An Overview of Development Processes and Farmers’ Interactions in a Participatory Forest Fire Prevention Programme in Jambi Province, Indonesia

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Abstract
The participatory forest fire prevention programme of Forest Fire Prevention Management Project (FFPMP) aims at intensive fuel management and fire control with the integrated green belt on community land on the boundary of Berbak National Park, Jambi Province, Sumatra. It aims to motivate farmers to cultivate their land continuously, reducing fire hazards and risks through formation of fuel breaks around the forest. Participating farmers face technical limitations in seedling production, land preparation without burning, and crop planting and protection. They cannot easily perceive benefits of the green belt with line planting of the small number of trees. Land-oriented farmers experienced in growing crops and constructing facilities are more advantaged than local farmers dependent on forest resources. Current socio-economic conditions have accelerated diverse programme evolution with farmers’ different responses. FFPMP has funded materials and facilities to substitute for farmers’ lack of technical and economic capabilities. It may also modify the programme to optimise farmer participation and facilitate effective fuel break formation, including flexible design of planting sites along the green belt with various crops, new land preparation technologies, establishment of pilot small-scale nurseries, and strengthening of community organisations for less advanced farmers. This paper addresses the socio-economic sustainability of the participatory green belt programme.

INTRODUCTION
The Forest Fire Prevention and Management Project (FFPMP) has implemented a participatory forest fire prevention programme at its site around Berbak National Park, Jambi Province, Sumatra, since 1997. The programme stresses park-border communities’ active participation in long-term prevention of wild fires on their land through establishment of integrated green belts (IGB) with fire-resistant tree rows along the park boundary, associated with intensification of farmers’ land uses. Through IGB trials FFPMP has determined crucial socio-economic factors for successful programme development at the community level.

This paper aims to analyse current progress and constraints on IGB trials of FFPMP at the Jambi site and to recommend viable programme modifications.

Site Description
The programme is implemented at Rantau Rasau and Sungai Rambut villages, Rantau Rasau Sub-District, Tanjung Jabung District, Jambi Province (Fig. 1). Both villages are situated along the boundary of Berbak National Park that protects indigenous lowland swamp forests. Inhabitants

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Figure 1. Project site
An Overview of Development Processes and Farmers' Interactions in a Participatory Forest Fire Prevention Programme

Consist of local in-migrants (Malay), Javanese transmigrants, and spontaneous in-migrants from South Sulawesi (Buginese). Most of the Malay live along the riverside for riverine fisheries and rice farming, while other ethnic groups live in inland areas and grow various crops. Communities’ settlements are well-organised along primary and secondary ditches, divided into small administrative units called neighbourhood associations (RT).

CONCEPT OF PARTICIPATORY INTEGRATED GREEN BELTS

Integrated green belts (IGB) aim to safeguard the park forests against wild fires and community land against wild boars through promotion of farmers’ land use intensification. IGB is established along the border of the existing cultivation land close to the park boundary with the expectation of farmers’ active participation. IGB consists of a wire fence, a ditch, and tree rows (Fig. 2). The wire fence is effective to block wild boars, while the ditch cuts off surface and ground fires and stores water for initial suppression. The tree rows are expected to control both surface fires and wild boars, and then stimulate farmers’ intensive cropping on their land.

Suitable tree species had to be selected for effective fire prevention (fuel control and fire resistance) and for economic benefits to farmers preferably with non-timber products. The selected trees have to be adapted to grow well on the wet and peaty soils of the site. Three species were

Figure 2. Model of Integrated Green Belt
selected from farmers’ preferences and the project needs for the first stage. They were areca nut (*Areca catechu*), albizia (*Paraserianthes falcataria*), and lamtoro (*Leucaena leucocephala*). Areca nut is planted along the wire fence to prop it up when existing wooden props decay. Albizia is one of the more valuable timber species, yielding profitable timber in a short period while forming tree stands quickly. Some farmers prefer lamtoro for its multipurpose functions, including soil improvement and fodder production. In the initial green belt design FFPMP restricted the number of tree species, based on fire prevention and ease of cultivation. At the second stage other promising species were introduced to study their fire prevention effectiveness. Fruit trees and multipurpose trees (MPTS), such as durian (*Durio zibethinus*), rambutan (*Nephelium lappaceum*), and melinjo (*Gnetum gnemon*), were planted inside the fence. Demonstration plots were established to test these new tree crops on the inner community land. The green belt is being expanded both toward the inner community land (inside the fence) and the park boundary (outside the fence) with the selected tree species. Nurseries were established in the two site villages to produce seedlings and improve farmers’ abilities to grow seedlings.

These tree crops are expected to be fire-resistant to some degree, although this needs to be examined during the trials. Farmers have observed that trunks of areca nut are fireproof due to their thick bark. Long branches of albizia can effectively control undergrowth and weeds on the ground, outweighing the vulnerability of its trunk to fire. Lamtoro is similar to albizia, but its trunk is more resistant to fires. Durian, rambutan, and melinjo are generally resistant to fire due to their long branches and high moisture of their trunk. The immediate benefit of IGB is to effectively control wild fires from community land or forests. However, it is also expected that IGB will facilitate reduction of inflammable undergrowth and farmers’ land burning by ensuring reliable growth of annual and perennial crops on their land. Target group farmers are expected to participate actively in green belt activities with material assistance from FFPMP.

**SUMMARY OUTCOMES OF PARTICIPATORY IGB PROGRAMME**

Up to March 1999, over 12 km of the fence has been constructed at two villages. The length of the ditch reached 10 km. The row of areca nut extends the full 12 km along the fence. However, the albizia and lamtoro are less successful on account of unfavourable site conditions. In addition to these three species, various other species were introduced to the green belts and three demonstration plots, including durian, rambutan, melinjo, coconut (*Cocos nucifera*), sugar palm (*Arenga pinnata*), breadfruit (*Artocarpus communis*), sungkai (*Peronema canescens*), jelutung (*Dyera lowii*), and pulai (*Alstonia scholaris*).

The green belt is being expanded from the initial three rows to about ten rows. Several forest trees such as jelutung, pulai, and sungkai, and MPTS such as areca nut and sugar palm are being tried in the park buffer zone outside the fence, while other new species are being tested on the inner community land free of wild boars. More than 160 000 seedlings were produced, or provided from the outside, for planting the green belts and demonstration plots. The rate of seed germination ranges between 75 and 90%. Three pilot nurseries with 39 seedbeds were built in the villages. Supporting facilities were constructed, including a base camp and a 23 m high fire lookout. Over 310 households in 13 groups have participated in the IGB activities. Self-help groups were organised out of the existing neighbourhood associations and farmer groups.

**Costs and Self-help Abilities of Participating Farmers**

IGB requires initial investment to support its various activity components. Table 1 analyses activity costs and farmers’ self-help abilities in IGB development. A large amount of funds and labour had to be allocated for wire fence construction, including provision of wire, props, nails, and tools as well as their transportation. A sharp rise of prices of wire and other materials has also influenced the cost of the wire fence construction, particularly since the economic crisis in early 1998. Farmer groups worked very hard on a voluntary basis...
plaiting wire and setting up fences, reflecting their strong desire to control wild boars on their land. Ditch construction cost much less because the experienced Javanese farmers carried it out efficiently. They were strongly motivated to dig ditches by themselves in order to enhance fire prevention and wild boar control, stimulated by assistance from FFPMP for wire fences.

Nursery management required funds for construction materials, seedlings, fertilisers, and wages. Participating farmers’ self-help abilities are still limited on seedling production owing to lack of their experience and skill. Consequently additional seedlings had to be purchased from the outside the site villages.

Planting activities were rather economical in terms of costs and labour inputs, except for weeding and land preparation of the idle land overgrown with thick undergrowth. Farmers often demanded small remuneration for these activities. The figures in Table 1 probably underestimate the costs and labour contributions to plant and protect trees, and may increase as the programme continues. Transportation of seedlings inside the village and fertilisation are somewhat laborious and costly, although farmers show strong interest in various perennial crops, expecting income generation in the future. Nursery establishment and seedling provision could be a big challenge to sustainable planting activities on the community land, especially when farmers are unfamiliar with tree growing technologies.

Initial funds were indispensable to develop IGB, particularly for wire fences, even though the programme is to be carried out with farmers’ self-help efforts. Farmers have difficulty in meeting all the costs of the intensive IGB establishment. Another emerging constraint on farmers’ activities is protection of crops, fences and other facilities. They cannot afford to maintain all of the activities for a long period without immediate tangible benefits, so protection of the planted trees and the fences is a burden. Costs of fertilisation will increase when farmers introduce fruit trees, such as durian and rambutan, which require large doses of fertilisers.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Activity cost</th>
<th>Voluntary contributions from farmer groups</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unit cost (Rp.)</td>
<td>Fund allocation (%)</td>
</tr>
<tr>
<td>Wire fence construction</td>
<td>5305 m⁻¹</td>
<td>32.9</td>
</tr>
<tr>
<td>Ditch construction</td>
<td>106 m⁻¹</td>
<td>0.5</td>
</tr>
<tr>
<td>Nursery/seedling production</td>
<td>315 tree⁻¹</td>
<td>14.6</td>
</tr>
<tr>
<td>Seedling provision</td>
<td>635 tree⁻¹</td>
<td>48.2</td>
</tr>
<tr>
<td>Planting on the green belt</td>
<td>356 tree⁻¹</td>
<td>3.8</td>
</tr>
</tbody>
</table>
This section analyses various responses of farmer groups to the IGB development.

Acceptability of ethnic groups to IGB
Outcomes of the IGB development are quite different among the participating farmer groups. Table 2 compares farmers’ performances in the IGB development between the two villages. These data show that in-migrant farmers (the Javanese and Buginese) at Rantau Rasau performance was better in terms of cost effectiveness and self-help abilities than local inhabitants (the Malay) at Sungai Rambut in all of the activities. Farmers of Rantau Rasau established the green belts more quickly with lower costs than those of Sungai Rambut. They were also active in seedling production.

In contrast, higher activity costs were caused by delayed implementation, price increases for wire and other materials, greater input of materials such as wire and props, and wage labour for weeding and land preparation at Sungai Rambut. Local farmers could not plait wire efficiently, and used more wire to set up fences than farmers at Rantau Rasau. Their self-help capabilities are also seriously limited in land preparation and farming. They cannot initiate ditch construction by lack of experience in digging soils with hoes.

This variation in farmers’ performance may derive from their diverse acceptability to the IGB programme, affected by their socio-cultural backgrounds. The Javanese and Buginese farmers as in-migrants are more motivated to take initiatives for new activities to improve their

4 The authors presume that the initial IGB development was disadvantageous to the local Malay farmers as compared with the in-migrant Javanese and Buginese farmers based on observation of their activities with field staff. However, it can definitely not be generalised that the Malay groups have the same tendency in all activities everywhere, as the assumption is supported by nothing but a case from the site villages. Nevertheless, the authors recognise the significance to understand farmer groups’ diverse responses to the IGB programme at the site for appropriate programme modifications. In the follow-up activities FFPMP will document evolution of both local and in-migrant farmers’ interactions and performances in the modified IGB programme to assess its adaptability to the site communities.
livelihoods at new settlements even at the risk of failure. They are very eager to make a success of their new life after leaving their homeland in Java or Sulawesi. These in-migrants have gained wide experience and interest in various activities, and evolved many communication channels through migration, which expedites their active participation in new activities with their own knowledge and skills. The Javanese have a strong tradition of hoeing the land, and very experienced in intensive farming with various annual and perennial crops. The Buginese are also acquainted with intensive farming with coconut and citrus. Both groups still maintain strong social bonds and are good at organising collective actions such as mutual assistance (gotong royong) for ditch construction and land cultivation. Conversely, local Malay groups maintain their traditional life usually along the riverside, depending on riverine fisheries, tapping latex of jelutung, and gathering of other forest resources besides rice growing for their livelihood. Part of the Malay inhabitants also migrated into the site out of other villages, but their experience and communication are still limited within the living sphere of the Malay. They are reluctant to run a risk in new activities without substantial experience, and are less positive about participation in the IGB activities before seeing benefits of the programme to other Malay farmers. Even the success of the Javanese and Buginese is not a convincing example for them due to different cultural backgrounds. They are unfamiliar with collective actions in the project, and tend to seek quicker benefits than the Javanese and Buginese on account of their poorer economic situations. They prefer rice and other annual crops to tree growing.

It is concluded that the initial IGB activities are more acceptable to the in-migrant farmers than the local farmers because of higher adaptability of the former groups to land preparation and planting activities.

### Farmers’ preferences for tree planting

Although the IGB development aims at intensive tree planting in a row along the border of farmers’ cultivation land, they often show more interest in tree planting on their inner cultivation land especially at Sungai Rambut, as suggested in Table 3. In particular they prefer to plant areca nut on their dryland or home gardens to gather seeds more easily. This adversely affects their willingness to maintain the green belt by weeding and fertilisation. It is often observed that they actively weed the inner land rather than the green belt farther from their houses. It might also be because they cannot yet perceive the benefits of the green belt before harvest of products from the planted trees. Line planting of small number of trees and high maintenance costs for a long period may be less satisfactory to them. Out of the three initial species, some albizia and lamtoro seedlings remained unused in the nursery.

Often farmers failed to schedule timely tree planting owing to inundation of the lower land, delayed rice harvest caused by the preceding long drought, and other income supplementing activities. Synchronisation of tree planting with farmers’ activities is difficult, aggravated by unforeseeable natural conditions and their unstable economic status.

<table>
<thead>
<tr>
<th>Village Area/ species</th>
<th>Proportion of planted trees (%)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Areca nut</td>
<td>Albizia</td>
</tr>
<tr>
<td>Green belt</td>
<td>75.4</td>
<td>48.4</td>
</tr>
<tr>
<td>Inner land</td>
<td>17.3</td>
<td>0.0</td>
</tr>
<tr>
<td>Replacement</td>
<td>6.1</td>
<td>15.9</td>
</tr>
<tr>
<td>Not yet planted</td>
<td>1.3</td>
<td>35.7</td>
</tr>
</tbody>
</table>

Table 3. Planting areas of three major species up to March 1999
Condition of crops based on farmers’ observations
Growing condition of farmers’ crops may largely affect their responses to the on-going IGB development. Table 4 compares mortality of six major crops and its causes in the green belt, based on a questionnaire survey with the participating farmers. Areca nut survives quite well, while the mortality rate of albizia, lamtoro, and melinjo is higher. Acid soils and inundation killed areca nut trees, while albizia and lamtoro mortality was mostly due to acid soils. Durian and rambutan survive best so far, though they are newly planted and so their growth needs to be carefully monitored. Melinjo was affected by not only inundation but also other various factors, especially wilt and pests, possibly due to farmers’ inadequate treatment. Some melinjo and rambutan seedlings were trampled by passers-by or cattle. It is expected that crops on the inner land will be more susceptible to disturbance by people and livestock, as compared with the initial species along the fence.

These results generally coincide with the plot survey of growth of the initial three species in five plots. The mortality rate is 0% in areca nut, 34% in albizia, and 28% in lamtoro. It is concluded that better growth of areca nut compared to albizia and lamtoro is due to its high adaptability and good planting environment on the embankment along the ditch. Some albizia and lamtoro trees were killed by inundation on the lower land.

The condition of planted tree crops has been influenced by farmers’ enthusiasm for crop protection, but simultaneously it may largely affect their concern with the crops. In this respect timber trees have so far few good prospects for development on the wet community land, discouraged by uncertain timber markets, despite initiatives of FFPMP and farmer groups for formation of the green belt with fast-growing timber species.

IMPEDEMENTS TO SUSTAINABLE IGB DEVELOPMENT
As discussed in the preceding sections, farmers’ participation in the IGB development is not yet optimal particularly at Sungai Rambut. The following obstacles confront the participating farmers during implementation of the IGB programme:

High initial investment costs
Initial investment in material assistance such as wire and seedlings will be a limiting factor for sustainable development of IGB in terms of cost-effectiveness. The wire fence is an effective tool to control wild boars, yet its cost may already be too high to be borne by farmers themselves. Meanwhile, no promising alternative technologies have yet been found for this site. Hedgerow trees might be recommended for formation of live fences by cuttings, such as waru (Hibiscus sp.) as observed at part of the site, but their survival rate is uncertain on the wetland.

Inadequate nursery technologies
Nursery establishment and seedling provision are another difficulty at the site villages. Seedlings of farmers’ favourite tree species are quite hard to produce at the village level, above all fruit trees,

<table>
<thead>
<tr>
<th>Species</th>
<th>Mortality Causes of crop death (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Inundation</td>
</tr>
<tr>
<td>Areca nut</td>
<td>17.8</td>
</tr>
<tr>
<td>Albizia</td>
<td>39.6</td>
</tr>
<tr>
<td>Lamtoro</td>
<td>37.2</td>
</tr>
<tr>
<td>Melinjo</td>
<td>37.2</td>
</tr>
<tr>
<td>Rambutan</td>
<td>7.8</td>
</tr>
<tr>
<td>Durian</td>
<td>9.2</td>
</tr>
</tbody>
</table>
owing to technical limitations. Few farmers can afford to purchase these seedlings.

**Difficulty of land preparation without burning**

Farmers encountered serious problems of land preparation through clearance of thick undergrowth and weeds without burning. The current government policy bans farmers from burning their land or spraying herbicides, but they have not yet worked out alternative land preparation technologies that they can apply easily.

**Insufficient green belt protection**

Farmers cannot easily protect the green belt due to their lack of capital and motivation. Their land cannot be cleared or cultivated continuously on the green belt and without enough capital or labour is quickly invaded with weeds and undergrowth. Furthermore, tree growth is stagnant without sufficient funds for fertilisation. Several fast-growing timber trees would be easier to grow on the favourable land, but are so far less attractive to farmers on account of uncertain marketing opportunities. Part of the green belts run across critical land, such as peat swamps or flood plains, which incurs high costs of soil amelioration and land improvement.

**Uncertain benefits of line planting**

Although line planting of tree crops might be advantageous in maintaining inner agricultural land in accordance with instructions by the local government, it is less favourable to farmers because crop harvests are small. A number of farmers are more concerned with broad-scale tree planting on the inner land.

**Disadvantage of local farmers**

Local farmers cannot easily develop their skills for the IGB activities as compared with in-migrant farmers. They lack experience in collective actions and land cultivation, as they still live on natural resource gathering for quick income. They are inclined to expect more short-term in-kind or cash incentives during the development of IGB. Consequently funds had to be provided to encourage their activities.

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**MODIFICATIONS OF THE PARTICIPATORY IGB PROGRAMME**

Although the IGB model is attractive to accomplish long-term fire prevention with tree planting at the community level, several constraints must be overcome to sustain farmers’ active participation for a long period. This section recommends technical and institutional programme modifications.

**Diversification of crop species**

In the later period of implementation FFPMP tried to give participating farmers better opportunities to design more suitable planting models through diversification of crop species, with more attention to their skills and interest. Farmers were encouraged to select their favourite crops that they can grow easily within their economic abilities. Table 5 shows the current preferences for perennial crops based on the questionnaire survey of 336 participating farmers. It indicates that a large number of farmers want estate crops such as local coconut, hybrid rubber (*Hevea brasiliensis*), cacao (*Theobroma cacao*), and coffee (*Coffea arabica*). The Javanese and Buginese groups (216 farmers) at Rantau Rasau favoured local coconut and citrus, while the Malay groups (120 farmers) at Sungai Rambut requested hybrid rubber and local coconut. Farmers’ preferences are more diverse at Rantau Rasau than at Sungai Rambut, reflecting variation in their cropping experience. Timber trees are less popular on account of few economic benefits, and even fruit trees are not favoured, except citrus and rambutan, because of long growing periods and high costs of management including fertilisation. Farmers’ choices of perennial crops are greatly influenced by marketing environment of the products rather than non-commercial factors.

These crops have various characteristics for fire prevention. Cacao is supposed to be resistant to fires, and effective in green belt formation due to its fast growth. Nonetheless, the fire-resistance of cacao must be closely studied at the FFPMP site. Trunks of rubber and coconut may be quite susceptible to fires, but they will effectively control weeds and undergrowth. At first FFPMP did not
approve the estate crops, afraid of exacerbation of farmers’ forest encroachment and fire occurrence. However, these crops are not suitable to grow outside the fenced area where there are more critical soils and pests. Farmers are also expected to be more careful with the use of fire after their land is planted with their selected crops. FFPMP will try a variety of perennial crops in and around the green belt to examine their resistance to fires, motivating farmers to plant and protect them.

**Modification of planting sites**

FFPMP will help farmers determine appropriate planting sites more flexibly in and around the green belt to guarantee optimal growth of the selected crops without heavy land improvement work. Figure 3 classifies farmers’ ideas which emerged in the questionnaire survey for tree planting in and around the green belt. Pattern 1 aims to expand the existing green belt along the fence with farmers’ favourite tree crops together with annual and short-cycle intercrops, which suits the project objective best. On the inner land, farmers grow rice and food crops every year, developing fuel breaks. Pattern 2 is to develop the fuel breaks with annual crops along the fence and the row of areca nut on the lower land, accompanied by the tree planting on the higher land. For this pattern, the effects of the fuel breaks to suppress weeds and undergrowth, and cut off surface fires will be examined, while closely monitoring farmers’ skills of controlled burning in land preparation. Patterns 3 and 4 are oriented to alley cropping with annual or short-cycle crops on the inner land, parallel or perpendicular to the initial green belt. Trees will be planted on ridges, embankments, or other higher topography, or otherwise indigenous wetland species will be introduced on the lower land. Pattern 2 is to be applied to areas where tree planting is difficult just along the fence due to frequent inundation or flood, but could be converted into Pattern 3 upon farmers’ initiatives, if the fuel breaks turn out to be ineffective in control of fuel and wild fires.

Farmers will be encouraged to mix several perennial and annual crops on the green belt and the inner land for economic and ecological stability. In spite of this, they may prefer single cropping of estate crops, above all rubber, to try to maximise cash incomes. Nevertheless, farmers will be advised to space out rubber and other estate crops and to intercrop them with rice or other food crops for several years. It is expected that farmers will be more eager and responsible to prepare their land and then plant and protect their selected tree crops with the modified models, while the functions of the green belt will be strengthened. Coupled more closely with farmers’ initiatives, tree growing should be more sustainable in and around the green belt, enhancing formation of fuel breaks and control of burning.

**Improvement of technologies for land preparation and crop protection**

Initial land clearance and subsequent weeding are still a problem for farmers without burning or spraying practices. Even though some farming tools might be helpful, farmers still feel it a burden.
Figure 3. Farmers’ ideas for land uses

Pattern 1

**Wire fence**

<table>
<thead>
<tr>
<th>Initial green belt (areca nut, albizia, lamtoro)</th>
</tr>
</thead>
</table>

**Mixed/single cropping with perennial/annual crops**

- Estate crops (coconut, rubber, etc.)
- Fruit trees (melinjo, durian, rambutan, breadfruit, citrus, etc.)
- Intercrops (pineapple, maize, soybeans, etc.)

**Fuel Break**

Rice/secondary food crops

Pattern 2

<table>
<thead>
<tr>
<th>Areca nut</th>
</tr>
</thead>
</table>

**Wire fence**

**Fuel Break**

Rice/secondary food crops

<table>
<thead>
<tr>
<th>Mixed/single cropping with perennial/annual crops</th>
</tr>
</thead>
</table>

- Estate crops (rubber, coconut/coffee, cacao (catch crops))
- Fruit trees (citrus, rambutan, durian, melinjo, etc.)
- Intercrops (rice, soybeans, maize, pineapple, etc.)
Pattern 3

**Wire fence**

| Initial green belt (areca nut, albizia, lamtoro) |

**Alley cropping**
- Estate crops
- Fruit trees (coconut, citrus, rambutan, durian, melinjo, breadfruit, etc.)
- Intercrops (rice, soybeans, pineapple, etc.)

Pattern 4

**Wire fence**

| Initial green belt (areca nut, albizia, lamtoro) |

**Alley cropping**
- Estate crops (coconut, cacao, coffee, etc.)
- Fruit trees (citrus, rambutan, durian, melinjo, breadfruit, etc.)
- Intercrops (rice, soybeans, pineapple, etc.)
to prepare their land by manual weeding. Assistance in food crops might be considered for participating farmers to facilitate weeding of the green belt with quick harvests. Gradual land use intensification with annual and perennial crops will help farmers prepare land more easily with reduction of weeding costs in the near future. Fertilisation problems could be surmounted by selection of crops requiring little fertiliser. FFPMP will also try to provide farmers with technical assistance in production of mulches and composts out of weeds and dung to minimise chemical fertilisation. Generation of the demand for green manure could also stimulate farmers’ sound land preparation in the future.

**Development of alternative fencing technologies**

More simple and effective fencing technologies must be found as an alternative to expensive wire fences for wide application in other areas. A potential method would be formation of hedgerows by direct sowing of seeds of several leguminous trees such as turi (*Sesbania grandiflora*) or planting of cuttings of local trees such as bungur (*Lagerstroemia speciosa*), although its technical feasibility needs to be tested at the site.

**Facilitation in seedling production and nursery building**

Table 6 indicates farmers’ willingness to produce seedlings inside the two villages with 27% interested in seedling growing. Farmers of Rantau Rasau (39) are more positive than those of Sungai Rambut (4). In correspondence with their crop preferences, farmers are eager to produce seedlings of coconut, citrus, cacao, rambutan, durian, coffee, rubber etc.

Farmers do not have sufficient experience for seedling production of all selected crops. Coconut seedlings are relatively familiar to farmers and growing of areca nut seedlings has been demonstrated during implementation of the project. Some farmers are experienced in producing albizia seedlings. A few have tried to plant cuttings of rubber on their land. Nonetheless, very few have raised seedlings of other species, above all fruit trees. Citrus and melinjo require special care with fertilisation and pest management to maintain the quality of their fruits. Farmers have not yet acquired grafting skills and other technologies to produce good quality seedlings of durian, rambutan, and duku (*Lansium domesticum*). They can grow jackfruit (*Artocarpus heterophyllus*) fairly well by simply transplanting wildlings that germinate around their houses.

As farmers’ technical and economic capacities are still limited for seedling production, small pilot nurseries need to be established and maintained for demonstration of seedling production technologies, with assistance by external agencies, including Ministry of Forestry and Estate Crops and local extension services. It is expected that the pilot seedling production will gradually assist technology transfer from farmer to farmer inside the villages.

**Strengthening of community organisation**

Community consultation and organisation processes are imperative to build up farmers’ working abilities especially in underdeveloped areas. The organisation work must be adapted to local socio-cultural conditions, and suitable personnel who comprehend them must be appointed to enable good communication with farmer groups. Oral instructions alone will never be enough for local Malay inhabitants. Joint field trials are indispensable together with frequent technical orientation and pilot demonstration. Considerable government support will be essential for community organisation and extension for the whole period of programme implementation.

| Table 6. Farmers’ interest in seedling growing |
|-----------------|-----------------|-----------------|-----------------|
| Crop species    | Interested farmers (%) | Rantau Rasau | Sungai Rambut | Total |
| Coconut         | 18               | 4              | 13             |
| Citrus          | 15               | 1              | 10             |
| Cacao           | 14               | 0              | 9              |
| Rambutan        | 12               | 1              | 8              |
| Durian          | 10               | 0              | 7              |
| Others (17 sp.)| 46               | 9              | 33             |


CONCLUSIONS

Although the IGB trials are a good example of participatory forest fire prevention along the forest boundary through intensification of farmers’ land uses, there are obstacles to their sustainable implementation. Main limitations are high initial investment costs in materials and facilities, above all wire fences, and farmers’ limited capacity for land preparation, seedling production, and protection of crops and facilities. Local inhabitants are less capable of the IGB development than in-migrant farmers.

To address these shortcomings, FFPMP will focus on more effective fuel management inside the fenced areas through agroforestry development with various perennial crops proposed by farmers. They have increasingly urged FFPMP to balance fire prevention objectives and their living needs in establishment of the green belt on their land, which results in diversification of tree crops and cropping patterns with adaptation of planting sites. FFPMP will also seek for opportunities to expand the green belt outside the fence along the park boundary with indigenous tree species resistant to pests and fires, with a view to upgrading fire prevention and wild boar control. Incentives may be indispensable for active participation of farmers, but more cost-effective funding techniques need to be explored with simpler technologies for economical fencing, sustainable seedling production, and sound land preparation and crop protection.

Careful modification and adaptation of the programme to the local conditions are crucial through positive integration of initiatives of farmers and the project to optimise outputs and minimise activity costs in the latter period of implementation. Community participation programmes inevitably involve processes of problem analyses, innovations, and programme modifications. Rigid and predetermined approaches result in ineffective programme organisation and intolerably high activity costs. Responding to various farmer groups’ performances, programme options and farmer organisation skills need to be diversified as far as possible for more sustainable development of IGB. Reiterative learning processes should be given high priority for disadvantaged farmer groups. The government must support the activities technically and financially.

FFPMP will use an evaluation matrix to assess effects of the on-farm green belt trials with various perennial and annual crops in fuel management, burning control, wild fire prevention, and farmers’ self-reliance. The developed expertise on participatory tree planting would be valuable for not only forest fire prevention but also rehabilitation of ex-fire forests around community settlements. It is highly expected that rehabilitation of degraded forests in park buffer zones will be facilitated through collaboration between forestry personnel and local people with evolved participatory techniques.

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