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Editors:

Percy E. Sajise
Maria Celeste H. Cadiz
Rosario B. Bantayan

CASE STORY 11

How Filipino Farmers Cope with Climate Change through Conservation Agriculture with Trees

Agustin R. Mercado, Jr.[1]*, Rodel D. Lasco*[1]*,*
and Manuel R. Reyes[2]

ABSTRACT

The areas with degraded landscapes in Southeast Asia are expanding rapidly. The conservation agriculture with trees (CAT) strategy is the best “tool box” for sustainable crop production intensification. CAT follows the Landcare approach, with principles and practices founded on minimal soil disturbance, continuous mulching, pests and nutrients management, species rotations, integration of trees, and rainwater harvesting.

This case story presents the outcomes of a project conducted in the municipality of Claveria in Misamis Oriental province, Philippines. Specifically, this chapter presents how the interplanting of maize with cowpea and then relayed with upland rice has ensured the food and nutritional security and has improved the incomes of smallholder upland farmers in the municipality.

Arachis pintoi grown with maize has provided farmers with the inputs to produce feeds for livestock. Likewise, the cropping system has provided better groundcover for protecting soil against erosion, eliminated the use of herbicides, and increased farmers’ crop yields. The project also identified promising varieties of maize, upland rice, cowpea, forage grasses, forage legumes, sweet potato, cassava, and sorghum that provide better economic and biomass yield. These crops produced higher yields than the locally grown varieties and are also suitable for conservation agriculture production systems.

The project implementers also identified a cost-effective way of creating rainwater-harvesting system through animal-built embankment. Establishing a series

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1 World Agroforestry Centre, Claveria, Misamis Oriental, Philippines
2 North Carolina Agricultural and Technical State University

of ponds can mitigate severe runoff during heavy rainfall events by increasing water infiltration, and thus mitigate flooding. Accordingly, rainwater-harvesting ponds has provided the farmers with an opportunity to grow fish, ducks, and other aquatic animals, which enhanced household food and nutritional security of farm households. The pond water enriched with nutrients could also be used to irrigate trees and crops during dry spells.

The research results of the project have been extrapolated to other upland areas in the Philippines through the Landcare approach. Through the active participation of farmer groups, local government units, and technical facilitators that constitute the Landcare approach, farmers were able to achieve rapid and inexpensive method of expanding the use of technologies in the Philippine uplands. These technologies can also be used in other areas in Southeast Asia with similar biophysical and socioeconomic environments.

INTRODUCTION

It is estimated that 40 percent of the Philippine population (approximately 40 million people) live on less than United States Dollar (USD) 2 per day, with the poorest areas of the country concentrated in the uplands (USAID 2009). Rural poverty increases pressure on natural resources like forest, soil, and water, which are considered as the last "capitals" of the poor. Thus, these resources must be managed sustainably.

Losses in agricultural productivity will lead to food insecurity, which will then compel the Philippine government to import food. Furthermore, market distribution networks that supply food to distant food-poor communities are vulnerable to natural calamities, conflict, and other factors related to climate change. If these networks collapse, communities dependent on imported food will become more food insecure.

Currently, conservation agriculture (CA) is being successfully implemented in the United States, Canada, Brazil, Argentina, Australia, Paraguay, and in the Indo-Gangetic Plains. About 95.8 million hectares (ha) (Derpsch 2008) are being used for conservation agriculture; however, only about half a million hectares were planted on small farms in 2002 (Wall 2007 and Ekboir 2003, as reported by Derpsch 2008). Only few countries (e.g., Brazil) have invested in CA research and have developed technologies for small farmers. Brazil is among the few countries that manufacture equipment for small farmers (Derpsch 2008).

In the Philippines, CA has not yet established a foothold, although there are some promising sustainable agriculture activities in the region. In 1996, the World Agroforestry Centre initiated the Landcare project in Claveria, which is a small farming community in the province of Misamis Oriental in the Philippines (Mercado et al. 2001). With the support from the Australian Centre for International Agricultural Research and Agencia Española Cooperacion Internacionale, these Landcare initiatives have expanded to other municipalities and provinces in Mindanao.

There are about 10,000 farmers in many communities in Mindanao who are members of Landcare groups. These groups practice conservation farming; they establish natural vegetative filter strips (NVS) along the contour, and practice agroforestry technologies to control soil erosion (Mercado and Cadisch 2004). The World Agroforestry Centre facilitates the formation and continuation of Landcare groups in many areas in Mindanao. "Landcare" is a community-driven approach where various stakeholders in local upland communities work together to address community natural resource degradation problems (Mercado et al. 2001).

DESCRIPTION OF THE ADAPTATION

The resource-poor upland farmers are highly vulnerable to the impacts of climate change, and their miseries are exacerbated due to erratic rainfall patterns, more frequent occurrence of extreme weather events, and other resource-degrading events that always stretch their carrying capacities. Many of them have migrated to urban areas in the hope of better opportunities, thereby overstretching the resources available in those areas. For example, 40 percent of the Philippines' domestic food requirements and 30 percent of the country's food exports come from Mindanao (the southernmost main island of the Philippines); yet in 2011, Typhoon Sendong (international name: Washi) damaged an estimated USD 48.4 million worth of properties and livelihoods in the area. The following year, Typhoon Pablo (international name: Bopha) devastated Mindanao again, affecting 6.3 million people, with more than 200,000 homes damaged or destroyed. Major sources of income, like production of banana, coconut, corn, and rice, were devastated as plantations had been flattened to the ground. Mindanao suffered an estimated loss of USD 780 million due to the typhoon. Many people who had migrated to urban areas became informal settlers who live along river banks, which are more prone to flooding or surges of water levels.

By planting more crops in one area, as in conservation agriculture with trees (CAT), farmers can rely on several streams of income and food sources. If one kind of crop gets damaged by a strong typhoon, then farmers practicing CAT will still have other crops to fall back on and sell. This method is also more environment-friendly since it fosters a more diverse ecosystem that has little reliance on external inputs like expensive fertilizers. It also attracts different forms of wildlife that cannot be found in monoculture plantations.

Upland farmers are typically smallholders who practice diverse integrated production systems. They are primarily interested in adopting systems that cater to their interests of diversification as a risk-aversion mechanism and as a way to ensure household food and money. Thus, CAT is a promising option relevant to their context.

Specifically, CAT is defined as the integration of trees into annual food crop systems by employing the following principles: minimal soil disturbance; diverse crop species; continuous ground cover; judicious integration of trees; and integrated water, nutrient, and pest management.

Depending on what kind of woody species is used and how the trees are managed, incorporating the planting of woody plants into crop fields and agricultural landscapes can help

- maintain vegetative soil cover year-round;
- bolster nutrient supply through nitrogen fixation and nutrient cycling;
- suppress insect pests and weeds;
- improve soil structure and water infiltration;
- enhance greater direct production of food, fodder, fuel, fiber, and income from products produced by the intercropped trees;
- enhance carbon storage both aboveground and below-ground;
- enhance formation of greater quantities of organic matter in soil surface residues; and
- promote more effective conservation of above- and below-ground biodiversity.

There are two CAT pathways, namely, the *annual-based system* and the *perennial-based system*. The *annual-based system* involves growing the annual food crops in between rows of trees that are particularly planted along the contour of sloping lands. Crops are planted in plots that are usually spaced 20–30 meters apart. One example of this system is planting maize intercropped with cowpea between rows of rubber trees + bananas + forages (Figure 11.1). The combination of rubber trees, bananas, and forages as contour hedgerows provide soil binding and anchorage that reduces—if not eliminate—soil erosion and landslides during extreme rainfall events.

On the other hand, the *perennial-based system* involves planting trees and annual crops through a multi-strata system. In the first 2–3 years before the tree canopy closes, annual food crops can be planted with trees similar to the practice of "taungya" system.[2] One example is the multi-strata of rubber + cacao + *Arachis pintoi* (Figure 11.2). This multi-strata system enhances the growth of resources aboveground and below-ground. The presence of rubber trees in cacao production will improve cacao's productivity; cacao requires shade, which the rubber trees can accordingly provide. Meanwhile, *Arachis pintoi* fixes nitrogen from the air, which complements the fertilizer requirement of cacao and rubber trees; it also provides good ground cover, which can suppress weeds and fodder for livestock.

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2 "Taungya" means growing food crops in between rows of newly planted or young trees.

Figure 11.1. Annual-based system, Claveria, Misamis Oriental, Philippines

Note: Maize intercropped with cowpea between rows of rubber trees + bananas + forages

Figure 11.2. CAT perennial-based system

Notes: (1) Multi-strata of rubber trees + bananas + forages
(2) CAT = conservation agriculture with trees

CAT Project in Claveria, Misamis Oriental

The CAT concept was first tested in the municipality of Claveria, Misamis Oriental province, Philippines. Claveria is located 42 kilometers (km) northeast of Cagayan de Oro City with a total land area of 82,475 hectares (ha). Claveria lies on an undulating plateau, with elevation ranging from 350 to 950 meters above sea level (masl). The soils in the municipality are classified as acid upland soils with fine mixed isohyperthermic, Ultic Haplorthox (Mercado 2007). About 62 percent of the total land area is rolling and very steep. On average, the annual soil erosion in the municipality is between 200 and 350 megagram per hectare (Fujisaka et al. 1995; Mercado 2007). The average annual rainfall in Claveria is 3,000 millimeters, which is distributed throughout the year with peak months in June and October. The dominant crops planted in the municipality are maize, upland rice, sweet potato, vegetables, and cassava. Claveria serves as the upper watershed area of 13 other municipalities located along the coastline.

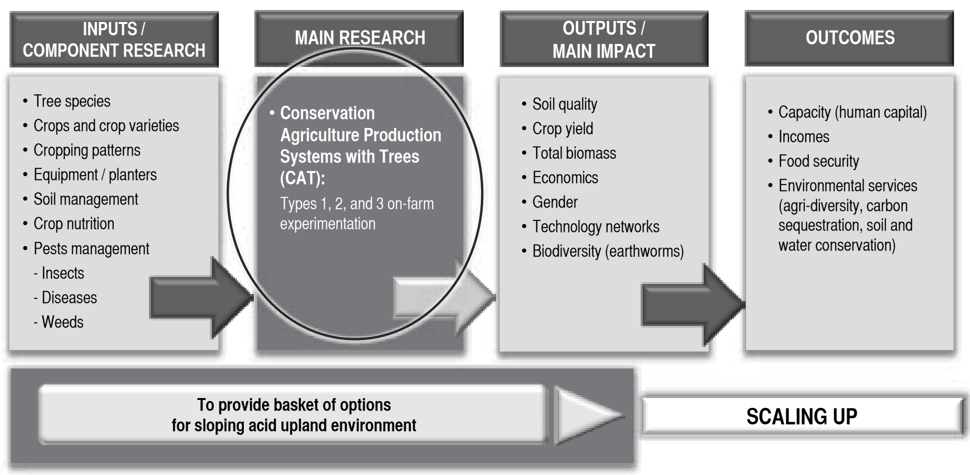
The current land use in Claveria is loosely differentiated into upper and lower elevation zones by agro-ecosystem characteristics, which determine the cropping and vegetation patterns. Land use in lower Claveria (400–600 masl) is dominated by the cultivation of maize, upland rice, and cassava. Upland rice is more common in lower Claveria. Upper Claveria (>600 masl) has more flatlands, cooler temperatures, and longer rainy seasons than the lower areas. The vegetable production on the flatter landforms in upper Claveria makes it the primary vegetable-growing region in Northern Mindanao.

Farmers in Claveria are generally poor, with 60 percent of the households earning below the food threshold level (USD 215 per month), and 70 percent earning below the poverty threshold level (USD 290 per month). These environments represent most of the acid upland areas in Southeast Asia, which consist of about 181 million ha. Hence, the technologies generated from Claveria can be potentially extrapolated to many parts of Southeast Asia.

The participatory research project on CAT implemented by different Landcare groups in Claveria used on-farm research methodologies based on the following:

1. Researcher-designed and managed trials;
2. Researcher-designed and farmer-managed trials; and
3. Farmer-designed and farmer-managed trials, particularly in the long-term research on CAT (Figure 11.3).

Figure 11.3. Conceptual framework of CAT research project in Claveria, Misamis Oriental, Philippines



CAT Treatments

The researcher-designed and -managed trials and the farmer-designed and -managed trials conducted in Claveria were composed of (1) five CAT treatments and (2) conventional farmer's practice, which served as the control treatment. These six treatments were treated with two fertility levels; they served as the subtreatments (subplots). Table 11.1 details the different treatments done in Claveria.

Table 11.1. Different CAT treatments tested in Claveria, Misamis Oriental

Treatment	Description
Treatment 1 (T1)	Maize + *Arachis pintoi* – maize + *Arachis pintoi*
Treatment 2 (T2)	Maize + *Stylosanthes guianensis* – fallow
Treatment 3 (T3)	Maize + cowpea – upland rice + cowpea
Treatment 4 (T4)	Maize + rice beans – maize + rice beans
Treatment 5 (T5)	Cassava + *Stylosanthes* – land preparation similar to that in T1
Treatment 6 (T6)	Farmer's practice: Two plowings and two harrowings using animal-drawn moldboard plow and spike-toothed harrow, respectively

Treatment 1

Two weeks before maize was planted, weeds had been sprayed with glyphosate (Brand name: Roundup) at the rate of 1.5 liters per hectare with a total of 720 grams active ingredient. The maize seeds were then dibble-planted using sticks, spaced at 70 centimeters (cm) × 20 cm, to make 72,000 plants per hectare. *Arachis pintoi* cuttings were planted in single rows in the middle of the maize rows spaced at 2 meters (m) apart. Two fertility levels were used: (1) 0-30-0 $NP_2O_5K_2$ (low-fertility level as F0) and 60-30-30 (moderate-fertility level as F1) during the first cropping.

Due to the poor performance of F0 during the first cropping, it was modified into high-fertility level with 120-60-60. All phosphorus (P) and potassium (K) were applied as basal. Nitrogen (N) was applied 30 days after crop emergence. A second maize crop was planted by furrowing using small double-moldboard plow drawn by carabao. This furrowing created a 10-centimeter open strip where the maize were seeded. After 30 days, the *A. pintoi* recolonized the opened space. At harvest, the maize stalks were cut at ground level to enable the project researchers to determine the biomass and grain yield of the planted maize. *Arachis pintoi* biomass was sampled after maize had been harvested. *Arachis pintoi* biomass was determined by sampling a 1 m × 1 m plot. Biomass was weighed, and subsamples were then taken for moisture determination.

Treatment 2

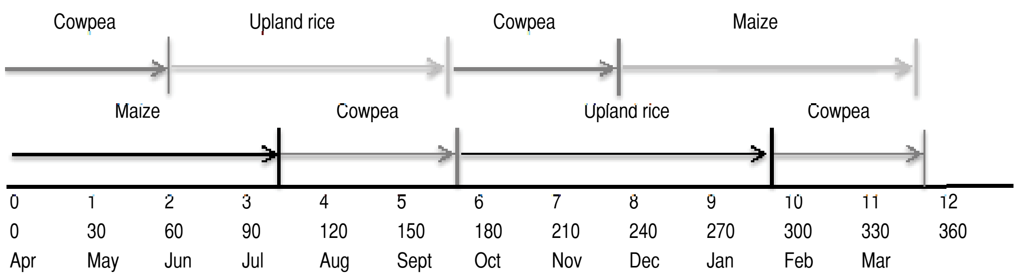
The maize was established and managed similar to how it was in T1. *Stylosanthes guianensis* seeds had been drilled in between rows of maize and then thinned to 10–15 plants per linear meter. Maize and *Stylosanthes* were sampled similar to how it was in T1. The sampling of maize and *Stylosanthes* were similar to that in T1.

Treatment 3

The land was prepared similar to how it was in T1. The maize was established in double rows at 35- and 20-centimeter spacing between plants to make a plant population of 72,000 plants per hectare. This was alternated by two rows of cowpea at 35-centimeter row spacing, with 10–15 plants per linear meter. After the cowpea had been harvested, upland rice was planted. After maize had been harvested, cowpea was planted. This planting scheme is shown in Figure 11.4.

Based on the schedule shown in Figure 11.4, in 340 days, farmers would have two full-crops of maize, two half-crops of upland rice, and four half-crops of cowpea. This intensive system can serve as the bridging harvest before the main crops are planted, and can thus provide farmers with harvests every 60 days. This would then help ensure their household food requirements and also augment household income.

Figure 11.4. Phenology of maize + cowpea/upland rice + cowpea cropping pattern



Treatment 4

The land preparation and planting of maize was similar to how it was in T1. Production of rice beans were established two weeks prior to maize harvest.

Treatment 5

Furrows were spaced at 100-centimeter intervals, and cassava cuttings were planted 50 cm apart to make 20,000 plants per hectare. The cassava was harvested approximately 10 months after planting. *Stylosanthes* was established by seeds in between rows of cassava.

Treatment 6

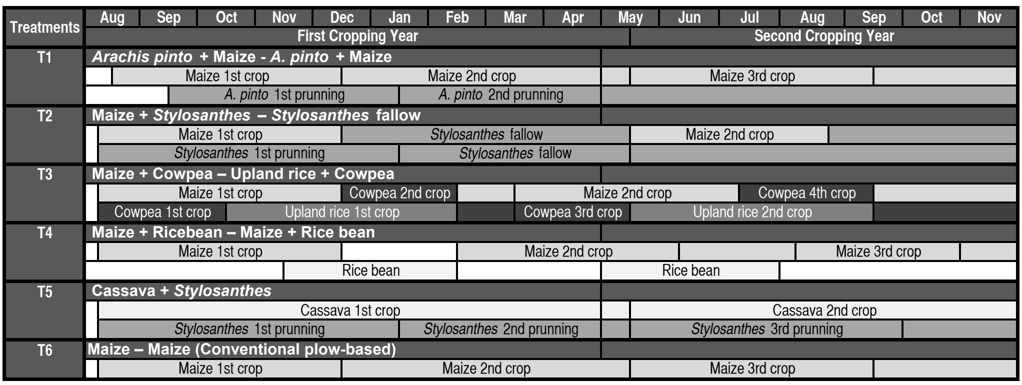
Rows were furrowed using animal-drawn moldboard plow. Maize was managed and harvested similar to that in T1, T2, and T3. In the second cropping, the stalks were spread uniformly and plowed under. The planting, management, and harvesting were similar to that in the first cropping.

Field Implementation

These five conservation agriculture production system (CAPS) treatments and farmers' practice of maize monoculture at two fertility levels were laid out and replicated four times. A total of 25 farmers tested the CAT treatment at the farmer-managed experiments, which were located across several villages in Claveria. Each farmer tested one CAT treatment in a 1,000-square-meter plot located in the middle of their traditional maize system.

Component researches like tree species, crops and crop varieties, soil management, and crop nutrition were also conducted to complement the main CAT research. The results of the component studies were fed back to the CAT system (Figure 11.5).

Figure 11.5. Crop phenology of six different conservation agriculture production systems

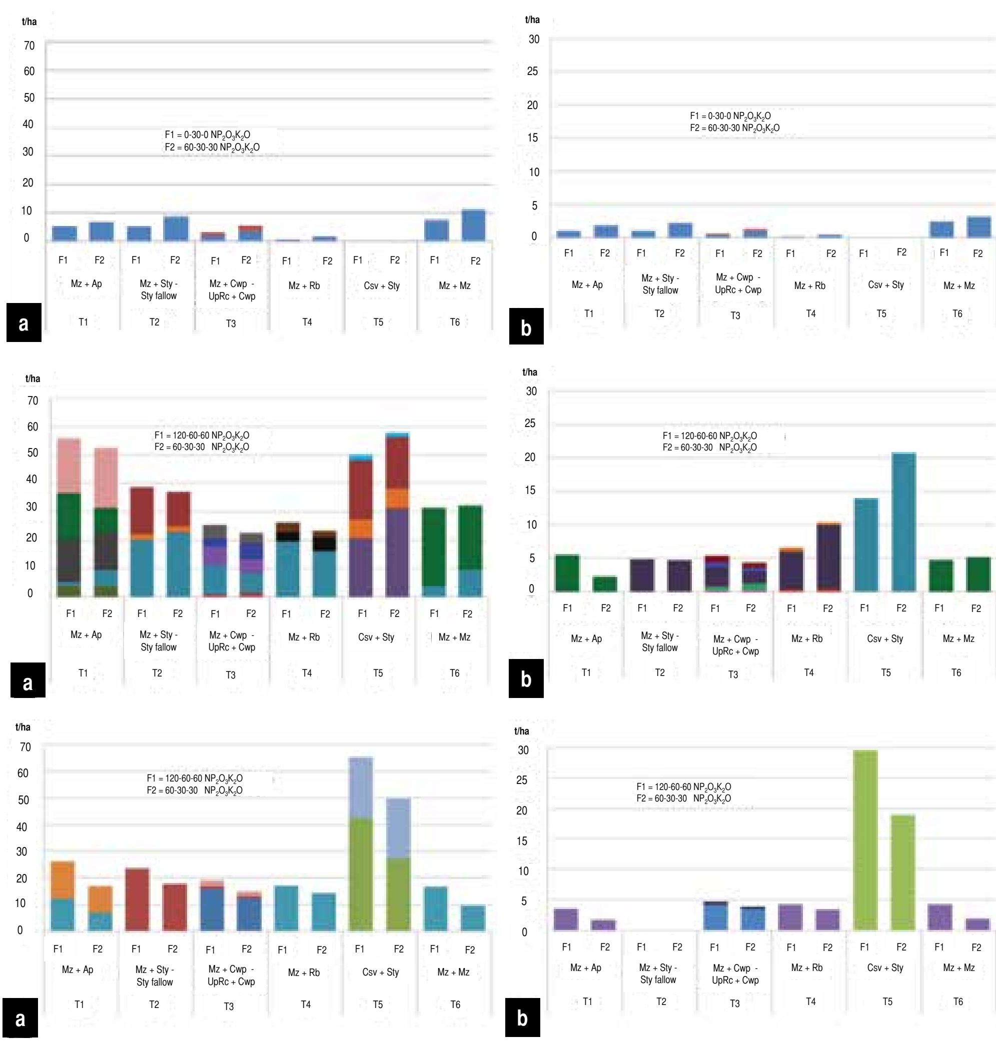


OUTCOMES OF THE ADAPTATION

Conservation Agriculture Production Systems

The results of the research project in Claveria showed that the conventional maize system had better yields than the other CAPS in terms of total biomass and grain yield during the first cropping experimentation in 2010. Maize with rice bean had the lowest yields among all cropping patterns. The moderate-fertility level (60-30-30) had higher yield across all CAPS as compared to that of the low-fertility level (0-30-0). In the subsequent year in 2011, cassava + *Stylosanthes* had the highest total biomass. This was followed by maize + *Arachis pintoi*, then by maize + *Stylosanthes*. A similar trend was observed in 2012. Still, cassava ranked first in total biomass, whereas the rest of the cropping patterns were comparable with one another, except for the traditional monoculture maize which had the lowest yield (Figure 11.6).

Figure 11.6. Annual productivity of different conservation agriculture production systems



The researchers found that cassava + *Stylosanthes* had the highest total system productivity among all of the CAPS treatments tested. Maize + *Arachis pintoi* had the highest total biomass and grain yield among all of CAPS treatments with maize. This may be due to the higher N_2-fixing capacity of *A. pintoi* that supplemented additional N to the soil, thus providing N to both crops. Meanwhile, the productivity of the conventional maize monocropping system declined in the subsequent years.

The results of the partial gross analysis indicated that in the first cropping, the annual total system profitability of the CAT treatments ranged between 7 percent and 20 percent; meanwhile, the conventional maize system was 123 percent higher than the CAT treatments (except in cassava + *Stylosanthes*). The reasons are two-folds: (1) CAT entailed higher initial land preparation costs, and (2) low crop productivity.

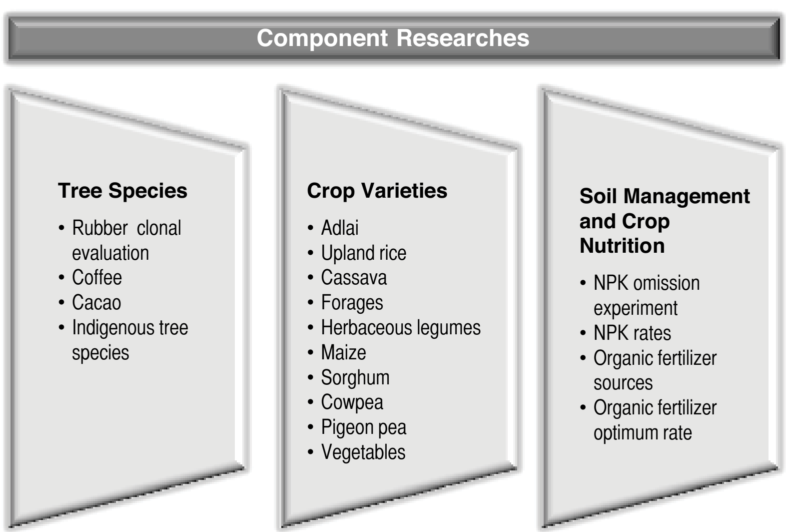
After four years of experimentation, the CAT systems increased the annual system profitability of the tested crops from 492 percent (cassava + *A. pintoi*) to 863 percent (maize + cowpea). The yield of maize + *A. pintoi* was 778 percent higher than that of the conventional maize (excluding the value of *A. pintoi* herbage harvest) at 5,250 kg/ha at 21-day clipping interval, which should be accounted for. Grain legumes (like cowpea and rice beans) integrated systems had higher total system profitability than the other systems due to higher bean price.

Stylosanthes grown with cassava and with maize yielded significantly better than the *A. pintoi* planted in association with maize. *Arachis pintoi* is usually a low-starter forage legume. *Stylosanthes* planted with cassava grew better than *Stylosanthes* with maize. This was due to slower growth of cassava that would allow *Stylosanthes* to get established and grew along with it as opposed to the fast-growing maize.

Component Research to Support CAT

The researchers also determined which crop varieties are best-suited for CA. Specifically, the researchers looked at different crops and crop varieties that have both high biomass production and economic crop yield and are also suitable for CA systems. These include adlai (Job's Tears), forage grasses, sorghum, cassava, and open-pollinated maize (Figure 11.7). The following subsections describe the different crops and varieties evaluated in the project.

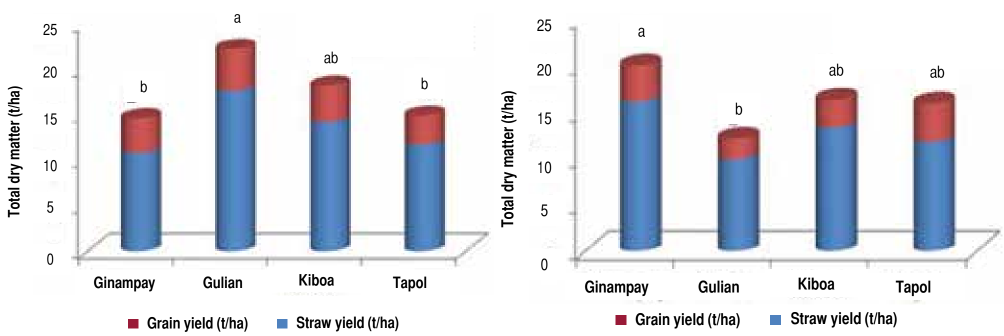
Figure 11.7. Component researches to support the main CAT research



Varietal trial of adlai (Coix lacryma-jobi L.)

Gulian, an adlai variety, performed well in an acid upland condition; it superseded other adlai varieties like Kiboa, Ginampay, and Tapol. Ginampay performed best at rationed crop (Figure 11.8). The results imply that Gulian and Ginampay can be good sources of organic matter (OM) for the soil; these varieties also promise higher yield and income for farmers in an integrated CAPS. The slow-degrading biomass due to the wide carbon-nitrogen ratio can be used as mulch to control weeds and to preserve soil moisture. The roots of adlai can grow up to 3 m into the subsoil, which enable the plant to withstand dry spells.

Figure 11.8. Performance of adlai varieties as first and rationed crops



Open-pollinated maize varietal evaluation

The maize varieties IPB-13 and IPB-6 outyielded the traditional varieties such as Tinigib and Seniorita (Figure 11.9). These open-pollinated maize varieties are suitable for upland maize farmers because they can collect seeds for the subsequent cropping. Choosing maize varieties that have both high grain yield and stalks will provide benefits to the soil and to the farmers. These top two varieties are included in the seed production for future distribution to farmers.

Sorghum varietal evaluation

ICSU-93034 and IC-93046 sorghum varieties showed better adaptation in acid soils as opposed to other entries (Figure 11.10). At present, farmers in Claveria are using these two cultivars in the farmer-managed plots.

Figure 11.9. Relationship between grain yield and biomass yield of open-pollinated corn varieties for CAPS

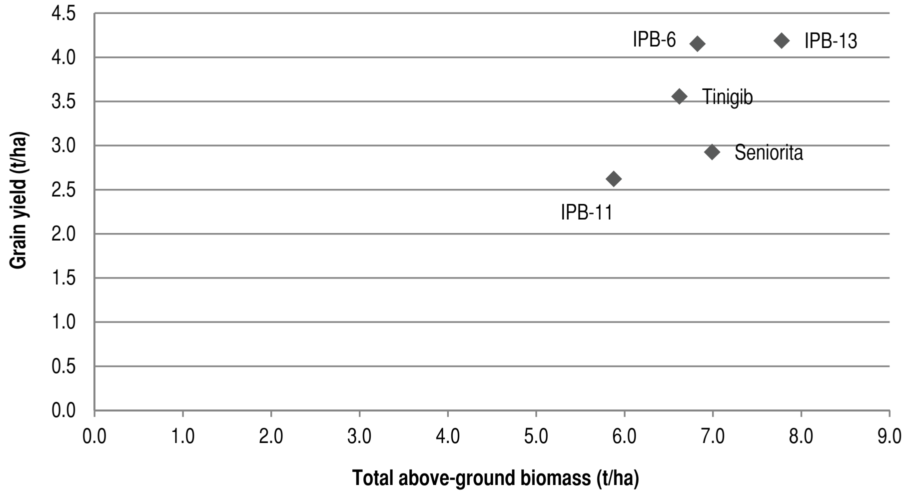
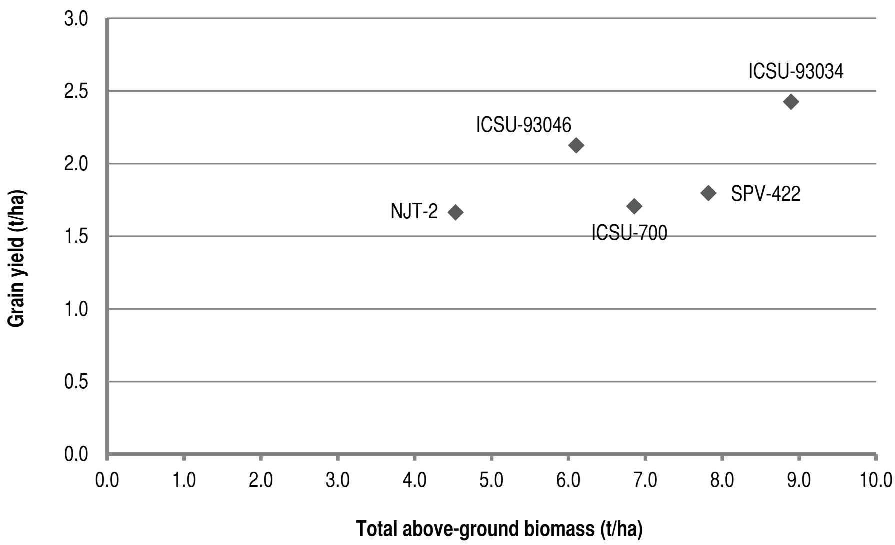


Figure 11.10. Relationship between grain yield and biomass yield of sorghum varieties



Forage species evaluation

Seven collections of six different fodder grasses from different sources in the provinces of Bukidnon and Misamis Oriental in the Philippines were evaluated for biomass production for possible inclusion in CAPS. These fodder grasses were *Bracharia rhuzinensis*, *Bracharia decumbens*, *Setaria sphacelata* (var. splendida), *Setaria sphacelata* (var. nandi), *Pennisetum purpureum*, and *Panicum maximum*.

In terms of plant height and total aboveground biomass, *Pennisetum purpureum* was the top performer, followed by *Setaria* (var. splendida) (Table 11.2). These two forage grasses are the erect type and are suitable for a cut-and-carry system or to be planted as grass strips for soil conservation measures in sloping lands. *Brachiaria rhuzinensis* is another alternative forage grass, which is a creeping type of grass and adapts well to acidic soils. These promising forage grasses could be integrated into CAPS, which would generate high biomass for soil fertility regeneration.

Table 11.2. Biomass and plant height of forage grass cultivars three months after pruning, evaluated for CAPS

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

Notes: (1) Means having the same letters are not significantly different from each other by DMRT at 5% level. (2) CV = coefficient of variation; SED = standard error of the mean difference

Forage herbaceous legumes evaluation

Stylosanthes guianensis and *Crotolaria juncea* outperformed the rest of the herbaceous legumes evaluated (Table 11.3). *Arachis pintoi* yielded approximately three times lower than *Stylosanthes* did five months after planting. Both *Stylosanthes* and *Arachis* have already been integrated into the wider evaluation in both the farmer-managed and researcher-managed trials. *Crotolaria juncea* has not yet been integrated, but the crop also performed well under acidic soil environment. This could also be integrated into wider experimentation so that its potential can be realized.

Table 11.3. Aboveground biomass of herbaceous legumes five months after planting

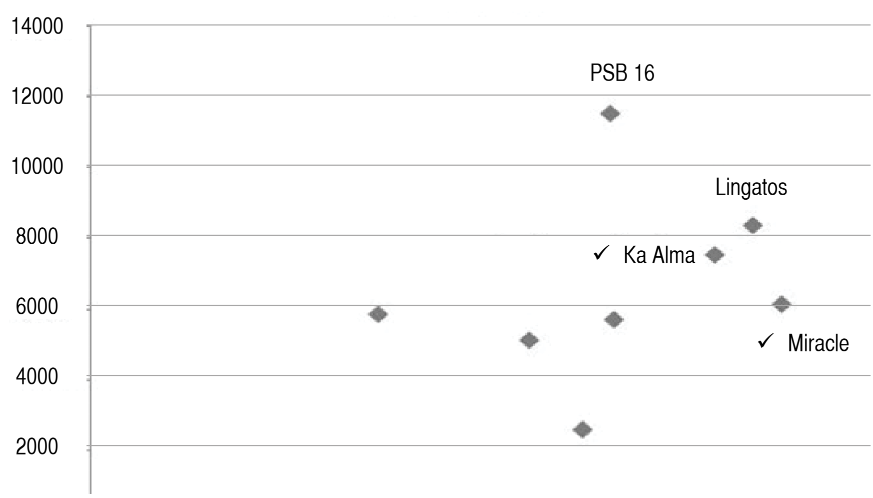
Herbaceous Legumes Species	Biomass (t/ha)
Arachis pintoi	1.38b
Calopogonium mucunoides	0.33b
Centrosema pubescens	0.71b
Crotolaria juncea	3.82a
Stylosanthes guianensis	4.64a
Mean	2.05
SED	0.43
CV (%)	42.00

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

Sweet potato varietal evaluation

The newly introduced PSB-16 and Lingatos yielded better than the local varieties Ka Alma and Miracle in both aboveground biomass and roots (Figure 11.11). These four varieties are now planted in a wider scale to be able to produce cutting planting materials for possible inclusion in the CAPS experimentation.

Figure 11.11. Relationship between sweet potato root weight and total biomass



Upland rice cultivar evaluation

Under acid-poor soil, IR-55419-04 and NCIRC-9 had comparable grain yield and total dry matter yield with IR-30716, which is currently used in CAPS experiments (Figure 11.12).

Cowpea cultivar evaluation

The variety IT82D-889 outyielded the cultivar taken from the Northern Mindanao Integrated Agricultural Research Center. IT82D-889 matures 60 days after sowing (Figure 11.13). It has shown good adaptation to acidic soils, and is now integrated into the researcher- and farmer-managed experiment in combination with maize and upland rice.

Figure 11.12. Relationship between total biomass and grain yield of different upland rice varieties

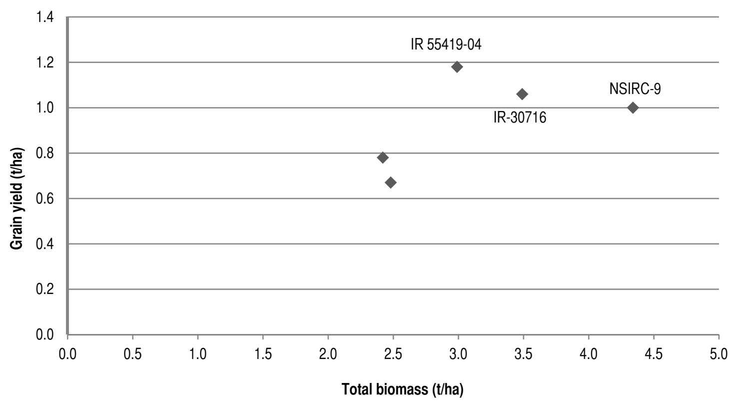
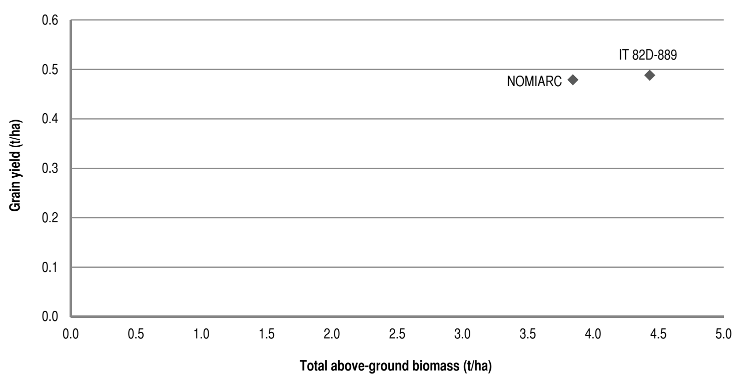


Figure 11.13. Relationship between grain yield and total biomass of different cowpea varieties



Other Components of CAT Good Innovation for Climate Change Adaptation

Natural vegetative filter strips establishment

Establishing natural vegetative filter strips along contour lines is the initial and simple, low-cost conservation measure that will allow natural vegetation to grow at 50-centimeter width strips spaced at 8–10 m apart. This will effectively protect the soil from erosion (Figure 11.14). NVS systems provide foundation for establishing cash perennials on the contour strips.

Rainwater harvesting through animal-built embankment

Meanwhile, rainwater harvesting addresses rainfall variability, thus making water available to crops and livestock during dry spells (Figure 11.15). It increases water infiltration to provide subsurface irrigation to perennial crops. It also provides additional income to farmers as it allows them to culture fish, frogs, and ducks. Such activities will increase farmers' income while improving the nutrient load of the pond water, which will accordingly improve crop growth if used for irrigation.

Figure 11.14. Natural vegetative filter strips for effective soil erosion control

Figure 11.15. Animal-built rainwater harvesting as climate change adaptation strategy against drought

Organic fertilizer production at the farm level

Organic fertilizer production at the farm level (e.g., vermicomposting) is important in addressing farmers' fertilizer requirements. Using organic fertilizers increases soil OM, which improves soil structure and soil moisture holding capacity. Water then becomes available to crops during dry spells, thus making a suitable growing environment for crops. Its use also mitigates climate change as the practice prevents CO_2 emission through fertilizer substitution from the use of inorganic fertilizers and from injection of carbon into the soil that enhances its sequestration. This low-cost technology has the potential for mass participation of smallholders to climate change mitigation.

Vegetable agroforestry

Integrating properly managed trees into an intensive vegetable production system can improve vegetable yields up to 40 percent. This is because trees provide desirable microclimate for vegetable production as they reduce wind speed and temperature, increase relative humidity, provide high soil moisture, and improve soil organic matter content. Trees also provide environmental services such as habitat for wildlife, soil erosion control, and carbon sequestration. Lastly, trees provide additional nutrients to crops (through N_2-fixation) and additional income to farmers coming from timber harvests.

SUMMARY OF LESSONS AND WAY FORWARD

The body of evidence showing that CAT innovations improve agricultural activities is apparent. The CAT strategy helps increase crop yields, soil OM, and soil moisture; and helps improve the income and resilience of farmers to environmental stresses (e.g., drought, intense rainfall, typhoons) while reducing labor and capital costs. Currently, many farmers in Mindanao are adopting the strategy.

Given these benefits, government, NGOs, private companies, and other stakeholders should then address the barriers to CAT research and development by providing funds and subsidies, by investing on CA machinery and equipment, and by strengthening linkages between research and development activities.

The researchers' and farmers' experiences in Claveria, Misamis Oriental provided the foundation for the expansion of CAT innovations in the Philippines. This system can also be used in other countries in the humid tropics with similar biophysical and socioeconomic environments as the Philippines.

Accordingly, the following activities should be done to provide an enabling environment for the expansion and acceptance of the CAT strategy:

1. Massive information dissemination about conservation agriculture, its principles and benefits;
2. Establishing demonstration/model sites (cum experimental fields) at strategic locations;
3. Development of appropriate CAT tools and equipment relevant to smallholder farmers and sloping lands;
4. Provision of planting materials at the early stage of adoption;
5. Provision of initial capital, particularly to smallholders;
6. Adequate institutional support through suitable policy formulation that will include CAT in the projects and programs of line agencies; and
7. Provision of technical capacities at the local level to promote and facilitate the adoption of CAT.

The project proponents/implementers established a CAT center in Claveria, Misamis Oriental in order address the need for CAT information dissemination. At the center, interested individuals can come, see, learn, and discuss the various issues, facets, and components of CAT relevant to their specific context.

Scaling Out and Up through Landcare Approach

The Landcare approach is based on effective community groups being in partnership with the local government. Such groups respond to the issues affecting them, and they are more likely to find and implement solutions independently rather than just follow those imposed by external agencies. Landcare is about people; the key to its success is based on a mature social capital and a close bond between and among farmer "communities" and governments. The success of scaling out technologies through Landcare is dependent on how these three key actors interact and work together:

1. Concerned citizens in the community who are
    - willing to share their talents, skills, and other resources;
    - usually resource poor who want to improve their livelihoods;
    - willing to learn, share experiences, and employ new sustainable farming techniques;
    - committed to resource conservation and protection and the creation of work groups for that purpose; and
    - tillers, non-tillers, owners, or tenants of the land.

2. Local government units who can provide
   - policy support to institutionalize conservation farming, agroforestry, and other practices for sound environment and natural resource management;
   - budget allocations through the creation of local ordinances;
   - leadership in facilitating Landcare groups and related activities;
   - capacity-building programs for the overall development of Landcare; and
   - financial support for Landcare activities.
3. Technical facilitators (i.e., World Agroforestry Centre and other line agencies) who can provide
   - appropriate technologies for sustainable agriculture and natural resource management;
   - facilitation for Landcare group formation and their activities;
   - information, communication, and education programs; and
   - network support for Landcare groups

Meanwhile, the different modalities for expanding the CAT strategy through the Landcare approach can be

1. through the local development planning process, which will require an engagement with LGUs in their local development planning process, resulting in the institutionalization of the project at the planning stage;
2. through integrating the strategy into the conventional extension program of local government line agency;
3. through the local development planning process and integration of CAT into existing local programs;
4. through province-wide expansion by integrating CAT into the programs implemented by government line agencies and special local warm bodies at the provincial level; and
5. through integrating CAT at the national level by including it in the programs, projects, workshops, and planning process of the national government's line agencies.

The Landcare approach may be suited to scale out and scale up CAT in other locations in the Philippines and elsewhere in Southeast Asia. Landcare can provide a national focus for the sustained management of farm and other natural resources by farmers, with minimal local government support in the context of climate change and in the process of adapting to it.

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REFERENCES

Derpsch, R. 2008. "No-Tillage and Conservation Agriculture: A Progress Report." In *No-Till Farming Systems* edited by T. Goddard, M.A. Zoebisch, Y.T. Gan, W. Ellis, A. Watson, and S. Sombatpanit, 7–39. Bangkok, Thailand: World Association of Soil and Water Conservation.

Ekboir, J.M. 2003. "Research and Technology Policies in Innovative Systems: Zero Tillage in Brazil." *Research Policy* 32(4): 573–586.

Fujisaka S., A.A. Mercado, and D. Garrity. 1995. *Farmer Adaptation and Adoption of Contour Hedgerows for Soil Conservation*. Manila, Philippines: International Rice Research Institute.

Mercado, A.R., Jr. 2007. *Potential of Timber-Based Hedgerow Intercropping for Smallholder Agroforestry Option on Degraded Soils in the Humid Tropics of Southeast*. Bogor, Indonesia: World Agroforestry Centre, Southeast Asia Regional Research Programme.

Mercado, A.R., Jr., and G. Cadisch. 2004. "Soil Conservation and Social Capital Formation: The Landcare Experience in the Philippines." Paper presented at the 6th National Watershed Summit, 18–21 November 2004, Malaybalay City, Philippines.

Mercado, A.R., Jr., D.P. Garrity, and M. Patindol. 2001. "The Landcare Experience in the Philippines: Technical and Institutional Innovations for Conservation Farming." In *Development in Practice*, Vol. 12 edited by S. Franzel, Denning, G.L. and P. Cooper, 495–508. Florida: Routledge and Taylor and Francis Group.

USAID (United States Agency for International Development). 2009. "Country Assistance Strategy Philippines: 2009–2013." Accessed 30 November 2009. http://pdf.usaid.gov/pdf_docs/Pdacn452.pdf

Wall, P.C. 2007. "Tailoring Conservation Agriculture to the Needs of Small Farmers in Developing Countries: An Analysis of Issues." *Journal of Crop Improvement* 19(1/2): 137–155.