Technical Agriculture and Agroforestry Options for Sustainable Development Promoted by SFDP in the Song Da Watershed

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0. Introduction

Improvement of living conditions in the Song Da Watershed depends crucially on practising sustainable land use. In its focus on promoting sustainable land use, SFDP has been addressing technical options and their institutional integration both with regard to forestry as well as agriculture and agroforestry. The initial approach at the onset of project implementation has been documented in SFDP Working Paper No. 2 ('Technology Options for Upland Development in the Song Da Watershed', 1996). SFDP approaches to forestry issues are documented in a series of working papers by the Community Forestry Unit. The following paper summarises experiences with regard to agricultural issues. Following a description of general strategies guiding project activities, a detailed documentation of the technical options is provided in this paper. The identification and dissemination of these options is carried out by the extension service under SFDP coaching and monitoring as documented elsewhere.

1. General strategy for technology identification in agriculture and agroforestry

Sustainable agricultural technology options need to be identified for different types of land. In terms of sustainability issues, land used for agricultural production may be categorised into paddy land, gently sloping upland (dry land) which allows continuous ‘sustainable’ production, and marginal upland with steep slopes, high erodibility and quickly decreasing soil fertility.

Problems of unsustainable production occur mainly on marginal upland. Obvious indicators are decreasing yields and declining soil quality. Wherever feasible these areas are taken out of production and converted into forest. However, where upland areas are essential for food production, soil conservation measures are the primary focus for promoting sustainable land use.
The use of paddy land is generally environmentally sustainable, as is the use of fertile, gently sloping upland. However, as marginal land is taken out of production, it is crucial to increase productivity on these areas as compensation. Furthermore increased productivity is essential for improving income and living conditions of the rural population. In the long run, economic sustainability on all agricultural land depends on productivity increases through intensification.

Based on the requests from farmers in the project villages, SFDP is focusing both on direct soil conservation measures as well as on promoting agricultural intensification to alleviate pressure on upland. The following 5 working areas are differentiated:

1. upland soil conservation measures
2. intensification of crops on upland
3. intensification of crops on paddy land (incl. vegetable)
4. fruit tree development and
5. intensification of animal production

Within these 5 working areas technology options are chosen according to sustainability criteria. The main factor for considering a new and technically promising technology is the (1) farmers' interest in this technology and its appropriateness in the prevailing farming system. This interest and appropriateness is discussed and determined during Village Development Planning. Interest in a new crop entails (2) expectations of positive financial benefits. These are analysed with regard to potential temporary effects (e.g. temporary subsidies) and long-term consumption needs and market access. At the same time, the required capital intensity, capital productivity and risk is compared to current farm production activities. Selection is furthermore based on (3) ecological sustainability requirements, considering in particular the issues of soil conservation on sloping land and the option of integrated pest management (IPM) for intensive paddy crops. Finally the (4) required management capacities are considered, which determine the necessity for training and coaching and thus dissemination costs. In Table 1 these sustainability criteria are listed. Main questions relating to these criteria are determined together with the means of verification.

Selection of options is thus firstly based on what farmers prioritize and which will likely be ranked according the expected positive financial benefit and ease of integration into their farm system. The working area of upland soil conservation, however, requires a more integrated perspective, considering effects in downstream areas, that clearly lie beyond the interest of an individual farmer and thus become a government concern. Even with regard to the effects on the farm itself, soil conservation and environmental sustainability require a long-term perspective and thus do not likely rank high on the priority list of individual farmers. Ecological issues are thus raised by 'experts' outside the village. Selection and scope of implementation of individual options is again decided by farmers.

Land tenure security is clearly a prerequisite for interest in long-term sustainability. Implementation of agricultural options are a follow-up of the land use planning and land allocation (LUPLA.) activities initiated in the project.

Having farmers select and prioritize options rather than allocating to them government set programmes, is one of the main elements introduced by SFDP that differs from prevailing extension methodology. By monitoring farmers' selection and priorities, adaptations and incentives can be designed to facilitate farmers’ acceptance of those options that appear desirable but are not convincing to the farmer. Close monitoring and provision of technical assistance rather than a mere distribution of seed, is another new element of SFDP extension methodology designed to improve efficiency and preparing extensionists for their future role.

**Tab. 1 Sustainability Criteria used in the SFDP Song Da**

<table>
<thead>
<tr>
<th>Criteria and main questions</th>
<th>Means of verification</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Farmers' interest and integration of new technology into farming system</td>
<td>Village Development Planning (initially and after trial experience)</td>
<td>Farming systems approach is a new concept for extensionists</td>
</tr>
<tr>
<td>Does it fit into the prevailing farming</td>
<td>Cropping calendar</td>
<td>Consider working requirements for</td>
</tr>
</tbody>
</table>
2. Five working areas: Perspectives and strategies for agricultural development

Through the extension system, SFDIP is covering issues in 5 working areas (sub-sectors), namely upland soil conservation, upland intensification, paddy intensification, fruit tree and animal production. For each of the 5 working areas, potential technology options are tested in line with the medium and long-term development potential seen for each sub-sector within the development path of the existing farming systems7. This

<table>
<thead>
<tr>
<th>system in terms of labour requirements?</th>
<th>In terms of land requirements, how does it alter current land use?</th>
<th>Does it fit into consumption pattern? If not, can it be sold? (see 2)</th>
<th>main crops: paddy rice, upland maize.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Care must be taken not to substitute consumption crops with commercial crops in insecure production and market environment</td>
<td>Current land use</td>
<td>Village discussion, small-scale trial introduction</td>
<td>Note differences in consumption patterns between ethnic groups: e.g. Hmong do not eat Cassava</td>
</tr>
</tbody>
</table>

2. Financial benefit to farmers

- Financial benefit includes marketed and home-consumed products

<table>
<thead>
<tr>
<th>What is the return on farmers’ investment (Cost Benefit Ratio)?</th>
<th>Financial calculations</th>
<th>Financial calculations without subsidies</th>
<th>Capital is the scarcest factor, capital productivity is high in traditional production, new options must at least guarantee a medium capital productivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>– Financial calculations</td>
<td>– Determination of results at lower investment levels</td>
<td>– Determination of smallest investment amount, determination of alternative investment options</td>
<td>Especially in the introduction phase, technologies which can be tested on small scale are advantageous.</td>
</tr>
<tr>
<td>Can investments be sustained in the absence of subsidies?</td>
<td>Analysis of market channels, temporary provision of access</td>
<td>New options often only feasible with subsidies</td>
<td></td>
</tr>
<tr>
<td>Can investments be sustained in the absence of subsidies?</td>
<td>Financial calculations without subsidies</td>
<td>New options often only feasible with subsidies</td>
<td></td>
</tr>
</tbody>
</table>

3. Environmental Sustainability

- Analysis of effects usually not conclusive for the individual farmer

<table>
<thead>
<tr>
<th>Does production negatively affect soil fertility?</th>
<th>Monitoring of productivity over a number of years</th>
<th>Analysis of effects usually not conclusive for the individual farmer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Can production be continued at demonstrated levels?</td>
<td>Monitoring of productivity over a number of years</td>
<td>Large annual fluctuations prohibit evaluation on the basis of short-term experience</td>
</tr>
</tbody>
</table>

4. Management and training and dissemination requirements

Note that technicians are generally not facilitators.

<table>
<thead>
<tr>
<th>Can extension staff transfer the technology (technical capacity)?</th>
<th>Review of staff training needs</th>
<th>Collision of interests may occur between farmer and extensionist</th>
</tr>
</thead>
<tbody>
<tr>
<td>Can the proposed technology easily be taught in one extension effort?</td>
<td>Review of training inputs and their impacts</td>
<td>Collision of interests may occur between farmer and extensionist</td>
</tr>
<tr>
<td>Will extension staff transfer the technology (financial priorities, incentives)?</td>
<td>Review of budget, budget lines and incentive structure</td>
<td>Collision of interests may occur between farmer and extensionist</td>
</tr>
</tbody>
</table>
development potential is largely influenced by general market access, but also by population pressure, access to paddy and ethnic preferences. Thus the development potential differs for the two districts the project is working in.

In the following chapter general perspectives for the 5 working areas are outlined and specified with regard to the situation in both districts. Based on these perspectives, SFDP strategies in the form of technical options are listed for each of the working areas. A summary list of options is provided in Table 3. For a detailed documentation of implementation experience with individual options please refer to Chapter 3 for Yen Chau and Chapter 4 for Tua Chua. Annex 1 provides an overview of individual technical options in the form of ‘factsheets’.

2.1. Soil conservation measures on sloping land (upland)

Upland agriculture will increase in importance in the future with rising population pressure, limited paddy land, and increasing options for upland use. In Tua Chua population pressure is lower resulting in greater access to upland (3.03 ha/household vs. 0.95 ha in Yen Chau), but due to natural conditions access to paddy land is much lower (0.16 ha/household vs. 0.21 ha/household in Yen Chau when considering options for double cropping). An overview is given in Table 2 on agricultural land resources in Yen Chau (YC) and Tua Chua (TC).

<table>
<thead>
<tr>
<th>Type of agricultural land</th>
<th>Area in Yen Chau project villages (ha/hh)*</th>
<th>Area in Tua Chua project villages (ha/hh)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cultivated area/hh</td>
<td>1.16</td>
<td>3.20</td>
</tr>
<tr>
<td>Paddy with 1 rice crop</td>
<td>0.07</td>
<td>0.16</td>
</tr>
<tr>
<td>Paddy with 2 rice crops</td>
<td>0.07</td>
<td>0.00</td>
</tr>
<tr>
<td>Upland</td>
<td>0.95</td>
<td>3.03</td>
</tr>
<tr>
<td>Fruit trees</td>
<td>0.06</td>
<td>0.00</td>
</tr>
<tr>
<td>Fish ponds</td>
<td>0.01</td>
<td>0.01</td>
</tr>
</tbody>
</table>

* average land resources per household in the project villages in 1998, covering 22 villages in Yen Chau, 13 project villages in Tua Chua (other 5 project villages omitted due to incomplete information)

<table>
<thead>
<tr>
<th>Technology</th>
<th>Implemented in Yen Chau</th>
<th>Implemented in Tua Chua</th>
<th>Remarks on differences between locations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Upland (sloping land) soil improvement</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hedgerows</td>
<td>x</td>
<td>x</td>
<td>species differ with locations</td>
</tr>
<tr>
<td>Improved fallow</td>
<td></td>
<td>x</td>
<td>few fallow in Yen Chau</td>
</tr>
<tr>
<td>Micro-terrace</td>
<td>x</td>
<td></td>
<td>labour input too high for TC</td>
</tr>
<tr>
<td>Improved terracing</td>
<td></td>
<td>x</td>
<td>smaller paddy area facilitates higher interest in terracing</td>
</tr>
<tr>
<td>Cover crops (perennials)</td>
<td>x</td>
<td>x</td>
<td>few fruit trees in Tua Chua</td>
</tr>
<tr>
<td>Intercropping maize-beans</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>3-year cassava fallow</td>
<td>x</td>
<td></td>
<td>not suitable for Hmong</td>
</tr>
</tbody>
</table>
SFDP promotes crops for soil conservation/recuperation on sloping lands which facilitate a long term increase in soil productivity. Two major issues are addressed, the prevention of soil erosion and the improvement of the organic matter content of the soil and thus the nutrient and water retention capacity. As outlined above, this area of intervention derives from the understanding that only some of the upland areas are currently sustainably used, while not all marginal areas currently subject to erosion and soil mining can be entirely taken out of production and converted to forest.

Beneficiaries of this intervention are farmers of all income strata as technologies are simple and capital

| Improved organic matter management |  |  |
| 2. Upland intensification |  |  |
| Improved maize | x | x |
| Second maize crop | x | climate not suitable in TC |
| Fertiliser use on uplands | x | in TC even on paddy not common |
| Improved cassava | x | not suitable for Hmong |
| Improved upland rice | x | not competitive when enough paddy for self-sufficiency |
| 3. Paddy intensification |  |  |
| Improved rice | x | x |
| Maize as second crop for food security | x | maize self-sufficiency only issue in TC |
| Diversification (2nd crop) | x | x |
| Winter crops (3rd crop) | x | x |
| IPM | x | no pesticide use in TC |
| Compost & green manure | x | new only for TC |
| 4. Promotion of fruit trees/perennials |  |  |
| Improvement of existing fruit gardens | x | no fruit gardens in TC |
| Introduction of improved fruit trees | x | x | selection differs between location |
| Transfer of nursery and grafting technology | x | x |
| Improvement of existing tea plantations | x | no tea plantations in YC |
| 5. Animal intensification |  |  |
| Bee promotion | x | x |
| Para-veterinarian training | x | x |
| Toolkits for para-veterinarians | x | x |
| Pig ration design | x | low market integration limits scope of intensification |
| Animal fodder sources | x | x |
| Promotion of grazing regulations | x | x | (in connection with expansion of cropping cycle) |
| Training in fish raising | x | suitability for TC yet to be determined |
investments are low. In fact it has been shown in Thai Nguyen that especially the poorer strata resorts to these technologies, while richer farmers tend to focus on short-term higher input/output technologies.

**For preventing soil erosion** the first and main activity of SFDP is the promotion of hedgerows with various species and in flexible distances. These vegetative barriers along contour lines are more appropriate on steeper slopes compared to stone barriers based on their superior soil retention capacity, the relatively lower labour requirement and the potential usefulness of hedgerow species for fodder or fuel wood. Disadvantages are the loss of land (10-15 %, depending on distance between hedgerows), shading of crops, and labour requirements for cutting hedgerows. When hedgerows are integrated into a fallow-rotation, they can be used as improved fallow management that shortens fallow period.

As a potential alternative to hedgerows, erosion control with **micro-terraces** is proposed from 1998. These 'micro-terraces' are small terraces of a width of 50-100 cm established along contour lines with a slight inclination towards the slope, as to catch eroded material. Farmers are encouraged to incorporate crop residues and organic material at the 'root/hill-end' of the terrace to increase soil organic matter content and alleviate the need for burning crop residues. Where paddy access is extremely constrained, **improved upland terracing** is promoted, whereby the cover soil is separated to reuse as top soil.

As alternative to hedgerows and micro-terraces the project is seeking to identify suitable cover crops. The usefulness of cover crops is based on the understanding that soil erosion is mainly caused by the impact of rain drops on bare soil. A vegetative cover is thus necessary to protect the soil from the impact of monsoon rains prior to the cropping season and during the early development stages of the crop. Cover crops between annual crops must be low-growing as not to shade the crop. Between fruit trees they must be shade tolerant. Ideally cover crops should have no negative impacts (require no labour in times of labour scarcity, not compete with the main crop for water/nutrients, not require replanting, ...) and should provide some additional benefits (suppress weeds, provide feed for animals, food for humans).

The approach for **improving soil fertility** is based on the experience that this improvement traditionally occurs during fallow. During fallow an increase in organic matter content in the soil takes place, nutrients leached into lower soil levels are recaptured by deeper rooting perennials and finally nitrogen fixation of legume species improves the N-content of the soil\(^9\). The project promotes (in some cases yet investigates) crops that utilise the same effect. These can be either annual **inter-planted legume crops** or a form of a managed and intensified fallow, e.g. **three-year-cassava**, or hedgerows used for improved fallow as mentioned above.

**Medium/Long-term perspective for Yen Chau regarding soil conservation measures:** The predominant soils in Yen Chau are deeply weathered sandstones with high clay content. Due to the soil depth an impact of erosion on the fertility of the slopes is not obvious to farmers. Even so, erosion control is considered as an issue in those communes where in the past soil erosion has silted in irrigation structures. Furthermore intensified upland crops such as sugar cane have sensitised farmers to a soil and fertiliser loss caused by erosion. These two factors help to encourage farmers to apply soil conservation measures.

On the other hand, however, as rising population pressure effects the availability of upland fields there are objections to accepting an area loss caused by hedgerows, even if the soil retention capacity of the hedgerow becomes obvious after only 2 years. The application of micro-terraces is seen as a possible alternative and is facilitated by the 'ridging along contour lines' which is currently promoted by the sugar company to alleviate fertiliser loss. Especially the recovery of crop residues along contour lines should provide some vegetative barrier. It is however not clear, if pests are hosted in these crop residues, how much weed pressure increases if burning is omitted and finally on which soils micro-terraces are effective means of erosion control\(^10\).

Cover crops should have a good potential as long as they do not compete for labour during peaks and provide some obvious benefits. It is however, not clear whether cover crops can provide a sufficient vegetative cover to prevent erosion at the onset of the rainy season.

Improvement of soil fertility is an issue on all uplands as farmers are used to fallowing the land for soil fertility increase. The high clay content in most of the soils explains the great potential for improving water and nutrient accessibility through increased organic matter content (clay-humus-complex). In many cases, farmers in Yen Chau use a 3-year cassava crop for soil recuperation, i.e. cassava is covering around 50 % of the cropping area\(^11\). However, with stagnating markets for cassava and an increasing demand for maize cassava cropping is reduced wherever possible. Any method for alleviating the need for fallowing and for cassava is welcome by farmers.
Medium/Long-term perspective for Tua Chua regarding soil conservation measures: In the project communes in Tua Chua population pressure on upland is lower and fallow rotations are more common. Here, hedgerows may be developed into an improved fallow management system, that may reduce the fallow period. A reduction in fallow period would substantially increase the average annual productivity of the upland. However, hedgerows compete with the chance to burn organic matter, which effectively generates short-term yield increase (mineralization of nutrients) and reduces labour requirements, and only in the long run has negative effects (reduction of organic matter).

Alternatives to hedgerows seem few: As Hmong people do not like to consume cassava, this crop is not available for soil improvement in continuous cropping. Interest in micro-terraces is hampered as they require a higher labour input than prevailing soil preparation while labour is the limiting factor for upland cultivation. Instead interest in upland terracing may justify promotion of this activity. On the predominant soils with higher pH (limestone based soils), beans are used for intercropping with maize. In some areas, limestone formations limit soil erosion. On the more acid soils where the productivity of edible beans is too low, SFDP is seeking to identify acid tolerant legume species for soil improvement.

SFDP strategy for upland soil conservation in Yen Chau (YC) and Tua Chua (TC):

<table>
<thead>
<tr>
<th>Technology</th>
<th>in YC</th>
<th>in TC</th>
<th>Remarks on differences between locations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identify most suitable hedgerow species, and planting technique and determine how to promote it to farmers</td>
<td>x</td>
<td>x</td>
<td>species differ with locations</td>
</tr>
<tr>
<td>Identify alternative soil erosion control to hedgerows such as (micro)-terrace, bean intercropping, and cover crops</td>
<td>x</td>
<td>x</td>
<td>terracing focused on places with highly restricted paddy access (TC)</td>
</tr>
<tr>
<td>Identify soil improvement options (bean intercropping, cover crops, 3-year cassava, improved fallow, organic matter management)</td>
<td>x</td>
<td>x</td>
<td>cassava not suitable for Hmong (TC)</td>
</tr>
</tbody>
</table>

2.2 Intensification of crops on upland

Currently not all of the uplands are used to their sustainable production capacity. Increases of crop productivity (yield increase/ha) through introduction of improved varieties and new crops are possible. These yield increases compensate for taking marginal areas out of agricultural production as well as for increasing population pressure/area. If increases are more substantial they furthermore improve food sufficiency and household income.

Activities concerned with introducing improved varieties have the advantage that they provide fast recognisable success and can therefore act as a door-opener for less obvious, long-lasting improvements suggested with regard to soil protection and forestry. Furthermore these activities are easily taken up by the local extension system whose activities are focused on seed distribution.

Maize, upland rice and for Thai people, cassava, are the main upland crops. At the moment the productivity of the commonly used upland varieties (i.e. traditional and degraded improved varieties) is low thus introductions of new varieties can show high yield increases. Improved maize, cassava and possibly upland rice crops can be promoted. Short maturing and drought resistant maize varieties cannot only improve yield stability but also expand the cropping intensity to 2 crops on upland. Promotion of a 2nd upland maize crop is an important means of increasing area productivity.

In comparison to paddy land a higher risk is attached to upland production. Seasonal droughts limit the suitability of high-input high yielding crops for most farmers. While high yielding crops are grown readily by an increasing number of farmers, fertiliser use is rare on uplands. In the long term this development will result in soil fertility decline, which is masked by the high performance of new varieties, until serious depletion has taken place. Promotion of fertilizer use is thus important. For uplands with good access to water some of the options identified for a 2nd crop on paddy land are suitable. Suitability for fruit trees is discussed separately below.

Medium/Long-term perspective for Yen Chau: Market access in Yen Chau will largely determine the optimal
use of the upland and thus the future cropping pattern. With a developing feed market, maize is the crop with the best potential. Sales peak in August/September and show a second rise in December. Cassava markets could improve in the same direction, with sales spaced between December and March. However, lower value/kg and thus higher labour input required for harvesting per monetary output will likely cause cassava to rank second to maize. Industrial crops like coffee and sugar cane will expand only at the rate production credits are made available by the Government. Private investment is unlikely.

The importance of upland rice decreases substantially with market involvement and the possibility to purchase rice for consumption in exchange for crops with higher land and labour productivity such as maize. However, speciality varieties will remain important (e.g. sticky rice for TET) as will the function of rice for risk alleviation, thus justifying SFDP involvement in identifying improved varieties.

With regard to starch tubers (cassava, taro, sweet potatoes) little is currently available for yield improvement. In 1998 however, a Chinese fast maturing high yielding cassava variety has been tested in Son La and will be introduced in the project region from 1999 under careful supervision, as in many countries Cassava is seen as responsible for serious soil depletion.

Medium/Long-term perspective for Tua Chua: In Tua Chua food self sufficiency is more important, as market integration is still low. In the medium term maize will continue to be the main food crop, with rice complementing the grain supply and adding to risk diversification. New varieties for both upland crops will be successful if they allow for low production intensity. Double cropping on uplands seems to have no potential due to prolonged water shortage on karst soil formations.

Edible beans and Job's tears are main local protein sources. A number of species are available for intercropping and relay cropping in accordance with the quality of soil (e.g. Phaseolus ssp for less acid soils, Job's tears, Vigna ssp and Mucuna ssp for poorer soils). Available varieties are well adapted to large variations in climate which generally limit the options for introducing higher yielding introductions. Best practices can be identified and promoted by emphasising their soil improvement characteristics.

The promotion of grazing regulations is an important prerequisite for any kind of upland intensification that results in expansion of cropping season.

**SFDP strategy for upland intensification in Yen Chau (YC) and Tua Chua (TC):**

<table>
<thead>
<tr>
<th>Technology</th>
<th>in YC</th>
<th>in TC</th>
<th>Remarks on differences between locations</th>
</tr>
</thead>
<tbody>
<tr>
<td>– Introduce improved (drought resistant, shorter-maturing, higher yielding) maize varieties</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>– Introduce a second upland maize crop</td>
<td>x</td>
<td></td>
<td>climate not suitable in TC</td>
</tr>
<tr>
<td>– Promote fertiliser use on uplands</td>
<td>x</td>
<td></td>
<td>in TC even on paddy not common</td>
</tr>
<tr>
<td>– Introduce improved cassava strains</td>
<td>x</td>
<td></td>
<td>not suitable for Hmong</td>
</tr>
<tr>
<td>– Improved upland rice</td>
<td>x</td>
<td></td>
<td>not competitive when enough paddy for self-sufficiency</td>
</tr>
</tbody>
</table>

2.3 Intensification of crops on paddy land

The main impact of crop intensification is expected for paddy crops. High yield stability based on steady water availability and good management practices allow for intensification of rice production as well as for expansion of the cropping cycle.

Intensification of paddy rice, by using improved rice varieties results in spectacular yield increases. For paddy rice, e.g. in Tua Chua yield increases from the statistical quote of 2 t/ha for the 'common' variety to 5.5 t/ha of the variety D36-1 have been recorded. In addition to yield increases fast maturing drought resistant crops allow for utilisation of paddy land for a second (pre-season spring) crop or in some cases even for a third (winter) crop, e.g. of potatoes.
Variety and crop selection is based on requests from Village Development Planning. SFDP combines these requests with knowledge of new releases/successful experiences from project experts and their network as well as suggestions of the centrally-planned extension programmes. SFDP furthermore selects those varieties/crops for its trials/demonstrations that can be used by a large percentage of farmers if proven successful. For the 2nd pre-season spring crop this includes dry rice, maize, soybean, peanuts, and mung beans. Cost-benefit ratios are still high (albeit lower than for traditional varieties), even at medium input levels and production risk on paddy is lower than for the uplands. Thus the poorer strata of farmers are not excluded from applying this technology.

Speciality crops which promise only a small market and require relatively high investment/area (e.g. 5 mio VND/ha for sugarcane vs. 2 mio VND/ha for soybean and < 1 mio VND/ha for paddy maize) and thus are suitable only for the richer strata are not tested/promoted by the project. The winter crop (3rd crop) of potato is somewhat an exception as it is developing from a speciality product to a staple vegetable in the delta and regional markets for table potatoes seem attractive although yet small. Most interesting but well guarded by established multipliers is the market for seed potatoes.

The local market for vegetables is expanding rapidly, with good prices being paid especially for non-leafy vegetables. Crops are likely competitive at medium intensification level.

Intensification of crop production on paddy land entails some level of pesticide application. Knowledge of Integrated Pest Management (IPM) options is important for farmers both with regard to environmental concerns and farm economics.

**Medium/Long-term perspective for Yen Chau:** Interest in new varieties for paddy intensification is large and intensification is taking place. The necessity for joint management (e.g. water management, enforcement of grazing regulations) facilitates the integration of all population strata into the application of new varieties, especially for paddy rice. With increasing national rice outputs and export surpluses, in combination with improved road access, the necessity for regional rice self-sufficiency will decline. Places with good road access like Yen Chau will expand growing higher-value protein sources (peanuts, soybean, mung bean) and market gardening. Leafy vegetables will be restricted to the local market, but non-leafy vegetables (cucumber, squash, eggplant, tomatoes) have a potential to reach the delta markets. Especially summer vegetable production will likely expand given that favourable climatic conditions in the mountains (cool nights) favour high quality produce with high sugar and acid content. Currently main constraint during the spring and winter (dry) season clearly is the variable water availability and high drought risk. Cropping is limited by required labour or investment related to accessing water and ultimately total water availability.

**Medium/Long-term perspective for Tua Chua:** Given limited paddy area and limited market integration, self-sufficiency for rice and maize will determine the cropping choice for a while to come. Market oriented production of starch or protein sources is envisaged in the long term, vegetable production will likely be limited to the local (district centre) market.

Again, the promotion of grazing regulations is an important prerequisite for paddy intensification that results in expansion of the cropping season.

**SFDP strategy for paddy intensification in Yen Chau (YC) and Tua Chua (TC):**

<table>
<thead>
<tr>
<th>Technology</th>
<th>in YC</th>
<th>in TC</th>
<th>Remarks on differences between locations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduce improved (drought resistant, shorter-maturing, higher yielding) rice varieties</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Introduce improved maize for food security as second crop on paddy</td>
<td></td>
<td>x</td>
<td>maize self-sufficiency only issue in TC</td>
</tr>
<tr>
<td>Introduce improved legumes and other crops for diversification of rotation (soy bean, peanuts, sweet maize)</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Introduce winter (3rd. season) crops (potato, vegetables)</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Facilitate Integrated Pest Management (IPM) practice</td>
<td></td>
<td></td>
<td>no pesticide use in TC</td>
</tr>
</tbody>
</table>
2.4 Development of fruit trees and other perennials

As in most of Asia, farmers and government institutions put great hopes on the development of fruit production. Rising demand for fresh fruit paired with land tenure security on uplands facilitates introduction or diversification and expansion of fruit production in the project districts.

Yen Chau is well known for its fruit production. Fruit trees were originally planted more than 30 years ago in relatively small home gardens until space was exhausted. Improved management of existing home gardens is required, as in many cases productivity of the trees seriously declined over the years. With the area of home gardens exhausted, expansion continued in remote gardens on uplands following tenure security within the last 5 years. Species chosen by farmers include lower value plums, apricots and tamarind as well as higher value green mango, longan, and litchi. Selection of improved varieties, quality assurance associated with local nurseries and pre-selection options associated with grafting could greatly improve productivity.

Expansion of fruit trees is fuelled by expected profitability as much as by the need for diversification in a highly variable production environment, e.g. a ‘poor rice year’ may coincide with a ‘good mango year’. Introduction of new species could further add to the risk-alleviation strategy. Fruit orchards have an important function as ‘old-age-insurance’ as they promise low-strength labour requirements with high labour productivity. Expansion of fruit production, however, is slow due to capital restrictions. While profitability of existing fruit trees is relatively high compared to other agricultural crops, yield fluctuation, high management risks due to expansion on rainfed uplands, and unclear future market potential justify this moderate pace of expansion.

In Tua Chua, tea plantations are seen by farmers as a good activity for diversification. Establishment of some plantations dates back to the 1970s. Recent allocation of individual ownership rights facilitates testing improved management of tea plantations.

**Medium/Long-term perspective for Yen Chau:** Farmers are primarily interested in fruit as cash crops, with low value fruits with poor market potential ranking lower (apricot, plum, tamarind). Marketing opportunities vary widely and may temporarily change the preference rating. E.g. at the end of 1998 there seems to be a strong demand for Tamarind. While mango show highly fluctuating yields, their overall rating is higher due to the good market potential for green fruit. Pomelo reaches a medium rating, Litchi and Longan reach highest. There may be some potential for introducing new species and varieties, however, few seedlings are available in Phu Ho Fruit Tree Research Center and new species would have to be imported. Capacity building for local nursery management and grafting are prerequisites for lower-cost dissemination.

**Medium/Long-term perspective for Tua Chua:** On account of climate and poorer market access, fruit production is more limited than in Yen Chau. However, success stories from more accessible areas fuel the interest in Litchi and Longan, both of which would find only a very small local customer base. Lower value fruits would likely be easier to market locally. In remote locations as Tua Chua, easily stored nuts and fruits (e.g. Chestnut, Walnut, Persimmon) may be favoured over fruits used primarily for fresh consumption.

When growth performance is determined and a market for trees is established, nursery and grafting technology can be transferred to a commercial level.

Tea is another perennial that has been introduced to Tua Chua in the past. However, high management input is required for high productivity. Currently stands are poor as a result of poor management under unclear joint ownership in the past. With management improvements, medium productivity levels may be reached.

**SFDP strategy for fruit tree development in Yen Chau (YC) and Tua Chua (TC):**

<table>
<thead>
<tr>
<th>Technology</th>
<th>in YC</th>
<th>in TC</th>
<th>Remarks on differences between locations</th>
</tr>
</thead>
<tbody>
<tr>
<td>-- Improve productivity and management of existing orchards (mango and mixed stands)</td>
<td>x</td>
<td></td>
<td>no fruit gardens in TC</td>
</tr>
<tr>
<td>-- Introduce improved tree varieties of known tree</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
</tbody>
</table>
2.5 Intensification and expansion of animal production

Animal production is an important means for providing food self-sufficiency and increasing farm income. Animal products still present the major marketable goods and have an important savings function. Table 4 gives an overview of current animal resources in the project areas.

The income contribution of animal production can be raised in two ways: either increasing productivity per animal (intensification) or increasing the number of animals raised (expansion). Two questions are of major importance. Firstly the question arises which type of animal is most promising? Secondly constraints which are most seriously inhibiting intensification and expansion of animal production must be identified and resolved. These issues can potentially concern breed selection, veterinary issues, and feeding aspects including the free roaming of livestock vs. barn feeding or defined grazing lands and grazing regulations.

Main characteristics of extensive animal production is the access to 'free feed' (i.e. feed without any or with very low opportunity costs, i.e. nutrients that cannot be used otherwise). For ruminants 'free feed' is available as long as grazing areas are no restriction, for pigs 'free feed' consists of by-products with no alternative use or main products that cannot be sold or stored appropriately.

Intensification of animal production usually concerns increased inputs in feed requiring either in increased labour or capital input. The first step from free ranging animals to controlled feeding is taken now as areas become scarce and crop production increases: instead of fencing swiddens, pigs and buffaloes are herded, tethered, or fenced and barn-fed. Wherever the crop production season is to be expanded, village grazing regulations are a minimum requirement.

In a second step animal production is intensified either with decreasing labour availability (increasing opportunity costs for labour) or with expansion of the number of animals per household. In this step feed ration composition changes to higher value feeds (more concentrate, less roughage, less materials which require a lot of preparation) instead of using by-products and low-nutrition wild plants. Farmers are interested in identifying new feed sources. The promotion of feed ration improvement for pigs is requested where pigs are raised for marketing. Ration improvement can greatly improve productivity of production.

However, intensification and expansion of all animals crucially depends on a functioning veterinary service resulting in low disease incidence. Currently, veterinary services are provided by District Veterinary Stations. They primarily act as drug dispensaries, in addition they implement bi-annual vaccination campaigns that are partly subsidised by Government. In case an animal gets sick, assistance from the District Veterinarian is rarely requested, as distances are too far and communication is too difficult. Instead farmers may purchase medicine in the district, without a clear idea of the disease and treatment requirements, or concerned farmers may approach the person in the village, they feel is most knowledgeable in veterinary issues. These 'village Para-veterinarians' have a varying degree of knowledge and usually only few tools and no stock of medication. Provision of training to para-veterinarians and supply of a medical toolkit with basic tools and medicines greatly improves their activity level and effectiveness.

Based on the constraints imposed by disease pressure and current feeding levels breed improvement is not a priority of the target group. For pigs improved breeds are available in the market. For cattle the Government extension service in Yen Chau is promoting Sindhi bulls.

Bee keeping is known in both project areas as an extensive side-line activity with products used for home consumption (wine, medicine). Introduction of improved bee keeping technology is a potential option for increasing productivity and expansion into a market product.

Expansion of fish keeping is seen in both districts. Many farmers are starting this activity, often with little management knowledge and consequently poor results. Training for improvement of fish raising is requested.
by many farmers.

**Tab. 4: Animal production in Yen Chau and Tua Chua project villages**

<table>
<thead>
<tr>
<th>Animal Type</th>
<th>No of animals/hh in Yen Chau</th>
<th>No of animals/hh in Tua Chua</th>
</tr>
</thead>
<tbody>
<tr>
<td>pigs</td>
<td>1.14</td>
<td>1.96</td>
</tr>
<tr>
<td>buffalo</td>
<td>0.89</td>
<td>1.14</td>
</tr>
<tr>
<td>cattle</td>
<td>1.05</td>
<td>0.22</td>
</tr>
<tr>
<td>horses</td>
<td>0.11</td>
<td>0.78</td>
</tr>
<tr>
<td>goats</td>
<td>0.09</td>
<td>0.23</td>
</tr>
<tr>
<td>chicken</td>
<td>13.55</td>
<td>7.17</td>
</tr>
</tbody>
</table>

* average in project villages: 22 villages in Yen Chau, 18 villages in Tua Chua; data collected in 1998 but may reflect earlier surveys

Medium/Long-term perspective for Yen Chau: The greatest interest is definitely in pig production. Pig raising is facilitated by its short production cycle and good market access resulting in comparatively favourable economics. Pig production is generally on the first intensification step: Pigs are tethered or barn-fed, which is facilitated by the availability of feed stuffs (maize and/or cassava) in the region. In the future, pig numbers will likely increase. For market-oriented production improvement of ration design following physiological and financial criteria is important. The availability of improved breeding material allows for further intensification. However, disease pressure is cited as a major constraint.

For market production, poultry (eggs and meats) ranges second. Medium scale production size prevails (5-20 birds) and thus a significantly lower annual turnover then for pigs.

Expansion of keeping large ruminants is unlikely beyond 1-2 animals/household. Reduced grazing availability due to land allocation, reforestation efforts and expansion of crop production will limit the expansion potential in the near future. In this situation of increased land pressure, improvement of natural pasture will likely not be competitive compared to crop production. Intensification is also unlikely based on unfavourable economics in comparison with pigs (long production cycle). A local dairy market will not likely develop and is not on the political agenda either for Yen Chau or Tua Chua. Reduced grazing availability also reduces the options for free-roaming goats, while stall-feeding of goats requires high management inputs.

Bee production proved to compete only poorly with other activities, and faces difficulties with year-round feed supply. Fish production is steadily increasing and provides an important protein supply for the local market.

Medium/Long-term strategy for Tua Chua: Both pig production and ruminant production rank high. Pigs are primarily used as 'savings device', and provide an alternative 'maize storage' over the dry season. The savings function is facilitated by its short production cycle and relatively stable market access. In the medium term, only dispersed efforts to improve the efficiency of market-oriented production can be expected. With expansion, disease pressure will increase and may become a constraint.

Poultry production also provides some cash income, albeit only on a small scale. Wide-spread small scale production seems to satisfy the local market and local prices are generally lower than on provincial capital level.

Large ruminants will likely expand beyond 1-2 animals/household as grazing land is not as constraining as in Yen Chau. Where seasonal fodder shortage is experienced, hedgerows with fodder value are of interest. Improvement of natural pasture would require a high management input (fencing, seasonal regulation of stocking rate) that is unlikely to be feasible. The number of free-roaming goats may increase, albeit not without detrimental effect on vegetative composition. Prevailing low management (feeding) levels are the main constraints for breed improvement for all types of animals.

Intensification of bee production is taken up with interest. Fish production will slowly expand and will become an important protein source.
3. Experiences with the tested technological options in Yen Chau

In Chapter 2 the 5 working areas of SFDP project were described in detail. It was explained how the current situation, farmers requests and the envisaged future perspective have formed SFDP strategies in these 5 areas. In this Chapter project experiences in 3 years of project implementation are summarised for Yen Chau. Experiences for Tua Chua are described in Chapter 4. The descriptions cover both successes and failures. These form the basis for recommendations given in Chapter 5 on the most promising involvement of the extension system to be replicated in other villages and on how to continue services in these villages.

For each technological option, it is described what farmers selected to do and what results were achieved. Results are listed regarding the sustainability criteria outlined in Chapter 1, i.e. farmers' continued interest, economic issues, environmental issues and required dissemination efforts.

As to farmers preferences it must be noted that they differ widely between villages and farms, depending on access to resources, achieved productivity levels and perceived problems. However, generally, the following preference ranking can be noted: farmers are primarily interested in intensification of crops on paddy land (incl. vegetable) as they see the best chances for improvement. Higher production uncertainty leads to intensification of crops on upland ranking second. Similar uncertainty and in addition a long-term investment horizon puts fruit tree development and intensification in third place. Intensification of animal production usually ranks fourth unless the veterinary situation is perceived as sufficiently stable. Improvements in the veterinary situation may shift the ranking into animal production up to place 2. Last rank upland soil conservation measures, as they have no short-term economic benefit and long-term benefits of increased yield levels and yield stability are uncertain.

This ranking is largely influenced by the service options provided by extension, i.e. access to new technologies through training, small trials and assistance in organising access to seeds. It reflects the ranking of investment options given farmers' current capital access. This explains differences to experiences in other projects where linked credits are provided.

Following, technical options within the 5 working areas of the project are discussed in the same sequence as in Chapter 2.

3.1 Upland soil conservation measures

In Yen Chau the promoted upland soil conservation measures include hedgerows, micro-terraces, cover crops, legume inter-cropping and three-year cassava.

3.1.1. Hedgerows

Technical issues: A number of species were tested (see also Table 5). Initial trials were based on a mix of
tephrosia, pigeon pea and leucaena. However leucaena is shaded out in the mix during establishment, and pigeon pea has only a short survival period of less than 3 years. As a consequence, pure tephrosia, and pure leucaena of different strains (with/without inoculation) were tested. Establishment of tephrosia is easiest, however growth period averages only four years as plants do not survive being cut after harvesting during the dry season. Leucaena establishment was generally good, after initial problems with high seeding rates (recommended rate now is 15 kg/ha). Survival seems to be no problem even when cut in dry season. Sugar cane, and Pennisetum purpureum also establish well. In small trial plot Flemingia, Gliricidia, Calliandra were tested. Flemingia and Gliricidia did not germinate, Calliandra (red-blooming) is developing well. No major disease incidence was observed\textsuperscript{15}.

For further dissemination (organisation, costs) the production of seeds is important. Tephrosia is producing the largest amount of seed (approximately 0.3 kg/row m or 1 ha delivers sufficient seed material for 10 ha). Although a number of Leucaena cultivars seem to produce few seeds in the north, seed production seems to be acceptable (estimate of about 0.1 kg/row m or 1 ha delivers sufficient seed material for 7 ha for XX cultivar).

**Tab. 5: Overview of hedgerow species tested in Yen Chau**

<table>
<thead>
<tr>
<th>Type (Variety)</th>
<th>established since</th>
<th>approx. area</th>
<th>technical result</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leucaena/Tephrosia/ Pigeon pea</td>
<td>96</td>
<td></td>
<td>species mix not suitable for leucaena; pigeon pea poor survival</td>
<td>discontinue</td>
</tr>
<tr>
<td>Leucaena pure (different strains, with/without inoculation)</td>
<td>97</td>
<td></td>
<td>stable local seed supply, good establishment, good seed production, easy management</td>
<td>continue with soil from existing hedges as inoculant</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>inoculation improves growth rate</td>
<td></td>
</tr>
<tr>
<td>Tephrosia pure</td>
<td>97</td>
<td></td>
<td>stable local seed supply, good establishment, good seed production, cutting management crucial</td>
<td>continue (main variety)</td>
</tr>
<tr>
<td>Sugar cane</td>
<td>97</td>
<td></td>
<td>no effective barrier, plant losses due to roaming livestock</td>
<td>discontinue</td>
</tr>
<tr>
<td>Pennisetum purpureum</td>
<td>97</td>
<td></td>
<td>farmers not interested in establishing grasses on upland</td>
<td>discontinue</td>
</tr>
<tr>
<td>Calliandra (red blooming)</td>
<td>97</td>
<td>trial plot</td>
<td>good establishment</td>
<td>expand trial</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>no seeds yet</td>
<td></td>
</tr>
<tr>
<td>Flemingia</td>
<td>97</td>
<td>trial plot</td>
<td>no germination; unstable seed supply</td>
<td>discontinue</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>foreign unstable seed supply</td>
<td></td>
</tr>
<tr>
<td>Gilricidia</td>
<td>97</td>
<td>trial plot</td>
<td>no germination</td>
<td>discontinue</td>
</tr>
</tbody>
</table>

Environmental issues: Hedgerows, especially tephrosia and leucaena, prove to form an effective barrier for soil erosion. After only 2 years ‘steps’ of between 10 and 30 cm height are formed below the hedgerow, indicating the degree of soil retention.

Soil improvement, however, cannot be confirmed by soil analysis and measuring crop yield\textsuperscript{16}. Provision of organic matter and Nitrogen fixation is basically not beneficial for crops (but limited to the area at the foot of the hedgerow).
Farmers’ acceptance: Generally farmers’ acceptance of hedgerows is low. They are agreeing to trying out this technology based on ‘good-will’ (as they benefit from cooperation with extension in other areas) or based on the misconception that they may be able to improve soil quality quickly and noticeably increase yields on poor land. A short term soil and yield improvement is not obvious to farmers. A further disadvantage is shading of the crop if farmers lack labour for cutting. Furthermore the necessity to stop burning residues is seen as disadvantage as long as no alternative organic matter management is practised.

The additional benefits provided by hedgerows (fuel wood, animal feed) are not regarded sufficient compensation for disadvantages. Due to lack of perceived benefits, farmers tend to neglect proper management of hedgerows (i.e. they cut during dry season), leading to low survival: less than 50 % of the hedgerows are in good condition 3 years after planting.

Originally SFDP promoted hedgerows with quite close spacing (4-6 m), resulting in an area loss of 10-15 % for growing productive crops. Some farmers have widened the distance between hedgerows and found the reduced space loss more acceptable. A distance between rows of 10-15 m is now recommended. In old stands every second row may be taken out.

Farm-economics: For farmers, hedgerows do not have a perceivable positive economic effect, as no yield increases on hedgerow plots are experienced. In contrast, farmers see the negative effect of increased labour demand (for planting and tending) and area loss.

Required dissemination efforts: As no positive benefits are obvious for farmers, substantial dissemination efforts are necessary. Farmers have to be convinced about long-term benefits (without misinforming about lack of short-term benefits) within their farm-system. Furthermore farmers have to be encouraged through incentives. These incentives can be that hedgerows are part of a 'package approach' (e.g. if they grow hedgerows, they also get access to certain amounts of improved seeds, trainings, etc.). However, long-term sustainability of hedgerows cannot be assured with providing incentives for only a short time period. One option for a long-term incentive is a tax exemption for hedgerow areas, where upland taxes are enforced. However, this measure is only an incentive if the perceived yield loss amounts to roughly the same quantity as the tax reduction17. For areas with high yields or double yields, tax exemption will not be a sufficient incentive.

Total dissemination costs for hedgerows are quite high in view of the efforts involved. Establishment costs/ha cover personnel input in initial village discussions and promotion meetings as well as technical trainings and seed inputs. Total establishment costs per ha range from 300.000 VND upward, including promotion inputs, technical inputs, seed costs (ranging from 200.000 VND/ha for tephrosia, higher for leucaena) and possible incentives. Furthermore, continued guidance and monitoring is necessary to ensure survival of hedgerows, otherwise the investment is lost within few years and a support for a second round can hardly be generated.

3.1.2 Micro-terraces

Technical issues: In 1998 four training courses were conducted for farmers in the 4 project communes in Yen Chau. Farmers were shown how to establish 50-100 cm wide terraces along contour lines with a slight inclination toward the slope for catching eroding material. They were furthermore shown how to incorporate crop residues and organic material at the ‘root/hill-end’ of the terrace, so as to increase soil organic matter content and alleviate the need for burning crop residues. A series of photos were shown from similar activities in Central America18. Care was taken to invite women into the training as they are the main implementers of soil preparation. After the training course, a number of farmers were interested enough to try out this methodology on their field. Farmer’s interest is also based on the fact that the sugar factory promotes ridging along contour lines for reducing fertiliser losses through run-off.

Experiences of farmers were monitored during the growing season. It was determined that terraces are unsuitable for growing upland rice as weeding is more difficult and upland rice requires clean weeding. For maize micro-terraces do not pose a weeding problem.

Environmental issues: The efficiency of these small terraces for reducing soil erosion needs yet to be determined. The stability of the micro-terraces likely varies with soil properties, animal access, and soil preparation practice and needs to be monitored. Erosion measurements are planned for 1999. Micro-terraces are likely less effective than hedgerows, especially on steeper slopes and unstable soils.

Farmers’ acceptance: Especially in places where access to both paddy and upland is limited, farmers are generally interested in improving their upland, as much as they have ‘unused labour’ during soil preparation
time. With regard to labour requirements micro-terraces range between traditional terracing practices for land improvement and ridging recommendations for sugar cane.

Sustainability of terraces and crop management issues (weed pressure, water logging and pest increase) will determine continued interest. Yield improvements are unlikely to be noticeable in the short-term. Micro-terraces may be seen by farmers as a first step to terracing (by joining two micro-terraces). It remains to be seen if farmers adopt the practice of incorporating organic material instead of burning.

Farm-economics: Micro-terraces are of interest where land is scarce and ‘access labour’ is available. In those situations only long-term increases in yield and increased yield stability may be realised. Higher impact is expected, if fertiliser is applied. Where labour is a constraint during soil preparation time, micro-terracing cannot compete with the alternative of expanding the area of upland cultivation.

As no capital input is required, this technology is particularly suitable to being adopted by poor farmers, relying on a small area of upland.

Required dissemination efforts: Micro-terracing will likely not be adapted by farmers spontaneously. Discussions on soil erosion and the benefits of organic matter integration are necessary. Furthermore intensive monitoring is necessary, as many management issues remain unclear yet, as e.g. maintaining planting density, potential increase in weed pressure, change in weed composition, water logging after heavy rains, pest increase stemming from crop residue. Farmers are testing out various options, that need to be taken up in field discussions. A yield comparison between areas with and without micro terraces is unlikely to be convincing. Contracts may be made with farmers to continue the practice on trial basis and allow the measurement of soil erosion.

3.1.3. Cover crops under fruit trees

Technical issues: Based on the idea that cover crops could be useful for reducing erosion and improving soil fertility, a number of cover crop varieties (legumes and grasses) were established in small trial plots. In these trials, basic characteristics were identified: establishment performance (competitiveness), suitability as fodder (palatability), growth performance especially during dry season and seed production. Successful cover crops were then tested in fruit-tree plantations, that are currently kept bare. Cover crops in maize are discussed under ‘legume integration’ below, fodder crops are discussed under 3.5 ‘Intensification of animal production’.

The tested grasses were established by seed and developed slowly. None of the grass species seem to reach a productivity comparative to Pennisetum purpureum but only that of local grasses. They are no fodder source during dry season as productivity declines at the same rate as for local grasses.

Of the legume crops, Stylosanthes (St. hamata Verano)

showed promising establishment performance and seed production at the end of the first growing season and is not well liked by ruminants. Stylo was transferred to field conditions under fruit trees in the second year (98). Establishment was poor, due to competition with weeds, prolonged dry conditions and destruction of young seedlings by heavy rain and free-roaming chicken. Survival remains to be determined after the onset of the second growing season (99). However, it seems unlikely that survival will be convincing. Instead, for 1999 it is proposed to test a local legume (Crotalaria ssp) as cover crop in field conditions. This bushy legume is well established in some upland fields in Yen Chau with good productivity. It shows good nodulation, poses no weeding problem and re-establishes itself. With its bushy growth habit it is less suitable as cover crop than a viny species, but viny species pose problems climbing up trees.

Only Centrosema ssp. could have been suitable to grow in maize, as it is a low-growing viny legume providing good soil cover. However, it is not very competitive and produces seed only after the second year. It is unlikely that it would survive field conditions for the two year period before regenerating through seed.

Only Centrosema ssp. could have been suitable to grow in maize, as it is a low-growing viny legume providing good soil cover. However, it is not very competitive and produces seed only after the second year. It is unlikely that it would survive field conditions for the two year period before regenerating through seed.

Soil moisture loss through evaporation is likely a limiting factor for fruit productivity that could be reduced by using cover crops. Without grazing soil moisture is well kept under the vegetative cover from the second year of establishment. Establishment to that effect would require grazing management. It is important to note that only non-palatable cover crops can provide an effective cover, as long as livestock are grazing freely.

Environmental issues: Cover crops can provide both soil improvement and soil erosion protection under fruit trees. However, during the onset of the rainy season when the main impact on erosion is expected, a substantial vegetative cover has to exist which can only be maintained through grazing restrictions or by using non-palatable species. Else cover crops are likely less effective than hedgerows for erosion control.
Farmers' acceptance: Farmers eye the cover-crop trial plots with suspicion, as no obvious productive benefit derives from these 'weeds'. Their value as fodder seems to be low: Productivity of grasses seems to correspond to that of local grasses, and growth habits remind too much of local 'weeds'. Tested legumes are not well liked by cattle and buffaloes, although their higher nutritive value may justify haying, which leads to higher acceptance by the animal.

In terms of soil protection and improvement under fruit trees, farmers and extensionists do not readily like the idea of having a vegetative cover under fruit trees as they fear competition for nutrients and moisture especially during dry season. However, if a dense vegetative cover could be established (by protecting it from chicken and buffalo), moisture retention under this cover would likely be convincing, ideally supplemented by obvious N-fixation. Benefits would then have to be substantiated by productive fruit trees.

Farmers also see vegetation under fruit trees as a host for pests, a fear that needs to be analyzed thoroughly.

Farm-economics: Positive economic benefits of cover crops will likely be difficult to determine. In the long run fruit tree performance will likely improve but improvement rates will likely not be obvious in field trials with limited options for standardisation.

Required dissemination efforts: Farmers can only be convinced of allowing a vegetative cover under their fruit trees if they see its effectiveness in moisture retention in the field, no increase in pest incidence and at the same time see a high fruit tree performance. However, so far no suitable species was identified. Soil improving legumes are more acceptable then grasses, but imported species are not competitive. Contracts would be the only option to establish trials with local species and must include close monitoring of pest life cycles and potential host plants. Contracts with farmers must further include technical guidance, close monitoring and loss insurance.

3.1.4 Legume intercropping

Technical issues: Legume intercropping is seen as a good option for increasing organic matter content and Nitrogen supply in upland maize and for providing a protective soil cover after maize harvest until the onset of the spring rains prior to the next growing season. Legumes can only develop, if one crop/year is sown and areas are not compatible with current upland intensification into two crops/year.

Commonly an edible legume 'Nho Nhe bean' (Vigna ssp) has locally been intercropped with maize. An improvement of this system is to 'relay-crop', i.e. seeding the bean during first weeding, otherwise the climbing vine develop too vigorously, pulling down the maize stem, before the maize is harvested. Nho Nhe beans can be harvested in November. Vegetative growth is vigorous, requiring a seeding density of only 3 kg/ha. However, seed production may sometimes be very low (15 kg/ha), and seed collection is hard work. Only in few cases plants do not have to be re-established every year.

A widely found legume is Pachyrrhizus erosus (Cu Dau), a legume which produces a beet-like tuber that in fall is marketed locally and in Hanoi. Vigorous viny growth and good root system likely increases organic matter content. Seed production seems high and as seeds are poisonous they remain on the field for self-propagation. Little is known on this legume, and its N-fixing properties are not evident.

Alternatively to an edible legume, a wild legume, Crotalaria is proposed for testing in 1999. This bushy legume its yellow flower is found in a few maize stands in high concentration. It develops only after the maize is mature and is thus no competition and does not increase weeding input. Good nodulation indicates a high rate of N-fixation, which seems to be supported by the fact that farmers recognise fields with Crotalaria to show high productivity even in continuous maize cultivation. It remains to be determined if Crotalaria can be established on poorer soils or if it only is an indicator plant for good soils. Due to high seed production it persists long-term without further input after initial seeding.

Environmental issues: Intercropped beans provide soil cover for erosion control and water retention, may fix Nitrogen beyond levels used by themselves and likely most importantly increase soil organic matter content. Maize-bean intercropping is reported by farmers as a means allowing for continuous maize cropping.

Intercropped beans, however, provide no erosion control during spring rains, when soils are prepared at the onset of the cropping season.

Farmers’ acceptance: Farmers’ interest in Nho Nhe differs with location. The ‘new technology’ of relay cropping has caused increased interest in this bean and will continue to do so where few areas are suitable
for a second maize crop. However, where a second maize crop is being harvested, interest will likely recede even on remaining 1-crop areas as the bean yield is quite low considering the required labour input for harvesting. The soil improvement capacity is not evident enough to convince farmers into annual reinvestment into seeds.

Pachyrhizus seems to be harvested and marketed in relatively large quantities. However, both by farmers and the general public it is regarded as a 'poverty crop', associated with high labour input and low profits for the producer and a substitute food during poor food supply for the consumer.

For Crotalaria, farmers will initially question why they should seed a 'weed'. However, as labour input for weeding does not increase and in following years no additional investment is envisaged, farmers may be interested.

Farm-economics: It is scientifically proven that legumes with dense, live nodules can fix Nitrogen beyond their own consumption. However, the impact on yields is in most cases not significant enough to be obvious to the farmer. The problem may relate to low N-fixation, but more likely is related to the fact that P-availability not N is the limiting factor for upland productivity. P-availability could be improved through improvement of organic matter content, which could at best be a long-term effect of intercropped legumes.

Growing Nho Nhe provides low evident economic benefit, given the low yield and the required labour input. However, as investment into seeds is low (costing around 15,000 VND) relay cropping may be feasible for farmers without labour scarcity in fall (related mainly to few areas of secondary maize crop). For Crotalaria, only initial investment is necessary and further dissemination is facilitated by high seed productivity.

Required dissemination efforts: Nho Nhe may disseminate by itself, where direct economic feasibility is given, after farmers have seen 'relay cropping' to be functioning. Crotalaria will not disseminate by itself, as results will not be so obvious in the short term and cannot easily be related to this technical option. Extension involvement is necessary to explain the long-term benefits of organic matter, soil water retention and N-fixation. Establishments of trials and field days and farmer visits to productive fields need to be organised. For the first cycle seeds have to be supplied.

3.1.5 Three-year cassava

Technical issues: Farmers in Yen Chau claim that following a rotation of upland rice and one or several maize crops soil productivity rapidly declines. Soil productivity is then recaptured by planting cassava for 3 years. After 3 years, cassava yields are up to 20-30 t/ha (at 500 VND/kg, approx. equal to 10-15 mio VND/ha).

Environmental issues: Leaving cassava for a period of 3 years is claimed by farmers to provide a similar effect as for fallow. This effect could be based on (a) weed composition under cassava leading to N-fixation, (b) weed composition leading to Phosphor-accumulation, (c) increased organic matter content due to soil not being worked (fallow), (d) nutrient recovery from deeper soil layers by deep rooting cassava. Currently, this phenomenon is not understood and is investigated by several national and international research institutions. Studies on weed composition are initiated in cooperation between the University of Hohenheim and Hanoi Agricultural University.

Farmers' acceptance: Cassava ‘fallow’ is commonly used by farmers when soil fertility declines. In addition to its soil improvement characteristics it is also an essential part of diversification for risk alleviation. However, with increased living standard and market access to food home consumption of cassava declines. Thus its marketability becomes a more crucial criteria. Potential reduction in soil fertility with decreasing 3-year cassava in the rotation are likely to be masked by utilisation of improved maize varieties.

Even if cassava markets are good, 3-year cassava area will likely decline as new high-yielding and fast-maturing varieties will likely replace the old varieties (see under (ii) below).

Farm-economics: Recently cassava area declines as cassava has lower financial benefits than maize, and food security has increased.

Required dissemination efforts: Interest of farmers in cassava planting is clearly linked to the marketability of this crop and its economic benefits in relation to maize. The need for cassava becomes evident if soil fertility declines such that maize yields drop in comparison to other fields. However, improved maize varieties offset the effect of declining soil fertility. Soil fertility decline remains unnoticed for a longer time.
An effort by extension to promote 3-year cassava on the basis of its soil improvement properties would find little attention by farmers and little political support as traditional cassava growing is regarded a sign of poverty and endangered food sufficiency and not part of modern agriculture. Farmers would clearly prefer fast-maturing varieties.

3.2 Intensification of crops on upland

Intensification of crops primarily increases food security, but it is becoming similarly important for increasing farm income. Any new introductions must thus be viewed with regard to its technical and financial performance and that is with regard to the amount of money that can be earned from the land (revenues in VND/ha) as well as with regard to the question how much investment is needed and how well the invested money is being used (Cost-benefit ratio). These data are determined on the basis of trials and demonstrations established. The information can assist farmers in identifying where he should best spend his money. An overview of financial parameters is provided in Annex 2.

3.2.1 Improved maize varieties

Technical issues: A number of improved maize varieties have been distributed in Yen Chau district over the past few years. Varieties are provided from Hanoi after testing in the delta. Technical recommendations derived from cultivation on paddy in the delta are generally higher than feasible for upland conditions in Yen Chau. Fertiliser use is not common on uplands, thus it is important to determine the superiority of a new variety without fertiliser application or with a low level of fertiliser. Technical specifications for testing new varieties in Yen Chau are thus adapted from the recommendations given in Hanoi. An overview of the technical specifications used by SFDP for the main crops currently recommended is provided in Annex 1 (Fact sheets).

Highest yields have been achieved by LVN10. Without fertiliser application, best results have been 2.6 t in 1997 and 4.3 t in 1998 (‘maize year’), with fertiliser, the yield has increased to 3.4 and 4.8 t in the respective years. Thus LVN10 is the recommended variety at the moment (see also overview in Table 6).

It has to be noted that it is difficult to determine yield performance of new varieties due to large annual fluctuations, variability between fields and the frequent necessity to replant (often with a degraded or traditional variety). Quoted yields thus have to be interpreted with caution and need to be substantiated at least over a period of 3 years.

Environmental issues: Improved varieties achieve higher yields even under extensive management. Higher yielding varieties use and deplete soil nutrients at a faster rate. Furthermore, higher yields mask the fact that soil fertility is declining. Thus farmers do not react to decreased soil fertility as they have in the past by rotating to a soil improvement crop.

Farmers' acceptance: Production costs and yields are the main determinants of farmers' acceptance. As production risks are high, farmers reject high investments in seed and initial fertiliser application. Hybrid varieties are considered as too costly in view of purchase costs (at above 25,000 VND/kg) and the necessity to repurchase them every year.

In addition to the productivity of the maize variety, a number of other criteria are important for farmers, such as taste, storability, and market price. Varieties are preferred that can be used for human consumption and sold, as versatility in use is a means of risk reduction. Bioseed hybrids are not considered good for human consumption, the market price is lower.

Short maturing varieties are furthermore of interest to farmers depending on his labour and land resources for planting a second maize crop.

Farm-economics: Main determinant of economics on upland is the production risk. New varieties are financially beneficial, if not a large amount of initial investment is put at risk. Traditional varieties require an investment in seed of below 100,000 VND/ha, which often is no cash expenditure. In contrast, hybrids require an investment of above 300,000 VND/ha and realise a markedly increased productivity only if fertiliser is applied (i.e. investments of about 1 Mio. VND/ha). In addition some of the hybrids (e.g. Bioseed 9681) are considered not edible but ‘feed maize’, with prices in 1998 being about 200 VND/kg lower than for edible varieties (1800 VND/kg vs. 1600 VND/kg).
Subsidies are a common tool to reduce investment requirements. For some varieties subsidization during the introductory period (2-3 years) facilitates further dissemination of this variety under market conditions.

So what benefits get farmers if they invests into expensive seeds or into fertiliser? A number of trials have been conducted within the project. The results of these trials give a first indication, although they have to be further substantiated by monitoring over several years and under different soil conditions. In Table 6, the results for different maize varieties grown with and without fertiliser are listed. The data shows clearly, why farmers are hesitant to use fertiliser, but are instead first of all interested to intensify by using improved seeds. They likely have better investment options elsewhere than investing into fertiliser. In Box 1 the economic reasoning and economic terminology for relevant indicators is explained in detail.

Tab. 6 Technical and financial results of different maize varieties grown with and without fertiliser

<table>
<thead>
<tr>
<th>Maize variety</th>
<th>year</th>
<th>fertiliser</th>
<th>yield t/ha</th>
<th>investment VND/ha</th>
<th>Gross margin¹ (GM)Mio VND/ha</th>
<th>CBR²</th>
<th>CBR for increm.³ investm.</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>'traditional'</td>
<td>97</td>
<td>none</td>
<td>2.8</td>
<td>50,000</td>
<td>3.590</td>
<td>73</td>
<td>-</td>
<td>best use of capital, average labour productivity5 (18,000 VND/d)</td>
</tr>
<tr>
<td>'traditional'</td>
<td>97</td>
<td>N 0 P 100 K 0</td>
<td>3.2</td>
<td>190,000</td>
<td>3.970</td>
<td>22</td>
<td>3.7</td>
<td>fertiliser use reduces capital productivity markedly (future option)</td>
</tr>
<tr>
<td>LVN8</td>
<td>97</td>
<td>none</td>
<td>3.2</td>
<td>130,000</td>
<td>4.030</td>
<td>32</td>
<td></td>
<td>first intensification option</td>
</tr>
<tr>
<td>LVN8</td>
<td>97</td>
<td>N 0 P 100 K 0</td>
<td>3.6</td>
<td>260,000</td>
<td>4.420</td>
<td>18</td>
<td>4.0</td>
<td>100 % increase in investment brings only 10 % increase in yield</td>
</tr>
<tr>
<td>LVN10</td>
<td>97</td>
<td>none</td>
<td>2.6</td>
<td>370,000</td>
<td>3.010</td>
<td>9</td>
<td></td>
<td>poor intensification option in bad years</td>
</tr>
<tr>
<td>LVN10</td>
<td>97</td>
<td>N 100 P 150 K 50</td>
<td>3.4</td>
<td>1,000,000</td>
<td>3.420</td>
<td>4</td>
<td>1.7</td>
<td>fertiliser level too high, capital not well used</td>
</tr>
<tr>
<td>'traditional'</td>
<td>98</td>
<td>none</td>
<td>3.0</td>
<td>50,000</td>
<td>4.890</td>
<td>96</td>
<td></td>
<td>high returns on capital, but GM of LVN10 50 % higher</td>
</tr>
<tr>
<td>LVN10</td>
<td>98</td>
<td>none</td>
<td>4.3</td>
<td>300,000</td>
<td>7.440</td>
<td>26</td>
<td></td>
<td>good intensification option in good years (short-term view)</td>
</tr>
<tr>
<td>LVN10</td>
<td>98</td>
<td>N 65 P 65 K 150</td>
<td>4.8</td>
<td>915,000</td>
<td>7.724</td>
<td>9</td>
<td>1.5</td>
<td>fertiliser level too high, capital not well used</td>
</tr>
<tr>
<td>Fall:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bioseed 9681</td>
<td>97</td>
<td>N 100 P 150 K 50</td>
<td>2.8</td>
<td>1,380,000</td>
<td>2.260</td>
<td>3</td>
<td></td>
<td>fertiliser level too high, capital not well used in poor year</td>
</tr>
</tbody>
</table>
1 Gross margin is calculated as revenues-expenditures, i.e. only looking at cash-flow, excluding family labour and other benefits such as feed-value of straw.

2 CBR=Cost Benefit Ratio: Cost/Benefit; This parameter indicates how well the invested capital is used; how much money I earn from every 1000 VND I invest, e.g. a CBR of 4 indicates that I get 40,000 VND for every 10,000 VND I invest.

3 Incremental investment is the additional investment into fertiliser as compared to the situation without fertiliser

4 ‘traditional’ is usually a degraded earlier introduced variety

5 Labour productivity varies widely with distance from the farm house. For a rough estimate of labour productivity see also Annex 2.

<table>
<thead>
<tr>
<th>Bioseed 9681</th>
<th>98</th>
<th>N 55</th>
<th>3.1</th>
<th>608,000</th>
<th>4.353</th>
<th>8</th>
<th>adapted, lower fertiliser level</th>
</tr>
</thead>
</table>

Box 1: Economics of using improved varieties and fertiliser on upland determined by production risk - Explanation to Table 6

Several factors have to be looked at when we discuss the economics of upland intensification. The main indicators listed in Table 5 are explained in more detail to make the decision path of farmers more transparent.

**Initial investment level and investment risks:** From the above data, it can be seen, that investment amount increases markedly, when farmers use improved varieties and fertiliser. With higher initial investment, production risks increase: when the crop fails the Bioseed-farmer loses 27-times more than his colleague growing traditional maize. Thus the more farmers fear loss, e.g. poor farmers or farmers working poorer soil, the less they invest.

**Increase in gross margin:** How much does the farmer have left in his pocket after he deducts his expenses? In a ‘poor maize year’ like in 1997, farmers who grew the traditional variety had on average about the same amount left in their pocket if they sold their crop and deducted the expenses, as farmers who invested in improved varieties with or without fertiliser. Their additional investment seemed wasted. Only in a good maize year, improved varieties realise their potential and provide higher gross margin (by 40 %). An important factor is of course the market price. High market prices (as in 1998: 1,800 VND/kg vs. 1,300 VND/kg in 97) increase the advantage of improved varieties: the price however will likely go down again.

The gross margin per ha also determines how well the farmer is using his labour. At around 200 labour days/ha, he can calculate that he ‘earns’ for each day also 40 % more if using improved seeds in a good year.

**Productivity of capital:** Where should farmers best invest their capital? Crop production on upland reminds a little of gambling: farmers may lose everything or may win high. Farmers using traditional variety, get as much as VND 700,000 for every VND 10,000 they invest (in good years, even 900,000 VND). Investments in better seeds are still highly profitable: even in a poor year a farmer gets 32 times his investment if he chooses improved seed (LVN8). More expensive seed like LVN10 reduces the productivity of capital to 9 (90,000 VND for every 10,000 VND).

**Use of incremental (=additional) capital for fertiliser investment:** When comparing the investment into seed and into fertiliser, it becomes evident that fertiliser investment is much less feasible. Thus it is difficult to encourage farmers to do it, even if in the long term it is important to keep soil productivity. Highest returns on investment were recorded for adding a small amount of fertiliser (P) to the LVN8 or the traditional variety: The recorded capital productivity was 3.7 and 4, i.e. for every 10,000 VND invested, the farmer gets around 40,000 VND back. It is a normal phenomenon that the higher the investment into fertiliser, the lower the capital productivity. The fertiliser level the farmer chooses depends on other alternatives he has for investing his money and again on the risk he is willing to take. There are currently few farmers who have not better investment options than to follow fertiliser
Required dissemination efforts: Dissemination of new varieties is an easy task, if farmers have heard and seen about the new varieties in comparative production conditions (i.e. grown on upland without fertiliser in neighbour villages) and if the initial seed costs are moderate. Before subsidies are provided for seeds, it must be assessed (calculated), if there is a long-term chance that farmers will continue to apply the new variety after subsidies are removed. This assessment would facilitate that subsidies are more effectively in facilitating dissemination.

3.2.2 Second upland crop

Technical issues: Only since 1998 in Chieng Dong District, Yen Chau, a second crop of maize is grown from Sept.-Dec., if fast-maturing varieties are chosen in both cropping seasons. Yields can be approximately as high as for the main crop, albeit are subject to larger variation as water availability is less certain. Expansion is limited to good soils with good water retention and labour availability. Expansion fluctuates each year with weather conditions.

Environmental issues: As cultivation period is extended, there is less time for some naturally occurring legumes to develop (e.g. Crotalaria). Furthermore, nutrient extraction increases and thus the danger of soil mining if no counter measures are taken. High yields may leave decline of soil fertility unnoticed, until it has deteriorated substantially. As yield fluctuations are more common, and thus production risk is higher, it is even less likely that fertiliser will be applied in this crop in the near future.

Farmers' acceptance: Great interest as land access is limiting factor and a second crop is a good possibility to increase farm income. Higher risk associated with this second crop facilitates extensive production technique (own seed, no fertiliser). Low investment levels facilitate the use of this technology by the poor.

Farm-economics: Improved varieties show a high yield (up to 4.8 t/ha), high labour productivity (at around 250 labour days up to 30,000 VND/day) and a good return on investment (Cost-Benefit-Ratio of above 20). The detailed results are listed in Table 6 and are explained in detail in Box 1.

Currently high prices and 1998 'bumper harvests' will facilitate an increase in upland production with only low investment levels in the short term. In the long term, however prices will go down as they are considerably higher than world market prices. At the same time intensification will be required to counteract soil fertility decline. Expected decrease in organic matter content (less cover crops can establish during dry season) will increase the impact of dry spells and thus the incidence of crop failures. If not counteracted, upland cultivation becomes more risky, with higher investments, crop failures are more devastating for the farm economy.

Required dissemination efforts: Farmers hearing of this technology and seeing some fields are likely to apply this technology soon, given the access to improved seed. Further dissemination effort is necessary only for more remote areas (support in seed access). However, a serious effort to reduce adverse ecological impact must be made by promoting fertilizer application and measures to increase the organic matter content.

3.2.3 Fertilizer use on upland

Technical issues: With the introduction of improved maize varieties and a second cropping season, the danger a declining soil nutrient level has gained momentum. At the same time that nutrient extraction increases, traditional mechanisms of nutrient supply are declining. Wild legumes that used to thrive in harvested maize fields are now weeded out for the second crop before they produce seeds. The second crop
furthermore hinders the intercropping of maize and beans. The use of another traditional methods of soil-recuperation, the inclusion of 3-year cassava into the crop rotation, is also declining as market conditions for cassava are inferior to those for maize.

Currently fertilizer use on upland is not practised: the supply of organic fertilizer is limited and its use is restricted to paddy land and home gardens, as is the use of chemical fertilizer. Crop productivity seems to react especially to Phosphor fertilization.

Environmental issues: With increased nutrient extraction, and decreased soil recuperation methods, soil fertility deteriorates substantially. In the short-run this fertility decline has no obvious impact on yields as it is compensated by high productivity of new plants. However, in 'poor maize years', i.e. under subverse weather conditions, the incidence of crop failures will become more pronounced as a result of lower organic matter content in the soil and lower water and nutrient retention.

Farmers' acceptance: With the use of improved maize varieties, yields increase and the decline of soil fertility remains unnoticed. Farmers therefore do not see the necessity to use fertilizer on their upland. If high market prices for maize continue, farmers will likely adopt some fertilizer application in the later part of the growing season when production risk is easier to assess.

The likely decline of market prices, however, will reduce the incentive for using fertilizer. Especially poor farmers will see better investment options for their limited capital.

Farm-economics: As is shown in Table 6 and described in Box 1, the Cost-Benefit-Ratio (CBR) for fertilizer use is not as good as for investment in improved seeds. Application of a small amount of Phosphor has the best capital productivity, a CBR of around 4. Application of NPK only has a CBR of 1.5-1.7 - even at application levels well below recommendations. CBR decreases further when product prices decline, which is likely to happen. In addition, lower soil fertility will increase production risk and thus also result in lower fertilizer application.

Required dissemination efforts: As long as prices remain high, fertilizer trial with small amounts of Phosphor can convince some farmers to adopt this technology. Tests on the impact of late Phosphor application (to affect cob formation and filling stage) would improve the acceptability as production risk is more easy to assess at this stage. Decreasing prices reduce the acceptance of fertilization.

For farmers with little cash, however, investments in improved seeds will rank first, as it provides better return and may exhaust their investment capacity. In this case, more labour-intensive alternatives for soil improvement options without cash requirement should be promoted (as discussed in Chapter 3.1).

3.2.4 Improved cassava

Technical issues: Improved cassava strains introduced from China are fast maturing and show high yields. Yields of over 20 t/ha are reported over a growing time of only 6 months, while traditional varieties were left in the field for 2-3 years to achieve a yield of 16-25 t/ha. After 7 months, yields of only 7-8 t are reported.

Environmental issues: The environmental effect of fast-maturing cassava is two-fold: on one hand, higher productivity translates into higher nutrient extraction and nutrient depletion if no countermeasures are taken. On the other hand, traditional cassava itself was used for soil improvement, and its absence will leave a serious deficit of soil regeneration methods.

Farmers' acceptance: Farmers are eager to test the new variety, based on the rumour of a good income opportunity. Many issues however, have to be determined yet, e.g. the taste of new variety, its storability, its suitability for being kept in the field longer than 6 months, and finally a potential difference in market price. Careful monitoring is necessary, before recommendations can be given.

Farm-economics: The market price and the marketability of the crop determine financial feasibility in the short term, both remains to be determined. Before 1998 the market for cassava fluctuated greatly, main marketing option was to small-scale local starch extractors, who were often insecure about when they would have next marketing option. Since 1998, the emerging feed industry seems to provide a secure and regular demand situation.

In the long term higher input requirements have to be expected, as soil nutrients are taken out faster than with the traditional variety. The competitiveness with maize remains to be determined, and many open questions
remain to be answered. Trials start in 99.

**Required dissemination efforts:** Farmers may adopt the new cassava variety quickly if there is a high financial benefit. The role of extension in this case is rather to monitor negative effects on soil productivity. Based on these effects, it is necessary to review economic issues over the long run, i.e. the average income over the next 5-year rotation, and yield expectations in 5 years.

### 3.2.5 Improved upland rice varieties

SFDP is not testing any varieties for upland rice, mainly, as it is not voiced a priority by farmers at the moment. Currently the area of upland rice is declining for three main reasons: (a) labour requirements for upland rice are higher than for other crops, as repeated clean weeding (hoeing) is required, (b) weed pressure after maize seems too high (best planted after 3-year cassava), and (c) yields are low, leaving financial returns much lower than for maize. Farmers tend to grow special varieties for home-consumption during the TET-festival.

SFDP's reluctance is further based on the fact that the chance of achieving yield improvement with higher yielding varieties is relatively low, as growing conditions are very variable. In 98, e.g. all upland rice died during a prolonged dry spell. Finally, the negative impact of upland rice on soil erosion seems to be comparatively high since it requires the most intensive soil cultivation.

Two reasons remain for looking into upland rice production: firstly its importance as diversification in order to alleviate overall production risk in the farm-system. Secondly, it remains important for farmers with little access to paddy, and that remains true, the less they are integrated into the market. Remote villages with little paddy continue to rely on their upland paddy production for self-sufficiency.

The difficulty to find a clear strategy for upland rice is reflected by Government extension policies: While on province level recommendations are given to decrease the upland rice area, in Mai Son district, the extension system is entering the existing 'commercial' distribution for Tan Pau variety, originating from China.

### 3.3 Intensification of crops on paddy land (incl. vegetable)

For the intensification of crops on paddy land, improved rice varieties are the first option. With intensification, plant protection and Integrated Pest Management (IPM) are of importance. Furthermore promotion of a second (spring) and third (winter) crop are discussed.

#### 3.3.1 Improved rice varieties

**Technical issues:** Improved rice varieties can increase yields dramatically from the 3 t/ha sometimes quoted for 'traditional' or degraded varieties to as much as 8 t/ha for San UU63 in spring of 1997. Commonly organic fertiliser (animal manure, green manure) is used on the paddy, as well as some level of chemical fertiliser. Table 7 gives an overview of all different crops tested for 'paddy intensification'.

Fertiliser levels depend both on the nutrient availability in the soil and the requirement of the crop (based mainly on type of crop and productivity level). Together with a new variety, usually fertiliser recommendations come from the delta. Local adjustments are necessary, to combine technical requirements with financial and environmental conditions. These adjustments require repeated testing and monitoring and are not available yet.

**Environmental issues:** Soil nutrient depletion in paddy soils is not an issue. Farmers use fertiliser and if they use too little, the impact is quickly evident in the next crop. On the contrary, intensification of paddy production often is promoted as a package, in which the 'modern' farmer is encouraged to use high fertiliser levels. Exceedingly high levels of fertiliser use can only be expected when farmers receive free inputs through government promotion efforts. When financing themselves, financial returns will limit fertiliser inputs to lower levels; hazards most likely occur as a result of improper timing.

Technical packages often also contain a certain level of 'medicine', i.e. pesticides. Integrated Pest Management (IPM) is an important measure to reduce negative environmental impact from deliberate pesticide use, but also from extensive fertiliser use.
Farmers' acceptance: Farmers are first and foremost interested in improving their rice yields. This is based on two facts: comparatively lowest production risk (especially for 'first' = summer crop) and the importance of rice for self-sufficiency.

Where farmers grow 2 paddy crops per year, it is important to them to use a variety both for 'first' (=summer) crop and for ('second'=spring) crop. Spring crop is commonly more uncertain, and the area may vary greatly between years. Thus, leftover seeds should be reusable for the summer crop, as it cannot likely be stored for the following year.

Farmers furthermore prefer seed, that they can use for 2-3 crops before having to buy new seeds, as financial benefits are higher when using own seed. This is evident when comparing e.g. the investment for VT in 97 and 98 (Table 6). Important is also that production risk associated with cash loss is much lower when own seed is used.

Farm-economics: For farmers, summer paddy crop is their main crop with highest importance for self-sufficiency. Investments into improved varieties of above 2 Mio VND/ha are required to get yields of as much as 8 t/ha in one crop. Only on fields with steady water supplies, these levels of investments are taken. For more uncertain areas, farmers will choose lower investment levels (around 1 Mio), and likely use VT instead of San UU63, especially as the Gross margin for both crops is similar (around 14 Mio VND/ha), when the farmer uses own VT seed.

Tab. 7: Overview of technical options on paddy land in Yen Chau

<table>
<thead>
<tr>
<th>Variety</th>
<th>Year</th>
<th>fertiliser kg/ha N</th>
<th>P kg/ha</th>
<th>K kg/ha</th>
<th>yield t/ha</th>
<th>investment VND/ha</th>
<th>Gross margin2 (GM) Mio VND/ha</th>
<th>CBR3</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>San uu 63</td>
<td>98</td>
<td>350</td>
<td>300</td>
<td>160</td>
<td>7.1</td>
<td>2,295,000</td>
<td>14.75</td>
<td>7</td>
<td>first choice for good land</td>
</tr>
<tr>
<td>San uu 63</td>
<td>97*</td>
<td>200</td>
<td>250</td>
<td>150</td>
<td>8.0</td>
<td>2,180,000</td>
<td>13.82</td>
<td>7</td>
<td>suitable for both crops!</td>
</tr>
<tr>
<td>VT</td>
<td>98</td>
<td>150</td>
<td>250</td>
<td>0</td>
<td>6.5</td>
<td>925,000</td>
<td>14.68</td>
<td>17</td>
<td>own seed high profitability</td>
</tr>
<tr>
<td>VT</td>
<td>97</td>
<td>200</td>
<td>330</td>
<td>0</td>
<td>6.5?</td>
<td>1,660,000</td>
<td>11.34</td>
<td>7</td>
<td>2nd choice to San UU 63</td>
</tr>
<tr>
<td>Bac UU 64</td>
<td>97</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Insect damage, not as good as San UU63</td>
</tr>
<tr>
<td>HB (sticky)</td>
<td>97</td>
<td>200</td>
<td>330</td>
<td>0</td>
<td>5.0</td>
<td>1,660,000</td>
<td>23.34</td>
<td>15</td>
<td>High yield, but taste disliked</td>
</tr>
<tr>
<td>Other:*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maize, Sweet, VN2</td>
<td>98</td>
<td>155</td>
<td>214</td>
<td>0</td>
<td>30 thsd. cobs?</td>
<td>840,000</td>
<td>6.0-10.0</td>
<td>7-12</td>
<td>Continued</td>
</tr>
<tr>
<td>Maize, Sweet, VN2</td>
<td>97</td>
<td>100</td>
<td>150</td>
<td>50</td>
<td>30 thsd. cobs?</td>
<td>920,000</td>
<td>5.00</td>
<td>7</td>
<td>continued: early planting (M2) necessary</td>
</tr>
<tr>
<td>Maize, local sweet</td>
<td>97</td>
<td>100</td>
<td>150</td>
<td>50</td>
<td>20 Thsd. cobs</td>
<td>780,000</td>
<td>4.20</td>
<td>6</td>
<td>lower productivity than VN2</td>
</tr>
</tbody>
</table>
Cash expenditure are greatly reduced if farmers can reuse their seed. Comparing the data for VT in 97 and 98 the difference in investment is the seed price (2,500 vs. 6,000 VND in the second year). Even if this seed is bought from the neighbour, capital productivity increases greatly\(^\text{31}\). Productivity likely declines in the 2nd and 3rd crop. A 20 % decrease in productivity would still provide a capital productivity of above 10.

A second important means of reducing the investment needs, is an efficient utilisation of fertiliser. On paddy land, no trials were made to compare crop productivity with and without fertiliser levels, as fertiliser application is already an accepted technology. However, with increasing fertiliser levels, capital productivity levels decline\(^\text{32}\). It is thus important to the farmer to decide where he best invests his money, i.e. which options for capital productivity he wants to choose. Trials of different fertiliser levels would help the farmer to make an informed decision.

In other provinces, IPM courses are used to teach farmers about soil analysis and to test out different fertiliser levels, combinations and timings. Extensionists also show farmer how to select seed material from their own grains.

**Required dissemination efforts:** An initial trial of a new variety and the determination of its superiority is required to facilitate acceptance. Subsequently, access to seed, and some technical training is all extension needs to provide. It is important that the final choice is made by the farmer on the basis of his field conditions and his financial conditions. Extensionists need to assist the farmer in making objective comparisons between different varieties.

Subsidies should only be paid for the initial introduction. Subsequently, farmers' choices should be based on market prices, and Government money be better spent elsewhere. Rather extension should assist farmers in 'saving money on fertiliser' and on seed by using their own seed. By showing farmers how to select seeding material from their own harvest, they can greatly increase farm economics. However, this type of assistance

<table>
<thead>
<tr>
<th>Variety</th>
<th>Year</th>
<th>Seed Stage</th>
<th>Days to Harvest</th>
<th>Yield</th>
<th>Capital Productivity</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peanuts 4329</td>
<td>97</td>
<td>30</td>
<td>90</td>
<td>60</td>
<td>3.5-4.0</td>
<td>growth poorer than LD5</td>
</tr>
<tr>
<td>Peanuts LD5</td>
<td>97</td>
<td>30</td>
<td>90</td>
<td>60</td>
<td>4.0</td>
<td>2,560,000 17.4</td>
</tr>
<tr>
<td>Mung Bean TX21</td>
<td>97</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1.1</td>
<td>2,100,000 4.5</td>
</tr>
<tr>
<td>Gr. Bean V123</td>
<td>98</td>
<td>220</td>
<td>140</td>
<td>0</td>
<td>1.8</td>
<td>1,204,000 7.80</td>
</tr>
<tr>
<td>Potato VT2</td>
<td>97</td>
<td>200</td>
<td>250</td>
<td>0</td>
<td>14.0 (13.0)</td>
<td>2,900,000 32.2</td>
</tr>
</tbody>
</table>

1 Season is noted in brackets: SP=Spring, W= Winter

2 Gross margin is calculated as revenues-expenditures, i.e. only looking at cash-flow, excluding family labour and other benefits such as feed-value of straw.

3 CBR=Cost Benefit Ratio: Cost/Benefit, indicates how well the invested capital is used, e.g. a CBR of 7 indicates that a farmer gets 70,000 VND for every 10,000 VND he invests.

4 2 further varieties proved unsuccessful in tests: rice X21 was tested in 97 and showed low yields due to disease; maize LVN7 was also not successful on paddy in 97)
puts extensionists in a conflict of interest, as they receive commissions from input sale.

Production credits are a good means for intensifying production when farmers lack cash at the beginning of the season, as production-risk is fairly low. At Cost-Benefit Ratios of above 7, interest levels are not an issue, rather the timely access to capital.

### 3.3.2 Expansion of cropping rate with legumes, sweet maize, and vegetables

**Technical issues:** On areas where insufficient water availability restricts the utilisation by rice, alternative crops can be grown from Feb.-May. Expansion of these 2nd paddy crops is limited by two main factors, i.e. stable access to water, and labour availability. Labour availability is limited due to competition with rice preparation, upland preparation, communal work assignments (house & irrigation construction) and leisure for New Year.

**Environmental issues:** Nutrient depletion again is not an important issue, as it would be noticed in the subsequent rice crop and would be corrected. Especially for vegetables, however, deliberate utilisation of pesticides could become a health hazard for people and adversely affect adjacent fish-production and subsequent crops. IPM for vegetables, focusing on companion cropping and biological pesticides will be important in the future.

**Farmers’ acceptance:** Farmers are interested in diversifying production and growing high-value crops for marketing. However, the risk associated with unstable water supply, high management requirements, and insecure markets is a major obstacle. Farmers are especially reluctant to include a new activity into their farming system, that does not fit with their traditional activities: in this case new crops compete for labour input with upland crops and paddy crops. Furthermore, social obligations in spring (communal work, festivities) are important and restrict labour availability.

**Farm-economics:** All crops tested are high-value crops with high gross margins, e.g. up to 17 Mio VND/ha for peanuts (see Table 6). However, they also require high investments (1-2 Mio VND/ha). High investment requirements in an unstable production environment (drought risk, high management requirements, fluctuating markets) translate into high risk.

**Required dissemination efforts:** Dissemination is easiest along Road 6, where farmers have better market access and anticipate good financial returns. Access to reliable seed (so far only available in Hanoi), technical training and management support needs to be provided to establish new crops. Expansion of these crops will continue to be limited due to poor access to water resulting in high production risk, and due to competition for labour requirements with existing upland cultivation.

### 3.3.3 Introduction of winter crops

**Technical issues:** Following the harvest of the summer/fall rice, a number of leafy vegetables as well as potatoes can be grown on well-drained paddy soils with close-by water access.

A large number of potato varieties is available in Viet Nam, originating from France, Germany, Latin America, and China. Bumper yields of as much as 24 t/ha are reported in the delta under high management.

Potato production is usually based on seed potatoes, lately also TSP (True Potato Seed) is available but access is extremely restricted. Seed potatoes are available from various sources, and it is difficult to determine if they are really clean seed potatoes or table potatoes, resulting after several multiplications. With increasing number of multiplications, disease incidence increases dramatically and even under high management, yields often drop to 10 t/ha, if not the whole crop is devastated. Many diseases restrict the potential for growing potatoes in the future, some affect the entire adjacent area (e.g. leaf virus transmitted by aphids).

When starting potato production, Yen Chau, as a high altitude, disease-free region could have become a multiplication region for seed potatoes, however the seed producer network is extremely difficult to enter. In Yen Chau, yield levels of up to 14 t of table potatoes are acceptable under chosen (medium) management levels.

**Environmental issues:** Potatoes are often grown under high levels of pesticides and can create an environmental hazard. Good planting material is a prerequisite to keep pesticide levels low. An IPM approach should be applied when good training material is available from the delta.
Farmers' acceptance: Farmers are very interested to expand their cropping cycle. However, high investment levels and management requirements limit expansion. Government seed subsidies have helped to generate interest in potatoes. With decreasing subsidies, yield and market developments will determine further interest of the farmer. Potatoes will not develop into a major component of the diet, due to local taste preferences and limited storability.

Farm-economics: Financial performance is currently extremely good. However, high investment levels and high risk, caused mainly by uncertain seed quality and a limited local market will determine future economics. Currently prices are higher than in Hanoi (above 2,000-4,000 VND/kg vs. 1,000-2,000 VND/kg in Hanoi). With a lot of transport capacities coming up empty to pick up maize, it is likely that the local market in Yen Chau will be saturated by Hanoi products and prices drop to Hanoi levels.

Required dissemination efforts: Trials with high technical support and seed subsidy are a good tool to initiate production. Access to high quality seed is important for future success. Expansion is likely limited to villages along Road No 6 with good market access.

3.3.4 Dissemination of IPM knowledge

Technical issues: Yen Chau District Plant Protection Station has conducted IPM Farmer Field Schools for rice under the national IPM programme as well as with SFDP financing. The methodology of doing training in the field instead of the classroom and to space the training over a growing season covering field related topics is a great achievement in farmer training. Evaluation of the course shows that farmers have decreased pesticide application and furthermore have substantiated their management knowledge. Management knowledge to be promoted in IPM classes consists of fertiliser application management and variety comparisons and selections in addition to pest identification, pest treatment and sanitary precautions. These are topics that clearly overlap with the tasks of the extension system.

It is a characteristic of Farmer Field Schools to facilitate active participation of the students and their ability to organise the main activities by themselves. However, the transfer of these abilities varies widely with teacher capacities. Most of the teachers have only participated in 1 teacher training course and have conducted on average only 1-2 courses/year.

In Farmer Field Schools usually 'key farmers' from several villages participate. It is important to design follow-up activities within the villages for trained farmers to effectively practice and to disseminate their knowledge. So far it remains unclear, to which extent villagers are able to act as trainers themselves and to what extent district or province staff are capable to provide outside support for this 'farmer-to-farmer training'.

Within the national programme the creation of 'IPM Clubs' is practised. These clubs are organised and formally registered on Commune level. Their activities cover various issues far beyond plant protection, which allows for flexibility but at the same time may result in another umbrella organisation with shallow and unfocused activities. Village activities which may be called 'farmer-to-farmer training' or Farmer Interest Groups, are clearly a more operational field related option. On province level this issue has not been discussed, on national level discussions have not yet resulted in a structured operational follow-up approach, e.g. field books for 'farmer-farmer-training' are not yet available.

Within the whole programme it must be noted that a conflict of interests arises as long as the Plant Protection Sub-Department and the Plant Protection Station are involved in provision of chemicals. In Son La, as in some other provinces they have transferred this business to other offices under Agriculture and Rural Development Department (e.g. the Input Supply Station). However, they keep a small volume of stocks in case 'epidemics' brake out. Although their annual turnover is small (officially 150 Mio VND in 98 in all of Son La province), commissions from pesticide dissemination may still cause a conflict of interests.

Environmental issues: IPM practice clearly facilitates environment protection. Benefits of the courses depend on the level of pesticide use recorded prior to the class and the rate of reduction. These benefits are often difficult to estimate based on the current indicators used, i.e. officially registered sales of pesticide. An independent management survey before and after the course would be a better indicator, but is costly and difficult to arrange. It can, however, safely be assumed that a number of health hazards can be avoided when increasing pesticide availability is combined with relevant background information.

Farmers' acceptance: Farmers are very interested to save money by reducing production inputs. Participation in Farmer Field Schools is high and regular. However, farmers' acceptance of the course is difficult to assess, as farmers are being paid for participation (compensated for loss of work time). Thus the motor for
participation becomes unclear. As pesticide application level are low, scope for cost reduction is also low. The felt benefits must therefore include benefits from better production management.

**Farm-economics:** National surveys indicate that higher gross margins were realised by farmers following IPM applications. Quoted figures for rice of 350,000-750,000 VND likely concern areas with previously very high pesticide application and clearly include yield increases based on provision of better seed.

Under medium management levels like in Yen Chau, investments into pesticide application likely range around 200,000 VND/ha. Thus at an average paddy area of 0.2 ha/household savings from reduced pesticide application are possible at a level of 20,000-40,000 VND (100,000-200,000 VND/ha). This level of savings likely is of little interest for better-off households in view of the required time input. Therefore, it is important to generate additional benefits through increasing the efficiency of fertiliser use and providing access to better seeds in order to motivate farmers to participate.

**Required dissemination efforts:** The efforts and costs of getting IPM practice applied on village level are high. For paddy rice, and many concentrated crops, effective integrated pest management requires joined management decisions within the village, else pests will migrate from treated into untreated fields.

In order to facilitate village application, a large number of persons in the village have to have a clear understanding of the methodology. Furthermore pest monitoring must be established and results must be regularly exchanged between villagers. All these activities require a great deal of organisational management and time input by the farmer. Felt benefits need to compensate for this, else high external financing is necessary.

Currently IPM programmes in Yen Chau run with high external financing: Farmers are paid for participating in courses, dissemination within the village is low without external financing of an organisational structure, a village trainer and an external coach. These external subsidies should be slowly reduced. The anticipated final situation in the village should be that farmers themselves pay for (part of) the village-based IPM activities through membership fees. Only then the benefits are clearly proven.

Expansion of IPM programmes to other crops must clearly be related to (a) the area expansion of that crop and (b) the current level of pest-related yield loss or else the expenditures for pesticides. Fruit trees, and especially mango are suggested by the district as a focus for IPM activities, and area expansion and pest-related yield loss seem to justify involvement. However, experts pointed out that Yen Chau provides only marginal growing conditions for mango and yield improvements would only be achieved at unfeasibly high expenditures for pesticides.

Undoubtedly ‘farmer field schools’ are an appropriate tool for farmer training that both extension and plant protection should use in coordination, as topics beyond plant protection need to be covered and staff capacities of the plant protection stations are considerably smaller than that of the extension stations.

### 3.4 Fruit tree development and perennial crops

With regard to fruit tree development three activities are promoted: the improvement of existing orchards, the introduction of improved varieties and new species and the transfer of nursery and grafting technology. Other perennials, such as tea, mulberry and coffee have not proven successful in Yen Chau in the past and do require a large-scale approach.

#### 3.4.1 Improvement of existing orchards

**Technical issues:** Old Mango and mixed ‘home gardens’ have been an important component in the major farming-system of Yen Chau. However, while overall productivity was good, annual fluctuations are high. Productivity declines may also be caused by low management levels and by the age of the trees.

Various improvement of orchards have been requested by farmers. These include trimming of trees, thinning of stands to improve growing conditions for remaining trees, staged replacement of old trees, fertilisation, pesticide and hormone application.

Interventions started in 98 and impacts on yield can so far not be assessed.
Environmental issues: Intensification of pesticide and hormone use can have negative impacts on the ecosystem. Especially bee production is likely to be affected. Thorough training is necessary to limit misuse of chemicals.

Farmers’ acceptance: As fruit production is seen as a major cash source in the farming system, farmers are alarmed in case of declining productivity or crop failures, as in 97. However, the decision to cut down a potentially productive tree is difficult to take. Also farmers are hesitant to invest money into intensification, due to the uncertainty of a positive impact of these investments.

Farm-economics: The economics of existing fruit orchards in Yen Chau is difficult to assess. Even more difficult is it to determine feasibility of investments in intensification. In the selected home gardens, intensification measures at a level of around 1 Mio VND/garden (including technical support) have been designed. As farmers calculate roughly an income of 1 Mio VND/grown mango tree, the chosen investment level seems potentially feasible: it could be regained within 1 year by increasing the productivity for 10 trees by 10 % each.

Required dissemination efforts: From 1998 6 home garden have been selected to test intensification measures. If the interventions can be proven to have a positive financial impact, a number of field days will be necessary to disseminate this as a service-offer of extension, that farmers finance themselves. Financing would most likely be based on a contract including direct payments (e.g. for inputs) and result-based incentives to the extensionist (sharing of additional yields), although the later is extremely difficult to predict and to verify.

3.4.2 Introduction of improved varieties and new species

Technical issues: Fruit trees are traditionally grown close to the house, in ‘house gardens’ located on flat land, close to a water supply. With limited area available for further expansion around houses, new fruit orchards are developed on the uplands. Here, soils are less fertile, and access to water is more restricted and high management intensity is more difficult to maintain.

Improved, grafted varieties of longan and litchi were supplied by the project in 1997 and 1998. Both trees are known by farmers and they have a strong wish to expand them. Grafted trees highly improve the investment success in contrast to former practice of having to wait for 3 years until the first fruit prove the suitability of the tree. Survival rates and initial growth of the supplied trees is good, productivity will remain to be assessed.

In cooperation with the Fruit Tree Research Centre Phu Ho contracted by SFDP in 1997 and 1998 and an international short term expert, several species were selected for dissemination. Out of the new introductions recommended for Yen Chau, only Pomelo, Khaki and Avocado can be supplied nationally by the Phu Ho Fruit Tree Research Centre. Avocado is yet to be supplied (in 1999).

Environmental issues: As fruit production expands to sloping lands while maintaining the practice of bare soil under the trees, soil erosion increases especially until the canopy closes. Continuous soil cultivation furthermore leads to a decline in soil organic matter and thus reduced water and nutrient retention. Promotion of cover crops is tested by the project, as described above.

Farmers’ acceptance: Farmers are eager to expand fruit production, especially if they can trust into a secure high-quality seedling supply. Investment however takes place in cautious steps which allow for close monitoring of achievements under risky production conditions and maintain risk alleviation of a mixed cropping system. There is a good market for grafted known trees. New species generate less interest, until productivity and marketability are demonstrated.

Farm-economics: From the farmers’ point of view fruit trees are a good long-term security. However, only under secure production conditions with sufficient access to water, and stable markets, feasibility of investments will be high. As little information is available even on current yield developments, investment risks must be considered high and a cautious expansion of mixed stands is justified. The transfer of nursery and grafting technology to district and village level is an important prerequisite for reducing investment failures.

Required dissemination efforts: Even if farmers like fruit trees, dissemination of trees must be well planned in the village so farmers make the necessary preparations and are committed to looking after them. Village level grazing restrictions must be in place (or jointly developed and agreed) before trees arrive. Farmers must cover some of the costs, in order to value the trees. Farmer visits to established orchards are necessary for promoting new species.
3.4.3 Transfer of nursery and grafting technology

Technical issues: Farmers used to have to wait 3 to 4 years to find out whether the fruit trees they planted produced an acceptable fruit quality. Often trees with sour fruit had to be cut down, when their performance became evident.

Nursery and grafting technology was transferred to staff of the extension centres and a few farmers. Teachers are available from a number of institutions. Training sessions must include a number of days of practical work. The issue of potential damage to mother trees and seedlings must be solved in advance.

Environmental issues: - as for promotion of fruit trees -

Farmers' acceptance: Farmers are eager to use grafted trees, as they reduce the risk of having to replace unproductive trees. They are also eager to learn grafting. However, a lot of practice is necessary to achieve high success rates.

Farm-economics: For customers the availability of grafted trees markedly improves the feasibility of the investment. Grafting technology is highly appreciated and services can likely be provided commercially. In other districts 'grafting teams' are travelling through communities being paid for their services.

However, establishment of fruit tree nurseries with grafted trees depends on an existing market for trees and a basic understanding of the product. Decentralized village nurseries are likely not feasible as the market is too small, except for villages in a central market location.

Required dissemination efforts: Training must be provided for learning grafting in 'hands-on' courses, likely with a few repetitions. For further practising grafting at least a small scale nursery must be set up. Investment into a nursery is only feasible if a market exists.

3.5 Intensification of animal production

Based on the development options identified for intensification of animal production in Chapter 2 the strategy in Yen Chau includes 6 different activities, i.e. promotion of bee keeping, training for village para-veterinarians, supply of a veterinary toolkit for them, training on ration improvement for pigs, identification of new feed sources, and finally identification of training needs for fish raising.

3.5.1 Bee promotion

Technical issues: Promotion of bee keeping was one of the first activities in animal production, SFDP supported. In cooperation of the Bee Research Institute in Hanoi activities focused on villages with existing management experience. Technical improvements concentrated on the construction of improved hives, division of hives, disease management and harvesting.

The crucial point turned out to be the insufficiency of a year-round feed supply which requires investment in feed (sugar) and close monitoring during wet season to reduce the number of swarms absconding. Alternatively, bee producers would have to migrate with their bees over the course of the year, as they do in other areas. This specialisation is not likely to take place.

Environmental issues: Interest in bee keeping and expansion could lead to a more thoughtful selection of pesticide application.

Farmers' acceptance: Traditionally honey is consumed in the household as alcohol or in some cases for medicinal purposes. In most cases, men are involved in bee keeping. Few farmers have taken the step from regarding bees as a freely available minor side line activity for home consumption to seeing it as one major income-generating activity and consequently expanding to more than 10 hives and considering investments. Constraining factors for further expansion were an unreliable market access, and the problem to meet the high monitoring demand during labour peaks in crop production (beginning of wet season). Faced by these constraints cash investments were not regarded feasible by most farmers.

Mainly households with 'excess labour' around the house, e.g. persons not directly involved in field work, may
choose this activity. After three years of technical support, the number of bee raising households in 4 communes had only increased 17 to 37, the number of hives had barely doubled from 60 to 116.

**Farm-economics:** Bee keeping in Yen Chau is not competitive compared to other activities, does not well fit into labour calendar, and has no stable market access. Investments in seasonal feed supply are not feasible as a medium management input results in high production risk.

**Required dissemination efforts:** In view of the low financial feasibility of the activity, even high efforts to improve management capacities have shown little success. The guided formation of a producer club on district level has not noticeable improved dissemination of information, as logistics proved too difficult. Reformation of producer clubs on commune level seems not to have changed the dynamics. The motor of expansion, i.e. seeing this activity as a major income-generation source, is still lacking.

### 3.5.2 Training for para-veterinarians

**Technical issues:** The persons identified on village level as most knowledgeable in medicinal and veterinary issues have a widely varying level of training and practical knowledge. Activities within the project are not comprehensive enough to provide a solid foundation but instead are designed to address the most frequent tasks required. Topics include, the knowledge of the main commonly available medications, symptoms and curative measures for major diseases, disease infection cycles, proper use of antibiotic, use of helminthics, safety measures to stop the spread of infectious diseases etc. After initial 3 day training courses, a coaching-training system between the district veterinarian and the para-veterinarians are foreseen for 1999.

In many cases curative measures do not sufficiently improve the veterinary situation, but must be combined with improving vaccination coverage. Vaccination coverage in turn is difficult to improve when farmers are asked to pay for vaccination and vaccination effects are not convincing. The subjective assessment of a poor disease protection may be explained with poor vaccine quality, re-infection after low vaccination coverage and misinterpretation of symptoms.

**Environmental issues:** The training of para-veterinarians may help to reduce the improper use of medication, especially antibiotic, which poses a serious threat for future development of treatment resistance.

Generally, expansion of animal production results in a higher availability of manure. If applied to the fields, it helps to maintain soil organic matter content, nutrient availability and water storage capacity.

**Farmers’ acceptance:** Farmers are interested in improving access to veterinary care. In some cases villages pay a monthly allowance for the veterinary in addition to paying for the treatment. A community-based veterinarian may then also exert more influence in improving vaccination coverage.

**Farm-economics:** Feasibility of investing in veterinary training is likely high, but difficult to verify, as disease outbreaks are highly irregular and reduction in disease incidence cannot be statistically confirmed. Similarly the increase in the number of successfully treated animals is not a reliable indicator for better service, but reflects only a general trend. Beyond the direct financial benefit of having animals successfully treated, is the indirect benefit of farmers increasing their investments in animal production (increasing herds, higher production intensity) once they feel that production risk is reduced. Higher farm income from animal production is envisaged.

**Required dissemination efforts:** Improvements in the veterinary service are only possible to a certain degree and in small steps. Continuous training and monitoring is necessary for those veterinarians who prove to be practising. Supervision by a village management board is beneficial to determine extent and appropriateness of service and discuss a viable reimbursement structure. At the same time the coaching tasks of the district veterinary service must be defined and operational. Functioning mechanisms for disease prevention, i.e. regular vaccination campaign with sufficient coverage, should be built up concurrently.

### 3.5.3 Toolkits for village para-veterinarians

**Technical issues:** Availability of simple tools and medication in the village improves treatment success. Based on experiences of Action Aid, toolkit contents were adapted at the onset of the support activity to fit local requirements. Investment per toolkit amounts to about 600,000 VND, which is spent above half on tools and medication each. Contents were again reviewed after 1 year of implementation based on actual usage.

Regulations for the use of the toolkit are discussed in the village before toolkits are handed over and are
agreed upon by the village development board. Monitoring sheets are provided for the para-veterinarian and follow-up and monitoring activities are designed for the district veterinarian. The village para-veterinarian signs, that he agrees to be held responsible for toolkit management and replacement of used medication. Outside replacement of used medication would endanger the sustainability of the intervention.37

Environmental issues: Care has to be taken to exclude harmful substances (e.g. Strychnine) and reduce the use of unnecessarily powerful antibiotic. Expiry dates have to be monitored when assembling the toolkits as to minimise the need to shortly dispose of non-used materials.

Farmers’ acceptance: In general farmers agree on the provision of services against payment when they call the para-veterinarian for support, although payment morale may vary. It is obviously difficult to enforce payment of farmers for treatments if there is an indication that external funds can be used for replacement of medications. Payments may be delayed until harvest time.

Farm-economics: Investments into veterinary toolkits are likely positive for the community, as treatment success may be increased, reducing animal losses and improving the investment conditions into animal production. However, these effects may be difficult to verify. For the veterinarian, the initial investment into toolkits may allow him to expand his services to a commercial level. Private investments into expansion of medical supply would be an obvious indicator for success.

Required dissemination efforts: The mere supply of toolkits is quite an easy exercise but far from sufficient for ensuring an effective and sustainable improvement of veterinary services. Instead toolkits must be part of a training, coaching, monitoring and supervision system that requires a great deal of staff and management capacities. The following 5 steps must be taken:

a. initial discussion with village management on the selection of suitable para-veterinarian as toolkit manager,

b. training of para-veterinarian in general and in the management of toolkit incl. monitoring formats required,

c. design and signing of agreement on the use of toolkit and sharing of responsibilities between village management, para-veterinarian and district veterinary station,

d. design and implementation of coaching plan by district veterinary station, and

e. design and implementation of external monitoring (e.g. once per year) and enforcement of corrective measures (e.g. transfer of toolkit in case of mismanagement or lack of activities). It should be noted that external replacement of medication is detrimental to the enforcement of the whole system.

3.5.4 Ration improvement for pigs

Technical issues: With increased availability of feedstuffs and of cash farmers are interested in increasing the growth rates of their pigs. At the same time, the number of free roaming pigs decreases and barn-feeding is common. Currently there is still a potential to increase the efficiency in the use of home-grown feeds. Farmers lack the basic understanding of nutrition, e.g. the necessity to supplement energy feeds like maize and cassava with farm-produced or purchased protein feeds (fish paste, snails, dried fish and fish-leftovers, soybean meal). As a result they tend to provide unbalanced rations where energy feeds cannot be utilised fully due to lack of protein.

Two improvement options have been designed and disseminated in a number of training courses. For farmers who do not wish to invest into purchased feed components, it was suggested to make better use of their available protein sources (e.g. fish leftovers) and to improve the selection and the digestibility of wild fodder. Nutrient content of major fodder stuff varies widely and knowledge on these differences may facilitate the use of more nutritious species: e.g. commonly banana stem are fed in winter, which have a low dry matter content, and low protein and energy levels. In contrast, cassava leaves have a 5-times higher dry matter and energy content, and a 10-times higher crude protein content. A similar nutritional improvement is provided with Leucaena and a number of wild growing legumes.

In addition to the selection of more nutritious species, the digestibility of the green fodder can be improved. On farm level this can be done by initiating a fermentation process, by adding water from rice washing to the
finely chopped leaves and feeding them 2 days later. Some testing is necessary to determine which leaves are accepted by the animal.

A few farmers in the village are interested in purchasing feeds or feed additives to improve the growth performance of the animals and at the same time reduce the time input of having to cook the feed. Those farmers are confronted with many concentrate feeds and feed additives being offered in the market as they are mainly distributed through a concessionaire system. While these ready-mixed feeds are a good feed source for larger scale or sub-urban producers, they are a rather expensive option for farmers growing feed components themselves. Those farmers better use their own feed stuffs and supplement only with those components that are in short supply (usually protein). When recalculating feed costs per g of protein, compound feeds are easily twice as expensive as alternative protein sources.

By explaining the basics of animal nutrition, the product information of the major available feed components and by calculating lowest-cost rations under locally relevant feed prices and availability, farmers can be assisted to greatly improve their production efficiency. Thus the step from a currently unbalance low-efficient ration to a well-balanced effective use of feed resources requires only a small cash investment (less than 200,000 VND/finished pig over a period of 6 months, equal to an average 1,000 VND/day).

In addition, in the district town a number of medium sized pig producers (10-20 fattening pigs) are familiar with the use of yeast for improving protein content and digestibility of feeds, likely at a level of around 5-10 %. Further benefit is that yeast application replaces the need for cooking the feed, which is both a saving of labour and of fire wood. Costs of yeast are included in the above calculation.

Environmental issues: Barn-feeding of animals allows for a more effective collection of animal manure and its recycling into the crop production system, thus improving organic matter content of the soil. The value of manure is well understood for paddy land, however its use on upland is limited. It will likely expand into higher-value crops on upland (vegetables, fruit trees) in the future. In China, e.g. the availability of manure is seen as limiting factor for expanding fruit orchards to low-pH uplands.

Farmers’ acceptance: Pig production is mainly the concern of women. Women farmers are interested in improving the growth rate of pigs. They eagerly follow explanations of basic nutrition if conveyed in a farm-house while showing every-day food and feed items. They eagerly get involved in a discussion of locally available fodder stuffs and their acceptability by the animal.

While a number of these farmers are using some level of marketable products for pig production (i.e. they decide to feed pigs instead of selling the feed), few farmers are willing to invest cash into feed purchases. Yet their number will expand and it is important that they may not be lured into a ‘modern’ capital-intensive compound-feed ration that most often leads to high financial losses.

Farm-economics: The globally known pig cycle invariably influences pig production in Viet Nam. Flexibility in ration design and production intensity, paired with independence from feed prices due to availability of farm-grown feeds are a good footing to survive low-price periods. A cash investment of below 200,000 VND/finished pig may reduce production period by 2 months (from 9 months to 6-7 months). A shortened fattening period translates into quicker return on investment, increased number of production cycles (2 pigs/year instead of 1.3) and a savings in home-grown feed of approx. 140 kg (2 kg/day), a sales value that approximates the required cash investment of 200,000 VND.

Required dissemination efforts: Promoting ration improvement obviously differs from currently known activities of credit or subsidy driven promotion of new breeds and modern feeds. While in a given village a number of villagers may sign up for a new breed following a one-time successful promotion campaign, effects of a training course on ration improvement are less obvious and likely less pronounced. Repetition of training topics in a continuous external coaching and information sharing between farmers (e.g. Farmer Interest Groups) are prerequisites for transferring the basic understanding of pig feeding into increased financial feasibility.

This kind of course, i.e. the supply of information rather than material inputs, is clearly the role of the extension system. However, training and coaching require a high degree of knowledge, preparation time and enthusiasm which are currently contrasted by the fact that incentives for information dissemination without input supply are rather low. It is therefore much more likely to provide this kind of course though the involvement of one of the mass organisations, likely the women’s union.

In Yen Chau, some experienced pig producers are members of the Women’s Union and compare production
experience with a sound training and experience in information dissemination. These persons are prime candidates for giving training, after being supplied with relevant training information (e.g. nutritionally and financially verified example rations) and a comprehensive lesson plan. A further incentive for their work will likely be the supply of feed additives (e.g. yeast) or being called by larger producers for seasonal ration adaptation according to feed availability and prices. This incentive would clearly translate into a preference for larger producers using purchased feed. Alternative incentives have to be set if the focus is to be put on small-scale producers.

3.5.5 Identification of new feed sources for cattle, pigs and fish

Technical issues: The issue of improving feed sources is often voiced as a concern by farmers. Visions may include lush pastures for ruminants and pig troughs full of concentrate. It is rather difficult for these visions to become reality.

With regard to ruminants a focus is placed on improving green fodder availability through introduction of new varieties with higher nutrition value, higher area productivity, and prolonged seasonal fodder availability. Cultivated and seeded pastures on arable land is ruled out as it cannot compete with crop production activities. Improvement of natural pastures (be it along dikes, paths or in concentrated areas) is very difficult as new varieties have to compete with the well adapted climax vegetation that has developed under the existing grazing pressure. Usually higher productivity grasses compete poorly with existing grasses when planted from seed. Legumes are commonly shaded out by the faster growing grass species or else are destroyed by selective grazing as they provide higher nutrition. Successful improvement of natural pastures requires strict pasture management that proves practical in countries like Australia where one individual cattle producer manages large herds and large areas and has the required infrastructure of fencing in place. Where pasture management requires an organisational structure facilitating the involvement of a large number of small producers, obvious benefits have to be quite high to compensate for time input of individuals and an appointed well-trained pasture supervisor.

Alternatively concentrated plantations of improved fodder species along fences and as hedgerows can be considered. Pennisetum Purpureum (elephant grass) has shown high biomass production and its growth habit makes it suitable for cut & carry feeding systems. However, its expansion is limited to the vicinity of the house as it attracts all neighbours free-roaming ruminants. Leucaena leucocephala planted in hedgerows or along fences improves the fodder availability at the time of highest scarcity: at the end of the dry season when protein feeds are needed to prepare buffalo for their draught labour. It could replace currently used wild legume trees that grow far from the house and are difficult to establish.

Occasionally ideas surface to improve the utilisation of straw through chemical or bacterial treatment. Concerted efforts would be necessary to develop a respective service structure and would likely not be justified.

An emerging issue is the improvement of utilising sugar cane by-products. Cane tops remain with the grower, bagasse collects at the processors. Both are fed directly. Fermentation treatment which could highly improve digestibility of bagasse.

For pigs ration improvement options are discussed above. In Ba Vi Goat and Rabbit Experiment Station the tree Trichantera Gigantea has been promoted not only as goat feed but also as pig feed to surrounding small scale pig producers. However, nutritional value of gigantea is only comparable to that of banana, and its biomass production not likely higher than that of a number of local trees. Thus concentrated plantations are not justified.

For the expanding fish production, green fodder sources are an issue: fish (grass carp and other) are fed with bamboo leaves and a mix of wild growing grasses, collected nearby. Pennisetum Purpureum is a good fodder source as it has a high productivity, high digestibility, long growth season, withstands repeated cutting and is suitable for embankments. Some farmers, however, have complained that high grasses on embankments host fish parasites.

Environmental issues: Environmental issues concerning new feed sources basically comprise the general benefits of increasing animal production as discussed above. Furthermore, hedgerow species may have the dual effect of providing soil erosion control and improving fodder availability.

Farmers’ acceptance: Fodder for ruminants still seen as freely available, only activities requiring a low degree of inputs in land and labour are acceptable. Pennisetum patches around the house and Leucaena in nearby hedgerows for spring feeding are likely the most acceptable options.
For pigs a training on nutrition required to understand improvement options, which then may be followed by using some of the farm-grown protein sources, possibly also beans considered inferior for human consumption, i.e. The bean or Tiger bean (Vigna ssp).

Pennisetum expansion for fish is the most accepted activity, if rumours of its negative impact regarding fish pests are not substantiated.

**Farm-economics:** Economics of fodder production is difficult to monitor and calculate under small farm conditions. Analogous to farmers' acceptance Pennisetum purpureum for Fish likely gives the highest notable return in terms of a savings in labour for fodder collection. Spring supply of protein fodder for buffalo also may save labour and improve the strength of the animal when being used for draught.

**Required dissemination efforts:** Prior to any efforts a village-specific analysis of the fodder constraints is important to guaranty that there is sufficient interest in testing out fodder species. Small demonstration plots of plants are necessary for farmers to judge their productivity and suitability as feed source. Pennisetum purpureum and Leucaena remain the two most promising species.

### 3.5.6 Identification of training options for fish-raising

**Technical issues:** Fish production is currently expanding rapidly. After initially using natural ponds or fields where poor drainage prevents from growing 2 paddy crops, or combining pond digging with using the soil for brick making, an increasing number of farmers are converting agricultural land to fish ponds. The statistical average of 0,01 ha/family does likely not reflect most recent developments. Fish have a good potential for expansion on small scale, however, when starting it as a low-input sideline activity, the rate of failure is high as basics of space requirements, feeding and veterinary care are not well understood. Farmer training courses start in 1999.

**Environmental issues:** Fish producers may get a better understanding of eco-system relationships when fish are effected by deliberate use of pesticide on neighbouring fields. Use of antibiotics in fishponds is likely another issue that needs to be addressed. As for all animal production, faeces (pond sediments) is a valuable organic fertiliser.

**Farmers' acceptance:** Farmers are interested in expansion of fish production and in training. The option of small scale expansion, and management under relatively low capital investment levels makes it suitable for less wealthy farmers. Acceptance of training depends on the relevance of the provided information.

**Farm-economics:** Economics of fish production is good, if basic management requirements are met.

**Required dissemination efforts:** Design of a proper training course must be based on a thorough village-based problem analysis. A course is best organised at the pond in the form of a 'Farmer Field School' system. Once a specialist has gained good reputation, extension on this topic could likely be provided commercially, paid by the farmer.

### 4. Experience in Tua Chua

The situation in Tua Chua is quite different from Yen Chau, as described in Chapter 2. Technical options are more limited, as climate is more restrictive and market access is poorer.

As above, technology options are grouped in 5 working areas and each option is discussed according to the sustainability criteria outlined in Chapter 1, i.e. farmers' acceptance, economic issues, environmental issues and required dissemination efforts.

Farmers' preferences for different working areas vary with village and household specific endowments. However, in general the following ranking can be noted: intensification of crops on paddy (including use of improved varieties and expansion of cropping rate) has first priority followed by improvement of upland soils through improved fallow management. Intensification of upland crops does not yet provide viable options, animal production is rather expanded than intensified (except for bees) and fruit tree expansion continues cautiously.
In the following detailed experiences with individual options are discussed.

4.1 Upland soil conservation measures

As in Yen Chau, Hedgerows are promoted as the main soil conservation measure. In areas where fallow rotations are still common, hedgerows are then used for improved fallow management. They are complemented by promotion of legume-intercropping, cover-crops, and improved terrace making. In contrast to Yen Chau 3-year cassava is not identified as a soil improvement option, as the predominantly Hmong population do not consume cassava.

4.1.1 Hedgerows

Technical issues: Compared to Yen Chau, fewer species are suitable in the higher altitude with a shorter cropping season. Tephrosia establishes successfully and produces abundant seeds. Leucaena has not been successfully established yet, partly, as it needs to be well protected from livestock, partly as it was attacked by a psyllid in the nursery. Pennisetum purpureum established well, however as it attracts free roaming livestock; it is also best grown in protected areas for livestock feed. In few of these locations it could at the same time serve as erosion control.

Environmental issues: Step formation underneath a hedgerow seems less pronounced then in Yen Chau pointing at lower erosion rates. Soil improvement in the short term depends on the incorporation of organic matter into the soil. As this is commonly not done by farmers, no soil improvement is obvious. In the long-term soil organic matter content improves under a closed hedgerow canopy (see under hedgerows for improved fallow management).

Farmers’ acceptance: Farmers with little land resources are interested in improving their land quality. However, if they agree to grow hedgerows, they commonly destroy them by burning them within 2 years of establishment, as soil improvement is not obvious and area loss is not accepted.

Improved organic matter management is considered too labour intensive, as benefits remain unclear.

Farm-economics: Direct benefit of hedgerows is negligible, as long as fuel wood is not in scarce supply and expansion of hedgerow species with fodder value is restricted by free-grazing practice. Indirect benefits could accrue, if the crop rotation could be expanded against the fallow period.

Required dissemination efforts: Hedgerow promotion itself is not useful, as few of them survive for more than 2 years. Instead farmers with larger upland resources can be encouraged to use hedgerows for improved fallow management (see below), while farmers with scarce upland resources must be convinced to practice improved organic matter management. Labour input and benefits remain to be monitored closely in a small trial basis with interested farmers (1999/2000) to determine its feasibility for the farmer, before it can be promoted on a larger scale.

4.1.2 Hedgerows for improved fallow management

Technical issues: Many of the Tephrosia hedgerows were seeded out on poor land that was cropped for the last year before being left fallow. Hedgerows were then left uncut and developed into high shrubs with a closed canopy. After 3-4 years this intensified shrub fallow shows rich dark soil with high organic matter content due to fallen leaves and rhizobia activity. Weeds are almost entirely suppressed.

In 1999 one of these plots in its 4th year is transferred into cropping land. The yield of the rice crop will determine the suitability for reducing the fallow period from 8 years to 4 years through tephrosia improved fallow. A shortening of the fallow period would increase upland productivity by over 50 % as it results in an intensification of cropping rate from 0.3 to 0.5.

Environmental issues: Improved fallow management would still retain most of the functions of traditional fallow, i.e. suppression of weeds dominating on cultivated plots, organic matter build-up, retrieval of nutrients from lower soil levels, and Nitrogen accumulation.

At the same time hedgerows would provide efficient erosion barriers if they could be retained for the following
cropping cycle.

**Farmers’ acceptance:** Farmers themselves have chosen to use hedgerows for improved fallow management as they seeded it on areas assigned as fallow land.

Termination of the fallow period is less labour intensive as for common fallow and yields an acceptable amount of fuel wood (e.g. approx. 4 cubic meter/ha in Xinh Phinh). Productivity of these fallow areas has to be closely monitored and demonstrated widely to farmers to test their acceptance of a shortened fallow period.

**Farm-economics:** An increase in cropping rate on uplands markedly increases financial benefits per area\(^44\). This is of importance, where uplands become scarce, or even where it allows for remote areas to be taken out of production. Currently farmers frequently work fields that are more than 10 km from their house, resulting in high labour input especially for transporting harvest.

**Required dissemination efforts:** Farmer’s preference for growing hedgerows on land assigned for fallow is clearly shown when promoting hedgerows. Impacts of improved fallow management, however, remain to be demonstrated to farmers in trials and disseminated in farmer field days.

As commonly fire is used for clearing fallow vegetation, care has to be taken to promote clearing without fire. Otherwise especially Tephrosia will be destroyed. Even for hedgerow species that better withstand fire (as Leucaena), burning would largely destroy organic matter build-up.

### 4.1.3 Terracing

**Technical issues:** Farmers have usually made terraces wherever a stream exists at least during the main rice season. On these fields they can then grow wet rice, at higher yields and better yield security then upland rice. Terraces are expanded up the hill, depending on the availability of water and of labour.

Where water is insufficient for wet rice production, terraces can still improve water retention, serve as a barrier for soil erosion and prevent soil deterioration. Better water availability leads to higher yields for upland rice which is not negatively affected by occasional water submersion. For other crops, like maize, beans, peanuts, however, terraces have to drain well after heavy rainfall to prevent crop damage.

Yield decline in the first years following terrace construction is associated with the practice to mix topsoil with lower soil levels. Separation of topsoil and reuse as topsoil on the newly established terraces shows a better yield result.

It must be noted that there is a substantial area loss, when sloping land is converted to terraces. At 45° slope the area loss amounts to as much as 30 % even if terrace bounds are vertical. An increase in area yield of more than 20 % is necessary to compensate for area loss on common slopes (20-35°).

Micro-terracing is not regarded a viable option as compared to Yen Chau farmers lack any experience with ridging and free-grazing livestock which destroys terraces is more common.

**Environmental issues:** Terraces are an effective means to prevent soil erosion.

**Farmers’ acceptance:** Farmers are interested to expand their wet-rice area, associated with relatively high yields and low production risk. High labour input for construction is accepted where paddy area is small. However, farmers are hesitant to invest a marked number of labour days for terrace construction where there is no stream feeding the terraces, unless it can be shown, that area yields increase.

**Farm-economics:** Financial benefits of terrace construction accrue both from higher yields and from better yield security. Both factors remain to be proven for different soils and locations. A minimum area yield increase of 20 % is necessary to compensate for area loss associated with terracing.

**Required dissemination efforts:** In the last few years provincial efforts to encourage farmers with incentive payments into constructing terraces have failed. Reasons for failure where a lack of technical guidance (failure to retain topsoil) and insufficient farmers participation in the design. Terrace promotion must be based on village discussions, selection of interested households with suitable locations, good technical guidance, and at best concurrent introduction of higher yielding varieties.
In 1999 terraces have been established with a few households and yield measurements are taken on terraces and adjacent control plots.

4.1.4 Cover crops

Technical issues: Cover crops are regarded as an alternative to fallow where area availability is reduced. As in Yen Chau a number of cover crops were tested in small trial plots and similar results were achieved. None of the grasses showed the productivity of Pennisetum purpureum or expanded productivity into the dry season. Of the legumes, Stylosanthes proved to establish well, showed high green matter yield and developed seeds. It was subsequently (1998) tested in tea stands as cover crop. However, as in Yen Chau competitiveness was poor. Dissemination is being restricted by difficulties in seed harvesting due to seed shedding.

As in Yen Chau, Crotalaria was identified as a locally growing alternative for soil fertility improvement. However, blooming and seed production of Crotalaria takes place only in spring, much later then in Yen Chau. Thus Crotalaria is not suitable for broad seeding on cultivated land. Instead it can be grown for improved fallow or as hedgerows. A suitable cover crop for tea stands or maize has not been identified yet.

Environmental issues: Cover crops could provide soil improvement and soil erosion control if suitable species could be identified. However, during spring rains when fields are cultivated for the new crop they are not present and their overall effectiveness for soil erosion control would thus be lower than for hedgerows. Cover crops for improved fallow management could shorten the fallow period as discussed above.

Farmers’ acceptance: Farmers are interested in finding alternatives to fallow. They are familiar with using legumes for maize intercropping wherever soil productivity allows for legume yields. Where soils are too poor, a wild legume would be a good alternative soil improver. However, dense canopy in the maize is disliked as it increases the incidence of snakes.

Farm-economics: A reduction in fallow period or an increase in the number of cropping years would provide an obvious financial benefit. Short-term effects on yields are unlikely obvious (i.e. unlikely higher than 10 %).

Required dissemination efforts: The search for a suitable cover crop for fallow improvement or for intercropping needs to be continued, based on an analysis of the current legume flora. As effects of a cover crop are likely not easily observable, close monitoring of improvements and control plots is necessary with involvement of farmers.

4.1.5 Intercropping maize with edible legumes

Technical issues: Farmers in Tua Chua use a number of beans for intercropping with maize. Depending on soil characteristics they choose among a large variety of Vigna, Phaseolus, and Cannavalia ssp. Beans are often used for replanting soil in places where maize plants have died out. Quantities are usually small and yields are not recorded. Planting density is low as dense vegetative cover is said to increase the incidence of snakes.

Environmental issues: Bean intercropping provides N-fixation, soil cover for erosion control for a large part of the year, soil water retention, and soil organic matter build up. Erosion control through spring rains is not provided.

Farmers’ acceptance: Farmers recognize that fields with maize bean intercropping have been used continuously for over a hundred years. Beans are an integral part of their diet, albeit in small amounts. Promotion efforts are necessary to raise the awareness of farmers for both the issue of soil recuperation and for nutritional aspects.

Farm-economics: Currently beans are grown in small amounts for home consumption. Seeding density is low and yields, albeit not recorded, are likely low as well. As a result labour productivity for harvesting is low. Obvious short-term financial benefits are unlikely to result from bean promotion. Improvement of soil fertility will only become obvious in the long-term.

Required dissemination efforts: In spite of this existing traditional practice of legume intercropping, further promotion efforts are necessary to stress the importance of this practice both for soil improvement and for protein availability in human consumption. Else the expansion of legume intercropping likely decreases with market integration and crop diversification. As only small seed amounts for home consumption are available, a structured testing and dissemination depends on inventorizing existing subspecies and cultivars, seed
collection from farmers and collection of technical information.

4.1.6 Improved organic matter management

Technical issues: Organic matter on rice fields is commonly burned prior to spring soil cultivation. Benefits of burning are a suppression of weeds and an increased availability of nutrients from the ash. In maize fields, organic matter is commonly raked into long piles that snake up the hills and can easily be burned from the bottom of the hill upward. Benefits of weed suppression are thus limited to the small area underneath the ashes. In subsequent soil ploughing by buffalo along contour lines, ashes get distributed over the whole field.

Zero-tillage is not seen as an option for farmers, except for newly swiddened areas, as weed competition is too high. For rice fields clean-weeding is necessary. Even for maize stands initial growth is easily depressed by weeds and hoeing and slashing is required at least twice during the growing season.

Incorporation of organic matter is often suggested by agricultural experts. This practice would clearly require an increased labour input. At the same time it may suppress yields over the first years, as nutrients may be less easily available then from the ashes. The extent of the increase in labour for soil preparation and weeding and the extent of a potential decrease in yield due to reduced nutrient availability and higher pest incidence is not known. A longer-term trial is necessary to determine these effects.

Environmental issues: Increase in organic matter content improves nutrient and water availability and reduces soil erosion as soil structure and aggregation improves.

Farmers' acceptance: Farmers are not easily convinced to change current cultivation practices. Farmers can only be convinced if they see noticeably higher yields. Discussions and a closely monitored trial on contract basis are necessary to initiate a comparison of suggested improved organic matter management to a traditionally managed control plot.

Farm-economics: Financial benefits for farmers cannot be expected in the short-run, instead negative financial impacts may accrue from increased labour input and possibly reduced yield. Only in the long-term soil fertility and yield security will improve.

Required dissemination efforts: Improved organic matter management is very difficult to disseminate. Farmers will not listen to theoretical instructions but only be convinced by positive results. So far costs and benefits of improved organic matter management are not known. Only once they are known it can be determined what incentives, demonstration and field day measures are necessary.

4.2 Intensification of crops on upland

The options for intensifying upland use are more limited then for Yen Chau. Improved maize varieties may be suitable for increasing area yield, however, the cropping season is too short for a second maize crop. As the predominantly Hmong population do not consume cassava, and there is no reliable market integration, improved cassava also is no option for intensification. The Hmong preference for maize cultivation over rice limits the suitability of looking for improved upland rice varieties. There are a few options for diversification of rotation worth further attention.

4.2.1 Improved maize varieties

Technical issues: Improved maize varieties have been introduced in Tua Chua for a number of years. They have been primarily distributed for the use on 1-crop paddy, but have also been tested by farmers on their uplands. For upland use the characteristics of drought resistance and higher yielding are of importance. Shorter-maturing varieties are not of use. Of additional importance is that cobs remain closed after seed maturity and resistance to post-harvest pests is low. As commonly maize is dried on the standing plant, storage pests easily attack them and open cobs increase rat damage.

So far no standardized trials have been made for upland maize cultivation. However, farmers’ upland practices have been observed. Bioseed hybrids show high yields (estimated 5 t/ha for variety 9670 in 97). At the same time, however, Bioseed varieties show high incidence of post-ripening pest damage on the cob. Nearly all kernels are damaged by the time they are carried to the house. TSB2 showed closed cobs and a pest resistance similar to that of the local variety. Yields are reported to be higher than for the local variety,
e.g. in 1997 an estimated 3 t vs. 2 t for the local variety. Under poor growing conditions yields go down to similar level as for local variety (1.3 t/ha in 1998).

Environmental issues: Higher yielding maize varieties pose an environmental danger on upland where little nutrient recycling takes place. They deplete soil nutrients at a higher rate than traditional varieties. At the same time they mask that soil fertility is declining. Marginal areas are kept in production longer instead of being rotated to soil improvement measures.

Farmers' acceptance: Farmers are interested in higher yielding varieties as long as storage characteristics and taste are as good as for local varieties. Farmers are not interested in varieties that require harvesting right at maturity as labour input and losses for maize drying are high. Varieties with poor taste are disliked as in the current farming system the variability of a crop, e.g. its use for human consumption and animal feed is an important part of risk management.

Farm-economics: Financial benefits of improved maize varieties are high in good maize years as long as no further fertilizer inputs are required. Table 8 provides an overview of investment costs, gross margins and Cost Benefit Ratios for different crops. An important cost factor is the use of true seeds or composites as in contrast to hybrids farm-grown seed from these varieties can be reused in subsequent crops. Especially in view of the highly variable production environment on uplands resulting in wide yield fluctuations (e.g. for TSB2 between 1.3 t/ha in 98 and 3 t/ha in 98), low investments are an important factor of risk alleviation.

Required dissemination efforts: For introduction of improved maize varieties it is important to select a true variety rather than a hybrid to keep production costs and especially cash expenditures low. Farmers are eager to test out new varieties and no standardized trials are required if differences in performance are pronounced. Once one new variety has been introduced structured on-farm trials become important to assess the suitability of each variety for specific locations. Taste, maturing characteristics and storability are further important criteria. They seem to be fulfilled for the variety TSB2.

Free or subsidized seed supply seems a good option during the introduction time of a new variety (1-2 years). Subsequently subsidies will not facilitate the selection of varieties with highest productivity, but instead will be detrimental to farmers maintaining seed security.

4.2.2 Options for diversification of rotation

Technical issues: Under the heading of upland soil improvement, the option for intercropping various legumes was discussed. In few cases legumes are grown as single crop. Commonly this is done with Phaseolus on limestone-based soils. Access to water is the most restricting factor for expansion. Soybean and peanuts are thus grown on only few upland areas with good water retention, commonly on non-sloping land. The tested peanut variety 4329 did not show good results in 97 and its use was discontinued: plant development was poor and seeds were too small. The soybean variety AK-02 showed the same problems. High yields of over 1 t/ha are recorded for soybean varieties DT84 and D42 (Table 8).

Seed drying is a problem during the rainy season that may result in high post-harvest losses.

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<th>Variety</th>
<th>year¹</th>
<th>fertiliser kg/ha</th>
<th>P kg/ha</th>
<th>K kg/ha</th>
<th>yield t/ha</th>
<th>investment VND/ha</th>
<th>Gross margin² (GM)/Mio VND/ha</th>
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<td>1.32</td>
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<tr>
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<td>90</td>
<td>60</td>
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<td>1,960,000</td>
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<td>0</td>
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<td>225,000</td>
<td>3.53</td>
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Tab. 8 Overview of upland and paddy crops tested in Tua Chua
Few other crops are used on uplands: Taro and to a lesser extent arrowroot and sweet potato are common starch tubers. Job's tears is a widely used grain crop. For none of these crops improved varieties are available.

Environmental issues: Diversification of rotation is an important means for maintaining environmental balance and soil fertility. Especially for tuber crops which can remain in the soil for more than 1 season, reduced cultivation can improve soil organic matter content and reduce soil erosion.

For high-yielding soybeans currently good yields are recorded even without fertilizer input. However, these yield levels can only be maintained in the long run if fertilizer is applied.

Farmers’ acceptance: Farmers are using a variety of crops for home consumption. Diversification is a common means of risk alleviation. Only with selected market integration of individual crops may expansion of traditional non-marketable crops be reduced.

The newly introduced varieties for diversification (soybean and peanut) require access to water and are thus not 'sloping upland crops' where usually water is lacking. Their expansion is further restricted by the fact that they require high management input and compete for labour with upland maize planting. Taste is an important factor: even if poor taste of DT84 is not reflected in its market price, many farmers do not like to grow it as they prefer a crop suitable for home-consumption and marketing.

Farm-economics: Little is known on productivity and prices of currently used varieties. For soybean on upland some financial indicators are listed in Table 8. As discussed for Yen Chau, investment into fertilizer shows a much lower feasibility then investments into seed. The Cost-Benefit Ratio (CBR) for the overall investment including fertilizer is 4 and 6 for the two recorded cases. The additional investment into fertilizer provides a capital return of less than twice the costs. In contrast, the CBR for using the improved variety DT84 in 98 provided a CBR of above 20.

Required dissemination efforts: In order to maintain an environmentally and economically favourable diversity of crops, increased monitoring efforts are necessary. Successful existing varieties can then be inventorized and 'best-practices' can be identified and disseminated.

Newly introduced varieties need to be carefully monitored as to their investment requirements. An introduction of true varieties that do not require seed purchase for every crop and can grow with low fertilizer inputs is more likely to be successful. Competition for labour with traditional crops, taste and storability are further factors to be monitored.

4.3 Intensification of crops on paddy land
Improved rice varieties are the first option for intensifying paddy land use. With improved varieties, fertilizer application and later on Integrated Pest Management (IPM) become important. The expansion into a second crop on 1-crop paddy is one the most important steps to improve food security in spring. Diversification of crops into legumes and the introduction of winter crops (potatoes, vegetables) have hardly gained momentum.

4.3.1 Improved rice varieties

**Technical issues:** As in Yen Chau improved rice varieties can increase yields by more than 100 % from the quoted 2 t/ha to more than 5 t/ha. The main characteristics in addition to the higher yield are drought resistance and shorter-maturity which allows for slightly later seeding and transplanting and leaves enough time for an initial spring maize crop.

Differences in seedbed preparation, transplanting time, and transplanting density must be observed. Especially during introduction and testing of a new variety it is important that grain ripening is timed in line with that of the commonly grown variety. Else the new variety may attract all rodents if it ripens earlier than the remaining fields.

Improved rice varieties further require the use of fertilizer as either animal manure, green manure or chemical fertilizer in order to maintain soil fertility. An exception are those areas flooded by the river and supplied with fertile sediments. Here a yield increase is obvious for a number of subsequent years without fertilizer application.

**Environmental issues:** Higher yielding varieties on paddy land improve food security and thus take pressure from marginal areas. However, where fertilizer promotion is not successful, a decline in paddy soil fertility is unavoidable.

**Farmers' acceptance:** It must be noted that for Hmong farmers, maize has the highest priority for food security. Farmers are nonetheless interested in higher yielding paddy rice varieties if taste is acceptable and they are able to cope with management requirements. Good disease resistance are a prerequisite for introducing new varieties into a low-input system. Where cash is scarce, it is again important to reuse farm-grown seeds for subsequent crops. Hybrids are not readily adopted.

**Farm-economics:** Financial benefits in the short-term are marked even as some new varieties are introduced with low fertilizer application (see Table 8: D36-1 in 97 yielded 5.5 t/ha). If no fertilizer is applied, the new variety yields better than the old one in only a few fields. After a few crops a decline in fertility becomes obvious and some kind of nutrient recycling is necessary.

**Required dissemination efforts:** Dissemination of seeds without the concurrent technical training has not proven successful in the past. When new varieties are introduced it must be clearly identified in how far management requirements change in comparison with the traditionally grown variety. Even if seeds initially are provided free of charge, farmers will remain reluctant to invest into fertilizers. The new variety should thus at least perform comparably to the current variety if grown under predominant management. Promotion of using increased inputs are then a second step.

4.3.2 Promotion of green manure fertilizer use on paddy land

**Technical issues:** Improved varieties usually only perform better than the traditional variety if at the same time management intensity increases. Both fertilizer application and pest management are important.

Hmong farmers commonly practice no nutrient recycling, except for the small amounts of animal manure left in the field during free grazing. In general they consider animal manure to be unhygienic and not suitable to be taken where food is grown. On the other hand, they are hardly willing to invest their scarce capital into fertilizer.

An alternative is the promotion of green manure as a first step of introducing fertilizer application. Green manure can also be composted (using Phosphor, lime and small amounts of animal manure). Thus animal manure could be used without retaining the characteristic smell and potentially without meeting farmers' hesitance.

**Environmental issues:** Nutrient recycling is an important part of intensification in crop production. Intensification is only sustainable, if soil nutrient depletion is counteracted.
Farmers’ acceptance: Farmers are reluctant to use animal manure due to hygienic concerns and chemical fertilizer due to required high cash expenditures. Introduction of green manure and awareness raising into hygienic concerns are likely to exert a positive influence of farmers’ acceptance to practice nutrient recycling. However, care has to be taken in organizing the timing of compost preparation as it easily clashes with labour requirements for upland maize cultivation.

Farm-economics: Financial benefits for fertilizer application in higher yielding varieties and on paddy areas with a stable supply of water (translating into high yield security) are high. Cost-Benefit -Ratios are above 10. Without fertilizer improved varieties can only in very few locations gain higher yields than local varieties.

Required dissemination efforts: Initial tests with green manure and green manure compost applications have to be done in close cooperation with interested farmers. Trials have to be well structured, including comparable test and control plots. On fertile soils these tests are likely best introduced at a time when improved varieties have been grown for a few years and fertility levels decline. Yield monitoring of test and control plots in close cooperation with farmers may then convince farmers to adopt fertilizer application. The use of chemical fertilizers may then be a further step.

4.3.3 Expansion of cropping rate with improved maize as second crop on paddy

Technical issues: The greatest break-through in terms of improving food security was the introduction of an improved maize variety as second (spring) crop on 1-crop paddy land. Faster-maturing varieties allow for harvesting prior to the transplanting time of paddy rice in May/June.

An important prerequisite for expanding the cropping season to a spring maize crop is the introduction of village grazing regulations. Only if a substantial percentage of the households working in a paddy area (and in this case comprising a number of villages) agree to restrict their grazing animals, can the crop be successful. Village discussions and yield trials are important tools in the process.

Production of spring maize on 1-crop paddy is very risky. Weather conditions may prevent early planting. Later droughts may destroy the crop or lead to early initiation of the reproductive phase when plants are still too small to fill the cob.

Late planting may force farmers to harvest the corn at milk-stage. These cobs can then be used for human consumption and animal feed, but cannot be stored. Seeds cannot be retained for the next cropping season. If seed storage is not guaranteed, it is even more important that a variety is grown which can also be grown on upland (where then seed can be produced for the next year).

Production levels in 1997 and in 1998 were quite high: 2.4 and 2.3 t/ha respectively without fertilizer. As much as 3.3 t/ha was reached in 1997 with medium levels of fertilizer supply.

While many of the farmers wait currently for district seed supply, some farmers have started to use their own seeds for growing on the paddy. Some of these ‘house-varieties’ prove well adapted to a shorter growing season and may even outyield TSB2 under certain conditions.

Environmental issues: An expansion of the cropping season further depletes soil nutrients while currently virtually no nutrient recycling is practiced.

Farmers’ acceptance: Farmers were initially hesitant to expand the cropping season. Main reason of the hesitation was the necessity to arrange for a communal agreement on grazing restrictions. Secondly farmers were aware of the high risk associated with this investment. Therefore for two years they waited for free seed from the district to plant in their field. From the third year it was obvious that they tried own seeds and compared them with seed provided by the district. The third reason for farmers’ hesitance is the competition of tending with the labour input for upland preparation. However, benefits of an early maize crop providing food security in May/June outweigh the disadvantages of a higher labour input in April/May. Finally the last constraint is the risk of not being able to harvest seed material for the next season. Using versatile maize varieties for both spring paddy crop and summer upland crop alleviates this problem.

Farm-economics: Food self sufficiency at the onset of the rainy season ranks very high. Thus the benefits of an additional maize crop go far beyond a monetary evaluation of the yield. In spite of the positive benefits so far, the investment remains to be risky. Longer-time evaluation is necessary to determine whether farmers would invest large amounts of their seed grain in the absence of district subsidized seed supply.
**Required dissemination efforts:** First, attention has to be placed on assisting farmers in village discussions to set up grazing arrangements. For initial testing free seed has to be supplied, as farmers are hesitant to invest into such a high-risk activity. In addition to the seed supply, it is important to assist in technology transfer (especially regarding planting density). In the long term, it is more important to find a versatile variety for upland and paddy use. Investment into free seed supply is not the best investment in the long term. Instead fertilizer application should be facilitated.

### 4.3.4 Improved legumes for diversification of rotation (soybean, peanuts)

**Technical issues:** Similarly to the situation on upland, expansion of soybean and peanuts is limited to areas with access to water. The situation on paddy land is aggravated by the fact that seeding time is restricted to an earlier time in order to harvest before summer rice is being planted. In addition to the areas planted to pure legumes, farmers are testing intercropping paddy maize with soybean and with Phaseolus as they also do on some of their uplands.

For a soybean variety DT84 a medium yield of 1.5 t/ha is recorded on a relatively high input level (Table 8). The peanut variety 4329 was tested with and without fertilizer (3.0 t/ha vs. 2.6 t/ha respectively).

**Environmental issues:** Integration of legumes into the paddy rotation is an important aspect of nutrient recycling. However, without additional fertilizer application the problem of nutrient depletion will continue.

**Farmers’ acceptance:** Diversion of the spring cropping season to other crops beside corn are of great interest where most of the paddy area cannot be used for spring rice. Farmers are interested in diversifying paddy use for risk alleviation. However, new legume varieties seem to require high investment. Farmers are interested in testing introduced varieties with low input levels and compare them with their local varieties. Taste is an important factor as market integration is low.

**Farm-economics:** In the short run the financial returns are high. Without fertilizer application a Cost-Benefit Ratio (CBR) of 13 can be reached with a yield of 2.6 t/ha. Fertilizer input increases yield by about 15 %, but gross margin by less than 2 %. CBR decreases down to 5.

**Required dissemination efforts:** New varieties have to be introduced in small trials with medium input levels. Results of these trials determine whether farmers accept the taste and increased management requirements. Expansion will be limited to few areas with sufficient water access. In the long term farmers may invest into small irrigation measurements to increase the area.

### 4.3.5 Introduction of winter crops (3rd crop)

**Technical issues:** Potato growing is technically possible. However, as discussed for Yen Chau, the potato seed market is not sufficiently transparent and seed quality is highly variable. Poor seed exacerbates hygienic problems and thus dramatically increases management and financial input and at the same time production risk.

**Environmental issues:** The main environmental concern with potato production is the high pesticide requirements.

**Farmers’ acceptance:** Farmers interest is limited. Farmers are not interested in high investments of above 2 Mil VND/ha. Utilization is questionable as they are not interested in consumption and market access is limited. Storage of potatoes is extremely difficult and results in high losses.

**Farm-economics:** High investment and management requirements combined with the limited size of a local market pose a high risk.

**Required dissemination efforts:** Considerable extension efforts are necessary to raise the management knowledge paired with considerable investment subsidies. Currently these efforts are not justified in areas with poor market access. In the medium term potato production will at best be competitive with the delta in areas with good road access in the vicinity of provincial towns.

### 4.3.6 Dissemination of IPM knowledge

**Technical issues:** In 1998 the district has started to conduct IPM Farmer Field Schools for rice under the
national IPM programme, as is described for Yen Chau. Courses were conducted in Thai villages who are using new varieties and some levels of fertilizer. Course contents include the introduction of a new variety, fertilizer recommendations as well as an increase in knowledge on pest control. However, pest control is not yet an issue as fertilizer input levels and the expansion of new varieties is quite low. Thus main course topics may not meet farmers' needs.

**Environmental issues:** Integrated Pest Management is an important factor of environmental protection once the use of pesticides is being considered.

**Farmers' acceptance:** Farmers are interested to learn about improved management for new paddy rice varieties. Pest control issues are not yet seen as a major problem.

**Farm-economics:** The lower the level of pesticide application, the lower are obviously any potential savings from a reduction of pesticide input.

**Required dissemination efforts:** The concept of farmer field schools is an important extension tool. However, without the addressed problems in pest control being obvious to farmers, success in learning will be low. Instead fertilizer application should be the main topic of farmer field schools (see Chapter 4.3.2 on promotion of fertilizer application).

### 4.4 Fruit tree development and other perennials

Fruit production is yet poorly developed in Tua Chua. In the district town a few trees of plums, apricots, and guava are in production. Litchis and longan have recently been introduced. Activities for fruit tree development are concentrating on introduction of improved varieties and new species as well as on the transfer of nursery and grafting technology. Furthermore old existing tea stands need improvements.

#### 4.4.1 Introduction of improved varieties and new species

**Technical issues:** Fruit tree production is limited due to a number of environmental factors, the main ones being the high altitude, and the long cold dry season, and hail. Nevertheless a number of fruit trees were identified as being suitable in this area. Grafted litchis and longan were supplied to the farmers and Persimmon are introduced in the district nursery. Survival rates are low, partly due to adverse environmental conditions, partly due to a lack of care provided to protect young trees from grazing animals.

**Environmental issues:** Expansion of the fruit tree area could be one factor of increasing the statistical forest cover. An increase in forest cover improves the water retention capacity of a watershed.

**Farmers' acceptance:** Interests in fruit trees are low for farmers who have not seen fruit trees as a major income generation activity at all or else cannot imagine their position within a mixed farming system. Where farmers are taken on a study tour to see fruit growing areas, farmers' interest increases. Financial benefits generated in other areas are a main factor. Still, most farmers practically decide that management input and production risk are too high.

**Farm-economics:** Too many factors are yet unclear to determine farm-economics. Production risks are high as many of the management issues are currently tested. Survival rates are low, and fruit quality and market access are unknown.

**Required dissemination efforts:** High risks associated with the promotion of fruit trees justify a cautious approach. Study tours are an important tool to get farmers interested in this activity. Main extension input is the selection of suitable locations (‘plantation design’), an introduction at small scale to facilitate the incorporation of the new management requirements into the existing farming system, and a clear discussion of grazing protection arrangements (protection in home gardens or protection by individual tree fencing).

#### 4.4.2 Transfer of nursery and grafting technology

**Technical issues:** Introduction of grafting technology results in a higher success rate of tree plantations, as the genetic aspects of fruit quality are clear. The transfer of nursery technology to the district allows for seedlings being available on time in the required numbers.
Technical issues of nursery management are very difficult. Disease pressure is high due to extreme weather conditions with low temperatures and morning fog followed by high radiation and high day time temperatures. Training and intensive coaching is necessary and was provided by the Fruit Tree Research Center Phu Ho.

**Environmental issues:** Nursery and grafting technology facilitate expansion of fruit production with the positive environmental effects associated with it.

**Farmers' acceptance:** Nursery and grafting technology are not transferred to farmers but to extension staff. Farmers accept grafted trees from local nurseries as much as trees from elsewhere.

**Farm-economics:** Nursery management is not feasible under the present demand situation and in view of the unsolved management problems. Training and coaching has to be subsidized. Inputs (trees, fertilizer, bags) have to be either subsidized, or more effectively, a contract is made guaranteeing a certain demand. Contracts are designed to enforce quality criteria.

**Required dissemination efforts:** High training and financial input is necessary in establishing district nurseries. This step is only feasible if there is a commercial or project-generated demand.

### 4.4.3 Potential for improving existing tea plantations

**Technical issues:** In Tua Chua a number of tea plantations were established in the 1970s. Until recently these plantations remained under joint management. With low market integration and unclear ownership and responsibilities effectively no management existed. Productivity is low and not monitored. Productivity increase is possible with pruning, weed control and even small fertilizer inputs. It is yet unclear which productivity levels can be achieved under medium management and low financial input.

**Environmental issues:** Tea plantations are seen as a good land use option for erosion control on slopes. Expansion is environmentally favourable.

**Farmers’ acceptance:** Farmers are interested in tea for home consumption. Thus they see small tea plantations as a useful part of their farm system. However demonstrated low productivity and poor marketability limits farmers’ interest in increasing labour and financial inputs.

**Farm-economics:** Lack of management has resulted in extremely low productivity. With few management inputs productivity can be raised, but levels are unclear. Currently used processing technology limits marketability of the products even on the local market. Competition from Moc Chau Tea Company is providing a better quality tea and its presence is high.

**Required dissemination efforts:** Improvement of tea plantations require training inputs for tending and pruning as well as for processing. These inputs are quite high in view of the limited areas addressed and the limited scope for privately motivated expansion. Expansion of tea area is only possible with a concerted Government effort on production, processing and marketing.

### 4.5 Intensification of animal production

Bee keeping is successfully promoted in a number of villages. With regard to pigs and ruminants veterinary issues, i.e. training and an initial supply of toolkits are seen as primary prerequisites for expansion. A second issue is fodder availability prior to the onset of the rainy season.

#### 4.5.1 Bee promotion

**Technical issues:** Farmers in Tua Chua are familiar with bee keeping on a small scale. Commonly bee swarms are collected in the wild and put into hives made from hollow tree trunks. No further inputs are provided. Honey is harvested for home consumption (medicine, alcohol production).

A number of technical improvements are possible to increase the productivity of bee keeping. Square hives with top bars provide easier monitoring of the hive and easier harvesting. They can be made by farmers following a training course. Close monitoring of swarms provides for timely harvesting and division of big hives into separate hives. In addition monitoring allows for assessing the feeding situation. In times with poor
availability of feed the danger is high that the swarm absconds. Feed (sugar) provision reduces the incidence of absconding and allows for continuous production and expansion. Finally improvements in the veterinary situation of the swarm, particularly with regard to predators improve productivity.

Technical training and coaching was initially provided by the Bee Research Institute, Hanoi. They then trained district extension staff as well as a local farmer. After 2 years these two persons take over all coaching and training requirements. Farmers are encouraged to organize themselves as ‘interest groups’. These groups meet when there is a technical problem and organize meetings when the district or farmer extensionist visit them.

Environmental issues: Bee keeping has no direct environmental effect. However, knowledge of bee keeping can be used to explain interactions in the eco-system and the importance of a careful balance.

Farmers’ acceptance: Farmers are familiar with bee keeping and are interested in expanding it for market production, provided that there is a market. Labour requirements fit well into the existing labour calendar.

Farm-economics: Honey is generating a market price of 25,000-30,000 VND/l. Prices depend mainly on the rather subjective assessment of its quality. In some cases clean bottles with good corks receive a lower price than dirty bottles. The regional market seems to be expandable.

Required dissemination efforts: Training is required to familiarize farmers with improved management technology. Training cannot be provided as a one-time activity but has to follow the style of farmer field schools, introducing relevant management aspects when they are seasonally suitable. Training thus is like a coaching activity. It needs to be continued over a period of at least 2 years. Together with technical issues, organizational issues must be considered, e.g. the formation of ‘farmer interest groups’ to further decentralize assistance.

4.5.2 Training for village para-veterinarians

Technical issues: As in Yen Chau veterinary problems are seen as a major constraint for intensifying animal production. When diseases occur, farmers seldom access the district veterinary service. Instead they usually address the most knowledgeable person on village level, acting as a village para-veterinarian. Village para-veterinarians have a varying and generally low level of veterinary knowledge. In order to improve their effectiveness, training courses are designed. Training subjects include presentation of main commonly available medications, discussion of symptoms, practice in simple curative measures for major diseases, use of helminthics and promotion of vaccinations.

Improvement in the understanding of veterinary issues is seen as a prerequisite to improve acceptance of preventative measures.

Environmental issues: Improvement of the animal health situation is the primary prerequisite for intensification of production, which incorporates e.g. grazing restrictions and investments into regulated fodder provision. These changes in animal husbandry in turn allow for expansion of natural regeneration.

Farmers’ acceptance: Farmers are interested in reducing disease incidence and mortality in their stocks. Initial results indicate that farmers are willing to pay for veterinary services.

Farm-economics: Direct benefits of an improved veterinary service are likely difficult to verify. They would consist of reduced animal losses and thus an improved investment environment. Higher farm income from animal production is envisaged.

Required dissemination efforts: Training requirements are high given the low level of existing veterinary knowledge. As in Yen Chau it is considered to organize the training as a coaching programme. Training is an important tool to increase the coverage of current vaccination programmes that are inefficiently used even though provided free of charge.

4.5.3 Veterinary toolkits for village level

Technical issues: Village para-veterinarians commonly do not have a supply of basic medication and instruments. Thus the effectiveness of their work is very low. In 1998 veterinary toolkits were supplied on trial basis in a few villages. Contents of the toolkits were adapted to assumed local requirements and valued at 600,000 VND/kit. Regular adaptation of contents for further toolkits is envisaged based on field experience.
Village para-veterinarians are held responsible to replace used medication by payments collected from the farmer. Monitoring sheets are provided and tasks are differentiated between Village Management Board, village para-veterinarian and the district veterinary station.

Environmental issues: Reduced risk in animal production can lead to an intensification of production with reduction in free grazing.

Farmers’ acceptance: Village communities are interested in managing a tool kit for their use. Toolkits are being used. Payment moral varies.

Farm-economics: Investments into toolkits are comparatively low, given the potential for improving productivity and management in animal husbandry. In the short term, however, village para-veterinarians will not be able to generate incomes that would justify private investments into these toolkits.

Required dissemination efforts: The provision of material inputs alone is by no means successful. As listed for Yen Chau 5 steps are necessary to facilitate their effective management (see Chapter 3.5.3). In comparison to Yen Chau, however, it is even less likely in Tua Chua that village para-veterinarians can reach the reputation necessary to build up veterinary service provision into a major income generating activity. Investments into training and monitoring will be higher while successes may be more difficult to determine.

4.5.4 Fodder sources for ruminants and fish

Technical issues: Fodder supply for ruminants is a problem at the onset of the rainy season, when buffaloes are regularly used for traction and can roam neither on remote fields nor can they access the cultivation area for grazing.

Pennisetum purpureum, leucaena, stylo were identified within the species tested as hedgerow species and cover crops as the best options for providing fodder in a cut & carry system. Pennisetum purpureum was grown in hedgerows close to the house, but is also tested by one farmer in a protected house garden. Several attempts to introduce leucaena in hedgerows have failed as grazing livestock destroyed the young plants. Both species need to be grown in areas well protected from grazing animals. Dissemination of stylo is discontinued due to problems in seed collection and germination.

Environmental issues: Provision of fodder sources for cut & carry could reduce pressure on natural vegetation and improve the regeneration potential of forest stands.

Farmers’ acceptance: Farmers are interested in improving the fodder supply especially for draught animals directly before the growing season. Currently poor feed supply restricts their labour performance and increases mortality.

Farm-economics: As long as free grazing prevails, fodder crops need to be well protected from grazing animals. This protection requires an investment into fencing and puts fodder production in direct competition to other agricultural and horticultural crops. However, in order to alleviate a seasonal shortage that results in high animal losses, the activity is feasible.

Required dissemination efforts: Demonstration plots need to be set up and issues of animal grazing and fodder production raised on village level. After initial provision of seeding material further dissemination is organized within the village.

5. Conclusion and future outlook

Extension in Vietnam is currently in a phase of trialing effective and efficient technology dissemination. While the dissemination of technology packages is quite straightforward and successful in the low-land, the complexity of the upland situation requires a separate analysis and a different approach: Mixed production systems are the answer to a highly variable and fluctuating production condition.

For the two locations the project is working in, different technical options were identified based on what farmers are interested in doing. Project strategies are based on assumed development perspectives in both regions and project implementation experiences (described in detail above). The following tables (9 and 10)
summarise the assessment of technical options based on the main sustainability criteria: technical suitability, ecological impact, farmers' acceptance, farm economics and finally required dissemination efforts.

Based on SFDP experience over the last three years, future outlook for technology dissemination can be derived. Two question can thus be answered, i.e. the question which technologies extension should disseminate in the Northwestern mountainous area and the question of how these technologies should be disseminated, i.e. which role extension will have to play in facilitating the further development process.

**Which technologies are easy to disseminate?**

Those technologies are easily disseminated that a) show obviously higher financial benefits, b) only slightly increase the input intensity, and thus increase risks only slightly, c) are compatible with the existing range of activities, and d) require only low additional management capacity. Based on these criteria, some ranking can be established: farmers are primarily interested in paddy intensification measures, followed by upland intensification measures, fruit tree growing or intensification of animal production. When effects are obvious, farmers may become interested enough to discuss with the extensionist about long-term soil improvement, but not without short-term incentives.

Intensification options are limited in a highly variable environment: Issues of water redistribution and seasonal water shortages will become of major concerns for communities intensifying production.

In all cases, it is important that farmers are involved in adapting general recommendations to their specific situation, and that these adaptations are recognised, recorded and disseminated to other farmers. It must be clearly understood by extensionists and politicians that standard packages developed in Hanoi are not suitable for diverse upland conditions.

**Fixed technology packages for upland or capacity building of farmers? What is the role of extension in the future?**

The role of extension is to supply the support required by farmers from outside: The introduction of new varieties is a first and important step. However, supplying seeds cannot work without providing technical assistance.

Furthermore supplying seed cannot continue to generate benefit increases as high as currently experienced. Marginal increases will steadily converge to a point where more sophisticated tests are necessary to determine the superiority of a new variety under exactly which conditions. At that point the cost-benefit ratio of promoting new introductions may no longer rectify government involvement and may be left to farmers and commercial forces.

Instead extension will be requested to assist in the determination of financially suitable input levels, assist in determining which crop is the best for their field, for their farming-system and how to find out, how to calculate. Extension needs to closely monitor what is happening, collect and structure this information and make resulting 'fine-tuned' recommendations available to farmers. Extension must further understand and teach farmers the basic principles of investment decisions within the individual farm system.

If the role of extension in future goes beyond input supply, then training topics, programme designs and especially, incentives for extensionists have to be adjusted accordingly to facilitate that extensionists prepare for their future role.

There is no miracle crop and no fixed package for the uplands, just a sound methodology for steady improvements of a flexibly adapting mixed agriculture.

Three main issues may be concluded with regard to the role of extension in promoting agricultural development:

1. Measures for upland soil protection and improvement do not convince farmers for their financial benefits, as they are negligible. Environmental benefits are not convincing for the individual. Therefore, external support is needed to create short-term obvious advantages (seed access, tax reduction) for the farmer. These benefits must last over the entire investment period (upon confirmation of continued existence of the soil protection measure), not only for the establishment period.
2. Crop intensification measures are most successful for paddy land with stable water access. Based on technical and economic parameters, this should be the first issue addressed in all villages. There is still a lot of scope for increasing efficiency by disseminating successful farmer adaptations, structured fine-tuning of recommendations, and by including issues of household economics into the extension message.

3. In contrast, intensification on upland requires close monitoring as to halt depletion of soil fertility when it is still economical to do so. With the use of high yielding varieties, soil fertility decline remains largely unnoticed for the individual farmer and can only be made obvious through structured long-term monitoring of extension.

For all of these issues extension remains to be equipped. Staff training, new incentive structures apart from seed commissions, participative approaches and a focus on technical and financial monitoring and analysis have to replace the current focus on seed supply. In Table 9, last column, the priorities of SFDP for supporting this change are noted.

**Tab. 9 Assessment of technology options in Yen Chau**

<table>
<thead>
<tr>
<th>Technology</th>
<th>Technical suitability</th>
<th>Ecological impact</th>
<th>Farmers’ acceptance</th>
<th>Farm economics</th>
<th>Dissemination effort</th>
<th>SFDP (1)</th>
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<tr>
<td>Upland soil improvement</td>
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<td>Demo, provide seed, incentives</td>
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<tr>
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<td>Erosion control?</td>
<td>Low</td>
<td>Low</td>
<td>Training, demo</td>
<td>2</td>
</tr>
<tr>
<td>Cover crops (fruit trees)</td>
<td>Best chance: local species</td>
<td>Increase OM*?</td>
<td>Low</td>
<td>Low</td>
<td>Demo, seed provision</td>
<td>1</td>
</tr>
<tr>
<td>Legume intercropping</td>
<td>Limited area</td>
<td>Increase OM</td>
<td>Low</td>
<td>Low</td>
<td>Demo</td>
<td>2</td>
</tr>
<tr>
<td>Cassava fallow</td>
<td>Good</td>
<td>No scientific evidence yet</td>
<td>Low when intensifying</td>
<td>Lower than other crops</td>
<td>Success depends on economics</td>
<td>2</td>
</tr>
<tr>
<td>Upland intensification</td>
<td>Low-medium</td>
<td>Negative or neutral</td>
<td>Medium</td>
<td>Medium (Good risk)</td>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td>Improved maize</td>
<td>Good</td>
<td>Depletes nutrients</td>
<td>Medium</td>
<td>Medium to good</td>
<td>Demo</td>
<td>2</td>
</tr>
<tr>
<td>Second maize crop</td>
<td>Limited area</td>
<td>Depletes nutrients</td>
<td>Medium</td>
<td>Medium to good</td>
<td>Demo</td>
<td>2</td>
</tr>
<tr>
<td>Fertiliser use</td>
<td>Medium</td>
<td>Positive</td>
<td>Low</td>
<td>Low</td>
<td>Identify effective levels</td>
<td>3</td>
</tr>
<tr>
<td>Improved cassava</td>
<td>Medium</td>
<td>Depletes nutrients</td>
<td>Medium-good</td>
<td>Good</td>
<td>Demo</td>
<td>2</td>
</tr>
<tr>
<td>Improved upland rice</td>
<td>Low</td>
<td>Good soil erosion</td>
<td>Medium</td>
<td>Low-medium</td>
<td>Demo</td>
<td>2</td>
</tr>
<tr>
<td>Paddy intensification</td>
<td>Good</td>
<td>Neutral</td>
<td>Good</td>
<td>Good</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td>Improved rice</td>
<td>Good</td>
<td>Neutral</td>
<td>Good</td>
<td>Good, low-risk</td>
<td>Demo, technical training</td>
<td>3</td>
</tr>
<tr>
<td>Diversification (2nd crop)</td>
<td>Medium</td>
<td>Positive</td>
<td>Medium</td>
<td>Medium</td>
<td>Demo, technical training</td>
<td>2</td>
</tr>
<tr>
<td>Winter crops (incl. veg., 3rd crop)</td>
<td>Limited area</td>
<td>Neutral</td>
<td>Medium</td>
<td>Good, but high risk</td>
<td>Demo, technical training</td>
<td>1</td>
</tr>
<tr>
<td>IPM</td>
<td>Good</td>
<td>Positive</td>
<td>Medium-Good</td>
<td>Medium-good</td>
<td>High: intensive guidance</td>
<td>2</td>
</tr>
<tr>
<td>Technology</td>
<td>Technical suitability</td>
<td>Ecological impact</td>
<td>Farmers’ acceptance</td>
<td>Farm economics</td>
<td>Dissemination effort</td>
<td>SFDP (1)</td>
</tr>
<tr>
<td>------------------------------------</td>
<td>-----------------------</td>
<td>-------------------------</td>
<td>---------------------</td>
<td>----------------</td>
<td>----------------------</td>
<td>-----------</td>
</tr>
<tr>
<td>Upland soil improvement</td>
<td>medium</td>
<td>Positive = Good</td>
<td>Low</td>
<td>Low, long-term</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>Hedgerows</td>
<td>Tephrosia</td>
<td>Evident under fallow:</td>
<td>Low: area loss</td>
<td>Low</td>
<td>Demo, provide seed, incentives</td>
<td>3</td>
</tr>
<tr>
<td>Improved fallow</td>
<td>Tephrosia</td>
<td>High OM increase</td>
<td>Good: fallow period reduced ?</td>
<td>Good: Higher cropping intensity</td>
<td>Demo, field days</td>
<td>3</td>
</tr>
<tr>
<td>Terrace (saving top soil)</td>
<td>Good</td>
<td>Good erosion control</td>
<td>Medium</td>
<td>Medium, long-term</td>
<td>Training, demo</td>
<td>2</td>
</tr>
<tr>
<td>Cover crops</td>
<td>Best chance: local species</td>
<td>Increase OM*?</td>
<td>Low</td>
<td>Low</td>
<td>Demo, seed provision</td>
<td>1</td>
</tr>
<tr>
<td>Intercropping</td>
<td>Medium</td>
<td>Increase OM</td>
<td>Low-medium</td>
<td>Low</td>
<td>Further trials</td>
<td>2</td>
</tr>
<tr>
<td>Improved organic matter management</td>
<td>Questionable</td>
<td>Positive</td>
<td>Low</td>
<td>Low</td>
<td>Further trials</td>
<td>3</td>
</tr>
<tr>
<td>Upland intensification</td>
<td>Low-medium</td>
<td>Negative or neutral</td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td>Improved maize</td>
<td>Medium</td>
<td>Depletes nutrients</td>
<td>Medium</td>
<td>Medium, high risk</td>
<td>Monitor farmer testing</td>
<td>2</td>
</tr>
<tr>
<td>Diversification</td>
<td>Medium: few varieties known</td>
<td>Positive</td>
<td>Medium</td>
<td>Medium, unknown</td>
<td>Monitoring of farmer practice, further trials</td>
<td>1</td>
</tr>
</tbody>
</table>

OM = Organic Matter, (1) legend: 1 = low, 3 = high
<table>
<thead>
<tr>
<th>Paddy intensification</th>
<th>Good</th>
<th>Neutral</th>
<th>Good</th>
<th>Good</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improved rice</td>
<td>Good</td>
<td>Neutral-negative</td>
<td>Good</td>
<td>Good, low-risk</td>
<td>Demo, technical training</td>
</tr>
<tr>
<td>Fertilizer promotion</td>
<td>Good</td>
<td>Positive</td>
<td>Low</td>
<td>Medium, long-term</td>
<td>Demo, technical training</td>
</tr>
<tr>
<td>Maize 2. crop</td>
<td>Medium-good</td>
<td>Negative without fertilizer</td>
<td>Medium</td>
<td>Good, high risk</td>
<td>Demo, technical training</td>
</tr>
<tr>
<td>Diversification: legumes</td>
<td>Medium</td>
<td>Positive</td>
<td>Medium</td>
<td>Medium</td>
<td>Demo, technical training</td>
</tr>
<tr>
<td>Winter crop (potato)</td>
<td>Low: high management</td>
<td>Neutral-negative</td>
<td>Low</td>
<td>Medium, very high risk</td>
<td>Demo, technical training</td>
</tr>
<tr>
<td>IPM</td>
<td>Low: not yet applicable</td>
<td>Positive</td>
<td>Low</td>
<td>Low: little savings</td>
<td>High: intensive training</td>
</tr>
<tr>
<td>Fruit trees</td>
<td>Medium</td>
<td>Positive or negative</td>
<td>Medium</td>
<td>Good, but long-term</td>
<td>High</td>
</tr>
<tr>
<td>New varieties</td>
<td>Medium-low</td>
<td>Improved tree cover</td>
<td>Medium</td>
<td>Unclear, long-term</td>
<td>Long-term trials, discussions, training</td>
</tr>
<tr>
<td>Nursery technology</td>
<td>Medium</td>
<td>Neutral</td>
<td>Not for farmers</td>
<td>Subsidy necessary</td>
<td>Training and coaching</td>
</tr>
<tr>
<td>Improving tea</td>
<td>Medium</td>
<td>Positive</td>
<td>Medium</td>
<td>Medium</td>
<td>Training and marketing</td>
</tr>
<tr>
<td>Animal intensification</td>
<td>Medium</td>
<td>Neutral or positive</td>
<td>Medium</td>
<td>Good if low disease risk</td>
<td>Medium</td>
</tr>
<tr>
<td>Bee keeping</td>
<td>Good</td>
<td>Neutral</td>
<td>Good</td>
<td>Good</td>
<td>High: Training and coaching</td>
</tr>
<tr>
<td>Veterinary training</td>
<td>Medium</td>
<td>Neutral</td>
<td>Good</td>
<td>Medium</td>
<td>Low</td>
</tr>
<tr>
<td>Veterinary toolkits</td>
<td>Medium</td>
<td>Neutral</td>
<td>Good</td>
<td>Medium</td>
<td>Medium: monitoring</td>
</tr>
<tr>
<td>Animal fodder</td>
<td>Elephant grass for fish ruminants</td>
<td>Positive: controlled grazing</td>
<td>Low: few farmers interested</td>
<td>Medium</td>
<td>High: demo and further trials</td>
</tr>
</tbody>
</table>

OM=Organic Matter, (1) legend: 1 = low, 3 = high

Endnotes

1. See in particular Community Forestry Unit Working Paper 6 on technical issues: Community forestry management strategy of the SFDP Song Da, Revised Version 11/98.


3. See also SFDP consultancy report Christ, Herbert, and Dirk Kloss (4/1998): Land Use Planning and Land Allocation in VN with particular reference to ... SFDP

4. The checklist provided in SFDP working paper No. 2 is regrouped and adjusted based on implementation experience.

5. See also SFDP manual on Village Development Planning
6. For details on extension approach see also project working paper No. 4: Status quo on agriculture/agro-forestry extension and SFDP priorities for 99-2001.

7. see also project consultancy report No. 8 by J.H.D. Ludwig (97): General farming systems development strategies

8. Information on the two districts is available in many project documents, e.g. Working Paper 2: Yen Chau District, Son La Province: 250 km from Hanoi; 300-800 m asl; 87,000 ha with 46,000 persons; population density 53 pers/km2; major ethnic group: Thai Tua Chua District, Lai Chau Province: 480 km from Hanoi; 800-1000 m asl; 71,000 ha with 30,000 persons; population density 43 pers/km2; major ethnic group: Hmong

9. A detailed analysis of the impact of fallow on soil productivity is conducted by a student of the University of Hohenheim with field studies in 98 and analysis in 99

10. A study of erosion control by micro-terraces was proposed to be jointly implemented by the Hanoi Agricultural University and the University of Hohenheim in summer 1998.

11. This reported phenomenon of 3-year cassava improving soil is discussed further in Chapter 3: Experiences.

12. If maize yields reach 4+3=7t per ha p.a. with a gross margin of 10 Mio. VND they require a labour input of 230 trips to the field with 30 kg each. In comparison 10 Mio VND worth of cassava equals 50 t of tubers (at 200 VND/kg) and thus 7 times as many trips to the field. (and only slightly less labour for cultivation)

13. This interest may in turn have been generated by project trial plots or neighbouring communes/districts' experience. For details on the process see also SFDP manual on Village Development Planning

14. See also the consultancy report on fruit production (Chapmann et al, 1997)

15. For Leucaena, frequently a Psillid problem is reported from other countries and the south of VN. Psillids also showed up in Tua Chua, but not in Yen Chau. Peter Horne from the FAO-'Forages for Smallholder Project' in Laos reports of a Psillid resistant strain (K636).

16. See also Tho (1999): Report on 3 year implementation of hedgerows in SFDP Project: Slight increases in yield for hedgerow plots compared to controls may not be the result of hedgerow.

17. E.g on some uplands taxes of 65 kg maize have to be paid (= 100.000 VND/yr). At yields of 1 t/ha a perceived area and yield loss of 10 % would approximate the tax savings.

18. Photos were kindly provided by Roland Bunch during his consultancy assignment in the project in 1997

19. Stylosanthes hamata Verano is described as a weak perennial, but seems to keep well into the third year. It can be distinguished by its hooked seeds. The other variety Stylo Guianensis CIAT 184 seems a little less competitive and slower growing.

20. In Northern Thailand spineless mimosa has proven to need regular 'flattening' by tractor-pulled implements to keep it from climbing trees; Somchai Onprasert et al. (1997): Use and management of viny legumes as Seasonal fallow in Intensified Shifting Cultivation and Orchards in Northern Thailand. Workshop Paper RVC-VACVINA, Hanoi, Vietnam

21. Small doubt remains, as Crotalaria may either be the reason of high productivity or may just be developing well on good soils (indicator plant).

22. An 'obvious yield increase' is an increase of above 10 %.

23. In some cases much higher yields of 100 t/ha have been measured in 3-year cassava (Annette Luibrand, data collection 1998. University of Hohenheim)

24. Annual fluctuation is e.g. noted in the paragraph above: from 1997 to 98 an increase in LVN10 yield by 65 %.

25. Some of the Vietnamese 'hybrids' may actually be 'composites', i.e. crosses between two relatively similar strains (lines). Thus they do not digress as widely from the parent material if they are grown a second or third time. After that degradation is marked: farmers would have to replace at least 1/3 of their seed every cropping season. Average national replacement rate for maize is 26 %.

26. In another district of Yen Chau (Tu Nang) in only 30 km distance maize has been grown for a while. Farmers’ attempts to copy it had so far failed.
27. According to Finance & Market, Hanoi, import prices within the last year ranged between 70 and 95 USD/t compared to local producer prices of around 110 USD/t in fall 98.

28. See Nicole Hirth (98): Data on maize and cassava collected for her master thesis, University of Hohenheim, Germany.

29. Annette Luibrandt has analyzed this phenomenon in detail in her data collection for her dissertation (Yen Chau 1997/98)

30. National average replacement rate for rice seed is only 5% (Vietnam News, April 10, 99)

31. In this case, capital productivity increases from 7 to 17. Part of this increase is due to a price increase for rice. At 1997 prices, capital productivity would have increased to 13.

32. Fertilizer application follows the law of diminishing returns: e.g. the first 50 kg may increase the yield by 500 kg, the second 50 kg of fertilizer will only cause an increase of another 200 kg, further 50 kg of fertilizer result in only 100 kg of increase.

33. The national IPM Programme was started in the late 80's with main support from FAO and other international donors. Nationwide more than 300,000 farmers participated in Farmer Field Schools and around 2000 trainers were trained.

34. In Son La IPM-classes started in 94. 15 of the 30 plant protection staff are trained as teachers, and have conducted 87 courses till 12/98, i.e. an average of 19 courses/year.

35. Some household members frequently move out to huts inside those new orchards to protect and manage the trees.

36. See also the consultancy report on fruit production (Chapmann et al, 1997)

37. Reinvestment is considered by Action Aid Vietnam in Mai Son. SFDP has strongly advised against it and will monitor closely negative effects in case reinvestment takes place.

38. Nutrition levels of banana stem: Dry Matter(DM) =5.7 %, Crude Protein (CP)= 0.6 %, Metabolizable Energy(ME)= 0.39 MJ. Cassava leaves: DM=25.7 %, CP= 6.6 %, ME= 3.04MJ, according to National Animal Husbandry Institute: Feedstuff Analysis.

39. With a concessionary system the visibility of a product may not reflect its market acceptance, i.e. although countless outlets for compound feeds are found along Road No. 6, actual sales volume is probably rather small.

40. Example calculation: A compound feed with 20 % protein costs 3,000 VND/kg, i.e. 15,000 VND/g protein. In contrast dried fish in the market with 50 % protein may be available also for 3,000 VND/kg, i.e. only 6,000 VND/kg.

41. Rations may further be differentiated according to household resources (e.g.: lowest expenditure ration for maize and cassava producers, lowest-cost ration for alcohol brewers, for tofu processors, for fish raising households) and onset of production (e.g. feeding of spring piglets, feeding of fall piglets in time for TET, etc).

42. They voice, that nutrition information is at the same time valuable for their decisions on human nutrition: where protein supply for children is still so low that eggs are considered medicine, it is important to make an informed decision before treating children to 'snack foods'.

43. The number of programs where credit-promoted utilization of concentrate rations have failed is quite high.

44. E.g. assuming 4 maize crops of 2 t/ha at a price of 1500 VND/kg over a 12 year rotation, leads approximately to an average annual gross margin of 1 Mio VND/ha. Intensified fallow would result in an average annual gross margin of 1.5 Mio VND/ha (4 crops X 2 t/ha, followed by 4 year fallow).

45. The University of Hohenheim together with the Hanoi Agricultural University is looking into genetic diversity of legumes, a study which might facilitate the identification of suitable cover crops.

46. For a detailed explanation of the financial indicators like gross margin and CBR see Table 6 and Box 1 in Chapter 3.2.2.

47. Composites are crosses between 'lines' of one variety. When seeds are reused, productivity decline is less marked as for hybrids and genetic variation of F1 variety is less pronounced. Replacement rates of 25-30 % are commonly applied.

48. Investment into irrigation is not discussed here. It must be noted that in any places where investment into
infrastructure is feasible this is the most effective way for intensifying paddy land use. As it results in improved yield security if will facilitate use of improved varieties and fertilizer inputs.

49. See also the consultancy report on fruit production (Chapmann et al, 1997)

50. This concept is also addressed under the term 'Participatory Technology Development'