


Improving Smallholder Livelihood and Soil Management in Laos through Conservation Agriculture and DMC systems

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Lao National Agro-Ecology Programme

Provincial Agriculture and Forestry Office
Xayabury and Xieng Khouang Provinces

- **Cases of Southern Xayabury and Xieng Khouang Province**
  - Why do we have to manage our soils differently?
- **About the Lao National Agro-Ecology Programme**
- **What is Conservation Agriculture & Direct Seeding Mulch Based Cropping Systems**
- **Examples:**
  - Implementation of DMC systems with small hold farms in Southern Xayabury
  - Regeneration of savannah grasslands in the vicinity of Phonsavanh
- **Challenges in scaling-up DMC systems**

Characteristics of Southern Xayabury and Xieng Khouang Province

Southern Xayabury

- **In Southern Xayabury** (Mekong corridor) where market forces are prevalent, shifting cultivation systems have given way to more conventional high input agricultural systems
  - ✓ High environmental and financial costs of the present agriculture production
  - ✓ Increasing use of pesticides is another major issue from this agricultural intensification. Herbicides are now widely used for land preparation after burning or ploughing, and for post-emergence application on maize




Environnemental, Social and economic costs

- ❑ Within a few years, this conventional land preparation generates heavy soil degradation, risks of pollution by misuse of pesticides and depletion of natural resources.
- ❑ Destruction of infrastructures: paddy fields, roads.
- ❑ Seasonal migration occurs due to collapsing livelihoods.

Xieng Khouang

- In Xieng Khouang Province, it is estimated that more than 60.000 ha of land (ecology of Plain of Jars) are 'under-utilized' by smallholders

Xieng Khouang

- In remote areas, the traditional swidden system, with long rotations, has been put under pressure due to modification of land access and increasing population pressure

Why do we have to manage our soils differently ?

- The soil is the base of the agro systems. It is not a renewable resource but a living system which can be irreversibly affected by unsuitable human interventions.

- Maintaining and enhancing productive capacity of the soil and preservation of natural resources is a crucial element for long-term improvement of smallholders' conditions and poverty alleviation (GoL, 2004).

Soil erosion after ploughing, southern Xayabury

Rationale management of the soil has to reach 4 main objectives

- **Contributing to self-sufficiency producing food for communities**
- **Producing agricultural products (for market) with minimum use of inputs**
- **Preserving soil potentialities**
- **Minimizing the effects on environment**

Promotion of Conservation Agriculture (CA) and DMC systems in Laos

About the Lao National Agro-Ecology Programme

- PRONAE is a partnership between NAFRI and CIRAD.
- It is funded by the French Government through the French Agency for Development (AFD), the French Global Environment Facility (FFEM) and the Ministry of Foreign Affairs.

About the Lao National Agro-Ecology Programme

PRONAE is a partnership between NAFRI and CIRAD

Three mains locations

- Southern Xayabury (2002) and Xieng Khouang Provinces (2003)

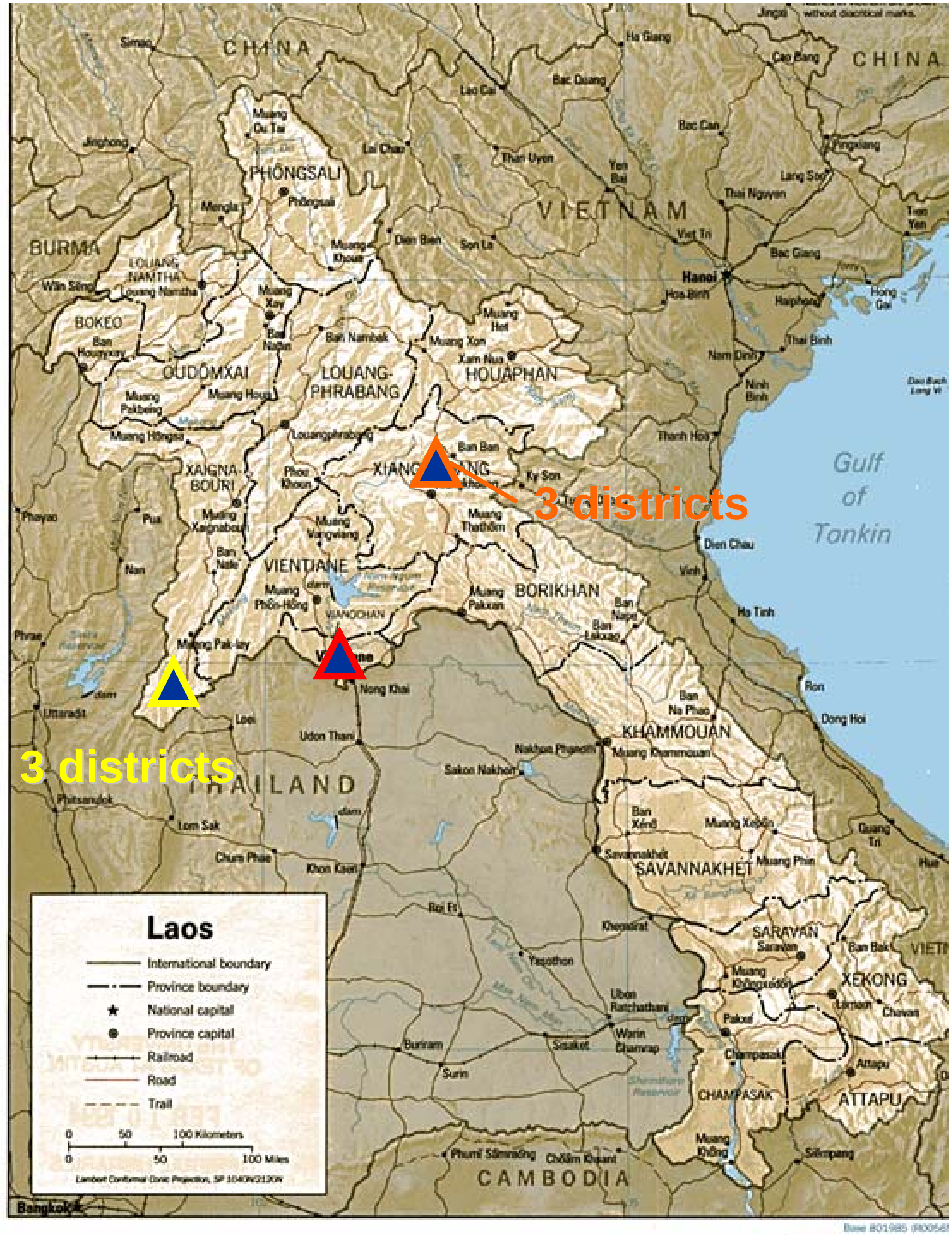
✓ 6 districts covering 12.000 km²

- Headquarter in Vientiane

Staff

- 44 permanent staff

✓ 33 agronomists - extensionists. 52% come from extension agencies at local level (PAFO-DAFO) and MAF



MSOffice21

Institutional framework

- **Agreement PRONAE – Provincial Agriculture and Forestry Office of Xayabury and Xieng Khouang Provinces**

- **Specific Agreement (2005-2008) with a Rural Development Project of Xayabury Province (PASS-PCADR)**

- **Contract for Consultancy services for NAFES and Nam Ngum River Basin Development Project**
    - Feasibility study to implement Conservation Agriculture in Nam Ngum River basin
    - Training of DAFEO staff on integrated approach and Conservation Agriculture
    - Demonstrations fields

Decentralization of research activities and permanent transfer from research to extension

MSOffice21 The institutional framework of this programme.
We have a memorandum of understanding between the Ministry of Agriculture and Forestry of Laos and CIRAD. This memorandum is essential in order to have an agreement for specific activities. So we have specifi agreement between NAFRI and CIRAD for the Lao National Agroecology Programme and as a mentionned before we define some specific and formal agreements between PRONAE and the Provincial Agriculture and Forestry Office of Xayabury and Xieng Khouang provinces.

We have also agreements with two divisions of NAFRI : the Agriculture Research Center and the Forestry Research Center
, 11/12/2005

Methodological framework

Approach characterized by 5 components

Initial assesment	Technical, economic and social assessment of farming systems, physical and human environments
Reference data acquisition	Long-term implementation to adapt systems to local conditions and to generate a large range of technologies Characterization for short, medium and long-term biological and physicochemical processes
Adaptation and validation with smallholders	On-farm implementation with farmers groups At landscape and village level: analyses of the conditions for adoption
Training and Information	Permanent training of smallholders, extension agents and researchers Information for policy-makers and stakeholders
Monitoring and Evaluation	Feed-back agriculture – development - research Dissemination process, transfer of information between stakeholders

Main Research and Development goals

- **Validation with smallholders of Direct Seeding Mulch-Based Cropping (DMC) systems for the Mekong Corridor**
- **Regeneration of altitude plains (Plain of Jars, Xieng Khouang Province)**
- **Diversification and Stabilization of swidden systems**
- **Diversification and integration between cropping (annual and perennial) and livestock production**
- **Alternative DMC systems for the upper terraces on lowland**

Research topics

Reference data acquisition

- Long-term implementation to adapt systems to local conditions and to generate a large range of technologies
- Characterization for short, medium and ‘long-term’ biological and physicochemical processes:
  - ✓ Productivity (grain, straw, roots)
  - ✓ Chemical, physical and biological soil (Kasetsart University, Federal University of Ponta Grossa - Parana) characteristics
  - ✓ Changes in flora (EU-OSWALD)
  - ✓ Externalities: soil, water and nutrients losses, xenobiotics pollution

Policy support

- **Decree of the Ministerial Council (April 2005) and of the Ministry of Agriculture and Forestry (May 2005) to promote Conservation Agriculture and Direct Seeding Mulch-Based Cropping Systems in Laos.**

What is Conservation Agriculture?

Permanent soil cover

No soil disturbance

Diversified crop rotations


Residue retention distinguishes Conservation Agriculture from conventional farming systems, which are characterized by leaving the soil bare and unprotected, exposed to climatic agents.
The soil cover is not incorporated into the soil by tillage.
FAO, 2002

Principles & Definitions

Sesame crop on rice-bean residues

Peanut on *B. ruziziensis* mulch

- **The main principle is that the soil is no longer disturbed by mechanical action (ploughing, hoeing…) and always kept covered by crop residues and cover crop**

Principles & Functions

Sowing machine for tractor (Knapik, 4 sowing lines)

Hand-jab seeder

- **Mechanical action on soil are performed only for sowing by the use of specific equipments (sowing machine with cutting disks)**

Principles & Functions

Brachiaria ruziziensis

Eleusine coracana – Finger millet

- **Mechanical actions (hoeing, ploughing) are replaced by biological improvement of soil structure by rooting systems of relay crops**

Principles & Functions

Maize + [*B. ruziziensis* + *C. cajan*]

- ❑ **Spatial and temporal diversified schemes (rotations, association, annual crop sequence) are provided in order to increase farming incomes by reducing cost production and climatic risks**

Principles & Functions

Cattle fattening in Xieng Khouang, Plain of Jars

- ❑ **Nutritional function for livestock by rational use of fodder**

Principles & Functions

Maize direct seeded on *Vigna umbellata* residues

Vigna umbellata direct seeded on Job's tears residues

- ❑ **Nutritional function for the main crop via mulch mineralization**

Principles & Functions

- Integrated management of weeds through shade and/or allelopathic effects

Rice-bean direct seeded on Maize+*B. ruziziensis* mulch

Principles & Functions

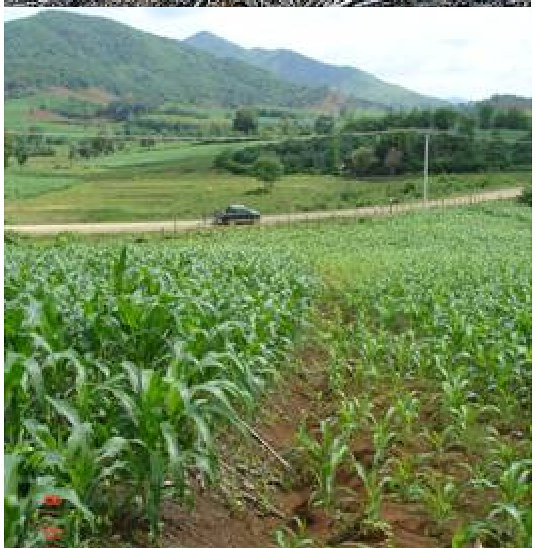
Deep and strong rooting systems of *Eleusine coracana* (finger millet) and *Cajanus cajun*

- ❑ **Recycling nutrients and water leached deep into the soil below soil layers used by cash crops or rice by deep rooting systems of the cover crops**

Principles & Functions

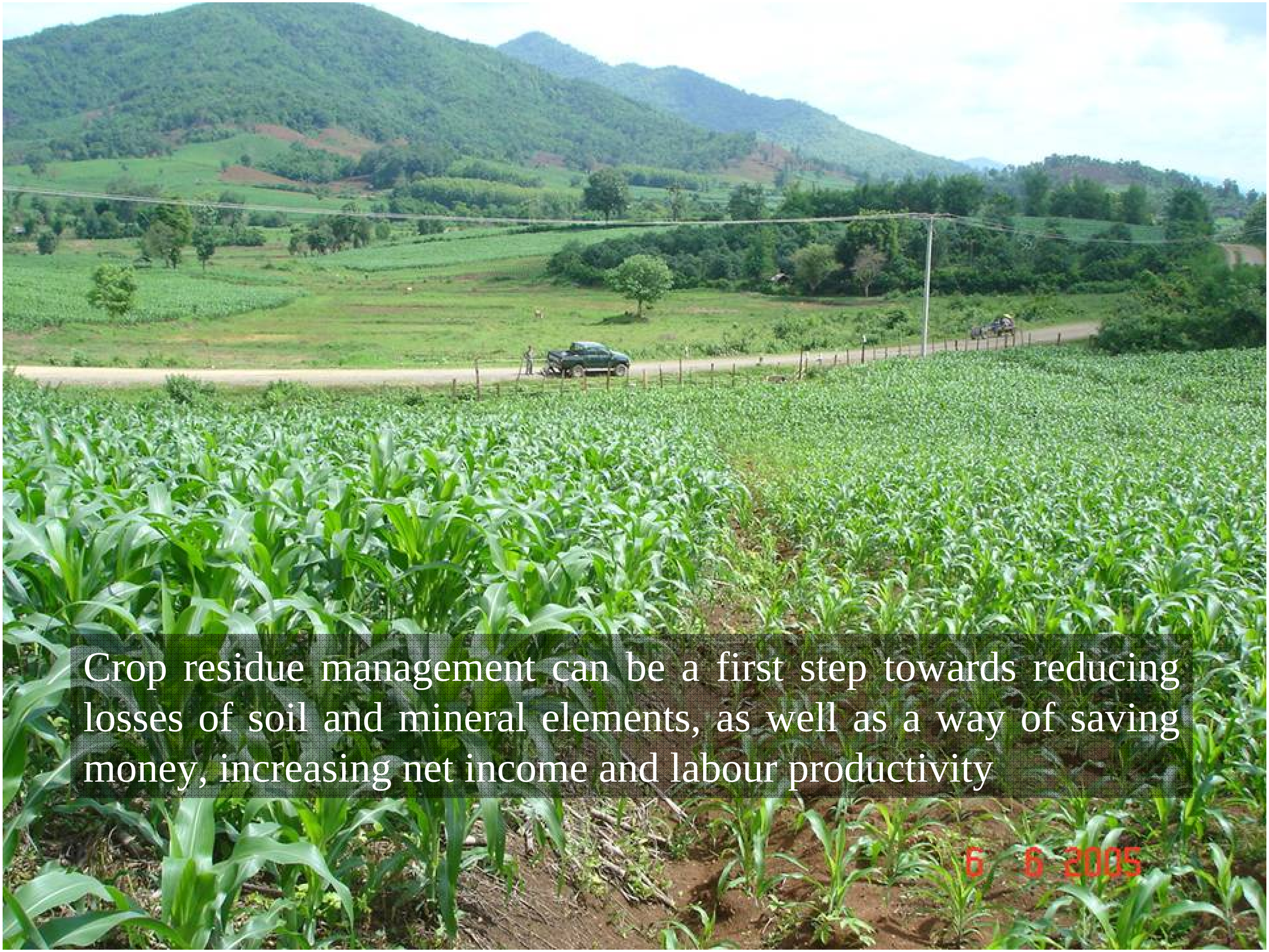
- An organic skeleton to maintain the soil constituted by the rooting systems and by biological activity

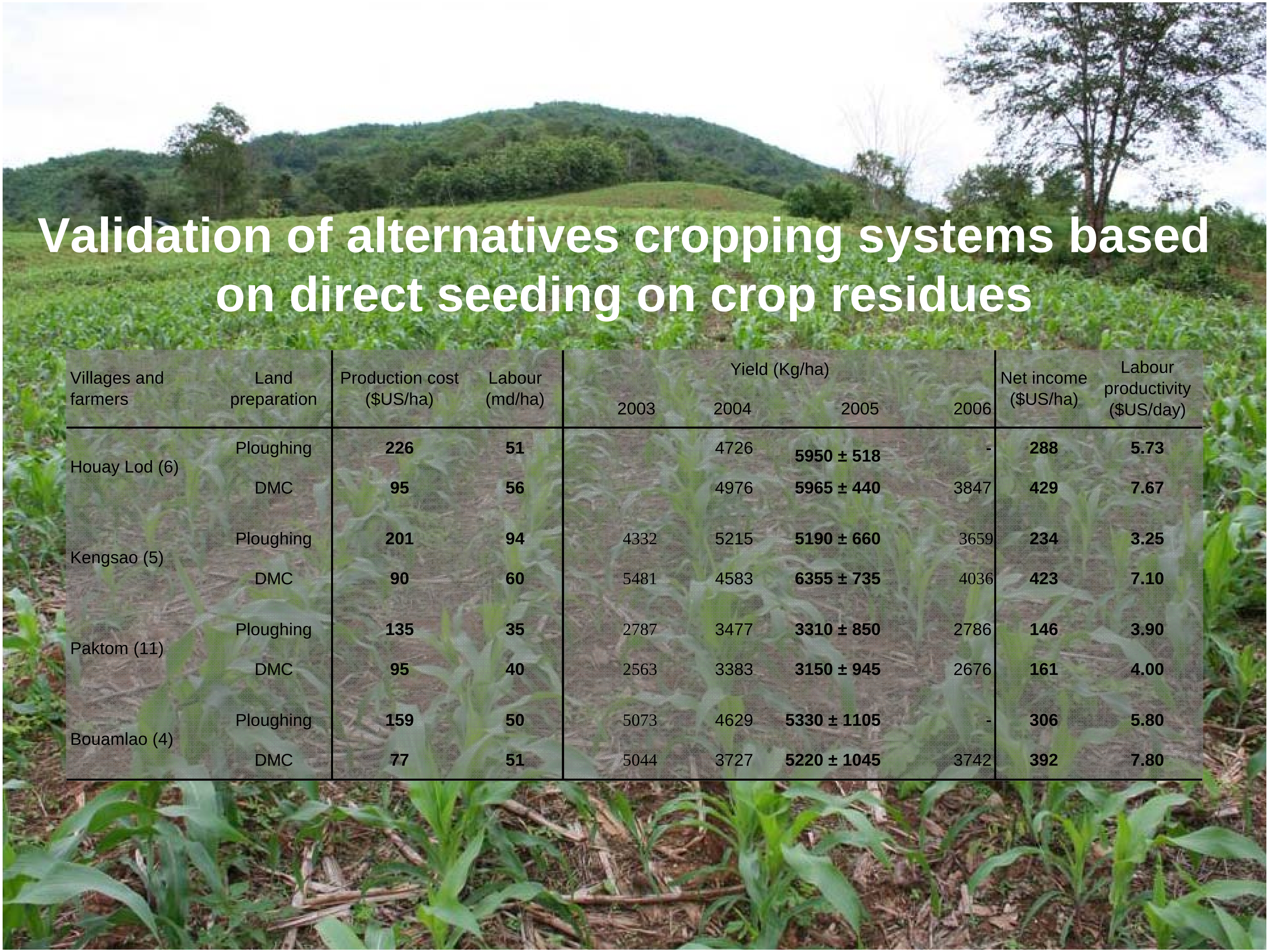
One of the main functions of cover crops is to enhance belowground insect and microbial activity which improve soil structure and plant nutrition


On-farm experiments

Implementation of DMC systems with smallhold farms in Southern Xayabury (Mekong corridor)


Crop residue management can be a first step towards reducing losses of soil and mineral elements, as well as a way of saving money, increasing net income and labour productivity
6 6 2005



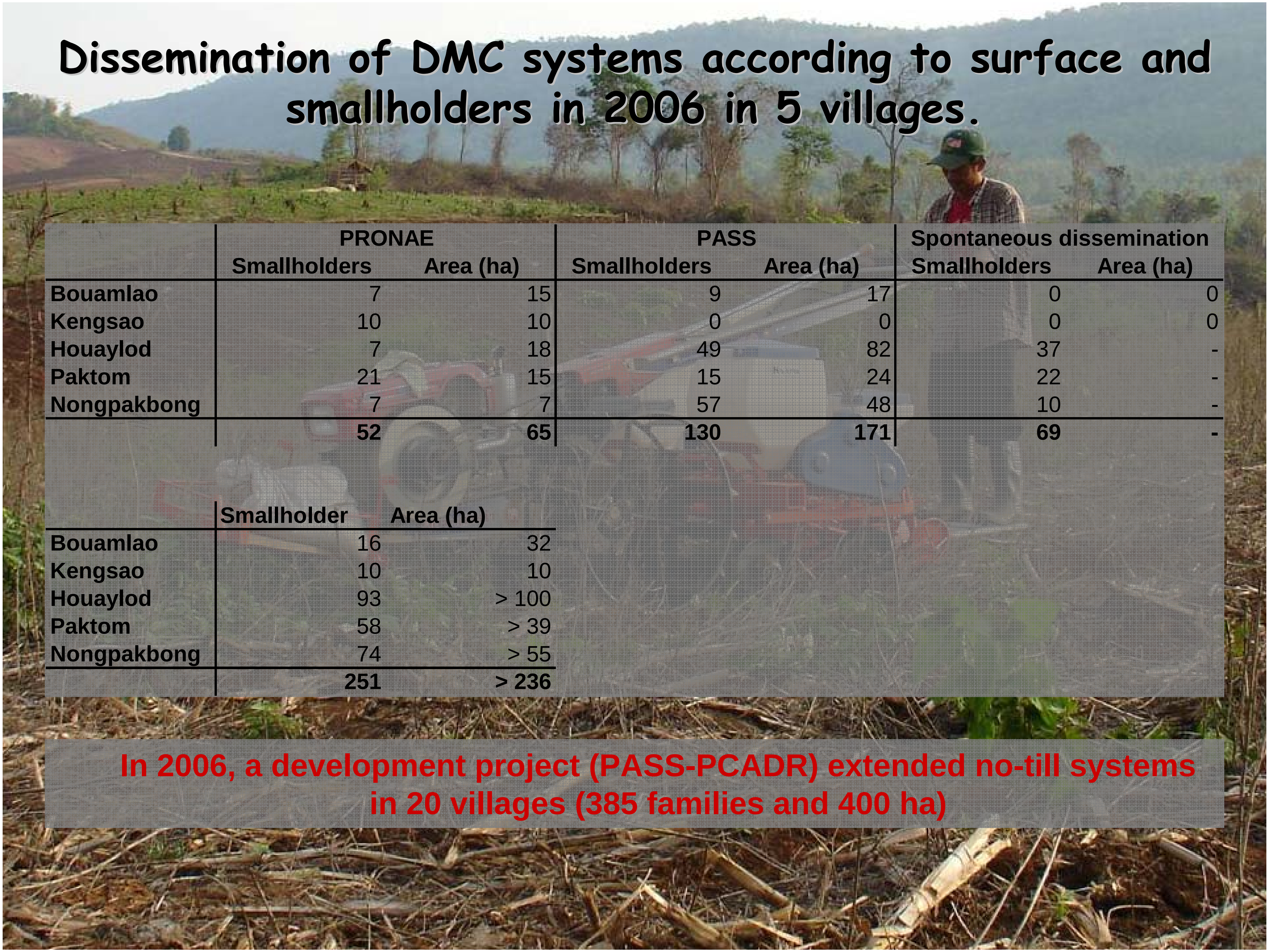
Validation of alternatives cropping systems based on direct seeding on crop residues

Villages and farmers	Land preparation	Production cost ($US/ha)	Labour (md/ha)	Yield (Kg/ha) 2003	2004	2005	2006	Net income ($US/ha)	Labour productivity ($US/day)
Houay Lod (6)	Ploughing	**226**	**51**		4726	**5950 ± 518**	-	**288**	**5.73**
	DMC	**95**	**56**		4976	**5965 ± 440**	3847	**429**	**7.67**
Kengsao (5)	Ploughing	**201**	**94**	4332	5215	**5190 ± 660**	3659	**234**	**3.25**
	DMC	**90**	**60**	5481	4583	**6355 ± 735**	4036	**423**	**7.10**
Paktom (11)	Ploughing	**135**	**35**	2787	3477	**3310 ± 850**	2786	**146**	**3.90**
	DMC	**95**	**40**	2563	3383	**3150 ± 945**	2676	**161**	**4.00**
Bouamlao (4)	Ploughing	**159**	**50**	5073	4629	**5330 ± 1105**	-	**306**	**5.80**
	DMC	**77**	**51**	5044	3727	**5220 ± 1045**	3742	**392**	**7.80**

Dissemination of DMC systems according to surface (%) and smallholders (%) between 2003 and 2006 in 4 villages

Villages	**Houay Lod**				**Paktom (North)**				**Nongpakbong**				**Bouamlao**			
Smallholders	169				131				101				383			
Samples	[90 - 103]				[90 - 124]				[74 - 80]				[155 - 137]			
Year	**2003**	**2004**	**2005**	**2006**	**2003**	**2004**	**2005**	**2006**	**2003**	**2004**	**2005**	**2006**	**2003**	**2004**	**2005**	**2006**
Slash and burn	72,2	54,5	17,6	**18,5**	16,6	13,7	6,8	**13,4**	35,1	33,3	38,1	**40,9**	7,6	2,5	0,1	**1,7**
Ploughing	22	23,4	38,5	**38,8**	80,1	81,9	84	**71,7**	58,3	56,9	43,1	**17,1**	92,4	97,5	99,9	**90,1**
DMC	5,8	22,1	43,9	**42,7**	3,3	4,4	9,2	**14,9**	6,6	9,8	18,8	**42,0**	0	0	0	**8,2**

Villages	**Houay Lod**			**Paktom (North)**			**Nongpakbong**			**Bouamlao**		
Total Smallholders	169			131			101			383		
Replications	[90 - 103]			[90 - 124]			[74 - 80]			[155 - 137]		
Year	2003	2005	**2006**	2003	2005	**2006**	2003	2005	**2006**	2003	2005	**2006**
% of Smallholders	4	50	**66**	8	50	**68**	5	22	**76**	0	0	**13**



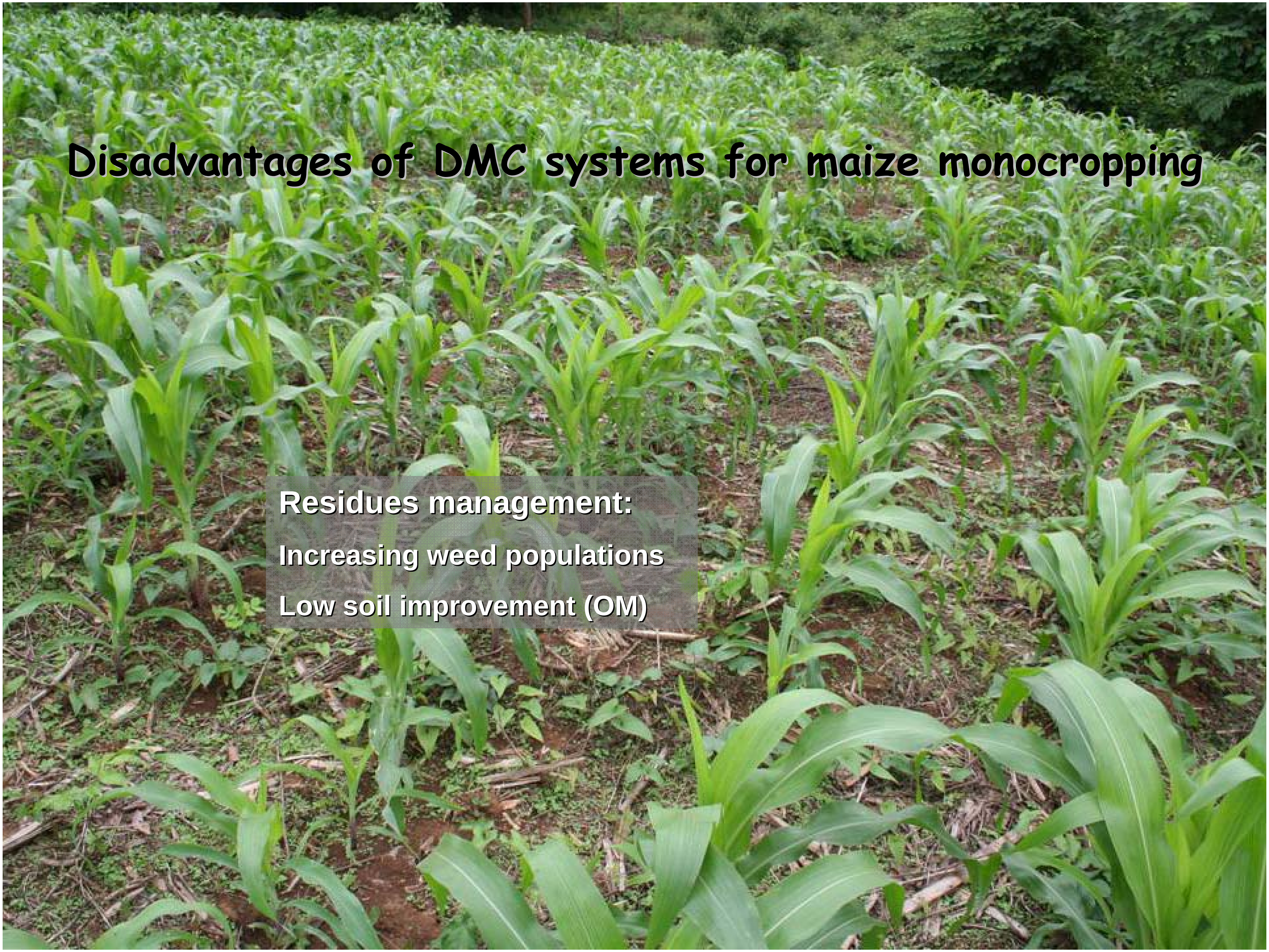
Dissemination of DMC systems according to surface and smallholders in 2006 in 5 villages.

	PRONAE		PASS		Spontaneous dissemination	
	Smallholders	Area (ha)	Smallholders	Area (ha)	Smallholders	Area (ha)
Bouamlao	7	15	9	17	0	0
Kengsao	10	10	0	0	0	0
Houaylod	7	18	49	82	37	-
Paktom	21	15	15	24	22	-
Nongpakbong	7	7	57	48	10	-
	52	**65**	**130**	**171**	**69**	**-**

	Smallholder	Area (ha)
Bouamlao	16	32
Kengsao	10	10
Houaylod	93	> 100
Paktom	58	> 39
Nongpakbong	74	> 55
	251	**> 236**

In 2006, a development project (PASS-PCADR) extended no-till systems in 20 villages (385 families and 400 ha)

Disadvantages of DMC systems for maize monocropping

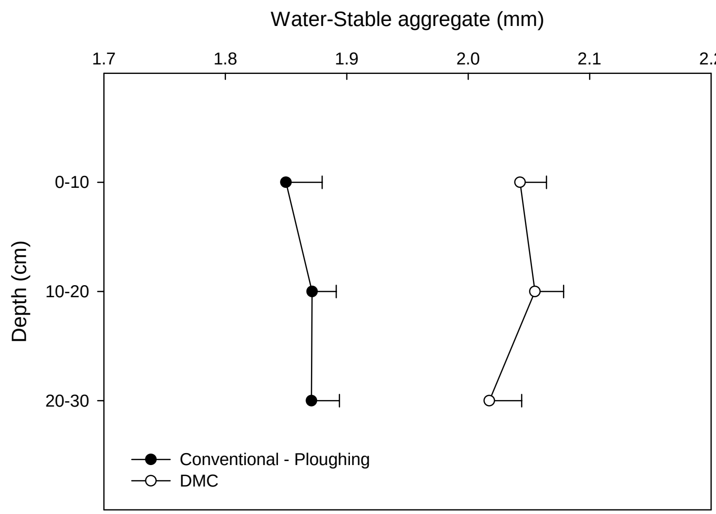


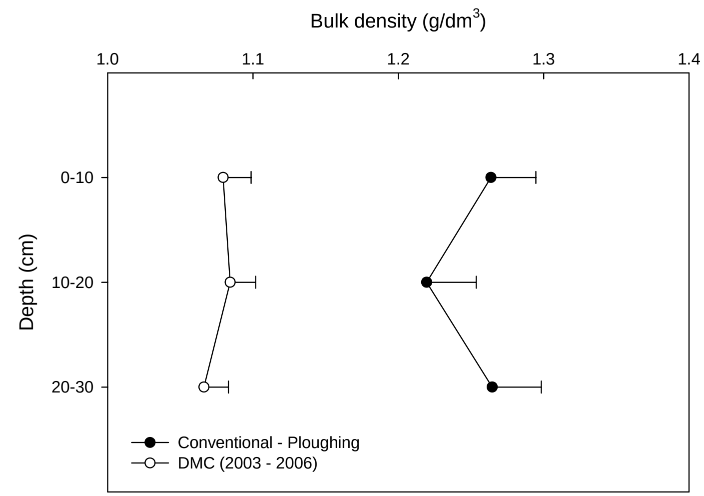
Residues management:

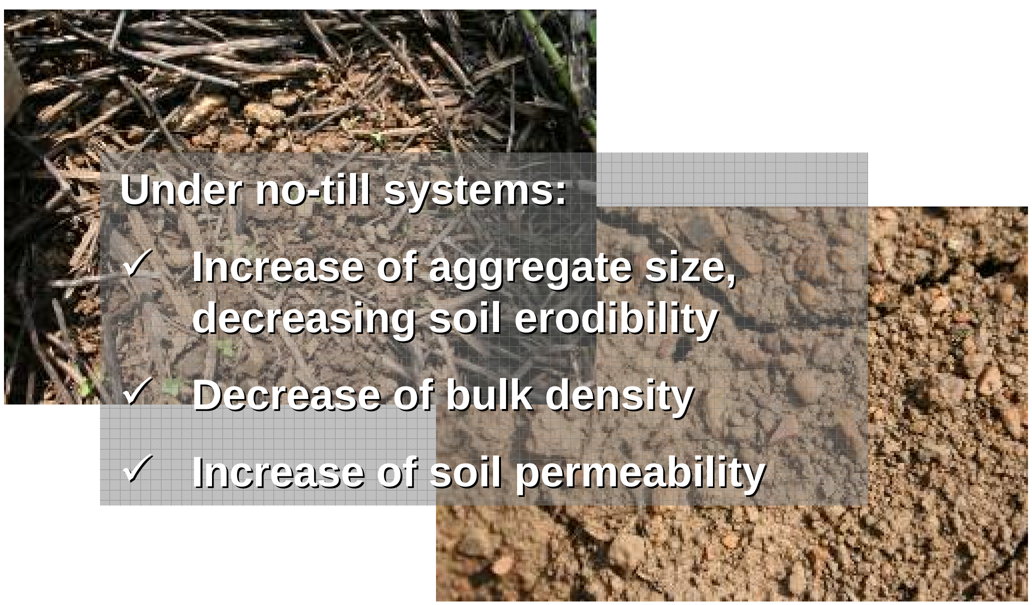
Increasing weed populations

Low soil improvement (OM)

Biophysical advantages of No-till systems with residues management

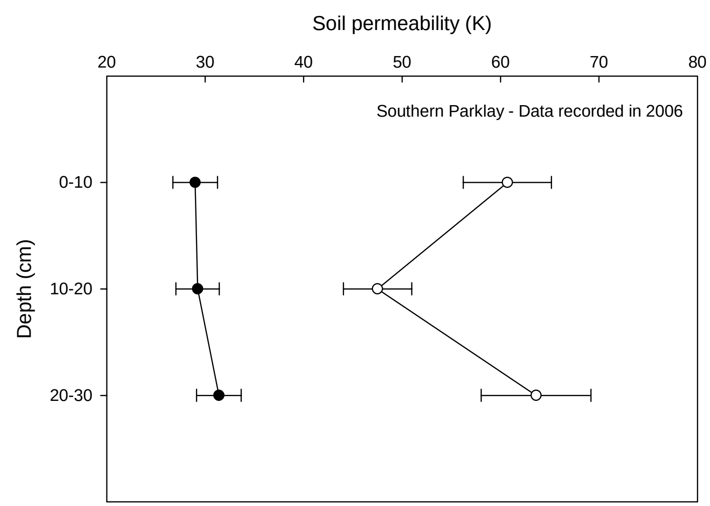






Under no-till systems:

- ✓ **Increase of aggregate size, decreasing soil erodibility**
- ✓ **Decrease of bulk density**
- ✓ **Increase of soil permeability**



Needs for more efficient DMC systems

Year 1: Maize + *B. ruziziensis*

Despite rapid adoption in some areas, no-tillage systems have to be improved with rational crop rotations, relay crops and cover crops in order to diversify the production,

Year 2: Rice-bean

Or

Soybean / Finger millet

and so reduce agronomic, economic and climatic risks while optimising the main functions of DMC systems through adequate use of main and relay crops.

Savannah grasslands on altitude plains

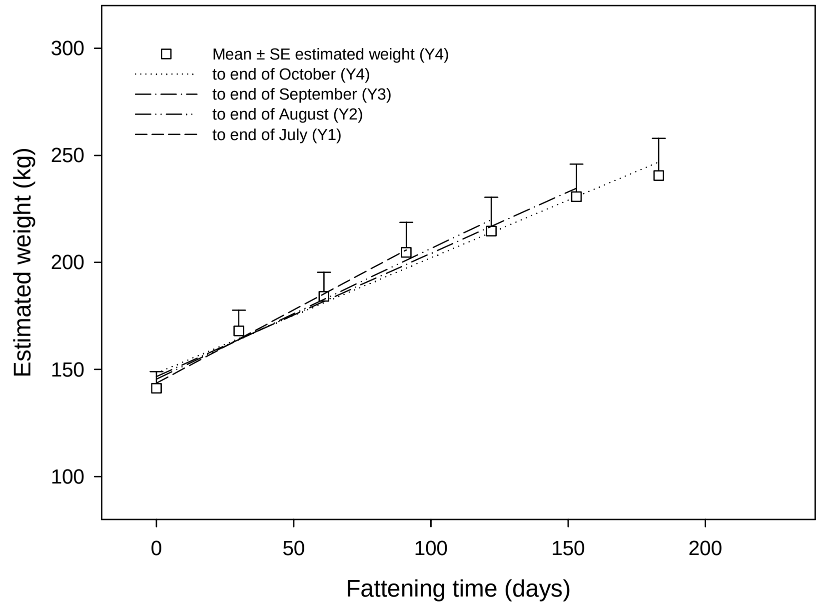
Regeneration of savannah grasslands on altitude plains

A large range of forage species (*Brachiaria* sp., *Stylosanthes*, *Cajanus cajan*, *Eleusine coracana*) and cover crops (Crotalaria sp.), tolerant to drought and soil acidity, is being used to regenerate waste lands.

First step: Livestock production

Second step: Annual cropping and diversification (trees)

Livestock production



Cattle fattening on *B. ruziziensis* pasture during the rainy season

In 2006, mean growth rate from end of May to end of October reached 539 g/day with no protein supplement

On natural pasture land: 100 – 170 g/day

Livestock production

Improved pastureland 1.5 ha	2005		2006	
	Qty	Total (US $)	Qty	Total (US $)
Costs		**852**		**260**
Plot fencing & designing		530		0
Land preparation		35		0
Seeds (*B. ruziziensis*) & fertilizer		272		245
Animals care		15		15
Labour input	**160**		**82**	
Fencing & land preparation	23			
Sowing & fertilizer broadcasting	57		2	
Seeds harvesting	30		30	
Bulls management	50		50	
Benefits				
Bulls added value	6	615	8	804
Seeds production (2005)	132	264		
Gross income		**879**		**804**
Net income		**27**		**544**
labour productivity		**0.17**		**6.64**

The first year fencing and fertiliser formed the main expenses. Cost of fencing could be reduced using local materials and by growing living fences.

In 2006, without taking into account seed production, bulls fattening represents an income per ha of $362 (1.8 t/ha of paddy) and a labour productivity of 6.6 $US/day.

Traditional management of savannah grasslands

Regeneration of savannah grasslands on altitude plains

(upper part of Nam Ngum River Basin)

Great social and environmental impacts: land 'allocation' and land protection during the dry season

Possibility of reafforestation, diversification and new income generation (livestock, forage seed production)

Wildfires on the Plain of Jars, November 2006

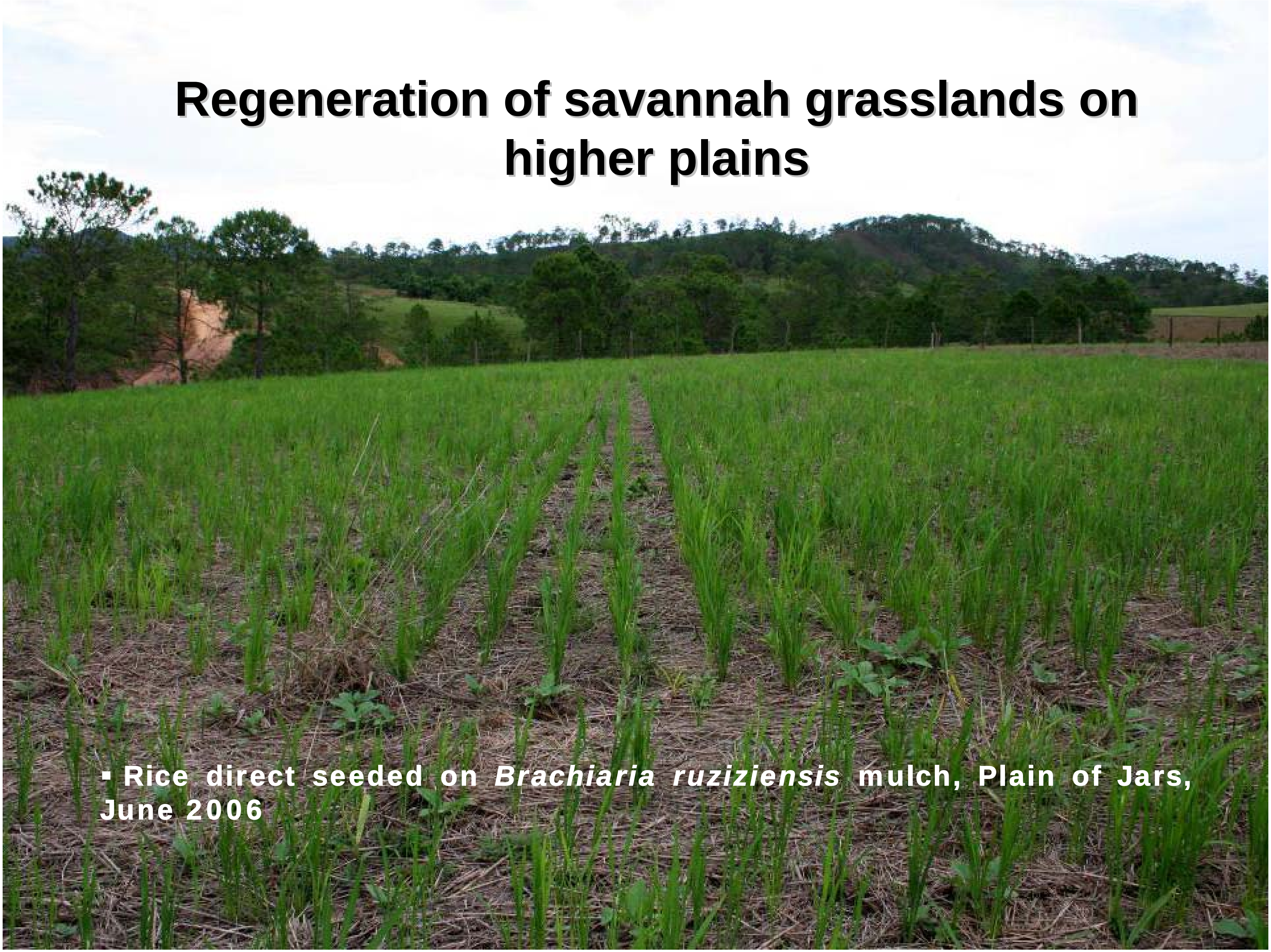
Regeneration of savannah grasslands on higher plains

A large range of forage species (*Brachiaria* sp., *Stylosanthes*, *Cajanus cajan*, *Eleusine coracana*) and cover crops (Crotalaria sp.), tolerant to drought and soil acidity, is being used to regenerate waste lands.

- Rotational sequences between improved pasture and edible or cash crops (rice, maize, soybean) direct-seeded onto forage mulch are tested.

Rice direct seeded on *B. ruziziensis* mulch

Regeneration of savannah grasslands on higher plains



- Rice direct seeded on *Brachiaria ruziziensis* mulch, Plain of Jars, June 2006

Annual cropping on the Plain of Jars

System	Rice after two years of ***B. ruziziensis*** no fodder exportation
Sowing	1/6
Fertiliser	30N - 45 P_2O_5 - 30K_2O
Yield (kg/ha)	1744 ± 224
Gross income ($US/ha)	401 ± 52
Production cost ($US/ha)	157
Income ($US/ha)	248 ± 52
Labour inputs	0
Labour productivity ($US/day)	5.2 ± 1.1

Characterization of biological and physicochemical processes for different systems

Annual cropping on the Plain of Jars

May to beginning of August → **August to….** → **May to ….** →

Finger millet

Finger millet + pigeon pea

Radish, oat, bean, wheat….

Rice + *Crotalaria / S. guianensis….*


A global approach involving credit access, technical and political support has to be defined to develop productive and efficient systems (annual and perennial cropping, livestock) on this ecology. This poses a great challenge which, if grasped, could yield great benefits on the upper part of the Nam Ngum river basin.

Challenges in scaling-up this approach and DMC systems




Challenges in scaling-up this approach and DMC systems

Positive results from DMC are evident; however, different constraints limit the dissemination of these systems even if agronomic and economic successes have been highlighted.

- Economic incentives have to be promoted. One of the major limiting factors to adoption may be that the practice promoted was first perceived as being closely associated with a need to use cash income for equipment and inputs.

- Labour force is one of the main limiting factors, and specific tools have to be promote in order to reduce drudgery and labour inputs.

- Rules must be defined at the community level for management of residues and cover crops during the dry season.

Challenges in scaling-up this approach and DMC systems

- Land allocation must be flexible, taking into account the diversity of livelihoods in the uplands.
- Market access for forage seed and relay crops (*Brachiaria* sp., *S. guianensis*, finger millet, pigeon pea, *Sorghum*, pearl millet…) have to be found.
- Organic systems should be integrated into DMC systems in order to ensure sustainable and environmentally-friendly agriculture.
- Structuring the relationship between smallholders – extension agents and private sector.
- Methods/Terms of transfer of this approach and systems to smallholders, extension agents, private sector and policy-makers.


KNAPIK
Continuous and full soil cover
is the key factor for successful
CA & DMC systems
Thank You for your attention

Altieri (2002) and Dalgaard *et al.* (2003) define agro-ecology as a holistic study that focuses on the form, dynamics and functions of agroecosystems, including all physical, economical and human environments.

Direct seeding mulch-based cropping systems are considered as one component of agro-ecology strategy.