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3.6 DIRECT SEEDING MULCH-BASED CROPPING SYSTEMS FOR RICE-BEEF PRODUCTION IN THE PLAIN OF JARS, XIENG KHOUANG PROVINCE, LAO PDR: AN EXAMPLE OF THE «CREATION – VALIDATION» RESEARCH & DEVELOPMENT METHODOLOGICAL APPROACH

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Abstract

The Plain of Jars is an acid, infertile savannah grassland covering an area of about 60,000 ha in the western region of Xieng Khouang Province, northeastern Lao PDR. In this ecology, farming systems are mainly based on lowland rice cultivation and extensive livestock production. An increase in rice production and intensification of the livestock industry are two key components in the Lao government's poverty alleviation strategy for this area. The main agronomic constraints for developing crops and forage systems are related to serious unfavourable soil chemical characteristics. Low pH, along with nutrients deficiencies (in nitrogen, phosphorus, potassium, calcium and magnesium) and high levels of aluminium saturation probably have a negative effect on the growth of upland crops, as well as many pasture species. Moreover, severe phosphorus deficiency generates animal health problems. Since 2004, the Lao National Agro- Ecology Programme (PRONAE) has been working on innovative farming systems based on direct seeding mulch-based cropping system (DMC) principles, as a technical approach, and on a progressive in situ validation process with smallholders as a Research & Development (R&D) approach. The advantages of the methodology are presented through the case of a DMC system developed in 2005 by the project to intensify rice-beef production in the Plain of Jars. The farming system initially proposed was a 5-year rotational sequence where improved pasture land was implemented in the first year, fattening activities conducted in the following three years and pasture regenerated in the fifth year using rice as a cash crop to finance pastureland re- implantation. Costs and benefits of the system were simulated according to the data collected in the creation sites. At the end of the 5 years, an average net income of 160 $US/year/ha and an average labour productivity of 2.5 US$ per ha and working day were expected. The system was then proposed to 89 families forming 16 farmers' groups in 12 different villages for an in situ validation covering 76 ha. Even though promising results have been described at the creation site, 3-years of continuous validation have revealed several constraints for mass extension. In- field monitoring and interviews with farmers showed the main constraints to be (i) Market channels' constraints or malfunctioning, (ii) Fencing costs and maintenance, (iii) Production costs rising faster than benefits, (iv) Credit access and supply, (v) Technical skills required for good-quality pastureland implementation and management and (vi) Cattle fattening management. This feedback has given rise to development-related discussions and proposals regarding credit access, market channel functioning and training supports to be provided to farmers. This feed back has also given rise to new research topics, such as (i) how to generate higher incomes during the first year of implementation and (ii) how to reduce fertilizer use (main production cost) while maintaining at the same time improved pastureland productivity. New farming systems based on direct sowing of rice associated with forage

species on degraded native pastureland have therefore been tested at creation sites and are currently under validation with farmer groups. This rice-beef system "creation- validation" process shows (i) the need to maintain research activities in the development process and (ii) the merits of the "creation site / farmer validation group" system for determining the potential for technology dissemination.

Keywords: DMC systems, R&D methodological approach, "creation-validation" approach, rice-beef production, Plain of Jars, Xieng Khouang province, Lao PDR.

1 Introduction

1.1 Why (and how) try to improve agricultural research efficiency?

Agricultural research is a key component of agricultural development process. However, in most countries, agricultural research and extension is the responsibility of separate organizations. As recorded by NAFES (2005), this has often led to a number of interrelated problems:

- lack of consensus on priorities for agricultural development;
- a weak flow of technical information, particularly in response to field problems;
- conflicting advice being given to farmers;
- the development of technologies that are effective on research stations but which are not appropriate under normal farming conditions;
- recommendations being made by extension workers that have not been properly tested .

1.2 How promote a higher farmers' involvement in the Research process?

The Research and Development Methodological approach presented is based on five interdependent steps that are: I) the Assessment of farming systems and farming conditions (initial assessment, monitoring and evaluation of farming changes), II) the Creation and adaptation of innovative farming systems, III) the Training of involved stakeholders and related communication activities, IV) the Creation of a favorable environment for adoption and V) the Scaling up and promotion of the more promising innovative systems.

As underlined in illustration 1, the specificity of the approach has to be found in the creation phase that includes several validation steps with farmers. Farmers are associated in the assessment of the constraints, the creation and implementation of the innovative systems and in the monitoring and the evaluation of these systems.

The benefits of working with farmers to improve research efficiency are presented through a case study coming from PRONAE experience in the Plain of Jars, Xieng Khouang Province, Lao PDR.

1.3 Case study from PRONAE experience in the Plain of Jars, Xieng Khouang Province, Lao PDR

The Plain of Jars is an acid, infertile savannah grassland covering an area of about 60,000 ha in the western region of Xieng Khouang Province, northeastern Lao PDR (see illustration 2). In this ecology, farming systems are mainly based on lowland rice cultivation and extensive livestock production. Paddy rice and big ruminants represent respectively 20 to 50% and 50 to 80% of families' annual monetary income (Lienhard et al, 2006a). An increase in rice production and intensification of the livestock industry are two key components in the Lao government's poverty alleviation strategy for this area. The main agronomic constraints for developing crops and forage systems are related to serious unfavorable soil chemical characteristics. As reported by Hacker et al. (1998) and Gibson et al. (1999), low pH, along with nutrients deficiencies (in nitrogen, phosphorus, potassium, calcium and magnesium) and high levels of aluminum saturation have a negative effect on food crops' growth as well as on forage species' development. Severe phosphorus deficiency generates also animal health problems (Gibson et al., 1999).

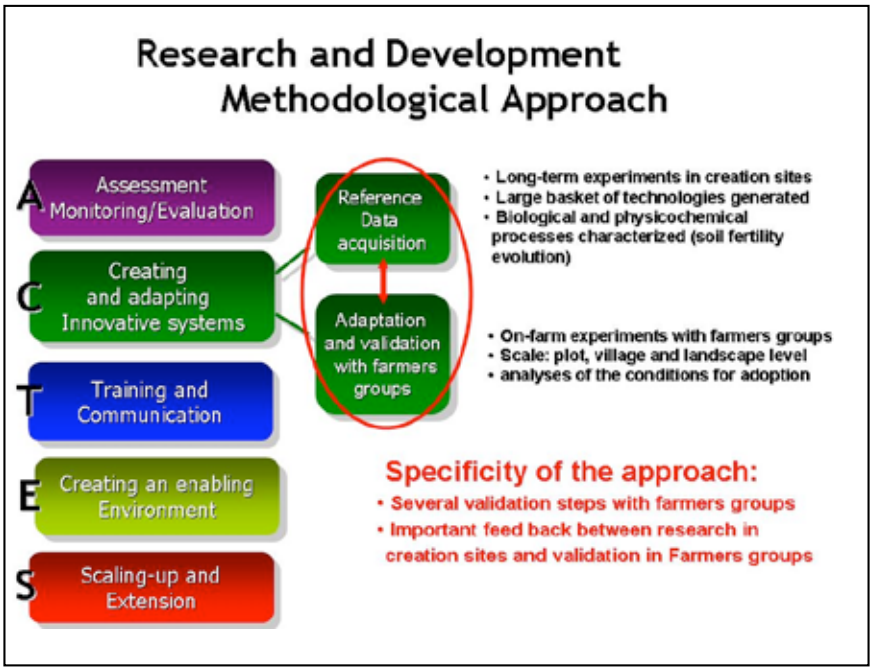

Illustration 1: Main principles of «Creation-Validation» R&D Methodological approach

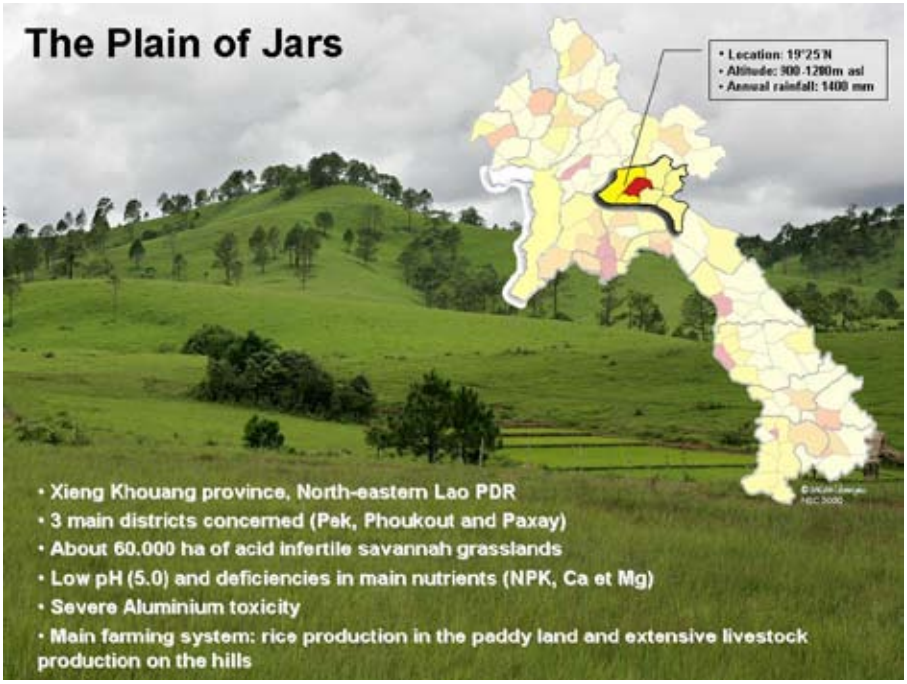

Illustration 2: Location and main characteristics of the Plain of Jars

Since 2004, the Lao National Agro- Ecology Programme (PRONAE) has been working on innovative farming systems based on Conservation Agriculture and Direct seeding Mulch- based Cropping (DMC) systems principles as a technical approach and on a progressive in situ validation process with smallholders as a Research & Development (R&D) approach.
In relation with the initial constraints analysis research activities have been focused on rice and cattle production. After two years of experiments on research stations, a first DMC rice-beef farming system was developed and proposed to farmers groups in 2006 for in- situ validation.

2 Materials and Methods

2.1 Innovative farming systems construction and evaluation in creation sites

As reported in illustration 3, research activities conducted in research stations for rice-beef systems creation were focused on three main topics.
1) Forage species selection: forage species were selected from two research stations representative of the Plain of Jars variability in terms of slope (respectively medium and low) and elevation (respectively 900m and 1100m above sea level). Forage collections were implemented in 2004 under DMC techniques (no tillage, direct sowing on degraded pastureland). Twelve forage species (ten grasses and two legumes) were cross-linked with four different level of fertilization and evaluated regarding forage production, fodder quality (palatability and fodder content) and seed production.
2) Cattle fattening management and performance: Cattle fattening opportunity was evaluated on a 1,6 ha plot of *Brachiaria ruziziensis* 'ruzi' grass implemented in 2005. Zoo-technical (animal stocking and growth rate) and economical (costs/benefits analysis, technical skills required for system implementation and management) performances were analyzed and compared with traditional livestock system.
3) Regeneration of improved pastureland using rice as a cash crop: since 2005, various cropping systems including trials on species association modalities (sowing date, sowing depth and density), fertilization level and rice cultivars' selection are tested and evaluated according their economical performance and technical feasibility.

2.2 Validation phase with farmers' groups

As presented in illustration 4, the validation process with farmers' groups included several steps with a progressive increase of the experimental size (increase in number of farmers and in surface), an evolution in the sharing of responsibilities (progressive backing out of the project) and in the number and kind of partners involved. Key points of the methodology are presented below:
- Different scale, different evaluation topics: experimental size has progressively increased during the evaluation process from 6 farmers groups, 6 villages and 14 ha in 2006 to 16 farmers groups from 12 villages and 76 ha in 2008. Data recorded at small scale (step 1) were focused on technical and economical aspects (in situ evaluation of system productivity and feasibility); at larger scale (step 2), organizational aspects were integrated to evaluate requirements/ constraints for mass extension (training gaps, human resources required to support farmers groups, credit and inputs management).
- Guarantees and responsibilities sharing: contracts were discussed and established between the project and the farmers groups to define responsibilities (who is doing what) and provide farmers financial guarantees regarding failure risk. In case of farmers groups' being unable to pay back improved pastureland implementation costs, the project guaranteed to make-up the missing amount up to a limit of 50% of total implementation costs. Project financial support was however conditional on farmers' capacity to fulfill their engagement (participation in fodder plot implementation, plot fencing and maintenance etc.), the agricultural services being involved as a referee.

Topics	Parameters & data record	
"Forage species selection"	• Species collection x fertilization • Above ground and below ground biomass production (forage adaptability) • Fodder quality (protein content) • Seeds production	
"Cattle fattening management & performances"	• Benefit/cost analysis • Average Animal Daily Growth Rate (DGR) assessment • Easy tools for GR monitoring without balance	
"Improved pastureland regeneration using rice as a cash crop"	• Cropping systems (rice cultivars x species association modalities x fertility) • Technical feasibility • Benefit/cost analysis	

Illustration 3: Topics and parameters evaluated in research stations

Validation process		1st step	2nd step	3rd step
Experimental design evolution	"Direct Seeding of Improved forage species on degraded Pastureland"	• 2006: 6 villages, 6 farmers groups, 24 farmers, 14 ha	• 2007: 12 villages, 13 farmers groups, 65 farmers, 62 ha	• 2008: Partnerships initiated with NNRBDP and Agri. Dev. Bank (250 ha)
	"Cattle Fattening activities"	• 2007: 6 villages, 6 farmers groups, 24 farmers, 14 ha	• 2008: 12 villages, 13 farmers groups, 65 farmers, 62 ha	
	"Regeneration of improved pastureland using rice as a cash crop"	• Not yet started with farmers groups		
Modalities of sharing of responsibilities		• Technical (training, technicians, equipment) & financial (credit) support provided • Financial risk shared with farmers (security if failure)	• Technical & financial support provided • Financial risk assumed by farmers	• Technical support provided • Financial risk assumed by farmers • Financial support provided by banking sector
Partners involved		• Research program (researchers + extension agents) • Farmers groups	• Research program • Farmers groups • Extension agencies (training)	• Research program • farmers groups • Extension agencies (training + implementing) • Banking sector
Monitoring and evaluation		• Cost/benefits analysis (in situ vs controlled site) • System evaluation by farmers (constraints /benefits analysis) • Credit reimbursement rate	• Cost/benefits analysis • Problems related to scaling up (inputs and equipments management) • Farmers evaluation • Credit reimbursement rate	• Cost/benefits analysis • Problems related to scaling up (credit managt, training quality) • Farmers evaluation • Credit reimbursement rate

Illustration 4: Principles of validation process with farmers' groups

- Number and kind of partners involved: the initial bilateral partnership (research project / farmers groups) was progressively extended to a development project (training of extension agents and then on- field support) and banking sector.

2.3 Constraints / benefits analysis

Constraints and benefits of the system were evaluated using two different tools:

1) In-field monitoring was conducted all year long to evaluate the in situ economic performance of the system (forage seeds production, animal daily growth monitoring) as well as the technical feasibility of the system (level of skills required for each operation: sowing, fertilizer use, stocking rate management)

2) Stakeholders' point of view on the system were also evaluated through working groups involving farmers' representative, projects' extension agents, private sector and decision makers. Two workshops were organized in June 2007 (118 persons, 39 farmers) and August 2008 (89 farmers). Participatory Rural Appraisal (PRA) methods were used to discuss (i) the constraints and the benefits of the system and (ii) the way to improve system performance. Discussion results were analyzed and presented using Mindjet MindManager Pro software.

3 Results and discussions

3.1 Initial DMC system developed to enhance rice-beef production

The farming system initially proposed was a 5-year rotational sequence where improved pasture land was implemented in the first year, fattening activities conducted in the following three years and pasture regenerated in the fifth year using rice as a cash crop to finance pastureland re- implantation.

The rationale of the system was based on the use of rustic perennial fodder grasses to improve the soil fertility and to raise new agricultural possibilities. The objective was to give farmers the possibility after 3-4 years of soil improvement either to keep on cattle fattening activities or start crops cultivation (rice, soybean).

Several species (Brachiaria decumbens, B. brizantha, B. ruziziensis, B. humidicola, and B. mulato) exhibit on the research station good adaptability and forage production under the specific environment of the Plain of Jars. However, *Brachiaria ruziziensis* was selected for this experiment due to its good balance between seed production, forage palatability and quality, and ease of pasture establishment under DMC conditions (Lienhard et al, 2006b).

Plot of 1 ha	1st year	2nd year	3rd year	4th year	5th year
	Pastureland implemen.	Bulls fattening	Bulls fattening	Bulls fattening	Pastureland re-implem (rice+forage)
COSTS (US $)	**240**	**765**	**803**	**842**	**303**
Plot fencing and designing	nd	nd	nd	nd	nd
Pastureland implementation	100	0	0	0	140
Fertilizer	120	125	132	139	146
Animals & animals care	0	615	645	675	0
Credit requirement	220	420	440	470	286
Credit interest	20	25	26	28	17
LABOUR (md.ha-1)	**68**	**72**	**62**	**62**	**55**
Fencing & Fence maintenance	30	20	10	10	10
Crops implementation and management	8	2	2	2	10
Seeds harvesting	30	0	0	0	35
Bulls management	0	50	50	50	0
BENEFITS (US $)	**210**	**1 000**	**1 050**	**1 100**	**395**
Bulls sale	0	1 000	1 050	1 100	0
Seeds production	210	0	0	0	395
NET INCOME (US $)	**-30**	**235**	**247**	**258**	**92**
LABOUR PRODUCTIVITY (US $/ wd)	**-0,44**	**3,26**	**3,98**	**4,16**	**1,67**

Illustration 5: Costs & Benefits expected from Beef-rice 5-years farming system (for 1 ha plot)

***Cost / Benefit simulation was made using the following figures:**

First year: Improved pastureland implementation:
- Plot fencing: use of local material (wood, bamboo); only labour is recorded
- Pasture land implementation cost: land preparation (30 US$/ha) + Seeds (35 $US/ha) + Operational costs (35 $US/ha)
- Fertilization: 60-80-60 kg of NPK/ha, total cost of 120 $US/ha
- Credit requirement: All pastureland implementation cost, credit interest of 12%/year during 9 months (from sowing to harvest and drying of the seeds)
- Seeds production: 140 kg/ha for ruzi grass seeds at 1,5$ US/kg

2nd to 4th year: Bulls fattening activity
- Inflation rate (all products): 5%/ year
- Bulls stoking rate: 4 animals/ha, initial price of 150 $US for a bull of 110-120 kg (1,2 $US/ living kg)
- Bulls fattening: fattening period of about 5,5 months; average growth rate of 15 kg/animal/month, ie gain of 80 to 90 kg/Al/fattening period
- Credit requirement: credit for buying 2 bulls (the 2 other ones are coming from owm farmer herd)+ fertilizer at interest level of 12%/year for 6 months

5th year: Pasture re-establishment using rice as a cash crop
- Rice + Pasture sowing cost: land preparation (40 US$/ha) + Seeds (60 $US/ha) + Operational costs (40 $US/ha)
- Rice production: 1,8 T/ha at 220 $US/T

Good daily growth rate were obtained with local breed (native x Redinski) with an average of 539g/animal/day during the six-month raining period (May-October) for an initial animal stocking rate of 540 kg of liveweight per hectare (4 young bulls) and a total fertilization of 60 kg/ha of N, 80 kg/ha of P2O5, 60 kg/ha of K2O (Lienhard et al, 2006b). In comparison, extensive grazing on native pastureland allow for the same period an average growth of 165g/ animal/day (PRONAE, unpublished data) for an estimated stocking rate of 0.3 animal per hectare. With a total meat production per hectare of 390 kg and 9 kg for improved pastureland and native grassland respectively (i.e. a 40 times higher production) improved pastureland really offered great opportunity for cattle industry intensification.
Based on the 2 years' data collected in creation sites, costs and benefits were simulated for the all 5-year period. Costs and benefits analysis is presented in illustration 5. For the 5 years period, an average net income of 160 $US/year/ha and an average labor productivity of 2.5 US$ per ha and working day were expected.

3.2 Lessons learnt from Farmers' groups validation process

Even though promising results have been observed at creation sites and encouraging results observed in farmers' field, three years of continuous validation have revealed several constraints to mass extension. Farmers' interviews conducted in August 2008 showed different level of cattle farming intensification. As shown in illustration 6, 40% of farmers were using the improved pastureland in an intensive way (fertility management of the fodder plot, cattle purchased to fatten and sell), 49% were using it to fatten animals but more extensively (non-permanent use of the fodder plot, no investment in fertilizer) and 11% of farmers that invested in improved pastureland were motivated by other reasons (income diversification through forage seeds sales, land appropriation).

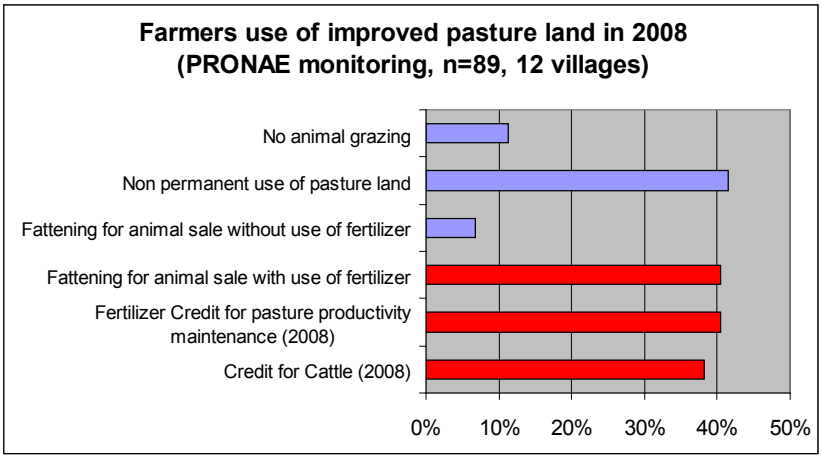

Illustration 6: Evaluation (PRONAE, 2008) of improved pastureland use by farmers

In-field monitoring and interviews with various stakeholders showed the main constraints to be:

3.2.1 Market channel constraints or malfunctioning

As shown in illustration 7, different constraints were highlighted regarding the two main sources of scheduled income:

- Forage seeds sale: with an average ruzi grass seeds production of 147 kg/ha recorded in 2006 and 2007 and an average need of about 15 kg/ha of ruzi grass seeds for improved pastureland implementation, the local market was already saturated and extra forage seeds production coming from farmers groups that recorded high forage seeds production could not be bought.
- Cattle purchase and sale: in a context of livestock being traditionally considered as living savings, some farmers experienced trouble finding young bulls to purchase for fattening; constraints regarding price negotiations between cattle breeders and traders were also emphasised especially in 2008 during which the border of Vietnam (the main demand source) was closed during 4 months for sanitary reasons.

3.2.2 Fencing costs and maintenance

As shown in illustration 8, fencing appeared to be the main trouble in cattle farming intensification. If collective fencing and maintenance is traditionally organized for paddy fields areas, collective fencing and collective fence maintenance for collective cattle fattening activities appeared to be much more complicated to organize. Moreover, the use of traditional material (bamboo) for fencing appeared to be too constraining in terms of maintenance needs, especially regarding the surrounding pressure of animals (in the context of animals free-grazing) and the high difference between quantities of fodder produced per hectare respectively by native and improved grasslands. The cost for a 4-line barbed wire fence using wood posts is about 240 US$ for 400 linear meters and can not be reimbursed in a single year (especially the first year).

3.2.3 Production costs rising faster than benefits

As reported in illustration 9, system was evaluated in 2008 by farmers as financially hazardous with a risk that benefits hardly cover implementation costs. The comparison of production costs vs. benefits for implementation of improved pastureland and for cattle fattening activity shows that, between April 2005 and June 2008, production costs have been increasing more rapidly than benefits with a difference of 20% and 17% respectively for improved pastureland implementation (see illustration 10) and cattle fattening (see illustration 11).

	Stakeholders' point of view	Constraint emphasized	What to do/change to improve the system?
	"We still have forage seeds we collected but no one to buy it" *(Farmers from My and Khangpeung village)*	• Forage seeds market too limited	• Work to be done on processing and promoting forage seeds to stimulate local and regional demand for them • Find new cropping systems in which generated income is not depending on forage seeds market • Facilitate exchanges between farmers and traders to better define the needs for animal fattening and animals buying/selling prices. • Facilitate information flux to and within farmers groups on market channels (prices, demand etc.)
	"It is difficult to find young bulls for purchase"*(Farmer from Xoy Nafa village)*	• Too few young bulls available for fattening	
	"It is difficult to sell animals at a good price: traders propose us really low prices when they come to buy animals; if we sell them at that price we can't even earn any money!..." *(Farmer from My village)* "We need contracts with traders to buy and sell animals at a defined price" *(Farmers from My village)*	• Too limited relationships between farmers and traders	
	"Traders tell us that this is now difficult to sell in Vietnam, but we don't know!" *(Farmer from Khangpeung village)*	• Insufficient information on demand in livestock markets	

Illustration 7: stakeholders' point of view referring to Market channel constraint

	Stakeholders' point of view	Constraint emphasized	What to do/change to improve the system?
	"Bamboo fences are not solid enough ; cattle can easily penetrate and destroy the forage plot ; if we use barbed wire, it is expensive and then it's difficult to pay back the credit and even to save money" *(Farmers from Xoy Nafa village)*	• Fence solidity and fencing cost	• Promote collective fencing/ collective animal fattening to reduce fencing cost per unit area • Promote lower cost fencing technologies (bamboo + living fence; mix simple + barbed wire etc.) • Develop financial incentives for living fence (agro-environmental funds related to reintroduction of trees in the landscape) • Make farmers conscious that they need to invest in fence maintenance to protect their initial investment (otherwise better not to invest in improved pasture land for cattle grazing; waste of money and time)
	"When farmers do not fix their fences every year, then animals can easily break fences and destroy totally improved pastureland" *(project technician)*	• Fence maintenance	

Illustration 8: Stakeholders' point of view referring to plot fencing constraint

	Stakeholders' point of view	Constraint emphasized	What to do/change to improve the system?
	"Implementation costs are too high; it is difficult to pay back..." *(Farmer from Lathouak village)* "Fertilizer price is too high ; too much risk not being able to pay back if we take a credit for fertilizer" *(Farmer from Khangpeung village)* "Fertiliser cost is increasing but not the bulls selling price; it is more difficult to get profit..." *(Farmer from Pouhoum village)*	• Production costs are increasing faster than the benefits	• Introduce fodder legumes to decrease pasture fertilisation needs (productivity maintenance) • Develop new cropping systems allowing generating higher incomes especially during the first year of implementation. • Develop financial incentives for fertilizers use (especially organic fertilizer such as thermo phosphate)

Illustration 9: stakeholders' point of view referring to Economics constraints

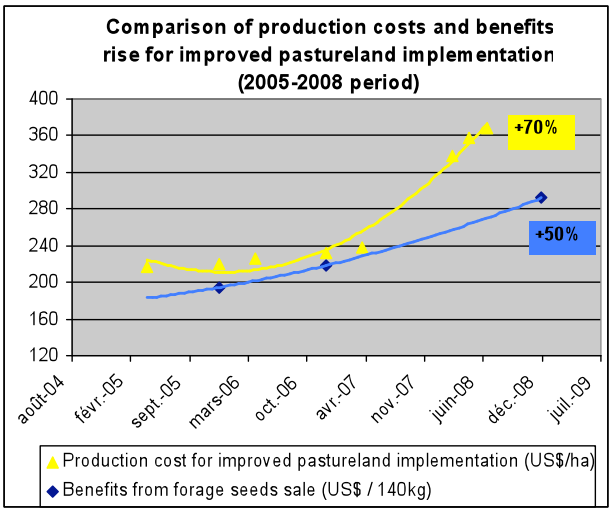

Illustration 10: Comparison of production costs and benefits rise for improved pastureland implementation (2005-2008 period, PRONAE data)

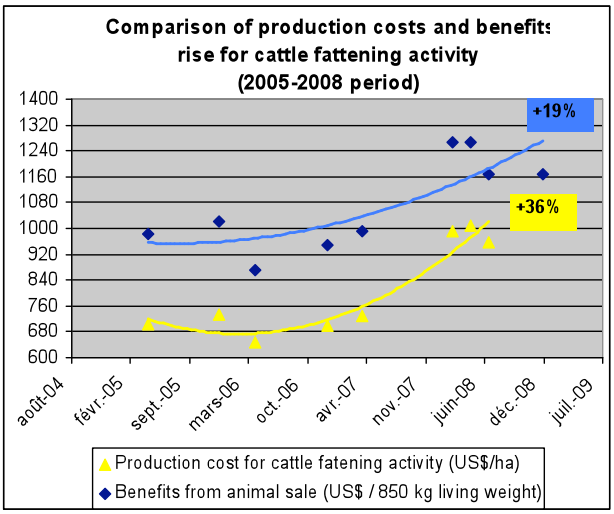

Illustration 11: Comparison of production costs and benefits rise for cattle fattening activity (2005-2008 period, PRONAE data)

		emphasized	system?
	"If you can not provide financial guarantees, you can not get any credit" *(Farmers from Nakhouan village)* "Procedures to get a credit are too complicated" *(Many farmers)*	• Credit access too difficult (guarantees & procedures)	• **Facilitate negotiations between farmers groups and banking sector in order to:** - **Facilitate credit access (promote collective guaranties vs individual financial one)** - **Negotiate specific lower interest rates** - **Simplify procedures for credit request and credit disbursement** • **Help farmers' groups to assess and define their credit needs, go through bank procedures and respect calendars (for request and pay back).**
	"Credit interest is too high! We need reduced interest rate for animal raising" *(All farmers)*	• Credit interest rate too high	
	"Credit amounts proposed are too limited; we need higher credit amounts for animal purchase" *(Farmers from My and Pouhoum village)*	• Credit amount too limited	
	"You ask for a credit and then money arrives 3 months later; it's too late!" *(Many farmers)* "Money disbursement is too slow" *(Many farmers)*	• Credit disbursement too slow	
	"Farmers are asking us money in February for March; it's too late! We need to know their needs in November" *(Head of Xieng Khouang Agricultural Development Bank)*	• Request for credit too late	

Illustration 12: stakeholders' point of view referring to Credit constraint

	Stakeholders' point of view	Constraint emphasized	What to do/change to improve the system?
	"Forage establishment was bad due to important delay between land preparation and forage sowing" *(Farmers from Gnapsy village)* "There are many weeds in my forage plots since they were not well controlled before forage sowing" *(one farmer from Leng village)* "In my plot ruzi is growing well in some parts but does not develop in other parts" *(one farmer from Khay village)*	• Lack of technical skills to insure a good pasture land implementation	• **Train and support technically farmers groups for each implementing step (pasture implementation but also pasture and animals management)** • **Make farmers conscious that they need to invest in the maintenance and the protection of their improved pastureland in order not to lose their investment (otherwise better not to invest in improved pasture land for cattle grazing; waste of money and time)**
	"Sometimes, ruzi grass has been overgrazed in some parts of the plot or native grasses are growing back but farmers do not do any weeding or pasture maintenance work" *(project technician)*	• Low investment in improved pastureland maintenance	

Illustration 13: stakeholders' point of view referring to technical skills required for a good pasture land implementation and management

	Stakeholders' point of view	Constraint emphasized	What to do/change to improve the system?
	"You tell a farmer only to put 4-5 animals per hectare and then he puts in all his animals; pasture is then overgrazed and disappears" *(project technician)*	• Bad management of animal stocking rate	• **Make farmers conscious that if they are not in a strategy of livestock system intensification, implementation of improved pastureland for bulls fattening will be a waste of time and money** • **For punctual use of fodder resources as animal diet complement, a cut-and-carry system conducted close to houses might be more interesting.**
	"You have improved fodder resources but at the same time, if farmers do not use vermifuge or vaccine, animals don't get fatter" *(project technician)*	• No specific animal care for fattened bulls	
	"Farmers do not bring animals every day to the fodder plot; they usually bring them late in the morning and bring them back home early in the afternoon leading to poor animal weight gains" *(Project technician)*	• Extensive use of improved fodder resource	
	"Animals are getting fat during the rainy season but then farmers do not sell them at the end of the rainy season; animals are getting thinner during the dry season and can loose all their weight gain! The farmers don't get any benefit and do not invest in fertilisation leading to a decrease of fodder production…" *(Project technician)*	• No animals sale after fattening period	

Illustration 14: Stakeholders' point of view referring to cattle fattening management

With an increase of 127% in 3 years related to the price of oil (from 104 $US in April 2005 for a fertilization of 60-80-60 kg NPK per hectare to 236 $US in June 2008), fertilization cost is the principal factor of this unequal rise between production costs and benefits.

3.2.4 Credit access and supply

As reported in illustration 12, guarantees and procedures required to get credit, high rates of credit interest, limited credit amount and too slow credit disbursement were pointed out by farmers as constraints for system implementation.

On the other hand, the need of an earlier evaluation of credit requirements was emphasised by bank representatives.

3.2.5 Technical skills required for a good-quality pastureland implementation and management.

In situ validation on a large scale has highlighted the variability of practices between farmers and supporting projects, providing information on the technical skills required to insure a good pastureland implementation and maintenance (see illustration 13).

3.2.6 Cattle fattening management

2-years of in situ monitoring of cattle management have shown up constraints regarding animal stocking rate management, animal care practices, forage resource management and overall fattening strategy (see illustration 14).

3.3 Farmers feed back importance for Research and Development.

3.3.1 Development-oriented discussions and proposals to improve the system

Discussions and proposals have been made regarding:

(i) Credit access and supply: negotiations between farmers' groups, development projects and the banking sector have been facilitated in order to:

- Make access to credit easier: the principle of a collective guarantee (vs. formerly individual financial ones) was accepted by the Xieng Khouang Agricultural Development Bank
- Negotiate specific lower interest rates: credit interest were reduced from 18% a year (casual interest rate for a credit concerning animal activity) to 12%
- Simplify procedures for credit request and credit disbursement: guarantees have been given by the bank to proceed to disbursement within a month after a credit request.

- Help farmers' groups to assess and define their credit needs, to go through bank procedures and to respect calendars (for request and pay back): guarantees have been given by the development projects supporting farmers groups to help assessing and requesting credit as early as possible.
(ii) Market channel functioning: exchanges between farmers and traders will be facilitated to better define the needs for animal fattening and buying/selling prices of animals as well as the changes regarding cattle market channels (animals desease outbreak, prices, demand.etc.).
(iii) Training content and support materials to be provided to farmers: a first tool-kit box for an extension agent - including a field guide with illustrations and videos enlightening what to do and not to do, according farmers and technicians - is being developed.

3.3.2 New research topics
This feed-back has also given rise to new research topics, such as (i) how to generate higher incomes during the first year of implementation, and (ii) how to reduce fertilizer use (main production cost) at the same time as maintaining improved pastureland productivity.
A new farming system - based on a first year of direct sowing of rice associated with forage species on degraded native pastureland - has therefore been tested at creation sites and is currently under validation with farmer groups.
This new system based on rice and not forage seed production in the first year (see illustration 15) should allow higher income the first year and motivate farmers to invest in fencing. A nitrogen-fixing forage legume (*Stylosanthes guianensis* CIAT 184) was added to B. ruziziensis to improve pastureland quality (higher protein content) and soil fertility.

4 Conclusion

This rice-beef system "creation-validation" process shows (i) the need to maintain research activities in the development process to provide more appropriate technologies to farmers and (ii) the merits of the "creation site / farmer validation group" system for determining the potential for technology dissemination.

Plot of 1 ha	1st year	2nd year	3rd year	4th year	5th year
	DS of Rice + forage	Bulls fattening	Bulls fattening	Bulls fattening	Pastureland re-implem (rice+forage)
COSTS (US $)	**466**	**1 017**	**1 063**	**1 115**	**625**
Plot fencing and designing	nd	nd	nd	nd	nd
Crop implementation	130	0	0	0	230
Fertilizer	310	245	255	270	360
Animals & animals care	0	735	770	805	0
Credit requirement	440	613	640	673	590
Credit interest	26	37	38	40	35
LABOUR (md.ha-1)	**73**	**72**	**62**	**62**	**60**
Fencing & Fence maintenance	30	20	10	10	10
Crops implem. and management	8	2	2	2	10
Seeds harvesting	35	0	0	0	40
Bulls management	0	50	50	50	0
BENEFITS (US $)	**512**	**1 360**	**1 430**	**1 500**	**860**
Bulls sale	0	1 360	1 430	1 500	0
Seeds production	512	0	0	0	860
NET INCOME (US $)	**46**	**343**	**367**	**385**	**235**
LABOUR PRODUCTIVITY (US $/ wd)	**0,62**	**4,77**	**5,91**	**6,20**	**3,91**

Illustration 15: Costs & Benefits expected from rice-Beef 5-years farming system (for 1 ha plot)

***Cost / Benefit simulation was made using the following figures:**

First year: Rice + forage implementation:
- Pasture land implementation cost: land preparation (35 US$/ha) + Seeds (rice 30 $US/ha and forage 50$/ha) + Operational costs (15 $US/ha)
- Fertilization: 60-80-60 kg of NPK/ha (total cost of 230 $US/ha) with Bo, Mn and Zn the first and the 5th year (80 $US/ha)
- Credit requirement: All pastureland implementation cost, credit interest of 12%/year during 6 months (from sowing to rice harvest)
- Rice production: 1,6 T/ha at 320 $US/T

2nd to 4th year: Bulls fattening activity
- Inflation rate (all products): 5%/ year
- Bulls stoking rate: 4 animals/ha, initial price of 180 $US for a bull of 110-120 kg (1,2 $US/ living kg)
- Bulls fattening: fattening period of about 5,5 months; average growth rate of 15 kg/animal/month, ie gain of 80 to 90 kg/Al/fattening period
- Credit requirement: credit for buying 2 bulls (the 2 other ones are coming from own farmer herd)+ fertilizer at interest level of 12%/year for 6 months

5th year: Pasture re-establishment using rice as a cash crop
- Rice production: 2,2 T/ha at 390 $US/T

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