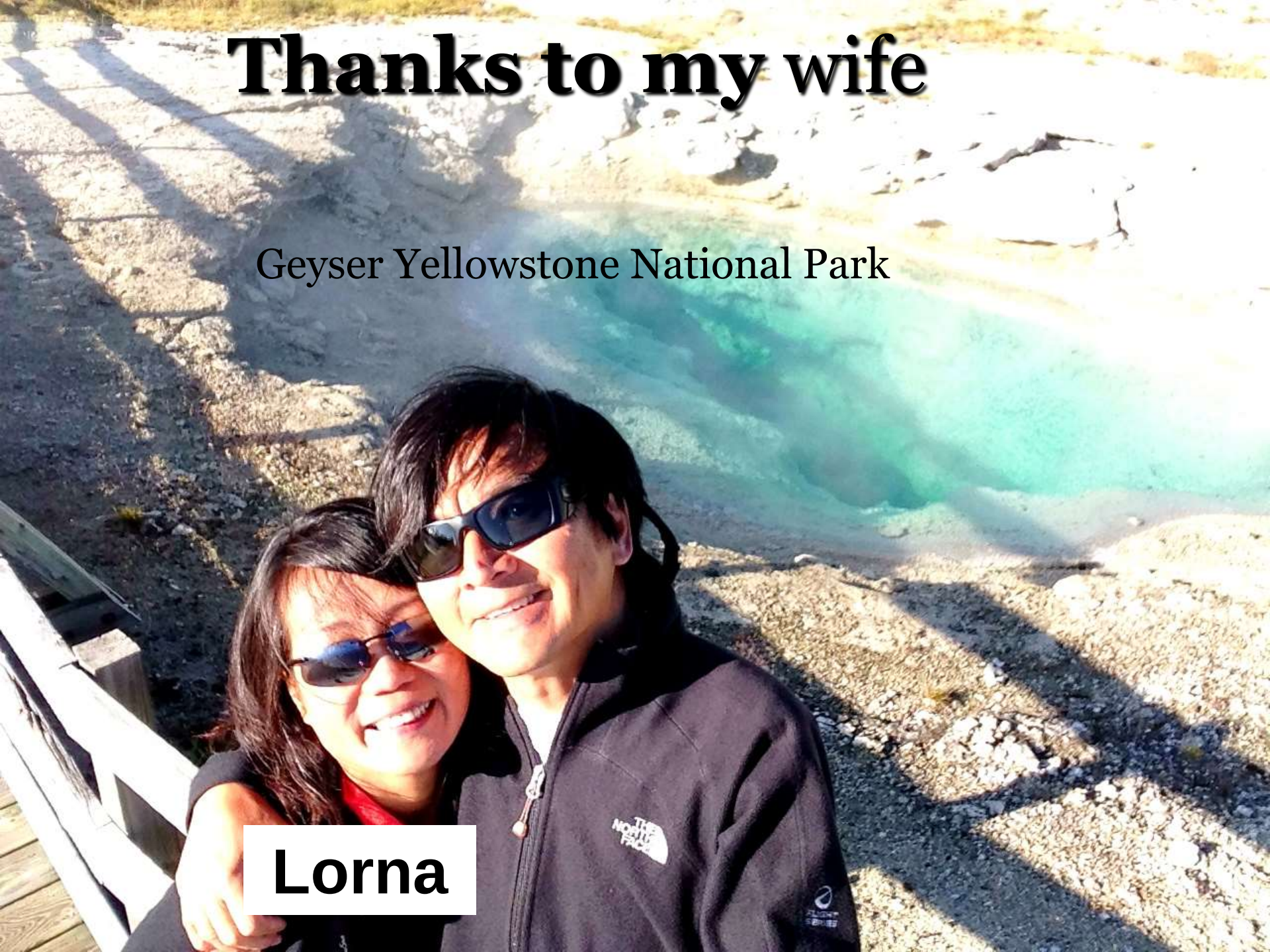
Conservation Agriculture for Food Security in Cambodia and the Philippines

Manny Reyes

Spokesperson Southeast Asia Team

North Carolina Agricultural and Technical State University

Thanks to my wife

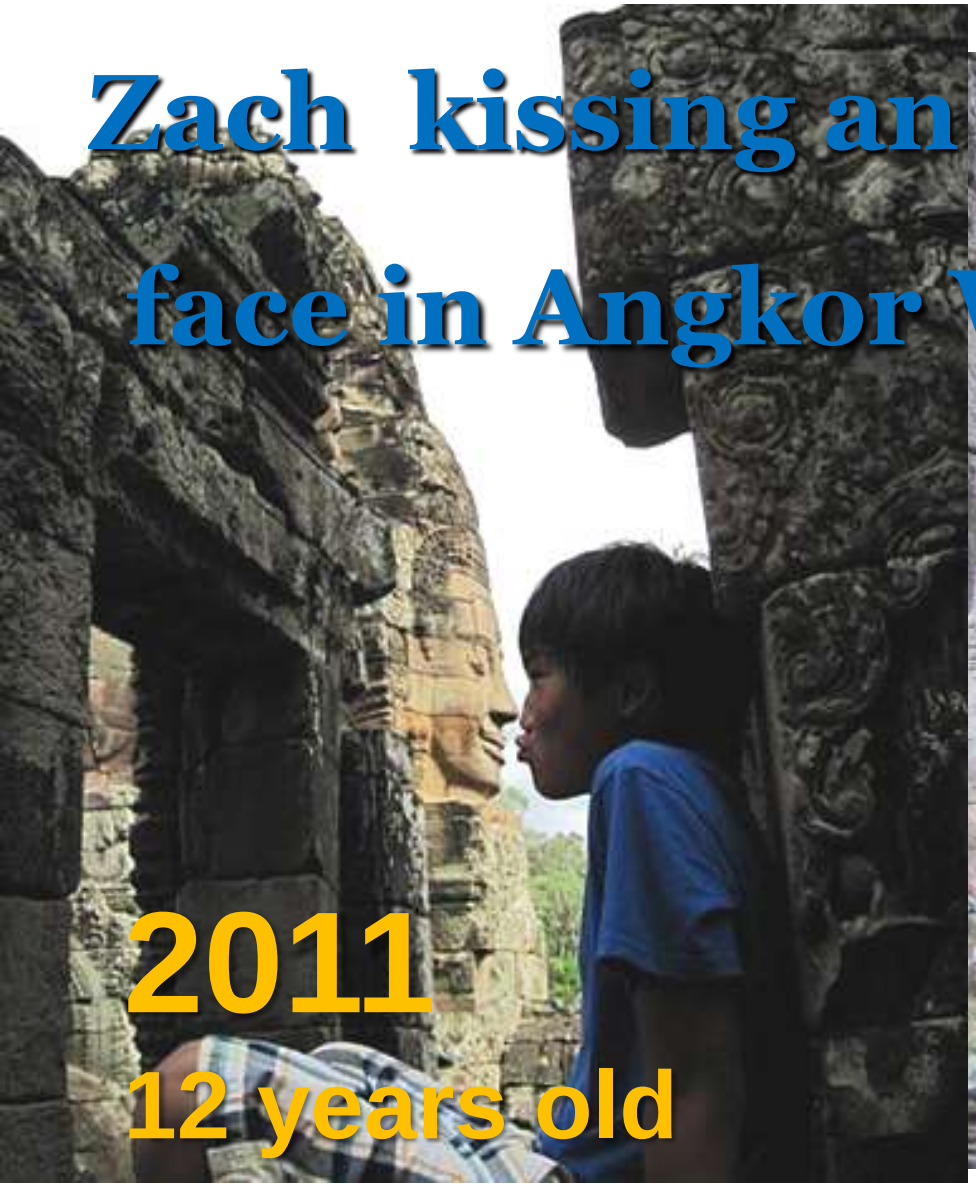


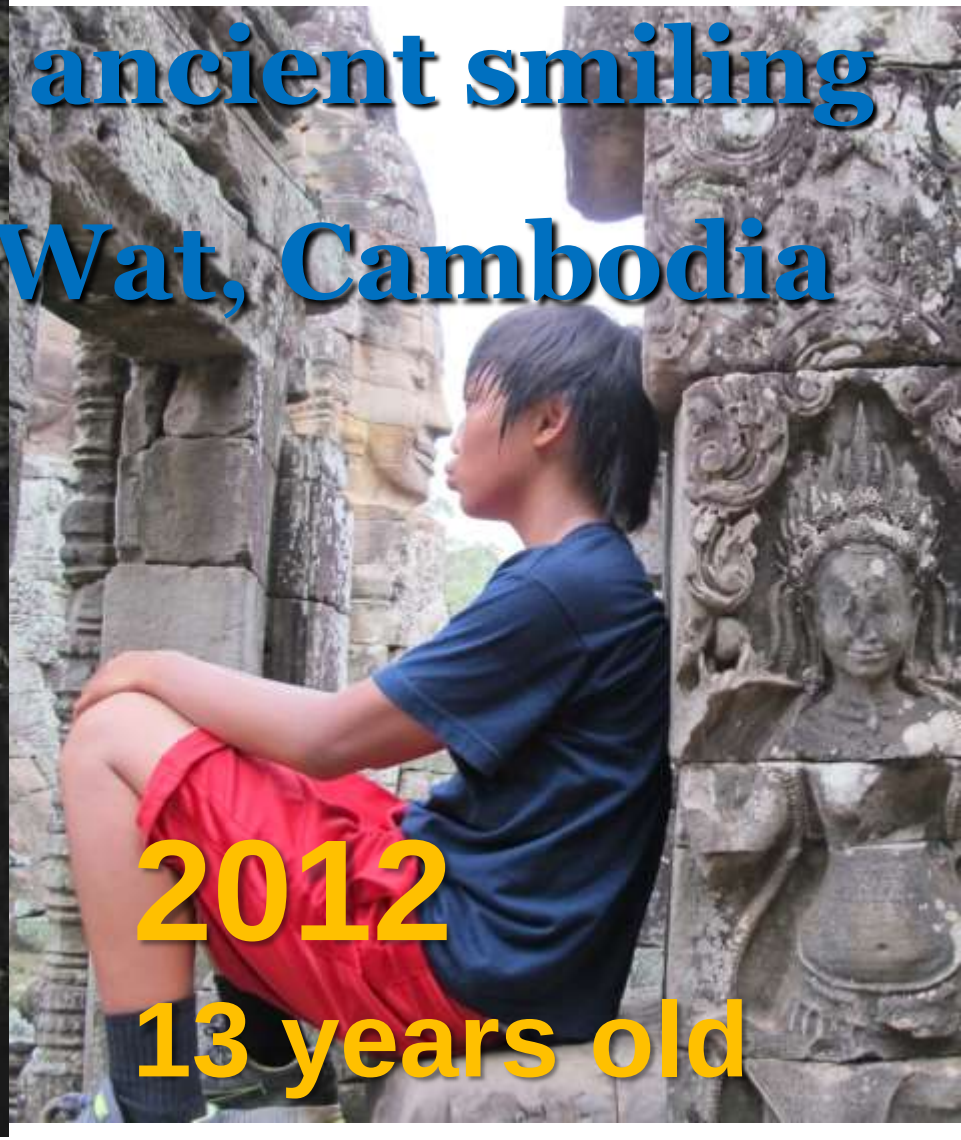
Thanks to my son Micah

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 <u>not yet Dad</u>!!!

Thanks to my son Zach

Zach kissing an ancient smiling face in Angkor Wat, Cambodia





Thanks to my son Zach

Zach still wearing blue shirt

Angkor Wat, Cambodia

Funding for Study

USAID
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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

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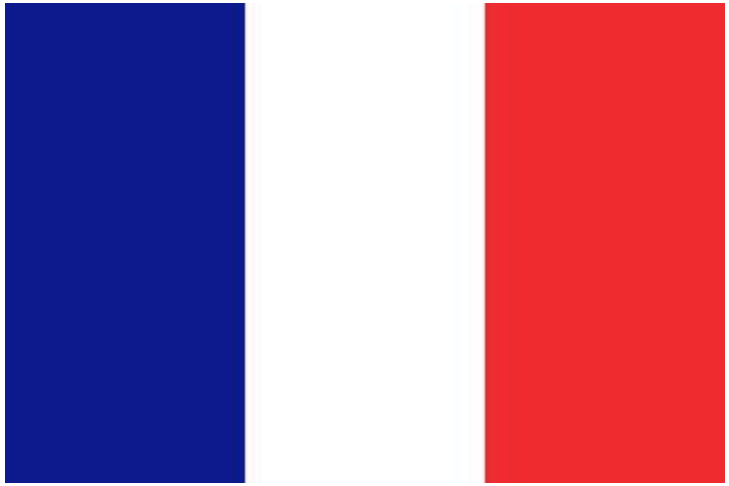
LA RECHERCHE AGRONOMIQUE POUR LE DÉVELOPPEMENT

Flags of Red White and Blue +



Brazil

Strong Partnership

USDA NRCS Natural Resources Conservation Service

AGGIES

General Directorate of Agriculture

Ministry of Agriculture, Forestry and Fishery

cirad

LA RECHERCHE AGRONOMIQUE POUR LE DÉVELOPPEMENT

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

N

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

We had a **DATE** Cambodia. Conservation Agriculture **D**esign, **A**ssessment, **T**raining and **E**xtension approach

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

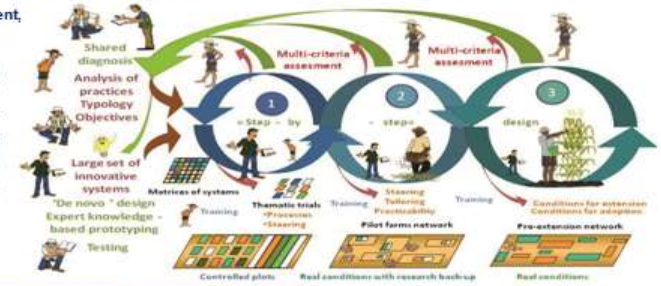
cirad S. Boulakia, R. Kong, O. Husson, V. Leng, V. Sar, K. Soeurng, B. Thy, L. Huot, S. Nhem, S. Pheav, M. Reyes, F. Tivet, L. Séguy

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 provide 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 (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/relay crops successions, associations, rotations and different levels of intensificsation) 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 Rattanak Mundol (Battambang province), this network covered 4 villages and involved 64 households, applying DMC systems on 200 ha (35 ha of spontaneous diffusion) in 2012.

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

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

cirad 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

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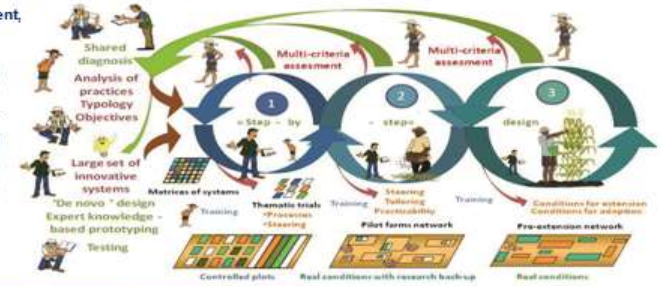

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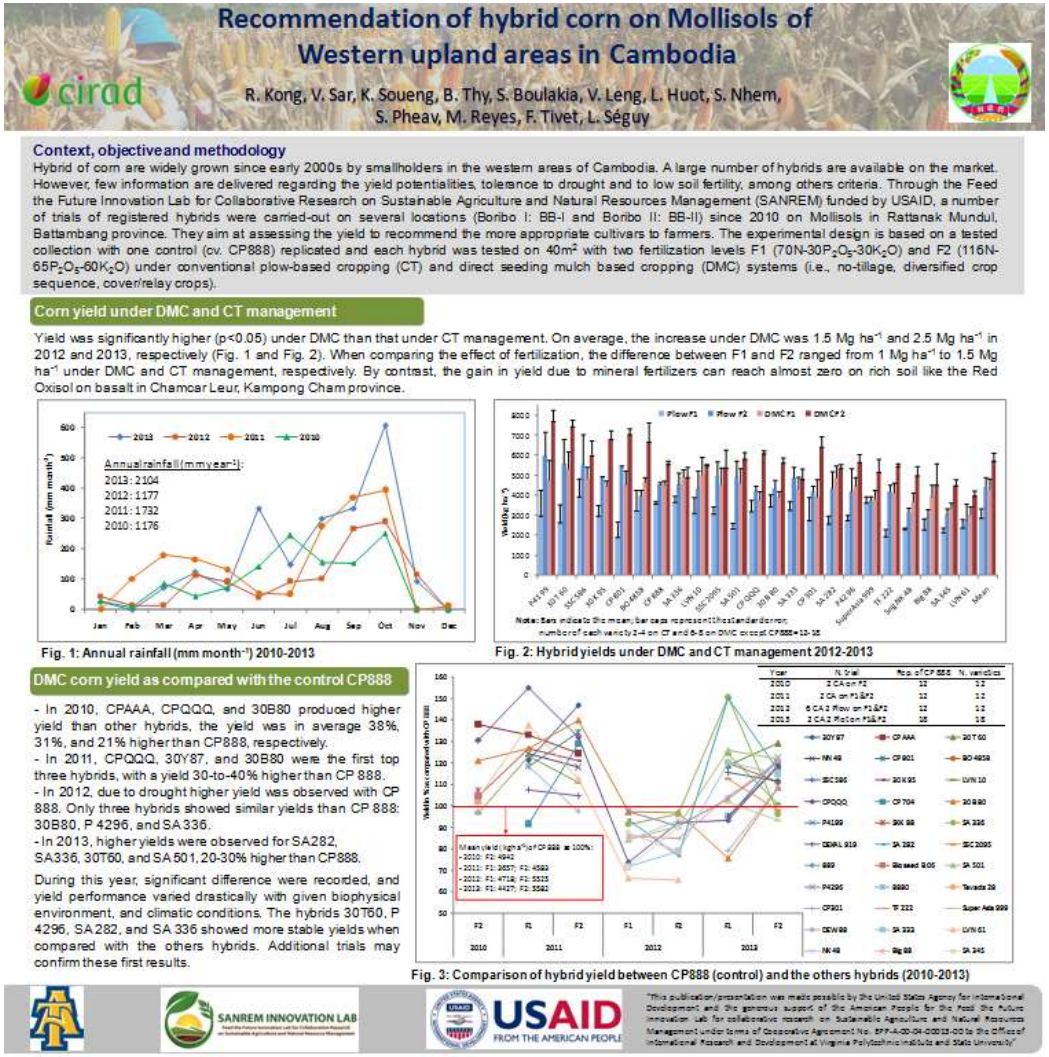
Did we succeed? Cambodia Testing Maize



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

Did we succeed?

Cambodia

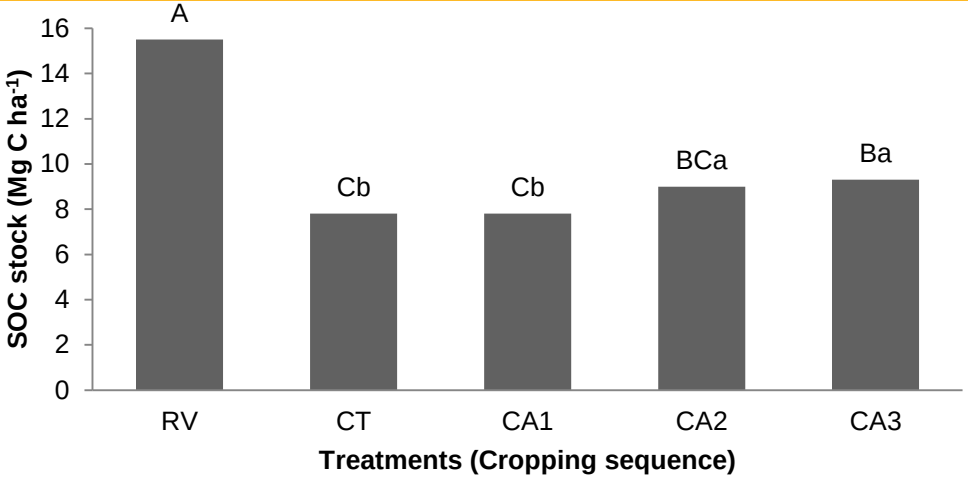
Cover crop germplasm

We have amassed more than 500 cover crop germplasms for you Cambodia. We know this living ‘gold’ mine you will maintain.

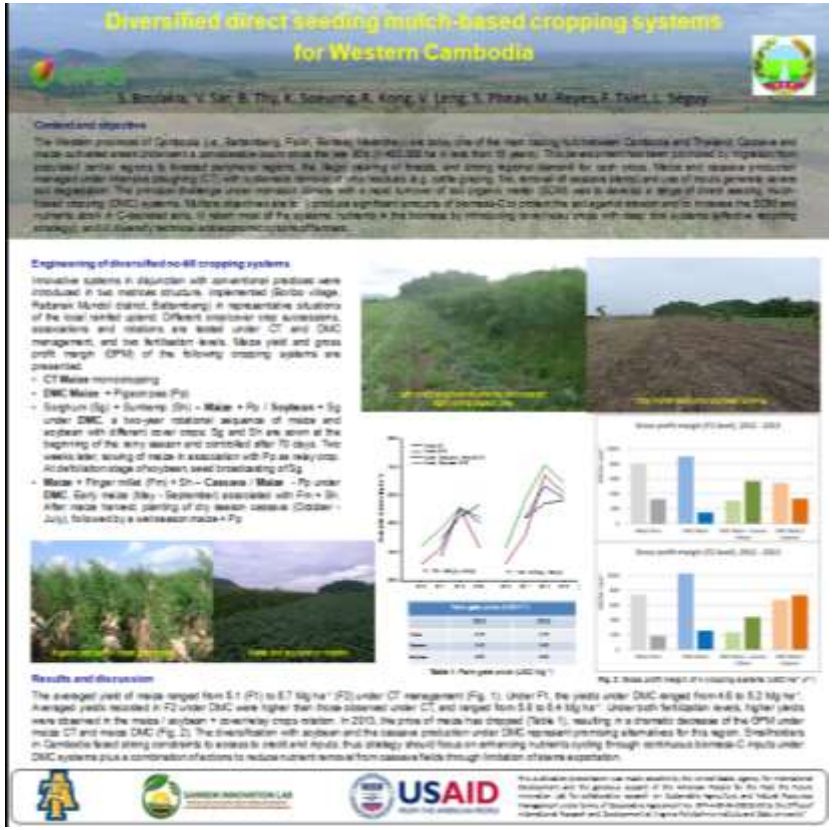
We built three pillars of conservation agriculture in Cambodia. Now there is a government department for CA and CA dedicated research station land.

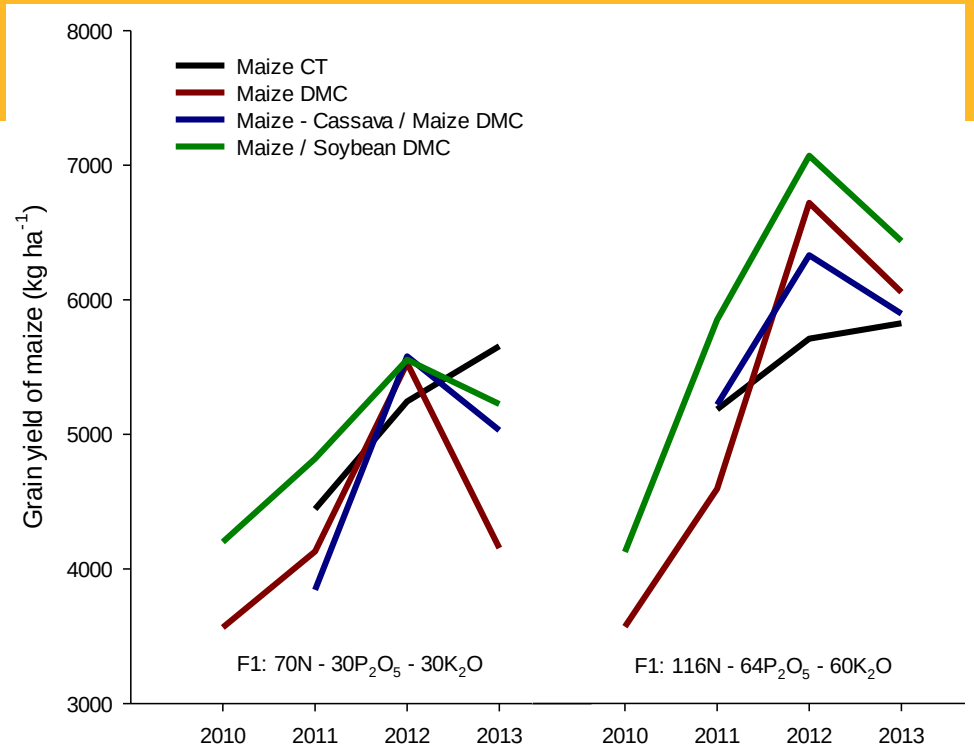
The name of the Department is: Conservation Agriculture Service Center. And some plots in the center are in CA for 8 years now.

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.

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

cirad

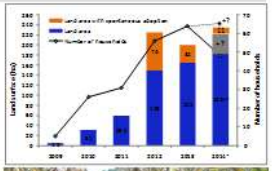
R. Kong, S. Boulakia, V. Sar, K. Soeurng, B. Thy, V. Leng, L. Huot, S. Nhem, S. Pheav, M. Reyes, F. Tivet, L. Séguy

Context and objective

Rattanak Mundol 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 weeds 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.

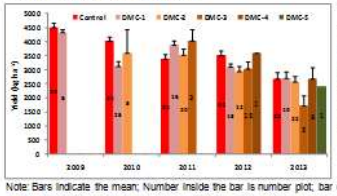
Proposed cropping systems and evolution of DMC adoption

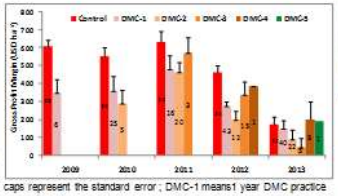
Pigeon pea (*Cajanus cajan*) is successfully tested as cover crop for corn to replace Stylo (*Stylosanthes guianensis*) on this highly-alkaline Mollisols soil with pH 6.5-8.0. For its possible competition, especially on poor soils with low fertilization, pigeon pea is sown 10-15 days after corn sowing 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)

Irrespective to 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-30P_2O_5-30K_2O) 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.





Note: Bars indicate the mean; Number inside the bar is number plot; bar caps represent the standard error ; DMC-1 means1 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. Others 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.

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/relay 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/relay crops (cash 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.

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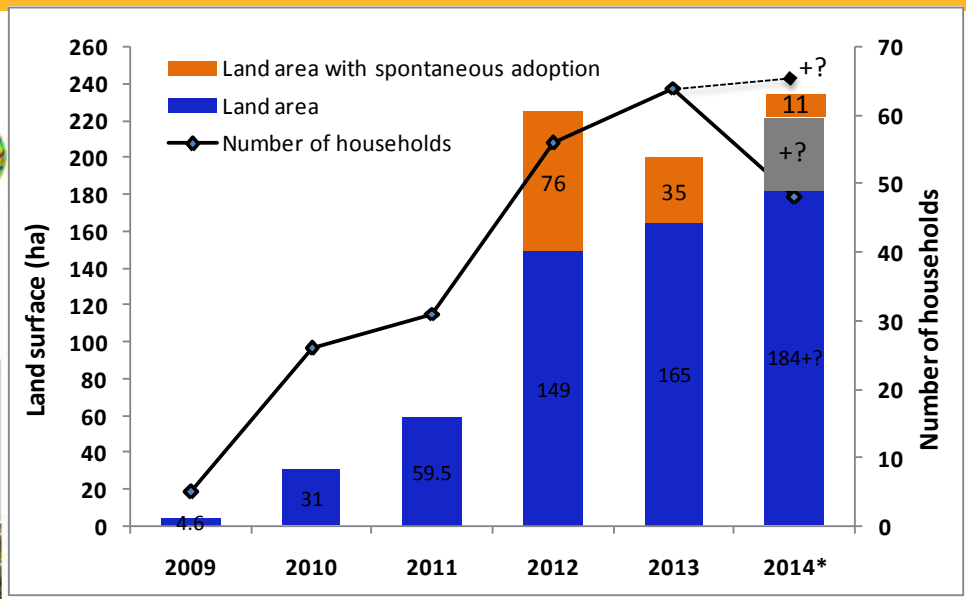
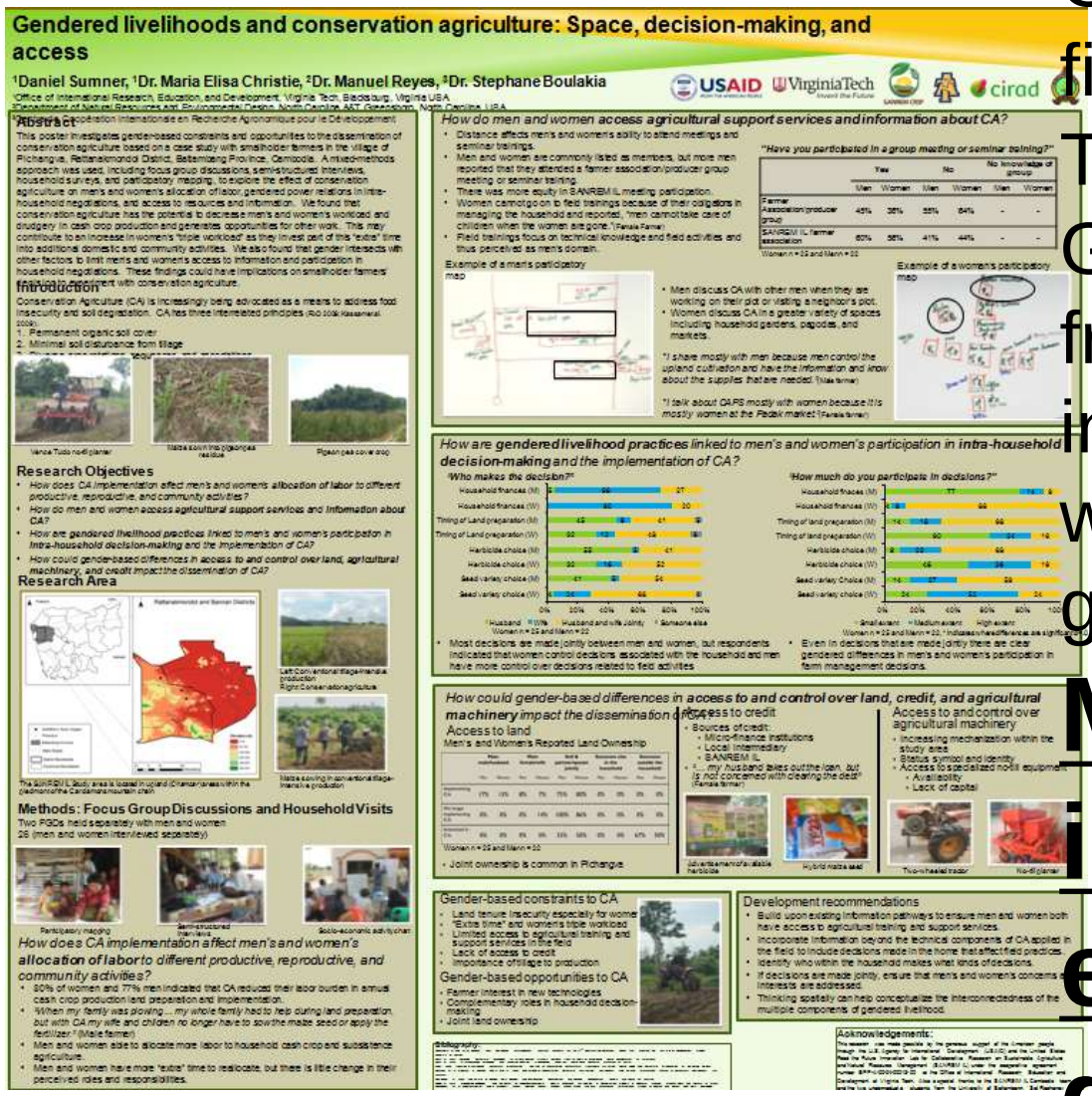
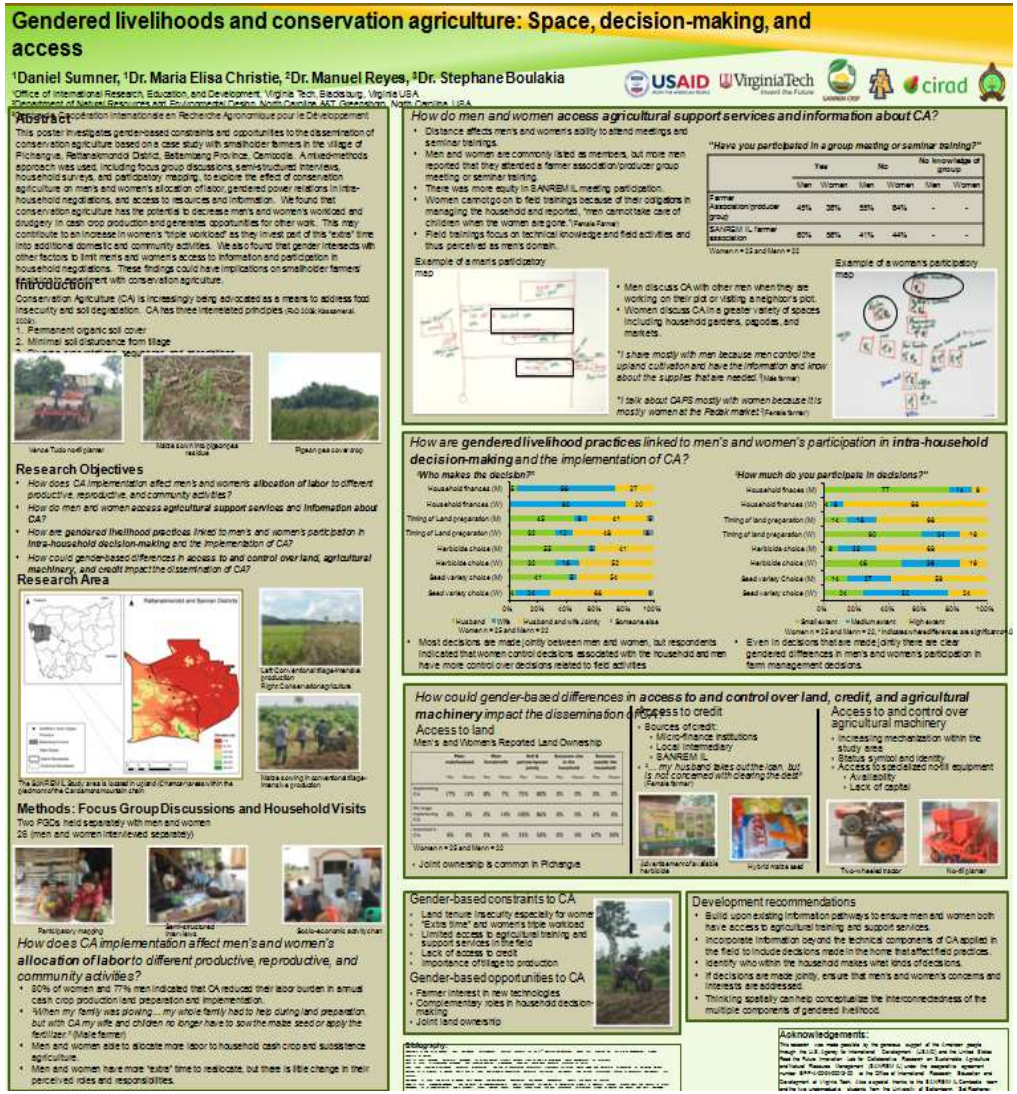


Oh Rada, what an exciting rise in CA adoption in 2012, but then a drop in 2013.



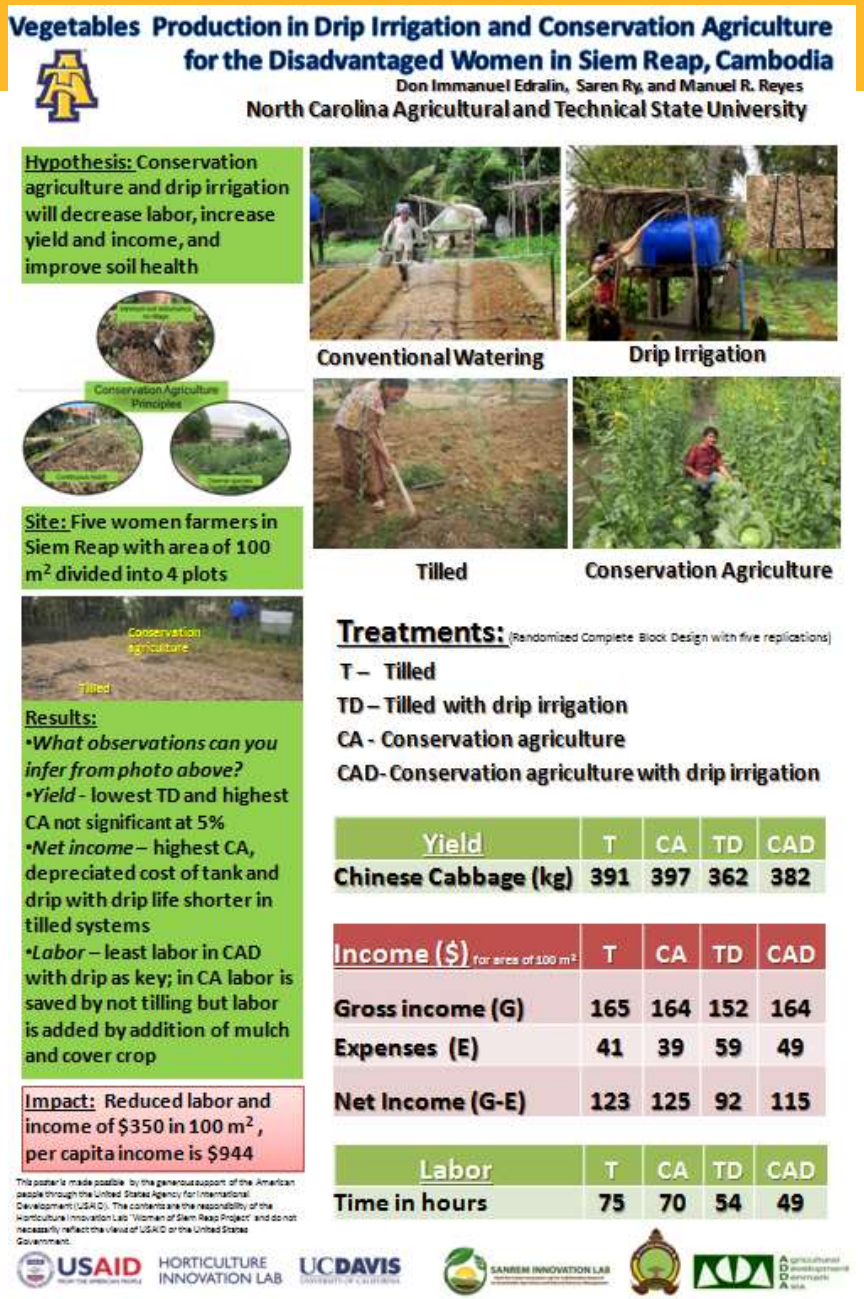
One of many interesting findings of that Virginia Tech student, Daniel. Gosh he flew all the way from the USA to join us in Cambodia. I heard he was trained by Gender guru Maria Elisa.

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

Rainforest replaced!!!!

Rainforest replaced!!!!

Rainforest replaced!!!!

Rainforest replaced!!!!

Pineapple


Del Monte

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

From SANREM-Philippines site

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

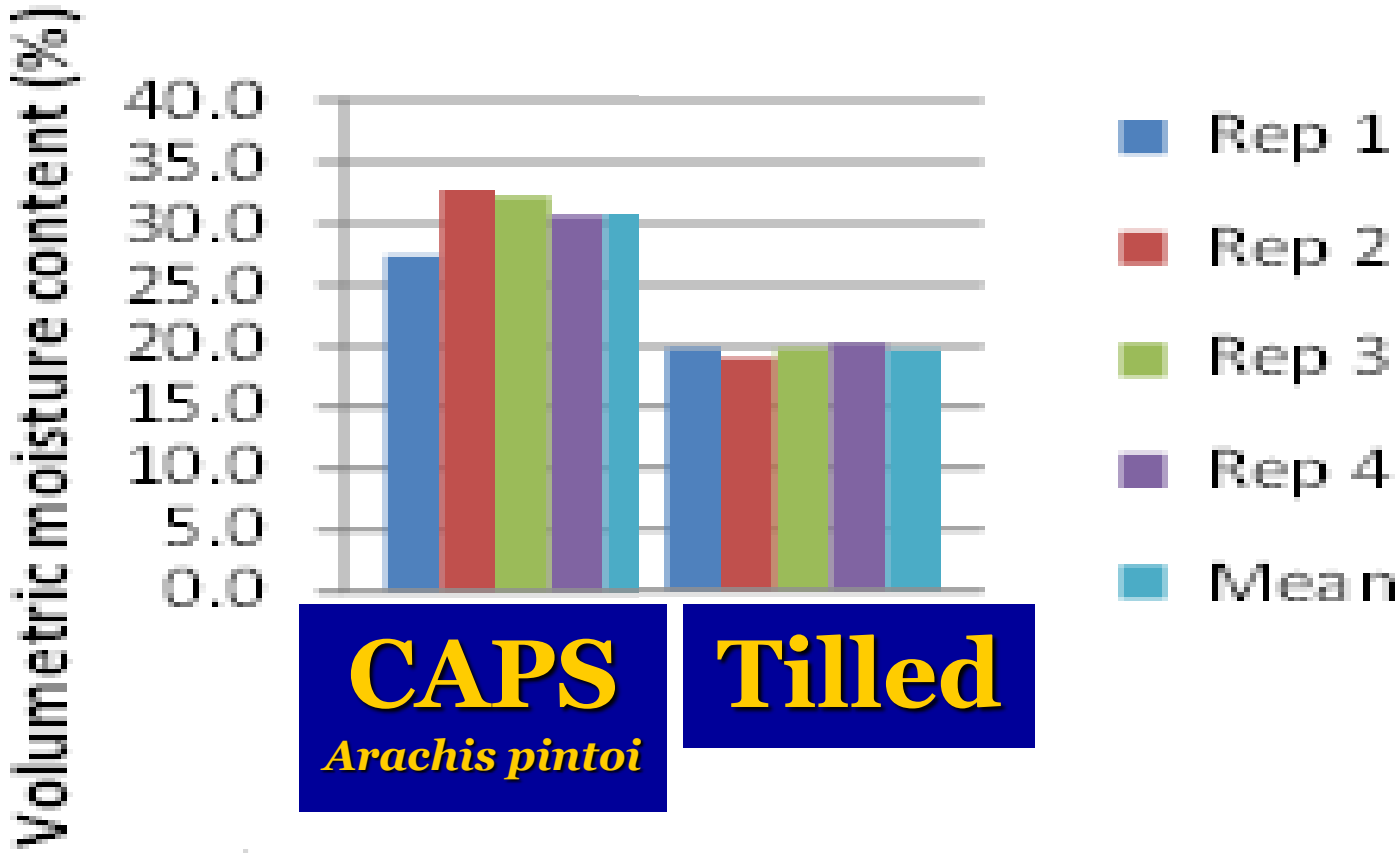
Residual moisture:

Did we succeed?

Climate change resilience

Residual moisture

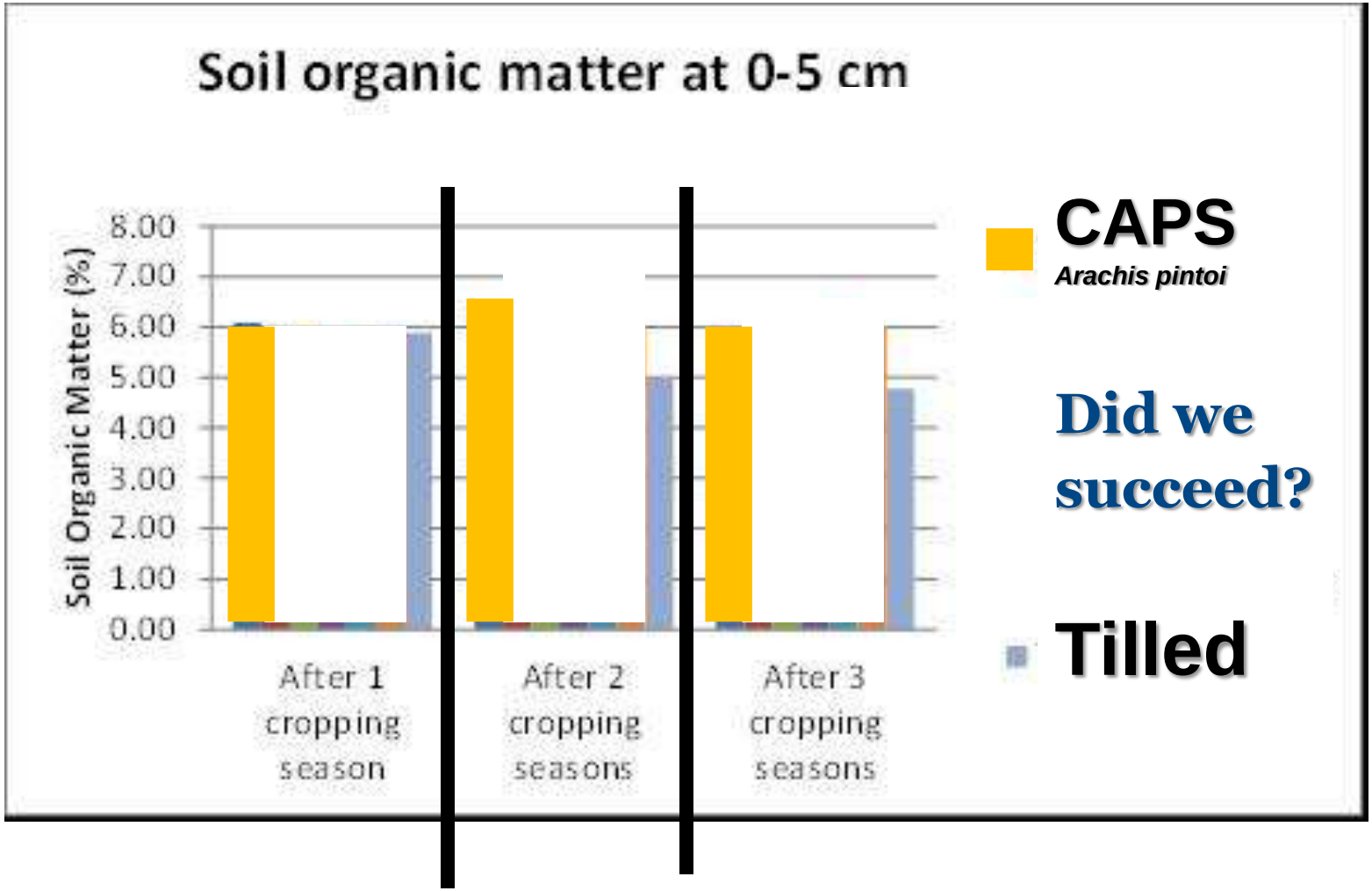
Residual moisture:



Did we succeed?

Soil Organic Matter

Soil Organic Matter:



Did we succeed?

Residual moisture:

Did we succeed?

Arachis pintoi for livestock

Did we succeed?

Pigs like *Arachis pintoi*

Residual moisture:

Did we succeed?

Arachis pintoi for carabao and cattle?

Did we succeed?

Arachis pintoi for fish

Did we succeed?

Conservation Agriculture seeding/planting


Dull Bolo


Animal Drawn
Single Moldboard
Plow


Dibble Stick


DABBLER


HAND HELD
PLANTER

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

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

Ma. Elena C. Javier[1], Kent C. Tangcalagan[1] and Manuel R. Reyes[2]
[1]De La Salle University – Manila, Philippines
[2]North 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
6 Filipino couples; 5 Khmer couples and 2 widows
(N=24; 13 women, 11 men)

Research Sites:
Claveria, Misamis Oriental, Philippines
Boribo, Pichangva & Singha Villages, Battambang, Cambodia

Household Profile

- Higher average annual farm income for Khmer smallholders ($1958) compared to Filipino small holders ($1157)
- Conjugally 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. brushing, 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 machineries.

WOMEN
MEN

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-acting herbicides, updated technical advice, more available and affordable machine service, 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.

SANREM INNOVATION LAB

USAID FROM THE AMERICAN PEOPLE

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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

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

To
is to
believe

To
is to
believe

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

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 <u>4000</u> <u>pounds</u> 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 <u>established</u> 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 lt-c

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