- Access to specialized mobile equipment
- Availability
- Lack of capital

Gender-based constraints to CA

- Land tenure insecurity especially for women
- "Extra" time and women's triple workload
- Limited access to agricultural training and support services
- Lack of access to credit
- Importance of access to production

Gender-based opportunities to CA

- Farmer interest in new technologies
- Complementary roles in household decision-making
- Joint land ownership

Development recommendations

- Build upon existing information pathways to ensure men and women both have access to agricultural training and support services
- Incorporate information on the technical components of CA applied in the field to include decisions made in the home that affect field practices
- Identify who within the household makes vital kinds of decisions
- If decisions are made jointly, ensure that men's and women's concerns/interests are addressed
- Thinking spatially can help conceptualize the interconnectedness of the multiple components of gendered livelihood

Acknowledgements: We would like to thank the generous support of the Virginia Tech Center for Environmental and Estuarine Science (Chesapeake Biological Laboratory) and the Virginia Tech Center for Environmental and Estuarine Science (Chesapeake Biological Laboratory) for their support in this research. We also thank the CIRAD team for their support in this research. We also thank the CIRAD team for their support in this research.

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.



Gendered livelihoods and conservation agriculture: Space, decision-making, and access

¹Daniel Sumner, ¹Dr. Maria Elisa Christie, ²Dr. Manuel Reyes, ³Dr. Stephane Boulakia



Office of International Research, Education, and Development, Virginia Tech, Blacksburg, Virginia USA
 Department of Natural Resources and Environmental Design, North Carolina A&T, Greensboro, North Carolina, USA

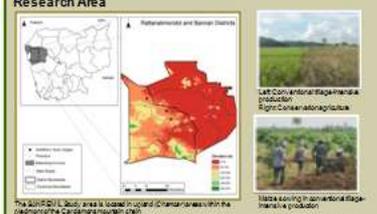
Abstract

This poster investigates gendered constraints and opportunities to the dissemination of conservation agriculture based on a case study with smallholder farmers in the village of Pichangia, Retalhuleu District, Guatemala. A mixed-methods approach was used, including focus group discussions, semi-structured interviews, household surveys, and participatory mapping, to explore the effect of conservation agriculture on men's and women's allocation of labor, gendered power relations in intra-household negotiations, and access to resources and information. We found that conservation agriculture has the potential to decrease men's and women's workload and improve in cash crop production and generate opportunities for other work. This may contribute to an increase in women's 'triple workload' as they invest part of their 'extra' time into additional domestic and community activities. We also found that gender intersects with other factors to limit men's and women's access to information and participation in household negotiations. These findings could have implications on smallholder farmers' interaction with conservation agriculture.

Conservation Agriculture (CA) is increasingly being advocated as a means to address food insecurity and soil degradation. CA has three interrelated principles (No-till, Residue cover, and Minimal soil disturbance from tillage).



- Research Objectives**
- How does CA implementation affect men's and women's allocation of labor to different productive, reproductive, and community activities?
 - How do men and women access agricultural support services and information about CA?
 - How are gendered livelihood practices linked to men's and women's participation in intra-household decision-making and the implementation of CA?
 - How could gender-based differences in access to and control over land, agricultural machinery, and credit impact the dissemination of CA?



Methods: Focus Group Discussions and Household Visits
 Two FGDs held separately with men and women
 26 (men and women interviewed separately)



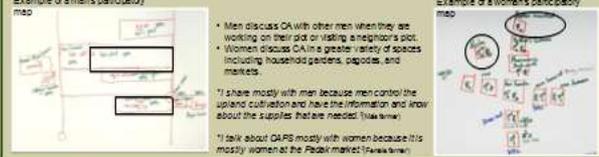
- How does CA implementation affect men's and women's allocation of labor to different productive, reproductive, and community activities?**
- 80% of women and 77% men indicated that CA reduces their labor burden in annual cash crop production (land preparation and implementation).
 - When my family was working... my whole family had to help during land preparation but with CA my wife and children no longer have to sow the male seeds or apply the fertilizer? (Male farmer)
 - Men and women able to allocate more labor to household cash crop and subsistence agriculture.
 - Men and women have more 'extra' time to reallocate, but there is little change in their perceived roles and responsibilities.

How do men and women access agricultural support services and information about CA?

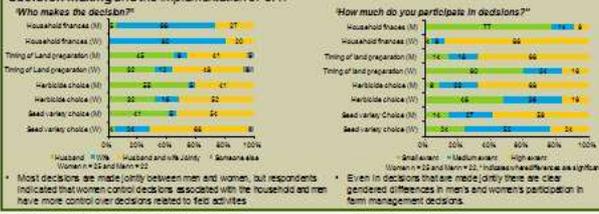
- Distance affects men's and women's ability to attend meetings and seminar trainings.
- Men and women are commonly listed as members, but more men reported that they attended a farmer association/producer group meeting or seminar training.
- There was more equity in BANREMI meeting participation.
- Women came more on to field trainings because of their obligations in managing the household and reported, 'men cannot take care of children when the women are gone.' (Teresa Farvia)
- Field trainings focus on technical knowledge and field activities and thus perceived as men's domain.

	Yes		No		No knowledge of group	
	Men	Women	Men	Women	Men	Women
Farmer Association/producer group	45%	35%	55%	64%	-	-
BANREMI farmer association	60%	55%	41%	44%	-	-

Women = 25 and Men = 22



How are gendered livelihood practices linked to men's and women's participation in intra-household decision-making and the implementation of CA?



How could gender-based differences in access to and control over land, credit, and agricultural machinery impact the dissemination of CA?



- Gender-based constraints to CA**
- Land tenure (especially for women)
 - 'Extra' time and women's triple workload
 - Limited access to agricultural training and support services in the field
 - Lack of access to credit
 - Importance of tillage to production
- Gender-based opportunities to CA**
- Farmer interest in new technologies
 - Complementary roles in household decision-making
 - Joint land ownership

Development recommendations

- Build upon existing information pathways to ensure men and women both have access to agricultural training and support services.
- Incorporate information beyond the technical components of CA applied in the field to include decisions made in the home that affect field practices.
- Identify who within the household makes what types of decisions.
- If decisions are made jointly, ensure that men's and women's concerns and interests are addressed.
- Thinking spatially can help conceptualize the interconnectedness of the multiple components of gendered livelihood.

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 and implementation.



Vegetables Production in Drip Irrigation and Conservation Agriculture for the Disadvantaged Women in Siem Reap, Cambodia

Don Immanuel Edralin, Saren Ry, and Manuel R. Reyes

North Carolina Agricultural and Technical State University

Hypothesis: Conservation agriculture and drip irrigation will decrease labor, increase yield and income, and improve soil health



Site: Five women farmers in Siem Reap with area of 100 m² divided into 4 plots



Results:

- What observations can you infer from photo above?
- Yield - lowest TD and highest CA not significant at 5%
- Net income – highest CA, depreciated cost of tank and drip with drip life shorter in tilled systems
- Labor – least labor in CAD with drip as key; in CA labor is saved by not tilling but labor is added by addition of mulch and cover crop

Impact: Reduced labor and income of \$350 in 100 m², per capita income is \$944

This poster is made possible by the generous support of the American people through the United States Agency for International Development (USAID). The contents are the responsibility of the Horticulture Innovation Lab "Women of Siem Reap Project" and do not necessarily reflect the views of USAID or the United States Government.



Conventional Watering



Drip Irrigation



Tilled



Conservation Agriculture

Treatments: (Randomized Complete Block Design with five replications)

- T – Tilled
- TD – Tilled with drip irrigation
- CA – Conservation agriculture
- CAD – Conservation agriculture with drip irrigation

Yield	T	CA	TD	CAD
Chinese Cabbage (kg)	391	397	362	382

Income (\$) for area of 100 m ²	T	CA	TD	CAD
Gross income (G)	165	164	152	164
Expenses (E)	41	39	59	49
Net Income (G-E)	123	125	92	115

Labor	T	CA	TD	CAD
Time in hours	75	70	54	49

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



This is what happens?

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



Tilled



From SANREM-Philippines site



Maize

Conservation Agriculture
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:

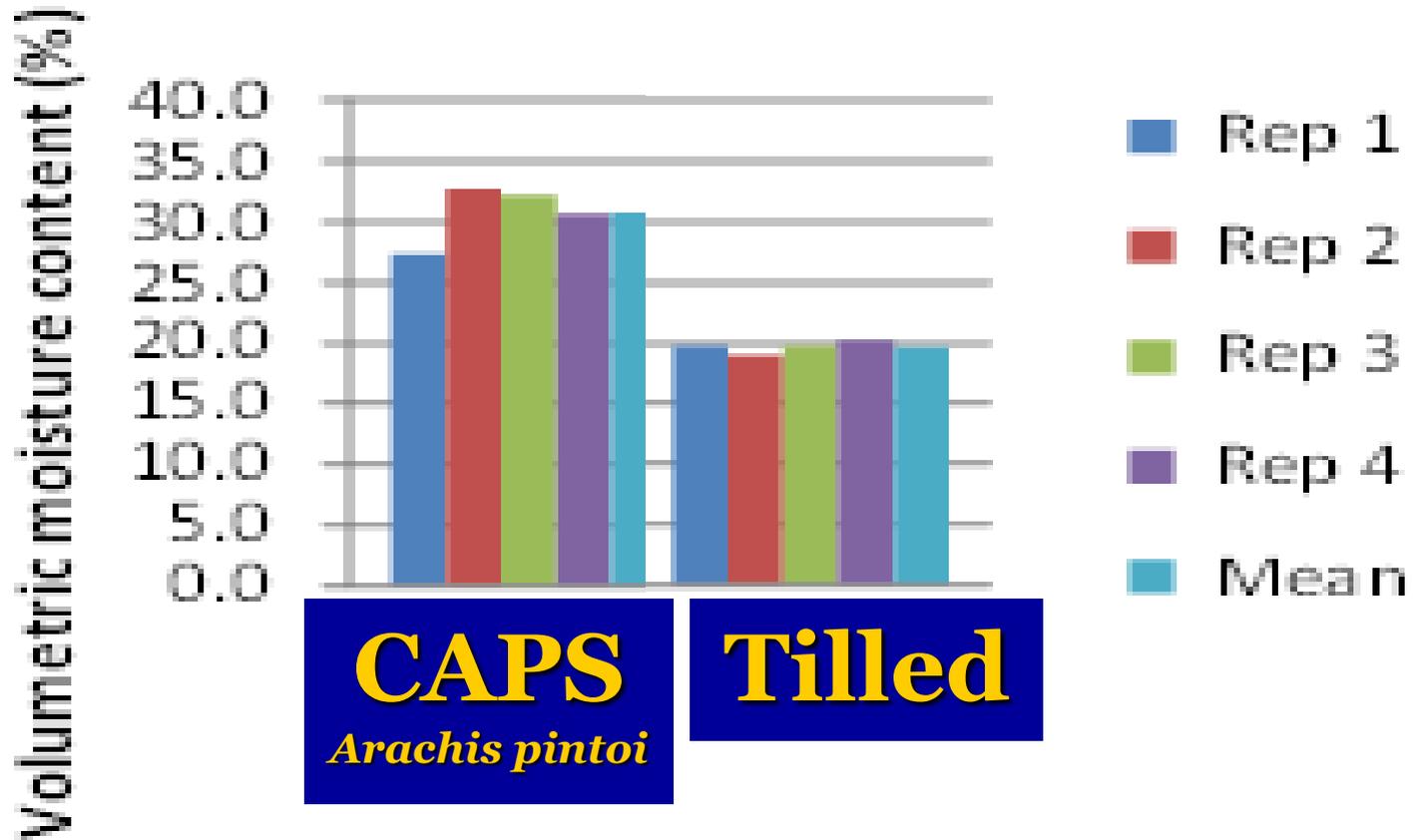
Did we succeed?

Climate change resilience

Residual moisture



Residual moisture:



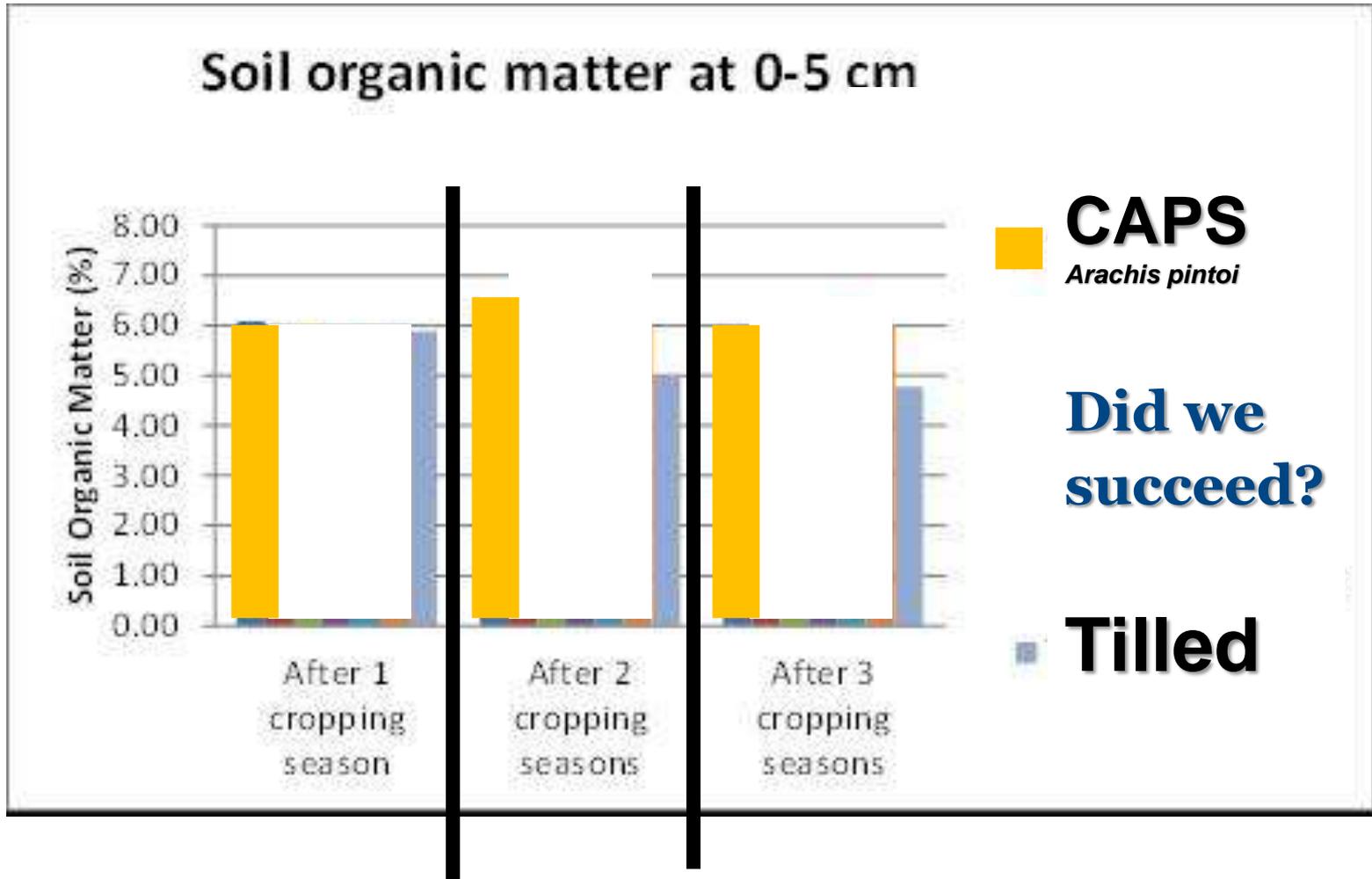


Did we succeed?

Soil Organic Matter



Soil Organic Matter:





Residual moisture:

Did we succeed?
***Arachis pintoi* for livestock**



Did we succeed?

Pigs like *Arachis pinto*



Residual moisture:

Did we succeed?

***Arachis pintoi* for carabao
and cattle?**



Did we succeed?

***Arachis pintoii* for fish**



Did we succeed?

**Conservation Agriculture
seeding/planting**







Dibble Stick







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



Gender

Labor reductions experienced through reduced weeding for Filipinas (women) and no till for Filipinos (men)

Practices and Gendered Impacts of Conservation Agriculture Production Systems (CAPS) Adoption among Smallholders in the Philippines and Cambodia

Ma. Elena C. Javier¹, Kent C. Tongcalagan¹ and Manuel R. Reyes²
¹De La Salle University – Manila, Philippines
²North Carolina Agricultural and Technical State University, USA

Main Objectives

1. Identify the CAPS adoption practices of selected households in both countries.
2. Determine the gendered impacts of CAPS in both countries.
3. Pinpoint the issues related to CAPS dissemination and expansion in both countries.

Methodology

Data gathering: In-depth couple interviews & Filipino couples; 5 Khmer couples and 2 widows (N=24; 13 women, 11 men)

Research Sites

Cloveria, Misamis Oriental, Philippines
Sraib, Pichangya & Singha Villages, Battambang, Cambodia

Household Profile

- Higher average annual farm income for Khmer smallholders (\$1958) compared to Filipino small holders (\$1157)
- Conjugal owned farms in Cambodia (except for widows having single ownership), while shared ownership (mostly with parents or relatives) in the Philippines.
- Almost half of smallholdings in both countries under CAPS.

CAPS Practices

- Husbands first to learn of CAPs in the Philippines; wives in Cambodia.
- Mechanized CAPS adoption in Cambodia; manual in the Philippines. Filipinos use and need more portable implements and draft animals.
- Filipino male farmers more involved in land preparation (i.e. burning, spraying, rolling cover crops, furrowing) compared to Khmer males; female farmers and children in both countries handle planting, fertilizer application, weeding, harvesting and marketing.
- Hiring of male laborers preferred by Filipino farm households; this is rarely practiced in Cambodia due to greater reliance on mechanization.

Gendered Impacts of CAPS

- CAPS perceived to be beneficial to both women and men in both countries.
- Labor reduction experienced through reduced weeding among Filipino wives, no-till among Filipino husbands, and machine use among Khmer farmers.
- Women more observant than men in identifying problems with CAPS adoption.
- Decline in demand for especially male farm labor (additional income source) owing to no-till, reduced weeding and machine use features of CAPS.

CAPS Dissemination and Expansion Issues

- Route of dissemination: neighbors first, then relatives, friends, organizations they belong to, and farm laborers.
- Non-adoption of CAPS due to lack of farmland and inputs, preference for ploughing, and particularly in Cambodia, inaccessibility of farms to machines.
- Willingness of Filipino farmers to expand CAPS practice in their farms after the project ends but not for Khmer farmers owing to land shortage and wait-and-see attitude.
- Continued adoption of CAPS generally contingent on provision of free inputs, financing assistance, stronger-secting herbicides, updated technical advice, more available and affordable machine services, and market outlet for cover crops.

Recommendations

- Harmonize CA adoption knowledge and training of women and men farmers
- Target widows as CAPS primary beneficiaries to empower independent farming
- Provide alternative sources of income to replace the loss of ploughing and weeding jobs
- Subsidize farm inputs and link farmers to financing assistance and technical advice for sustaining and expanding CAPs practices after farm trials.



WOMEN
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

To
is to
believe



Turf lawn, Sockwell Hall, 2011



Oasissofa Study, Fall 2011

To
is to
believe



Oasissofa Study: summer 2012 (left) and summer 2013 (right)

To
is to
believe



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



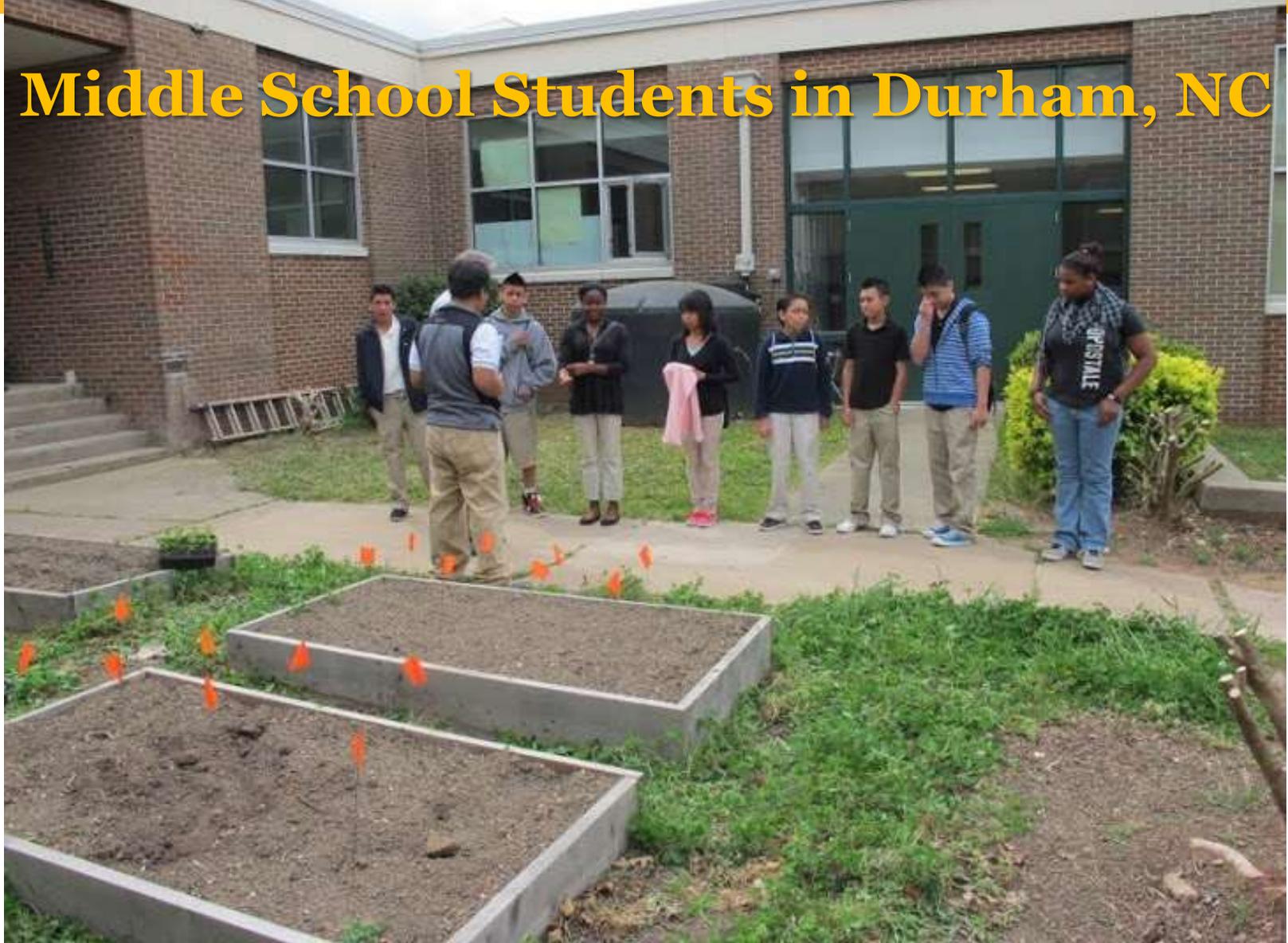


High School Students from NC





Middle School Students in Durham, NC





General Greene Elementary School. NC

Planting peppers



Staking tomatoes & peppers





Child Development Center Pre-K, NC





Did we succeed?

**Conservation Agriculture
Application in the United States
High School Campuses**



N.C. A&T Early STEM College





Yield Summer 2013 (lbs)

Varieties	Peppers	Tomatoes
Total	291	332
Lbs/bed	24	28

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)

Varieties	Peppers	Tomatoes
Total	235	205
Lbs/bed	20	17

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)

Varieties	Peppers	Tomatoes
Total	240	357
Lbs/bed	20	30

Bed is a size of a sofa 6 feet by 3 feet hence oasissofas. Oasis in the midst of a food desert.



Dudley High School, Greensboro





Yield Summer 2013 (lbs)

Varieties	Peppers	Tomatoes
Total	315	480
Lbs/bed	26	40

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)

Varieties	Peppers	Tomatoes
Total	341	420
Lbs/bed	28	35

Bed is a size of a sofa 6 feet by 3 feet hence oasissofas. Oasis in the midst of a food desert.



Southeast Guilford High School, Greensboro





Yield Summer 2013 (lbs)

Varieties	Peppers	Tomatoes
Total	184	334
Lbs/bed	15	28

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





Yield Summer 2013 (lbs)

Varieties	Peppers	Tomatoes
Total	215	30
Lbs/bed	18	3

Bed is a size of a sofa 6 feet by 3 feet hence oasissofas. Oasis in the midst of a food desert.



Scale School, Greensboro





Yield Summer 2013 (lbs)

Varieties	Tomatoes
Total	166
Lbs/bed	21

Bed is a size of a sofa 6 feet by 3 feet hence oasissofas. Oasis in the midst of a food desert.



Neal Middle School, Durham





Yield Summer 2013 (lbs)

Varieties	Peppers
Total	253
Lbs/bed	32

Bed is a size of a sofa 6 feet by 3 feet hence oasissofas. Oasis in the midst of a food desert.



General Greene Elementary School, Greensboro





Yield Summer 2013 (lbs)

Varieties	Peppers
Total	128
Lbs/bed	11



**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

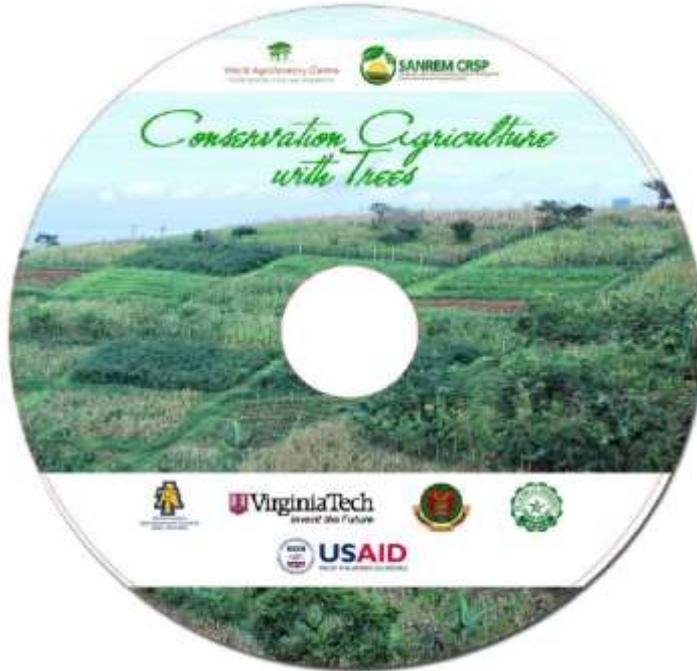


Cambodia

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



Philippines



Watch video in

https://www.youtube.com/watch?v=s8_-Z5QIt-c

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



**USAID & Virginia Tech
Thanks for SANREM
Did the Southeast Asia
team succeed?
Questions**