WORKING PAPER ON AGRICULTURE &

EXTENSION PROGRAMME

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I GENERAL OVERVIEW OF THE AGRICULTURE SECTOR IN THE NORTHERN UPLANDS

A. Context of development of farming systems

1. Main characteristics of the Northern provinces

The Northern uplands of Lao PDR comprise the 8 following provinces: Phongsali, Luang Namtha, Bokeo, Oudomxay, Houaphane, Luang Prabang, Xieng Khouang and Sayaburi. The total area of those 8 provinces is 112,805 with a total population of 2,032,000 inhabitants. The average population density (18 inhab./km2) is relatively low. The number of ethnic minorities and include all ethno-linguistic groups of Lao PDR.

The geography of the northern regions of Lao PDR is characterized by a mountainous terrain with many areas with sloppy lands and only a few flat or gently sloppy areas, mainly around the main towns of the provinces. That terrain is generally not favourable for agriculture production.
These regions have a tropical humid climate altered by the altitude: the rainfall is quite important during the rainy season (from 1200 mm to 2000 mm) and offers favourable conditions to rice production. With the elevation, in dry season, the temperature can go down until a few degrees above 0 (in some provinces like Houaphane or Phongsali) what make difficult the development of some crops like dry season rice.

In spite of growing network of roads in Lao PDR, road access is still very poor in the Northern provinces, due mainly to the mountainous terrain, the difficult conditions of transportation in rainy season and the scattering of villages. That represents a main constraint for the development of a commercial agriculture and the delivery at village level of government services.

In spite of development of social services at village level, remote villages from the Northern uplands present low levels of basic education and health care. Very few villages have a full primary school and still many villages have no access to clean drinking water supply systems. That impacts directly on the capacities of villagers and the availability of labour for agricultural activity.

2. Government policies

The objective of the government is to eradicate poverty by 2020, particularly in remote rural areas like in the Northern uplands. To reach that objective, the government has established a number of policies since the 90s.

The village relocation and consolidation programme (1989) was enabling to give villagers access to extension and social services as well as markets since villages were relocated next to road facilities.

The shifting cultivation stabilisation programme (1989) was aiming at eliminate pioneering shifting cultivation in order to promote commercial and permanent cropping systems. The village land use planning and allocation measures enabled to define a limited area for

agriculture production and allocate three plots (for upland rice swidden cultivation) to each household. That measure was favouring the shifting cultivation stabilisation programme.

The opium reduction programme (1999) had the objective to reduce opium production to a limited number of uses. It was completed by detoxification programme for drug addicts with improved medical services at village level.

The village cluster development programme (2004) aims at building a political base at kum ban level and addressing better poverty through decentralized extension and social services.

3. Market forces

With several trade agreements (particularly with ASEAN countries and China), the objective of the government to promote industrial and agriculture development and the development of road networks, the number of foreign direct investment projects (particularly from Vietnam, Thailand and China) has increased rapidly since the late 90s. Those FDI projects concern three main sectors: mining, hydropower and agriculture.

In the sector of agriculture, the FDI projects have mainly focused on two crops, rubber (generally through private Chinese companies) and corn (generally through Thai, Vietnamese or Chinese individual traders).
For hybrid corn production (for animal food), local authorities have adopted the 2+3 contract farming where farmers contribute in land and labour and traders in agricultural inputs, technical advice and marketing services.
For rubber, in some cases, the 2+3 contract farming has also been adopted but has sometimes evolved in a 1+4 model where the companies take over the land after a few years of plantation. In other cases, local authorities have signed with private foreign companies land concession agreements: in that case, villagers sell their labour (on a daily basis) to the company plantation and farmers become farm workers.

4. Extension services

The Lao Extension Approach (LEA) is a framework for extension activities in Lao PDR. The LEA was endorsed by the MAF in 2005. The approach consists in one vision, two concepts and three features.

The single vision can be expressed as extension for everyone (whatever your ethnicity, sex, level of wealth or literacy).

The two concepts are decentralization and pluralism. Government assistance to farmers must be planned and organized at the lowest level possible: subject matter specialists (from PAFO) support extension generalists (from DAFO) who respond to needs identified at village level.
Pluralism means basically that extension activities must vary from year to year and from village to village in order to adapt as much as possible to local conditions.

The three operational features of the LEA are:

- participatory approach, involving beneficiaries in the whole process of planning and organization of extension activities;
- needs-based approach, based on an analysis of local constraints and opportunities;
- group-based approach, based on groups at village and kum ban levels.

The LEA operates at village level through the establishment of the village extension system which have four components, (i) village authorities, (ii) production groups, (iii) village extension workers and (iv) learning projects. A further development of the village extension system is the creation of kumban extension networks which encompass it.

Normally extension staff has been allocated in each kum ban in order to organize extension activities and facilitate poverty reduction process through:

- the establishment of those village extension systems;
- the organization of meeting at kum ban level with village extension workers and other representatives;
- the establishment and management of an information centre;
- the establishment of kum ban demonstrations (district technical service centres);
- the establishment of links between producers and agribusiness stakeholders;
- the identification of new opportunities through sector-based studies.

Finally provincial technical service centres managed by PAFO staff, new technologies are identified and shown through demonstration plots for upgrading capacities of both DAFO extension staff and villagers.

B. Northern uplands farming systems

1. Past farming systems based on self-subsistence productions

The past farming systems until the late 90s were mainly based self-subsistence production with upland rice swidden cultivation and free range animal production systems. However, in many upland areas, opium production was the main source of cash income. Opium was generally produced in dry season and rotated with corn used as animal food (particularly for Hmong ethnic minority). Paddy production was only present in the large plains as very few farmers had already established paddy fields in the upland areas in the 90s.

Upland rice was cultivated under slash-and-burn practices after a long fallow period (more than 10 years) enabling soil fertility regeneration (through reconstitution of the forest biomass) and weed control. That system was able to produce surpluses of rice with little investment in capital (axes and hoes) and was not so demanding in labour force (due to little weeding work). Upland rice was not conducted as a monoculture but was associated with many other crops (produced in small quantity for own consumption) including vegetables (chilli, cucumber, gourd, pumpkin, bean), tubers (taro, cassava, sweet potato), other cereals (sweet corn, millet), sugar cane, banana, etc.

Animal production systems were very extensive in labour (free grazing and no production of forages) and capital (nearly no expenses for animal care or feeding except salt). Animal production was used as safety nets (sale of small livestock to cover shortage periods or address cash needs), as savings capital, as sources of cash income and for traditional or religious rituals (sacrifices). But the lack of good animal husbandry and health care practices resulted sometimes in the irruption of large epidemics and the loss of the whole animal stock. Animal production systems could be also a source of decapitalization.

Off-farm incomes consisted mainly of the collection of NTFPs (forest and wildlife resources were very important) for sale, use or own consumption. Collection of NTFPs was also considered as the main coping mechanisms during periods of rice shortages.

2. Current evolution of farming systems towards market-oriented systems

If the animal production systems have not much evolved towards intensive patterns, the other components of the past farming systems have much changed since the late 90s.

The government opium reduction programme has resulted in the eradication of the opium cropping system. Village relocation and consolidation programme as well as land use planning/land allocation process have resulted in an increase population density (within the community land area) and consequently a reduction of the fallow period (in upland rice cropping system) to 3-4 years. That has impacted on the global productivity of the system with a reduction of the yield (declining soil fertility) and an increase of labour requirements (weeding work is now a huge burden).

A few initiatives promoted by government and projects have enabled some farmers to establish paddy fields and produce one or two annual cycles of paddy rice. But the potential for paddy development in upland and remote villages still remains low due to an unfavourable topography.

The increasing number of foreign traders and investors in the agricultural sector as well as the promotion of commercialization agriculture by the government has led the farmers to develop cash cropping productions in place of upland rice systems, particularly with rubber plantations and hybrid corn production. That dynamics has been very rapid: in Houaphane province corn production area has increased from nearly 0 in 2005 to more than 33,000 ha in 2008.
Those crops are produced under monoculture cropping pattern on the same areas as upland rice ones. Mono-cropping production of corn in rotation with very short fallows (down to 6 months) has given decreasing levels of yields, increasing problems of weeds and pests and finally increasing use of pesticides and herbicides what had very negative impacts on environment and on human and animal health.

C. Main issues related to agriculture development

Access to agricultural land and forest resources

The conjunction of an increasing population density, market pressures (particularly for plantations, mining and hydropower projects) and the application of government policies (village relocation and consolidation, land use planning and allocation) has restricted the area available for upland rice cropping systems to a few hectares per household. As a result, farmers must practice swidden cultivation on very short fallows (very young forests), resulting in deficient soil fertility, increasing weeding work and travel time (to reach upland fields). Productivity per unit area and per labour has consequently much decreased leading to longer shortage periods of rice and higher levels of poverty.
The traditional coping mechanisms consisting of the collection of NTFPs has also been affected by a restricted access to forest resources (land allocation policy) and a decreased

availability and diversity of NTFPs (market pressure, population density, uniformity of vegetation in fallow areas).

Livestock productivity

The inexistence of improved animal husbandry techniques (animal feeding with forage production, animal reproduction management, animal health care) in the traditional extensive animal production systems results in very low animal growing rates and very high animal mortality rates. As a result, livestock productivity is very low (even sometimes negative). However livestock activity is very important for villagers as it represents a major safety net and the main capital of the farmers. Moreover the northern regions of Lao PDR with their mountainous terrain offer suitable conditions for livestock production. Therefore animal production and development will one of the main challenges of the programme.

Access to agricultural material and inputs

Except small agricultural tools (such as hoes or machetes), the farmers have no access (at district level) to a large and free market of agricultural material and inputs.
In consequence, they mainly rely on their own seeds and now on agricultural material (hybrid corn seeds) provided at village level by traders. But these traders are in a position of monopoly and therefore do not provide always good quality seeds.
DAFO should be the main supplier of animal vaccines for the farmers. But the lack of coordination between DAFO and PAFO on the one hand and between DAFO and villages hinders the supply in time of those vaccines and often results at the end in the failure of the vaccination campaigns.
Sometimes farmers rely on private sellers located at the district market, particularly for animal vaccines (private drug stores) and chemicals. But generally farmers lack of information on those products to get the appropriate ones and to use them in an adequate way.

Access to extension support

DAFO is the main actor in the provision of agricultural extension services to farmers. But the lack of means, of motivation and interest (mainly due to low levels of salary) and of capacities (the most capable staff is actually attracted by better remuneration in the private sector or international projects) represents a main constraint for carrying out extension and follow-up work at village level.
As a result, village extension systems and kum ban networks proposed by the Lao extension approach hardly exist, particularly for the most remote kum ban and villages and therefore there is a minimal access for farmers to extension services.
Kum ban have already been determined by district authorities and some government staff have already been allocated in some of them. But in most of them, there is no or very little number of staff coming from DAFO (due to its lack of human resources). DAFO staff that has been allocated at kum ban level is generally very young (sometimes students or volunteers without real remuneration apart daily allowances), inexperienced and not much capable. Therefore kum ban extension services are not operational.
Only in a few kum ban, called focal kum ban, benefiting from more resources (budget and staff), extension services are provided to farmers.

Producers' organization

With the rapid evolution of farming systems towards market-oriented ones, there is a real need for organizing producers' group, mainly for the supply of agricultural material and inputs and the commercialization of the production. Lao farmers have no long history of village organizations or farmers' associations since the production and the commercialization are mainly individual.
DAFO wants to organize producers' groups but due to lack of resources and support, most of those groups are actually formed by the private sector and consist only of a list of names, without any organization aiming at managing production and commercialization through the association of its members.

Marketing issues

The productivity of cash production systems is limited by many constraints related to marketing issues such as:

- important fluctuations of market prices: corn farm gate prices have decreased of 50% in 3 years;
- monopsony of traders: traders are allocated by DAFO to a determined zone where they can easily imposed their marketing arrangements to the farmers;
- absence of negotiation power: in front of that position of monopsony of the traders, the inexistence of real producers' organization as well as the lack of market information limits the negotiation power of the farmers and results in the distortion of farm gate prices;
- lack of post-harvest practices or added value activities: most of the production is sold as rough product and then traders carry out added value activities; therefore farm gate prices are minimal.

II PROGRAMME DESIGN

A. Strategy and approach

1. Strategy for securing and improving livelihoods

The programme will aim at securing and improving livelihoods as well as contributing to food security of the poor households through:

- increasing the productivity by production unit (area, animal unit), mainly by alleviating constraints on soil conditions and animal production development;
- increasing the productivity by labour force, by alleviating constraints on labour, what might enables to extend the production systems (increase of limit area per labour);
- strengthening existing safety nets and managing risks (mainly related to market constraints).

Other components of the programme related to access to potable water, preventive health care and nutrition will complement the agriculture component in order to secure food security.

To increase the agricultural productivity, the programme will contribute to the promotion, the development and the diffusion of integrated farming systems, including food and cash cropping systems associated with animal production and the strategy will consist of 5 main key axes:

- distribution of the production systems along the year (to reduce labour force constraints);
- distribution of the production systems within the different types of agricultural areas (to optimize soil productivity);
- association and rotation of multiple crops with multiple uses (for food, cash or animal food) in order to reduce risks related market price fluctuations and favour agronomic performances;
- improvement of agricultural techniques and material, in order to increase economic performances and strengthen safety nets (mainly through improvement of animal production);
- access (for the poorer families) to capital necessary for agriculture investment or production improvement.

2. Capacity building approach

For extension staff, the capacity building approach will mostly focus on DAFO technicians based at kum ban level and in charge of programme implementation.
Capacity building of extension staff will be achieved through 2 main ways:

- formal training and exchanges with PAFO and PTSC;
- on-the-job training through the establishment of technical trial and demonstration plots within the DTSC.

The daily involvement in programme implementation will also contribute to strengthen the technical (bottom-up capitalization process through exchanges with farmers) capacities of extension staff as well as its abilities for programme management.

For villagers, the capacity building approach will first focus on pilot farmers or village facilitators through:

- a reduced number of formal training (conducted at village level) or study tour when appropriate;
- but mostly on-the-job training through the establishment of trial plots (in farming conditions) and exchanges with DAFO technicians.

Secondly, the capacity building of the other villagers will be achieved through a diffusion process of acquired capacities from those pilot farmers or village facilitators through:

- the establishment of formalized networks of technical exchanges between farmers (field days);
- the organization of producers' group facilitating informal exchanges between farmers;
- the establishment of a bottom-up capitalization process (from village to kum ban) through feed back sessions on activity results.

B. Programme activities

1. Support, promotion and diffusion of agriculture models

All agriculture models presented hereafter must not be considered as prescriptive but rather as examples. Those models should be determined at village level according to the local constraints and opportunities during the village planning process (see paragraph C).
However, 5 types of agriculture models should be promoted and should be prioritized according to that following order:

- animal production models;
- upland food and cash cropping systems (on upland areas with low slope);
- vegetable gardens (near the village or on river banks);
- lowland cropping systems (in paddy fields);
- plantation or perennial cropping systems (on sloppy agricultural areas).

a. Improvement and development of animal production

see annexes for technical and economic details

The programme will support and promote the development of forage production and the improvement of animal feeding through the provision of training and forage seeds.
Three forage systems could promoted according to the type of animal production.
The first system is an association of Gramineae (Quini, Rusi, Mulato, etc.) and Stylosanthes (2 rows of Gramineae for 1 row of Stylosanthes) for 3 years. That system will be mainly promoted for ruminants (buffaloes, cows and goats) with two different management of animal feeding:

- cut-and-carry system (more efficient system in terms of animal production but more demanding in labour force);
- free grazing of that improved pasture.

It could be considered an equivalent forage area of 1 ha for 10 adult buffaloes or cows and 0.6 ha for 10 goats (with 50% for pasture grazing and 50% for forage feeding). Forages should be given in a proportion of 15-20% of Stylosanthes and 80-85% of Gramineae and in a quantity of 30% (in dry matter) of the body weight of the cows and buffaloes and 10% for the goats.

The second system is an association of cassava and soybean (2 rows of soybean for 1 row of cassava) for 1 to 2 years. The third system is an association of sweet potato with contour lines of Stylosanthes (4 rows of sweet potato for 1 line of Stylosanthes).

Both systems will be promoted for the feeding (cut-and-carry system) of pigs, poultry and fishes with the following standards:

- for pigs, around 0.1 ha of each system per female and feeding (completed by rice brand, corn residues) in a proportion of 5% of the body weight;
- for chickens and ducks, 10 m2 of cassava/soybean and 5 m2 of sweet potato/Stylosanthes per adult animal and feeding (completed by rice brand, corn residues) in a proportion of 5% of the body weight;
- for fishery (considering a population of 4000 fishes and a fish pond of 0.1 ha), 100 m2 of cassava/soybean and 50 m2.

The programme will contribute to the improvement of animal health care practices (prevention and treatment) through:

- an initial study of animal care practices and health problems in order to establish a first dialogue between villagers and technicians on those issues and solve punctually problems (provision of some veterinary services);
- the provision by kum ban technicians of regular vet services (during the first year of implementation) in order to establish a trust relationship with selected VVWs and villagers;
- the selection and training of VVWs during the first year of programme implementation;
- the definition with the villagers of roles and duties (including financial arrangements) of each actor (kum ban technicians, VVWs, village head, villagers) to facilitate the work of the VVWs and the coordination with kum ban technicians;
- the provision of an initial veterinary kit to VVWs (tools and medicines);
- the follow-up and coordination with VVWs (particularly for vaccination campaign).

The programme will contribute to the improvement of animal husbandry by promoting diverse techniques:

- selection of males and castration;
- animal housing: construction of pens and fencing (particularly for pigs and poultry);
- management of animal movement for ruminants between fallow land or forests and determined and rotating grazing areas.

The programme will support the development of small fish ponds (targeting the poorer families) through:

- the support for the establishment of fish ponds and their water supply and drainage systems;
- the provision of fingerlings and lime;
- the provision of technical advice and follow-up.

The programme will facilitate the access to animal (goats and pigs) capital for the poorer families through the establishment of animal revolving bank/funds.
The programme will provide females (ready to give birth) to a first villager (1 or 2 per beneficiary). Beneficiaries will be organized in groups of guarantee (5 or 6 villagers) in order to reimburse the value of the female in case of death, loss or thief.
Once given birth, the female should be given to the second beneficiary of the group. After sale of their production, beneficiaries should give back to the bank the value of one or two female in order to replace the old ones and make that process sustainable.
Modalities of the implementation of that activity should be discussed and determined in details with villagers.

b. Improvement of agricultural production in the upland fields

see annexes for technical and economic details

The programme will support and promote the establishment of integrated and diversified food and cash cropping systems in order to:

- facilitate soil fertility management, weed and pest control;
- manage risks related to market price fluctuations.

Those systems will consist of associations and rotations of diverse food and cash crop productions. According to soil availability, those systems could be established on permanent fields or associated with short fallows (3 to 4 years).

It would be recommended to develop those systems (if possible) on non sloppy areas where some land preparation work could be considered and might result in higher productivity (better weed and pest control).

Two types of cropping systems could be considered:

- upland rice associated with sesame and a neighbouring ginger garden (year 1) – legumes such as peanut, soybean or rice bean (years 2 and 3) – Job's tear (year 4);
- corn associated with 2 inter-rows of legumes (soybean/peanut) or monoculture of corn (year 1) in rotation with legumes (soybean/peanut) in years 2 and 3.

But the selection of the cropping systems to be promoted must be done at village level (at the same time as the participatory land use planning process) and mainly regarding market opportunities and constraints as well as labour and soil availability and agro-ecological conditions.

The establishment and then diffusion of those cropping systems will be facilitated by:

- the provision of quality seeds;
- the supply of small agricultural equipment: mechanical small seeders or weeders;
- the provision of technical advice for pilot trials on soil fertility management (association with livestock, management of crop residues), weed control (land preparation work, management of vegetal cover) and pest management (trap and barrier systems);
- the establishment of a process of seed selection and diffusion at village level.

c. Development of vegetable production

Vegetable production must be promoted on river banks (in dry season) and in village gardens (in both dry and rainy seasons). That activity should focus mainly on women and poorer households with the main objective of providing diversified sources of food (vitamins, nutrients and fibers) for reducing malnutrition of poorer households, women and children.

The commercialization of that production for cash income should remain a secondary objective.

The systems promoted should consist of diverse associations of vegetables crops such as: chilli, garlic, onion, cabbage and Chinese cabbage, salad, tomato, parsley, coriander, mint, etc.

But those systems should also integrate in a pilot way (particularly for the coldest areas of the northern uplands in dry season) crops which are usually produced in regions with temperate climate and that are not usually consumed by Lao people. Those vegetables such as leek,

turnip or radish have also very high nutritional interest. For that specific training should be provided for technical issues but also on nutritional issues (food preparation).

The establishment of these vegetable gardens will be facilitated by:
- the supply of quality seeds;
- the supply of small agricultural tools (hoes, machete, watering-can, etc.);
- the support for providing water supply equipment (gravity fed systems, boreholes, wells, water ram, solar energy pumps);
- the establishment of a process of seed selection and diffusion at village level.
- the provision of technical advice on vegetable production mainly regarding organic fertilization and association with animal production.

d. Improvement and development of agricultural production in the lowland fields
see annexes for technical and economic details

The programme will contribute to the extension of paddy rice areas of production through:
- the support for establishment of new paddy fields (particularly for poorer families who have labour force constraints) for rainy season production;
- the support for the construction of small-scale irrigation schemes (improved water management for paddy production in WS and development of DS paddy production).

The programme will also contribute to the increase of the productivity of both dry and rainy season paddy rice productions through:
- the provision of quality seeds;
- the establishment of a process of seed selection and improvement;
- the provision of technical advice on paddy rice production mainly regarding fertilization (both chemical and organic) and association with animal production, plot leveling and land preparation, water management

In areas where the construction of small-scale irrigation schemes is not feasible, the programme will promote the establishment of alternative dry season cropping systems (mainly legumes such as soybean and peanut and vegetables like onion, garlic, Chinese cabbage and cabbage) through:
- the provision of seeds;
- the establishment of a process of seed selection and reproduction (when possible);
- the provision of technical advice on those crops mainly regarding organic fertilization, weed and pest control and water management

e. Development of perennial crops and plantations
see annexes for technical and economic details

The promotion of perennial cropping systems must be considered as the last priority as market price fluctuations can limit the productivity of those systems.
However, on very sloppy land, those systems can constitute a good alternative for cash income generation.
According to labour and soil constraints as well as agro-ecological conditions and market opportunities, the perennial cropping systems that could be promoted will include:
- pigeon pea associated with insects for the production of shellac gum (cycle of 2 years): upland rice can be associated during the first year; pigeon pea can be grown on

a longer cycle (4 to 5 years) without the association with insects and constitute a good source of proteins for poultry and pigs (alternative to Stylosanthes);
- sapan associated with upland rice during the first year (cycle of 10 years with 8 years of production);
- galangal associated with upland rice during the first year and legumes for years 2 & 3 (cycle of 8 years with production from year 2);
- paper mulberry associated with upland rice during the first year (cycle of 8 years with production 6 months after transplanting);
- tea plantation (cycle of 25 years with production from year 3).

The establishment of these perennial cropping systems will be facilitated by:
- the provision of agricultural material;
- the provision of technical advice on plantation management (mainly nursery management, transplanting, harvest and pruning, post-harvest practices).

2. Capacity building for villagers

The capacity building programme for villagers will focus on 3 different categories:
- village facilitators such as VVWs and pilot farmers;
- producers' group;
- other villagers.

Two VVWs (one woman and one man) will be trained in each village in 5 days of formal training on:
- accounting and financial management, organization;
- diagnosis of the main diseases;
- treatment of the main diseases;
- preventive animal health: vaccination, deworming, quarantine.

The VVWs will benefit from on-the-job training through:
- accompanying delivery of vet services by kum ban technicians at village level, during the first year of programme implementation;
- organization, coordination and follow-up of VVWs work by kum ban technicians from the second year of programme implementation.

Producers' group will be organized around pilot farmers and according to the existing social relationships or groups of solidarity in the village. Through participatory discussions, selection of key members of the group, definition of roles and responsibilities of each member and financial management and arrangements will be carried out and a document related to those aspects will be issued.
Formal training will be conducted with the key members of the producers' group (for a total of 210 days.trainees per kum ban) on the following issues:
- supply of seeds and inputs and management of collective equipment;
- contact with DAFO and suppliers – contract farming management;
- organization of the production and diffusion of new technologies;
- organization of transport and added value activities;
- contact with traders and organization of marketing.

On-the-job training will take place during programme and activity implementation and follow-up.

Pilot farmers' capacities will be strenghtened at village level through formal training sessions about:

- animal production (forage production, animal husbandry and care practices) for a total of 42 days.trainees per kum ban;
- upland annual cropping systems (soil fertility management, pest and weed control, seed selection) for a total of 84 days.trainees per kum ban;
- vegetable production (establishment of gardens, sowing, transplanting, organic fertilization through association with animal production) for a total of 42 days.trainees per kum ban;
- paddy rice, vegetables and legumes production in the lowland (water management, land preparation and levelling, fertilization, seed selection) for a total of 21 days.trainees per kum ban;
- upland perennial crops (establishment of nursery and plantation, transplanting, harvest and pruning, post-harvest practices) for a total of 21 days.trainees per kum ban.

But most of the capacity building for pilot farmers will consist of the establishment and the implementation of pilot trials (and then their extension) in farming conditions of the promoted agriculture models as well as the follow-up of the kum ban technicians.

The capacities of other villagers will be strengthened through a diffusion process of knowledge and experience from pilot farmers (and not by formal training sessions) in 3 ways:

- informal exchange of information (and possibly agricultural material) on technical issues within producers' groups;
- exchange of information and experiences (capitalization process at village level) during plenary meetings with pilot farmers and kum ban technicians in charge of demonstration plots in DTSC fields (after the end of the agricultural cycle);
- exchange of knowledge and experiences (and possibly agricultural material) with pilot farmers (farmer-to-farmer approach) during field days organized by kum ban technicians at plot level (of pilot farmers); field days are managed and led by pilot farmers; around 7 field days per kum ban and per year (with 20 farmers participants) could be organized on diverse issues from the second year of programme implementation.

3. Capacity building for extension staff

A training need assessment will be conducted in each district (around 4 days per district) at the beginning of programme implementation in order to define a training plan for DAFO and extension staff, particularly on project management issues and institutional/organizational capacities.

According to the needs of the extension staff in terms of technical training, this staff based at kum ban level will be trained at provincial level on issues related to the agriculture models and technologies promoted at village level. 20 days of training (for the whole programme implementation period) will be offered in each target district to:

- 8 staff from crop production unit (on soil fertility management, pest and weed control, use of chemicals and their by-side effects, seed selection and reproduction, post-harvest practices);
- 8 staff from livestock unit (on forage production and animal feeding, forage seed selection and reproduction, management of livestock and grazing areas, animal health and husbandry practices, animal reproduction and selection of males, fingerling production);

- 4 staff from irrigation unit (on survey, design, construction and maintenance of small-scale irrigation scheme, water-pumping small equipment).

Capacities of DAFO technicians based at kum ban level will also be strengthened through on-the-job training by:

- the follow-up of the implementation by the pilot farmers of the agriculture models or technologies promoted by the programme;
- the establishment of trial/demonstration plots with similar (as pilot farmers) or different technologies in DTSC (these DTSC will not be located at a unique place but will consist in scattered small plots in different villages).

To facilitate that process, the programme will support the construction or rehabilitation of one kum ban office, the supply of office facilities and equipment, of agricultural material and equipment and of power-generating equipment (if necessary).

In addition kum ban technicians will establish a technical information centre at kum ban level on appropriate technologies and agricultural material through:

- establishment of information channels from Provincial Uplands Research Centre (NAFRI) or PTSC down to the kum ban centre;
- bottom-up capitalization process from the results of the demonstration plots at village level managed by pilot farmers and DTSC technicians up to the kum ban centre.

That technical information centre (which will be useful for capacity building or both farmers and technicians) will consist mainly on technical theoretical protocol (information from provincial level) and practical results (monitoring data from DTSC and pilot farmers' plots).

Moreover capacities on project cycle management of DAFO and kum ban technicians will be strengthened through formal training at provincial level (16 days for the whole programme implementation for 20 district staff). Those training should deal with the following issues:

- characterization and understanding of the diverse farming systems (SWOT analysis, problem tree analysis, etc.);
- participatory planning process/ support of the farmers to take decisions according to land, labour force and capital constraints or availability, market opportunities, agro-ecological conditions, farmers' interest and capacities;
- establishment of experiment/trial procedures and evaluation of the results;
- organization of producers' group;
- management of VVW activity (financial management and coordination arrangements);
- monitoring and evaluation of activities' results;
- reporting.

However, the implementation of the programme by kum ban technicians will be the main way to acquire all those capacities as they will be practically used.

Finally DAFO leaders (head and vice-head of DAFO, heads of administration and technical units) will be provided with formal training on institutional/organizational aspects (20 days for the whole programme implementation for 5 district staff). These training sessions will concern the following areas:

- human resources development (development of ToRs for DAFO staff);
- work/tasks management and organization (planning, monitoring and reporting systems);
- communication and coordination systems (information flow and management) within DAFO and with other district agencies;
- financial and means management.

C. Bottom-up planning procedures

The bottom-up planning process must be conducted at the beginning of each year (ideally at the end of the dry season cycle of production between January and February).

For the first year of programme implementation that process is a bit more complex and can distributed into the following steps.
First step: establishment of a village base line data per family.
That base line data (which will be a key tool for monitoring and evaluation – see details in paragraph E.) describe in a quantitative way the current cropping systems, their performance and the means of production for each family: it gives a rough picture of the current economy of each household.

Second step: location of cropping systems and natural resources.
Through discussions with villagers around a map (made by villagers) of the community land area, that step enables to locate the past and current cropping systems, the type and age of fallows, the grazing areas, the different types of forest and forest use, the water resources and the NTFPs collected for consumption, sale and use. Planning facilitators must have a comparative approach over the last ten years.

Third step: characterization of the socio-economic differentiation
With the facilitation of programme staff, the villagers have to build a map of the village itself where are represented:

- each house and village facilities (access road, water supply, school, health centre, other community infrastructure);
- for each house symbols of economic differentiation (generally rice self-sufficiency, animal capital, productive capital such as hand tractors, means of transport, rice-mill, type of roof, etc. but also active member of the family addicted to opium);
- social relationships between households (family relations, groups of solidarity with informal credit, groups of exchange of labour force for upland cropping systems): that social network within the village will be very useful to identify producers' group.

With the help of that village map and through participatory discussions with villagers, planning facilitators will identify socio-economic groups of villagers with their related farming systems and their level of individual capital and rice shortage or surplus as well as the possible social relationships between households belonging to different socio-economic groups.

Fourth step: characterization of constraints and opportunities
Through discussions by different socio-economic groups (women and men, groups of wealth), from a list of problems mentioned by villagers, planning facilitators must identify for each production area the causes of problems (constraints) and the possible solutions (opportunities) related to labour force, soil availability, soil conditions, capital, farmers' capacity, market and village infrastructures.

Fifth step: selection of possible agriculture models or technologies to be promoted
According to the previous identified constraints and opportunities, planning facilitators present a list of possible initiatives and their implication (in terms of labour, soil conditions, market opportunities or risks) to each of the socio-economic groups. After discussion and scoring activity, planning facilitators identify a few initiatives to be promoted during the first year with pilot farmers.

Sixth step: finalization of planning process
Planning facilitators present to all villagers the results of the different discussion groups and the selected activities. Villagers identify a list of beneficiaries (with at least 50% of poorer households) then identify producers' groups for each activity and pilot farmers within each producers' group or activity. The formation of producers' group is not absolutely necessary but would be essential for cash crop productions.

For the following years of programme implementation that process is much more simplified and related to the results of activity implementation.
During planning process, pilot farmers, head of producers' groups and VVWs present to the villagers the results of their activity, the problems or constraints they have faced and the good points. According to the results, villagers propose to extend, modify or stop the current activities and possibly propose others that have been suggested already in the past years.
Planning facilitators present the modalities (budget, number of beneficiaries, etc.) for the implementation of the activities proposed by the villagers for the next cycles of production.
According to those modalities, the villagers agree on a list of new beneficiaries for new activities or for extending the current ones.

D. Implementation mechanisms and arrangements

1. Role and responsibilities of programme staff in programme implementation

To facilitate the programme implementation a provincial coordinator (local TA) will be appointed in each target province as well as kum ban coordinator (local TA) in each targeted kum ban for the whole implementation period.

The provincial coordinator must have a technical background (agriculture) and a long experience (at least 15 years) in project management and implementation.
His main duties and responsibilities will be:

- management of programme implementation;
- budget management (at provincial level);
- assistance to kum ban coordinators for activity implementation;
- design of monitoring and evaluation systems;
- assistance to DAFO and PAFO for procurement (agricultural material) and provision of training;
- facilitation of coordination between provincial (PAFO) and district levels (DAFO);
- liaison, communication and reporting with provincial (PAFO) and central levels (MAF);
- facilitation of coordination between all government concerned agencies at provincial level;
- general project reporting.

The kum ban coordinator must have a technical background (agriculture) and a significant experience (at least 5 years) in rural development project and community work.
His main duties and responsibilities will be:

- management of activity implementation;
- budget management (at kum ban level);

- assistance to kum ban extension staff in the implementation of the activities (planning, implementation, follow-up, monitoring & evaluation, capacity building activities for villagers);
- assistance to kum ban staff in the establishment and the management of DTSCs;
- assistance to kum ban staff for procurement (mostly agricultural material);
- facilitation of coordination between kum ban and district levels (DAFO);
- yearly assessment of capacities of kum ban staff (progress and needs);
- annual reporting.

Apart provincial and kum ban coordinators, external expertise will be required for:
- the initial study on animal health practices and problems (national livestock or veterinary expert);
- the initial training need assessment conducted at DAFO level (national extension expert from NAFES/LEAP).

Kum ban staff will be responsible for the establishment and management of DTSCs, the implementation and the follow-up of programme activities at village level and the capacity building process of villagers. They will be particularly assisted by kum ban coordinators for monitoring and evaluation work and community work (organization and management of producers' group, animal bank and VVW activity).

PAFO staff (from extension unit or PTSC) will be responsible for planning, organizing and providing training to kum ban extension and DAFO staff. They will be particularly assisted by the provincial coordinator for training related to project management and institutional/organizational issues.

Coordination mechanisms between kum ban level and district level (DAFO) will take place through regular reporting and planning meetings (every three months). These coordination mechanisms will be facilitated by kum ban facilitators.
Annual meetings at provincial level facilitated by the provincial coordinator will enable to establish coordination links between the DAFOs and PAFO: these meetings will aim at providing an annual reporting of the results of programme implementation, a draft of a general plan for the following year (strategy) and its related budget.

Finally horizontal coordination mechanisms will take place at provincial level through a steering committee gathering all concerned government agencies (planning, governor's office and technical departments).

2. Financial support for programme implementation at village level

All seeds, seedlings, fingerlings and agricultural inputs will be granted to villagers but only on a small quantity. The rest will be provided on a market price basis by either the extension staff (including the production of DTSCs), the private sector or the farmers themselves.

The small agricultural equipment (mechanical seeders and weeders, pumping equipment) will be granted on a pilot basis to groups of producers. Modalities of use and management of that equipment will be defined by the groups themselves with the assistance of extension staff.

The support for the establishment of new paddy fields and the construction of small-scale irrigation schemes will be provided on a cash for work basis, with villagers required labour

and material (sand, gravel, wood) and the programme providing the necessary equipment (machinery), inputs (such as concrete) and technical advice.

The veterinary services provided in year 1 by the kum ban technicians will be free of charge. Only the cost of vaccines and medicines will be charged to villagers.

An initial veterinary kit (tools and medicines) will be granted to all VVWs. For the following years, the provision of veterinary services by VVWs will be charged to villagers (according to financial arrangements defined between VVWs and villagers) in order to sustain a veterinary store at village level and provide a remuneration for VVWs activity.

An initial animal fund (in kind) will be granted to village animal revolving banks. The modalities for the implementation of that activity will enable to sustain and renew that initial animal capital: they will consist of giving back the capital (animal female) to the bank and part of its production (offspring) in order to renew old females of the animal bank.

3. Workplan and distribution of programme activities

The programme will be implemented:

- in year 1, in 3 provinces, in 2 districts of each province and 2 kum ban for each district;
- in year 2, in 3 provinces, in 3 districts of each province, in 4 kum ban for the targeted district in year 1 and in 2 kum ban for the new targeted district;
- in years 3 and 4, in 3 provinces in 3 districts of each province and in 4 kum ban for each district.

The following tables summarize the targeted areas during the programme implementation period.

Cumulative number of targeted areas

Areas	2009/10	2010/11	2011/12	2012/13
Province	3	3	3	3
District	6	9	9	9
Kum ban	12	30	36	36
Village	84	210	252	252

Number of new targeted areas

Areas	2009/10	2010/11	2011/12	2012/13
Province	3	0	0	0
District	6	3	0	0
Kum ban	12	18	6	0
Village	84	126	42	0

Implementation years at village level

Number of targeted villages	2009/10	2010/11	2011/12	2012/13
84 villages	Y1	Y2	Y3	Y4
126 villages	/	Y1	Y2	Y3
42 villages	/	/	Y1	Y2

The distribution of activities along the whole programme implementation period will be as follows (figures are expressed in percentages – see also budget table for related costs):

Activities	2009/10	2010/11	2011/12	2012/13
Livestock				
Study on animal health practices and problems	100	0	0	0
Support for kum ban vet services	33	50	17	0
Support for initial VVW fund	33	50	17	0
Support for initial animal bank fund	33	50	17	0
Support for fodder initiatives (seeds)	33	50	17	0
Upland annual crops				
Support for annual crops initiatives (seeds)	11	26	32	32
Support for small agricultural equipment	33	50	17	
Vegetable production				
Support for vegetable production initiatives (seeds)	11	26	32	32
Support for small agricultural equipment	33	50	17	0
Cropping systems in paddy fields				
Support for paddy field establishment	17	33	33	17
Support for small-scale irrigation scheme	17	33	33	17
Support for lowland production initiatives (seeds and agricultural inputs)	33	33	17	17
Upland perennial crops				
Support for perennial crops initiatives (agricultural material)	11	26	32	32
Capacity building for villagers				
Technical training for pilot farmers (80% in Y1 – 20% in Y2)	27	47	23	3
Training for VVWs (50% in Y1 – 30% in Y2 – 20% in Y3)	17	36	31	16
Training for producers' group (60% in Y1 – 20% in Y2 – 20% in Y3)	21	38	28	14
Field days (exchanges between farmers – 7 days per kum ban from Y2)	0	15	38	46
Capacity building for extension staff				
Training need assessment	67	33	0	0
Support for kum ban office and infrastructures	33	50	17	0
Support for technical information centre at kum ban level	22	37	30	11
Support for DTSCs (equipment, seeds and fingerlings)	11	26	32	32
Training on technical issues	25	25	25	25
Training on project management issues (50% in Y1 – 31% in Y2 – 19% in Y3)	33	38	23	6
Training on institution/organization issues (50% in Y1 – 30% in Y2 – 20% in Y3)	33	37	23	7

NB: Y1/Y2/Y3 refers to the implementation year at village (see the table above) and as a result does not correspond to a precise year (depending on the villages)

E. Monitoring & evaluation system

The first system is based on a village base line data reflecting the situation of the household economy. That base line data which must be updated every year includes the following information:

- demographic data: number of persons, age, sex, number of labour force;
- crop production data: for each cropping system, area, input costs, yield or production;
- animal production data: for each type, stock number (adult and young animals), number of births, animal mortality, sale or consumption of animals;
- possession of productive capital such as hand-tractors, driers, etc.;
- possession of non-productive capital such as rice-mill, means of transportation, TV or video equipment;
- information on off-farm sources of incomes such as handicrafts, NTFPs, sale of labour force, etc.

That data base line enables to assess the evolution of the family income as well as the differentiation between better-off and poorer families.

The second system aims at assessing the impact of the programme activities. It mainly consists of comparative assessments (qualitative and quantitative) between the current and the past situations, and between beneficiaries and non-beneficiaries of the programme. It implies more elaborated indicators or measurements such as:

- number of beneficiaries who have adopted the proposed initiatives; rate of diffusion and extension;
- qualitative assessment of the activity of producers' group and financial (including collective equipment) statement;
- qualitative assessment of the activity of the VVWs, financial situation and situation of the veterinary stock;
- comparative animal mortality rate for the farmers who have adopted improved health care practices;
- comparative animal growing rate for the farmers who have adopted improved feeding and husbandry practices;
- number of beneficiaries of animal revolving bank (revolving rate); current capital (in animal or cash) of the bank compared to the initial one; ratio benefit for villagers (offspring) per current capital of the bank;
- comparative productivity per labour or per unit surface for the farmers who have adopted cropping systems initiatives;
- comparative malnutrition rate for the farmers who are involved in vegetable production.

That system will help the programme staff to understand the reasons for why some villagers have not yet adopted proposed initiatives and then modify activities or implementation methods in order to get a better efficiency of the programme.

The third system should enable to assess the capacities of kum ban technicians. But this is quite impossible in a quantitative way (and must not be done during or at the end of training sessions). The only consists of qualitative annual assessments by field facilitators through the evaluation of the work done at field level with villagers and the capacities to establish and manage DTSCs.

ANNEXES

SYSTEM A1 – Upland rice (associated with sesame and ginger) in rotation with soybean, peanut and Job's tear

Upland rice with sesame (90% of the area) and ginger (10% of the area) in year1 followed by soybean/peanut (years 2 and 3) and Job's tear (year 4)
Length of rotation cycle: 4 years

Technical protocol

Upland rice with sesame (year 1)

1) Pre-cultural operations
- Slashing (February);
- Burning (March-April);
- Land clearing (April);
- Fencing (April).

2) Cultural operations
- Sowing (rice): spacing of 25 to 30 * 30 to 35 cm – sowing density of 60 kg/ha – 10-15 seeds per hole (May);
- Sowing (sesame): seed broadcasting – sowing density of 3 kg/ha (May);
- Weeding: 3 times (from June to August);
- Rice harvest (from end of September to beginning of November, depending on rice varieties);
- Sesame harvest (November).

3) Post-harvest operations
- Rice drying in the field, after the harvest;
- Rice threshing in the field, 15 days after the harvest (no threshing operation is required when rice is harvested by hand);
- Sesame threshing, after the harvest.

Ginger garden (year 1)

1) Pre-cultural operations (same as upland rice field)

2) Cultural operations
- Land preparation (seed beds) (end of April)
- Planting (mid May until mid June): spacing of 30 * 50 cm – planting density of 1 t/ha – 1 root per hole;
- Weeding: 2 times (July and September);
- Harvest (November-December).

Soybean/Peanut (years 2 and 3)

1) Pre-cultural operations
- Land clearing (May);
- Burning (May);
- Reparation of fences (June).

2) Cultural operations
- Sowing (soybean): spacing of 50*25 cm – sowing density of 45 kg/ha – 5 seeds in each hole – Plant thinning to 3 shoots (July);
- Sowing (peanut): spacing of 40*30 cm – sowing density of 45 kg/ha – 3 seeds in each hole (July);
- Weeding (soybean/peanut): 2 times at 4 and 8 leaves growing stage;
- Soybean/Peanut harvest (end of September).

3) Post-harvest practices
- Soybean drying in the field, after the harvest;
- Soybean threshing in the field, after drying;
- Soybean pod drying under the house, after threshing and transport.
- Peanut pod drying in the village, after harvest and transport;
- Peanut seed extraction, after drying.

Job's tear (year 4)

1) Pre-cultural operations
- Land clearing (April);
- Burning (April);
- Reparation of fences (May).

2) Cultural operations
- Sowing: spacing of 100*100 cm – sowing density of 55-60 kg/ha (May);
- Weeding: 2 times at 4 and 8 leaves growing stage;
- Harvest (November).

3) Post-harvest practices
- Threshing, after the harvest;

Gross margin analysis (per hectare)

Labour and input costs

Cultural operations	Labour force costs	Input costs		
		Unit cost	Quantity	Total
Upland rice with sesame – Year 1				
Slashing	33			
Burning	1			
Land clearing	22			
Fencing	10			
Sowing (rice & sesame)	26	1500 K/kg (rice) 10,000 K/kg (sesame)	60 kg 3 kg	90,000 K 30,000 K
Weeding	120			
Harvest (rice)	48			
Drying (rice)	/			
Threshing (rice)	27			
Harvest (sesame)	15			
Threshing (sesame)	8			
Total Upland rice with sesame	310	/	/	120,000 K
Ginger – Year 1				
Slashing	33			
Burning	1			
Land clearing	22			
Fencing	10			
Land preparation	18			
Planting	10	6000 K/kg	1000 kg	6,000,000 K
Weeding	80			
Harvest	28			
Total Ginger	202	/	/	6,000,000 K
Average Year 1	299.2			708,000 K
Soybean/Peanut – Years 2 & 3				
Land	30 * 2			

clearing/Burning				
Fencing	30 * 2			
Sowing (soybean)	16	12,000 K/kg	45 kg	540,000 K
Sowing (peanut)	16	12,000 K/kg	45 kg	540,000 K
Weeding	60 * 2			
Harvest	10 *2			
Drying/Threshing (soybean)	20			
Pod drying (soybean)	6			
Post-harvest operations (peanut)	20			
Average Soybean/Peanut per year	169	/	/	540,000 K
Job's Tear – Year 4				
Land clearing/Burning	30			
Fencing	30			
Planting	16	2,000 K/kg	55-60 kg	115,000 K
Weeding	45			
Harvest	20			
Threshing	30			
Total Job's Tear	171	/	/	115,000 K
Average cropping system per year	202	/	/	476,000 K

Outputs

Production	Yield	Unit price		Total	
		Minimum	Maximum	Minimum	Maximum
Upland rice	1.5 t	1800 K/kg	2000 K/kg	2,700,000 K	3,000,000 K
Sesame	600 kg	9000 K/kg	11000 K/kg	5,400,000 K	6,600,000 K
Ginger	8 t	3000 K/kg	4000 K/kg	24,000,000 K	32,000,000 K
Soybean	2.2 t	2500 K/kg	5000 K/kg	5,500,000 K	11,000,000 K
Peanut	800 kg	4500 K/kg	5000 K/kg	3,600,000 K	4,000,000 K
Job's tear	2 t	1000 K/kg	2000 K/kg	2,000,000 K	4,000,000 K
Average per year	/			5,197,500 K	7,710,000 K

Productivity per unit surface and per labour

Production	Gross margin per unit surface		Gross margin per labour force	
	Minimum	Maximum	Minimum	Maximum
Upland rice/Sesame	7,980,000 K	9,480,000 K	25,700 K	30,600 K
Ginger	18,000,000 K	26,000,000 K	89,100 K	128,700 K
Soybean	4,960,000 K	10,460,000 K	28,800 K	60,800 K
Peanut	3,060,000 K	3,460,000 K	18,400 K	20,800 K
Job's tear	1,885,000 K	3,885,000 K	11,000 K	22,700 K
Average	4,721,750 K	7,234,250 K	23,400 K	35,800 K

SYSTEM A2a – Corn in association with soybean

Corn in association with inter-rows of soybean (2 rows of soybean for 1 row of corn).
Length of rotation cycle: 1 year

Technical protocol

Corn in association with soybean

1) Pre-cultural operations
- Slashing (April);
- Burning (April);
- Land clearing (April);
- Fencing (May).

2) Cultural operations
- Sowing of soybean: spacing on the line of 25 cm – spacing rows of soybean to soybean of 50 cm and 25 cm for corn to soybean – Sowing density of 35-40 kg/ha – 5 seeds per hole – Plant thinning to 3 shoots (end of May-June);
- Sowing of corn: spacing on the line of 35 cm – spacing rows of corn to corn of 100 cm and 25 cm for corn to soybean – Sowing density of 15 kg/ha – 2 seeds per hole – Plant thinning to 1 stem (end of May-June);
- Weeding: 1 time (when corn has reached 4 leaves growing stage);
- Harvest of soybean (September);
- Harvest of corn (October).

3) Post-harvest operations
- Corn drying, after the harvest;
- Corn shelling, when time to use or sell it;
- Soybean drying in the field, after the harvest;
- Soybean threshing in the field, after drying;
- Soybean pod drying under the house, after threshing and transport.

Gross margin analysis (per hectare)

Labour and input costs

Cultural operations	Labour force costs	Input costs		
		Unit cost	Quantity	Total
Corn with soybean				
Slashing	24			
Burning	2			
Land clearing	15			
Fencing	11			
Sowing (corn)	10	20,000 K/kg	15 kg	300,000 K
Sowing (soybean)	15	12,000 K/kg	35-40 kg	450,000 K
Weeding	45			
Harvest (corn)	27			
Harvest (soybean)	10			
Corn drying and shelling	6 + 10			
Drying/Threshing (soybean)	20			
Pod drying	6			

Total cropping system	201	/	/	750,000 K

Outputs

Production	Yield	Unit price		Total	
		Minimum	Maximum	Minimum	Maximum
Corn	3.5 t	600 K/kg	1200 K/kg	2,100,000 K	4,200,000 K
Soybean	1.5 t	2500 K/kg	5000 K/kg	3,750,000 K	7,500,000 K
Total	/			11,150,000 K	17,750,000 K

Productivity per unit surface and per labour

Production	Gross margin per unit surface		Gross margin per labour force	
	Minimum	Maximum	Minimum	Maximum
Corn	1,800,000 K	3,900,000 K	/	/
Soybean	3,300,000 K	7,050,000 K	/	/
Total	5,100,000 K	10,950,000 K	25,400 K	54,500 K

SYSTEM A2b – Corn in association with peanut

Corn in association with inter-rows of peanut (2 rows of peanut for 1 row of corn).
Length of rotation cycle: 1 year

Technical protocol

Corn in association with peanut

1) Pre-cultural operations
- Slashing (April);
- Burning (April);
- Land clearing (April);
- Fencing (May).

2) Cultural operations
- Sowing of peanut: spacing on the line of 25 cm – spacing rows of peanut to peanut of 50 cm and 25 cm for corn to peanut – Sowing density of 25-30 kg/ha – 3 seeds per hole;
- Sowing of corn: spacing on the line of 35 cm – spacing rows of corn to corn of 100 cm and 25 cm for corn to peanut – Sowing density of 15 kg/ha – 2 seeds per hole – Plant thinning to 1 stem (end of May-June);
- Weeding: 1 time (when corn has reached 4 leaves growing stage);
- Harvest of peanut (September);
- Harvest of corn (October).

3) Post-harvest operations
- Corn drying, after the harvest;
- Corn shelling, when time to use or sell it;
- Drying of peanut seeds in the village, after harvest and transport;
- Extraction of peanut seeds, after drying.

Gross margin analysis (per hectare)

Labour and input costs

Cultural operations	Labour force costs	Input costs		
		Unit cost	Quantity	Total
Corn with peanut				
Slashing	24			
Burning	2			
Land clearing	15			
Fencing	11			
Sowing (corn)	10	20,000 K/kg	15 kg	300,000 K
Sowing (peanut)	15	12,000 K/kg	25-30 kg	330,000 K
Weeding	45			
Harvest (corn)	27			
Harvest (peanut)	10			
Corn drying and shelling	6 + 10			
Post-harvest operations (peanut)	20			
Total cropping system	195	/	/	630,000 K

Outputs

Production	Yield	Unit price		Total	
		Minimum	Maximum	Minimum	Maximum
Corn	3.5 t	600 K/kg	1200 K/kg	2,100,000 K	4,200,000 K
Peanut	500 kg	4500 K/kg	5000 K/kg	2,250,000 K	2,500,000 K
Total	/			4,350,000 K	6,700,000 K

Productivity per unit surface and per labour

Production	Gross margin per unit surface		Gross margin per labour force	
	Minimum	Maximum	Minimum	Maximum
Corn	1,800,000 K	3,900,000 K	/	/
Peanut	1,920,000 K	2,170,000 K	/	/
Total	3,720,000 K	6,070,000 K	19,100 K	31,100 K

SYSTEM A2c – Corn in rotation with soybean

Corn (year1) in rotation with soybean (in year2).
Length of rotation cycle: 2 years

Technical protocol

Corn (year 1)

1) Pre-cultural operations
- Slashing (March);
- Burning (March);
- Land clearing (March);
- Fencing (April).

2) Cultural operations
- Sowing: spacing of 70*35 cm – sowing density of 18-20 kg/ha – 2 seeds per hole – plant thinning to one stem (May);
- Weeding: 2 times (at 4 and 8 leaves growing stages);
- Harvest (September).

3) Post-harvest operations
- Drying in the field, after the harvest;
- Corn shelling, when it is time to use or sell it.

Soybean (year 2)

1) Pre-cultural operations
- Land clearing (May);
- Burning (May);
- Reparation of fences (June).

2) Cultural operations
- Sowing: spacing of 50*25 cm – sowing density of 45 kg/ha – 5 seeds in each hole – Plant thinning to 3 shoots (July);
- Weeding: 2 times at 4 and 8 leaves growing stage;
- Harvest (end of September).

3) Post-harvest practices
- Drying in the field, after the harvest;
- Threshing in the field, after drying;
- Pod drying under the house, after threshing and transport.

Gross margin analysis (per hectare)

Labour and input costs

Cultural operations	Labour force costs	Input costs		
		Unit cost	Quantity	Total
Year 1 – Corn				
Slashing	24			
Burning	2			
Land clearing	15			
Fencing	11			

Sowing	16	20,000 K/kg	18-20 kg	380,000 K
Weeding	45			
Harvest	27			
Drying and corn shelling	6+10			
Total Corn	156			380,000 K
Year 2 – Soybean				
Land clearing/Burning	30			
Fencing	30			
Sowing	16	12,000 K/kg	45 kg	540,000 K
Weeding	60			
Harvest	10			
Drying/Threshing	20			
Pod drying	6			
Total Soybean	172	/	/	540,000 K
Average cropping system	164	/	/	460,000 K

Outputs

Production	Yield	Unit price		Total	
		Minimum	Maximum	Minimum	Maximum
Corn	5 t	600 K/kg	1200 K/kg	3,000,000 K	6,000,000 K
Soybean	2.2 t	2500 K/kg	5000 K/kg	5,500,000 K	11,000,000 K
Average per year	/			4,250,000 K	8,500,000 K

Productivity per unit surface and per labour

Production	Gross margin per unit surface		Gross margin per labour force	
	Minimum	Maximum	Minimum	Maximum
Corn	2,620,000 K	5,620,000 K	16,800 K	36,000 K
Soybean	4,960,000 K	10,460,000 K	28,800 K	60,800 K
Average per year	3,790,000 K	8,040,000 K	23,100 K	49,000 K

SYSTEM A2d – Corn in rotation with peanut

Corn (year1) in rotation with peanut (in year2).
Length of rotation cycle: 2 years

Technical protocol

Corn (year 1)

1) Pre-cultural operations
- Slashing (March);
- Burning (March);
- Land clearing (March);
- Fencing (April).

2) Cultural operations
- Sowing: spacing of 70*35 cm – sowing density of 18-20 kg/ha – 2 seeds per hole – plant thinning to one stem (May);
- Weeding: 2 times (at 4 and 8 leaves growing stages);
- Harvest (September).

3) Post-harvest operations
- Drying in the field, after the harvest;
- Corn shelling, when it is time to use or sell it.

Peanut (year 2)

1) Pre-cultural operations
- Land clearing (May);
- Burning (May);
- Reparation of fences (June).

2) Cultural operations
- Sowing: spacing of 40*30 cm – sowing density of 45 kg/ha – 3 seeds in each hole (July);
- Weeding: 2 times at 4 and 8 leaves growing stages;
- Harvest (end of September).

3) Post-harvest practices
- Pod drying in the village, after harvest and transport;
- Seed extraction, after drying.

Gross margin analysis (per hectare)

Labour and input costs

Cultural operations	Labour force costs	Input costs		
		Unit cost	Quantity	Total
Year 1 – Corn				
Slashing	24			
Burning	2			
Land clearing	15			
Fencing	11			
Sowing	16	20,000 K/kg	18-20 kg	380,000 K
Weeding	45			

Harvest	27			
Drying and corn shelling	6+10			
Total Corn	156			380,000 K
Year 2 – Peanut				
Land clearing/Burning	30			
Fencing	30			
Sowing	16	12,000 K	45 kg	540,000 K
Weeding	60			
Harvest	10			
Post-harvest operations	20			
Total Peanut	166	/	/	540,000 K
Average cropping system	161	/	/	460,000 K

Outputs

Production	Yield	Unit price		Total	
		Minimum	Maximum	Minimum	Maximum
Corn	5 t	600 K/kg	1200 K/kg	3,000,000 K	6,000,000 K
Peanut	800 kg	4500 K/kg	5000 K/kg	3,600,000 K	4,000,000 K
Average per year	/			3,300,000 K	5,000,000 K

Productivity per unit surface and per labour

Production	Gross margin per unit surface		Gross margin per labour force	
	Minimum	Maximum	Minimum	Maximum
Corn	2,620,000 K	5,620,000 K	16,800 K	36,000 K
Peanut	3,060,000 K	3,460,000 K	18,400 K	20,800 K
Average per year	2,840,000 K	4,540,000 K	17,600 K	28,200 K

SYSTEM B1 – Paddy rice (in dry and wet seasons)

Paddy rice (dry season) – Paddy rice (wet season)
Length of rotation cycle: 1 year

Technical protocol

Dry season paddy rice

1) Rice nursery operations
- Land clearing (January);
- Dyke re-building (January);
- Nursery land preparation: ploughing and harrowing (January);
- Fertilisation with manure: 1 kg/m2 (just before harrowing);
- Nursery fencing (January);
- Rice broadcasting: 300 g/m2 (January);
- Full-time irrigation;
- No weeding.

2) Paddy field operations
- Land preparation: harrowing and ploughing (February);
- Fertilisation with manure (5 to 10 t/ha) before harrowing;
- Field fencing (February);
- Transplanting: spacing of 20 to 25 cm * 25 to 30 cm (depending on soil conditions) – 3 seedlings per hill (February);
- Chemical fertilisation: 90 kg/ha N – 60 kg/ha P – 30 kg/ha K (in 3 times at 25, 45 and 75 days after transplanting);
- Weeding: 2 times, 45 and 75 days after transplantation;
- Full-time irrigation;
- Harvest (May).

3) Post-harvest practices
- Rice drying in the field or under the house (depending on weather conditions), in May;
- Rice threshing in the field or under the house (depending on weather conditions), in May.

Wet season paddy rice

1) Rice nursery operations
- Land clearing (May);
- Dyke re-building (May);
- Nursery land preparation: ploughing and harrowing (May);
- Fertilisation with manure: 1 kg/m2 (just before harrowing);
- Nursery fencing (May);
- Rice broadcasting: 300 g/m2 (May);
- If existing irrigation scheme, full-time irrigation, if not, only rainfed rice cropping;
- No weeding.

2) Paddy field operations
- Land preparation: harrowing and ploughing (June);
- Fertilisation with manure (5 to 10 t/ha) before harrowing;
- Field fencing (June);
- Transplanting: spacing of 20 to 25 cm * 25 to 30 cm (depending on soil conditions) – 3 seedlings per hill (June to July, depending on access to irrigation or rain conditions);
- Weeding: 2 times, 45 and 75 days after transplantation;
- If existing irrigation scheme, full-time irrigation, if not, only rainfed rice cropping;

- Harvest (beginning of October to end of November, depending on rice varieties).

3) Post-harvest practices
- Rice drying in the field, after the harvest;
- Rice threshing in the field, after the harvest.

Gross margin analysis (per hectare)

Labour and input costs

Cultural operations	Labour force costs (in men.day or md)	Input costs		
		Unit cost	Quantity	Total
Dry season paddy rice				
Land clearing	2			
Dyke re-building	6			
Nursery establishment and fencing	2			
Sowing	4	2500 K/kg	80 kg	200,000 K
Irrigation	5			
Fertilisation	2	50 K/kg	270 kg	13,500 K
Field preparation	3 (hand tractor) 15 (drought animals)	8000 K/l	30 l	240,000 K
Fencing	20			
Transplanting	30			
Fertilisation	2	50 K/kg 1800 K/kg 3000 K/kg 3000 K/kg	5 to 10 t 130 kg Urea 200 kg P2O5 200 kg 15-15-15	375,000 K 234,000 K 600,000 K 600,000 K
Weeding	45			
Irrigation/Drainage	25			
Harvest	25			
Drying	15			
Threshing	10			
Total dry season paddy rice	196 (hand tractor) 208 (drought animals)	/	/	2,262,500 K (hand tractor) 2,022,500 K (drought animals)
Wet season paddy rice				
Land clearing	2			
Dyke re-building	6			
Nursery establishment and fencing	2			
Sowing	4	2500 K/kg	60 kg	150,000 K
Irrigation	5			
Fertilisation	2	50 K/kg	200 kg	10,000 K
Field preparation	3 (hand tractor) 15 (animals)	8000 K/l	30 l	240, 000 K
Fencing	20			
Transplanting	30			
Fertilisation	2	50 K/kg	5 to 10 t	375,000 K
Weeding	45			
Irrigation/Drainage	25			
Harvest	25			

Drying	15			
Threshing	10			
Total wet season paddy rice	196 (hand tractor) 208 (drought animals)			775,000 K (hand tractor) 535,000 K (draught animals)
Total cropping system	392 (hand tractor) 416 (drought animals)	/	/	3,037,500 K (hand tractor) 2,557,500 K (draught animals)

Outputs

Production	Yield	Unit price		Total	
		Minimum	Maximum	Minimum	Maximum
Dry season rice	4.5 t/ha	1800 K/kg	2000 K/kg	8,100,000 K	9,000,000 K
Wet season rice	3.5 t/ha	1400 K/kg	1500 K/kg	4,900,000 K	5,250,000 K
Total	/			13,000,000 K	14,250,000 K

Productivity per unit surface and per labour

Production		Gross margin per unit surface		Gross margin per labour force	
		Minimum	Maximum	Minimum	Maximum
Dry season rice	With hand tractor	5,837,500 K	6,737,500 K	29,800 K	34,400 K
	With draught animals	6,077,500 K	6,977,500 K	29,200 K	33,500 K
Wet season rice	With hand tractor	4,125,000 K	4,475,000 K	21,000 K	22,800 K
	With draught animals	4,365,000 K	4,715,000 K	21,000 K	22,700 K
Total	With hand tractor	9,962,500 K	11,212,500 K	25,400 K	28,600 K
	With draught animals	10,442,500 K	11,692,500 K	25,100 K	28,100 K

SYSTEM B2a – Paddy rice in rotation with soybean

Paddy rice (wet season) in rotation with soybean (in dry season).
Length of rotation cycle: 1 year

Technical protocol

Wet season paddy rice

1) Rice nursery operations
- Land clearing (May);
- Dyke re-building (May);
- Nursery land preparation: ploughing and harrowing (May);
- Fertilisation with manure: 1 kg/m2 (just before harrowing);
- Nursery fencing (May);
- Rice broadcasting: 300 g/m2 (May);
- If existing irrigation scheme, full-time irrigation, if not, only rainfed rice cropping;
- No weeding.

2) Paddy field operations
- Land preparation: harrowing and ploughing (June);
- Fertilisation with manure (5 to 10 t/ha) before harrowing;
- Field fencing (June);
- Transplanting: spacing of 20 to 25 cm * 25 to 30 cm (depending on soil conditions) – 3 seedlings per hill (June to July, depending on access to irrigation or rain conditions);
- Weeding: 2 times, 45 and 75 days after transplantation;
- If existing irrigation scheme, full-time irrigation, if not, only rainfed rice cropping;
- Harvest (beginning of October to end of November, depending on rice varieties).

3) Post-harvest practices
- Rice drying in the field, after the harvest;
- Rice threshing in the field, after the harvest.

Dry season soybean

1) Pre-cultural operations
- Land clearing (January);
- Field preparation: ploughing and harrowing (January);
- Fencing (January).

2) Cultural operations
- Sowing: spacing of 20*25 cm – sowing density of 70-75 kg/ha – 5 seeds in each hole – Plant thinning to 3 shoots (February);
- No fertilisation;
- Weeding: 2 times at 4 and 8 leaves growing stage;
- Harvest (April to May).

3) Post-harvest practices
- Drying in the field, after the harvest;
- Threshing in the field, after drying;
- Pod drying under the house, after threshing and transport.

Gross margin analysis (per hectare)

Labour and input costs

Cultural operations	Labour force costs (in md or men.day)	Input costs		
		Unit cost	Quantity	Total
Wet season paddy rice				
Land clearing	2			
Dyke re-building	6			
Nursery establishment and fencing	2			
Sowing	4	2500 K/kg	60 kg	150,000 K
Irrigation	5			
Fertilisation	2	50 K/kg	200 kg	10,000 K
Field preparation	3 (hand tractor) 15 (animals)	8000 K/l	30 l	240, 000 K
Fencing	20			
Transplanting	30			
Fertilisation	2	50 K/kg	5 to 10 t	375,000 K
Weeding	45			
Irrigation/Drainage	25			
Harvest	25			
Drying	15			
Threshing	10			
Total wet season paddy rice	196 (hand tractor) 208 (drought animals)			775,000 K (hand tractor) 535,000 K (draught animals)
Dry season soybean				
Land clearing	30			
Field preparation	30			
Fencing	20			
Sowing	15	12000 K/kg	70-75 kg	870,000 K
Fertilisation	/			
Weeding	20			
Harvest	5			
Drying/Threshing	Drying 2 Threshing 10			
Pod drying	1			
Total dry season soybean	133	/	/	870,000 K
Total cropping system	329 (hand tractor) 341 (drought animals)			1,645,000 K (hand tractor) 1,405,000 K (draught animals)

Outputs

Production	Yield	Unit price		Total	
		Minimum	Maximum	Minimum	Maximum
Wet season rice	3.5 t/ha	1400 K/kg	1500 K/kg	4,900,000 K	5,250,000 K
Soybean	2.5 t/ha	2500 K/kg	5000 K/kg	6,250,000 K	12,500,000 K
Total	/			11,150,000 K	17,750,000 K

Productivity per unit surface and per labour

Production		Gross margin per unit surface		Gross margin per labour force	
		Minimum	Maximum	Minimum	Maximum
Wet season rice	With hand tractor	4,125,000 K	4,475,000 K	21,000 K	22,800 K
	With draught animals	4,365,000 K	4,715,000 K	21,000 K	22,700 K
Soybean		5,380,000 K	11,630,000 K	40,500 K	87,400 K
Total	With hand tractor	9,505,000 K	16,105,000 K	28,900 K	49,000 K
	With draught animals	9,745,000 K	16,345,000 K	28,600 K	47,900 K

SYSTEM B2b – Paddy rice in rotation with peanut

Paddy rice (wet season) in rotation with peanut (in dry season).
Length of rotation cycle: 1 year

Technical protocol

Wet season paddy rice

1) Rice nursery operations
- Land clearing (May);
- Dyke re-building (May);
- Nursery land preparation: ploughing and harrowing (May);
- Fertilisation with manure: 1 kg/m2 (just before harrowing);
- Nursery fencing (May);
- Rice broadcasting: 300 g/m2 (May);
- If existing irrigation scheme, full-time irrigation, if not, only rainfed rice cropping;
- No weeding.

2) Paddy field operations
- Land preparation: harrowing and ploughing (June);
- Fertilisation with manure (5 to 10 t/ha) before harrowing;
- Field fencing (June);
- Transplanting: spacing of 20 to 25 cm * 25 to 30 cm (depending on soil conditions) – 3 seedlings per hill (June to July, depending on access to irrigation or rain conditions);
- Weeding: 2 times, 45 and 75 days after transplantation;
- If existing irrigation scheme, full-time irrigation, if not, only rainfed rice cropping;
- Harvest (beginning of October to end of November, depending on rice varieties).

3) Post-harvest practices
- Rice drying in the field, after the harvest;
- Rice threshing in the field, after the harvest.

Dry season peanut

1) Pre-cultural operations
- Land clearing (January);
- Field preparation: ploughing and harrowing (January);
- Fencing (January).

2) Cultural operations
- Sowing: spacing of 30*40 cm – sowing density of **45** kg/ha – 3 seeds in each hole (February);
- No fertilisation;
- Weeding: 2 times at 4 and 8 leaves growing stage;
- Harvest (April to May).

3) Post-harvest practices
- Pod drying in the village, after harvest and transport;
- Seed extraction, after drying;

Gross margin analysis (per hectare)

Labour and input costs

Cultural operations	Labour force costs (in md or men.day)	Input costs		
		Unit cost	Quantity	Total
Wet season paddy rice				
Land clearing	2			
Dyke re-building	6			
Nursery establishment and fencing	2			
Sowing	4	2500 K/kg	60 kg	150,000 K
Irrigation	5			
Fertilisation	2	50 K/kg	200 kg	10,000 K
Field preparation	3 (hand tractor) 15 (animals)	8000 K/l	30 l	240, 000 K
Fencing	20			
Transplanting	30			
Fertilisation	2	50 K/kg	5 to 10 t	375,000 K
Weeding	45			
Irrigation/Drainage	25			
Harvest	25			
Drying	15			
Threshing	10			
Total wet season paddy rice	196 (hand tractor) 208 (drought animals)			775,000 K (hand tractor) 535,000 K (draught animals)
Dry season peanut				
Land clearing	25			
Field preparation	9			
Fencing	20			
Sowing	15	12,000 K/kg	45 kg	540,000 K
Fertilisation	/			
Weeding	10			
Harvest	10			
Post-harvest operations	16			
Total dry season peanut	105	/	/	540,000 K
Total cropping system	301 (hand tractor) 313 (drought animals)			1,315,000 K (hand tractor) 1,075,000 K (draught animals)

Outputs

Production	Yield	Unit price		Total	
		Minimum	Maximum	Minimum	Maximum
Wet season rice	3.5 t/ha	1400 K/kg	1500 K/kg	4,900,000 K	5,250,000 K
Peanut	1 t/ha	4500 K/kg	5000 K/kg	4,500,000 K	5,000,000 K
Total	/			9,400,000 K	10,250,000 K

Productivity per unit surface and per labour

Production		Gross margin per unit surface		Gross margin per labour force	
		Minimum	Maximum	Minimum	Maximum
Wet season rice	With hand tractor	4,125,000 K	4,475,000 K	21,000 K	22,800 K
	With draught animals	4,365,000 K	4,715,000 K	21,000 K	22,700 K
Peanut		3,960,000 K	4,460,000 K	37,700 K	42,500 K
Total	With hand tractor	8,085,000 K	8,935,000 K	26,900 K	29,700 K
	With draught animals	8,325,000 K	9,175,000 K	26,600 K	29,300 K

SYSTEM B2c – Paddy rice in rotation with cabbage

Paddy rice (wet season) in rotation with cabbage (in dry season).
Length of rotation cycle: 1 year

Technical protocol

Wet season paddy rice

1) Rice nursery operations
- Land clearing (May);
- Dyke re-building (May);
- Nursery land preparation: ploughing and harrowing (May);
- Fertilisation with manure: 1 kg/m2 (just before harrowing);
- Nursery fencing (May);
- Rice broadcasting: 300 g/m2 (May);
- If existing irrigation scheme, full-time irrigation, if not, only rainfed rice cropping;
- No weeding.

2) Paddy field operations
- Land preparation: harrowing and ploughing (June);
- Fertilisation with manure (5 to 10 t/ha) before harrowing;
- Field fencing (June);
- Transplanting: spacing of 20 to 25 cm * 25 to 30 cm (depending on soil conditions) – 3 seedlings per hill (June to July, depending on access to irrigation or rain conditions);
- Weeding: 2 times, 45 and 75 days after transplantation;
- If existing irrigation scheme, full-time irrigation, if not, only rainfed rice cropping;
- Harvest (beginning of October to end of November, depending on rice varieties).

3) Post-harvest practices
- Rice drying in the field, after the harvest;
- Rice threshing in the field, after the harvest.

Dry season cabbage

1) Cabbage nursery operations
- Land clearing (September);
- Land preparation: land digging (September);
- Fertilisation with manure (1 kg/m2), just after digging;
- Fencing (September);
- Seed broadcasting: 2.5 g/m2 (end of September);
- Plant watering: 2 times every day;
- No weeding.

2) Cabbage field operations
- Field preparation: digging of holes of 20*20*20 cm (end of October);
- Fencing (October);
- Fertilisation with manure (200 g per hole) before transplanting;
- Transplanting: spacing of 30*30 cm (end of October);
- Weeding: 2 times (November and December);
- Watering: 2 times per day (every day until one month before the harvest);
- Harvest (January).

Gross margin analysis (per hectare)

Labour and input costs

Cultural operations	Labour force costs (in md or men.day)	Input costs		
		Unit cost	Quantity	Total
Wet season paddy rice				
Land clearing	2			
Dyke re-building	6			
Nursery establishment and fencing	2			
Sowing	4	2500 K/kg	60 kg	150,000 K
Irrigation	5			
Fertilisation	2	50 K/kg	200 kg	10,000 K
Field preparation	3 (hand tractor) 15 (animals)	8000 K/l	30 l	240, 000 K
Fencing	20			
Transplanting	30			
Fertilisation	2	50 K/kg	5 to 10 t	375,000 K
Weeding	45			
Irrigation/Drainage	25			
Harvest	25			
Drying	15			
Threshing	10			
Total wet season paddy rice	196 (hand tractor) 208 (drought animals)			775,000 K (hand tractor) 535,000 K (draught animals)
Dry season cabbage				
Land clearing	3			
Nursery establishment and fencing	10			
Sowing	1	150,000K/kg	1 kg	150,000 K
Watering	5			
Fertilisation	1	50 K/kg	400 kg	20,000 K
Field preparation	10			
Fencing	20			
Transplanting	25			
Fertilisation	2	50 K/kg	22 t	1,100,000 K
Weeding	50			
Watering	10			
Harvest	10			
Total dry season cabbage	147	/	/	1,270,000 K
Total cropping system	343 (hand tractor) 355 (drought animals)			2,045,000 K (hand tractor) 1,805,000 K (draught animals)

Outputs

Production	Yield	Unit price		Total	
		Minimum	Maximum	Minimum	Maximum
Wet season rice	3.5 t/ha	1400 K/kg	1500 K/kg	4,900,000 K	5,250,000 K
Cabbage	8 t/ha	2000 K/kg	4000 K/kg	16,000,000 K	32,000,000 K
Total	/			20,900,000 K	37,250,000 K

Productivity per unit surface and per labour

Production		Gross margin per unit surface		Gross margin per labour force	
		Minimum	Maximum	Minimum	Maximum
Wet season rice	With hand tractor	4,125,000 K	4,475,000 K	21,000 K	22,800 K
	With draught animals	4,365,000 K	4,715,000 K	21,000 K	22,700 K
Cabbage		14,730,000 K	30,730,000 K	100,200 K	209,000 K
Total	With hand tractor	18,855,000 K	35,205,000 K	55,000 K	102,600 K
	With draught animals	19,095,000 K	35,445,000 K	53,800 K	99,800 K

SYSTEM B2d – Paddy rice in rotation with Chinese cabbage

Paddy rice (wet season) in rotation with Chinese cabbage (in dry season).
Length of rotation cycle: 1 year

Technical protocol

Wet season paddy rice

1) Rice nursery operations
- Land clearing (May);
- Dyke re-building (May);
- Nursery land preparation: ploughing and harrowing (May);
- Fertilisation with manure: 1 kg/m2 (just before harrowing);
- Nursery fencing (May);
- Rice broadcasting: 300 g/m2 (May);
- If existing irrigation scheme, full-time irrigation, if not, only rainfed rice cropping;
- No weeding.

2) Paddy field operations
- Land preparation: harrowing and ploughing (June);
- Fertilisation with manure (5 to 10 t/ha) before harrowing;
- Field fencing (June);
- Transplanting: spacing of 20 to 25 cm * 25 to 30 cm (depending on soil conditions) – 3 seedlings per hill (June to July, depending on access to irrigation or rain conditions);
- Weeding: 2 times, 45 and 75 days after transplantation;
- If existing irrigation scheme, full-time irrigation, if not, only rainfed rice cropping;
- Harvest (beginning of October to end of November, depending on rice varieties).

3) Post-harvest practices
- Rice drying in the field, after the harvest;
- Rice threshing in the field, after the harvest.

Dry season Chinese cabbage

1) Chinese Cabbage nursery operations
- Land clearing (October);
- Land preparation: preparation of seed beds of 150 cm wide and 15 cm high, with 50 cm between each seed bed (October);
- Fertilisation with manure (1kg/m2), just after digging;
- Fencing (October);
- Seed broadcasting: 2.5 g/m2 (October);
- Plant watering: 2 times every day;
- No weeding.

2) Chinese Cabbage field operations
- Field preparation: preparation of seedling beds of 150 cm wide and 15 cm high, with 50 cm between each seedling bed (end of October);
- Fencing (end of October);
- Fertilisation with manure (1kg/m2) before transplanting;
- Transplanting: spacing of 20*20 cm (beginning of November, 25 days after sowing);
- Weeding: 1 time (November);
- Watering: 2 times per day (every day until the harvest);
- Harvest: from December (50 days after sowing) until March (several successive production cycles of Chinese cabbage.

Gross margin analysis (per hectare)

Labour and input costs

Cultural operations	Labour force costs (in md or men.day)	Input costs		
		Unit cost	Quantity	Total
Wet season paddy rice				
Land clearing	2			
Dyke re-building	6			
Nursery establishment and fencing	2			
Sowing	4	2500 K/kg	60 kg	150,000 K
Irrigation	5			
Fertilisation	2	50 K/kg	200 kg	10,000 K
Field preparation	3 (hand tractor) 15 (animals)	8000 K/l	30 l	240, 000 K
Fencing	20			
Transplanting	30			
Fertilisation	2	50 K/kg	5 to 10 t	375,000 K
Weeding	45			
Irrigation/Drainage	25			
Harvest	25			
Drying	15			
Threshing	10			
Total wet season paddy rice	196 (hand tractor) 208 (drought animals)			775,000 K (hand tractor) 535,000 K (draught animals)
Dry season Chinese cabbage				
Land clearing	6			
Nursery establishment and fencing	5			
Sowing	1	50,000 K/kg	500 g	25,000 K
Watering	5			
Fertilisation	3	50 K/kg	200 kg	10,000 K
Field preparation	6			
Fencing	20			
Transplanting	25			
Fertilisation	5	50 K/kg	10 t	500,000 K
Weeding	50			
Watering	10			
Harvest	10			
Total dry season Chinese cabbage	146	/	/	535,000 K
Total cropping	342 (hand tractor) 354 (drought animals)			1,310,000 K (hand tractor) 1,070,000 K (draught animals)

Outputs

Production	Yield	Unit price		Total	
		Minimum	Maximum	Minimum	Maximum
Wet season rice	3.5 t/ha	1400 K/kg	1500 K/kg	4,900,000 K	5,250,000 K
Chinese cabbage	8 t/ha	2000 K/kg	4000 K/kg	16,000,000 K	32,000,000 K
Total	/			20,900,000 K	37,250,000 K

Productivity per unit surface and per labour

Production		Gross margin per unit surface		Gross margin per labour force	
		Minimum	Maximum	Minimum	Maximum
Wet season rice	With hand tractor	4,125,000 K	4,475,000 K	21,000 K	22,800 K
	With draught animals	4,365,000 K	4,715,000 K	21,000 K	22,700 K
Chinese cabbage		15,465,000 K	31,465,000 K	105,900 K	215,500 K
Total	With hand tractor	19,590,000 K	35,940,000 K	57,300 K	105,100 K
	With draught animals	19,830,000 K	36,180,000 K	56,000 K	102,200 K

SYSTEM B2e – Paddy rice in rotation with garlic

Paddy rice (wet season) in rotation with garlic (in dry season).
Length of rotation cycle: 1 year

Technical protocol

Wet season paddy rice

1) Rice nursery operations
- Land clearing (May);
- Dyke re-building (May);
- Nursery land preparation: ploughing and harrowing (May);
- Fertilisation with manure: 1 kg/m2 (just before harrowing);
- Nursery fencing (May);
- Rice broadcasting: 300 g/m2 (May);
- If existing irrigation scheme, full-time irrigation, if not, only rainfed rice cropping;
- No weeding.

2) Paddy field operations
- Land preparation: harrowing and ploughing (June);
- Fertilisation with manure (5 to 10 t/ha) before harrowing;
- Field fencing (June);
- Transplanting: spacing of 20 to 25 cm * 25 to 30 cm (depending on soil conditions) – 3 seedlings per hill (June to July, depending on access to irrigation or rain conditions);
- Weeding: 2 times, 45 and 75 days after transplantation;
- If existing irrigation scheme, full-time irrigation, if not, only rainfed rice cropping;
- Harvest (beginning of October to end of November, depending on rice varieties).

3) Post-harvest practices
- Rice drying in the field, after the harvest;
- Rice threshing in the field, after the harvest.

Dry season garlic

1) Pre-cultural operations
- Land preparation: cutting of rice straws, after rice harvest (December);
- Fencing (December);
- Field irrigation (one day before planting).

2) Cultural operations
- Planting: spacing of 15*15 cm – planting density of 400 kg per ha – 1 piece planted per hole;
- Fertilisation with manure (5 to 10 g per hole) when planting;
- Land coverage with hay, after planting;
- Weeding: 2 times (December and January);
- Watering: no;
- Harvest (March).

3) Post-harvest operations
- Cleaning and drying in the village, after harvest and transport.

Gross margin analysis (per hectare)

Labour and input costs

Cultural operations	Labour force costs (in md or men.day)	Input costs		
		Unit cost	Quantity	Total
Wet season paddy rice				
Land clearing	2			
Dyke re-building	6			
Nursery establishment and fencing	2			
Sowing	4	2500 K/kg	60 kg	150,000 K
Irrigation	5			
Fertilisation	2	50 K/kg	200 kg	10,000 K
Field preparation	3 (hand tractor) 15 (animals)	8000 K/l	30 l	240, 000 K
Fencing	20			
Transplanting	30			
Fertilisation	2	50 K/kg	5 to 10 t	375,000 K
Weeding	45			
Irrigation/Drainage	25			
Harvest	25			
Drying	15			
Threshing	10			
Total wet season paddy rice	196 (hand tractor) 208 (drought animals)			775,000 K (hand tractor) 535,000 K (draught animals)
Dry season garlic				
Field preparation	10			
Fencing	20			
Irrigation	2			
Planting	15	6,500 K/kg	400 kg	2,600,000 K
Fertilisation	15	50 K/kg	3.5 t	175,000 K
Hay coverage	15			
Weeding	30			
Harvest	25			
Cleaning and drying	5			
Total dry season garlic	137	/	/	2,775,000 K
Total cropping system	333 (hand tractor) 345 (drought animals)			3,550,000 K (hand tractor) 3,310,000 K (draught animals)

Outputs

Production	Yield	Unit price		Total	
		Minimum	Maximum	Minimum	Maximum
Wet season rice	3.5 t/ha	1400 K/kg	1500 K/kg	4,900,000 K	5,250,000 K
Garlic	5 t	3000 K/kg	5000 K/kg	15,000,000 K	25,000,000 K
Total	/			19,900,000 K	30,250,000 K

Productivity per unit surface and per labour

Production		Gross margin per unit surface		Gross margin per labour force	
		Minimum	Maximum	Minimum	Maximum
Wet season rice	With hand tractor	4,125,000 K	4,475,000 K	21,000 K	22,800 K
	With draught animals	4,365,000 K	4,715,000 K	21,000 K	22,700 K
Garlic		12,225,000 K	22,225,000 K	89,200 K	162,200 K
Total	With hand tractor	16,350,000 K	26,700,000 K	49,100 K	80,200 K
	With draught animals	16,590,000 K	26,940,000 K	48,100 K	78,100 K

SYSTEM B2f – Paddy rice in rotation with onion

Paddy rice (wet season) in rotation with onion (in dry season).
Length of rotation cycle: 1 year

Technical protocol

Wet season paddy rice

1) Rice nursery operations
- Land clearing (May);
- Dyke re-building (May);
- Nursery land preparation: ploughing and harrowing (May);
- Fertilisation with manure: 1 kg/m2 (just before harrowing);
- Nursery fencing (May);
- Rice broadcasting: 300 g/m2 (May);
- If existing irrigation scheme, full-time irrigation, if not, only rainfed rice cropping;
- No weeding.

2) Paddy field operations
- Land preparation: harrowing and ploughing (June);
- Fertilisation with manure (5 to 10 t/ha) before harrowing;
- Field fencing (June);
- Transplanting: spacing of 20 to 25 cm * 25 to 30 cm (depending on soil conditions) – 3 seedlings per hill (June to July, depending on access to irrigation or rain conditions);
- Weeding: 2 times, 45 and 75 days after transplantation;
- If existing irrigation scheme, full-time irrigation, if not, only rainfed rice cropping;
- Harvest (beginning of October to end of November, depending on rice varieties).

3) Post-harvest practices
- Rice drying in the field, after the harvest;
- Rice threshing in the field, after the harvest.

Dry season onion

1) Pre-cultural operations
- Land preparation: cutting of rice straws, after rice harvest (December);
- Fencing (December);
- Field irrigation (one day before planting).

2) Cultural operations
- Planting: spacing of 15*15 cm – planting density of 400 to 500 kg/ha – 1 head planted per hole;
- Fertilisation with manure (5 to 10 g per hole) when planting;
- Land coverage with hay, after planting;
- Weeding: 2 times (December and January);
- Watering: no;
- Harvest (March).

3) Post-harvest operations
- Cleaning and drying in the village, after harvest and transport.

Gross margin analysis (per hectare)

Labour and input costs

Cultural operations	Labour force costs (in md or men.day)	Input costs		
		Unit cost	Quantity	Total
Wet season paddy rice				
Land clearing	2			
Dyke re-building	6			
Nursery establishment and fencing	2			
Sowing	4	2500 K/kg	60 kg	150,000 K
Irrigation	5			
Fertilisation	2	50 K/kg	200 kg	10,000 K
Field preparation	3 (hand tractor) 15 (animals)	8000 K/l	30 l	240, 000 K
Fencing	20			
Transplanting	30			
Fertilisation	2	50 K/kg	5 to 10 t	375,000 K
Weeding	45			
Irrigation/Drainage	25			
Harvest	25			
Drying	15			
Threshing	10			
Total wet season paddy rice	196 (hand tractor) 208 (drought animals)			775,000 K (hand tractor) 535,000 K (draught animals)
Dry season onion				
Field preparation	10			
Fencing	20			
Irrigation	2			
Planting	15	6500 K/kg	450 kg	2,925,000 K
Fertilisation	15	500 K/kg	3.5 t	175,000 K
Hay coverage	15			
Weeding	30			
Harvest	25			
Cleaning and drying	5			
Total dry season onion	137	/	/	3,100,000 K
Total cropping system	333 (hand tractor) 345 (drought animals)			3,875,000 K (hand tractor) 3,635,000 K (draught animals)

Outputs

Production	Yield	Unit price		Total	
		Minimum	Maximum	Minimum	Maximum
Wet season rice	3.5 t/ha	1400 K/kg	1500 K/kg	4,900,000 K	5,250,000 K
Onion	5 t	5000 K/kg	8000 K/kg	25,000,000 K	40,000,000 K
Total	/			29,900,000 K	45,250,000 K

Productivity per unit surface and per labour

Production		Gross margin per unit surface		Gross margin per labour force	
		Minimum	Maximum	Minimum	Maximum
Wet season rice	With hand tractor	4,125,000 K	4,475,000 K	21,000 K	22,800 K
	With draught animals	4,365,000 K	4,715,000 K	21,000 K	22,700 K
Onion		21,900,000 K	36,900,000 K	159,900 K	269,300 K
Total	With hand tractor	26,025,000 K	41,375,000 K	78,200 K	124,200 K
	With draught animals	26,265,000 K	41,615,000 K	76,100 K	120,600 K

SYSTEM C1 – Plantation of pigeon pea in short fallows

Mono-cropping system of pigeon pea (year1 & 2) associated with shellac gum production (year 2) in short fallows (3 years).
Length of rotation cycle: 2 years

Technical protocol

Pigeon pea (year 1)

1) Pre-cultural operations
- Slashing (February);
- Burning (March-April);
- Land clearing (April);
- Fencing (April).

2) Cultural operations
- Sowing of pigeon pea (May): spacing of 150*150 cm or 50*300 cm – sowing density of 3 to 4 kg/ha – 4 to5 seeds per hole – plant thinning to 3 shoots;
- Weeding: 2 times (June and August);
- Release of stick-lac insects (February-March of the next year);
- Harvest of pigeon pea (March-April of the next year).

3) Post-harvest operations
- Pigeon pea drying in the field (April of the next year);
- Pigeon pea threshing in the field (April of the next year).

Pigeon pea with wasps (year 2)

1) Cultural operations
- Reparation of fences (March-April);
- Weeding: 2 times (March and September);
- Harvest of pigeon pea in March-April (of the following year);
- Collection of shellac gum in March-April (of the following year).

2) Post-harvest operations
- Pigeon pea drying in the field (April of the following year);
- Pigeon pea threshing in the field (April of the following year).

Gross margin analysis (per hectare)

Labour and input costs

Cultural operations	Labour force costs (in md or men.day)	Input costs		
		Unit cost	Quantity	Total
Year 1 – Upland rice and pigeon pea				
Slashing	33			
Burning	1			
Land clearing	22			
Fencing	10			
Sowing (pigeon pea)	25	10,000 K/kg	3-4 kg	35,000 K
Weeding	80			
Release of stick-	5	15,000 K/kg	150 kg	2,250,000

lac insects				
Harvest (pigeon pea)	15			
Drying/Threshing (pigeon pea)	10			
Total Year 1	201	/	/	2,285,000 K
Year 2 – Pigeon pea with wasps				
Fencing	30			
Weeding	50			
Harvest (pigeon pea)	15			
Collection of shellac gum	10			
Drying/Threshing	10			
Total Year 2	115	/	/	0
Average cropping system per year	158	/	/	1,142,500 K

Outputs

Production	Yield	Unit price		Total	
		Minimum	Maximum	Minimum	Maximum
Pigeon pea (years 1 & 2)	500 kg	7000 K/kg	7000 K/kg	3,500,000 K	3,500,000 K
Shellac gum (year 2)	2.5 t	6000 K/kg	12,000 K/kg	15,000,000 K	30,000,000 K
Average per year	/			11,000,000 K	18,500,000 K

Productivity per unit surface and per labour

Production	Gross margin per unit surface		Gross margin per labour force	
	Minimum	Maximum	Minimum	Maximum
Year 1	1,125,000 K	1,125,000 K	5,600 K	5,600 K
Year 2	18,500,000 K	33,500,000 K	160,900 K	291,300 K
Average per year	9,812,500 K	17,312,500 K	62,100 K	109,600 K

SYSTEM C2 – Plantation of sapan in short fallows

Plantation of sapan in young forests (3-year old fallows).
Length of rotation cycle: we will consider 10 years with 8 years of production of sapan

Technical protocol

Year 1 of the plantation

1) Sapan nursery operations
- Collection of sapan material (stems) in March;
- Preparation of seedling bags: mixing of soil, sand and manure (March);
- Plantation of one 15-25 cm stem of sapan per bag (March);
- Watering: 2 times for 15 days.

2) Pre-cultural operations
- Land clearing in order to dig holes for sapan transplanting (April);
- Fencing (April);
- Digging of holes for sapan transplanting with a size of 20*20 cm with 30 cm deep (May).

3) Cultural operations
- Sapan transplanting: spacing of 300*300 cm – 1 plant per hole (beginning of June);
- Weeding: 2 times (September and March);

Years 2 to 10 of the plantation

1) Cultural operations
- Reparation of fences (March-April);
- Weeding: 2 times during the second year of the plantation (September and March) and only 1 time from the third year of the plantation (in March);
- Harvest from the third year (March-April).

2) Post-harvest operations
- Bark processing in the village, after harvest and transport;
- Bark drying in the village, after bark processing.

Gross margin analysis (per hectare)

Labour and input costs

Cultural operations	Labour force costs	Input costs		
		Unit cost	Quantity	Total
Year 1 – Plantation of sapan without upland rice				
Collection of sapan material	2			
Preparation of seedlings bags and plantation in the nursery	2	12,000 K/kg	2 kg of bags	24,000 K
Watering	4			
Land clearing	30			
Fencing	10			
Hole digging (for sapan seedlings)	5			
Transplanting	8			
Weeding	50			

Total Year 1	111	/	/	24,000 K
Year 2 – Plantation of sapan not yet producing				
Fencing	30			
Weeding	50			
Total Year 2	80	/	/	0
Years 3 to 10 – Plantation of sapan already producing				
Fencing	30			
Weeding	15			
Harvest	15			
Bark processing	50			
Drying	5			
Average years 3 to 10	115	/	/	0
Average cropping system per year	111	/	/	2,400 K

Outputs

Production	Yield	Unit price		Total	
		Minimum	Maximum	Minimum	Maximum
Sapan (years 3 to 10)	2.5 t	3000 K/kg	5000 K/kg	7,500,000 K	12,500,000 K
Average per year	/			6,000,000 K	10,000,000 K

Productivity per unit surface and per labour

Production	Gross margin per unit surface		Gross margin per labour force	
	Minimum	Maximum	Minimum	Maximum
Average per year	5,997,600 K	9,997,600 K	54,000 K	90,000 K

SYSTEM C3 – Plantation of paper mulberry in short fallows

Plantation of paper mulberry in young forests (3-year old fallows).
Length of rotation cycle: 8 years

Technical protocol

Year 1 of the plantation

1) Paper mulberry nursery operations
- Collection of paper mulberry material (stems or roots) in March; nursery operations are only needed when collected paper mulberry material is stem as paper mulberry roots are directly planted in the upland field;
- Preparation of seedling bags: mixing of soil, sand and manure (March);
- Plantation of one 15-25 cm stem of paper mulberry per bag (March);
- Watering: 2 times for 15 days.

2) Pre-cultural operations
- Land clearing in order to make holes for paper mulberry transplanting (April);
- Fencing (April);
- Digging of holes for paper mulberry transplanting with a size of 20*20 cm with 30 cm deep (May).

3) Cultural operations
- Paper mulberry transplanting: spacing of 200*200 cm – 1 plant per hole (May-June);
- Weeding: 2 times (July and December);
- Harvest of paper mulberry (November-December, 6 months after transplanting).

4) Post-harvest operations
- Paper mulberry bark cleaning in the village, after harvest and transport;
- Paper mulberry bark drying in the village, after bark processing.

Years 2 to 8 of the plantation (paper mulberry only)

1) Cultural operations
- Reparation of fences (March-April);
- Weeding: 2 times per year after harvest;
- Harvest: 2 times in May/June and November/December.

2) Post-harvest operations
- Paper mulberry bark cleaning in the village, after harvest and transport;
- Drying of paper mulberry barks in the village, after bark processing.

Gross margin analysis (per hectare)

Labour and input costs

Cultural operations	Labour force costs	Input costs		
		Unit cost	Quantity	Total
Year 1 – Plantation of paper mulberry without upland rice				
Collection of paper mulberry material	2			
Preparation of seedlings bags	2	12,000 K/kg	5 kg (bags)	60,000 K

and plantation in the nursery				
Watering	4			
Land clearing	30			
Fencing	10			
Hole digging (for paper mulberry seedlings)	12			
Transplantation (paper mulberry)	15			
Weeding	50			
Harvest (paper mulberry)	20			
Bark cleaning	20			
Drying (bark)	5			
Total Year 1	170	/	/	60,000 K
Average of years 2 to 8 – Plantation of paper mulberry				
Fencing	30			
Harvest	40			
Weeding	55			
Bark cleaning	40			
Drying	10			
Average Total of years 2 to 8	175	/	/	0
Average cropping system per year	174	/	/	7,500 K

Outputs

Production	Yield	Unit price		Total	
		Minimum	Maximum	Minimum	Maximum
Paper mulberry (months 6 to 96)	1.5 t (year 1) 3t (year 2 to 8)	3000 K/kg	5000 K/kg	4,500,000 K (year 1) 9,000,000 K (years 2 to 8)	7,500,000 K (year 1) 15,000,000 K (years 2 to 8)
Average per year	/			8,437,500 K	14,062,500 K

Productivity per unit surface and per labour

Production	Gross margin per unit surface		Gross margin per labour force	
	Minimum	Maximum	Minimum	Maximum
Average per year	8,430,000 K	14,055,000 K	48,300 K	80,600 K

SYSTEM C4 – Plantation of galangal in short fallows

Plantation of galangal in young forests (3-year old fallows).
Length of rotation cycle: 10 years

Technical protocol

Year 1 of the plantation

1) Pre-cultural operations
- Slashing (February);
- Burning (March-April);
- Land clearing (April);
- Fencing (April);
- Collection of galangal material (roots) in May;
- Digging of holes for galangal planting with a size of 25*30 cm with 30 cm deep (May).

2) Cultural operations
- Plantation of galangal material: spacing of 100*50 cm – 1 plant per hole (May-June);
- Weeding: 1 time (September);

Years 2 to 10 of the plantation

1) Cultural operations
- Reparation of fences (March-April);
- Weeding: 2 times (March and September);
- Collection of galangal fruits from the second year of the plantation (September);
- Pruning of galangal trees from the second year of the plantation (after the harvest).

2) Post-harvest operations
- Drying of galangal fruits in the village, after harvest and transport.

Gross margin analysis (per hectare)

Labour and input costs

Cultural operations	Labour force costs	Input costs		
		Unit cost	Quantity	Total
Year 1				
Slashing	33			
Burning	1			
Land clearing	22			
Fencing	10			
Collection of galangal material	8			
Hole digging and plantation of galangal	5			
Weeding	20			
Total Year 1	99	/	/	0
Years 2 to 10				
Fencing	30			
Weeding	40			
Harvest	5			

Drying of galangal	10			
Cutting of galangal trees	10			
Average of years 2 to 10	95	/	/	0
Average cropping system	95	/	/	0

Outputs

Production	Yield	Unit price		Total	
		Minimum	Maximum	Minimum	Maximum
Galangal (years 2 to 10)	3t	6000 K/kg	12,000 K/kg	18,000,000 K	36,000,000 K
Average per year	/			16,200,000 K	32,400,000 K

Productivity per unit surface and per labour

Production	Gross margin per unit surface		Gross margin per labour force	
	Minimum	Maximum	Minimum	Maximum
Average per year	16,200,000 K	32,400,000 K	169,800 K	339,600 K

FORAGE SYSTEM D1 – Cassava in association with soybean

Cassava in association with inter-rows of soybean (2 rows of soybean for 1 row of cassava).
Length of rotation cycle: 1 year

Technical protocol

Cassava in association with soybean

1) Pre-cultural operations
- Slashing (March);
- Burning (end of April);
- Land clearing (May);
- Fencing (May).

2) Cultural operations
- Sowing of soybean: spacing on the line of 25 cm – spacing rows of soybean to soybean of 50 cm and 25 cm for cassava to soybean – Sowing density of 35 kg/ha – 3 seeds per hole (beginning of May);
- Planting of cassava: spacing on the line of 100 cm – spacing rows of cassava to cassava of 100 cm and 25 cm for cassava to soybean – Sowing density of 10000 stems per ha – 1 stem per hole (end of May-June);
- Weeding: 2 times (June and March of the year after);
- Harvest of soybean (September);
- Harvest of cassava (March-April of the year after).

3) Post-harvest operations
- Soybean drying in the field, after the harvest;
- Soybean threshing in the field, after drying;
- Soybean pod drying under the house, after threshing and transport;
- Cassava post-harvest practices: root chopping, drying and grounding into powder, after harvest.

Gross margin analysis (per hectare)

Labour and input costs

Cultural operations	Labour force costs	Input costs		
		Unit cost	Quantity	Total
Cassava with soybean				
Slashing	33			
Burning	1			
Land clearing	22			
Fencing	10			
Planting (cassava)	10	50 K/stem	10,000 stems	500,000 K
Sowing (soybean)	15	12,000 K/kg	35 kg	420,000 K
Weeding	50			
Harvest (cassava)	25			
Harvest (soybean)	10			
Cassava post-harvest practices	25			
Drying/Threshing (soybean)	20			
Pod drying	6			
Total Forage System	227	/	/	920,000 K

Outputs

Production	Yield
Cassava (fresh)	25-30 t
Soybean	1.5 t

NB: no income or financial productivity has been calculated as the production is used to feed animals.

FORAGE SYSTEM D2 – Gramineae in association with Stylosanthes

Gramineae in association with Stylosanthes (2 rows of Gramineae for 1 row of Stylosanthes).
Length of rotation cycle: 3 years

Technical protocol

Year 1 – Gramineae with Stylosanthes

1) Pre-cultural operations
- Slashing (March);
- Burning (April);
- Land clearing (May);
- Fencing (May).

2) Cultural operations
- Sowing of Gramineae: sowing in rows with an inter-row of 50 cm – Sowing density of 2 kg/ha (beginning of June);
- Sowing of Stylosanthes: sowing in rows with an inter-row of 50 cm – Sowing density of 1 kg/ha (beginning of June);
- Weeding: 1 time (September);
- Harvest of Gramineae: 90 days after sowing – 2 times a month in wet season and only once in dry season;
- Harvest of Stylosanthes: 90 days after sowing – 2 times a month in wet season and only once in dry season.

3) Post-harvest operations
- None for Gramineae;
- Drying of Stylosanthes under the house, after the harvest

Years 2 & 3 – Gramineae with Stylosanthes

1) Cultural operations
- Reparation of fences (March-April);
- Fertilisation with manure (5 to 10 t/ha) in March;
- No weeding;
- Harvest of Gramineae: 2 times a month in wet season and only once in dry season;
- Harvest of Stylosanthes: 2 times a month in wet season and only once in dry season.

2) Post-harvest operations
- None for Gramineae;
- Drying of Stylosanthes under the house, after the harvest

Gross margin analysis (per hectare)

Labour and input costs

Cultural operations	Labour force costs	Input costs		
		Unit cost	Quantity	Total
Year 1 – Gramineae with Stylosanthes				
Slashing	33			
Burning	1			
Land clearing	22			
Fencing	10			

Sowing (Gramineae)	20	250,000 K/kg	2 kg	500,000 K
Sowing (Stylosanthes)	10	150,000 K/kg	1 kg	150,000 K
Weeding	25			
Harvest (Gramineae)	150			
Harvest (Stylosanthes)	75			
Post-harvest practices (Stylosanthes)	10			
Total Year 1	356	/	/	650,000 K
Years 2 & 3 – Gramineae with Stylosanthes				
Fencing	30			
Fertilisation	5	50,000 K/t	5 to 10 t/ha	375,000 K
Harvest (Gramineae)	200			
Harvest (Stylosanthes)	100			
Post-harvest practices (Stylosanthes)	10			
Average of years 2 & 3	345	/	/	375,000 K
Average Forage System per year	349			466,666 K

Outputs

Production	Yield
Gramineae	40 to 50 t of dry matter
Stylosanthes	25 to 30 t of dry matter

NB: no income or financial productivity has been calculated as the production is used to feed animals.

FORAGE SYSTEM D3 – Sweet potato with contour lines of Stylosanthes

Sweet potato with contour lines of Stylosanthes (4 rows of sweet potato for 1 row of Stylosanthes).
Length of rotation cycle: 3 years

Technical protocol

Year 1 – Sweet potato with Stylosanthes

1) Pre-cultural operations
- Slashing (March);
- Burning (April);
- Land clearing (May);
- Fencing (May);
- Land preparation for sweet potato: preparation of seed beds of 1m. wide, 40 cm high with 30 cm between beds

2) Cultural operations
- Sowing of sweet potato: spacing of 100*25 cm – Sowing density of 30,000 vines/ha – 1 vine per hole (end of May);
- Sowing of Stylosanthes: sowing in rows – spacing of 100 cm with rows of sweet potato and 500 cm between rows (1 row of Stylosanthes for 4 rows of sweet potato) – Sowing density of 0.5 kg/ha (beginning of June);
- Weeding: 1 time (August);
- Harvest of sweet potato (September);
- Harvest of Stylosanthes: 90 days after sowing – 2 times a month in wet season and only once in dry season.

3) Post-harvest operations
- Sweet potato post-harvest practices: root chopping, drying and grounding into powder, after harvest.
- Drying of Stylosanthes under the house, after the harvest

Years 2 & 3 – Sweet potato with Stylosanthes

1) Pre-cultural operations
- Land clearing (May);
- Reparation of fences (May);
- Land preparation for sweet potato: preparation of seed beds of 1m. wide, 40 cm high with 30 cm between beds

2) Cultural operations
- Sowing of sweet potato: spacing of 100*25 cm – Sowing density of 30,000 vines/ha – 1 vine per hole (end of May);
- Weeding: 1 time (August);
- Harvest of sweet potato (September);
- Harvest of Stylosanthes: 2 times a month in wet season and only once in dry season.

3) Post-harvest operations
- Sweet potato post-harvest practices: root chopping, drying and grounding into powder, after harvest.
- Drying of Stylosanthes under the house, after the harvest

Gross margin analysis (per hectare)

Labour and input costs

Cultural operations	Labour force costs	Input costs		
		Unit cost	Quantity	Total
Year 1 – Sweet potato with Stylosanthes				
Slashing	33			
Burning	1			
Land clearing	22			
Fencing	10			
Land preparation for sweet potato	40			
Sowing (sweet potato)	12	4 K/vine	30,000 vines	120,000 K
Sowing (Stylosanthes)	5	150,000 K/kg	0.5 kg	75,000 K
Weeding	25			
Harvest (sweet potato)	16			
Harvest (Stylosanthes)	35			
Post-harvest practices (sweet potato)	30			
Post-harvest practices (Stylosanthes)	5			
Total Year 1	234	/	/	195,000 K
Years 2 & 3 – Sweet potato with Stylosanthes				
Fencing	30			
Land clearing	30			
Land preparation for sweet potato	40			
Sowing (sweet potato)	12	4 K/vine	30,000 vines	120,000 K
Weeding	25			
Harvest (sweet potato)	16			
Harvest (Stylosanthes)	50			
Post-harvest practices (sweet potato)	30			
Post-harvest practices (Stylosanthes)	5			
Average of years 2 & 3	238	/	/	120,000 K
Average Forage System per year	237			170,000 K

Outputs

Production	Yield
Sweet potato (fresh)	35 to 40 t
Stylosanthes	12 to 15 t of dry matter

NB: no income or financial productivity has been calculated as the production is used to feed animals.

ANIMAL SYSTEM 1 – Buffalo raising with pasture grazing and forage feeding

Buffalo raising with pasture grazing and forage feeding (cut-and-carry system).
We will consider as an equivalent forage area required for 10 adult buffaloes, 1 ha of Stylosanthes and Gramineae (forage system D2), with 0.5 ha for pasture grazing and 0.5 ha for forage feeding.
We will consider a ratio female/male of 10%.

Technical protocol

- Construction of pens and fencing;
- Movement control and management: daily release of animals in determined and rotating grazing areas;
- Feeding with forages (15-20% of Stylosanthes for 80-85% of Gramineae), in a proportion of 30% (in dry matter) of the body weight – 2 times every day;
- Supply of clean water and salt (about 4 kg per year per head);
- Vaccination: 2 times per year per head;
- Deworming: 2 times a year (7.5 cc each time) for young animals;
- Curative treatment only when diseases appear;
- Selection of males through castration process of the non suitable males;
- Natural reproduction process;
- Natural weaning after 3 months.

Gross margin analysis (per 10 adult goats)

Labour and input costs

Animal husbandry practices	Labour force costs	Input costs		
		Unit cost	Quantity	Total
Buffalo production with feeding through pasture grazing and forages (cut-and-carry system)				
Pen construction and fencing	15			
Movement control and management	25			
Production of forages (1 ha of forage system 2)	349			466,666 K
Feeding (purchased food)		1000 K/kg	40 kg of salt per year	40,000 K
Vaccination		4 000 K/head	10 adult animals 14.4 young animals	97,600 K
Deworming		8250 K/young animal	6 young animals	49,500 K
Other health practices				100,000 K
Total system per year for 10 adult animals	389			753,766 K

Technical and economic performances

Technical and economic parameters	
Number of births (animals born) per year per female	2/3
Age of the females at the first litter	5 years
Age of the females at the last litter	11 years
Age of the male able to reproduce	3 years
Price of male/female when 11 year-old	3,000,000 K
Adult mortality rate	0
Mortality rate of young animals	20 %
Age of the male at the sale	3 years
Price of the male at the sale	2,000,000 K
Age of the female at the sale	3 years
Price of the female at the sale	2,000,000 K

Outputs

Products	Number	Unit price	Total
Young male animals	2.23	2,000,000 K/head	4,470,000 K
Young female animals	0.9	2,000,000 K/head	1,800,000 K
Adult male animals	0.17	3,000,000 K/head	500,000 K
Adult female animals	1.5	3,000,000 K/head	1,500,000 K
Average system per year for 10 adult buffaloes	/	/	11,270,000 K

Productivity per 10 animals and per labour

Production	Gross margin per 10 adult animals	Gross margin per labour force
Total System per year	10,500,000 K	27,000 K/md

ANIMAL SYSTEM 2 – Cow raising with pasture grazing and forage feeding

Cow raising with pasture grazing and forage feeding (cut-and-carry system).
We will consider as an equivalent forage area required for 10 adult cows, 1 ha of Stylosanthes and Gramineae (forage system D2), with 0.5 ha for pasture grazing and 0.5 ha for forage feeding.
We will consider a ratio female/male of 10%.

Technical protocol

- Construction of pens and fencing;
- Movement control and management: daily release of animals in determined and rotating grazing areas;
- Feeding with forages (15-20% of Stylosanthes for 80-85% of Gramineae), in a proportion of 30% (in dry matter) of the body weight – 2 times every day;
- Supply of clean water and salt (about 4 kg per year per head);
- Vaccination: 2 times per year per head;
- Deworming: 2 times a year (7.5 cc each time) for young animals;
- Curative treatment only when diseases appear;
- Selection of males through castration process of the non suitable males;
- Natural reproduction process;
- Natural weaning after 3 months.

Gross margin analysis (per 10 adult goats)

Labour and input costs

Animal husbandry practices	Labour force costs	Input costs		
		Unit cost	Quantity	Total
Cow production with feeding through pasture grazing and forages (cut-and-carry system)				
Pen construction and fencing	15			
Movement control and management	25			
Production of forages (1 ha of forage system 2)	349			466,666 K
Feeding (purchased food)		1000 K/kg	40 kg of salt per year	40,000 K
Vaccination		4 000 K/head	10 adult animals 21.6 young animals	126,400 K
Deworming		8250 K/young animal	9 young animals	74,250 K
Other health practices				100,000 K
Total system per year for 10 adult animals	389			807,316 K

Technical and economic performances

Technical and economic parameters	
Number of births (animals born) per year per female	1
Age of the females at the first litter	4 years
Age of the females at the last litter	8 years
Age of the male able to reproduce	3 years
Price of male/female when 8 year-old	2,000,000 K
Adult mortality rate	0
Mortality rate of young animals	20 %
Age of the male at the sale	3 years
Price of the male at the sale	1,500,000 K
Age of the female at the sale	3 years
Price of the female at the sale	1,500,000 K

Outputs

Products	Number	Unit price	Total
Young male animals	3.35	1,500,000 K/head	5,025,000 K
Young female animals	1.35	1,500,000 K/head	2,025,000 K
Adult male animals	0.25	2,000,000 K/head	500,000 K
Adult female animals	2.25	2,000,000 K/head	4,500,000 K
Average system per year for 10 adult cows	/	/	12,050,000 K

Productivity per 10 animals and per labour

Production	Gross margin per 10 adult animals	Gross margin per labour force
Total System per year	11,243,000 K	28,900 K/md

ANIMAL SYSTEM 3 – Goat raising with pasture grazing and forage feeding

Goat raising with pasture grazing and forage feeding (cut-and-carry system).
We will consider as an equivalent forage area required for 15 to 20 adult goats, 1 ha of Stylosanthes and Gramineae (forage system D2), with 0.5 ha for pasture grazing and 0.5 ha for forage feeding.
We will consider a ratio female/male of 10%.

Technical protocol

- Construction of pens and fencing of yard, before starting goat raising;
- Movement control and management: daily release of animals in determined and rotating grazing areas;
- Feeding with forages (15-20% of Stylosanthes for 80-85% of Gramineae), in a proportion of 10% (in dry matter) of the body weight – 2 times every day;
- Supply of clean water and salt (about 1 kg per year per head);
- No vaccination;
- Deworming: 2 times a year (1.5 cc each time) for young animals (45 and 90 days after birth); 1 time per year (1.5 cc) for adult animals (before rainy season);
- Curative treatment only when diseases appear;
- Selection of males through castration process of the non suitable males;
- Natural reproduction process (females can be mated 45 days after giving birth);
- Natural weaning after 45 days.

Gross margin analysis (per 10 adult goats)

Labour and input costs

Animal husbandry practices	Labour force costs	Input costs		
		Unit cost	Quantity	Total
Goat production with feeding through pasture grazing and forages (cut-and-carry system)				
Pen construction and yard fencing	15			
Movement control and management	25			
Production of forages (0.6 ha of forage system 2)	209			280,000 K
Feeding (cut forages)	50			
Feeding (purchased food)		1000 K/kg	10 kg of salt per year	10,000 K
Deworming		1100 K/cc	15 cc for adult animals 108 cc for young animals	135,300 K
Other health practices				100,000 K
Total system per year for 10 adult animals	299			525,300 K

Technical and economic performances

Technical and economic parameters	
Number of births (animals born) per year per female	4
Age of the females at the first litter	8-10 months
Age of the females at the last litter	5 years
Age of the male able to reproduce	8-10 months until 5 years
Price of male/female when 5 year-old	30-40 kg – 16,000 K/kg
Adult mortality rate	0
Mortality rate of young animals	20 %
Age of the male at the sale	1 year
Price of the male at the sale	25 to 30 kg – 17,000 K/kg
Age of the female at the sale	1 year
Price of the female at the sale	25 to 30 kg – 17,000 K/kg

Outputs

Products	Number	Unit price	Total
Young male animals	14.16	467,500 K/head	6,622,000 K
Young female animals	12.28	467,500 K/head	5,742,000 K
Adult male animals	0.24	595,000 K/head	140,000 K
Adult female animals	2.12	595,000 K/head	1,260,000 K
Average system per year for 10 adult goats)	/	/	13,764,000 K

Productivity per 10 animals and per labour

Production	Gross margin per 10 adult animals	Gross margin per labour force
Total System per year	13,239,000 K	44,300 K/md

ANIMAL SYSTEM 4 – Pig raising with general feeding (produced food)

Pig raising with general feeding: animal food production and cut-and carry system.
We will consider as an equivalent forage area required for 4 females:
- 0.5 ha of cassava/soybean (forage system D1) +
- 0.5 ha of sweet potato/Stylosanthes (forage system D3).
Only females among adult pigs.

Technical protocol

- Construction of pens and fencing of yard, before starting pig raising;
- No movement: pigs stay all the day in their pens and in the surrounding yard;
- Feeding with forages (roots and leaves of cassava and sweet potato, soybean, paper mulberry leaves, corn, vegetables and rice brand), in a proportion of 5% (in dry matter) of the body weight – 2 to 3 times every day;
- Supply of clean water and salt (about 2.5 kg per year per head);
- Vaccination: 2 times per year, 45 days and 6 months after birth (for piglets) and in March amd September (for adult females);
- Deworming: 2 times a year (1.5 cc each time), 45 and 90 days after birth (for piglets) and in March and September (for adult females);
- Curative treatment only when diseases appear;
- Selection of boars for reproduction (through sow mating service) through castration process of the non-selected males (females can be mated 8 months after giving birth);
- Natural weaning after 45 days.

Gross margin analysis (per 4 adult females)

Labour and input costs

Animal husbandry practices	Labour force costs	Input costs		
		Unit cost	Quantity	Total
Pen construction and yard fencing	15			
Production of forages (0.5 ha of forage system 1a + 0.5 ha of forage system 3b)	232			545,000 K
Feeding (cut forages)	150			
Feeding (purchased food)		1000 K/kg	10 kg of salt per year	10,000 K
Vaccination		10,000 K/ head/year	4 adult animals 36 piglets	400,000 K
Deworming		1100 K/cc	12 cc for adult animals 108 cc for young animals	132,000 K
Other health practices				100,000 K
Sow mating service		250,000 K/time	6 times	1,500,000 K
Total system per year for 4 adult females	397			2,687,000 K

Technical and economic performances

Technical and economic parameters	
Number of births (animals born) per year per female	8-10
Age of the females at the first litter	12 months
Age of the females at the last litter	3 years
Price of female when 3 year-old	80-100 kg – 15,000 K/kg
Adult mortality rate	10 %
Mortality rate of young animals	20 %
Age of the male at the sale	8-10 months
Price of the male at the sale	50 to 60 kg – 15,000 K/kg
Age of the female at the sale	8-10 months
Price of the female at the sale	50 to 60 kg – 15,000 K/kg

Outputs

Products	Number	Unit price	Total
Young male animals	14.4	825,000 K/head	11,900,000 K
Young female animals	12.2	825,000 K/head	10,000,000 K
Adult female animals	2	1,350,000 K/head	2,700,000 K
Average system per year for 4 adult females	/	/	24,600,000 K

Productivity per 4 adult females and per labour

Production	Gross margin per 4 adult females	Gross margin per labour force
Total System per year	21,900,000 K	55,300 K/md

ANIMAL SYSTEM 5 – Chicken raising

Chicken raising with improved feeding (animal food production and cut-and carry system).
We will consider as an equivalent forage area required for 100 chickens:
- 0.1 ha of cassava/soybean (forage system D1) +
- 0.05 ha of sweet potato/Stylosanthes (forage system D3).
We will consider a ratio female/male of 1/15.

Technical protocol

- Construction of pens and fencing of yard, before starting chicken raising;
- No movement: chickens stay all the day in their pens and in the surrounding yard;
- Feeding with roots of cassava and sweet potato, corn, pigeon pea, vegetables, rice and rice brand, in a proportion of 5% (in dry matter) of the body weight – 2 times every day;
- Supply of clean water;
- Vaccination: 2 times for chicks (first week and 45 days after birth) and 4 times per year for adult animals (every 3 months);
- No deworming;
- Selection of males for reproduction (females can reproduce again 6 months after laying eggs);
- Natural separation between chicks and hens after 15 days.

Gross margin analysis (per 100 adult animals)

Labour and input costs

Animal husbandry practices	Labour force costs	Input costs		
		Unit cost	Quantity	Total
Pen construction and yard fencing	10			
Production of forages (0.1 ha of forage system 1a + 0.05 ha of forage system 3b)	35			100,500 K
Feeding (cut forages)	50			
Vaccination		1,200 K/ animal/year 600 K/chick/year	100 adult chickens 6500 chicks	5,100,000 K
Total system per year for 100 chickens	95			5,200,500 K

Technical and economic performances

Technical and economic parameters	
Number of births (animals born) per year per female	10 chicks (out of 15 hatched eggs) per time – 8 times per year
Age of the reproducing hens/cocks	6 months until 2 years
Price of hens/cocks when 2 year-old	25,000 K
Adult mortality rate	20 %
Mortality rate of chicks	20 %
Age of the chicks at sale	45 days
Price of the chicks at sale	10,000 K/kg
Production of eggs per female per year	0 (all the eggs are hatched for chick production)
Price of eggs	/

Outputs

Products	Number	Unit price	Total
Male chicks	2981	10,000 K/chick	29,800,000 K
Female chicks	2909	10,000 K/chick	29,100,000 K
Adult male chickens	4.44	25,000 K/chicken	111,000 K
Adult female chickens	62.2	25,000 K/chicken	1,560,000 K
Average system per year for 100 chickens	/	/	60,600,000 K

Productivity per 100 chickens and per labour

Production	Gross margin per 100 chickens	Gross margin per labour force
Total System 31 per year	55,400,000 K	583,000 K/md

ANIMAL SYSTEM 6 – Duck raising in the farmyard

Duck raising in pens in the farmyard with improved feeding (animal food production and cut-and carry system).
We will consider as an equivalent forage area required for 100 ducks:
- 0.1 ha of cassava/soybean (forage system D1) +
- 0.05 ha of sweet potato/Stylosanthes (forage system D3).
We will consider a ratio female/male of 1/15.

Technical protocol

- Construction of pens and fencing of yard, before starting duck raising;
- No movement: ducks stay all the day in their pens and in the surrounding yard;
- Feeding with roots of cassava and sweet potato, corn, pigeon pea, vegetables, rice and rice brand, in a proportion of 5% (in dry matter) of the body weight – 2 times every day;
- Supply of clean water;
- Vaccination: 2 times for ducklets (first week and 45 days after birth) and 4 times per year for adult animals (every 3 months);
- No deworming;
- Selection of males for reproduction;
- Egg hatching by chickens: ducks are unable to hatch their eggs; egg laying period of 1 month (around 25 eggs) and 45 days between 2 periods during which ducks lay eggs;
- Natural separation between ducklets and females after 15 days.

Gross margin analysis (per 100 adult animals)

Labour and input costs

Animal husbandry practices	Labour force costs	Input costs		
		Unit cost	Quantity	Total
Pen construction and yard fencing	10			
Production of forages (0.1 ha of forage system 1a + 0.05 ha of forage system 3b)	35			100,500 K
Feeding (cut forages)	50			
Vaccination		1,200 K/animal/ year 600 K/ducklet/ year	100 adult ducks 4000 ducklets	3,600,000 K
Total system per year for 100 ducks	95			3,700,500 K

Technical and economic performances

Technical and economic parameters	
Number of births (animals born) per year per female	10 ducks for a period of 75 days
Age of the reproducing male and female ducks	12 months until 3 years
Price of males when 3 year-old	30,000 K
Price of females when 3 year-old	25,000 K
Adult mortality rate	20 %
Mortality rate of ducklets	20 %
Age of the ducklets at sale	2 months
Price of the ducklets at sale	7,500 K/kg
Production of eggs per female per year	an average of 5 eggs per month per female
Price of eggs	1000 K/egg

Outputs

Products	Number	Unit price	Total
Male ducklets	1812	7,500 K/ducklet	13,600,000 K
Female ducklets	1759	7,500 K/ducklet	13,200,000 K
Adult male ducks	3.33	30,000 K/duck	100,000 K
Adult female ducks	46.7	25,000 K/duck	1,170,000 K
Eggs	5600	1,000 K/egg	5,600,000 K
Average system per year for 100 ducks	/	/	33,700,000 K

Productivity per 100 ducks and per labour

Production	Gross margin per 100 ducks	Gross margin per labour force
Total System per year	30,000,000 K	315,000 K/md

ANIMAL SYSTEM 7 – Fishery in ponds in both dry and wet seasons

Fishery in ponds in both dry and wet seasons with improved feeding (food production and cut-and carry system).
We will consider as an equivalent forage area required for 40000 fishes (1 ha fish pond):
- 0.1 ha of cassava/soybean (forage system D1) +
- 0.05 ha of sweet potato/Stylosanthes (forage system D3) +
- 0.1 ha of Gramineae/Stylosanthes (forage system D2).

Technical protocol

- Construction of fish pond with fences (April): fish population density of 4 fishes per m2 – fish pond depth: 1.5 m. – application of lime (400 kg/ha) and manure (5 t/ha); Fish ponds are established for 8 years;
- Establishment of water supply and drainage system for the pond (May);
- Feeding with roots and leaves of cassava and sweet potato, grass, Stylosanthes, paper mulberry leaves, corn and rice brand – 2 times every day;
- Collection of fishes after 6 months.

Gross margin analysis (per fish pond of 1 ha)

Labour and input costs

Animal husbandry practices	Labour force costs	Input costs		
		Unit cost	Quantity	Total
Establishment of fish ponds and water supply/drainage system	3000/8 (fish pond established for 8 years)	800 K/kg 50 K/kg	400 kg lime 5 t manure	320,000 K /8 250,000 K /8
Fingerling purchase	/	100 K/fingerling	80,000 fingerlings	8,000,000
Production of food (0.1 ha of forage system 1a + 0.05 ha of forage system 3b + 0.1 ha of forage system 2)	69			147,166 K
Feeding (fishes)	50			
Collection of fishes	30			
Total animal system (per year for a 1 ha pond)	524			8,218,466 K

Technical and economic performances

Technical and economic parameters	
Mortality/loss rate of fishes	50 %
Mortality/loss rate of fingerlings	50 %
Age of fishes at sale	9 months
Price of fishes at the sale	0.3 kg/fish – 15,000 K/kg

Outputs

Products	Number	Unit price	Total
Fishes	20,000	4,500 K/fish	90,000,000 K
Total (average per year per pond of 1 ha)	/	/	90,000,000 K

Productivity per pond of 1ha and per labour

Production	Gross margin per pond of 1 ha	Gross margin per labour force
Total System per year	81,781,534 K	156,100 K/md