Doing Together
What Can’t Be Done Alone

Conservation Agriculture Network for South East Asia

CANSEA Strategic Plan
2014-2018
Promote - Develop - Disseminate
Innovative and Ecologically More Intensive Farming Systems in South East Asia
October 2013
CANSEA


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Agriculture is an essential component of the South East Asian economy. In recent years, regional agriculture has experienced profound and rapid changes due to unprecedented population growth and subsequent increases in the regional demand for agricultural products.

New agricultural practices are creating new environments. Cultivated areas are rapidly expanding. The joint process of deforestation, new land extension and agricultural intensification has often led to vast soil erosion and gradual soil exhaustion. There is a need to create and develop alternatives that reconcile economic viability, social balance and environmental conservation.

In many situations (acid soils, degraded soils...), Conservation Agriculture (CA) has considerably improved this situation. Erosion has been halted and soil fertility restored where CA techniques such as direct seeding, plant cover and crops rotations have been introduced. Uncultivated acid lands were considerably improved after three years of Conservation Agriculture practices. Conservation Agriculture has also proved that it could be an interesting alternative to traditional Slash & Burn practices. Cultivation of rice and direct sowing of acid resistant fodder legumes have improved the organic matter status of the soil and decreased their acidity level. After some years these soils reveal great potential in producing rice and crop diversification as well as fodder production for cattle raising.

This ability of Conservation Agriculture to restore degraded environments is the basis of the regional CANSEA Strategic Plan. There are at least three major challenges facing South East Asia: i) the restoration of degraded areas; ii) to provide an interesting and sustainable alternative to slash & burn practices; and iii) the training of staff and technicians to practice this new form of agriculture.

In order to promote the ecological intensification of agriculture regional governments must play an active role in contributing support for change. Past experience has shown the need for competent and motivated extension services. The private sector should be more involved, particularly in the local production of specific agricultural equipment which is currently imported from abroad. Access to credit should be easier for farmers and the government should support the development of marketing channels for agricultural production.

At the regional level and within the framework of ASEAN, the Lao Government (MAF), based on its own experience, has proposed the “Lao Initiative” for developing and disseminating Conservation Agriculture in the 10 ASEAN Member States. This initiative was adopted by the ASEAN Secretariat and the CANSEA network will also be associated with the organization of regional workshops and meetings to prepare a coherent regional CA project that ASEAN can then propose to Donors. It is also requested that the CANSEA network be officially considered as an accredited institution by the ASEAN.

It is my pleasure to warmly thank the CANSEA network for its activity in Laos and in the entire region.

Our objective must be to “produce and preserve”.

Vice Minister of Agriculture and Forestry of the Lao PDR
Executive Summary

The Conservation Agriculture Network for South East Asia (CANSEA) was created in September 2009. CANSEA is made up of eight institutional partners from six South East Asian countries. The French “Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD)”, which cooperates with all these partners in South East Asia is also a founding member of the network.

The CANSEA mission is to conduct relevant activities to develop and promote Conservation Agriculture at the regional and national levels in order to increase both agricultural production and productivity as well as to preserve the environment. CANSEA proposes building a partnership over time to address the major issues of agricultural development by providing a strategic platform to foster national and regional networking that reinforces the capacities to develop CA. As a newly structured organization the CANSEA Regional Coordination (CR) gives priority to: i) a generic set of actions; and ii) preparing regional R-D projects having both national relevance and regional interest.

The CANSEA strategic plan, which is built on numerous consultations, describes how CANSEA will bring added value through supports to national institutions in charge of CA development and dissemination. The strategic plan lays out how CANSEA will advance these expected achievements.

In South East Asia the joint process of deforestation, agricultural land expansion and intensification has led to vast soil erosion and to a general decrease in soil and water quality. In addition, current agricultural practices, such as the deep ploughing of the soil or the burning of forest and crop residues, favour CO2 emissions and contribute to global warming. Conservation Agriculture is an alternative land use system reconciling economic viability, social balance, environmental conservation as well as climate change adaptation, which are crucial elements for the long-term improvement of smallholders’ living conditions and poverty alleviation.

The CANSEA strategic plan is designed to challenge three major issues for rural development in the sub-region.

The first challenge is the restoration of soil fertility in degraded areas.

A basket of CA technologies, including zero or reduced tillage, direct seeding, and residue management, has been developed in different countries. Promising results were obtained in (i) regenerating fertility of degraded soils, (ii) providing livestock with high quality forage and (iii) increasing soil carbon sequestration.

The second challenge is to provide alternatives to Slash & Burn systems as well as to intensify and diversify the existing upland farming systems.

There is a need to develop new innovative farming systems to successfully integrate crop and livestock, offering numerous advantages such as: diversification of incomes through such animal products as milk, meat, fibre and manure, weed control, soil erosion control, increased yield of main crops and income during the “start-up” period for tree crops.
The third challenge is to develop a capacity for “Human Resources Development” to address the needs of all CA development and dissemination actors.

The development of farming systems which are more intensive and more respectful of natural resources and the environment requires the acquisition of new stakeholder knowledge and skills. This is a priority since these stakeholders will initiate the changes.

The CANSEA strategic work plan 2014-2017 results from the priorities identified for rural development with an overall objective to optimize the similarities and the complementarities among countries and institutions in South East Asia (SEA) to improve the efficiency of research carried out by the various programmes and to optimize resources and means. CANSEA implements two types of activities: i) generic activities to capitalize results and experiences and facilitate the access to information; and ii) specific activities to develop and disseminate new innovative farming systems more intensive and more respectful of natural resources and environment and organizing training sessions which cover all aspects of CA implementation such as techniques, management, legal aspects, etc.

To cope with these challenges CANSEA has a network of projects in several countries in the sub-region, an efficient approach (DATE) to develop and test technical innovations and also a shared commitment by all members of the network to set up a regional training program. CANSEA is a young structure that needs time and support to successfully implement its defined strategy. This can only be done in a well-defined institutional framework and with the support of all political decision-makers in implementing necessary accompanying measures to develop and disseminate a more efficient agriculture, which will be more respectful of natural resources and the environment.

1. Background

South East Asian countries have demonstrated a comparative advantage in their rate of expansion, resulting in sizable gains in global market shares for key food and agricultural products. The challenge for South East Asia is to pursue economic development without placing additional pressure on natural resources and the environment. The degradation of agricultural resources is a major hurdle in improving the global situation of agriculture in the region. Natural resources upon which agricultural production depends are deteriorating due to land degradation, forest loss, and poor agricultural practices. The intrinsic fragility of soils, the rate of organic matter decomposition and increased population pressure have led to yield declines.

The negative impacts of conventional agricultural practices – land degradation, soil erosion, declines in biodiversity, pollution, desertification, etc., are well known. Added to these are the dramatic social implications of famine, poverty, out-migration, etc. Global food needs are rising with population growth. Agricultural production has to be increased to fulfill these pressing needs. Agricultural systems capable of meeting this challenge must now be productive, profitable and sustainable. Production and quality must be improved in order to boost farmers’ incomes while preserving natural resources and the environment. Through their many positive impacts in the field and to the environment, Conservation Agriculture and ecological intensification can effectively meet these substantial challenges in both developing and developed countries.
The principal identified route to feeding an increasing population while mitigating climate change, in particular in the developing countries, is assisting smallholder farmers in agricultural development and especially with the promotion of agroecological farming practices.

2. Agroecology and Conservation Agriculture

**Agroecology is a scientific discipline** based on ecological theory to study, design, manage and evaluate agricultural systems that are productive and resource conserving. Agroecological research considers interactions of all important biophysical, technical and socioeconomic components of farming systems and regards these systems as the fundamental units of study, in which mineral cycles, energy transformations, biological processes and socioeconomic relationships are analyzed as a whole in an interdisciplinary fashion.

**Conservation Agriculture is an agroecological approach** associating rural development with environmental preservation. It is a generic concept integrating all agricultural practices while aiming at the viability and sustainability of agriculture as well as environmental protection. Conservation Agriculture represents one of many agroecology strategy options among others, such as agroforestry, improved fallows, natural vegetative strips and strip tillage for ecologically based agriculture intensification.

**At the level of farm plots**, CA is based on the following three key principles:
- Practising minimum mechanical soil disturbance, which is essential to maintaining soil organic matter content, stopping erosion, and preventing water loss.
- Managing the top soil to create a permanent organic soil cover allowing micro-organisms to grow within the soil. Soil cover also helps in keeping soil temperature and moisture levels at a higher level rather than if it were tilled every year (FAO 2007).
- Practising crop rotations to reduce pesticide and herbicide requirements in order to control off-site pollution and enhance biodiversity.

**At village land, catchment and landscape levels**, CA includes land and water management practices: i) reforestation of upstream parts of catchment basins; ii) development of land conservation techniques to control flooding, avoid erosion and improve soil water storage; iii) perennial hedge plantation to create favorable cropping conditions and iv) land management protocols between farmers and stock breeders harmonizing cropping and livestock systems and optimizing forage production and use.

**Direct seeding on mulch.** Direct seeding is a technique to place seeds in condition to sprout directly in untilled soil with plant cover. Direct seeders are able to sow according to this principle. They must have the capacity to penetrate the mulch in order to place the seeds correctly and be able to operate on dense plant cover or crop residues.

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3. The CANSEA regional network

Since the 1990’s several Research for Development national institutions in the sub-region have developed and disseminated new CA farming systems contributing to ecological intensification and sustainable diversification. These projects have produced significant results and data on CA farming systems in South East Asia. The Conservation Agriculture Network for South-East Asia (CANSEA) was created in September 2009 to address various regional problems of research and development, which cannot be solved at the national level: *Doing Together What Can’t Be Done Alone.*

CANSEA is a structured regional organization aimed at implementing projects of regional interest with a comparable regional research design, harmonized environmental and economic assessment methods and comparable impact indicators.

**Figure 1: The CANSEA organisational structure**

3.1. Organization of the CANSEA network

This regional research for development network is made up of seven institutional partners from six South East Asian countries. The eight founding members of the network are:

- Cambodia: the Ministry of Agriculture, Forestry and Fisheries (MAFF);
Box 1: CANSEA’s Key Strategic Statements

The CANSEA Vision: To improve regional food security, preserve the natural capital and improve livelihoods, particularly for smallholder farmers from under privileged areas of the region thanks to sustainable Conservation Agriculture development and dissemination.

The CANSEA mission: To conduct relevant activities to develop and promote Conservation Agriculture at the regional and national levels to both increase agricultural production & productivity and preserve the environment.

The CANSEA Value Proposition: To build a partnership over time to address the major issues of agricultural development by providing a strategic platform to foster national and regional networking that reinforces the capacities to develop Conservation Agriculture.

Overall CANSEA programmes and objectives:

- Knowledge production:
  - Participatory design of innovative systems,
  - Experimentations, broadcasts, publications.

- Education & training:
  - Demonstration, support to farmers’ networks,
  - Academic and technical training.

- Communication:
  - Knowledge management,
  - Recommendations, Advocacy

- Build partnership for the long term:
  - Relevant and performant partnership between institutions within the region is a major output.
3.2. Challenges facing CANSEA:

At regional level the most important challenges faced by CANSEA are the following:
- To restore soil fertility in degraded areas;
- To propose alternatives to the traditional Slash & Burn systems in mountainous areas;
- To intensify and diversify conventional farming systems such as commercial mono-cropping, to improve production, productivity and farmers’ incomes while preserving natural resources and the environment; and
- To develop and implement the capacity for “Human Resource Development” at national and regional levels so as to address the needs of all CA development and dissemination actors.

3.3. CANSEA Activities:

CANSEA’s activities allow optimizing the similarities and the complementarities among countries and institutions in the South East Asia to: i) improve the efficiency of research and development carried out by the various programs; and ii) optimize resources and means.

As a newly structured organization CANSEA’s Regional Coordination (CR) gives priority to: i) a generic set of actions; and ii) preparing regional R-D projects having both national relevance and regional interest.

The generic activities aimed at: i) facilitating exchanges of results and experiences between members; ii) proposing mechanisms of cooperation; iii) capitalization of results and experiences; iv) developing common regional projects; and v) advocacy and lobbying.

The network plays the role of catalyst. This is all the more important in South East Asia since national R-D institutions have historically had very few exchanges between themselves and had therefore not developed strong cooperation mechanisms. CANSEA is contributing to improving this situation. A website has also been developed: www.cansea.org.vn

Priority activities recognized or defined by members:
- 1. Implement R-D approaches to develop and disseminate new innovative CA farming systems (ecologically more intensive);
- 2. Implement experimentation to better understand the processes involved in CA (Carbon cycle, role or micro-flora and macro-fauna…) and to develop research on cover crops as “crops for ecosystem services”, contributing to maintain and increase biodiversity by preserving and multiplying local germplasm and introducing new fodder crops in rotation or association with cash crops.
- 3. Local adaptation and development of suitable CA farming equipment;
- 4. Define and implement at the national and regional levels training sessions to address identified needs for CA actors.
4. Results and impacts of CA farming systems

Conservation Agriculture enhances the sustainability of farming systems by preserving them and also by contributing to natural resource development, increasing soil and cropping biodiversity through the diversification of production, micro flora and fauna, while not reducing yields or production. The soil - which is often the farmer’s main capital, is thus preserved.

Table 1: Principles and functions-benefits of Conservation Agriculture

<table>
<thead>
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<th>Principles</th>
<th>Functions/Benefits</th>
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| No tillage          | • Soil structure not upset  
                      | • Erosion control  
                      | • Rapid crop establishment  
                      | • Reduced labour  
                      | • More flexible cropping calendar  
                      | • Little equipment required  
                      | • Optimized use of available mineral and water resources - increased yields |
| Permanent plant cover | • Increased organic matter, water infiltration and retention capacity of soils  
                      | • Fixation of atmospheric carbon and nitrogen (legumes)  
                      | • Protection of soils from erosion and enhanced soil structure  
                      | • Increased quantity of nutrients via recycling of leached nutrients from deep horizons to the soil surface where they can be used by the main crops  
                      | • Reduced evaporative loss of soil moisture  
                      | • Weed control  
                      | • Facilitated tapping of deep groundwater  
                      | • Can be used as forage |
| Crop rotations      | • Diversification of agricultural production (food for humans and livestock)  
                      | • Risk reduction of disease outbreaks, pest attacks and weed infestation  
                      | • Better distribution of water and nutrients in the different soil layers  
                      | • Increasing nitrogen fixation through introduction of legumes  
                      | • More efficient use of water resources and soil nutrients via sequences or associations with plants having different root systems  
                      | • Better organic or mineral N/P/K balance  
                      | • Increased humus synthesis |

3Direct Seeding Mulch-Based Cropping Systems (DMC) by Cirad, AFD, FFEM, September 2007
Box 2: Multifunctionality of Cover crops

A cover crop is a crop planted primarily to contribute to soil fertility, soil quality, water management, weeds and pests control, biodiversity and wildlife preservation in agro ecosystems (L. Séguy et al., 2000). Conservation Agriculture, among other things, implies the integration into cropping systems of cover crops which can provide a number of “ecosystem services”. The most important of these services are the following:

- **Soil fertility management**
  One of the primary uses of cover crops (e.g., *Stylo xanthes guianensis*, *Mucunia pruriens*) is to increase soil fertility. They are used to manage a range of soil macronutrients and micronutrients. The impact of cover crops on nitrogen management has received particular attention from researchers and farmers, because nitrogen is often the most limiting nutrient in crop production. Leguminous cover crops through biological nitrogen fixation provide significant quantity of nitrogen which can replace chemical fertilizer form.

- **Soil quality management**
  Cover crops can also improve soil quality by increasing soil organic matter levels through supplying biomass over time. Increased soil organic matter enhances soil structure, as well as the water and nutrient holding and buffering capacity of soil (Patrick et al. 1957). It can also lead to increased soil carbon sequestration, which contributes to control atmospheric carbon dioxide levels (Kuo et al., 1997, Sainju et al., 2002, Lal, 2003). Although cover crops can simultaneously perform multiple functions, they are often grown for the sole purpose of preventing soil erosion.

- **Water management**
  By reducing soil erosion, cover crops also reduce both the rate and quantity of water that drains off the field, which would normally pose environmental risks to waterways and ecosystems downstream (Dabney et al., 2001). Cover crop biomass acts as a physical barrier between rainfall and the soil surface, allowing raindrops to steadily trickle down through soil profile. Also, as stated above, cover crop root growth results in the formation of soil pores, which in addition to enhancing soil macrofauna habitat provides pathways for water to filter through the soil profile rather than running off the soil surface. With increased water infiltration, the potential for soil water storage and the recharging of aquifers can be improved (Joyce et al., 2002).

- **Weed management**
  Thick cover crop competes with weeds during the cover crop growth period, and can prevent most germinated weed seeds from completing their life cycle and reproducing. The cover crop left on the soil forms a mulch layer, which is a nearly impenetrable mat. This drastically reduces light transmittance to weed seeds, which in many cases reduces weed seed germination rates (Teasdale 1993).

  In addition to competition-based or physical weed suppression, certain cover crops are known to suppress weeds through allelopathy (Creamer et al., 1996, Singh et al., 2003). This occurs when certain biochemical cover crop compounds are degraded that happen to be toxic to, or inhibit seed germination of other plant species.

- **Disease management**
  In the same way that allelopathic properties of cover crops can suppress weeds, they can also break disease cycles and reduce populations of bacterial and fungal diseases (Everts, 2002), and parasitic nematodes (Potter et al., 1998, Vargas-Ayala et al., 2000). Species in the *Brassicaceae* family, such as mustards, have been widely shown to suppress fungal disease populations through the release of naturally occurring toxic chemicals during the degradation of glucosinolate compounds in their plant cell tissues (Lazzeri and Manici, 2001).

- **Pests management**
  Some cover crops are used to attract the natural predators of pests by providing elements of habitat. This is a form of biological control using cover crops (Bugg and Waddington, 1994).

- **Diversity and wildlife**
  Cover crops improve farm habitat for wildlife. The use of cover crops adds at least one more dimension of plant diversity to a cash crop rotation.
4.1. Impacts of CA on soil fertility and the environment

**Improved erosion protection**
Erosion is limited by the presence of live or dead plant cover and the absence of tillage. Plant cover decreases the mechanical impact of raindrops on the soil and improves water infiltration, thus reducing runoff and soil loss. Experiments have shown that soil conservation issues were a very important reason for farmers to experiment CA farming systems and/or to expand their cultivated land under CA (Lestrelin *et al.* 2012b).

**Enhanced soil structure and biological activity**
Plant residue accumulation and no tillage lead to increased organic matter both on the soil surface (0-10 cm) and in deeper layers. Root systems of crops associated with cover plants, along with microorganisms and soil fauna, fulfill the soil tillage function and enhance the soil nutrient balance (biological tillage). Soil fauna such as worms and arthropods break down the organic matter which is then degraded by microorganisms and transported to deeper and more stable soil horizons.

During biological digestion of litter, polluting chemical molecules are degraded into simpler non-polluting molecules. CA techniques function as self-cleaning systems for soils and crops. Cover plants with powerful root systems loosen the soil and recycle nutrients from deep soil layers.

**Disease and pest pressure reduction**
CA is based on integrated pest and disease control methods, which is to say that crop rotations represent a key element of this new strategy to break the disease and weed cycle. The presence of permanent plant cover also helps control weeds, an effect of shade and allelopathy. Pesticide treatments are also reduced.

**Improved water management**
The soil is more humid under CA in dry climates thanks to the elimination of surface runoff, limited evaporation, and increased water holding capacity. Better water infiltration reduces flooding risks by storing high quantities of water within the soil.

**Contribution to biodiversity conservation**
Untilled fields with permanent cover crops provide physical protection for other species, which in turn attract insects, birds and other animals. Contrary to mono-cropping systems, genetic biodiversity is preserved and enhanced by diversifying crops, implementing rotations and using cover plants.

4.2. CA and resistance/resilience to climate change

The joint process of deforestation, new land extension and agricultural intensification has often led to massive soil erosion and gradual soil exhaustion. Crop residues are few, the organic matter in the soil decreases and carbon sequestration then becomes almost negligible.
In terms of greenhouse gas emissions\(^4\) these traditional systems contribute to polluting the atmosphere since they are based on fallow biomass burning. There is a need to create and develop alternatives that reconcile economic viability, social balance, environmental conservation and climate change adaptation. These are crucial elements for the long-term improvement of smallholders’ livelihoods and poverty alleviation.

The analysis of long-term climatic conditions in SEA shows clearly that the climate is very variable (Rod Lefroy \textit{et al.}, 2010). Using projections, the analysis has predicted that by 2050 the minimum and mean temperature will increase by up to 2\(^\circ\)C and the maximum by up to 5\(^\circ\)C. The predictions for rainfall suggest that for most of South East Asia rainfall events will be much more “aggressive”.

\textit{Carbon sequestration and reduction of the greenhouse effect}

Storing carbon in the soil, thus enhancing physicochemical and biological soil properties and reducing atmospheric CO\(^2\) emissions, is an agricultural and environmental challenge. CA systems were initially developed to control soil erosion, but CA systems appear also to be favorable to soil carbon storage. It is now clearly established that agriculture is responsible for substantial atmospheric greenhouse gas (GHG) emissions and that these emissions could be reduced by implementing CA cropping techniques. In CA, the balance is markedly in favor of carbon sequestration. The use of direct seeding reduces fuel consumption through less mechanized work, thus reducing CO\(^2\) emissions from tractors. CA also promotes carbon fixation in organic matter accumulated in the soil. By implementing CA, 0.5 to over 3 t/ha/year of carbon can be fixed.

\textit{Resistance and resilience to climate change}

Conservation Agriculture improves resistance to climate change, which is reflected in the increased number of extreme weather events. The presence of mulch at soil surface has been shown to positively affect soil water balance and to significantly reduce the negative effects of drought events. In addition, at plot level, the cropping system resilience to extreme weather events is enhanced by increased belowground and aboveground biodiversity. It is expected that droughts and floods will become more frequent and severe. Conservation Agriculture based on soil and crop biodiversity is better able to cope both with weather risks and the arrival of new pests, weeds and diseases due to global warming.

\textit{4.3. Economic returns and impacts of CA systems at field and farm levels}

In the absence of government subsidies for the agricultural sector and/or payment for environmental services, clear economic benefits must be apparent for smallholders to induce a change from conventional to Conservation Agriculture. The effects of CA on economic returns, calculated as value of production less operational costs per unit area vary according to its effect on the main grain or tuber yield of crops and implementing costs. The economic

\(^4\)A greenhouse gas (sometimes abbreviated GHG) is a gas in an atmosphere that absorbs and emits radiation within the thermal infrared range. This process is the fundamental cause of the greenhouse effect. The primary greenhouse gases in the Earth’s atmosphere are water vapor, carbon dioxide, methane, nitrous oxide, and ozone. Greenhouse gases greatly affect the temperature of the Earth.
valorization of the additional biomass produced by cover crops is important in the short term when this biomass is used for animal production. The effect in the medium or long term of the biomass on soil fertility is important but in the first phase of CA development and dissemination it does not, from the farmers’ point of view, constitute justification for changing their farming system.

**In productive lands with subsistence agriculture and extensive systems**, operational costs associated with CA systems are generally higher than conventional slash and burn systems, with such additional observed outlays as the costs of seed of secondary crops, minimum fertilization and/or pesticide use as well as fencing materials. The gains in economic returns rely therefore on the gains in productivity and these have been shown to be substantial (Husson, O, 2001), modest (Nicetic et al., 2011), or even nil (Affolder et al., 2009) according to the system tested and the number of years of experimentation.

**In productive lands engaged in the process of agriculture intensification and market orientation**, in mountainous areas which are newly connected to markets, farmers often practice high input cultivation but without adequate knowledge. Improved crops and input management plus inter-cropping with legumes have been described to significantly improve maize production and increase profits (Nicetic et al., 2011).

**In lands in the process of degradation with commercial intensive mono-cropping**, five-year experiments in Laos with a 2-year rotation of maize in association with rice bean compared to maize mono-cropping under tillage showed a significant increase (from 20 to 50% depending on the year) in CA economic returns due to reduced production costs for land preparation and weed control associated with increased maize yields (Tran Quoc et al., 2008). The reduction in production costs is the main reason given by 28% of farmers for expanding their cultivated surface under CA in the South of Sayabouri province in Laos (Lestrelin et al., 2012). Despite no significant differences in grain yields, the differences in costs for land preparation and weed control led to significant differences in economic returns (+10 to +15% higher profits) for continuous maize cultivation under no-till and crop residue management as compared to conventional mono-cropping under tillage (Tran Quoc et al., 2008; Slaat and Lestrelin, 2009). This positive impact explained the rapid and large diffusion of this cropping system in the south of Sayaboury Province. Cambodian rain-fed areas long engaged in intensive market-oriented agriculture showed greater economic returns under CA systems than under conventional tillage systems for maize (+15 to +25% under CA) and cassava (+20 to +35% under CA) production, thanks to substantial gains in productivity.

**In degraded acidic and weathered savanna soils of Northern Laos**, grain and forage production were significantly improved under CA systems and lead to significant gains in economic returns, but required higher initial investments in no-till machinery and fertilizers as compared to traditional tilled and unfertilized production systems (Lienhard et al., 2008).
In highly degraded poor and acidic sandy soils of Central and Southern Laos, with pH of around 4-5 and often aluminum toxicity, CA techniques including no tillage, direct rice seeding and rotation with legume and forage grasses have increased paddy rice production from 2.5 t/ha to 5.0 t/ha over an average of 3 years with the same level of fertilization. Forage production of *Brachiaria humidicola* and *Stylosanthes guianensis* in rotation with rice (3 years of forage production followed by 3 years of rice) allowed beef fattening activities during the rainy season. Mean cattle weight gain of 600 gr/day were recorded with an overall meat production of 500-600 kg/ha over the rainy season (Legoupil *et al.*, 2012).

**Box 3: The Sayaboury Province “CA Development Fund”:**

The Development Fund was created in November 2007 by a decree of the Governor of the Sayaboury Province. Up to now it is the only concrete experience of implementation and operation of a Conservation Agriculture Development Fund. The CA Development Fund was created to improve both the use of natural resources such as soil and water, and to improve farm productivity.

According to its internal regulation this “CA Development Fund is a financial tool to promote rural development in Sayaboury Province by improving agricultural production based on agro ecological principles. The CA Development Fund promotes the conservation of natural resources, the protection of the environment and the strengthening of the capacities of farmers’ groups, dealers and technicians”.

The Sayaboury Province Development Fund is managed by a “Management Committee” regrouping all interested actors, including producers, dealers, technicians and officials. The Management Committee appoints a President who is responsible for the good use of the fund along with a secretariat responsible for financial management and fund accountancy.

The Development Fund ensures financial support to PAFO / DAFO for CA development and dissemination. This development mechanism is funded by a contribution of $1 US/ton by exported maize. Export of maize from the south of the Province reaches more than 200,000 tons which represents about $200,000 US a year. This was mainly used for sustaining demonstration sites in 11 districts and facilitating exchanges between the producers and the private sector (organization of farmers and traders groups).

However, that interesting initiative shows financial limitations as CA development needs also a strong financial commitment from the private sector. It is essential for future CA development actions to:

• Identify traders who express interest in rural development and more particularly in the implementation of CA techniques for long-term sustainability of agricultural systems;
• Associate them in all activities that will facilitate the promotion and diffusion of CA techniques: credit, supply of seeds and inputs, sale or rental of equipment, marketing.

At the end of the R-D project in 2008 the estimated area under Conservation Agriculture was 1,500 ha. According to the study implemented by NAFRI in June 2010 the area would presently be of 5,600 ha with an objective of 12,000 ha by the end of 2013. If these evaluations were confirmed it would demonstrate the relevance and efficiency of the Development Fund to disseminate CA practices.

The example of the Sayaboury CA Development Fund is of high interest. It can be used as a model wherever a development process exists, driven by exports from which a contribution can be made without jeopardizing the production and marketing chains. In the provinces where this dynamic of export does not yet exist, but where the current agricultural techniques practiced on commercial cultures such as rubber trees, corn, coffee and Jatropha lead to a deterioration of environment, it would be possible to create a development fund based on the “Polluters-Payers” principle.
5. Regional challenges identified as priorities for agricultural development

5.1. First challenge: Restoration of soil fertility in degraded areas

Land degradation refers to land which, due to natural processes or human activity, is no longer able to sustain an economic function and/or the original natural ecological function properly due to such causes as deforestation, inappropriate agricultural practices or overgrazing (GEF, 1999). Land degradation involves two interlocking and complex systems: the natural ecosystem and the human social system. Land degradation can take various processes and forms, such as soil erosion due to water and wind, physical deterioration (compaction, sealing), chemical deterioration (soil fertility decline, salinization, acidification) or vegetation degradation.

Trends indicate that accelerated land degradation and related environmental problems will continue to impede economic and social development in South East Asia. There are direct links between production, the natural resource base and a high dependence on agriculture for income and employment. One major challenge is to achieve sustainable economic growth in a way that alleviates rural poverty without jeopardizing the quality of the environment.

Regrettably, the rate of degradation is accelerating in most regions of the world (table 2) and particularly in most countries of the South East sub-region. Some countries face a more serious challenge than others. This is partly due to differences in the rate of overall population increase or the rate of urbanization. Land degradation is also due, in large part, to failing to engage land users in the mitigation effort. Most soil and water efforts are stand-alone interventions and are not attractive to rural households. Poor farmers have little or no money to invest in conservation measures and have no incentive to change their land use if this increases the risk of not producing enough food for their families.

Table 2: Humid tropical forests deforestation and degradation rates (Achard et al, 2002)

<table>
<thead>
<tr>
<th></th>
<th>Latin America</th>
<th>Africa</th>
<th>Southeast Asia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total study area</td>
<td>1,155</td>
<td>337</td>
<td>446</td>
</tr>
<tr>
<td>Forest cover in 1990</td>
<td>669</td>
<td>198</td>
<td>283</td>
</tr>
<tr>
<td>Forest cover in 1997</td>
<td>653</td>
<td>193</td>
<td>270</td>
</tr>
<tr>
<td>Annual deforested area</td>
<td>2.5</td>
<td>0.85</td>
<td>2.5</td>
</tr>
<tr>
<td>Rate</td>
<td>0.38%</td>
<td>0.43%</td>
<td>0.91%</td>
</tr>
<tr>
<td>Annual degraded area</td>
<td>0.83</td>
<td>0.39</td>
<td>1.1</td>
</tr>
<tr>
<td>Rate</td>
<td>0.13%</td>
<td>0.21%</td>
<td>0.42%</td>
</tr>
</tbody>
</table>

5.1.1. The main different types of land/soil degradation and the climate change in South East Asia

*Water erosion* covers all forms of soil erosion by water, including sheet and rill erosion and gully erosion. Human-induced intensification of land sliding caused by vegetation clearance, road construction, etc.

*Wind erosion* refers to loss of soil by wind, occurring primarily in dry regions.

*Soil fertility decline is* used as a catch phrase to refer to what is more precisely described as deterioration in soil physical, chemical and biological properties. Whilst decline in fertility is indeed a major effect of erosion, the term covers forms of degradation other than erosion. The main processes involved are:

- Lowering of soil organic matter, with an associated decline in soil biological activity;
- Degradation of soil physical properties, such as structure, porosity and water holding capacity, due to reduced organic matter;
- Deficiency in soil nutrient resources, including reduction in availability of the major nutrients (nitrogen, phosphorus, potassium), onset of micronutrient deficiencies, and development of nutrient imbalances.
- Acidity of the soils including aluminum toxicity. These “acrisols” are very common in mountainous areas. Acidic soils can exist in rice plains where soils are issued from sandstone.

*Salinization* is used in its broad sense, referring to all types of soil degradation brought about by the increase of salts in the soil. It thus covers salinization in its strict sense, the buildup of free salts and the development of dominance of the exchange complex by sodium.
<table>
<thead>
<tr>
<th>Country</th>
<th>Shared Issues</th>
<th>Key Causes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brunei</td>
<td>Seasonal smoke and haze, solid wastes</td>
<td>Transboundary pollution from land and forest fires</td>
</tr>
<tr>
<td>Cambodia</td>
<td>Soil erosion, sedimentation, water pollution, deforestation, loss of biodiversity, and threats to natural fisheries.</td>
<td>Unmanaged waste &amp; effluent discharge into Tonle Sap lake; destruction of mangrove wetlands through extensive industrial &amp; aquaculture development.</td>
</tr>
<tr>
<td>Indonesia</td>
<td>Deforestation; Soil erosion &amp; loss of biodiversity; water pollution; air pollution in urban areas; national and transboundary seasonal smoke and haze; land degradation; pollution of Malacca straits.</td>
<td>Deficiencies in urban infrastructure - unmanaged industrial wastes and municipal effluents and waste; vehicular congestion and emissions; extensive land clearance and forest fires for pulp wood and oil palm production; extensive and unmanaged mining activities; national and transboundary industrial pollution; tourist developments in coastal regions beyond carrying capacity.</td>
</tr>
<tr>
<td>Laos</td>
<td>Deforestation; soil erosion; limited access to potable water; water-borne diseases.</td>
<td>Land clearance; shifting cultivation.</td>
</tr>
<tr>
<td>Malaysia</td>
<td>Urban air pollution; water pollution; deforestation; loss of biodiversity; loss of mangrove habitats; national and transboundary smoke/haze.</td>
<td>Vehicular congestion and emissions; deficiencies in urban infrastructure and municipal effluents; extensive land clearance and forest fires for pulp wood and oil palm production; unmanaged coastal developments; tourist developments in coastal regions beyond existing carrying capacity.</td>
</tr>
<tr>
<td>Myanmar</td>
<td>Deforestation; soil erosion, loss of biodiversity; urban air pollution; soil erosion; water contamination and water-borne diseases.</td>
<td>Land clearance; excessive mineral extraction; vehicular congestion and emissions; deficiencies in urban infrastructure – unmanaged industrial and municipal effluents.</td>
</tr>
<tr>
<td>Philippines</td>
<td>Deforestation in watershed areas; loss of biodiversity; soil erosion; air and water pollution in Manila leading to waterborne disease; pollution of coastal mangrove habitats; natural disasters (earthquakes, floods).</td>
<td>Illegal forest cutting; land clearance; rapid urbanization and deficiencies in urban infrastructure - unmanaged industrial and municipal effluents, inadequate water supply and sanitation; tourist developments in coastal regions beyond existing carrying capacity.</td>
</tr>
<tr>
<td>Singapore</td>
<td>Industrial pollution; limited natural fresh water resources; waste disposal problems.</td>
<td>Seasonal smoke/haze; limited land available for waste disposal.</td>
</tr>
<tr>
<td>Thailand</td>
<td>Deforestation; loss of biodiversity; land degradation and soil erosion; shortage of water resources in dry season and flooding in rainy season; conflict of water users; coastal degradation and loss of mangrove habitat; urban air pollution; pollution from solid waste, hazardous materials and hazardous waste.</td>
<td>Sporadic development and destruction of watersheds; unmanaged aquaculture; tourist growth exceeding growth in carrying capacity; deficiencies in urban &amp; rural infrastructure; freshwater resources polluted by domestic / industrial wastes &amp; sewage runoff.</td>
</tr>
</tbody>
</table>
Table 3 provides the key issues in terms of environmental degradation and gives the main reasons of these soil degradations. As far as agricultural soils are concerned the main cause of degradation is soil erosion due to important rainfall occurring on bare soil either after slash & burn or after land ploughing on steep soils mainly where commercial mono-cropping is practiced. Ploughing on steep slopes and foothills is largely practiced as it is often included in a global package proposed by traders in which credit, hybrid seeds and chemical inputs are supplied in exchange for grain production.

**Climate Change:**
The vulnerability to and the impact of climate change are major concerns for South East Asia. The Fourth Assessment Report of the Intergovernmental Panel on Climate Change, (IPCC, 2007), mentioned that warming of the climate system is evident from observations of increases in global average air and ocean temperatures. Since IPCC’s first assessment report in 1990, assessed projections have suggested that global average temperature increases between about 0.15° and 0.3° Celsius per decade for 1990 to 2005.

The IPPCC reports that, without further action to reduce greenhouse gas emissions, the global average temperature is likely to rise by a further 1.8°C to 4°C this century, and by up to 6.4°C in the worst case scenario. This projected global warming is likely to trigger serious consequences for humankind and for other life forms, including a rise in sea levels of between 18 and 59 cm which would endanger coastal areas and small islands, as well as a greater frequency and severity of extreme weather events. South East Asia is highly vulnerable to climate change as a large proportion of the population and economic activities are concentrated along coastlines. The region is heavily reliant on agriculture for livelihoods and the level of extreme poverty remains high.

**Soil Acidity (Thomas Dierog et al, 2001: “A toolkit for acid, upland soil fertility management in South East Asia”)**
About 21% of the lands in South East Asia (91M ha) is used for agriculture. Approximately 36% (33M ha) is classified as lowlands and 64% (58M ha) as uplands. These uplands represent the greatest potential for agriculture production despite the fact that most of they are made up of acid soils (table 4). Due to their low fertility status, only 20% of the uplands are at present being used for agriculture and characterized by diverse unstable agricultural systems. These areas often have poor infrastructure that limit farmers’ access to agricultural inputs which would be necessary to improve productivity.

### 5.1.2. Conservation Agriculture practices to restore soils fertility in degraded areas

**Soil erosion control** in sloping areas is a major issue in South East Asia, notably when land preparation is based on soil tillage. Amongst the different existing conservation tillage technologies (e.g., mulching, contour hedgerow systems, natural vegetative strips, strip tillage), crop residue retention is that which requires the least labour (Garrity, 1996), while having a significant impact in reducing runoff and sediment yields (Valentin et al., 2008). In sloping and soil tillage-based areas, no-till and crop residue retention are alternatives to tillage for limiting soil erosion.
The ten-year experiment in South East Asia with Conservation Agriculture has confirmed that soil organic carbon content was directly linked to land preparation (less C mineralization under no-tillage) and the biomass quantity returning to the soil (Lienhard et al., 2013). A basket of CA technologies, including zero and reduced tillage, direct seeding and residue management, has been developed and tested in different countries. Promising results were obtained in (i) regenerating fertility to degraded soils, (ii) providing livestock with high quality forage and (iii) increasing soil carbon sequestration. Despite these promising results their dissemination has been limited. Lestrelin et al. (2012b, 2012c) have shown that the innovation process was hindered by multiple stakeholder strategies that needed to be fully understood and disentangled before new practices could be widely adopted. It was already mentioned (see 4.2) that Conservation Agriculture techniques promote carbon fixation in organic matter accumulated in the soil.

In degraded acid and weathered savanna soils (Northern Laos) significant gains in economic returns can be obtained when initial investments in machinery and fertilizers are made (Lienhard et al., 2008).

In the highly degraded poor and acid sandy soils of the Savannakhet plain of Laos with its acid soils derived from sandstone and a pH of around 4-5 and often aluminum toxicity, CA techniques of no-tillage, rice direct seeding and rotation with legumes and forage grasses have increased paddy rice production with forage production allowing beef fattening activities during the rainy season (Legoupil et al., 2010-2013).

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Table 4: Extent of acid soils in South East Asian counties (www.fao.org) in 000 ha

<table>
<thead>
<tr>
<th>Country</th>
<th>Total Land area</th>
<th>Lowlands area</th>
<th>% of total area</th>
<th>Acid soils areas</th>
<th>% of total area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brunei</td>
<td>527</td>
<td>2</td>
<td>0.4</td>
<td>467</td>
<td>88.6</td>
</tr>
<tr>
<td>Cambodia</td>
<td>17,652</td>
<td>1,726</td>
<td>9.8</td>
<td>10,565</td>
<td>59.9</td>
</tr>
<tr>
<td>East Timor</td>
<td>1,487</td>
<td>30</td>
<td>2.0</td>
<td>274</td>
<td>18.4</td>
</tr>
<tr>
<td>Indonesia</td>
<td>181,157</td>
<td>8,863</td>
<td>4.9</td>
<td>122,289</td>
<td>67.5</td>
</tr>
<tr>
<td>Laos</td>
<td>23,080</td>
<td>448</td>
<td>1.9</td>
<td>19,009</td>
<td>82.4</td>
</tr>
<tr>
<td>Malaysia</td>
<td>32,855</td>
<td>606</td>
<td>1.8</td>
<td>26,185</td>
<td>79.7</td>
</tr>
<tr>
<td>Myanmar</td>
<td>65,755</td>
<td>3,893</td>
<td>5.9</td>
<td>40,642</td>
<td>61.8</td>
</tr>
<tr>
<td>Philippines</td>
<td>29,817</td>
<td>3,254</td>
<td>10.9</td>
<td>13,743</td>
<td>46.1</td>
</tr>
<tr>
<td>Singapore</td>
<td>60</td>
<td>2</td>
<td>3.3</td>
<td>42</td>
<td>85.0</td>
</tr>
<tr>
<td>Thailand</td>
<td>51,089</td>
<td>8,242</td>
<td>16.1</td>
<td>38,630</td>
<td>75.6</td>
</tr>
<tr>
<td>Vietnam</td>
<td>32,549</td>
<td>5,843</td>
<td>18.0</td>
<td>23,317</td>
<td>71.6</td>
</tr>
<tr>
<td>Total SE Asia</td>
<td>463,029</td>
<td>32,909</td>
<td>7.1</td>
<td>295,163</td>
<td>63.7</td>
</tr>
</tbody>
</table>
5.2. Second challenge: Providing alternatives to Slash & Burn – Intensification and diversification of existing farming systems in the uplands (rain fed rice-based systems, commercial mono-cropping system)

5.2.1. Existing farming systems in the “uplands”

Rice is the staple food grain produce in South East Asia, with around 50% of all agricultural land devoted to its cultivation. Farmers have made great progress during the past decade in improving average rice yields and modestly expanding crop areas. However, present food security is highly tenuous given that surplus rice production occurs mainly in lowland areas. The highland regions are still largely deficient in staple food grain production.

Highland areas represent large surfaces in South East Asia. Most of these areas are subject to a tropical monsoon climate with two distinct wet and dry seasons, the wet season occurring between May and November. It has been estimated that 70% of highland areas has a slope of greater than 20%, which precludes its use for permanent agriculture. Most farmers live in subsistence conditions, with very little production being marketed off the farm. Oil seed, pulses, root crops, fruits, vegetables, coffee and tea are the other crops.

Rain fed rice-based farming systems
The traditional highland/upland farming system is called “shifting cultivation” or “slash & burn”, where land is cleared of forest or scrub annually, then traditionally planted in rice with the use of a dibble stick. Historically, rice was grown for a single season on a plot of land cleared from the forest and then left fallow for a long period (10-20 years). For different reasons such as limitation of allocated land to farmers, demographic pressure, and extension of commercial mono-cropping… the fallow period has been drastically reduced to 3 years or less, leading to erosion, loss of fertility and declining production. A short-fallow farming system is simply not sustainable. Farming production systems still rely mainly on upland rice production under slash & burn techniques and cattle production (free grazing in forests and fallow areas), but the recent development of corn production often in mono-cropping, at the expense of former upland rice and fallow areas, is becoming economically increasingly important. Reduction of grazing areas has resulted in the decrease of the cattle stock. Producers have sold their cattle to develop corn production and such business activities as agricultural services and transport.
Commercial mono-cropping

Despite government policy to curb slash & burn cultivation to preserve forested lands, the aggregate agricultural land area in the uplands has actually increased owing to a surge of cash crop cultivation. In the provinces linked with transboundary markets and commercial exchanges, the rural economy is presently based on the production of cash crops. These cash crops are grown under contract for export markets.

The early integration to markets, led farmers to clear most of the communal forest areas and mobilize land more than 20 years ago (private land ownership and land titling process) and develop these new farming systems based on cash crop production. As a result, most of the forest areas have disappeared and the development of extensive livestock production systems is thus limited by a minor extension of the remaining forest areas, as forests are also used as grazing areas. These farming systems are completed by legumes, cassava, Job’s tear and mainly paddy rice systems in the lowland areas and some upland rice production mainly for farmers who have little or no access to paddy fields.

As a result of the increasing demand for land to produce both staple food grains such as rice and export products such as commercial crops, rubber or timber, the total forest area has significantly declined. The absence of diversification as well as the use of mechanized tillage practices have gradually resulted in decreased levels of soil fertility and soil degradation. The development of legume production systems in association or rotation with cash crops has always been limited by market demand and labour constraints. More recently in some areas farmers have developed other cropping systems such as cassava, which are more adapted to poor soils.

The development of farming systems based on cash crop production has been facilitated by the development of the private sector, with traders supplying seeds, inputs, services such as land preparation, credit and marketing. This dynamic has led farmers to a total dependency toward traders who are sometimes the unique actors in the rural areas to be able to deliver these services. Some farmers are now engaged in a cycle of indebtedness and decapitalization due to high interest rates, which range from 30% to 40% per annum. As a result, this farming system has generated a very high level of socioeconomic differentiation, in spite of an important increase of the average rural incomes, based mainly on:

• Access to equipment (tractors, trucks and two-wheel hand-tractors);
• Level of financial capital for covering the production costs; and
• Livestock capital.

5.2.2. Conservation Agricultures practices to intensify and diversify conventional farming systems

In order to overcome problems related to soil degradation and soil fertility decreases linked to the traditional slash and burn system and the recent development of mono-cropping cash crops, some projects in Laos, Vietnam and Cambodia (Slaats & Lestrelin, 2009) have developed since 2002, alternative techniques based on CA including direct seeding, management of crop residues and crop diversification through legumes production in association or rotation with corn. These projects have produced interesting results at the farm level in terms of the adoption of these techniques as well as economic and ecological benefits.
Farming systems that successfully integrate crop and livestock enterprises stand to gain many benefits which can in turn have a direct impact on agricultural production. Conservation Agriculture practices require a critical level of crop residues and cover crops to maintain or enhance soil chemical, physical and biological properties as well as prevent land degradation. Crops and livestock compete for the same resources, and require proper management to meet CA objectives. Farming systems that successfully integrate crop and livestock enterprises stand to improve synergies that directly impact production and agroecological efficiency offering numerous advantages such as: income diversification through animal products such as milk, meat, fibre and manure, weed control, soil erosion control, increased yield of main crops and incomes during the “start-up” period for tree crops (Sánchez, 1995).

The appropriate management of livestock is a key issue for improved productivity of grain production and even for livestock itself, by improving the sources and quality of feed, and indirectly improving the soil. In order to achieve this, the following practices are emphasized:

- **Not over-stocking**, but keeping a number of animals according to land availability and forage production capacity, balancing biomass production and consumption throughout the year. This will avoid overgrazing and maintain adequate soil coverage;
- **Increased land use intensity** by the establishment of fenced areas for the production of grasses and legumes for different uses: cutting, grazing, silage, hay, and for corrals; and
- **Controlled grazing** with rest periods which allow pasture recovery. However the investment for pasture division and rotational grazing is a real constraint.

Unfortunately, the dissemination of these new techniques is slow and a significant number of farmers have abandoned these systems due to several constraints: (i) lack of access to credit, suitable equipment and markets for legumes; (ii) lack of technical support from government; and (iii) lack of farmer or village crop and animal management organizations. On the other hand, an example of a “Development Fund for Sustainable Agriculture” has been implemented in Sayaboury, Lao PDR, (see Box 3). Based on a tax of 10 Lao Kip/kg on exported corn, the fund provides financial and technical support to farmers. This initiative has enabled it to facilitate the establishment of a favourable socioeconomic context through strong links between farmers and traders for credit, market and equipment access, which will be essential in developing similar adoption dynamics for more sustainable cropping systems using direct seeding techniques and promoting diversified production.

### 5.3. Third challenge: Develop capacity for “Human Resources Development” to address the needs of all CA development and dissemination actors.

#### 5.3.1. The present context

Training is a central issue for Conservation Agriculture and agroecology. The development of farming systems which are more intensive and more respectful of natural resources and the environment requires the acquisition of new stakeholder knowledge and skills, since stakeholders will be called upon to trigger these changes. The lack of resources and training managers on these issues is often mentioned as a key sticking point to further development.
R-D projects have specific objectives to transfer the knowledge and know-how they gain during project implementation to existing national institutions. To be effective, this transfer simultaneously requires a capacity building program in the area of professional training and communication. Different groups of actors such as farmers, extension agents, researchers, and technicians from national organizations must acquire competence to efficiently manage their new professional responsibilities. Capacity building is a long process which requires adequate human resources and financial means.

This training strategy is not only an accumulation of training sessions, field visits and other activities. It is a permanent attitude aimed at acquiring and assimilating knowledge and know-how. This will result from three types of actions: i) facilitating information access; ii) creating and supporting collective thinking during all the steps of program implementation; and iii) organizing training sessions to cover the technical, management and legal aspects of CA implementation.

**International CA training cooperation:**
At the regional level there are no academic or even technical offers in terms of agroecology and/or Conservation Agriculture. Several years ago a training offer was made by the University of Ponta Grossa (UEPG-Brazil). This initiative has been supported by various Brazilian research and extension organizations. The UEPG benefits from the university structures and has been developing specific curricula on CA and direct seeding since 1984. Six international training sessions were organized between 2006 and 2011 thanks to support from the “Multi Country Project for Agroecology–PAMPA”. These courses have so far trained 78 agronomists, researchers, and academics involved in the field of CA. These researchers came from 12 countries, including Cambodia, China (Shanghai and Yunnan), Laos, Thailand and Vietnam.

**Technical training in Laos:**
To meet the challenge of sustainable agricultural intensification in Laos, the Centre for Research and Training in Conservation Agriculture (CERFAC) in Ban Poa (Xieng Khouang Province) was created in 2007. The aims of the CERFAC Ban Poa Centre are:

- Training and awareness for a wide audience of students, technicians, farmers and policy makers. The centre began to assume a regional role of exchanges in the framework
of the CANSEA network. In 2011 Chinese technicians from the Yunnan Province and in 2012 Vietnamese technicians were received for general training in CA-DMC techniques; and
- Conducting innovative research to support the training program, including the development of ecologically more intensive innovative farming systems, based on CA principles.
- The training program of CA techniques includes the following modules:
  o Module 1: Soils and soil fertility management;
  o Module 2: Impact on the environment of different soil preparations;
  o Module 3: Integrated weed management - Knowledge and good practices for herbicides;
  o Module 4: Conception and optimization of CA farming systems;
  o Module 5: Growth and management techniques of the main commercial crops;
  o Module 6: Knowledge of forage species: implantation and management techniques;
  o Module 7: CA agricultural equipment diversity and use;
  o Module 8: Improving animal husbandry systems; and
  o Module 9: Monitoring and Evaluation Indicators. Nutrient requirements of edible crops, mineral fertilizers and fertilization.

5.3.2. Short terms perspectives

*Sensitization and Awareness training sessions in agroecology and Conservation Agriculture in the Kasetsart University of Sakon Nakhon (Thailand)*

“The French Development Agency (AFD)” and the “Thailand International Cooperation Agency (TICA)” are proposing the implementation of a three-year program of training sessions in the principles and techniques of agroecology and Conservation Agriculture. This program aims to raise awareness and training for technicians and decision-makers from Thailand, Laos, Cambodia and Myanmar. Each of the two agencies (AFD and TICA) has agreed to invest in a three-year program with two annual training sessions regrouping around 30 technicians each.

*Cooperation development between training institutions from Brazil, France and Thailand*

Funding was obtained in 2012 for the development of partnerships between universities, research institutes and training organizations from the North (UEPG Brazil, IRC and CIRAD in France) and from the South (training partners in agroecology and Conservation Agriculture) to facilitate the exchange and transfer between institutions aiming at the long-term development of university curricula. Kasetsart University was selected as the regional pilot University for South East Asia.

6. Implementing the CANSEA strategic plan

The CANSEA network operation required strong and active national CA programmes. CANSEA aims to develop at national level R-D projects, which meet the national priorities, have regional interest and are consistent with its vision, mission and value proposition. CANSEA is committed to improving the ability of CANSEA's partners to promote, develop and disseminate CA throughout the region. It does this by providing a strategic platform in order to
provide them with wider perspectives. The network’s overarching function is to enable the different actors to apply their comparative advantages to best effect by collaboratively addressing region-wide issues and opportunities. Greater collaboration between national and regional partners helps create a critical mass to collaborate on common priorities and the agenda with South Asian partners as well as capture economies of scale.

Table 5 shows how the CANSEA strategy areas link to, and are coherent with, national interests for defining common priority objectives. This demonstrates the clear opportunities and entry points for CANSEA members to cooperate with each other.

| Table 5: Interactions between CANSEA’s strategic topics and geographical areas |
|-----------------------------------------------|-----------------------------------------------|-----------------------------------------------|
| Fertility restoration of degraded areas (Erosion – Acidity) | Intensification Diversification of traditional farming systems | Human Resources Development |
| Traditional rain fed agriculture in Mountainous areas | - Acidity of mountain soils (Acrisols) | Intensification Diversification of subsistence rain fed and rice based farming systems | Academic training with: |
| Slash & Burn systems | - Water erosion of steep lands | | - National Agricultural faculties |
| | | | - Specific regional role of Kasetsart University |
| Commercial Agriculture Cash crops | - Water erosion of steep lands | | Technical training for CA practices with: |
| Monocropping systems in steep lands | - Soil fertility | | - Network of national institutions |
| | | | |
| Large plains with soil fertility problems | - Soil acidity (Sandstone) | Intensification Diversification of conventional farming systems linked to markets | |
| | - Salinity | | |
| | - General fertility problem | | |

6.1. A network of Research-Development projects in permanent construction

6.1.1. The present situation

Even though Conservation Agriculture appears to meet the ecological intensification challenges of agricultural production in the South-East Asian context, the development and dissemination of new CA farming systems was mainly due thanks to the implementation of national projects led by National Agricultural Research Institutions.

Essentially these were projects for the development and dissemination of CA systems based on CA principles and techniques. The sector-based Project to Support Agroecology (PROSA) in Laos was providing institutional support to the Ministry of Agriculture and Forestry for the development and dissemination of agroecology and Conservation Agriculture and preparing the implementation and management of a regional CA network for South East Asia (CANSEA).
All these projects have involved CIRAD as their French scientific partner providing technical assistance and capitalized results. A scientific collaborative program was implemented with Kasetsart University of Sakon Nakhon (KU-CSC) and with the Land Development Department (LDD) in Thailand.

In addition to these national projects, the AFD has also provided additional support through the Multi-Country Program to Support Agroecology (PAMPA). This cross-functional project is aimed at: i) strengthening scientific topics such as carbon and organic matter balance; ii) capitalizing on different national experiences; and iii) promoting exchanges of experiences and communication. This multi-country project involved other partners, including the French Institute of Research for Development (IRD), and the Brazilian University of Ponta Grossa (UEPG).

Despite these investments and a CA concept which is widely shared by the international community recognizing the need to re-invent sustainable patterns of growth for agriculture, Conservation Agriculture does not actually benefit from political and financial support or the commitments necessary for its advancement.

6.1.2. The perspectives

National projects:
The priority is to maintain, on a sufficiently long term basis, existing experimental sites that could also be used to train staff and demonstrate CA potential. Long term experiments are the only way to secure an unambiguous impact analysis of CA practices on parameters such as soil fertility and carbon sequestration. Donors are not able or do not wish to be committed in the long term to extend these experiments. Only a national commitment could secure both experiments and the land needed for those experiments.

The ADAM project in Vietnam and the PADAC project in Cambodia will be able to use the available resources from their budget in order to maintain their activities for one or two years. In Laos two new projects will be initiated at the end of 2013 for a four-year period. One is funded by AFD and the other by the European Union. These two projects will ensure R-D activities within the country.

Regional projects:

Expected regional projects are the following:
1. The French Development Agency (AFD) has agreed to continue its support for the development of agroecology in general and Conservation Agriculture in particular in South East Asia through a grant to support regional cooperation in order to: i) Strengthen the management capacity of the CANSEA regional coordination; ii) Facilitate the emergence of new initiatives; and iii) Promote, though a competitive grant system (CGS), research activities which are important at national level while having strong regional interest.
2. The AFD and the “Thailand International Cooperation Agency (TICA) have proposed (see 5.3.2) supporting a three-year program of sensitization and awareness training sessions on the principles and techniques of agroecology and Conservation Agriculture.

3. A Bilateral cooperation project between Laos and Thailand has been submitted for funding to the Thailand International Cooperation Agency (TICA). The 2014-2017 project aims to strengthen both the Lao CA research institution and Kasetsart University of Sakon Nakhon to implement R-D projects to: i) restore the fertility of acidic soils, which are widespread on both sides of the border; and ii) intensify and diversify conventional rain fed rice-based farming systems in the Savannakhet plain in Laos and in the North East Region (NER) of Thailand.

4. As part of the Phase 2 of the Core Agriculture Support Program (CASP 2 funded by Swedish cooperation – SIDA, and managed by the Asian Development Bank), CANSEA has prepared and submitted a consolidated regional project to include Cambodia, China (Yunnan), Laos, Thailand and Vietnam. CASP phase 2 proposes new strategic directions to address emerging challenges to agricultural development, specifically the degradation of natural resources and “climate change adaptation”.

The proposed regional CASP-ADB program to develop and disseminate Conservation Agriculture will be composed of:
- Five national components (Cambodia, China – Yunnan, Laos, Thailand and Vietnam) previously harmonized to be complementary at the regional level; and
- A regional coordination implemented by the CANSEA Network with technical assistance from CIRAD (Centre de Coopération Internationale en Recherche Agronomique pour le Développement).
Proposed CA research and experimentation will be conducted in the following locations:

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5. During the 34th meeting of the ASEAN Ministers of Agriculture and Forestry (AMAF, 27 September 2012, Vientiane, Lao PDR), “The Senior Officials Meeting (SOM) of the AMAF welcomed the Lao PDR’s initiative to launch and coordinate an initiative to develop and disseminate Conservation Agriculture in the ASEAN region as an “Eco-friendly and Climate –resilient agriculture Intensification in ASEAN region”. Considering the cross-cutting nature of the initiative and potential benefits to enhance cooperation under AMAF +3, Lao PDR and CANSEA were requested to organize regional consultations and develop a detailed proposal.”

6Association of South East Asia Nations.
7SOM-AMAF Plus Three chairman’s report to the 12th meeting of AMAF Plus Three.
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<th>Network</th>
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<th>Projects</th>
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| CANSEA  | Cambodia  | PADAC (2004-2013) | - Design, test and promote of CA technologies as sustainable ways to increase annual rain fed conventional farming systems  
- Conservation of germplasm, and seed multiplication;  
- Network of farmers reference to test and validate CA proposals.  
- Restoration of Soil fertility in degraded areas (mono-cropping of Cassava);  
- Analysis of the effects of crop residues to organic and carbon balances. | With the support of Cirad, CANSEA and other donors the remaining funds allow to extend the project for 2 years (2014-2015) | CANSEA Strengthening (AFD funding)  
- Improve management capacity;  
- Facilitate emergence of new programmes/projects;  
- Support research activities through a Competitive Grant system |
|        | Laos      | Component (NUDP project) | - Development of new diversified Conservation farming systems that contribute to improve rural conditions in mountainous areas of the Northern Laos | Development of new sustainable and eco-friendly farming systems | ADB-GMS & ASEAN  
Regional initiatives to promote CA development and dissemination within the region |
|        |          | EU Project Climate change | - Development of new CA innovative farming systems more resistant/resilient to climate change.  
- Engage local communities in designing low-carbon emission strategies at landscape level through participatory processes. | | Bilateral Lao-Thai project (TICA funding)  
to restore fertility of acidic soils in Savannakhet (Laos) and NER (Thailand) |
|        | Thailand  | Kasetsart University | - Development of a soil biology laboratory (macro fauna, soil microflora) and research on the impact of vegetation cover on macro fauna. | Continuation + New coopération with the Land Dev. Depart. | Cooperation to be developed with:  
ICRAF, CIAT, University of Queensland and SEARCA |
|        | Vietnam   | ADAM | - Adaptive design, evaluation and dissemination of CA for sustainable development of mountain tea-based farming systems in Vietnam. | Remaining funding will allow to extend the project for 1 year | |
|        | China (Yunnan) | YAAS-AERI | - Management of natural resources and fertility restoration of acid soils. | Locally funded activities to develop new CA innovative farming systems | |
|        | ASEAN Philippines | Mindanao Project | - Development of new CA innovative farming systems on steep lands to restore the agriculture after typhoons’ damages in 2011 & 2012. | National funding through an AFD loan From 2014 | |
6.2. A participative global approach “Diagnosis, Design, Assessment, Training & Extension” (DATE) applied to agricultural engineering for CA development and dissemination

In the adopted approach, the socio-economic and environmental agronomic performance of a diverse range of innovative cropping systems are tested and compared with conventional practices. This is an iterative multi-stakeholder participatory approach (co-designed with validation loops and re-designed), which integrates science, expertise and local knowledge (Figure 2). This iterative process can gradually improve farming systems and the “step-by-step” design is conducive to learning while taking only moderate risks. It lends itself well to gradual farmer mobilization.

**Diagnosis** will be implemented through the Participatory Land Use Planning – PLUP (see box 4). The diagnosis is made with the various stakeholders from the analysis of the main constraints, opportunities, practices and local knowledge acquired, and will allow us to define further specifications. This in turn sets objectives and criteria for evaluation. A range of crops and CA practices is then designed for experimentation.
An experimentation station will be set up in each target area to be used to develop different innovative agroecological systems derived from the diagnosis (PLUP) and also identify those which would be risky to test in pilot villages directly at the initial design stage. This reference site will show a large diversity of crops, techniques and tools. It will also become a training centre for projects and other local or national staff. They will learn by doing and be trained as trainers so as to be able to support extension activities in pilot villages.

Demonstration sites are embedded in the different land units delineated through the PLUP. This approach will be implemented and coordinated in close coordination with the beneficiaries. The project will support the inputs costs while part of labor costs will be provided by the beneficiaries.

Farmers innovation network will be developed in both pilot villages and other interested villages in coordination with extension services. Projects will support the innovation network by providing farmers with soft loans to cover part of their investment costs. Insurance mechanisms will be developed so innovating farmers will not lose their capital in the event of poor performance, destructive climatic events or unexpected pest damage.

These on-farm experiments and demonstrations will be one component of an innovation network managed by a consortium made up of multiple stakeholder groups including farmers’ groups, district officers, the private sector, etc. A description of the participatory innovation network is provided in Figure 3. However, the structure may vary from place to place depending on the institutional arrangements to be negotiated among consortium partners.

Figure 3. Stages and activities in the participatory innovation network
Box 4. Participatory Agriculture & Forest Land Use Planning (PLUP):

The term “PLUP” is used to indicate the process of Land Use Planning at village and village cluster levels with the active participation of villagers. The PLUP process includes 9 stages, which guide the implementing teams. Although these 9 stages include land registration (stage 7), the implementation of PLUP commonly comprises only stages 1 - 5, focusing on “land zoning” and “agriculture and forest land management planning.”

Stage 1 of the PLUP process is the general “planning preparation”, including the preparation of activity and budget plans, the collection and procurement of necessary materials, general office preparations and first activities in the target village, such as staging a village orientation meeting and the formation of the Village Land Management Committee.

The Stage 2 is the collection of socio-economic data at village and household levels, follows in the target village.

The Stage 3 describes the delineation of village and cluster village boundaries – an important step -, which involves representatives of surrounding villages in order to find a common agreement on the boundary which is mapped, described and endorsed through signature by those concerned.

The Stage 4 is the village land use zoning, in which current and future land uses are identified and negotiated, verified through GPS ground survey and demarcated in a zoning map which is also transferred to a village sign board for public display.

The (commonly final) Stage 5 is the “land management planning” which concludes in the formulation of land management descriptions for each identified zone, as well as village agreements to clarify rules and obligations for the use of land.

A completed PLUP document comprises of the narrative activity report and the boundary and zoning maps, which are endorsed by signatures of the local and provincial authorities.

Stages 6 to 9 include “land data and digital map record keeping”, “land registration”, “village and village cluster networks and networking” and “monitoring and evaluation”.

6.3. Regional learning and training strategy

6.3.1. General objectives

Education is one of the three pillars on which the CANSEA partnership approach is built. Indeed, in the context of agricultural engineering, it is necessary to create favourable conditions for the transfer of knowledge and expertise to all partners. The main objective is to provide
support to both academic and professional training. The partners consist mainly of universities and specific institutions for professional training. The CANSEA network will enable economies of scale, as support will be given in priority to regional institutions which will in turn ensure better regional dissemination.

Training and transfer between countries and continents are unique experiences. They should permit, based on the development of partnerships between universities, research institutes and training organizations, the promotion of exchanges with greater systematic knowledge transfer in order to ensure the long-term development of university courses.

### 6.3.2. Academic Training

CANSEA has neither the mandate nor the capacity to conduct a full and multidisciplinary training program on its own. CANSEA will establish specific partnerships with national and regional institutions to define and implement academic and professional training. CANSEA will support the development of teaching tools, training videos, digital tools and quizzes in connection with experimental bases and research-development programs, as supports for research and education. The objective is to identify the experiences and skills of partners in teaching and research and to define a development strategy as well as a range of original training in the field of Conservation Agriculture and agroecology.

**The CANSEA strategy for the coming years will include the following steps:**

- Study the training needs, institutional partners and alliance strategies needed to develop the expected training offers in CA and agroecology;
- Analyze existing training and educational resources on CA in the target countries and on the Internet: content, pedagogical approaches, management training, and target audience; and
- Use available CA publications in the form of digital learning resources as key issues to build partnerships, share resources and gain visibility.

**The deliverables will be the following:**

- A strategy to build a range of consistent CA and agroecology training including: i) positioning and content; ii) teaching methods; iii) training management; and iv) a partnership business model;
- The preparation of online learning resources highlighting available CA high standard publications;
- The co-construction of teaching modules; and
- The implementation of the first stage of transfer, adaptation and appropriation of academic and technical materials.

### 6.3.3. Professional Training (awareness and technical)

The Centre for Research, Experimentation and Training in Conservation Agriculture (CERFAC) in Xieng Khouang Province in Northern Laos is becoming a major component of the South East Asian training platform. It has conducted eight-month long technical training
sessions for technicians and national students regularly since 2007. More than 150 technicians and students have been trained in CA at the centre. Field visits of technical information and thematic sessions of short-term training are also provided with over 2,000 days of field visits and 500 short sessions. CERFAC is expected to play a key role not only nationally but regionally as well.

7. The CANSEA Governance and Status

The strategic plan concerns CANSEA as a regional non-profit structuring organization for research institutions and/or CA dedicated actors. Network Members agreed to: i) share experiences and results; ii) define regional priorities and design corresponding R-D programs; and iii) research and mobilize funding to implement regional programs. CANSEA will allow members to do together that which can’t be achieved individually.

7.1. CANSEA’s Governance

7.1.1. The Steering Committee and its Presidency

The Steering Committee is in charge of the strategic governance of the CANSEA. The Steering Committee prioritizes and selects the different topics to be dealt with and the projects to be designed. The Steering Committee also contributes to the annual operational plan (AOP) and budget by providing information in respect with the current and foreseen scientific, educational and technical activities. This information is provided to the Coordinator who is responsible for preparing and presenting the AOP to the Steering Committee.

The President will chair the SC meetings; he facilitates the meeting of the SC and facilitates its decisions. Decisions are taken on the basis of the majority of all present members.

7.1.2. The CANSEA’s Regional Coordination (RC)

The Regional Coordination (RC) is in charge of the daily management of CANSEA. The main tasks of the CANSEA RC are to technically & scientifically follow-up projects implemented within the network framework. The RC drives the communication policy of the network through a web site. He contributes to the dissemination of the networks outcomes & outputs and represents the networks in meetings and workshops. The RC prepares the annual report on network activities to be submitted to the Steering Committee.

7.2. CANSEA’s Status

Presently the CANSEA network has no legal status. He is operating under the legal status of the institution which will accommodate and welcome the Presidency of the Steering Committee and its operation are guided by a MoU.

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8MoU Creating CANSEA (Set 2009).
In despite CANSEA is not an “operating agency” the absence of legal status is penalizing the network when the network has to receive and manage funds to: i) facilitate regional activities; ii) support specific actions in the framework of national or regional projects; or even iii) manage, competitive funds for research or development on behalf and for the account of “Donors”.

A first step toward legal recognition would be to get an ASEAN accreditation (Association of Southeast Asian Nations). This affiliation will bring a number of privileges including:

- To use the name “ASEAN” and display the official ASEAN emblem in communication and in official meeting so long as the displaying is non-commercial in nature. CANSEA might become the “ASEAN Conservation Agriculture Network - ACAN”.
- CANSEA-ACAN might submit its own project proposals for third part funding to be channeled through the ASEAN Secretariat.
- CANSEA-ACAN might submit written statements or recommendations and views on policy matter or on significant events or regional or international concerns, to the ASEAN Standing Committee through the ASEAN Secretariat.
- Subject to rules and regulations, it may be allowed use the facilities of the ASEAN Secretariat for its official meetings …
CANSEA’s 2014-2017 Strategic Plan reflects what CANSEA has learnt from consultations, workshops, meetings and day-to-day interactions with its members and other stakeholders in CA development and dissemination.

This Strategic Plan is based on CANSEA’s mission, vision and Value propositions which are to provide a strategic platform to foster regional networking that reinforces the capacities of South East Asian Research and Development national systems and sub-regional organizations.

The objective of the CANSEA network is to develop synergies in conducting research in the field of conservation agriculture. Regional priority issues addressed targeted are: (i) Development of systems of conservation agriculture intensification and diversification of mountain agriculture in South East Asia including the transfer and adaptation of direct seeding techniques for agricultural development, (ii) Improvement or restoration of fertility of degraded soils-Impacts of Conservation Agriculture techniques on improving physical and chemical characteristics of soils (Carbon and organic matter balances-Relationships between direct seeding, plant cover and biological soil quality; and iii) Human Resources Development with the definition and implementation of curriculum of academic and technical training meeting the needs and expectations of regional partners.

This demonstrates the fact that CANSEA is uniquely positioned to deliver the specified outputs and thus to achieve its objective of improving broad-based agricultural production, productivity, competitiveness and markets in South East Asia in a sustainable way.

Vientiane (Jeen-Claude Legoupil) Nov. 2013
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