Developing Conservation Agriculture with Trees for Integrated Sloping Lands Management in the Philippines

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World Agroforestry Centre (ICRAF-Philippines)
North Carolina Agricultural and Technical State University

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Outline of the Talk

- Introduction: Challenges in the sloping lands in the Philippines
- Agroforestry and its benefits
- Conservation agriculture with trees research in the Philippines through SANREM – Feed the Future Innovation Laboratory
- Implementation of agroforestry through “Conservation Agriculture with Trees (CAT) on Sloping Lands” (Integrated Sloping Land Management)
- Conservation agriculture with trees (CAT) good practices
- Some ideas in scaling up CAT
- Summary

Upland areas and Smallholder's

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Philippines

- More than 7,000 islands
- Population is 92 M people
- Land area is 30 M has.
- 10 M has sloping acid upland soils
- 5 M has less productive upland areas due to degradation

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Challenges in the Philippine uplands

- Soils are inherently acidic and poor
- Small farm size (2 has = 5 acres)
- Inappropriate farming practices
- Soil erosion is high
- Declining farm productivity
- Deforestation in upper watersheds
- Poverty and malnutrition
- Lives and livelihoods of the people living at lowland communities are affected by the land degradation at the upper river basin

Philippines SANREM site

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Examples of some bad practices

Farmers cultivate their fields up and down the slope

Crops are planted parallel to the slope

The horror pictures

Upstream

Downstream

Context of Conservation Agriculture with Trees

Flat lands: >200 M hectares Brazil, Argentina, US, Australia, Cambodia and other places

Sloping lands: Philippines (10 M ha)

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In the context of sloping lands, there's a need for deliberate integration of trees .....

Enhancing community resilience, productivity and environmental services to changing climate in the Philippine uplands

Overall hypothesis

In tree-depleted sloping lands with poor soils and risks prone, farming systems purely based on annual food crops are not sustainable, but diversified tree-based farming systems are feasible and offer better prospects.

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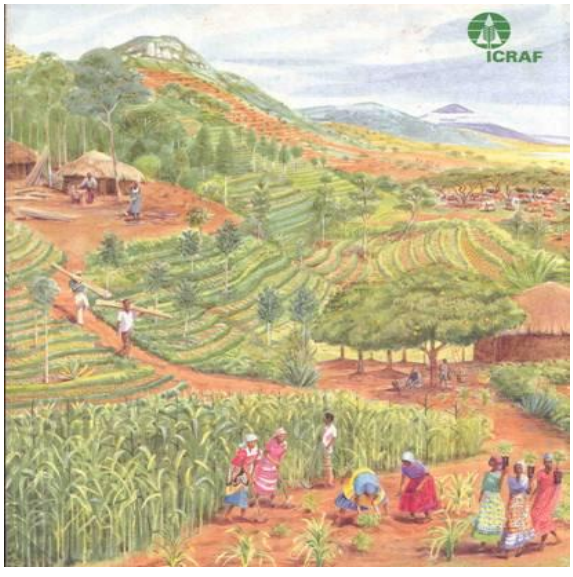
Conservation Agriculture with Trees (CAT) on Sloping Lands

CAT on sloping lands is a dynamic and ecologically based sustainable land management system that diversifies and increases production, while simultaneously promoting social, economic and environmental services for all land users



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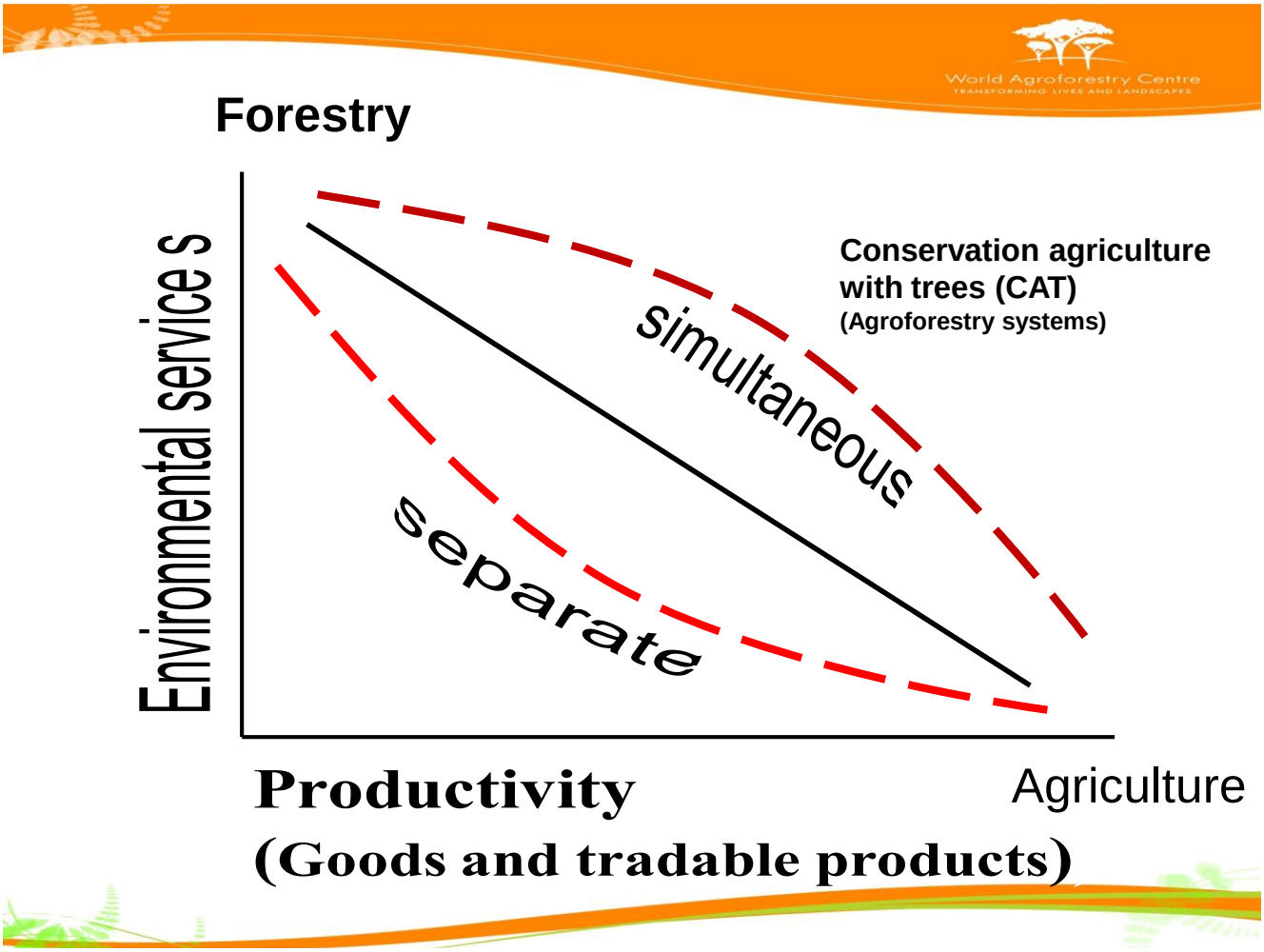
5 Important principles of CATSL

- Integration of trees
- Minimal soil disturbance
- Continuous mulch or ground cover
- Diverse crop species
- Integrated nutrient and pests management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Forestry
Environmental service s
Conservation agriculture
with trees (CAT)
(Agroforestry systems)
simultaneous
separate
Productivity
(Goods and tradable products)
Agriculture

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Examples of agroforestry practices at CAT Center

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Effect of different hedgerow types on soil loss

Hedgerow systems	Soil loss (Mg ha^{-1})
Grasses	2.20 c
Forage legumes	9.80 c
Shrubs	5.70 c
Trees	6.50 c
Contour cultivation	40.0 b
Traditional cultivation (up & down the slope)	350.0 a
Tolerable rate	12.0

Rainfall: 3000 mm annually

"The greatest immediate impact of timber hedgerow system is reduction of soil loss which is about 55 times than traditional up and down the slope cultivation thus making soil nutrients particularly N become available to the food crops".

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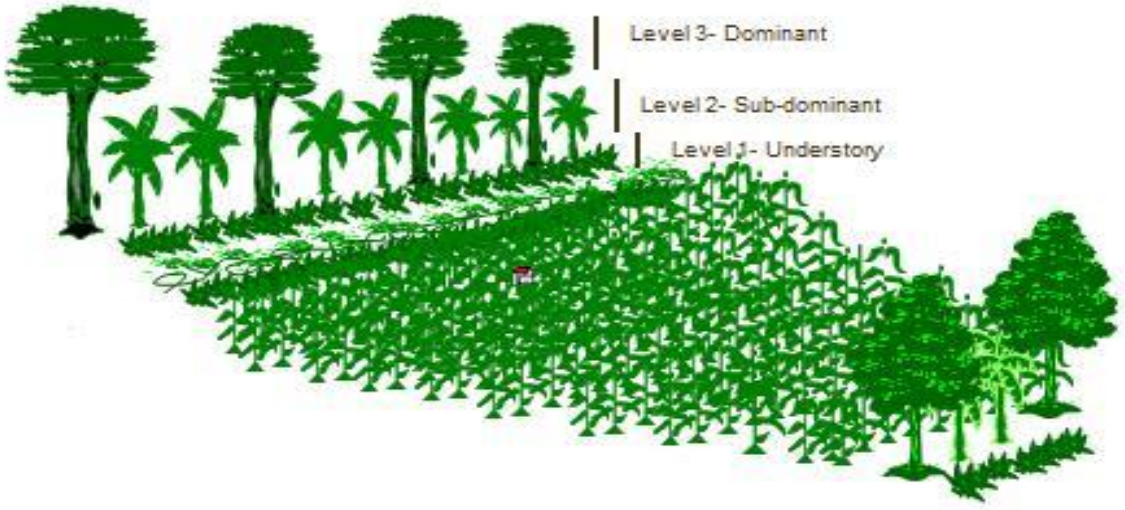
Optimization of aboveground resources by having multi-level canopies hedgerow systems



Schematic diagram of improved agroforestry system (Alleycropping system- Agrosilvopastoral)

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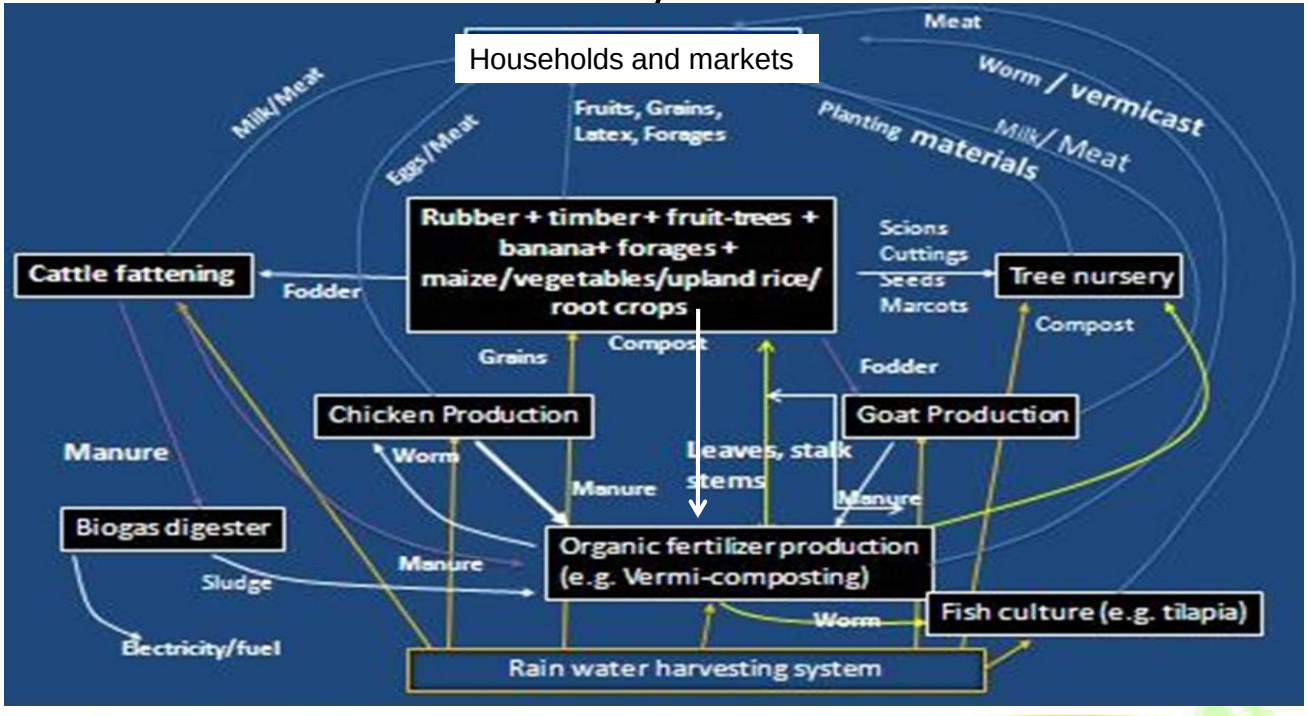
Resource flows of an integrated conservation agriculture with trees system



Sustainable Agricultural and
Natural Resources Management
Feed the Future Innovation Laboratory

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Conservation Agriculture for Food Security in Cambodia and the Philippines

Philippines site: a landscape rapidly multiplying every year

by GETS team

cirad
LA RECHERCHE AGRONOMIQUE POUR LE DÉVELOPPEMENT

General Directorate of Agriculture
Ministry of Agriculture, Forestry and Fishery

afd
Agence Française de Développement

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USDA NRCS Natural Resources Conservation Service

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GETS

- Gender
- Economics
- Technology networks
- Soil quality
- *Objective 1: Assess soil quality and* ***measure crops yield*** ***from conservation agriculture production systems (CAPS) and compare them with soil quality and crop yield from conventional plow-based systems in the Philippines***

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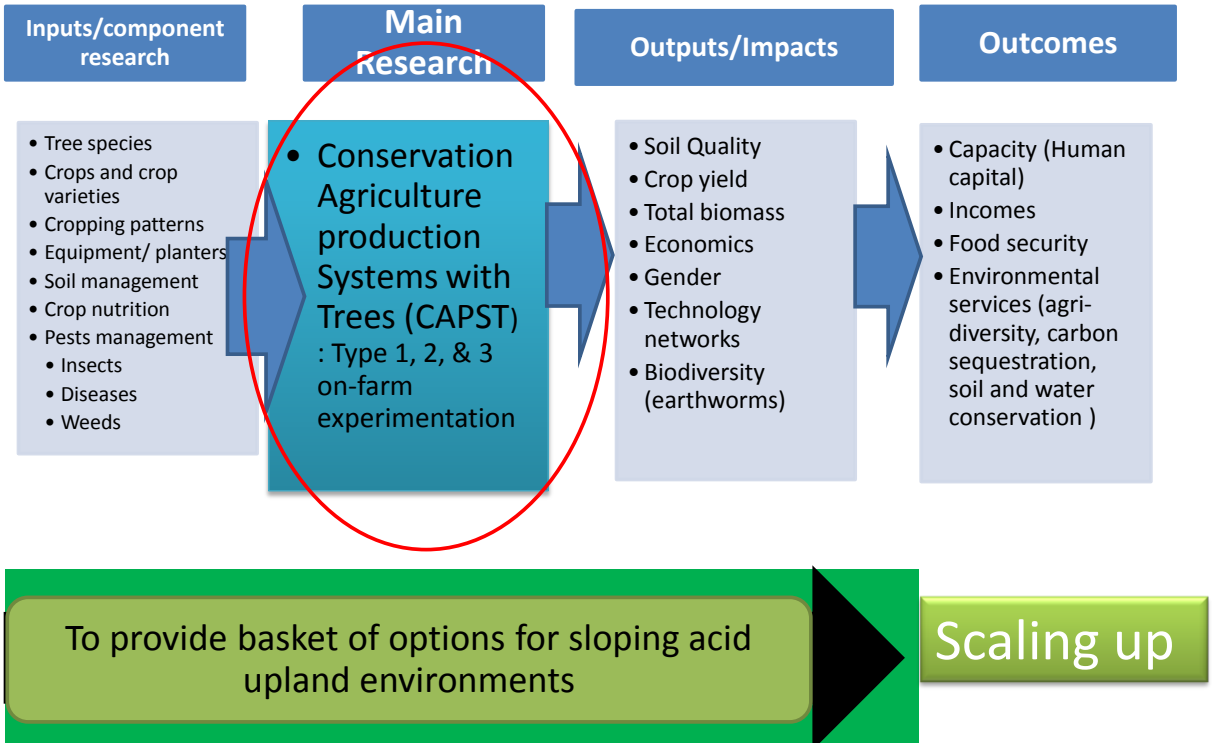
Conceptual Framework of Conservation Agriculture with Trees (CAT) Research in the Philippines



Component Researches

Tree species

- Rubber clonal evaluation
- Coffee
- Cacao
- Indigenous tree species

Crop varieties

- Adlai
- Upland rice
- Cassava
- Forages
- Herbaceous legumes
- Maize
- Sorghum
- Cowpea
- Pigeon pea
- Vegetables

Soil management and crop nutrition

- NPK Omission experiment
- NPK rates
- Organic fertilizer sources
- Organic fertilizer optimum rate

The researcher managed trial (RMT): Treatments

T1 - Maize + Arachis pintoi (AP) - Maize + AP
T2 - Maize + Sytlosanthes guinanensis (SG)- Fallow
T3 - Maize + Cowpea (CP)- Upland rice + CP
T4 - Maize + Rice beans (RB) - Maize + RB
T5 - Cassava + Stylo
T6 . Farmer's practice

Two fertility levels:

- 0-30-0 N P2O5K2O (Low fertility) (2012: 120-45-30 N P2O5K2O)
- 60-30-30 N P2O5K2O (Moderate fertility)

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Maize + Arachis pintoi

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Maize + Stylo – Fallow

Maize + Stylo

Stylo fallow

Maize on Stylo mulch

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Maize + cowpea – Upland rice + cowpea

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Maize + Rice bean

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Cassava + Stylosanthes

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Maize - Maize

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Grain yield in t/ha of various conservation agriculture production systems (CAPS) under two fertility levels established in acid upland soil. Claveria, Misamis Oriental, Philippines.

Treatments	Year 1		Year 2	
	Fertility 1	Fertility 2	Fertility 1	Fertility 2
1. Maize + *Arachis pintoi*	1.03	2.12	5.52	2.24
2. Maize + *Stylosanthes guianensis*	1.10	2.22	4.82	4.65
3. Maize + cowpea/ upland rice/cowpea	0.75	1.59	5.57	4.09
4. Maize + Rice bean	0.14	0.45	6.49	5.32
5. Cassava + Stylosanthes guianensis	13.94	20.73	29.51	18.93
6. Maize - maize	2.47	3.19	4.73	5.10
Mean	3.25	5.07	9.44	6.72
LSD	1.66	3.85	8.00	4.98

Fertility one (F1 or F0) was changed during the second year to 120-45-30 after the omission and NP

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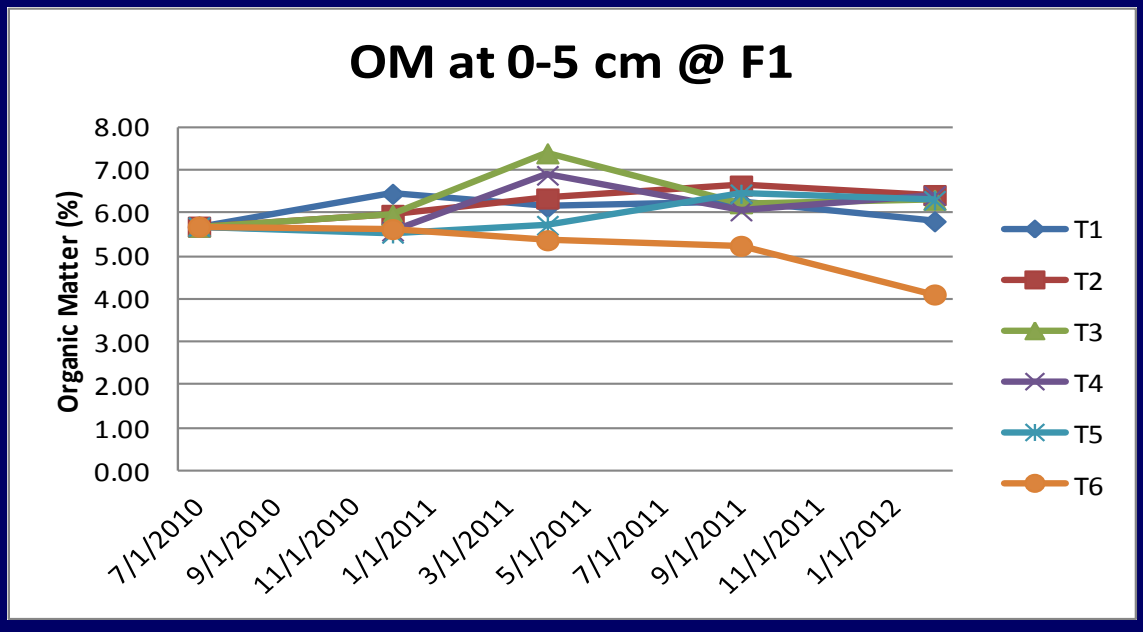
Temporal variation of soil organic matter at upper soil layer (0-5 cm) under various CAPS treatments



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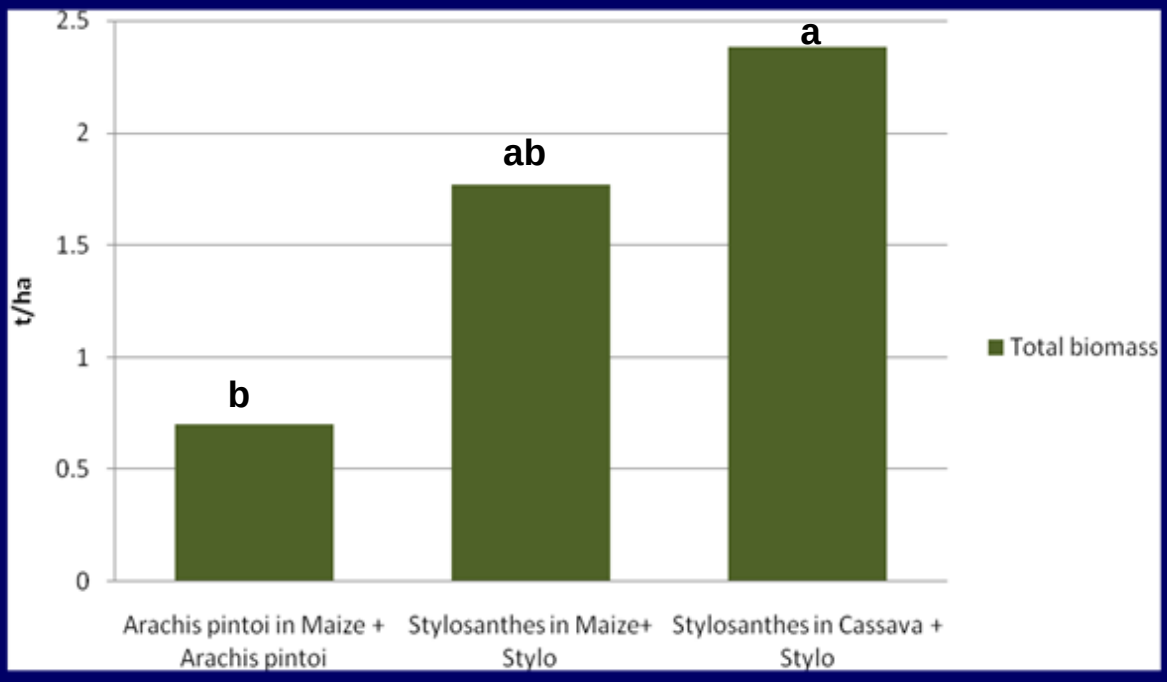
Aboveground biomass of different forage legumes as interplant at different cropping patterns 6 months after planting



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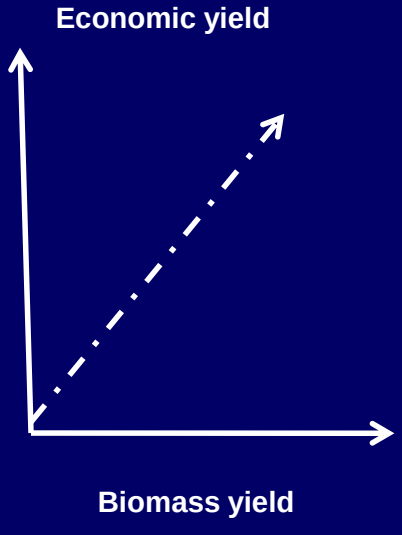
Component researches (Kitchen experiments)

- Evaluation of crop varieties that are best for conservation agriculture production systems that produce high biomass and economic yield which includes forage grasses, sorghum, cassava, upland rice, sweet potato, adlai, cowpea and open pollinated maize

- Key parameters



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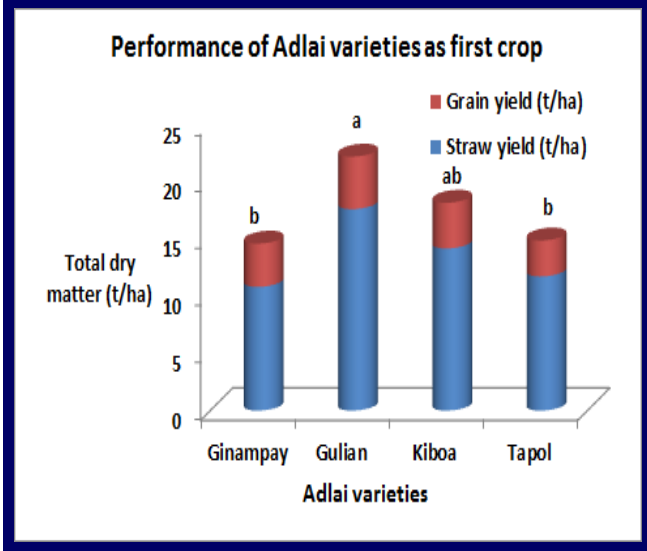
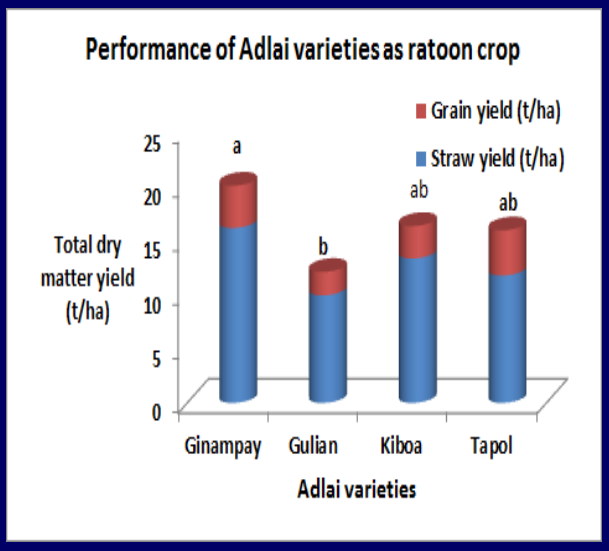
Adlai (*Coix lacryma-jobi* L.) for Conservation Agriculture Production Systems

Aboveground total dry matter yield of different Adlai varieties

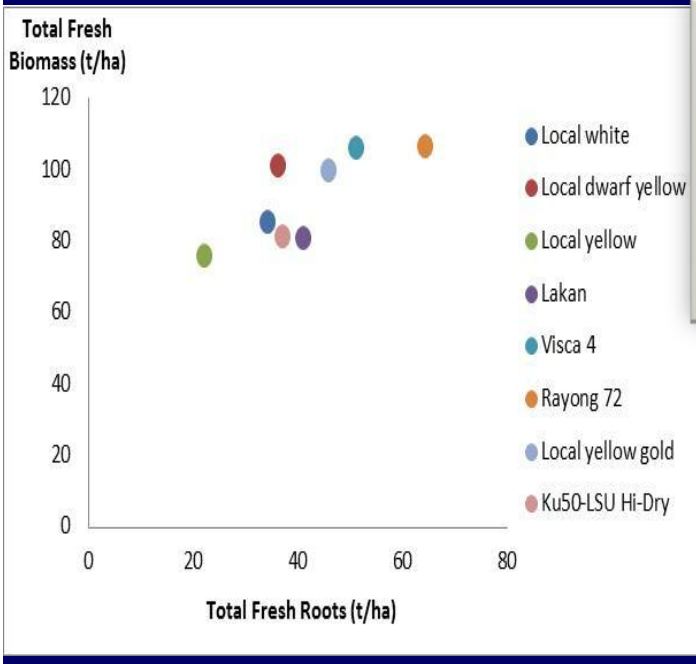
First crop



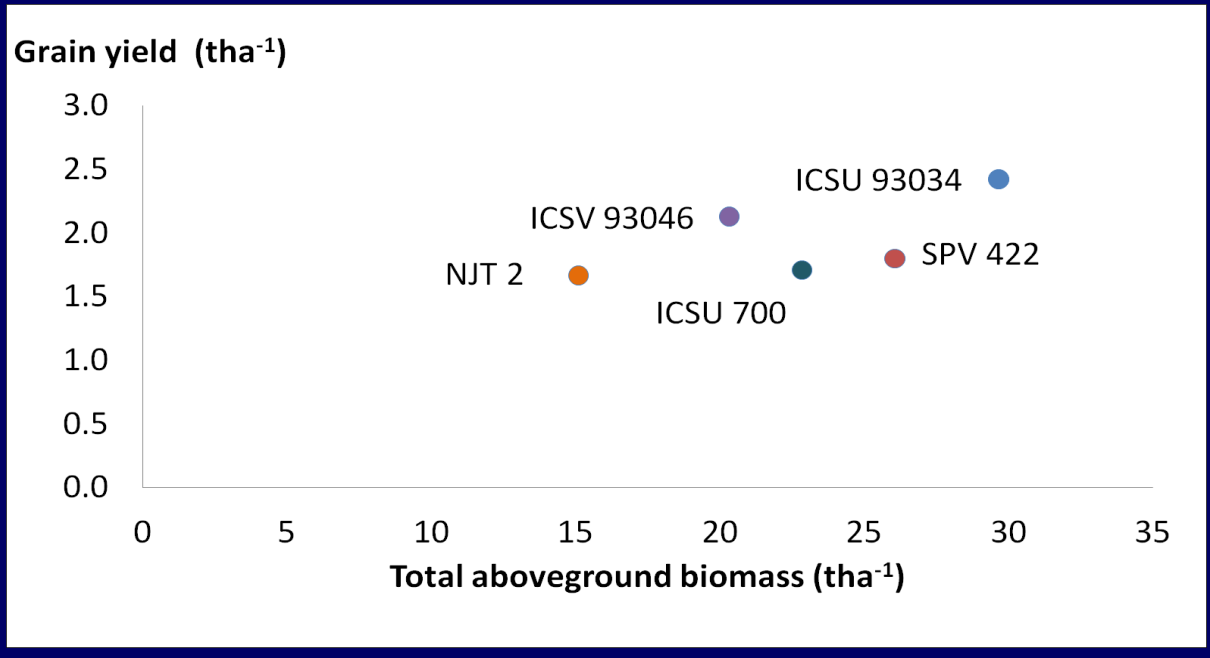
Ratoon crop



Relationship between total fresh weight and dried chips of different Cassava varieties. Claveria, Misamis Oriental, Philippines



Relationship between grain yield and total biomass of sorghum varieties evaluated for CAPS. Claveria, Misamis Oriental, Philippines



Relationship between grain yield and total above ground biomass of different maize cultivars. Claveria, Misamis Oriental, Philippines

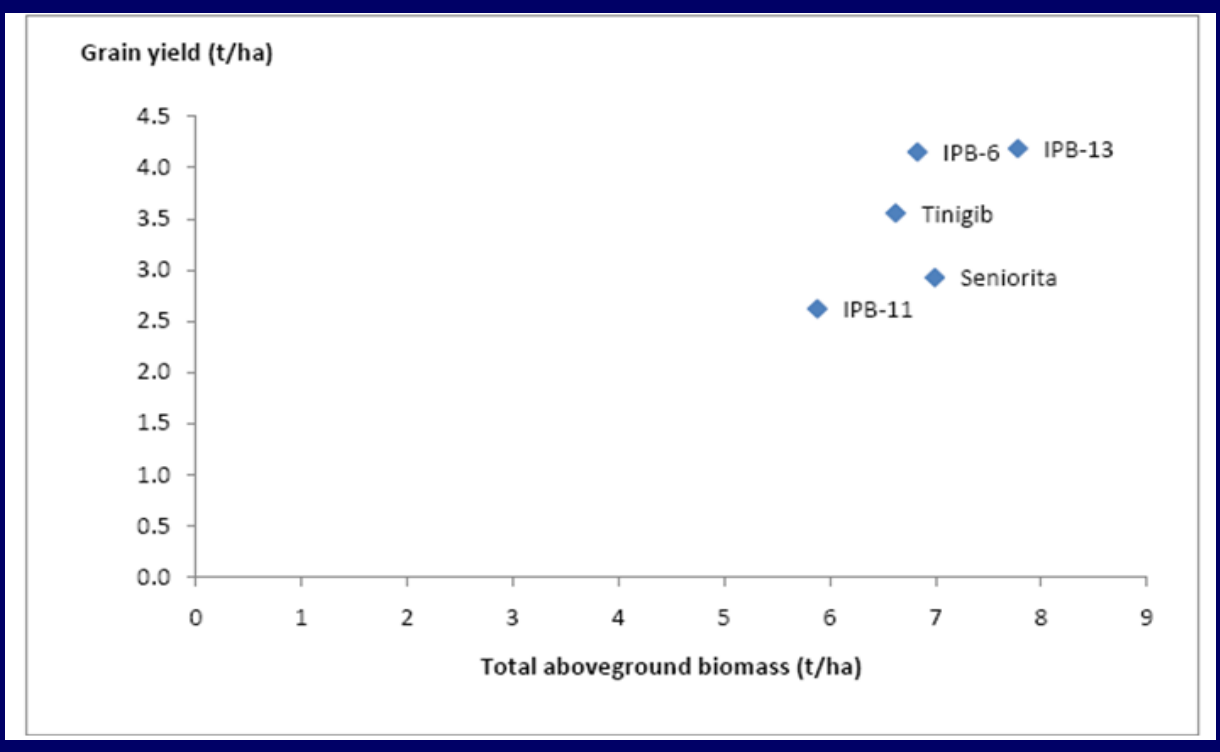


Table 2. Biomass and Aboveground biomass of forage grass cultivars 3 months from pruning. Claveria, Misamis Oriental, Philippines.

Forage grasses	Biomass (t/ha)	Plant height (cm)
Brachiaria decumbens	1.15c	73.80 c
Brachiaria rhuzinensis	5.05abc	68.20 c
Panicum maximum	3.13bc	95.80 c
Pennisetum purpureum	9.12a	160.75 a
Setaria nandi	4.23abc	61.47 c
Setaria splendida	7.97ab	106.15 b
Mean	5.13	94.36
CV (%)	62.89	22.24
SED	2.15	13.99

Means having the same letters are not significantly different from each other by DMRT at 5% level.

Upland rice (Oryza sativa) varieties for conservation agriculture production system

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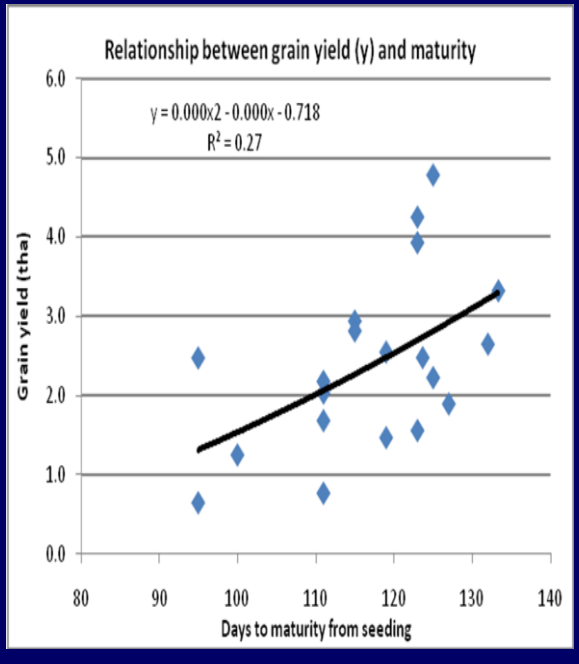
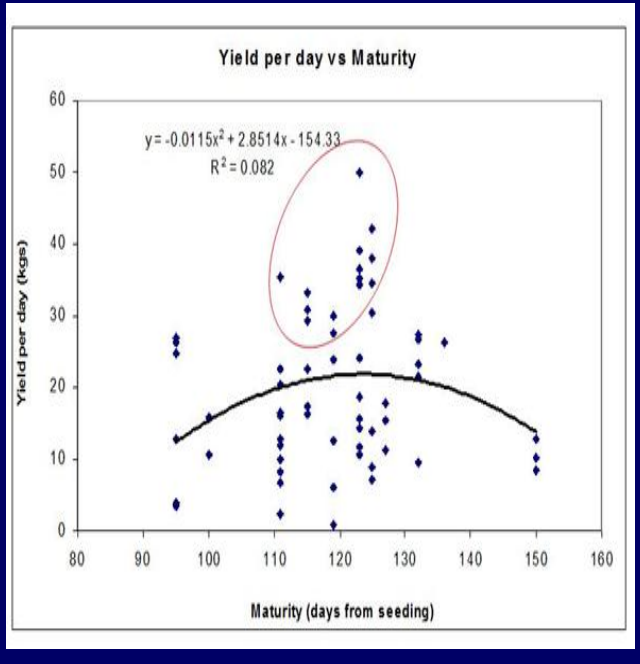
Desired upland rice characteristics





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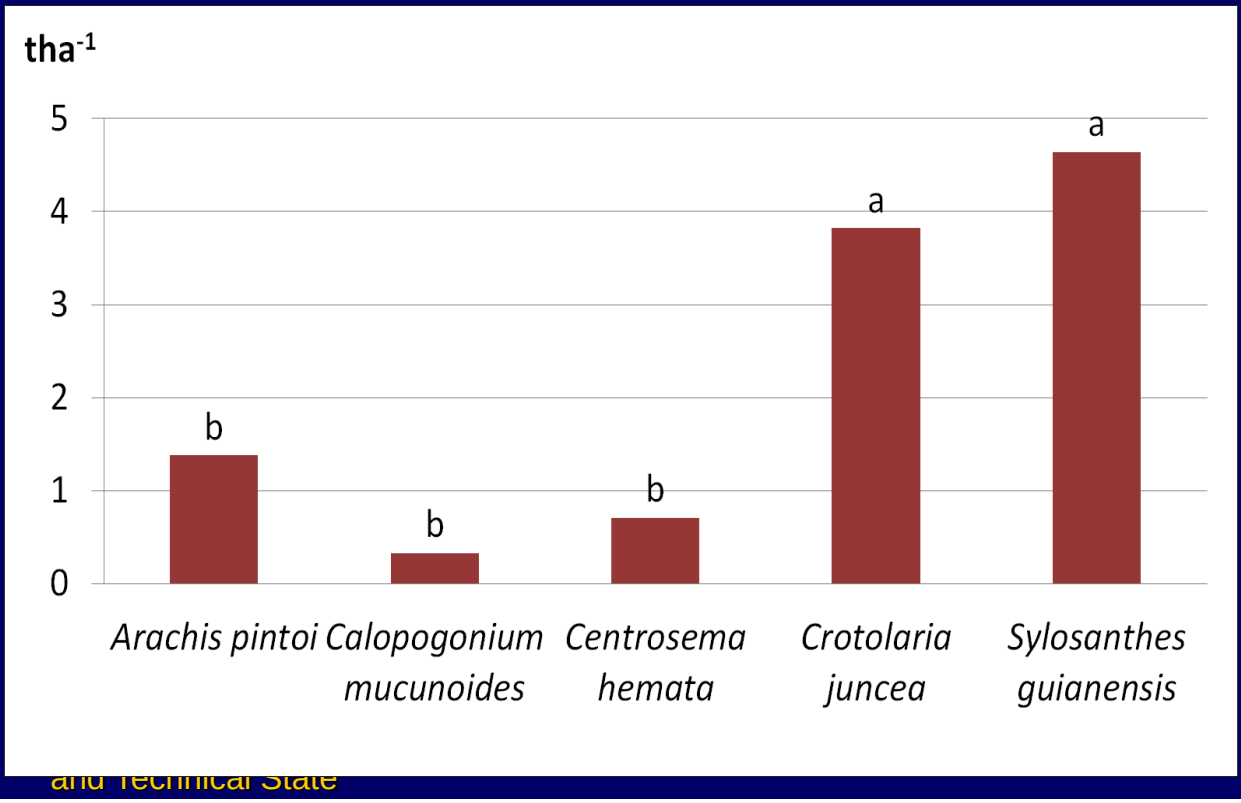
Herbaceous legumes

Stylosanthes guianensis

Arachis pintoi

Total Biomass of different herbaceous legumes 5 months after planting. Claveria, Misamis Oriental, Philippines



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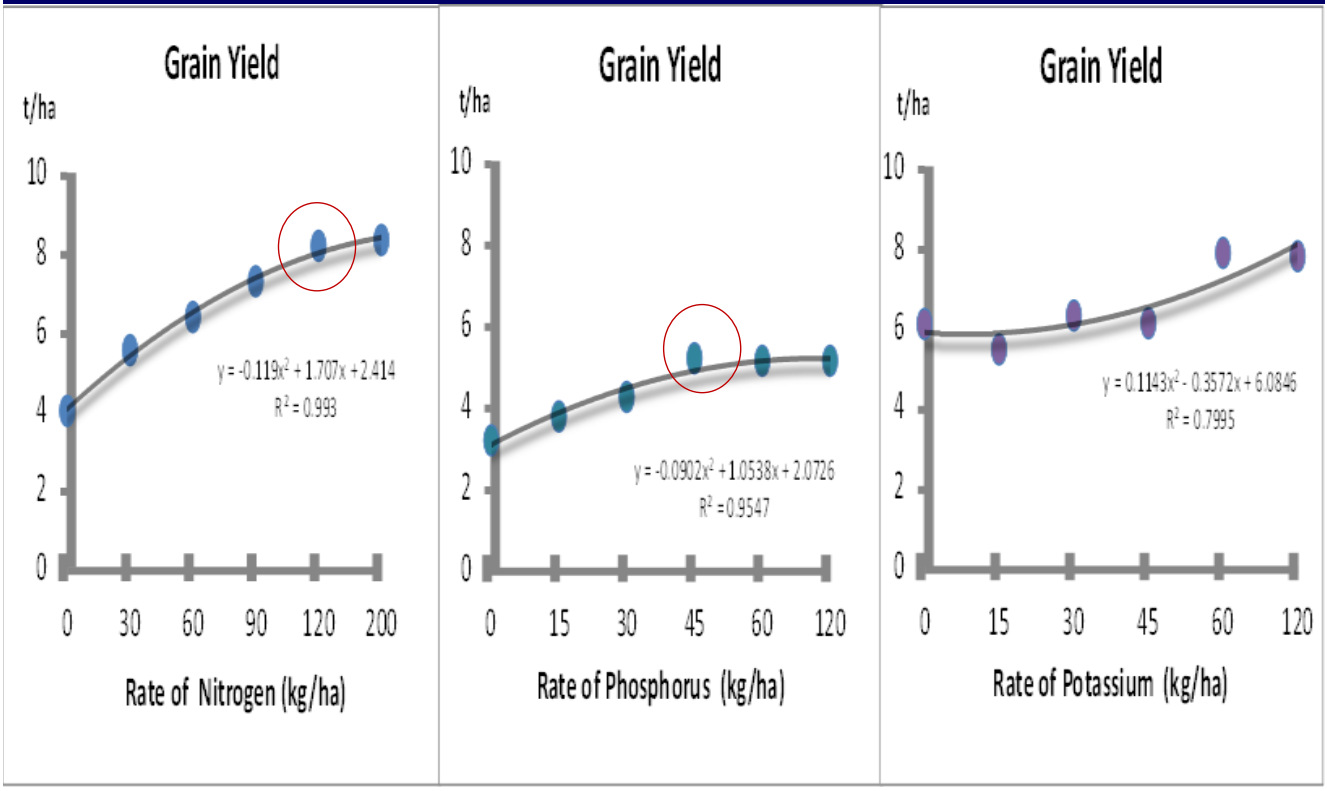
Grain yield of maize as influenced by the different NPK rates. Claveria, Misamis Oriental, Philippines



Other conservation Agriculture with Trees (CAT) : Good practices



1) Natural vegetative filter strips establishment

Establishment of natural vegetative filter strips along contour lines is the initial and simple low cost conservation measure allowing natural vegetation to grow at 50-cm width strips spaced at 8-10 meters apart to effectively protect the soil from erosion. NVS systems provide foundation for the establishment of cash perennials on the contour strips.

CAT: Good practices



2) Cash perennials integration and improved cropping pattern

Cash perennials such as rubber, timber and fruit trees including bananas, forage grasses and legumes established as enrichment from NVS provide farm agri-diversity and income. High root length densities of banana, creeping forage legumes and grasses provide soil binding function, and tree roots provide soil anchorage which will protect sloping lands against soil erosion and landslide. Crop rotation of vegetables, maize, upland rice and grain legumes reduces pest and diseases and enhances fertilizer use efficiency. Integration of upland rice complements lowland rice production and addresses Philippine self-sufficiency in rice.

CAT: Good practices

3) Timber- and fruit- based agroforestry

Inclusion of timber trees enhances farming system diversity and profit as well as the capacity to sequester more carbon. Integration of upland rice, maize and cowpea into the tree based system promotes food security. Moreover, the inclusion of N_2-fixing grain legumes increases sustainability in the productivity of upland soils.

CAT: Good practices

5) Livestock integration

Livestocks, such as cattle, goats, pigs, chicken and ducks, can provide additional income, food (meat and milk), draft power and manure. Animal manure can be useful for biogas for the household energy requirement as well as substrate for vermicomposting. The integration of livestock into the farm increases farm agri-diversity and as risk management strategy.

CAT: Good practices

6) Rainwater harvesting

Rainwater harvesting addresses rainfall variability during climate change making water available to crops as well as to livestocks during dry spells. It increases water infiltration thus providing subsurface irrigation to perennial crops. It also provides additional income to farmers by having fish, frog and duck culture. Raising fish, frogs and ducks, while increasing farmers income, will improve nutrient load to the pond water which will improve crop growth and yield if used for irrigation.

CAT: Good practices



7) Organic fertilizer production

Organic fertilizer like vermicomposting is important in addressing farmers' fertilizer requirements. The use of organic fertilizers increases soil organic matter (OM) improving soil moisture during drought thus making a suitable growing environment for crops. Its use also mitigates climate change through avoiding CO_2 emission through fertilizer substitution from the use of inorganic fertilizers, injection of carbon into the soil and potential of mass participation of smallholders to climate change mitigation.

CAT: Good practices

8) No/minimum tillage, mulch and cover crops

No/minimum tillage, mulch and cover crop maintain soil cover throughout the year which reduce soil erosion, increase water infiltration, reduce weed pressures and improve soil fertility. They also improve soil carbon thus help mitigate climate change. Cover crops, like *Arachis pintoi, Stylosanthes guianensis, etc.,* provide nitrogen and render phosphorus available to the associated crops.



Are these fields weedy? *Arachis pintoi* live mulch

CAT: Good practices

4) Vegetable agroforestry

Properly managed trees improve vegetable yields up to 40% as a result of having a desirable microclimate such as low wind speed, suitable temperature, increased relative humidity, high soil moisture and soil organic matter content. Trees also provide environmental services such as habitat for wildlife, control of soil erosion and carbon sequestration for climate change mitigation apart from providing additional nutrients to crops through N_{2}-fixation

Percent yield increase of vegetables under tree based system

Vegetables	Wet season (June – Sept)	Dry season (Feb – May)	Average
Chinese cabbage	37	30	34
Cabbage	13	0	7
Tomato	40	10	25
Bell pepper	20	10	15
Carrots	37	30	34
Mean	29	16	18

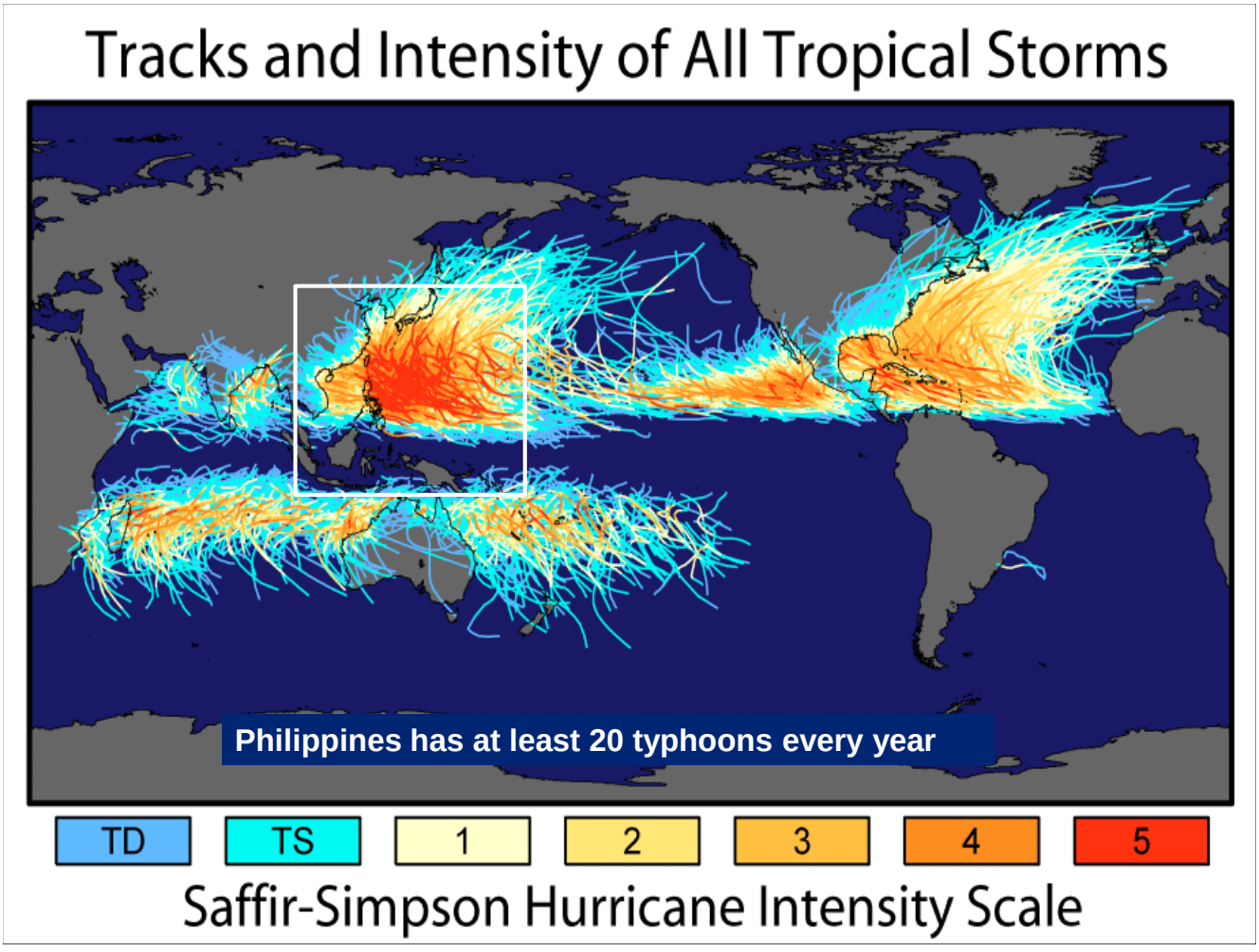
Capacity building program at CAT Center

Training participants

- **2012**: 924 (45% Women); **2013**: 1034 (40% Women)

Sustainable crop production intensification and natural resources use on sloping lands in the Philippines: Enhancing resilience and productivity amid climate change

CAT scaling up


Tracks and Intensity of All Tropical Storms
Philippines has at least 20 typhoons every year
TD
TS
1
2
3
4
5
Saffir-Simpson Hurricane Intensity Scale

The horror pictures: Why upland management important?

Tragedy happens when people care less; when they are complacent!

Impact of extreme events on farming systems

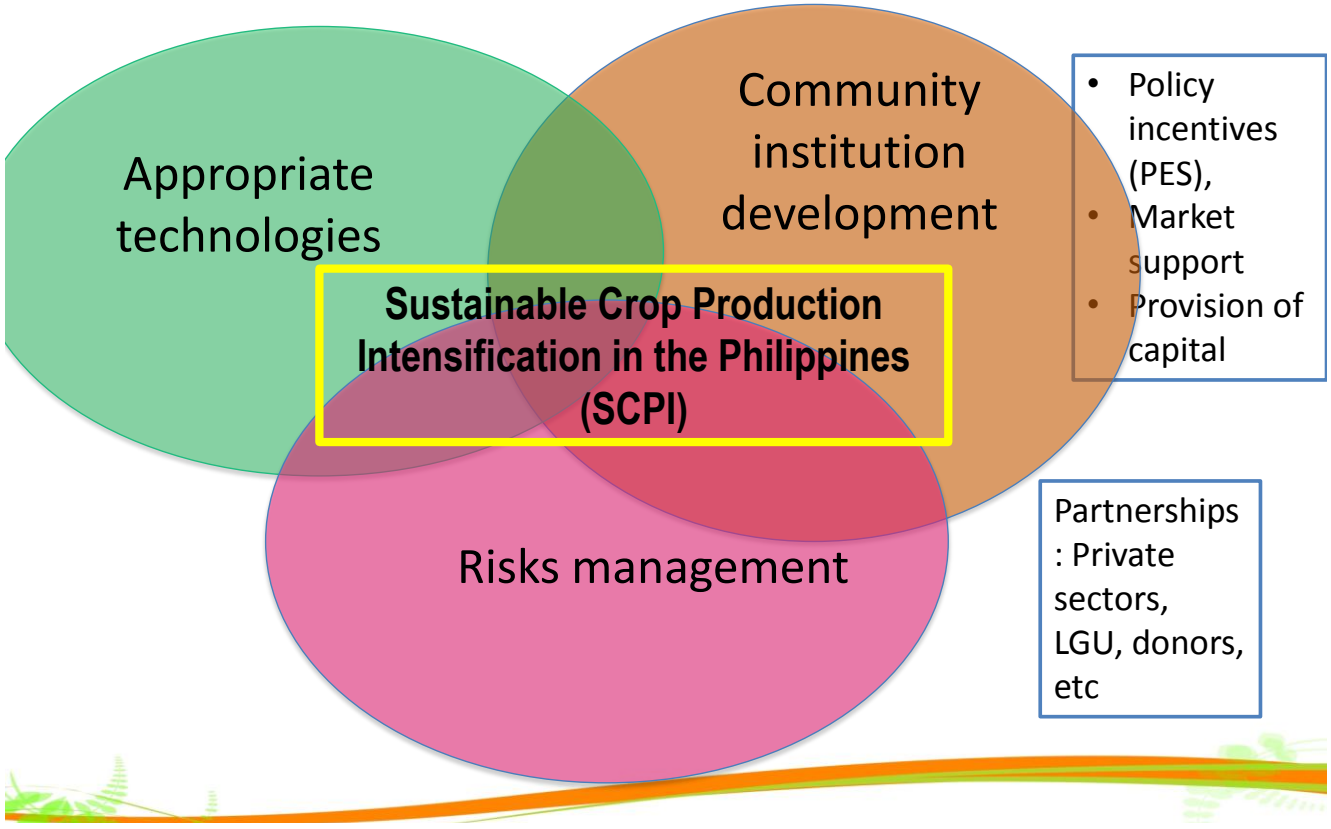
Monoculture maize

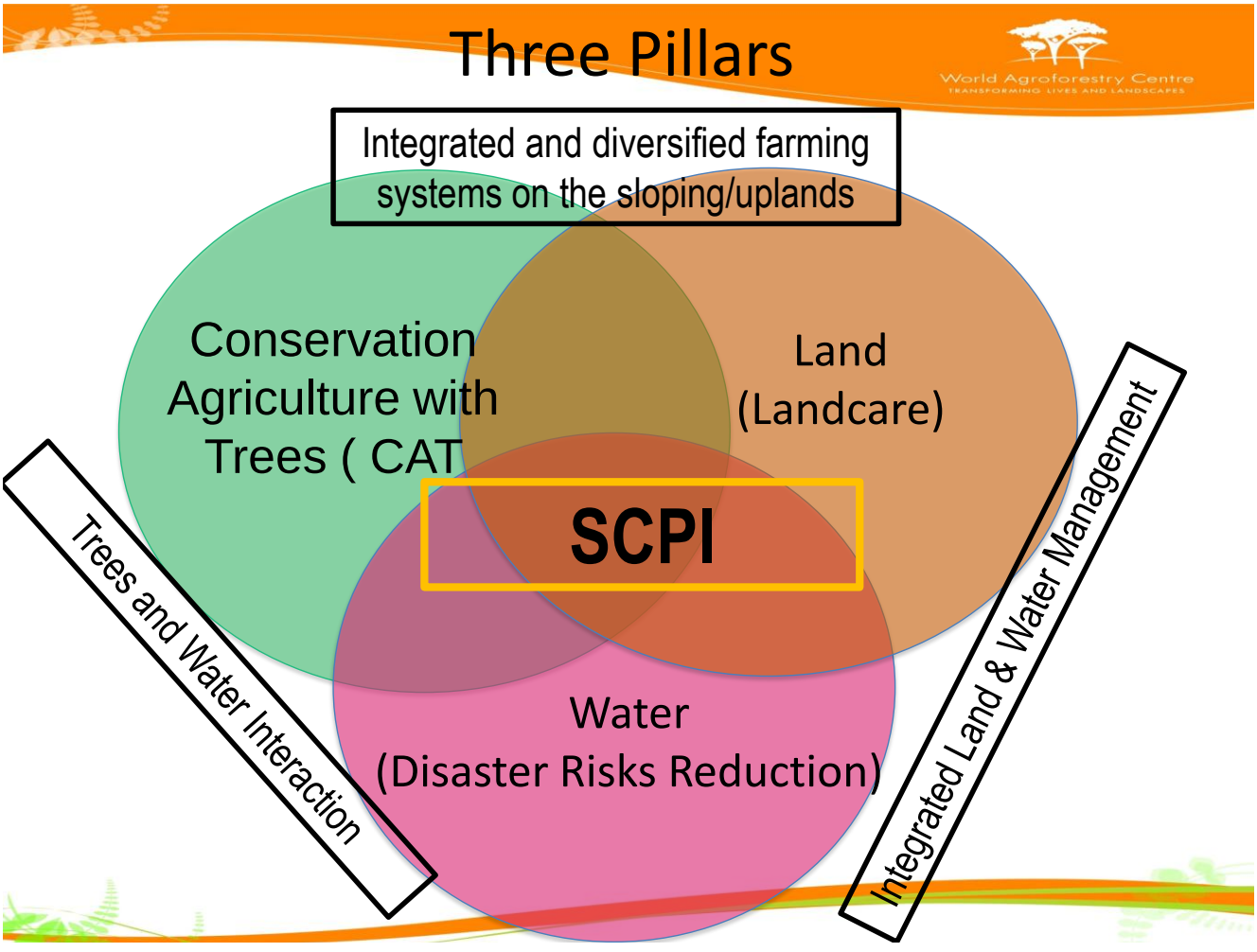
Agroforestry (CAT)

Monoculture banana

Quick recovery of CAT

Three Pillars




Three Pillars
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Integrated and diversified farming systems on the sloping/uplands
Conservation Agriculture with Trees (CAT
Land (Landcare)
SCPI
Water (Disaster Risks Reduction)
Trees and Water Interaction
Integrated Land & Water Management

The Landcare approach

Landcare Groups

- *Share knowledge, skills, time and low-cost materials*
- *Committed to resource conservation*
- *Share experiences and draws local support*
- *Adapt and innovate conservation technologies*

Support

Feedback

Local Government Units

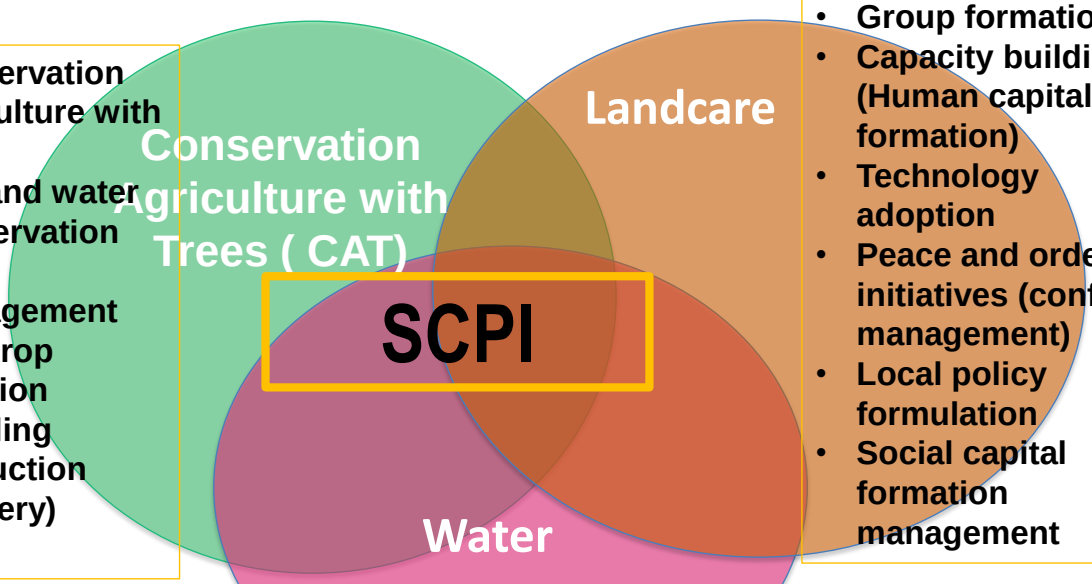
- *Provide policy support and appropriate incentives*
- *Provide financial and material support*
- *Complement technical and facilitation needs*
- *Provide capacity building programs*

Technical Facilitators

- *Share information on appropriate technologies*
- *Facilitate group formation and development*
- *Provide IEC programs*
- *Provide capacity building programs*
- *Provide network support*

Activities that would relate to:

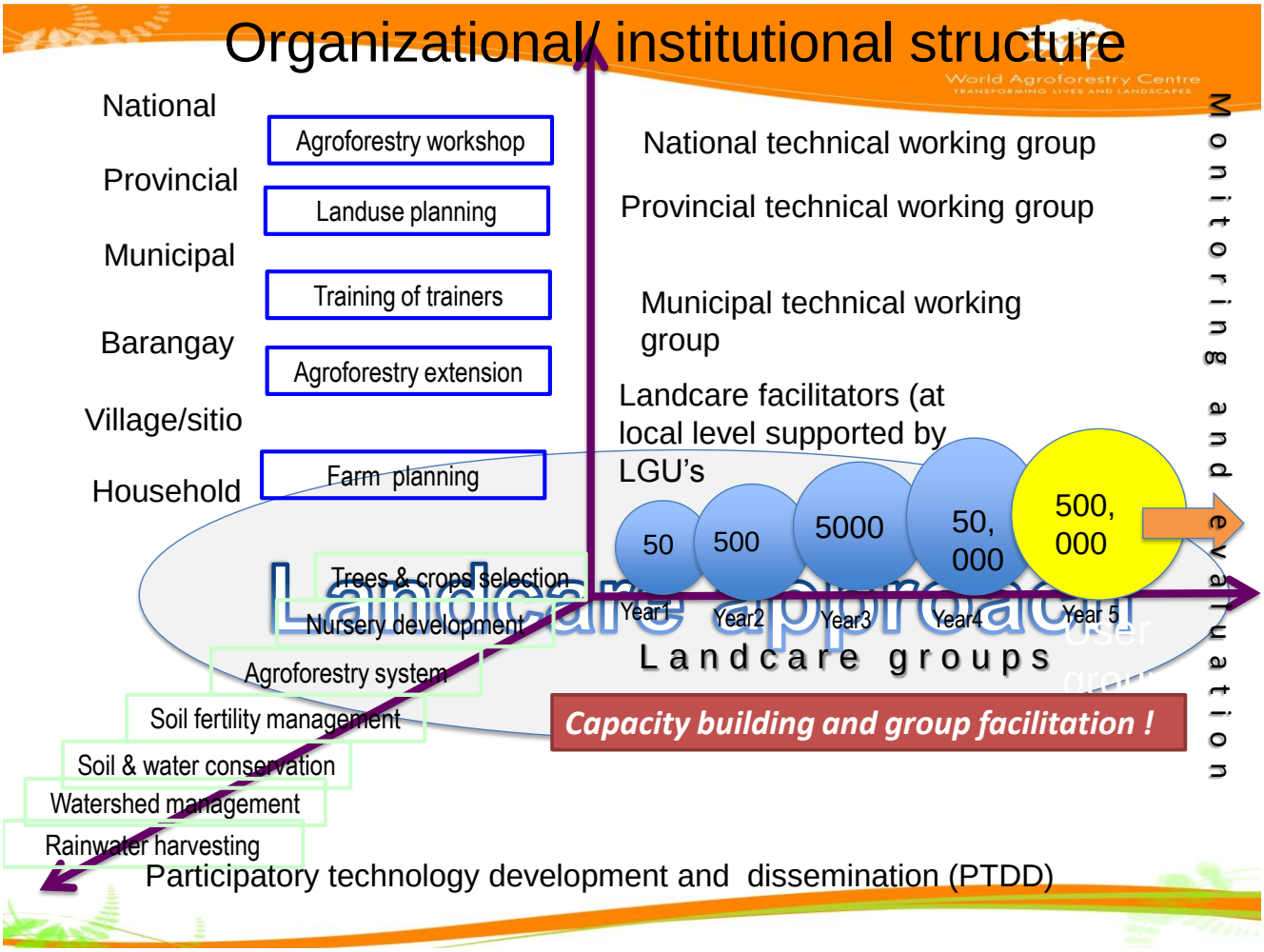
- Conservation agriculture with trees
- Soil and water conservation
- Soil management and crop nutrition
- Seedling production (nursery)



- Group formation
- Capacity building (Human capital formation)
- Technology adoption
- Peace and order initiatives (conflict management)
- Local policy formulation
- Social capital formation management

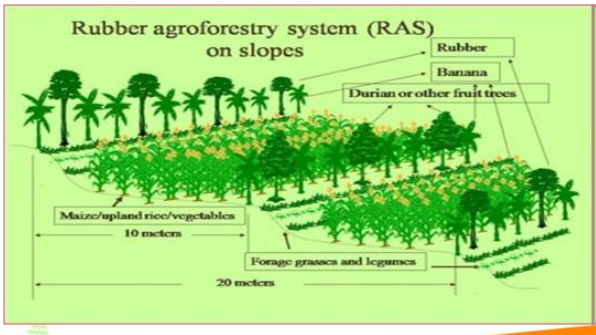
Disaster risks management:

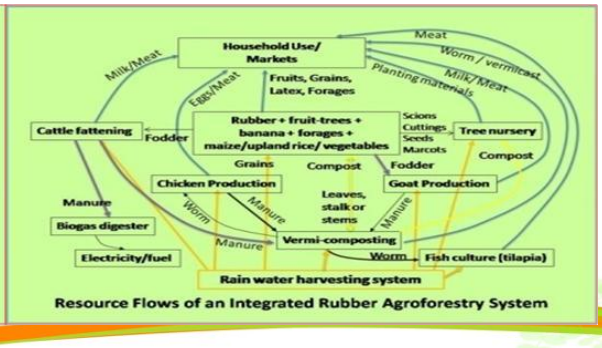
1. **Less water**: Drought – Rainwater harvesting/irrigation
2. **More water**: Floods/landslides mitigation
3. Risks reduction management
4. Risks preparedness


Organizational/ institutional structure
National
Provincial
Municipal
Barangay
Village/sitio
Household
Agroforestry workshop
Landuse planning
Training of trainers
Agroforestry extension
Farm planning
National technical working group
Provincial technical working group
Municipal technical working group
Landcare facilitators (at local level supported by LGU's
50
500
5000
50, 000
500, 000
Year1
Year2
Year3
Year4
Year 5
Landcare approach
Landcare groups
Capacity building and group facilitation !
Trees & crops selection
Nursery development
Agroforestry system
Soil fertility management
Soil & water conservation
Watershed management
Rainwater harvesting
Participatory technology development and dissemination (PTDD)
Monitoring and evaluation

Summary

- CAT on slopes is a delivery mechanism for multi-functional agriculture (MFA) on sloping lands
- Better ways of managing agroforestry systems enhance environmental services and socio-economic benefits and make agroforestry more acceptable to farmers





Summary

- Integrated sloping land management requires the elements of appropriate technologies, active community institution participation, and better risks management
- Experiences in the Philippine SANREM Feed the Future Innovation Lab provided the foundation to these elements and experiences that are ready for scaling up in the country as well in other areas in Southeast Asia of similar bio-physical and socio-economic environments

Thank you very much for listening!

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This project was made possible through support provided by the United States Agency for International Development (USAID) and the generous support of the American people for the SANREM – Feed the Future Innovation Laboratory under terms of Cooperative Agreement Award No.EPP-A-00-04-00013-00 to the Office of International Research and Development at Virginia Tech.