

TABLE 6

Financial analysis of rubber based cropping systems : characteristics of calculation.

In this first financial analysis, there is no depreciation of initial investment during the immature period. It is assumed that farmers do not use credit in order to simplify the assessment of rubber systems performances. To provide a criteria of comparison for this initial investment, we present the number of days of work at local opportunity cost (generally in a estate nearby for a daily wage of 3 500 rp⁹, that is the case in West-Kalimantan) that are required to cover costs of investment. A further analysis should include a credit scheme. A credit scheme will not significantly change the long term financial analysis. Costs and benefits are calculated in net present value (NPV) with value at the end of the period (1 year) with a rate of interest at 15 %, equivalent to the current real interest rate in Indonesia (table 1). The total net benefit includes that of rubber, rice, fruits, cinnamon and timber for the overall lifetime of each system, voluntary limited to 35 years (possibly more). RAS 2.2 and 3 systems with associated trees may also evolve, beyond the rubber lifespan, into fruit and timber based agroforestry systems. Rubber wood from seedlings is counted only as fuelwood with a limited value but may be sold later as a valuable product (for particle board or pulp for instance). Clonal rubber wood is expected to be sold as a valuable timber product in particular for furniture industry. In all case, rubber wood harvest is contracted. Costs are effective costs observed in current on-farm experimentation of SRAP. Prices are those observed in February 1996. Production and labour requirements are assumptions based on previous surveys (Gouyon, Barlow....) or farmers interviews.

The analysis is based on the situation in West-Kalimantan with no fencing cost (except for RAS 2.5 system, based on rubber and cinnamon in Jambi only). In RAS 2.2 and 3, timber trees are harvested 35 years after planting yielding a modest benefit. Fruit production is annual for petai and jengkol and durian, duku and rambutan are assumed to fruit every 3 years. We also assume that yields are low and only 50 % of the production is actually sold for which gives us 40 producing trees/ha. Distribution between trees is the following : fruit trees : 75 % (70 trees/ha with 60 producing trees) and timber trees : 25 % (22 trees/ha).

Labour for tapping is limited in RAS systems to 120 tapping days (1 tapping day is 0,5 manday) as PB 260 and other selected clones allow a D/3 tapping system (tapping every 3 days) without any decrease in production. Jungle rubber is tapped more frequently (200 tapping/year so 130 man days including other activities). Labour is converted into total man days in our calculation. It is assumed that rubber is tapped by the owner.

Production patterns have been carefully adjusted to account for the normal evolution of production including losses of trees. In RAS 1, 2.2 and 3 ; rubber yield has been slightly reduced (10 %) due to possible competition with associated trees compared to that of a TCSDP monoclonal rubber plot (this is an assumption). RAS 2.5 rubber production is assumed to be similar to that of TCSDP as cinnamon is harvested the 8th year with no further competition. Production and prices for fruit and cinnamon have been assessed from interviews with farmers and ENSO/West-Kalimantan for pulp trees production. TCSDP system may be adopted by farmers on their own or through projects. A line in table 2 shows the actual cost of TCSDP system in project, including project costs (evaluated at 1,5 millions rp in 5 years).

⁹ However official minimum daily wage is 4600 rp in March 1996 in Indonesia, the daily wage observed in West-Kalimantan and Jambi provinces is generally close to 3500 rp

the Barisan mountains in Sumatra. RAS 2.2 is the most intensive system aimed at farmers with severe land limitation such as transmigrants. Farmers in degraded areas with Imperata (in West-Kalimantan for instance where the risk is high) are targeted for RAS 3.

Cost benefit analysis of rubber based cropping systems.

The analysis is based on incremental benefit related to the jungle rubber system (fig 14) and has been made with 3 levels of labour daily cost⁵. Details of calculation characteristics are in table 6.

The incremental benefit of RAS systems is in the same range as that of TCSDP for RAS 1 and significantly superior for RAS 2.2, 2.5 and 3 due to the non-rubber components production such as fruits cinnamon or FGT production. The most intensive systems, TCSDP and RAS 2.2 are very sensitive to labour cost, in particular for RAS 2.2. The less sensitive systems are, of course, the jungle rubber system with clonal seedlings (very extensive) and, to a less extend, RAS 1 and 3 (intermediate level of intensification)(fig 14).

RAS incremental benefit is far higher than that of jungle rubber, even using clonal seedlings, mainly due to the fact that the bulk of total income comes from rubber and rubber productivity with clones is multiplied by 3, in addition to other sources of income. Incremental benefit is even attractive at high labour cost, but then comparative advantages over the other systems disappear. RAS systems are aimed to decrease labour requirement and give a very interesting output in the case of low opportunity cost, which is generally the case in most rubber producing areas except South and North-Sumatra provinces.

Fig 12 shows that rubber contributes to around 80 % of total income and up to 95 % in RAS 1, but the use of Net Present Value of production increases the importance of rice during the immature period and decrease the final value of the wood at the end of lifetime. In fact, clonal rubber wood and timber output is expected to be high enough to enable the farmer to further invest in his/her preferred improved cropping system (monospecific plantation of rubber or oil palm or agroforestry systems). The fruits, timber for local use, medicinal plants, rattan and firewood which are produced within jungle rubber are generally for self-consumption. Production for self-consumption is not taken into account in this calculation, but is considered as a general benefit for the farmer that is comparable for all systems except TCSDP⁶ which is monoculture.

The return to labour : a sensitive argument for farmers in selecting a cropping system.

An important factor for the farmer is to maintain a good return to labour or to improve it. The evolution from an input extensive system such as jungle rubber into an intensive system such as RAS 2.2 or TCSDP is generally limited by cash

⁵The first one, 2000 rp/day, is equivalent to the output of upland rice farming in shifting cultivation. The second one, 3500 rp/day, is the wage offered by local estates (that can be considered as the 'real regional opportunity cost'). The last one, 5000 rp/day, represents the cost of bagi-dua system (share-cropping using external labor for rubber tapping).

⁶ TCSDP like monoclonal rubber plot is the only system without non-rubber products but it is also not an agroforestry system.

availability and labour. Two conditions must prevail for adoption of new technology : limited risks and high return to labour, or at least conservation of return to labour comparable than that of a jungle rubber. Figures in fig16 show rubber return to labour is definitely improved with TCSDP and RAS (around 50 000 rp/man day compared to 9 000 rp for jungle rubber at the year 15 in full potential production). A better estimation of the return to labour in the long term may be done using the labour cost that leads to Net Present Value equal to zero (fig 15). One can see that this opportunity cost (OC/0) for jungle rubber is close to the bagi-dua labour cost giving little room for extension. OC/0 of TCSDP is similar to that of RAS 2.2 and lower than that of more extensive system (RAS 1) of intermediate (RAS 2.5 and 3). The interest of these intermediate systems is that they are still affordable for farmers (investment cost is limited) with limited labour requirement and a good optimization of labour. RAS 1 is typical of that situation. A possible constraint is in the distribution of required labour, in particular during the immature period. TCSDP and RAS require labour prior to production systems (respectively 300 to 500 man days for RAS and 600 for TCSDP) in contrasting with jungle rubber (54 man days) (Table7). In RAS, labour required during immature period is less than TCSDP. In RAS 2.2, the required labour for weeding rubber is diminished due to rice cropping where rubber profit from crop weeding. The main constraint for adoption of a clonal rubber based system is the necessary minimum level of maintenance during the immature period. The first 2 years are critical as rubber clones require a minimum level of weeding (probably around 6 weeding/year compared to 12 for TCSDP but that is still under experimentation with farmers). Labour requirement in RAS systems is 50 to 75 % that of TCSDP monoculture system suggesting there would be a better adoption of clones by farmers in a much as labour during immature period is concerned (table 7) . After opening (meaning the trees are being to be tapped), the low tapping frequency of clones leads to a significantly improved return to labour. For these reasons, the use of clonal seedlings do not yield a real significant impact on return to labour as well as income. Exploitation system and tapping frequency are key issues in improving return to labour during production period. Return to labour is optimized in the RAS 1 system and is especially suitable for farmers in remote or pioneer zones as well as those with poor cash availability. The immature period investment is half that of TCSDP and may be within the range of possibility for some farmers without any access to credit (fig 13). RAS 1 is aimed to decrease the labour requirements by 30 % during immature period (table 7). For RAS 2.2, rice intercropping has significant benefits for rubber growth however rice production does not have a great economic value compared to that of rubber. Nevertheless, it is important for some farmers to grow rice during the immature period in order to ensure short returns on labour investment, in particular for those with limited access to land such as transmigrants. Then rice intercropping is not only a choice but also a necessity, explaining why rice intercropping is always attractive for farmers (at least for the first year) when rubber is not yet producing. The investment during the immature period is not so heavy as the figure includes the inputs cost for rice which are to be paid off within 4 months.

COST BENEFIT ANALYSIS OF DIFFERENT RUBBER BASED SYSTEMS

table 11 : labour requirement per system

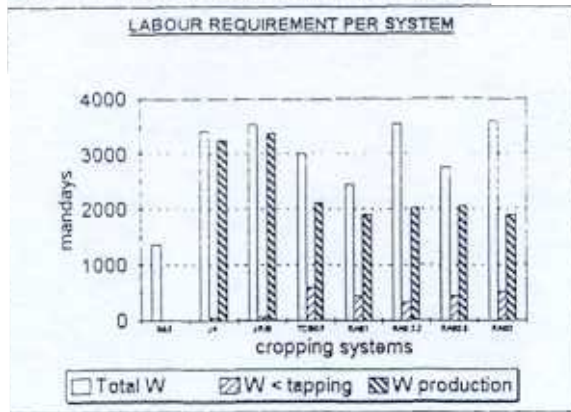


Table 12 : production values per system

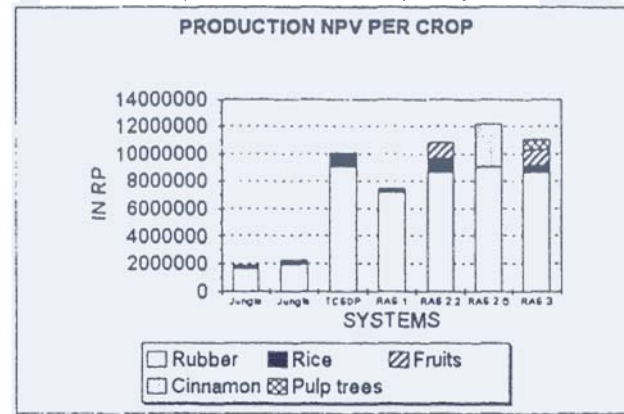


Table 13 : initial investment required per system

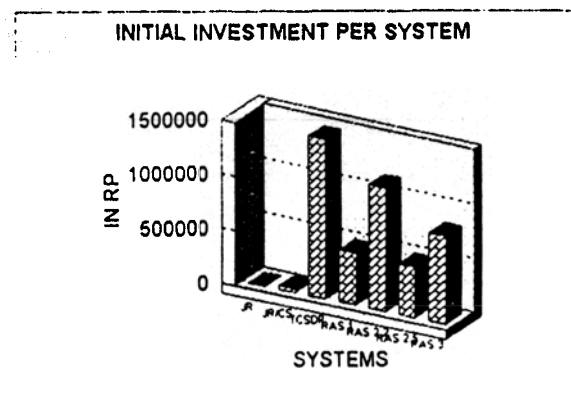


Table 14 : financial return per system

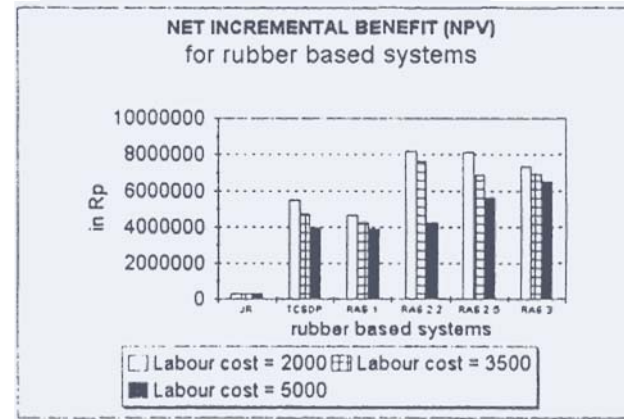


Table 7

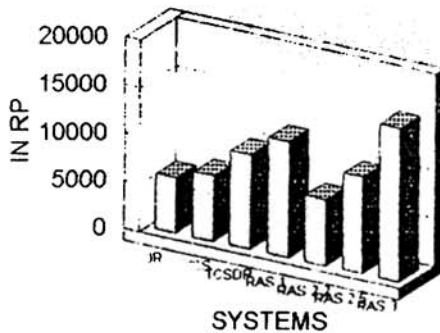
**COMPARISON BETWEEN RUBBER BASED AGROFORESTRY SYSTEMS
LABOUR REQUIREMENT AND RETURN TO LABOUR**

LABOUR		Upland rice slash and burn system	Jungle rubber unselected seedlings	Jungle rubber clonal seedlings	TCSDP like clonal plantation	RAS 1	RAS 2.2 rice inter-crop	RAS 2.5 Cinnamon inter-cropping	RAS 3 with FGT (*)	
% of TCSDP total labour requirement tapping system FOR RUBBER ONLY/immature period			113% D/1, D/2	117% D/1, D/2	100% D/3	81% D/3	118% D/3	92% D/3	119% D/3	
% of TCSDP total labour requirement			9%	9%	100%	73%	53%	74%	86%	
RETURN TO LABOUR (full production)										
RUBBER return to labour : YEAR 15	Rubber/15		8,979	12,210	50,839	45,714	51,246	51,246	51,246	
Average RICE return to labour (1 or 3 years)	Rice	1,992	3,500	3,500	5,000	2,917	5,000		6,000	
FRUIT return to labour : YEAR 15	Fruit/12-15						12,861		12,861	
CINNAMON return to labour (year 7)	Cinnamon/7							38,400		
FGT return to labour (year 8)	FGT/8								18,667	
RETURN TO LABOUR ASSESSMENT IN THE LONG TERM										
Labour productivity if NPV = 0				5,790	6,828	9,893	12,157	6,900	10,057	16,000

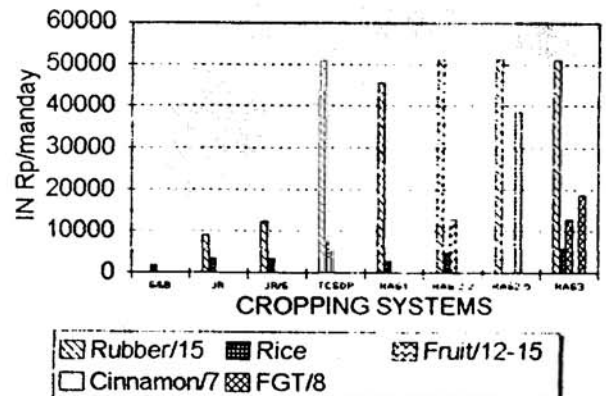
Fig 15 : estimation of the return to labour in the long term

Fig 16 : return to labour at a fixed date

**OPPORTUNITY COST FOR NPV = 0
FOR ALL SYSTEMS**



**RETURN TO LABOUR OF CROPS
YEAR 15 : real value**



For RAS 2.5, cinnamon is definitely a very interesting crop in association with rubber as it fits well with the strategy of local farmers in the Muara Bungo area, a hilly area where rice is not often cropped. This extensive system fits also local farmers' strategies focused on low labour investment. For RAS 3, FGT's are an important source of additional income. This may help the farmer to reimburse any credit.

Initial investment is also an important component of farmers strategies. RAS systems are low to medium inputs systems. Table 13 shows the importance of initial investment in NPV related to that of TCSDP with respectively 30 %, 55 % and 78 % for RAS 1 and 2.5, RAS 3 and RAS 2.2 of that of TCSDP (if adopted by farmers on their own without projects cost). If we had the TCSDP project cost, estimated at 1.5 millions rp/ha, then it is clear that RAS technology is more affordable for farmers and constitutes a very interesting alternative to the current rubber development policy.

Final conclusion

This preliminary simple cost-benefit analysis of various rubber based cropping systems (based partly on technical assumptions that should be confirmed by experimentation) gives an idea of the improved economic output resulting from the choice of using rubber clones compared to unselected seedlings in jungle rubber. Both NPV and return to labour are significantly improved in RAS and TCSDP systems with advantages to RAS in terms of income diversification, environmental benefits and return to labour as well as limited investment during immature period compared to TCSDP and for biodiversity conservation for RAS 1 in particular.

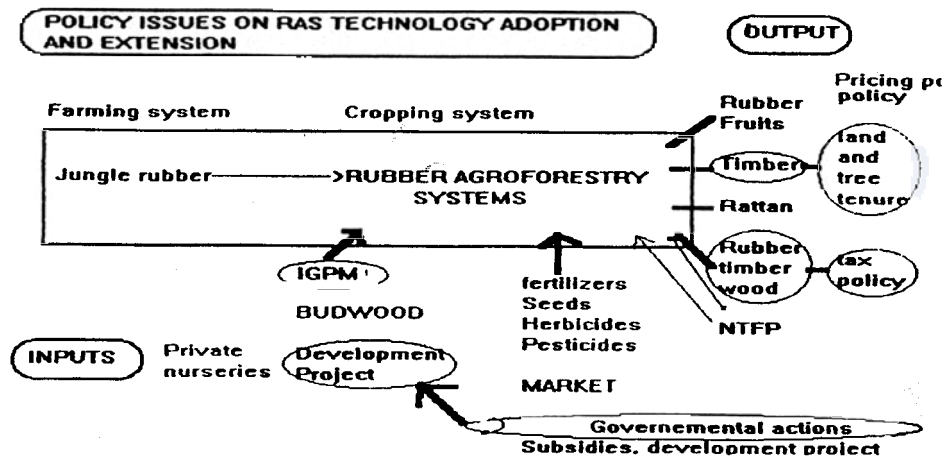
Further in-depth investigation is required, including the results of the current on-farm experimentation on RAS systems giving more accurate information about on-going labour requirements, cost and production. This hypothetical financial calculation enables us to see the scope of such systems and their potential economical performance compared to current existing systems and show clearly that RAS systems may be interesting alternatives to jungle rubber and TCSDP like system. RAS systems are low to medium labour and input systems with valuable economical outputs, compared to TCSDP, and, of course, compared to jungle rubber. By providing a good return to labour for a limited initial investment, the RAS systems are especially suitable for farmers with limited cash availability. One possible trade-off in term of development is to identify the systems which provide the best sustainability and the best biodiversity conservation as well as soil conservation. The current on-farm experimentation and the farming system surveys will enable us to obtain accurate data on labour and production as well as information on technology adoption by farmers currently practicing these RAS systems.

Policy implication of RAS technologies

The development of RAS technologies at a larger scale will yield ground to some policy issues (fig 13) the most important being following : land/tree tenure, pricing policies for fruits, timber and rubber, governmental approaches for RAS extension (partial or complete approach) and quality/purity of IGPM.

Objectives for 1997

The objectives for 1997 are, for the on-farm trials network, to analyze rubber



growth in different RAS systems, further investigate the appropriateness of upland rice intercropping during the first 3 years in RAS 2, select the most suitable combination of covercrops, MPT and pulp trees in RAS 3 and validate the relevant weeding and fertilization levels for RAS 1 in different sites in order to produce technical recommendations on RAS alternatives. Socio economic surveys will be conducted to characterize farming systems, analyze constraints and opportunities in all sites, according to the socio-agro-economical situation typology. The main output will be an operational farmers' typology focused on conditions for RAS technology adoption. Another tool, still to be developed, may also be useful for potential users or developers of RAS technology is a land-use analysis in some selected areas (with GIS) in order to identify priorities and suitability for RAS adoption by farmers. This research is aimed to develop tools for an holistic approach on Rubber Agroforestry Systems.

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in note

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