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UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

ORIGINAL: ENGLISH

OPPORTUNITY STUDIES FOR SMALL AND MEDIUM SCALE AGROINDUSTRIES IN THE MEKONG AREA

Project Number: US/RAS/90/039

KINGDOM OF THAILAND AND LAO PDR

TERMINAL REPORT

VOLUME I

Prepared by the

United Nations Industrial Development Organization

Based on the work of

Agro-Economic Services (UK) Limited

in association with

Landell Mills Limited

MARCH 1992

Backstopping Officer: Michael Davidsen, Feasibility Studies Branch

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EXECUTIVE SUMMARY

This document is the Terminal Report of the 'Opportunity Studies for Small and Medium Scale Agroindustries in the Mekong Area' (Project number US/RAS/90/039). What follows is an executive summary of the main findings of the Report, presented as a preface to the Main Volume.

The purpose of the project was to identify opportunities for agroindustrial investment in the Mekong Basin areas of the Kingdom of Thailand (Thailand) and the Lao Peoples' Democratic Republic (Lao). A list of possible opportunities had been identified in earlier and major developmental phases of this project in 1987 and 1988. Fieldwork for the current study was conducted between August and November of 1991. A range of projects and products (including those originally identified in 1987/88) were considered for study at Review Meetings in Bangkok and Vientiane. Of the opportunities eight eventually studied, six were pursued to the point of the level of financial and economic analysis required by the UNIDO guidelines (ID/206), and two (MDF and cashews) were studied at somewhat less than this level for reasons connected with fieldwork difficulties and availability of data. The eight opportunities studied were

- dairying in Chiang Rai, Thailand
- the production of fruit and vegetables in Isarn (Northeast Thailand)
- the production of straw mushrooms at Chumpae, Isarn
- the production of medium density fibreboard (MDF) from bagasse in Isarn
- the production of sugar from cane at Savannakhet in Lao
- the processing of coffee at Pakxong in southern Lao
- the production and processing of cashews near Vientiane
- the production of seedlac in both Thailand and Lao.

The opportunities therefore cover a range of products, agroindustrial processes and geographical locations. They also have many other different characteristics. The opportunities differ in scale (ie, investment cost and annual operating costs and annual operating profit), in their rate of return, their payback period, their complexity and management intensity, and their degree and source of risk.

It is worthwhile for a short comparison to be made amongst these possible projects for the following reasons. Firstly, from a national point of view (and this is especially the case in Lao) investment capital is scarce, and, where possible, it would be expected that government policy would be to direct or encourage investment to the most profitable areas. 'Most profitable' would have to be determined by some combination of 'rate of return/absolute benefit' on the one hand and an acceptable degree of risk on the other – this would be a policy choice. This policy can be implemented by direction or, more usually, by instruments such as differential tax rates for different sectors or regions.

Secondly, from a potential private investor's point of view, the choice amongst opportunities may not be clear cut. Although some investors will be confined by choice to particular areas or processes with which they are familiar, others may be more flexible. For this reason it is important for them to be able to compare the start-up costs of different opportunities, the absolute and relative profitability of various opportunities, the level of risk involved, and the management requirement in order to minimise risk. It is critical to understand whether the main sources of risk exist within the area of management control (eg, in processing costs) or are determined elsewhere (eg, in world commodity markets). It is also useful to know whether previous in-country experience of similar projects exists upon which to draw.

The table overleaf summarises the major features of each of the eight opportunities identified in the study. All financial estimates were calculated following the formulae contained in ID/206. All financial figures are the base case ones quoted in the texts.

Table 1 MEKONG AREA OPPORTUNITY STUDIES A COMPARISON OF OPPORTUNITIES

Opportunity: THAILAND	Investment costs Baht (000)	Investment Costs US$ (000)	Annual Operating Costs (Baht 000)	Annual Operating Costs Profit (Baht 000)	Rate of Return (%)	Payback Period (Years)	Degree of Complexity	Major Risk source	Any previous Experience
Dairying at Chiangrai	10000	400	19728	2402	16.5	4.3	Simple	Management	Yes
Processing model for Isarn	35000	1400	29775	17380	42.0	2.6	Average	Materials	Yes
Straw Mushrooms at Chumpae	25000	1000	90936	4589	20.3	3.8	Simple	Materials	No
Medium Density Fibreboard	Up to US$ 35 million			No financial analysis undertaken			Very Complex	Technology	Limited
Opportunity: LAO	(Million Kip)	US$ (000)	(Million Kip)	(Million Kip)	(%)	(Years)			
Sugar at Savannakhet	1345	705	449	336	17.2	4.2	Fairly Complex	Price	Yes
Coffee at Paksong	84	119	18	20	16.8	4.3	Simple	World price	No
Cashews from Vientiane				No financial analysis undertaken			Simple	Materials	No
Opportunity THAILAND/LAO	(Baht 000)	US$ (000)	(Baht 000)	(Baht 000)	(%)	(Years)			
Seedlac production in Isarn	7800	312	35624	1383	12.8	5.1	Fairly complex	World price	Yes

Notes:

The calculation of annual operating cost, annual operating profit, rate of return and payback period follow the guidelines in the UNIDO manual ID/206

All figures taken from tables in the individual opportunity studies.

Seedlac has been analysed with Thai costs and benefits, but is also applicable to Lao.

Exchange rate used US$1.00 = Baht25/Kip705

As regards the Thai opportunities, it can be seen that the level of investment in dairying is relatively modest compared to fruit and vegetable processing, but that its base case rate of return is substantially less than the model fruit and vegetable processing plant. Of the three first alternatives, the processing plant appears the most obviously attractive in relative and absolute financial terms, but its scale is larger than the others. Like the straw mushroom investment, its main source of risk is the supply of raw materials, and, being multi-product, it is slightly more complex than the other investments. There is previous experience of both dairying and multi-product fruit and vegetable processing in Thailand, but this is essentially not the case with straw mushrooms in sheds. Medium density fibreboard is thought to require an investment of up to some US$ 35 million, and is extremely risky due to the complexity of the technology and the limitations of in-country experience.

In Lao, both sugar at Savannakhet and coffee at Pakxong have reasonable and similar base case rates of return and payback periods, though the scale of investment in sugar is some 15 times larger. The main risks associated with sugar are the establishment of cane-growing land and the domestic wholesale price; coffee returns depend on the world price increment being achieved for better quality, and on farmers responding to grade/price differentials. Experience in sugar in Lao exists at the Pak Sap mill, though it is to be hoped that its management problems can be avoided at Savannakhet. The financial returns to cashews from Vientiane were not analysed, but the main risk from this very simple project must be simply the quality of the nuts which will come from the established trees.

The level of fixed investment in seedlac for Isarn (and possibly for Lao) is modest, and less than for all other Thai investments. Annual operating costs are high, due to the purchase of the raw material (sticlac) from farmers. It has the lowest base case rate of return and the longest payback period, but there is substantial in-county experience and, with reasonable management processing, costs could be kept down. Vulnerability to prices is the main source of risk.

In general, therefore, the opportunities cover a range of geographical locations, offer a choice of scale of enterprise and project complexity, allow for various degrees of risk aversion, and generally allow both private investors and RTG and GOL to choose the nature of development in the Mekong Basin.

At this stage it is impossible to predict the level of potential private sector interest in any of these opportunities, given the nature of the rapidly changing circumstances of the economies of Thailand and Lao in general, and the particular levels of (largely unmeasured) risk associated with each of the individual investment opportunities. For this reason it has been recommended that a Workshop be held between members of the public and private sectors from Thailand and Lao in the near future so as to gauge the extent of investor interest, to explain the degree of study undertaken to date, to identify any hurdles to implementation and to generally extract critical comment from an informed audience. These concepts are developed more fully in Part D of the Main Volume.

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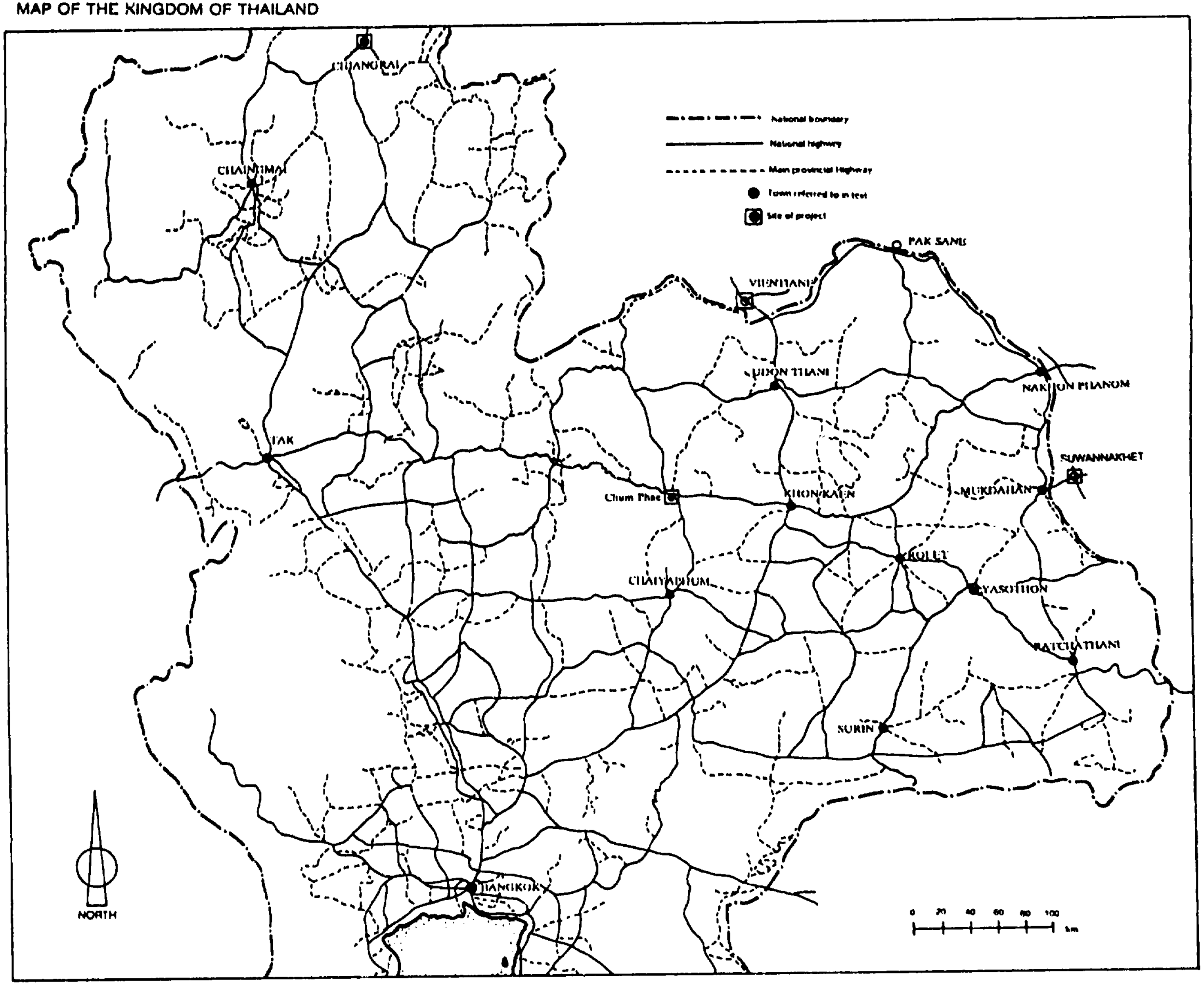
UN. INDUSTRIAL DEVELOPMENT ORGANIZATION	JOHAN NELIS	PROGRAMME OFFICER
UN. INDUSTRIAL DEVELOPMENT ORGANIZATION	MARAKKU KOHONEN	ACTING CHIEF
UN. INDUSTRIAL DEVELOPMENT ORGANIZATION	MICHAEL DAVIDSEN	INDUSTRIAL DEV. OFFICER
UN. INDUSTRIAL DEVELOPMENT ORGANIZATION	DR.ULRICH LOESER	CHIEF
UN. INDUSTRIAL DEVELOPMENT ORGANIZATION	SERGIO M.MIRANDA DA CRUZ	-
UN. INDUSTRIAL DEVELOPMENT ORGANIZATION	SUNIL MAHAJAN	PROJECT COORDINATOR
UN. INDUSTRIAL DEVELOPMENT PROGRAMME	JOHANN STUYT	PROGRAMME OFFICER
UN. INDUSTRIAL DEVELOPMENT PROGRAMME	SUNIL SAIGAL	ASST. REGIONAL REPRESENTATIVE
UN. ESCAP	LIPO SURVO	MARKETING ECONOMIST

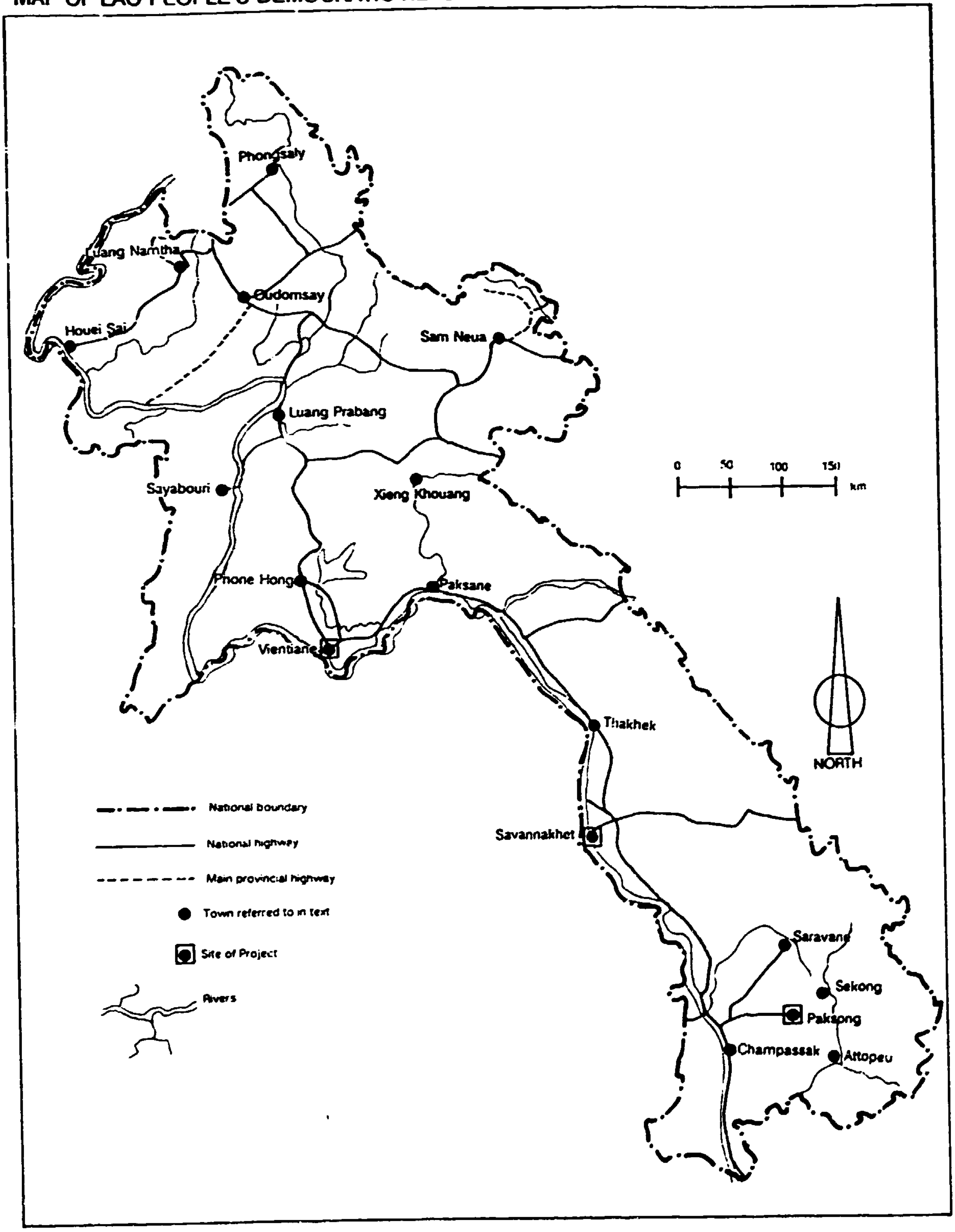
LAOS

COMPANY	NAME	POSITION
AGRICULTURE & FORESTRY	SOUKASEUM BODHISANE	VICE PROVINCIAL SERVICE GOVERNOR
BURAPA DEVELOPMENT CONSULTANTS	PETER FOGDE	MANAGING DIRECTOR
BURAPA DEVELOPMENT CONSULTANTS	SUMPHORN MANODHAM	EXECUTIVE DIRECTOR
COFFEE COMPANY OF PAKSONG	SIMEK THIOLLIER	CONSEILLER DE COOPERATION
CONSEILLER CHAMBRE NATIONALE	OROTH CHOUNLAMOUNTRY	PRESIDENT DIRECTOR DE COMMERCE GENERAL
INDUSTRY AND HANDICRAFTS DEPARTMENT	DR.PHENGTA PHILAKHAMPOUH	CHIEF SERVICE
INSTITUT DE RECHERCHES DU CAFE' DU CACAO ET AUTRES PLANTES STIMULANTES	MICHEL JACQUET	SERVICE PROJECT DEVELOPMENT
LAO SOFT-DRINK COMPANY	SENGCHANH VANNASANE	GENERAL DIRECTOR
LAOS HUNT OIL COMPANY	TERRY MULHOLLAND	GEOPHYSICAL CONSULTANT
LANI GUEST HOUSE	-	-
LE PARASOL BLANC	-	-
MINISTRY OF AGRICULTURE	TONY BOTT	FINANCIAL CONTROLLER
MINISTRY OF COMMERCE AND TOURISM DEPARTMENT OF FOREIGN TRADE	NOKHAM RATANAVONG	DIRECTOR
MINISTRY OF ECONOMY,PLANNING AND FINANCE EXTERNAL FINANCE DEPARTMENT	HOLADY VOLARATH	DEPUTY DIRECTOR
MINISTRY OF INDUSTRY AND HANDICRAFT	SOULIVONG DARAVONG	ACTING MINISTER
PROJECT CREDIT INDUSTRIEL	PHANTHABOUN SAYAPHET	PROJECT OFFICER
SOCIETE LAO IMPORT-EXPORT	KANHKEO SAYCOCIE	GENERAL DIRECTOR
SOCIETE LAO IMPORT-EXPORT	PHOUKHAM CHANTHAVONG	DEPUTY CHIEF OF IMPORT-EXPORT DEPT
THANGONE FEED MILL CORPORATION	SANEU CHOUNRAMANY	GENERAL DIRECTOR
UNITED NATIONS DEVELOPMENT PROGRAMME - VIENTIANE	HAKAN BJORKMAN	ASSISTANT RESIDENT REPRESENTATIVE

MAP OF THE KINGDOM OF THAILAND



MAP OF LAO PEOPLE'S DEMOCRATIC REPUBLIC



PART A: CONSULTANT'S APPROACH AND METHODOLOGY

1. Introduction

This document is the Terminal Report of the UNIDO 'Opportunity Studies for Small and Medium Scale Agroindustries in the Mekong Area' project (number US/RAS/90/039).

It follows an earlier stage of the study of agroindustrial opportunities in the same geographical area which had been conducted in 1987/88. That evaluation study identified the following major product areas thought worthy of investigation for the Kingdom of Thailand (Thailand) and the Lao People's Democratic Republic (Lao)

- paper, pulp, wood chips and wood products
- bioethanol, glucose and fructose from cassava
- cassava flour
- edible oil from beans and rice bran
- sugar from sugar cane
- canned fruits and vegetables.

Fieldwork for the project began at the beginning of September 1991, although preliminary research on the identification of opportunities (and especially on identifying market-led possibilities) had been carried out prior to this in Europe. This report marks the end of the fieldwork and analytical stages of the project, and is intended to form the basis for further, more detailed, pre-feasibility study of at least some of the opportunities identified herein, as well as the basis for discussions at a projected Workshop to be held in 1992.

2. Structure of the Report

This Report is written with several major considerations in mind. Paramount is the need to follow the UNIDO 'Yellow Book' format for the presentation of opportunity studies (Manual for the Preparation of Industrial Feasibility Studies – Reference ID/206). Accordingly, the core of the Report is the various opportunity studies presented in that format, and a short description of the format follows in the next section. The format for the studies is brief, and has been kept to a maximum of a few pages in all cases. Where possible, the names of potential private investors identified by the study are included. Where specific potential investors are not named, description of their likely required characteristics are included.

These opportunity studies are preceded by short sections which set the context for the current work. The content of these sections represents the distillation of a large volume of material on Thailand and Lao acquired by the Consultant during the course of fieldwork. The macroeconomic and agroindustry circumstances of Thailand and Lao are so different from one another, as well as both being in a state of major change, that description of these circumstances is warranted in order to set the scene for the presented opportunities. (These are discussed at more length in various of the Annexes to the Main Volume of the Report). The headings dealing with general economic data, the economic system and characteristics of each country, and economic policy, which might usually be included in the text of the opportunity studies are therefore included in these earlier sections, to avoid repetition in every opportunity study. Each individual opportunity study therefore begins with an analysis of the market demand for the specific product.

It is also felt that some discussion of the trade and investment relations between Thailand and Lao is useful, as this is presently also in a state of change and development; this will affect investment options in Lao, the use of Lao raw materials by Thai enterprises, the possible export of Lao goods through Thailand, and the domestic competition experienced by Lao industries in the face of Thai exports to Lao.

It has also been felt useful to document the process by which the particular opportunities studied were selected (see Part C of this Volume). The project began with a set of opportunity areas which were necessarily dated, due to the time lapse between the earlier evaluation study and the current project. Thus, review and investigation of these and other areas of opportunity was the first step in conducting this project, and led to agreement about which products and processes would be studied in further detail. This process was begun in Europe, with particular emphasis on defining market-led areas of opportunity. A section on the methodology used for the screening of opportunities is therefore included.

Another consideration concerning the present opportunities surrounds the nature of the data upon which the studies are presented. Unlike many opportunity studies, both Thailand and Lao have specific (but very different) circumstances which means that obtaining data concerning, for example, equipment and operating costs is difficult to obtain. This has an impact on the extent of realistic analysis which has been possible, and has perhaps laid a greater emphasis on the analysis of risk and uncertainty (through sensitivity testing) than is often the case. Because of this uncertainty, some opportunities (eg MDF and cashew nut processing) are therefore presented in terms of the conditions which would be required to be met for them to become viable. There is therefore a short section outlining data considerations and implications for investment.

Following the specific opportunity studies is a section which compares the various opportunities for agroindustrial development in Thailand and Lao. Again, these differ greatly by country but it is observable that apparently quite diverse activities in each country suffer similar constraints.

The opportunity studies themselves, plus the sections which precede and follow them constitute the Main Volume of the Terminal Report. It is intended that this Volume would be the base document for UNIDO's purposes, would serve the needs of the general reader, and would be available for participants at a Workshop in-country in 1992. Also contained in this main volume are details of persons and institutions contacted during the course of the study and a bibliography of relevant material.

During the course of the fieldwork large amounts of detailed information was obtained regarding specific products and processes. While the UNIDO 'Yellow Book' suggests that opportunity studies should be based on pre-existing studies of a similar nature, very little relevant material was in fact available to the Consultant in Bangkok or Vientiane. It was therefore found necessary to approach equipment suppliers and manufacturers in, for example, Australia, Europe and India, as well as in Thailand, and from market intelligence and other sources in the UK and elsewhere. The amount of information obtained and its direct relevance vary across opportunities, and quite clearly it would be inappropriate to include this material in the main body of the opportunity studies texts. However, much of this material could be of direct and fundamental interest to potential investors. For this reason, the material is included in a series of Annexes to the Main Volume. The material is taken from a variety of published sources, and is meant to be a collation and summary of relevant information rather than a representation of any new work.

These Annexes are prepared on an opportunity-by-opportunity basis in the form of 'Potential Investment Opportunity Packs (PIOPs)'. The Annexes include all the available supporting material upon which the opportunity study was developed, preceded by the text of the individual opportunity study itself, but with the names of any identified potential investors omitted. The intention is that UNIDO may wish to use this material for promoting the opportunities in discussions in a confidential manner with a range of interested investors. The PIOP Annexes include more detailed papers on marketing aspects where these are available. Annexes are therefore presented in the nature of working papers and technical background material.

As well as these PIOPs, other Annexes contain supporting material for the opportunity studies generally. These include macroeconomic and regional data for Thailand and Lao, the tariff schedule and trade agreements between Thailand and Lao signed in 1991, and details of all the products and processes considered at the start of the project fieldwork. They also include various background papers prepared in the course of the study on the general circumstances of Thai and Lao agroindustrial development (including product marketing), on resource and demand considerations in Northeast Thailand, on demand in Thailand generally, and on the lessons of entrepreneurial experience, plus fruit processing technology and the packaging of fresh fruit and vegetables.

3. The Format for Opportunity Studies

The format for UNIDO opportunity studies is governed by that described in the UNIDO publication ID/206 which has already been mentioned. To the extent possible, the Consultant has followed this format, deviating from it only where data were unavailable, or where repetition (eg of national statistics and economic data) in every study would be inappropriate.

An opportunity study is conducted during the pre-investment phase of the project development cycle. In many developing countries the private business sector is still sufficiently weak for the public sector to need to adopt a role of providing assistance and encouragement to private investors in investment management. Even where the private sector is quite active (eg Thailand), the mere publication of a list of opportunities will not be sufficient to encourage investment, both more detailed study and further public sector action will be required.

In this context, the purpose of an opportunity study is to identify investment opportunities or project ideas which will be subject to further more detailed scrutiny at a later date. The desired outcome of an opportunity study is a quick and inexpensive determination of the salient facts of an investment possibility. As regards specific project opportunity studies, these may be defined as the transformation of project ideas into broad investment propositions in need of further study.

The conduct of an opportunity study should involve, inter alia, the analysis of the natural resource base and agricultural pattern that serve as inputs to agroindustry, the demand for finished products (and national import substitution/export earnings/balance of payments considerations), comparison with similar industries in similarly developed countries, investigation of possibilities for diversification and the realisation of economies of scale, together with an understanding of the general investment climate and policy framework.

The material on which an opportunity study is based is essentially secondary. Data from similar countries, regions, enterprises etc should be used to form the basis of the study, rather than involving the collection of original data (through surveys, studies etc). Consequently, all the data in both this Main Volume and the Annexes derive from the Consultant's earlier work or are gleaned from other sources.

In terms of the range of possible opportunity studies which UNIDO defines, the current project is a mixture of a general area opportunity study and a group of specific project opportunity studies. The general study is an area opportunity study in that it is concerned with opportunities in a specific geographical location (ie the Mekong Basin in Thailand and Lao), but has also involved the preparation of specific project opportunity studies following the identification of, and agreement upon, those products and processes the Consultant would study.

Thus the Consultant's task was, firstly, to build upon the earlier 1987/88 evaluation work and review the opportunities now existing in the Mekong Basin, and secondly, following the Review Meetings in Bangkok and Vientiane, to pursue a set of specific project opportunity studies.

In practical terms, one result of trying to combine the two tasks has been that some specific project opportunities agreed to be investigated in the first stage of fieldwork have been discovered to have major problems connected with them. In the case of the production of MDF from bagasse in Northeast Thailand for example, it has emerged that the current agroindustrial technology is by no means well-developed (the only manufacturer is still very much on his own learning curve).

Notwithstanding this, the opportunity has been written up as fully as possible and outlines the conditions which would be required to make it viable. In this case it has been impossible to stick to the standard format. On the other hand, it is the case that one opportunity (seedlac production) not agreed upon at the end of the first stage has since been included as a specific project study on the basis of subsequent information.

The core of this Main Volume is therefore the eight opportunity studies covered in Part C, Section 11. There are four specific project opportunities for Thailand (MDF, dairying, the production of straw mushrooms, and the development of a model fruit and vegetable canning operation), three for Lao (cashew nut processing, sugar from cane in Savannakhet, and coffee grading in Pakxong), plus the seedlac opportunity which exists (in slightly different form) in both countries.

The financial and economic analysis of each of the projects is summarised in the UNIDO format in a LOTUS 123 (Version 2.2) table at the end of the text. From these tables it is possible to see how the assumptions described in the text are turned into formulae in the spreadsheet.

Before presenting the opportunities themselves it is useful to consider the macroeconomic and agroindustrial environments in both countries.

PART B: THE INVESTMENT ENVIRONMENT

4. Thailand: Summary of Macroeconomic Circumstances

Thailand's recent macroeconomic performance has been impressive by any standards. Recent reports by major institutions such as the World Bank, Asian Development Bank, and major journalistic sources (the 'Economist', Financial Times etc) routinely refer to Thailand as being poised to join the Asian 'Tigers', and thereby acquire the status of Newly Industrialised Countries (NIC).

Recent real Gross National Product (GNP) growth is summarised below:

Year	% Real GNP Growth
1986	2.6
1987	7.7
1988	11.4
1989	10.5
1990	8.5

Source: National Economic and Social Development Board (NESDB)

These growth rates have been achieved despite serious infrastructural problems, decreases in remittances from overseas and a decline in tourism earnings. According to estimates made by NESDB, it is expected that Thailand's per capita GNP will have trebled by the late 1990's (for more detailed information see Annex 10. If these predictions prove accurate, Thailand will have broken away from the pack of other countries (eg, Malaysia, Indonesia) chasing NIC status.

However, the simple macroeconomic indicator of GNP growth masks major structural changes which have been occurring in the Thai economy. Fuelled largely (but by no means entirely) by an influx of foreign investment (from Japan, US and Europe), manufacturing industry has shot past Thailand's agricultural base and now accounts for over a quarter of GNP. Recent real growth rates for the agriculture and manufacturing sectors are shown below.

Year	Agriculture % Real Growth	Manufacturing % Real Growth
1986	0.4	10.8
1987	-0.3	13.3
1988	10.2	16.5
1989	6.7	15.2
1990	-1.8	13.6

Source: National Economic and Social Development Board (NESDB)

Although the relative growth rates of the two subsectors are suggestive of a classical process of structural transformation taking place, in Thailand's case it is arguable that the very rapid pace of manufacturing and industrial growth itself has led to some specific problems which may actually inhibit growth in the future. Emerging inflationary pressures, worsening infrastructural problems (eg Bangkok's traffic and telephones), environmental damage (especially in the forests and on parts of the coastline) and (perhaps most importantly of all) uneven development are all encouraging the Royal Thai Government (RTG) to pursue more 'sustainable' rates of economic growth.

The unevenness of development is perhaps more striking in Thailand than any other large economy; the value of production, wage and savings rates and all social indicators of welfare (eg doctors per thousand of population) all vary greatly by region, with the disparity between Bangkok and the Northeast, in which most of the Mekong Basin is located, being most obvious.

Over 60% of Thai workers are classified as farmers, and they are seeing their relative share of national income decline. It is also arguable that the rapid growth in manufacturing has outpaced the ability of agriculture to keep up with the needs of agroindustry. This will be discussed in more detail below. The Seventh Five Year Plan therefore stresses more cautious economic growth, and places greater emphasis on even and equitable growth; this means creating wealth outside the Bangkok region and the Central Plains, and creating jobs both in industry and agriculture. The plan sets a real growth rate for agriculture of 3% pa.

Exports have been the driving force behind Thailand's rapid expansion, growing at an average of more than 20% pa in the last 4 years, and touching 28% last year. But export growth is now slowing (perhaps to 17% in 1991), with a weaker US economy and other contributory factors. Imports of capital goods and raw materials (including oil) needed by Thai industry are still rising however. This, coupled with an increasing Thai taste for imports and reduction in tourism earnings and remittances means that the balance of trade has steadily been worsening. Import, export and balance of trade figures (in Billions of Baht) for the last few years are shown below.

Year	Exports	Imports	Trade Balance
1986	233	241	-8
1987	299	334	-35
1988	403	513	-110
1989	516	662	-146
1990	589	852	-263

Source: National Economic and Social Development Board (NESDB)

While the balance of payments may be a worrying feature in the short-term, Thailand has large foreign exchange reserves (about 6 months imports coverage) and a relatively modest foreign debt (some US$ 20 billion).

As regards the general investment climate, Thailand remains an attractive proposition. The gradual reduction of import tariffs, financial liberalisation – including the recent abolition of exchange controls – and the RTG's determination to mobilise private capital to help solve some of the worst of the country's infrastructural problems, all suggest that foreign fixed investment will continue to grow.

It must be expected, however, that both foreign and domestic investment will increasingly be 'directed and encouraged' towards hitherto neglected areas. A range of tax breaks and incentives are already in place (implemented by agencies such as the Board of Investment – BoI), and attempts to disperse the industrial base through graduated zoning incentives are also being been pursued. So far, these have had only limited impact, but are likely to be an increasingly important feature of the future investment pattern. In the context of identifying investment opportunities in agroindustry in the Mekong Basin area therefore, the present study is particularly timely in that it addresses the problems of botl uneven development and the need to match the growth in agroindustrial processing to the ability of the agricultural sector to supply raw materials.

5. Thailand: Summary of Agroindustrial Circumstances

Within the framework of Thailand's overall macroeconomic performance just described, the experience of agroindustry has been mixed (see Annex 11). It has been at the interface of a rapidly increasing scale of manufacturing activity and a (relatively) stagnant agricultural sector. Whether a narrow (food, beverages and tobacco) definition or a broad definition (these, plus leather, wood, furniture, rubber and paper) is used, agroindustry has grown at rates less than those for industry generally (probably by about 5 percentage points on average) throughout the last decade. Furthermore, the rates of growth in export-oriented markets have fluctuated tremendously between years.

Agroindustry has its problems in Thailand, just as in other countries. Problems in managing raw material supply from a primarily smallholder base in terms of harvesting/timing, quantity and quality are the most obvious. The scale of these problems in Thailand generally and in the Northeast in particular is large, however. Despite a good road infrastructure, large-scale private sector agricultural extension activities, and contracts between well-managed factories and farmers, supply of produce is by no means guaranteed. The Thai farmer is famous both for his price-responsiveness and a relatively casual approach to contractual arrangements. This can place agroindustrial installations in something of a risky position. One visit by the Study Team to a major canning installation at Si Chiang Mai, for example, gleaned the information that lorries travelled up to 400 km to collect tomatoes, and even then the plant was operating at something less than 50% capacity.

Part of the problem with agroindustry is due to the relatively low level of support given to agriculture by RTG. Largely because Thailand has always both fed itself and exported staple crops (especially rice, cassava), small farmers have been left to their own devices. The mechanisms for the delivery of agricultural produce for export work well, despite a negative effective rate of protection (ERP) for rice and only modest positive rates for most other crops. This 'hands off' approach works less well when encouraging the promotion of non-traditional crops for non-traditional purposes.

Agroindustry in Thailand is also affected by weaknesses in coordination between the various agencies involved in its support, by a lack of information regarding appropriate processing technology, by poor research and development support, by poor support from the packaging industry, and by the need to meet very stringent standards in export markets (this latter is often unrealised by investors until too late). Despite Thailand's apparent sophistication in many areas, access to information is fairly limited. Discussions held with the Study Team at both the Federation of Thai Industry in Bangkok and the Khon Kaen Chamber of Commerce confirmed the impression that the general level of knowledge about food processing was not high (despite some of the work done by the Thai Scientific and Technical Research Institute at Kasetsart). It should be noted that all these problems exist despite no shortage of capital in both the public and private sector to address them.

These problems are compounded by other factors for agroindustries in the Northeast of the country (see Annexes 12, 13 and 20). In general, those entrepreneurs who have gone into agroindustry have done so very much on their own, on a 'copycat/me-too' basis. The result has often been the use of inappropriate technology, the wrong scale of development being attempted (invariably too large), disillusionment with the performance of farmers, and poor quality output which is unsuitable for export.

Despite the historical problems associated with agroindustrial development, the RTG is keen to promote agroindustry. The Sixth National Development Plan (1987-91) placed considerable emphasis on agroindustry as a sector for absorbing resources left unused as a result of the weakening situation of traditional agricultural products – the possible bleak future for cassava highlights this possibility. Agroindustrial activities (and especially installations located in rural areas) are seen by RTG as a way of alleviating such diverse problems as unemployment, regional imbalances and balance of payments problems through both exports and import substitution. Furthermore, small and medium-scale enterprises in rural areas are thought to not only generate employment, but also to encourage price stability, a greater range of crops to be grown and thus reduce the seasonality of farmers' incomes. In addition such enterprises should raise farmers' productivity, and raise the level of value-added in the country in general and in rural areas in particular. In general they should provide more links between agriculture and industry and strengthen the base of the rural economy. The Seventh Five Year Plan emphasises labour-intense modes of production where economically viable. The plan also formally introduces the 4-party approach to rural and agricultural development, whereby the private sector is to play the role of implementor/manager with RTG acting as facilitator.

Agroindustry is in a very positive situation regarding the future demand for its products. Apart from pineapples, frozen shrimp and canned tuna, Thailand produces only a fraction of the world's imports of processed foods and so the scope for the export of any graded quality food product must be large, especially for the growing markets of east Asia. The demand for banana, mango and papaya products in these markets is growing at over 10% pa for example. On the domestic market, the income elasticity of demand for nearly all processed food products is positive, if not greater than unity in most cases. Overall, the analysis suggests that agroindustry should have a rosy future, if some of the lessons of the past can be learnt.

Many of the hardest lessons concerning agroindustry have been learnt in the Northeast region. Investments have frequently been characterised by all the problems listed above, and have been compounded by distance to markets for finished products (Bangkok or further), a lack of trained staff to work in factories, difficulties in retaining management in rural areas, and (often) a poor resource base on which farmers are encouraged to move away from traditional crops.

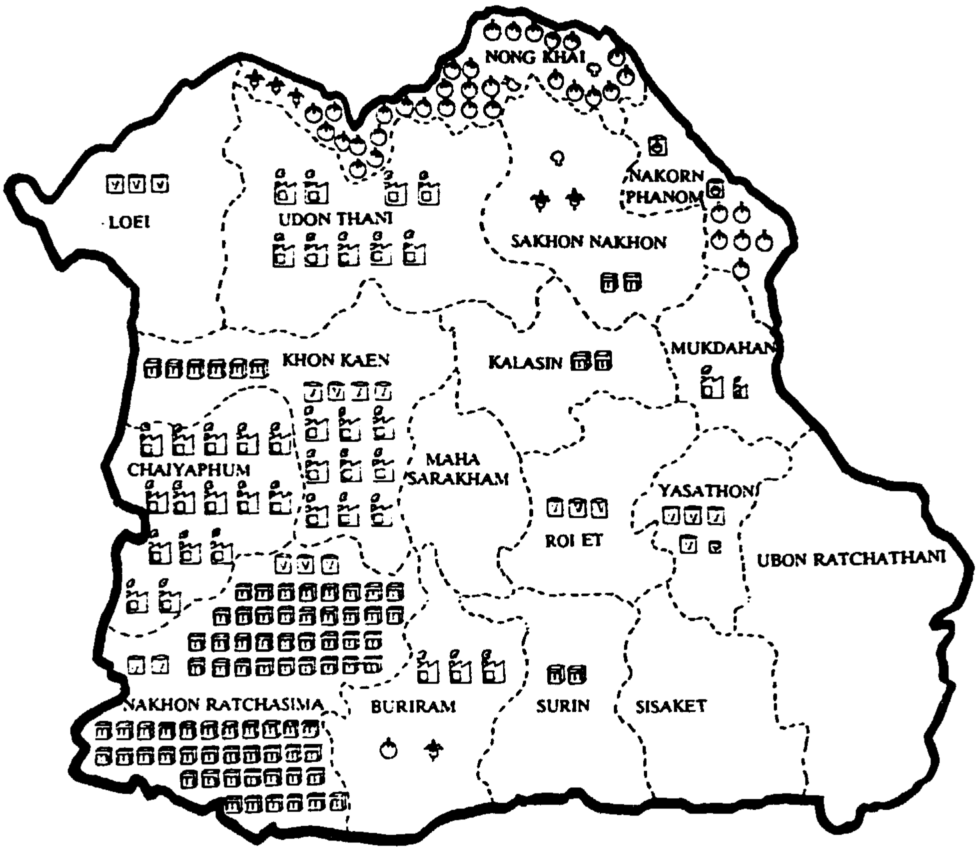
The situation of Universe Foods in Roi Et Changwat is a case in point; originally established as a multipurpose cannery, the only crop it could ever buy was tomatoes, and not sufficient of these to warrant its staying open. Furthermore, the factory, in asking farmers to grow dry season crops, was competing with the traditional migration patterns of farmers – the only produce it managed to buy was from women whose husbands had migrated after the rice harvest. Much of the produce came from very dry areas (eg Tung Kula Ronghai), and the resultant low yields and poor quality depressed the farmers' projected earnings.

The difficulties in establishing agroindustries appear to increase with the distance from Bangkok and with the proximity to the Mekong River. The map overleaf shows the extent of fruit and vegetable processing, dairying and the location of sugar mills (all in terms of installed capacity) on a Changwat basis throughout the Northeast. It can be seen that the southern and easternmost Changwats have almost no processing facilities for these industries.

Overall, it appears that there is an increasing understanding within the public sector of the potential for agroindustry in Thailand, and it must also be assumed that the private sector (at least as far as the Northeast is concerned) is learning by experience.

FIGURE: LOCATION AND CAPACITY OF CANNED FRUIT AND VEGETABLE, MILK INDUSTRIES AND SUGAR MILLS.

NORTHEASTERN THAILAND 1991



LEGEND

- : = 1 TON/MILK OF MILK
- : = 10,000 TON/YEAR OF CANNED TOMATO
- : = 1,000 TON/YEAR OF CANNED FRUIT AND VEGETABLE
- : = 1,000 TON/YEAR OF CANNED STRAW MUSHROOMS
- : = 1,000 TON/YEAR OF CANNED MANGO
- : = 1,000 TON/YEAR OF BABY CORN
- : = 10,000 TON/YEAR OF CONDENSED TOMATO JUICE
- : = 1,000 TON/DAY OF SUGAR MILLS

Sources 1. For sugar mills, office of cane and sugar board

2. All others, Small-scale industry development project

PROJECT: OPPORTUNITY STUDIES: AGRO-INDUSTRY (UNIDO PROJECT NO. US/RAS/90/039)

6. Lao: Summary of Macroeconomic Circumstances

It is hard to imagine a greater contrast between two economies of neighbouring countries than that between Thailand and Lao. The Thai economy is characterised by its dynamism, diversity and private sector activity. By contrast, Lao is emerging from decades of state control, is still dominated by subsistence agriculture and has a very low rate of growth (see Annex XXX). Lao also suffers from landlockedness, has only a very small population (around 4 million) and fragmented internal market, and is obviously a 'late developer' even by southeast Asian standards. Most of the things it might produce either for internal consumption or export are already being produced by Thailand, and most of its exports leave via one form or other of the Thai infrastructure.

When the Communist Party of the Lao PDR (the Pathet Lao) came to power in 1975 they embarked on a closed economic policy. The result was more than 10 years of stagnation until a policy reversal in the mid-1980s took place. This policy reversal was the announcement of the introduction of the New Economic Mechanism (NEM), and has largely guided the development of the Lao economy in the last few years through a set of further announcements and decrees.

Prior to the NEM the state controlled all aspects of the economy through both the formal public sector Government of Lao (GOL) Ministries and also through hundreds of state owned enterprises (SOE). This resulted in very low levels of growth across the economy generally. At this point it should be mentioned that measuring growth, or any other economic indicator in Lao is fraught with difficulties. Not only are statistics at the macroeconomic level somewhat doubtful, analysis of profitability at the enterprise level is virtually impossible. At the macroeceonomic level prior to the Second Five Year Plan (1986-90) national accounts were based on the Material Produce System (MPS) and excluded items such as depreciation and services; all estimates have now had to be reworked as far as possible along the UN System of National Accounts (SNA). Furthermore, because of the lack of internal accounting at the enterprise level – one state owned enterprise receives inputs 'cost free' from another and is directed to produce outputs for use or disposal elsewhere – almost no records of operating costs or profitability, value-added or employment were kept; thus it is almost impossible to measure real costs of production of most items.

It is generally accepted within Lao that the state involvement in the economy has not worked, largely due to the poor management performance of the SOEs. According to the General Secretary and Prime Minister Phomvihane (1986)

> '. . . the organizational and managerial standard of state enterprises is still very low. A correct economic accounting would show that almost all of our state enterprises, especially those in the production branches, are in a situation of financial deficit.'

The performance of the SOEs was largely responsible for the low rates of growth achieved in the First and Second Five Year Plan periods. The annual growth rates, planned and actual, for the Second Five Year Plan are compared with expectations for the (indicative rather than controlled) Third Plan period below.

	2nd 5YP		3rd 5YP
	Plan	Actual	Planned
Agriculture	9.8	3.4	5.7
Industry	13.6	7.7	9.6
Transport	11.3	15.2	11.1
Construction	12.6	8.6	11.1
Commerce	7.7	6.5	6.1
Services	-	7.1	7.8
Lao Economy	10.4	5.06	6.9

Source: Consultants' findings

Since the introduction of the NEM in 1986 a number of features of the Lao economy are discernible. Within agriculture, droughts in 1987 and 1988 make the picture complicated, but it appears that in subsequent years the production of paddy has risen markedly. The growing service sector has absorbed many of the 20% of the civil service who were made redundant. The value of the Kip has been allowed to find its own level, GOL monetary policy has been prudent, and the ability of the GOL to mobilise tax revenues has increased. Actual annual growth rates of real GNP have been estimated for the period as follows:

Actual Annual Growth Rates of Real GNP

Year	Real GNP Growth (%)
87	-5.9
88	2.4
89	8.9
90	8.4

Source: Consultants' findings

On the negative side, however, macroeconomic imbalances have persisted with the current account deficit increasing, an expansion of the budget deficit, the rate of inflation has increased, and savings have only risen very marginally in response to financial deregulation.

Although it is certainly the case that the GOL are pursuing a rapid implementation of the reform programme and are seeking both credibility and sustainability for the programme in an attempt to reduce uncertainty, there is little doubt that this implementation has come up against major rigidities and bottlenecks within the economy. The effects of these bottlenecks manifest themselves in the continuing preponderance of imports over exports, and the resultant accumulation of external debt, and the payment of interest and principal amounts of foreign debt by foreign exchange transfers for development projects. It is hopefully the case that the accumulation of this debt at least partly reflects the imports of capital equipment which will be used to build up (especially resource-based) industries in the future.

Despite these problems, the outlook for the Lao economy looks brighter than for many years. The investment climate has improved markedly since the promulgation of the Foreign Investment Law in 1989, with its associated procedures and tax implications for investing through the various (three) approved forms. The GOL has also allowed privatisation through acquisition of SOEs by domestic and foreign investors, in a general ideology of 'perestroika'. These reforms are receiving support from a number of multilateral and bilateral agencies through a range of projects (UN foreign investment project, World Bank credit line etc), currently being implemented. Overseas conferences, publicity in journal articles and travels by Lao Ministers are all helping to spread the knowledge of these changes.

These reforms are undoubtedly attracting some foreign investors, as the following data for the period September 1988 to March 1991 show:

Approved Foreign Investment, by Type

Type	Number	($m) Proposed value
Contract	11	23.9
Joint ventures	63	43.5
Foreign-owned	42	90.1
Total	116	157.5

Source: Consultants' findings

Despite these improvements, doubts about the current process remain, both from an investor's and from the GOL points of view. On the investor's side (and largely because of the novelty of the process) some features of the New Economic Mechanism and investing under it are unclear; for example, the concept of limited liability does not appear to exist under domestic enterprise law, and no new legislation nor case law yet exists to clarify the situation. Similarly, most 'privatisation' to date has involved the second best solution of rental agreements rather than outright sale and transfer of ownership. On the GOL side, the logic of offering SOEs for privatisation must imply that the most efficient (or potentially efficient) SOEs will be sold off, leaving GOL to deal with the lame ducks and continuing losses.

7. Lao: Summary of Agroindustrial Circumstances

Lao agroindustrial circumstances are set within the context of the macroeconomy just described (see Annex 17). All the problems regarding the quality of management, record-keeping, quality of output, etc apply to SOEs in agroindustry just as much, if not more, as to other sectors. Agroindustry is conspicuous by its absence from the list of approved foreign investments which have gone ahead.

The agroindustrial subsector as a whole is therefore extremely undeveloped; the only non-wood agri-based manufactured products being produced are animal feed, edible oil, noodles, roasted coffee, beer, cigarettes and soft drinks. (This of course excludes rice milling, basic primary processing such as tanning, and other cottage industries). No sugar cane is presently being milled, though the new Pak Sap mini mill should begin operations early in 1992. Processing and production of these items for both domestic consumption and for export has to compete with products from elsewhere. Primarily, this means Thailand for the widest range of goods, but Vietnam and China also produce many items (eg sugar, cigarettes) for which there is a strong demand in Lao.

Production in volume terms of many agroindustrial commodities fluctuates wildly year to year, as the very basic example of animal feed shows.

Year	85	86	87	88	89	90
Animal feed ('000 ton)	3.7	5.6	6.8	1.9	3.8	2.5

Source: Consultants' findings

Lao agroindustry suffers from a very poor physical infrastructure for moving agricultural produce or finished commodities around the country, has to deal with an undeveloped service sector (for banking, insurance, communications etc), suffers from a lack of both human/technical and financial resources, and has to overcome a sense of dependence and lack of confidence when dealing with potential foreign investors. This last point has meant that most agroindustrial installations within Lao have been installed by foreign governments with Lao acquiescence, but without much Lao enthusiasm or participation.

Despite the current problems, the potential for agroindustry in Lao is bright, just as it is for the rest of the economy. Lao is rich in agricultural resources (land, water, forest reserves etc), and its farmers have a tradition of hard work and responsiveness to the right circumstances similar to their neighbours in Isarn. (Indeed, it is arguable that Lao today is not much different to Isarn 40 years ago). These primary resources are found within a range of climatic zones, producing a range of crops suitable for agroindustrial processing, ranging from coffee on the Bolovens Plateau to horticultural produce in the north of the country (Luang Prabang, Plain of Jars etc). Parts of the country (and the south in particular) are well-placed for trade within the region, and any reasonable (in terms of quality and price) agroindustrial products should have ready access to markets.

As a starting point for agroindustrial developments, it should be noted that many of the most costly parts of investment in poultry, swine farms, dairy operations, feed milling, sugar refining and other agroindustrial ventures are already in place – usually as a result of the foreign assistance referred to above. Although some would undoubtedly require replacement, much of this capacity could be refurbished. Lao agroindustry also has a major human resource in the thousands of its people who have studied agriculture and business in Australia, the US, Europe and Cuba, and who are now to be found working in the service sectors in urban areas. In the right circumstances these specific skills could be mobilised.

8. Thailand – Lao: Trade and Investment Relations

Trade and investment relations between Thailand and Lao are important in affecting agroindustrial development in both countries (though necessarily more so for smaller Lao) for many reasons. As regards trade between the two countries, for example, tariff rates on Lao goods going into Thailand largely determine the extent of Lao's export market for those goods it can produce, and, conversely, tariff rates on Thai goods going into Lao help determine the extent of protection which is given to the relatively small Lao industrial sector. Further, many Lao exports to third countries are exported via Bangkok or other Thai ports and must therefore travel through Thailand.

Official Thai exports to Lao mainly comprise motorcycles, fans and other electrical goods, and chemical products, although wheat products, milk and cream, cane sugar and rice also figure prominently in the statistics. Unofficially, the importation of food and consumer items across the highly permeable border is on a very large scale, and this is tacitly allowed by both governments. This has a direct effect on Lao agroindustry.

The case of cane sugar is a case in point. In order for a Lao sugar industry to compete with the imported (either officially or unofficially) Thai product it must either

- produce at a lower than border price (unlikely in view of the efficiency of the Thai sugar industry), or
- produce sugar of a different/lower quality and aim for different market by selling at a lower price, or
- ask the GOL to impose a tariff on imports of sugar, and adequately police the Mekong border.

This situation applies to most Lao agroindustries not based on direct resource extraction, where it is usually the case that the Thai producers are already reaping such economies of scale in producing for the Thai domestic market and/or export that it is very difficult for the Lao to compete.

On the other hand, some measure of support to the development of agroindustry in Lao is now being given by Thailand in the form of preferential tariff rates for the importation of goods originating in Lao. The 1991 Trade Agreement between Thailand and Lao abolished or reduced tariffs on a range of (mainly agricultural) products, including garlic, cashew, cardamons and coffee (see Annex 18). This was introduced at the request of Lao, and there is hope that the relatively small range of items will be extended in the future. It is also the case that Thailand in general turns a blind eye to the use of Lao produce for processing in Isarn. Several factories near the Mekong River in Thailand claim to access Lao agricultural produce, and the Thai authorities have so far made little attempt to restrict this development.

As regards the export of Lao produce via Thailand, it used to be the case that all exports were required to travel by the Express Transport Organization (ETO) – a state-owned enterprise run by the Ministry of Communications. Lao exports were subject to delays, high transaction costs and uncertainty of delivery. Transport costs used to be nearly three time those for Thai goods on a similar routing. Since 1991, however, the RTG lifted this requirement, and now private transporters are operating, most notably a Thai-Lao joint venture called 'T.L. Enterprises'.

In some measure as regards trade it therefore appears that Lao's situation is improving, although it is still necessarily greatly disadvantaged vis-a-vis Thailand by both its size and location.

Investment in each other's economy is largely one-way traffic, with Thai investors being keen to exploit Lao's natural resources. Of all formally-approved investments in Lao in the last two and a half years the largest outside the transport sector have been in petroleum and mining. In the same period, Thailand made the greatest number of formal investments in Lao (57 approvals), worth a total of $34.1 million. This was the largest value of investments with the exception of those made by the USA.

The fact remains, however, that most Thai investment is essentially short-term and based on the extraction of natural resources notably timber, but also minerals. Investments in costly, complicated and long-term agroindustrial ventures seem a long way off. The situation may be changing somewhat, however, because of two factors. First is the present ban on logging announced this year, in order for the GOL to take stock of the situation and conduct a forest inventory of the country. Second is simply the increasing believability of the GOL's intentions, manifest through increasing numbers of reforms in the banking and monetary systems. Also, the differential tax rates applied to investments in different sectors should encourage investments in agriculture and processing and away from house construction, services and forestry.

PART C: THE OPPORTUNITY STUDIES

9. The Screening of Opportunities: Methodology

It has already been mentioned that the first part of the current project involved the review of those areas of opportunity identified during the 1987/88 evaluation study. The Consultant's first task was therefore to re-examine those and other areas with a view to establishing appropriate products and processes for further analysis.

The screening methodology adopted was based on the Consultant's experience with a similar exercise in Indonesia, and involved a three stage process. This process comprised (firstly) an inventory of natural resource endowments, in combination (secondly) with an assessment of human, technical and financial resources in each country in the determination of which products and processes might (thirdly) be expected ultimately to be able to achieve a competitive advantage in domestic or export markets.

Thus, with reference to specific opportunities, the process was as follows

- identification of natural factors of endowment
- technical and economic examination of possibilities to make use of those factors
- subjection of the most hopeful opportunities to further more detailed study.

The first two stages were completed at the time of the two Review meetings in Bangkok and Vientiane, the last stage is essentially the current work on the identified opportunities, plus any further work which is done subsequently (ie feasibility studies etc) in the project pre-investment phase.

The full range of projects suggested to and considered by the Consultant prior to the selection of the opportunities identified in this Report are listed in Annex 23. It is necessary at this point, however, to make some comments on the reasons for the omission of opportunities identified in the 1987/88 work. In the case of cassava processing it was felt that there was adequate installed capacity in Thailand for starch production in relation to supplies; that there were doubts about long-term EC policy towards the Tapioca Agreement, and that the technology for the production of modified starches (while theoretically available) was likely to remain confidential, and that the technology for fermentation products (ethanol etc) was still experimental.

As regards the production of edible oils, it was argued that rice bran was being almost fully utilised already, to the extent possible, and limited by collection constraints, and that the production of soya bean etc was unlikely to rise much in the future. Already, Thailand is importing vegetable proteins, and, although cotton was considered as a source of oil, it was argued that the production constraints would be such that agroindustries would not be likely to be able to overcome them.

Similar arguments were advanced for the original areas of opportunity identified for Lao, and in the absence of data it was decided to attempt opportunity studies for products about which reasonable data could be found. In practical terms for Lao, this meant the inclusion of the production of sugar from cane (which had been identified in the earlier work), as well as the improvement of coffee grading and packaging in Pakxong and cashew nut processing near Vientiane (neither identified in the original work).

10. Data Considerations

Before proceeding with the opportunity studies themselves some comment on the nature of the data on which they are based is appropriate.

Firstly, the Consultant had substantial difficulty in getting reliable technical and cost data from private sector enterprises in Thailand. The private sector in the areas of opportunity which were studied are most reluctant (unsurprisingly) to divulge information about their processes and costs. This was most marked in the case of MDF; the only producer of MDF from bagasse in Thailand (Khon Kaen Wood) had developed his own methodology over a period of several years by adapting equipment designed for other purposes. He was most reluctant to discuss the process or to consider its replicability at other sugar mills in Northeast Thailand under anything except some form of licensing arrangement. Even with the assistance of the regional Ministry of Industry office no information could be gleaned, beyond the names of some of the equipment suppliers. Similarly, in the case of most fruit and vegetable processing installations, it is the case that individual entrepreneurs have put together combinations of machinery on an ad hoc basis, and little in the way of 'turnkey' projects exist. Also, and surprisingly for a country of Thailand's apparent sophistication, little in the way of manufacturing equipment information was available in-country. Most manufacturers eventually contacted had regional representation in Singapore, rather than Bangkok, or were found in Europe or Australia.

Any reference to specific producers does not imply endorsement of products by either consultants or United Nations Industrial Development Organization.

The data situation was not helped by a paucity of information available at the MoI in Thailand. Statistics on industrial installations are collected primarily on a provincial basis, and little aggregation appears to be done in Bangkok. The production of the map showing fruit and vegetable, dairying and sugar installations in Isarn in Part B, for example, was compiled by the Consultant due to the absence of such collated data in Bangkok.

In Lao the problems were more severe, but for different reasons. Whilst GOL officials were unfailingly helpful, almost no data exists about operating costs of state enterprises due to the particular planning process which has been followed in Lao for many years. The Consultant's repeated visits to both GOL offices and agroindustrial plants yielded very little in the way of hard information. This is a well-documented phenomena in many reports concerning Lao.

The result of the above situation is that recourse has been made to equipment and other suppliers, and efforts made to draw on experience trom other countries. It is felt that this situation, whilst not typical of most opportunity studies, has merit in that much material should be available for potential investors and should facilitate any further investment work.

Part D: Learning from Success, and The Way Ahead

This section of the Main Report considers the implications of recent experience in the investment environment in agroindustry in the Mekong Basin, and discuses what lessons this offers for future investment success. It draws heavily on the experience of fruit and vegetable investment in Chiang Mai. It then considers how best to take the work of the current project forward, given these circumstances.

The Lessons of Experience

Private investment is not always 'planned'; intuition, status and opportunism often play a part. As a result, the success rate - even amongst the more systematic investors - is not high, with failures probably outnumbering successes (though it is only the latter that get publicity), and both are outnumbered by enterprises that survive but make only a modest profit.

In the case of agroindustry the success rate of most enterprises is probably below average because of the above- average supply side risks, the false assumption that value-added processing is intrinsically profitable, the above-average element of status seeking (local boy returns to his roots to demonstrate his entrepreneurial success), and pressures on local businessman by the local community to keep ex-farm profits in the locale.

These and other less than rational behaviour patterns can not be legislated against(indeed their existence is proof of a vibrant economy) but - through the means of an opportunity study - ways can be found to direct would-be investors towards the better options, and to alert them as to the nature and extent of the risks involved. The opportunity study approach also gives the potential local investor valuable data and analysis to, hopefully, better excite the interest of a possible venture 'external' investor.

In the case of Thailand, agroindustry is but one of many investment opportunities and, despite the generally positive short and long term market prospects, value added agricultural product processing does not attract keen interest. As such, there is a high incidence of irrational investment. This is most obvious in the 'me-too' spate of fruit and vegetable processing plants in Isarn.

In the case of Laos the overall lack of any significant industrial sector per se, plus the pre-occupation with short term returns on investment leaves agroindustry very much on the sidelines, especially as there are apparently much more attractive long term investment opportunities outside agriculture - forestry and mining for example. In addition, most private investment is externally sourced (albeit a significant proportion originating with individuals having Lao connections). The result is that personally motivated local investment is limited, and naturally focuses upon urban not rural enterprises.

The Chiang Mai Food Complex

As an example of the pitfalls inherent in agroindustrial investment, and the lessons which can be learnt from them, the Chiang Mai Food Complex provides a good case study.

From the initial feasibility studies in 1972 through five years of operation to its winding up in 1978 the Chiang Mai Food Complex experienced a series of setbacks. Their implications, viewed with the advantage of hindsight, are worthy of careful consideration by would-be investors.

Principal causal factors contributing to problems were

- inadequate and misleading feasibility studies on both the macro and micro levels.
- an uneven supply of raw material deficient in both quantity and quality
- technical difficulties with most of the varieties of fruit and vegetables grown;the result of inadequate research
- land inferior in fertility and lacking sufficient water
- inexperienced extension workers with low motivation
- cumbersome administrative procedures
- suspicion of the company's motives and methods by suppliers
- inexperienced, and, possibly, self seeking promoters
- lack of skilled, experienced, easily, available factory workers
- Thai management staff too theoretical
- remoteness and lack of total awareness on the part of foreign managers
- conflicts and delays over the provision and quantity of working capital.

Although many of the problems described have a subjective element there is little doubt that this is especially so in the canning and freezing industries, which require a great deal of initial capital and where it is tempting to build a larger plant than current suppliers can support in order to benefit from economies of scale. The result is that the high break-even points are rarely reached and the diseconomies become very significant. Consequently initial investigations, in detail, become vital, and subsequent plans for the acquisition of raw materials become essential. A major defect in the initial feasibility studies was that, not only were they too general on the technical aspects but that they tended to ignore, almost completely, the social structures and attitudes of suppliers and factory workers.

Other lessons from the Chiang Mai experience include the fact that canning factories established for the first time in traditional rural areas need to build up operations gradually, so that they can expand to meet supplies as they, grow rather than expecting raw materials to suddenly appear in the right quantity and quality. The relative success of tobacco factories, which although their process are simple, can in some measure be related to a slow modular build up. At the same time such an approach enables managers to observe the key elements in their environment, become sensitive to them and allows them time to correct their mistake before they become too large.

Similarly, a processing complex needs to be aware of its alien aspects, which are likely to be considerably more in evidence in under developed traditional rural areas than they would be in more sophisticated metropolitan environments such as Bangkok. For example, a system of written contracts and operational specifications were shown to be virtually worthless in dealing with farmer-suppliers in the Chiang Mai area.

Again, a Western-type factory system per se is not easy for rural people to relate to. It tends to run counter to traditional approaches to work with its machine-paced systems, monetary incentives, and factory discipline. Agricultural work tends to give even labourers an important autonomy in the way in which they do their jobs and to an extent the individual makes his own decisions about methods, rest pauses, work pace and so on. A factory takes much of this away.

Money and the prospect of employment does not necessarily buy people who may well have equally important, to them at least, priorities. Even when the need for reorganisation to improve the company's profitability became obvious at Chiang Mai the emphasis was still placed on structures and money which, although important, still need cooperative attitudes from suppliers.

Such undertakings need managers who are competent in more than the traditional techniques of factory operation. A realisation that what succeeds elsewhere will not necessarily bear fruit in Thailand is very necessary.

More Government involvement on a continuous basis would contribute a great deal to the success of new undertakings - not only in tax concessions and subsidies but in terms of low profile help with the development of the whole infrastructure of agents, fertilizers, seeds and particularly farmer confidence, so that this burden does not rest entirely on entirely on the company.

In addition to the production problems just described, a further level of difficulty and constraint has often been self-imposed by processors leading to manufacturing and marketing problems. Due to lack of technical expertise or inadequate capital, some new processing operations have been established using old or low grade technology resulting in low productivity and poor quality finished products which have difficulty finding a profitable outlet in the market place. All of these have combined to make agro-industrial investment, and fruit and vegetable processing in particular, a highly risky venture.

A new approach to investment in the fruit and vegetable canning industry needs to be undertaken. But there are no easy answers and the single most important ingredient for success lies in entrepreneurial competence in the total range of activities from production through processing to marketing. There needs to be a unique combination of technical and business expertise and a high degree of integrity in securing producer confidence and loyalty. And overall, the processor needs to establish direct contractual relationships with farmers without the interference of disinterested middlemen. From one example, some of the ingredients for success can be identified, as exemplified by a very successful fruit and vegetable canning operation which was established three years ago in Yasothon. This is an entirely Thai-owned operation but with a Taiwanese manager with twenty-one years experience in the industry in Thailand. Initial production was based on tomatoes, mangoes, baby corn and straw mushrooms and after three years the company is beginning to make a profit and is looking for new opportunities to expand into another operation. The secret of success is quite simple when taken in logical steps.

Yasothon was not selected for any particular reason except the absence of other processing operations in the area to compete for supplies of raw materials. It was completely virgin territory but the downside of this situation was that only small quantities of fruit and vegetables were being produced at a subsistence level – there was no tradition of producing crops for sale. After deciding to establish the factory, the company arranged a large number of meetings in local villages with farmers to explain what was wanted and what the company would provide in the way of support and prices. As a result a number of farmers registered their interest and signed up.

Raw material production and processing steadily increased, farmers were paid on time and after three years the company now has thirteen extension officers who provide farmers with seed and technical support. Collecting depots are sited strategically for each crop during the harvest period where raw materials are weighed and checked for quality. A bond of trust has been established between the processor and the farmers and the major problem now is to restrain farmers from trying to grow too much and getting into difficulties with quality control and harvesting. Over 1,000 farmers are now signed up on direct contracts, there are no middlemen, and new farmers are joining on a regular basis.

However, it has to be admitted that there are still problems with some farmers who are unreliable but they are in a minority. There is also a relatively low 'conversion rate' among traditional rice farmers and the company has to travel up to 250km for supplies, although 60% is obtained from with an 150km radius.

But none of this would have been possible if the company management had not worked equally hard in the area of product marketing. This had to be developed from nothing by gradually building up contacts with Bangkok based export houses and Taiwanese importers. The quantities of each product are not large by world standards and the company is able to fill gaps in the market place left by larger operations. The company is therefore able to manage the crucial match between fluctuating supply and demand so essential for the success of an agro-industrial enterprise.

After due consideration of these many complex factors, the Consultant is of the opinion that a number of new fruit and vegetable canning units can be located in Isarn subject to the suitability of land and rainfall, an adequate density of small farmers and the absence of competition. In other words, the opportunity is not location-specific but the following conditions are considered to be essential for success.

The Criteria for Success

These are, adequate finance to both establish the factory and buffer the low production cash flow during the first three years of operation until sufficient raw material is available to generate profitable operation, an ability to gain farmers' trust and provide an efficient extension service to supply planting material and technical inputs, an ability to organise collection and quality control of raw materials, the presence of sufficient technical expertise and finance to establish high-technology processing facilities in order to maximise productivity and finished product quality (it is just as expensive to produce finished products with a poor colour, flavour and presentation as it is to produce the best, but only the latter will enjoy strong market demand and secure the highest prices), an understanding of the market place and an ability to establish good trading relationships with traders to enable a good balance to be achieved between the supply of raw materials and the sale of finished products.

Isarn now offers many opportunities to enterprising entrepreneurs, with plenty of land and ample low cost labour relative to other areas in Thailand. For example, labour costs are in the region of at 100 – 200 per day in the central plains but the official rate in Isarn is only at 83 per day. In practice because many overseas workers have returned home following the Gulf War, actual rates can be as low as Rt 50 per day (as at November 1991). All that is needed is an intelligent and logical plan of development and the acquisition of expertise or the ability to develop know-how in the areas listed above. Agroindustry is not the easiest path to riches and is not for amateurs as the learning curve is generally too long and expensive.

Finally it should be mentioned that the foregoing opportunity exists equally well in

Lao as in Thailand, which has lower labour costs and abundant good land and rainfall. The major constraint could be shortage of labour and as a consequence both the location and crops will have to be carefully selected to take this into account. One entrepreneur has already been identified who is investigating the possibility of setting up a canning operation in southern Lao.

The Way Ahead

This Volume of the Report has identified various possible investment opportunities for the Mekong Basin. In addition, various Annexes have proposed specific Technical Assistance inputs (eg for packaging support) or policy changes (eg in Thai-Lao Trade relations) for assisting in the further development of these possibilities. Central to the carrying forward of any of these proposals is a clear understanding of their implications on the part of the public sector and sufficient interest and commitment on the part of the private sector in both countries. For this reasons it is suggested most strongly by the Consultant that in order to proceeded meaningfully to further stages a Workshop should be held to discuss the investment possibilities in as well-structured a format as possible.

Bearing in mind the nature of the Final Report Material, the participation of public sector staff from two countries plus private individuals, it is suggested that the Workshop take the form of short presentations of the opportunities by the Consultant's staff, followed by general discussion of each opportunity, and then working groups at a later time to discuss individual opportunities. The presentation of opportunities would include slides taken during fieldwork. It is suggested that each presentation might take 10-15 minutes, followed by 30 minutes for general discussion. Thus it would be feasible to conduct the Workshop over two days, with four presentations each morning, and working group sessions each afternoon. Each evening would be available for informal contact, and particularly for private entrepreneurs to ask questions of UNIDO staff, the Consultant's staff or RTG/GOL officials; as a result of this, UNIDO should be able to gauge the extent of private sector interest in each of the various opportunities, and minimise the time between the current work and future studies and/or investment.

Various locations suggest themselves for the Workshop. On the basis that it is best to encourage the exchange of views and contacts between Thailand and Lao it is suggested that all opportunities be discussed by participants from both countries together, though it is recognised that some opportunities will be of more interest than others to particular individuals. For simple logistical reasons it would be best to hold the Workshop either in Bangkok or in Khon Kaen. Chiang Mai is also easy as regards flights and communications, but has the disadvantage that it is not in the study area.

POTENTIAL INVESTMENT OPPORTUNITY - I

DAIRYING IN CHIANG RAI

Introduction

This opportunity study concerns the production of processed milk at a newly-established dairy farm near Chiang Rai in Northern Thailand.

Market, and Demand for Product

The major demand for processed milk is in the Bangkok area, but there are signs of a gradual increase in demand in regional towns and rural areas. While much of this demand is based on sweetened and flavoured milks, school milk programmes and advertising are awakening the population in general to the benefits to be derived from natural milk for improved health and nutrition.

It is currently estimated that the Thai milk production industry is only geared to supply some 30% of the demand for fresh milk. This is in an environment where demand is likely to increase by 10% – 15% annually, due mainly to changing food habits. For details of the level of current demand, projections of future trends and estimates of the proportion of demand met by local production see the market paper contained in Annex I.

Pasteurised rather than UHT milk has been selected as an opportunity for investment as it is more suitable for the small scale of operation in terms of capital and operating costs, plus the technical skills needed for operation and maintenance. Both processing and packaging costs are also lower than for UHT milk.

The product would be full-cream homogenised pasteurised milk, which has a better flavour than UHT milk and is nutritionally superior. It would be packed in both 0.5 and 1.0 litre plastic bottles (to be bought-in), and 250/1,000cc sachets. This would provide the widest retail and catering market opportunities.

The new international airport currently being completed north of Chaing Rai is expected to boost local development, and a rapid increase in the number of tourists visiting the area is expected. Based on current and estimated future demand for fresh pasteurised milk in the district, combined with the possibility of capturing some of the existing market in Chiang Mai and the replacement of some of the current UHT market, it is suggested that there is an opportunity to establish a modest milk processing facility at the Mae Chan dairy farm.

The processing plant would be designed initially to process 3 – 4 tonnes of milk daily, and represents a very real business opportunity with guaranteed supplies of high quality raw material to satisfy a growing local market. There is also potential for sales out of the district to other areas in Thailand and eventually, via the new airport, to overseas markets such as Singapore.

Supply of Raw Material Input

While milk processing is well established in Thailand, based largely on the present recombination of imported milk powder, there is a steady increase in the supply of fresh milk for the manufacture of both pasteurised and UHT milks.
Up to 30,000 litres of fresh milk are expected to be available from the Mae Chan farm each day, and it is suggested that the new processing operation should be located close enough to the milking parlours to enable milk to be pumped or simply tankered for processing. This will guarantee a very high quality raw material each day at minimal delivery costs.

Other materials such as detergents and packaging will need to be delivered on a regular basis from suppliers in Bangkok. They are currently being supplied to processing operations in the adjacent city of Chiang Mai and will not present any supply problems other than relatively high delivery costs.

Potable water and electricity will already be available on the dairy farm and the proposed packaged processing plant will only require connecting to these services to be operational. There is no independent steam boiler requiring fuel. Effluent disposal will be handled by the same settling tanks and lagoons being established for the dairy farm. There are therefore no environmental implications for the proposed development.

Approximate Location and Site

The Consultant has studied the milk production, processing and marketing situation both in Thailand as a whole and within the project areas of Northern and Northeast Thailand (the Mekong Basin). A detailed evaluation has been made of the published data, and discussions were held with relevant RTG ministries and institutions, and with several private companies and industrial sources. Field visits were made to the several areas to gain first-hand knowledge of the local problems and potential for development.

As a result of these investigations, it was concluded that no potential investment opportunities presented themselves for Isarn, as the existing small milk processing facilities at Khon Kaen, Sakhon Nakhon and Surin, combined with supplies of UHT milk delivered from Bangkok and Khorat, appear to be adequate to meet the current and near future level of demand. In fact, most of the fresh milk produced in the Khon Kaen and Sakhon Nakhon areas is delivered raw to Khorat and Bangkok for processing, as local demand is very low.

However, for the Chiang Rai district in Northern Thailand the situation is very different in that, firstly, a steadily increasing local demand for fresh milk is only satisfied by a small Thai-Danish cooperative plant at Pa Tan; this is some 52 kms from Chiang Rai and produces an average of only 600 litres per day of pasteurised milk. All other pasteurised milk is delivered daily from processing plants in Chiang Mai and a range of UHT milks come in from the same plants and as far away as Bangkok. Secondly, a new 2,000 head dairy herd is being established by a Bangkok-based businessman at Mae Chan, some 30 kms north of Chaing Rai; this is expected to be in production by the second half of 1992. It is planned that early production will be tankered to Bangkok and other areas for processing.

With professional expatriate management and the current very successful trial plantings of fodder crops (such as a high-protein Napier Grass) production is expected to be in the region of 30,000 litres per day of fresh milk.

While the new processing operation could be located anywhere in the Chiang Rai area with suitable infrastructure and services, for the purpose of the current opportunity it is proposed that it will be actually located on the Mae Chan Dairy Farm. The entrepreneur who is establishing the farm is keen to develop processing once farm production is well established. Further, location on the farm will show considerable benefits in reduced land and installation costs combined with simplified raw material supply. As the farm is only 30 kms north of Chiang Rai it is well positioned to supply both the town and the growing Golden Triangle area with finished products.

Location on the farm site would only incur nominal land costs but it is understood that in the Chaing Rai area land is in the region of Baht 100,000 to Baht 350,000 per rai, depending on location; at least 2 rai would be needed for the factory site.

Adequate refrigerated storage would appear to be available at both retail and domestic levels to ensure a straightforward distribution operation and secure a good 5 – 7 day shelf life.

Project Engineering

The suggested capacity for the plant of processing 3 - 4 tonnes of milk per day is based on a packaged 500 lph pasteurising and filling operation which will enable the production of 3 – 4 tonnes per day, 7 days a week, making a total of some 1,400 tones per year. Future expansion can be achieved by installing further packaged units of a similar size. An alternative would be to start with larger scale individual components which could be progressively expanded or added to. However, this would incur a much higher initial capital outlay and is not recommended unless future market studies closer to the investment date suggest that a much larger initial capacity can be justified.

The technology for producing pasteurised milk consists essentially of taking cold raw milk and heating it in a plate heat exchanger to around 72°C for 15 seconds in order to destroy harmful/spoilage organisms. During this process, after preheating, the milk is homogenised to break down the fat globules and distribute them evenly throughout the milk to prevent subsequent separation. After pasteurising, the milk is rapidly cooled to 4°C and automatically filled into plastic bottles and sachets for refrigerated storage and distribution.

For simplicity of installation and operation, a packaged unit is proposed which requires only connection to water and electrical supplies to be operational. Such equipment is manufactured in several European countries, and both Alfa-Laval and APV are represented in Thailand. To keep the initial costs as low as possible, local filling machines, which are technically quite adequate, have been included in the price.

A typical factory layout is shown in Diagram A, in Annex I. This is somewhat more complex than is needed in the first stage of operation and can be simplified by merging some of the areas. A flow diagram for the pasteurising process is shown in Diagram B, also in Annex I.

An indication of the range of plant and equipment needed is listed below, which includes installation and commissioning and 3 insulated delivery vehicles for marketing finished products. An example of a mini dairy plant produced by APV and microtherm heat-treatment equipment produced by Alfa Laval are also included in Annex I.

Equipment for 3-4 tonnes/day Milk Processing Factory

Milk reception
Pasteurising and homogenising
Buffer storage
CIP station
Control panel
SS pipes and fittings
Filling m/c plastic bottles
Filling m/c plastic sachets
Cold store
Laboratory
3 insulated delivery vehicles

The estimated cost of equipment is US$ 200,000.

Manpower and Management

Suggested staffing for the factory would be:

Manager
Foreman
3 operatives (male)
2 operatives (female) for packing
2 drivers.

Operatives and drivers could be costed at the minimum wage of some Bt80 per day; the foreman at Bt200 per day and a manager at Bt400,000 per year. Similar costs are applied to all other investment opportunities.

Project Scheduling

The total implementation and construction period would be in the region of 12 – 18 months to cover the preparation of plant and building quotations, equipment delivery, installation and commissioning, and building construction.

Financial Analysis

Building costs are likely to be somewhat variable, depending on site conditions, the type of building and its complexity. For the purpose of the study a simply-constructed building is proposed, some 8 x 15 metres, ie 120 sq.metres, at an estimated construction cost of Baht 4,000 sq.metre. There will also have to be provision for hard standing, drainage, etc. This gives an estimated all-in building cost of some US$ 200,000, and total investment costs of some US$ 400,000.

Given its scale, the financing of this investment is likely to be either entirely through private capital, or with some 50% of investment and operating costs borrowed from local commercial banks.

Estimated operating costs are summarised below.

Raw milk purchase price	Bt 7.0/litre
Wholesale selling price	Bt 19.0/litre (average)
Retail selling price	Bt 24.0/litre (average)
Khon Kaen dairies processing costs	Bt 3.3/litre + packaging
Chiang Rai College processing	Bt 3.7/litre + packaging
Plastic bottles (1 litre)	Bt 3.50 each
Plastic bottles (0.5 litre)	Bt 2.50 each
Plastic sachets (1 litre)	Bt 0.75 each
Plastic sachets (0.25 litre)	Bt 0.25 each

With 4 tonnes/day processing, say: 50% in 0.50 litre bottles, 10% in 1.00 litre bottles, 20% in 0.25 litre sachets and 20% in 1.00 litre sachets,

2,000 =	4,000 x 0.50 litre bottles	@ Bt 2.50	=	Bt 10,000
400 =	400 x 1.00 litre bottles	@ Bt 3.50	=	Bt 1,400
800 =	3,200 x 0.25 litre sachets	@ Bt 0.25	=	Bt 800
800 =	800 x 1.00 litre sachets	@ Bt 0.75	=	Bt 600
TOTAL Bt				12,800

Average packaging cost	Bt 3.20/litre
Average processing cost	Bt 3.50/litre
Total packaging and processing costs	Bt 6.70/litre
TOTAL COSTS:	Bt 13.70/litre

Total production costs (including interest and depreciation) are thus of the order of Bt20,948,000.

There is therefore a margin of some Bt 5.30 (ie Bt 19 – Bt 13.70) per litre. This accords with current estimates of profitability of current investors in the industry. The dairy is assumed to work 360 days per year giving an operating profit of some Bt2,402,000 per year.

Production costs, rate of return and repayment period estimates are shown in the following spreadsheet table. A rate of return of nearly 17% is suggested, and this would appear conservative when compared with rates suggested by informal industry contacts.

Risk and Uncertainty

The opportunity is more sensitive to changes in the estimated operating costs than in the scale of the investment cost. A 50% increase in total investment costs, for example, causes the rate of return to drop to 10.5%, but a 2 Baht per litre increase in total production costs (to 15.7 Baht) causes the investment to become unprofitable.

Table 1 MEKONG AREA OPPORTUNITY STUDIES:

DAIRYING AT CHIANG RAI

Financial analysis summary (year of full production)

	(000 Baht)	US$ (000)
Investment cost:	10000	400.00
Production cost:		
Operating costs	19728	789.12
Depreciation	670	26.80
Interest	550	22.00
Total production costs	20948	837.92
Rate of return:		
Sales revenue	22800	912.00
Operating cost	19728	798.12
Depreciation	670	26.80
Operating profit	2402	96.08
Interest (average 11%)	550	22.00
Gross profit pre-tax	1852	74.08
Corporate tax (40%)	740.8	29.63
Net profit	1111.2	44.45
Rate of return (%) =	16.6	16.6
Repayment period (years) =	4.3	4.3

Notes to table:

1. The format for the financial summary follows the UNIDO guidelines in the publication reference ID/206.

2. The rate of return is calculated as the sum of net profit and interest divided by total investment outlay.

3. The re yment period is calculated as total investment outlay divided by the sum of net profit plus interest plus depreciation.

4. For both Thailand and Lao depreciation and interest are calculated at 6.7% and 11% respectively.

5. All opportunity studies assume the equity of the sponsor is 50%, and borrowed capital, on which interest is payable, a further 50%.

6. Exchange rate used at February 1992: US$1.00 = Bt25/US$1 = Kip705

POTENTIAL INVESTMENT OPPORTUNITY - II

FRUIT AND VEGETABLES IN ISARN

Introduction

An outline of the problems and potentials associated with the future establishment of fruit and vegetable canning operations in Isarn is discussed at length in Annex 14. Similarly the background papers on Thai Agroindustrial Circumstances, Demand Considerations in North-east Thailand, and the Lessons of Entrepreneurial Experience have examined the current overall situation for agroindustry, including possibilities for fruit and vegetable processing. From these it has been concluded that many of the, as yet, undeveloped areas in this region of Thailand have strong potential for the establishment of medium-sized canning facilities, given entrepreneurial flair and technical competence. The map of Isarn at the start of this Main Volume suggests that possibilities for expansion may exist in the more eastern and southern Changwats, provided that local production can be stimulated.

As a consequence the following opportunity study has been developed as a generalised model, and is not location-specific. It may be used as a basis for the evaluation of a specific project, and modified to suit the actual capacity and range of raw materials and finished products envisaged for any new investment.

The Need for the Model

Field visits by the Consultant to a number of medium-sized canning operations in Isarn which have all been commissioned within the last three to four years have provided a clear insight into many of the technical and operational aspects affecting the viability of this type of enterprise. However, it is appropriate to mention at this point the wide variations in building design and equipment installed in these factories and noted by the Consultant. In some cases, both the buildings and processing facilities were so poor that failure of the venture seems inevitable. In one instance, a very expensive concrete and brick building had been constructed to house processing operations, which was totally unsuitable in terms of finishes and facilities for food processing operations. It had then been filled with poor quality plant and equipment without any clear thought given to product flow and handling. Not surprisingly, this enterprise has already failed due to overall lack of business expertise and technical competence.

Others have generally been much better, but there has been a universal lack of attention to factory flooring. A food processing plant is not a warehouse, and a simple concrete floor in the processing areas is not adequate. Many aggressive fluids are used which spill onto the floor, for example brine and cleaning and sterilising solutions. Fruit juices themselves tend to be acidic and corrosive. In all the factories visited there was evidence of serious breakdown in the floor structures in those areas most subject to splashing with these liquids and in some cases the concrete was close to disintegration. Subsequent repairs invariably will prove to be difficult, expensive and disruptive. It is also unhygienic and, most importantly, is unlikely to meet with customer and FDA approval for export to the USA and Europe when visits are made to factories by potential buyers and exporters. Instead of concrete, a good quarry tile of non-slip quality should be used with acid and alkali resistant grouting in those areas most subject to corrosive attack. (Floors should also be laid with adequate fall to give good drainage.) Walls in the processing area should also be tiled or coated with special paints that will allow regular washing down, but higher levels and roofing can be of a cheap and simple construction, with the minimum of framework to avoid the accumulation of dust. The factory should be light and airy to provide optimum working conditions and good visibility for plant hygiene and quality control. While the final autoclaving process to sterilise finished products will mask many unhygienic practices in the preparation of canned foods, in the long run problems will arise with both the work-force and the product quality which can be difficult to correct.

Much of the equipment used in local canning factories is made in Thailand and is both relatively cheap and well constructed. More specialised equipment such as sterilising retorts and can seamers, is probably best imported as failure at this stage of processing can have serious consequences. Locally made batch evaporators do not produce a good enough product for export in most instances and should be avoided. They have not been used in Europe and the USA for many years. They are cheap to instal but expensive to operate and tend to produce discoloured products with a degraded, cooked flavour; this has been a problem in some sectors of the Thai tomato paste industry. Continuous, multiple-effect evaporators are expensive in terms of capital costs and the manufacture of concentrated juices and pastes is not generally recommended for small to medium scale operations unless a very high value product can justify the investment costs.

While the processing of a single product reduces installation costs and simplifies management and raw material supply, it leaves an enterprise very exposed to the vicissitudes of weather, suppliers, transportation, market fluctuation and a host of other factors. It is also difficult to get year-round supplies of raw materials generally needed to cover factory operating overheads and depreciation. A simple, multi-product unit is therefore proposed for the model, which can make use of a variety of fruits and vegetables in season. For Isarn a choice might be made from the following, although this list is by no means comprehensive and the actual selection will depend on the locality and perceived export and domestic demands.

Raw Material	Season	Products
Mushrooms	Year round in sheds	Whole, sliced in brine
Baby corn	June to March	Canned, whole in brine
Bamboo shoots	July to October	Canned, whole in brine
Lychee	April to July	Canned, juice or syrup
Logan	June to August	Canned, juice or syrup
Mango	January to May	Sliced or puree
Papaya	Year round	Sliced
Tomato	3 crops with irrigation	Whole, chopped or juice

Seasonality may vary slightly with location and rainfall.

By judicious selection of a well-balanced mix it is possible to minimise equipment costs, as the same lines can be used for several products. It will also enable year-round operation apart, from an annual shut-down period for major maintenance and overhaul.

Prices of raw materials and finished products can vary widely depending on the area, seasonality, level of production and world market demands as they relate to supply, quality and brand. As a consequence, the figures used in the following text can only be indicative and would need to be adjusted for specific projects. The actual mix of products and volume of each can also have a major bearing on operating costs and revenue. It is still felt, however, that investment opportunities exist in these areas, along the general lines indicated by the model.

It should also be noted that although this study is developed from Isarn experience and costs, it could be equally suitable for parts of Lao.

The Product Mix

The model canning operation has been based on the following mix of raw materials, being those most widely available and with a good market demand.

PRODUCT	PER CENTAGE
Straw Mushrooms	40%
Baby Corn	30%
Bamboo Shoots	10%
Mango/lychee/papaya	20%

It is assumed that 80% of production will be in A1-15-ounce retail packs with the balance in A10 cans for the catering market. Fruits will be packed in syrup or natural juice. There is an increasing demand for the latter in the European and North American markets.

While bottled products are steadily increasing in popularity, this requires somewhat more skill in processing and is more expensive. This process is, therefore, normally reserved for high quality products only. It has not been included in the study but should be a subject for consideration by any interested entrepreneur. Suitable bottles are manufactured in Thailand but the caps may have to be imported.

Market, and Demand for Specific Product

The domestic and export demands for a range of fruit and vegetable products have been dealt with in the Annexes already mentioned. Essentially there is an outlet for any quality product for sale at reasonable cost. Many processors have hitherto only been able to deliver to the market on these terms intermittently, and the intention of the current opportunity is to overcome these problems. The level of output from the proposed investment would have no effect on the market price of the products overall.

Supply of Raw Material Inputs

Raw materials would be produced by outgrowers on a direct contract basis, with the enterprise providing seeds and planting material etc through its own extension service. The requirements for success in securing adequate supplies of good quality raw materials have been identified in various of the Annexes. The shed growing of mushrooms should be considered as a possibility to give year-round production of the required size and quality. For more technical details on straw mushrooms see the opportunity study for the production of them at Chumpae (PIOP III)

Other materials such as salt, sugar, detergents and sterilising compounds plus canning and packaging materials are readily available from domestic manufacturers and suppliers. Only the best quality materials should be used for export products, and the final presentation is particularly important.

A good supply of potable water is important and this can be a limiting factor in the selection of a suitable site for the factory as salinity is an increasing problem in some areas of Isarn. Electrical power and fuel will also be required. There should be no major effluent problems from this type of factory but some pre-treatment and a pond will be required.

Approximate Location and Site

The project is not location-specific, but various factors will need to be considered in selecting a suitable site. These include the availability and cost of land and services, the availability of labour, both for crop production and factory operation, the quality of roads and general infrastructure, water and power supplies, and suitability of locality for growing the required crops.

Land costs in Isarn are generally lower than in other parts of Thailand, although it may be well to plan on the basis of the figures quoted in the dairying opportunity for Chiang Rai and expect costs of anywhere between Baht 100,000 and Baht 350,000 per rai. It has already been suggested that future possibilities and growth areas may well be mainly within the southern and easternmost Changwats of Isarn.

Project Engineering

The suggested capacity for the factory is based on a maximum throughput of 10 tonnes per day of raw materials on two canning lines and one juicing line. A target annual throughput of 2,500 tonnes of fruit and vegetables is envisaged, ie some 7–8 tonnes per day for 330 days which will yield about the same tonnage of finished products. Although yields from raw materials to canning can fall by as much as 50% in some cases, the balance is made up with juice, sugar, brine and the weight of the cans. Total production of cartons is hoped to be in the region of 200,000 per year.

General purpose processing lines are required, incorporating raw material sorting, blanching, preparation, can filling and sealing stages to handle a variety of fruits and vegetables. Where possible, locally-fabricated equipment should be used to reduce initial costs, subject to the quality being adequate for the purpose. A flow diagram for the sequence of operations in the canning of baby corn is shown in the PIOP Annex II. In addition, a brief outline covering the technology of food processing is included in Annex 19.

A layout drawing for a typical medium-sized fruit and vegetable canning factory is also included in the PIOP. This includes provision for extension in the future by adding a third canning line and an evaporator for the manufacture of concentrated juices and pastes.

Investment costs can vary widely depending on the source of equipment and degree of automation. As labour costs are relatively low in Isarn, expensive labour-saving equipment is not necessary at this time (of the type provided by many European manufacturers): blanching can be carried out in simple open vats rather than on continuous machines; cans can be filled manually and sealed semi-automatically, for example. Based on discussions with several enterprises visited by the Consultant during field trips, an installed equipment cost of US$ 600,000 is thought to be adequate. A list of major components is shown below.

Typical list of major components for a fruit and vegetable canning operation:

1. Washing and feeding units
2. Inspection tables and scales
3. Trimming, sizing, peeling line
4. Blanchers
5. Elevators
6. Slicers
7. Juice extractors, pulpers, fillers
8. Can washer
9. Canning line
10. Check weighers
11. Brine, syrup preparation vats
12. Brine, syrup filler
13. Conveyor-exhauster
14. Can seaming machines
15. Crates and autoclaves/retorts
16. Accumulating tables and labelling machines
17. Carton sealer
18. Miscellaneous tables and conveyors, bins, trolleys

19. Pallets and forklifts
20. Laboratory and workshop equipment
21. Steam boiler and water treatment.

Building and civil engineering costs, including internal roads and hard standing, outbuildings, warehousing and effluent disposal will total a further US$ 600,000. (These costs came from the only available informal estimates the consultants could obtain. Whatever the size of enterprise, a marked reluctance to allow investment costs to be discussed was apparent.)

Manpower and Management

Total labour requirements tend to be very seasonal in this type of operation, as there are inevitably periods when raw material intake is low, while at other times there can be a flood of material at the times of peak harvest. A high degree of flexibility is therefore required in the work-force, and a core of workers is retained throughout the year who have experience in a wide range of preparation and processing operations. These will be supplemented with general workers who are recruited on a casual, seasonal basis. Minimum staffing may be as low as 50, rising to 150 during times of peak production, with an average of around 100 throughout the year.

A typical breakdown would be:

1	factory manager
3	line foremen
20	reception, preparation and blanching
60	canning line
6	can sealing and packaging
4	warehousing
4	drivers and miscellaneous
2	laboratory
3	engineers
10	extension officers

ie, some 113 in total, operatives and drivers could be costed at the minimum wage of some Bt80 per day, the foreman at Bt200 per day and a manager at Bt400,000 per year. Similar costs are applied to all other investment opportunities.

Project Scheduling

The total implementation and construction period would be in the region of 18 months to include the preparation of plant and building specifications and quotations, followed by equipment delivery, erection, commissioning and building works. During this period it will also be essential to sign up enough farmers to produce crops for the first season and organise planting materials, other inputs, and recruit a small team of extension officers.

A three-year period should be allowed to build up to full operating capacity but it is important to get off to a good start to minimise operating capital requirements. A reasonable schedule of throughput might be:

Year 1	1,000 tonnes
Year 2	1,800 tonnes
Year 3	2,500 tonnes

Implementation costs would need to include the following elements: funds for crop purchase; funds to support factory operations until an economic level of production is achieved; funds to support extension activities and farmer inputs; and marketing expenses. A lump sum amount of US$ 200,000 has been added to construction costs for these.

Financial Analysis

The total investment cost is, therefore, of the order of US$ 1,400,000 (ie, US$ 1,200,000 for construction, plus funds for extension etc). At full production, seven to eight tonnes of fruit and vegetables per day probably translates into an average of 675 cartons per day.

The following are estimates of raw material costs for the earlier suggested crops, based on 1991 market price data:

PRODUCT	RAW MATERIAL COSTS
Straw Mushrooms	20 Baht/Kilo
Baby Corn	15 Baht/Kilo
Bamboo Shoots	20 Baht/Kilo
Mango/lychee/papaya	17 Baht/Kilo

Overhead costs, electricity, water, labelling, cans and bottles, labour, and transport to market, etc, are estimated at an average of Baht 180 per carton, irrespective of type. This data is higher than was used in the straw mushroom opportunity study, expecting that the factory will be more complex to manage and maintain. In the case of straw mushrooms, for example, labour costs for sorting will be higher for production based on fields rather than sheds.

Typical FOB, Bangkok values per carton for these products canned might be as follows:

PRODUCT	VALUE PER CARTON
Straw Mushrooms	16 US$
Baby Corn	8 US$
Bamboo Shoots	8 US$
Mango/lychee/papaya	8 US$ (average)

If throughput and production were in the annual volume and proportion suggested earlier, total annual expenditure on product would be Baht 29,975,000, and total sales revenue would be some Baht 49,500,000, as the first table, below, suggests.

On these estimates of investment and operating costs and revenues, the rate of return is estimated at a highly positive rate of around 42% (second table).

Risk and Uncertainty

As presented, the opportunity appears fairly resilient to costs changes. A 20% increase in investment costs only causes the rate of return to fall to 26%, and a similar increase in operating costs only causes the rate to fall to 21%.

Isarn offers a potential for the setting up of a number of new fruit and vegetable canning operations along the lines of this opportunity study based on locally produced raw materials. But any new enterprise must be market-led, and entrepreneurs will need to establish good contacts with export agents and overseas importers to secure data on market demand and prices for a variety of finished products. These then need to be balanced with the producing ability of a particular location so that a specific capacity and mix can be used as the basis for a profit plan and equipment costs, etc.

Having decided to go ahead, the various requirements and conditions for a successful outcome which have been discussed in the preceding pages and in various Annexes must be met. They may be summarised as follows: good business sense and technical competence will be required as will effective communication with farmers and the ability to build up a trusting working relationship; the availability of sufficient funds for crop purchase and to support factory operations until a profitable level of production has been achieved; an ability to apply high standards of quality control at all stages of the operation is essential; and, in general, the establishment of appropriate processing technology in a suitable building to achieve the best value for money and enable a high quality of production to be achieved consistently at minimum cost. This requires considerable effort and research at the design stage and can only be achieved if the entrepreneur has sufficient appreciation of the technical and agroindustrial constraints and requirements.

MEKONG AREA APPORTUNITY STUDIES

MULTIPRODUCT MODEL PROCESSING PLANT

Throughput volumes, operating costs and sales revenue based on suggested annual throughputs

Product	Throughput (tons)	Total Operating Costs (Baht 000)
Straw Mushrooms	1000	14400
Baby corn	750	6750
Bamboo shoots	250	2625
Mango/lychee/papaya	500	6000
TOTAL	2500	29775

Product	Output (Cartons)	Sales Revenue (Baht 000)
Straw Mushrooms	72000	28800
Baby corn	54000	10800
Bamboo shoots	13500	2700
Mango/Lychee/Papaya	36000	7200
TOTAL	175500	49500

NOTES TO TABLE

1 Operatives and drivers could be costed at the minimum wage of some Bt80 per day, the foreman at Bt200 per day and a manager at Bt400,000 per year. Similar costs are applied to all other investment opportunities.

2 Total operating costs are based on standards for the typical list of components presented earlier, plus an estimate of raw materials costs (these can very seasonally and regionally).

Table 2 MEKONG AREA OPPORTUNITY STUDIES:

MULTIPRODUCT PROCESSING PLANT IN ISARN

Financial analysis summary (year of full production)

	(Baht 000)	US$ (000)
Investment cost:	35000	1400.00
Production cost:		
Operating costs	27375	1095.00
Depreciation	2345	93.80
Interest	1925	77.00
Total production costs	31645	1265.80
Rate of return:		
Sales revenue	49500	1980.00
Operating cost	29775	1191.00
Depreciation	2345	93.80
Operating profit	23030	921.20
Interest (average 11%)	1925	77.00
Gross profit pre-tax	21105	844.20
Corporate tax (40%)	8442	337.68
Net profit	12663	506.52
Rate of return (%) =	41.7	41.7
Repayment period (years) =	2.1	2.1

Notes to table:

1. The format for the financial summary follows the UNIDO guidelines in the publication reference ID/206.

2. The rate of return is calculated as the sum of net profit and interest divided by total investment outlay.

3. The repayment period is calculated as total investment outlay divided by the sum of net profit plus interest plus depreciation.

4. For both Thailand and Lao depreciation and interest are calculated at 6.7% and 11% respectively.

5. All opportunity studies assume the equity of the sponsor is 50%, and borrowed capital, on which interest is payable, a further 50%.

6. In both countries the total of corporate taxes have been estimated at 40%.

7. Exchange rate at February 1992 = US$1.00 = Bt25/US$1.00 = Kip705

POTENTIAL INVESTMENT OPPORTUNITY - III

STRAW MUSHROOMS AT CHUMPAE

Background

This opportunity study begins with some background to the original investment, the enhancement of which is now proposed.

E-Sun Foods is an existing fruit and vegetable canning factory under private ownership which has been selected for technical assistance The investment is to be in growing sheds for the high-volume production of straw mushrooms to improve operational efficiency and increased profitability by securing an increased throughput of high quality raw material. The main investment costs would be borne by farmers, with the aim of improving the throughput of the factory: thus, the opportunity is presented as being of economic benefit to the region (extra jobs, larger incomes, etc) and financial benefit to the factory; as a result it does not follow a standard format for financial profitability. A separate financial analysis for the position of the factory then follows.

E-Sun foods was originally established in 1986/87 as a Thai and Taiwanese joint venture, with Taiwanese technology and a Taiwanese marketing manager. However, after three years the company ran into serious operating problems due to a combination of poor quality and irregular supplies of raw materials and a very saline water supply. The company was subsequently taken over in 1989 by a local businessman at a cost of Baht 18 million (US$ 720,000); he did not want to see the factory collapse and he wished to promote the cultivation of high-value crops by local farmers. The contact address for E-Sun foods and some examples of their produce are included in Annex III.

The original plan was to process only one product (straw mushrooms) based on the local availability of mung bean husks for cultivation. Straw mushrooms enjoy a strong demand on world markets, particularly in Singapore, Hong Kong, Japan and Taiwan.

During 1989 and 1990 the company was canning some 4–5 tonnes per day against an installed capacity of 15 tonnes per day (on an eight-hour working day basis). In 1991 competition from Indonesia created intense marketing problems. The company appears to be unable to contract forward because they are uncertain of raw material supply, and conversely they cannot contract with farmers and middlemen as they are uncertain of their market. As a consequence of this situation their production of canned straw mushrooms is spiralling downwards and farmers in the area are becoming disillusioned. To make up production, the company are attempting to process baby corn, but there are quality and supply problems with these and they cannot get bamboo shoots from local farmers as an alternative.

The opportunity therefore exists to increase the supply of straw mushrooms to the factory from production based in sheds rather than the traditional manner. It is assumed that the regular supply of the required type and quality of raw material will in fact largely solve the current marketing problems.

Market, and Demand for Product

E-Sun Foods Industries Ltd claim that the best market in terms of straw mushrooms is for large mushrooms, but these presently only represent 2% of the supply from farmers. Also the peeled black variety is preferred by customers, whereas their supplies are primarily of the white variety. The company make a wide range of canned mushroom products in both 15-ounce and A10 catering packs, including whole and sliced/peeled, and unpeeled in brine. The major production is in 15-ounce retail cans which are packed 24 to the carton for export.

Statistics regarding the domestic consumption and export volumes of straw mushrooms are complicated to analyse because these are typically combined with all other mushrooms. However, the volume and value of all mushrooms exported from Thailand has increased dramatically in recent years, with 12 and 20 fold increases respectively.

Year	Volume (tonnes)	Value (Baht million)
1987	531	12.5
1988	1,064	26.6
1989	3,766	122.6
1990	6,668	239.8

Declining exports by Taiwan have been increasingly replaced by the Thai product, principally for the USA and European markets. Overall, world market demand is growing by some 7.5% (ITC).

Domestically, a 420-gram gross weight can is sold for around Baht 30 in Bangkok.

The intention of the opportunity in the long-term would be to minimise bulk packaging, and maximise smaller and more specialist packs for particular customers.

Supply of Raw Material Inputs

Current production of canned straw mushrooms is inhibited due to lack of consistency or quality control in the raw material supply. Many producers prefer to market through the traditional fresh produce marketing channels. At present it is thought that some 3,000 local families supply mushrooms through middlemen (who may also sell them on the fresh market if the price is better); there are no contractual arrangements either end of the marketing chain. Middlemen just buy what the farmers give them and there is no attempt at quality control. There are some 35 middlemen who act as contractors, and supply farmers with fertilisers, supplies and credit.

Mushrooms are grown in a traditional way in the paddy after the rice harvest between February and August. Raised beds, some 1 metre x 5 metre, are built up in the fields using mung bean husks as a base. After sowing the spawn, they are covered with plastic sheets and straw.

The problems resulting from this method include low production and productivity, labour intensity, poor quality and size control, heavy contamination with moulds and dirt, and a relatively short growing season.

The management of E-Sun Foods Industries Ltd consider that, in order to achieve efficient operation and good profitability, they need to secure regular supplies of large black straw mushrooms of a reasonably uniform size at an average rate of 10 tonnes per day. They would like to experiment with shed production, but do not have the technical know-how at the moment, and are unsure how to go about investing. The company are willing to finance the initial construction of trial sheds and, based on results, would provide advice and extension services to farmers. This would be critical to the project's success. In addition to providing benefits to E-Sun Foods Industries Ltd, this project, if correctly designed, will provide improved year round income to local farmers and could be replicated elsewhere in Isarn.

Approximate Location and Site

The investment in shed cultivation is to be within the region of the existing

E-Sun factory site at Chumpae.

Project Engineering

It is uncertain whether the technology for the commercial shed growing of straw mushrooms presently exists in Thailand. There is however some know-how in various microbiology and horticultural departments of local universities and agricultural colleges. It is possible that this accumulated experience can be extended to the commercial and industrial requirements for efficient and profitable production. During visits to several other canning operations in Isarn by the Consultant the idea of shed growing was raised, and one company at least is hoping to get the know-how from Taiwan. The technology is not complex, and the costs per shed (see below) are relatively modest. To give the required output (see below) the sheds should be large enough to allow for the establishment of 150 square metres of beds, of which half would be cultivated and half in rotation at any one time.

Manpower and Management

It is envisaged that the existing management of the company would continue. Extra manpower requirements at the factory would depend on the realised scale of throughput, and more full-time employment would be available to farmers.

Project Scheduling

Having identified the technology, implementation is likely to be possible virtually immediately, although some time for encouraging farmers to make investments is unavoidable.

Financial Analysis

The investment opportunity is analysed in two steps, first with the costs of sheds, and then with the benefits of extra production. The costs and benefits of developing shed production between the farmers and factory would be divided as follows: the company would absorb research and development costs in establishing the agronomic practices and would benefit from greater levels of throughput and more continuous raw material supply. Farmers would incur gives a total annual estimted income from the sheds of Baht 40,000 x 1,000 = Baht 40 million per year.

The financial position of the factory is summarised in the third table. Costs incurred by the factory include the establishment of trial research sheds (assumed to be 10 in the first instance, at US$ 1,200 each) plus the extension effort. On this basis the financial return to the R&D effort is very high, at an estimated 62%.

Risk and Uncertainty

There are few sources of risk to either farmers or the factory, as long as the product can continue to be marketed. The support of the factory to secure sufficient numbers of interested farmers in the early days would be essential, however. The only technical doubt on the production side concerns the availability in sufficient quantity of mung bean waste, cotton husks etc, but the extent of this risk is impossible to quantify at present; the shipping of mung bean waste from other areas of the country may have to be investigated.

TABLE 1 MEKONG AREA OPPORTUNITY STUDIES:

STRAW MUSHROOMS AT CHUMPAE

Financial analysis summary

	(000 Baht)	US $
		25.00
Investment cost:	38,000	1,520
Production cost:		
Operating costs	58,000	2,320
Depreciation	2,546	102
Interest	2,090	84
Total production costs	62,636	2,505
Rate of return:		
Sales revenue	72,000	2,880
Operating cost	58,000	2,320
Depreciation	2,546	102
Operating profit	11,454	458
Interest (average 11%)	2,090	84
Gross profit pre-tax	9,364	375
Corporate tax (40%)	3,746	150
Net profit	5,618	225
Rate of return (%) =	20.3	
Repayment period (years) =	3.7	

Notes to table:

1. The format for this economic summary follows the UNIDO guidelines in the publication reference ID/206.
2. The rate of return is calculated as the sum of net profit and interest divided by total investment outlay.
3. The repayment period is calculated as total investment outlay divided by the sum of net profit plus interest plus depreciation.
4. For both Thailand and Lao depreciation and interest are calculated at 6.7% and 11% respectively.
5. All opportunity studies assume the equity of the sponsor is 50%, and borrowed capital, on which interest is payable, a further 50%.
6. In both countries the total of corporate taxes have been estimated at 40%.

TABLE 2 MEKONG AREA OPPORTUNITY STUDIES:

STRAW MUSHROOMS AT CHUMPAE

Farm Budget: Financial summary (at full production)

	(000 Baht)	US $
		25.00
Investment cost:	25,000	1,000
Production cost:		
Operating costs	10,900	436
Depreciation	1,675	67
Interest	1,375	55
Total production costs	13,950	558
Rate of return:		
Sales revenue	54,000	2,160
Operating cost	10,900	436
Depreciation	1,675	67
Operating profit	41,425	1,657
Interest (average 11%)	1,375	55
Gross profit pre-tax	40,050	1,602
Corporate tax (40%)	N/A	0
Net profit	40,050	1,602
Rate of return (%) =	165.7	
Repayment period (years) =	0.6	

Notes to table:

1. The format for this economic summary follows the UNIDO guidelines in the publication reference ID/206.
2. The rate of return is calculated as the sum of net profit and interest divided by total investment outlay.
3. The repayment period is calculated as total investment outlay divided by the sum of net profit plus interest plus depreciation.
4. For both Thailand and Lao depreciation and interest are calculated at 6.7% and 11% respectively.
5. All opportunity studies assume the equity of the sponsor is 50%, and borrowed capital, on which interest is payable, a further 50%.
6. In both countries the total of corporate taxes have been estimated at 40%.
7. This budget is based on 1000 sheds , each producing 10Kg of mushrooms per day
8. The farm gate price is assumed to be the same as the factory gate price (ie Bt 20/Kg)
9. The forma for opportunity studies has been folowed for purposes of consistency, but any further analysis should involve the const. uction of detailed farm budgets

TABLE 3 MEKONG AREA OPPORTUNITY STUDIES:

STRAW MUSHROOMS AT CHUMPAE

Factory financial analysis summary

	(000 Baht)	US $ 25.00
Investment cost:	13,000	520
Production cost:		
Operating costs	58,000	2,320
Depreciation	871	35
Interest	715	29
Total production costs	59,586	2,383
Rate of return:		
Sales revenue	72,000	2,880
Operating cost	58,000	2,320
Depreciation	871	35
Operating profit	13,129	525
Interest (average 11%)	715	29
Gross profit pre-tax	12,414	497
Corporate tax (40%)	4,966	199
Net profit	7,448	298
Rate of return (%) =	62.8	
Repayment period (years) =	1.4	

Notes to table:

1. The format for this economic summary follows the UNIDO guidelines in the publication reference ID/206.
2. The rate of return is calculated as the sum of net profit and interest divided by total investment outlay.
3. The repayment period is calculated as total investment outlay divided by the sum of net profit plus interest plus depreciation.
4. For both Thailand and Lao depreciation and interest are calculated at 6.7% and 11% respectively.
5. All opportunity studies assume the equity of the sponsor is 50%, and borrowed capital, on which interest is payable, a further 50%.
6. In both countries the total of corporate taxes have been estimated at 40%.

POTENTIAL INVESTMENT OPPORTUNITY - IV

MEDIUM DENSITY FIBREBOARD

Introduction

At the Thai Review Meeting in Bangkok, Medium Density Fibreboard (MDF) manufacture was identified as a potential investment opportunity, based on the assumed availability of adequate supplies of waste wood timber in the project areas.

Subsequently the Consultant identified an existing factory in Isarn using bagasse, the waste cane from sugar mill operations, as a raw material to the production process. This had an immediate appeal as there ware several large sugar mills operating in Isarn and bagasse is a low-cost and conveniently available raw material. While most bagasse is consumed as a boiler fuel to operate sugar mills, there is frequently a surplus to this requirement unless the normal production of plantation white sugar is further refined at the end of the season which requires extra fuel.

However, as a result of the Consultant's detailed evaluation of the production process, it has become clear that MDF does not represent a realistic investment within the terms of reference of the current study as the likely investment costs are very high, in the region of US$15 - 20 million, and the manufacturing technology of MDF from bagasse is not fully established.

Notwithstanding this, there is undoubtedly an opportunity for a major investor who is willing to persevere with the technology or who is willing to pay a licensing fee for advice from current manufacturers. Adequate supplies of bagasse would appear to be available in Isarn and there is a strong export demand for the MDF. The following notes provide an outline of the current status of the production of MDF from bagasse. they are largely derived from meetings with timber product specialists in Bangkok and the present sole manufacturer in Thailand (Khon Kaen Wood).

The Product and Its Market

MDF is a fibreboard with a density between 500- 850 kilos/m^3 but most of the MDF manufactured is produced with a density between 700 - 750 kilos/m^3. The product was an instant success when it was first developed in the USA and launched in 1966. It is a natural substitute for natural wood. Unlike paper pulp and other products derived from wood, which require large quantities of water and produce large volumes of unpleasant effluent, MDF is produced by a 'dry process' and is therefore environmentally friendly.

Manufacture consists of breaking down woody materials into their individual fibres which are resin coated, dried and formed into a mat which is cut and pressed into panels 8mm - 40mm thick. Production costs are roughly the same as for particle board, but the end product is far superior. It is completely homogeneous with no identifiable grain or variations in surface hardness. It is machineable and has excellent edge properties as well as screw holding and dimensional stability.

These characteristics give MDF a continuously growing market and explain why it is popular for high quality furniture and kitchen cabinets, wall panelling, toys and similar wood-based products. Export prices from Thailand are understood to be in the region of US$250 FOB cubic metre, and in Europe the price is about 30% higher than particle board.

Japan is a growing market for MDF, as its quality demands are very high. Statistics detailing growth in the markets for MDF are contained in Annex IV.

Current Manufacturing Operations

As of 1988 there were 68 MDF factories in the world and it was projected that for 1990 there would be about 87 MDF factories. The first and only MDF factory using bagasse as raw material was established by the Khon Kaen MDF Board Company based on their sugar mill in the Nam Phong district of Khon Kaen Changwat in 1986. Subsequently, similar operations have been established in Turkey and Pakistan but considerable technical difficulties have been encountered. It is understood that the Turkish plant is closed down and the Pakistan operation has only been able to continue following an agreement with the management at Khon Kaen to provide technical assistance. The Chinese are also apparently asking for technical assistance and an Indonesian investor is looking for a joint venture partner.

The Khon Kaen operation was initially established at a cost of some Baht 400 million (approximately US$15 million) based on a turnkey contract with Sund Defribrator AB of Sweden. A further Baht 100 million was needed over the following years for major modifications and improvements. The factory processes some 250 tonnes of bagasse each day and produces 80 cubic metres per day of MDF. Hitherto, this was all sold locally but now the company is fully integrated with the completion of a large furniture factory on the site which produces a wide range of quality furniture for export to Europe; they have recently signed a contract to supply hotel furnishings to a Japanese client.

The company is now expanding its MDF capacity to 250 cubic metres per day. New techniques are being introduced to enable the manufacture of a much wider range of panels and boards. This has been a very successful operation but the level of financial investment and technical expertise needed to achieve the present situation should not be underestimated. Some notes detailing the actual production process for MDF are included in the 'Potential Investment Information Pack' in Annex IV.

Future potential

There are 6 sugar mills currently operating in North East Thailand which are listed below and shown on the map of Isarn at the start of the Main Volume

Buriram Province	1 factory	-	Buriram
Mukdahan Province	1 factory	-	Saga Rang
Udon Thani Province	2 factories	-	Rerm Udon
		-	Kumpawapi
Khon Kaen Province	1 factory	-	Khon Kaen
Chaiyaphum Province	1 factory	-	United Farmer & Industry

The Khon Kaen factory is, of course, already producing MDF and United Farmer and Industry at Chaiyaphum are currently constructing a particle board factory. It is also understood that a large MDF factory with a capacity of 500 tonnes per day of raw material is being constructed east of Bangkok which will use para-rubber and eucalypt as raw material.

Financial Analysis

During the course of the current study it was impossible for the Consultant to obtain detailed information regarding equipment required and installation and operating costs for reasons of confidentiality; Khon Kaen Wood were reluctant to divulge the fruits of their experience. For this reason, no detailed financial and economic analysis has been attempted. Clearly, however, MDF from bagasse has a good future when once the manufacturing technology is generally available. What information is available on MDF obtainable in Thailand is presented in Annex IV.

POTENTIAL INVESTMENT OPPORTUNITY - V

CASHEW NUT PROCESSING IN LAO

Introduction

During the Consultants' first visit to Vientiane, a meeting was held at the Ministry of Agriculture and Forestry when it was pointed out that some 70,000 cashew trees had been planted between three and five years ago under an initiative from the Ministry. The trees were of local and Vietnamese varieties and had been established by small farmers in the expectation of valuable export markets being developed. However, yields had been low and the nuts were rather small and apparently not of a good export quality. The trees were somewhat neglected as a consequence.

It was understood that a US company had apparently paid for the crop to be harvested earlier in the year but not all nuts had been sold and there were some six tonnes of nuts in local storage. It was suggested that these trees could form the basis of a modest project to improve and expand production and processing for both the local and export markets.

The Consultant subsequently visited the cashew planting area close to Vientiane and found that, while most of the trees appeared to be healthy, there was some die-back and the trees were either planted too close or needed thinning out and pruning. The groves were full of weeds and lack of maintenance was clearly a major problem. At a subsequent wrap-up meeting at the Mekong Secretariat, it was agreed that cashew nut processing could be identified as an investment opportunity.

On return to Bangkok, discussions were held with cashew nut specialists at Kasetsart University and the Mah Boonkrong Company (who have extensive cashew plantings in Thailand). This was followed by field visits to Cashew Research at Si Sa Ket Horticultural Research Centre and to Buriram Agricultural College. At the latter institution it was discovered that a specialist from the college and a local farmer had visited Vientiane earlier in the year and had prepared a detailed report on the status of the trees there. Apparently a project had already been established along the lines proposed by the Consultant, following a commercial agreement between the Thangone Feed Mill Corporation within the Ministry of Agriculture and Orient Expressions Ltd of Pennsylvania, USA. This project is now known as the Lao Cashew Project (LCP). A copy of the project document was obtained on a subsequent visit to Vientiane.

As this project appears to already be in existence it clearly cannot be identified as a potential new investment within the terms of reference of the present study. It may, however, still be of future interest to investors should the present arrangement fail to proceed as planned. For this reason the following notes are not presented in the standard opportunity study format, but are provided as general background for any future studies that may emerge and for any local entrepreneurs who may wish to assist in expanding this potentially viable industry.

The Market for Cashew Nuts

The world market situation for cashew nuts is briefly described in the paper in Annex V. The base price of cashew (the S320) seems set to rise in the short to medium term. The USA is the major importer but, as with most commodities, the prime determinant of price is quality. It is almost certain that Lao could sell as much as it could produce, through Orient Expressions, given that quality can be achieved and maintained.

Laos Cashew Nut Plantings and Estimated Production

Tables 1 to 3 in Annex V show: the estimated cashew nut plantings in Vientiane Province and Municipality as at March 1991 (this indicates an actual total of only 40,690 trees with a potential yield now of 123.75 tonnes of nuts), Lao cashew planning factors upon which projected returns to the project are based, and a costing worksheet which outlines basic purchasing prices and processing costs for export. Also included in Annex V is a paper on the world market situation for cashew, the Lao Cashew project document itself, and some technical literature on cashew cultivation.

The long term objectives of the Project are:

- to establish Lao cashews as a viable export crop based on internationally accepted standards
- to establish Lao cashews as a long-term development crop within the Lao PDR agriculture and economic plans
- to improve the quantity and quality of the crop
- to develop the technologies and expertise required to ensure the export capabilities of Lao PDR
- to develop the Lao cashew industry to be able to support the shipment of one container a month from Lao PDR by the year 2000. (This objective requires the shipment of some 415 tonnes of cashew nuts per year which would need the establishment of some 240,000 trees.)

Cashew Nut Processing

The cashew nut is a kidney-shaped nut that grows at the end of a curiously shaped fleshy portion known as the cashew apple. The shell of the nut is in three layers. The outer and inner layers are dry but the middle layer contains a dark caustic oil called Cashew Nut Shell Liquid (CNSL). This oil is driven off in dry roasting, but can be extracted and has various industrial uses including paint, varnishes and lacquers.

In small-scale processing, after separating the nut from the fleshy part, the nuts are roasted to drive off the caustic CNSL and then opened individually on hand shelling machines. It is understood that using these machines, one operator can shell approximately six Kilo of nuts per day. Automatic equipment is produced by Peabody in the UK and there are also manufacturers in Italy and Switzerland, but large volumes of nuts are required to justify investment in this equipment. Mah Boonkrong in Thailand consider 500,000 trees yielding some 2,500 tonnes per year at maximum production is the minimum economic size. This needs substantial financing, in the order of US$ 5–10 million for the establishment of the factory and the one-time purchase of the crop for year-round processing.

The astringent Cashew Apple may also be processed into juice, jams, candy and chutney, etc. The Mysore Central Food Technological Institute has carried out substantial development work in this area. Large quantities of fruits are processed into juice in Brazil but generally speaking it is not practical to process the crop for both juice and nuts as there are different requirements for each; eg, the fruits need to be picked fresh each day for juice extraction, whereas for nuts the fruits are allowed to ripen and fall on the ground where they are collected only periodically.

Current status of the Lao Cashew Project

It is understood that within the terms of the joint venture agreement, the Thangone Feed Mill Corporation has already sent some 30 employees together with 30 farmers to Buriram College in Thailand for training, and that the Municipality of Vientiane has purchased 30 hand shelling machines from Khon Kaen for the establishment of a central processing facility.

The Chance of Investment Success

While the general formulation and intentions of the project are good, for it to succeed it is essential that the following matters should be given particular attention. Firstly, the future success of the project relies on the early increase in production and productivity from increased plantings of cashew trees and improved husbandry and maintenance. This will need considerable expertise and effective extension work, combined with an adequate return to farmers for their efforts.

Secondly, current and anticipated yields per tree are not particularly good, due mainly to the varieties planted. Small low-yielding trees will need to be removed and selective pruning carried out.

Thirdly, discussions should be held with Sisaket Research and other institutions to select the most suitable varieties for future planting, possibly SK 60-1 or SK 60-2 and the composite variety Si Sa Ket SK-A which is derived from 10 selected clones. These can be expected to produce both higher yields and larger nuts although, without trials, their exact performance cannot be prejudged. However, trials take a long time and new plantings might best be based on a range of selected varieties.

POTENTIAL INVESTMENT OPPORTUNITY - VI

SUGAR AT SAVANNAKHET

Introduction

Until recently Lao has had to import all its requirements for crystal sugar to satisfy the domestic requirement. This amounts to approximately 10,000 tonnes per year, made up of sugars from Vietnam and refined white sugar from Thailand.

However, in 1983 a plan was developed to construct a sugar mill and this finally resulted in the establishment of the Pak Sap Sugar Mill, 30 kilometres north-east of Vientiane. This was commissioned in 1990 after three years' delay. The installation was initiated by the Vientiane Municipality within the Ministry of Agriculture and Forestry under a World Bank Agricultural Production Support Project, as part of a plan to increase agricultural production. The main targets were rice, animal feed and sugar with a view to reducing imports. The original plan was to construct a small sugar mill with an annual output capacity of 1,000 tonnes of plantation white sugar per year, but this was uprated during the design stages to 2,000 tonnes per annum as being more economic.

The mill was designed and installed by an Australian company, Batstone Technology Pty Ltd, and is considered to be of good quality in terms of technology and installation. It was constructed as a turnkey project at a total cost of US$ 2.3 million which was financed by a World Bank soft loan to include land preparation and transport.

Major problems have arisen in getting the mill into production due to lack of sugar cane for processing. The enterprise has not had sufficient operating capital to establish more than 30 hectares of their own cane and this is now to become a nursery to supply outgrowers. After much effort smallholders have been persuaded to plant some 100 hectares which will be ready for the February 1992 season; yields are expected to be in the region of 40 tonnes/hectare, thus giving a total production of 4,000 tonnes for the season. However, the factory needs at least 20,000 tonnes to reach its design capacity of 2,000 tonnes per annum of sugar, and the disappointing response by farmers will therefore have serious implications for the future cash flow and profitability of the mill.

Some 300 hectares have been allocated for cane production, and the practice has been for the mill to clear and plough the land ready for planting, and to provide planting material and technical assistance; the owners of the land supply the labour for planting, maintenance and harvesting. But the plans have been frustrated by the lack of working capital and irrigation facilities.

Establishing large areas of cane is expensive as it costs around Kip 100,000 per hectare for clearing only. Roads and culverts in the area also need substantial repairs and upgrading, and accommodation on the site is limited and needs to be expanded to allow field and factory staff to make their permanent homes on the site.

In spite of the foregoing problems with this particular project, given better financing and extension services to encourage local farmers, the expansion of sugar processing activities in Lao is seen by the Consultant to be a logical progression in order to increase the level of import substitution, improve cash returns to smallholder farmers and promote institution-building. The following opportunity study proposes the replication of the Pak Sap mill in Savannakhet to supply the local market (ie, southern Lao).

Some technical improvements have been made to the latest design of the mini sugar mill as supplied to Pak Sap by overcoming a bottleneck in the shredder to give an increased cane throughput of 250 tonnes of cane per day (TCD). Operating costs have been reduced by replacing the membrane filters with a fine screening and flotation (flocculation) system. The potential output of the redesigned mill now becomes 2,500 tonnes in a 100-day operating season.

Before suggesting the replication of the current mill, the Consultant has given consideration to an alternative lower technology vacuum pan method commonly employed in India. However, installation costs are no lower and it gives a lower percentage of sugar recovery – it is, therefore, not recommended.

Market, and Demand for Specific Product

In the cane industry, the most common alternative to the construction of a fully-fledged refinery has been the production of what is variously known as mill, or plantation white, sugar, or crystal sugar. This omits the final refining stage following affination and produces a perfectly acceptable product for direct marketing at a somewhat lower cost.

This plantation white sugar would compete with various imported products, namely Thai refined white sugar and Vietnamese brown and white sugars. It is suggested that a market for the domestically-produced Lao sugar would exist if it could be sold at a lower price than the Thai import; essentially it would compete with the Vietnamese product in the south of the country. (This is discussed in more detail in the paper in Annex VI.)

The suggested capacity for the plant is based on a maximum throughput of 250 TCD which, assuming average yields, will produce around 2000–2,500 tonnes of plantation white sugar per year. This compares with current national consumption of around 10,000 tonnes per year; it is therefore considered that the economy could absorb this level of output.

POL extraction in the crusher should exceed 93% with overall recovery in the region of 82%. The plant has been sized at this capacity as this is very much the smallest size of mill for economic operation, but will still satisfy some 25% of national demand when fully operational.

Supply of Raw Materials Inputs

The factory will require the supply of 25,000 tonnes of cane in a normal 100-day operating season. At an assumed (modest) yield of 40 tonnes of cane per hectare this will need the planting of something like 625 hectares. In practice this will represent the major component of the project, requiring the energetic promotion of smallholder participation, adequate funding for land clearing and the supply of high quality, disease-resistant planting material which will give satisfactory yields and sugar content under local conditions.

Other materials such as detergents, chemicals, lime for neutralising and packaging materials will need to be supplied on a regular basis. Some, such as poly bags, may have to be imported. The operations of the existing Pak Sap mill should establish sources for these, and joint purchasing, if this can be arranged, may lead to lower costs.

Modest quantities of potable water and around 350 kilowatts of electrical power will be required each day which will presumably present no problems in Savannakhet. Fuel for the operation of the factory is provided by bagasse and only a relatively small pond will be needed for handling the effluent. There are therefore no adverse environmental implications of the project.

Location and Site

Savannakhet has been selected as the location for the new mill as it is the second largest and most densely populated town and province in Lao. The produced sugar will be sold here and further south towards Pakxe. It also has a history of supplying cane to an earlier Vietnamese sugar mill and local farmers can still grow cane for domestic consumption. Both land and rainfall are thought to be suitable for cane growing and according to the Savannakhet branch of the Ministry of Agriculture and Forestry, local farmers are keen to move into cane production. In fact a co-operation agreement has been signed recently to grow cane locally for supply to the existing mill across the river in Mukhdahan.

From the point of view of availability of suitable land, a site to the north of the town is suggested, but, as there appears to be little agriculture in this area at the present time, the availability of local farmers and labour will need to be confirmed.

Project Engineering

The technology for the production of plantation white sugar consists essentially of crushing cane between steel rollers, the juice being pumped to holding tanks while the bagasse is elevated to the boiler where it is burnt to generate the steam needed to operate the factory. After filtering, clarifying and neutralising with lime, the juice is concentrated in a triple effect evaporator and is subsequently crystallised in a vacuum tank. It then passes through a series of washing, recrystallising and centrifuging stages before finally passing along a vibrating drier-conveyor for packaging. Some 500 tonnes of molasses will also be derived as a by-product which can be fermented or used for animal feed etc.

The Batstone equipment proposed for the mill comes in partially assembled modules in shipping containers and as a consequence is relatively quick and easy to assemble on site with little risk of commissioning problems. A layout drawing of the mill and a flow chart for the process are included in the 'Potential Investment Opportunity Pack' – Annex VI.

The estimated current cost of the installation is US$ 1 million including erection and commissioning. Full equipment lists and specification are detailed in the PIOP Annex VI. In addition the project will need the supply of five or six large trucks for hauling the cane at a cost of, say, US$ 250,000 depending on size and source of supply.

A simple shed design of factory building will be adequate for this operation. The building will be around 10 metres x 35 metres and should be located on a hectare of land. The total cost for outbuildings, fencing around the compound, internal roads and hard standing and a settling pond would be in the region of US$ 270,000.

Manpower and Management

Suggested staffing for the factory would be:

1 factory manager
1 foreman/technician
2 mechanical electrical engineers
1 laboratory technician
8 can unloaders and feeders
8 plant operatives
6 drivers

The manager will need to be experienced in all aspects of factory and plantation operations and it is suggested that an expatriate specialist should be employed for the first 12 months to direct operations and train a local manager. Some overseas training of other technical and maintenance staff would also be desirable. This replicates the development of the Vientiane mill.

Additional staff will be required to operate the nursery and the sugar mill estate together with extension workers for liaison with local farmers, plus engineering staff for the maintenance of vehicles and farm equipment.

Project Scheduling

The total implementation and construction period would be in the region of 18 months to cover the preparation of plant and building specifications and quotations, and allowing for equipment delivery, erection, commissioning and site works.

During this period it will be essential to initiate the planting of cane for the first year's operation of the mill as the crop will need some 15 months growing time following land clearing operations.

Bearing in mind the historical problems associated with establishing cane for the Pak Sap mill, a practical schedule needs to be drawn up for the gradual build up of factory operations to achieve full capacity. It is suggested that a five-year programme is realistic and adequate funds need to be provided to support the operation of the factory and for land clearing until profitable working is aci. ·ved. A plan along the lines outlined below might be realistic.

Year	Cane (tonnes)	Area requirement (hectares)
1	5,000	125
2	10,000	250
3	15,000	375
4	20,000	500
5	25,000	625

Financial and Economic Analysis

Implementation costs include the provision of expatriate management (Kip 36 million) (based on the IBRD consultant rate for the new Pak Sap manager), funds to support factory operations until an economic level of throughput is achieved, funds for the clearing and preparation of land for planting at Kip 100,000/ha, and Kip 350,000/ha for planting and maintenance of the mill plantation up to harvesting. These costs are based on the Pak Sap experience. It is assumed that the enterprise will clear and plant 100 hectares of their own land each year to give them a total plantation size of 500 hectares by year 5.

Operating costs (including electricity, lime and other chemicals, poly bags, etc) are based on the current levels estimated by the Pak Sap Mill, except that wage rates for local staff have been doubled. These rates are based on the published GOL minima (see Annex 16). Production costs are summarised in Annex VI. The only costs obtainable were from informal records discussed with junior management at one meeting at Pak Sap. Sugar cane would be purchased at Kip 10,000 per Ton from farmers, and its wholesale ex-factory price is Kip 350 per Kilo (to compete with Vietnamese imports).

The financial analysis is summarised in the following table. For simplicity, costs are shown to be those at full operation, as is the throughput of the factory (ie, by year 5).

As well as being financially profitable (on the base annual full development costs, a rate of return of 17% is suggested), economic benefits accrue in the form of income-earning opportunities for a relatively large number of farmers (several hundred), jobs at the sugar mill (around 100) and import substitution.

Risk and Uncertainty

As regards sources of risk, the potential for success of the investment will depend on smallholder farmers being recruited at an early stage and a programme developed for the progressive expansion of cane planting in the Savannakhet district. This will require adequate funds for land clearing and preparation, a guaranteed price to farmers which will show an adequate return for effort, the development of suitable varieties of sugar cane and the recruitment of a skilled and enthusiastic team of extension workers to be attached to the enterprise.

A rise in operating costs by 20% due to problems of supply quantity or management failure would cause the rate of return to fall to less than 13%, and a fall in the wholesale price of sugar by 20% would cause the rate to drop to just over 11%; it therefore seems that, if management problems can be overcome, the opportunity has a good chance of success.

The recruitment of an experienced expatriate for the first year's operation of the enterprise and a farming/agronomic expert during the initiation phase of establishing cane both on the enterprise plantation and among local farmers would also be essential.

The provision of adequate finances to support the factory operations during the early years until a profitable level of operation is achieved is vital, as demonstrated by the Pak Sap experience.

Table 1 MEKONG AREA OPPORTUNITY STUDIES

SUGAR AT SAVANNAKHET

Financial Analysis summary

	(Million) Kip	US$ (000)
Investment cost:	1345	1908
Production cost:		
Operating costs	449	637
Depreciation	90	128
Interest	74	105
Total production costs	613	670
Rate of return:		
Sales revenue	875	1241
Operating cost	449	637
Depreciation	90	128
Operating profit	336	477
Interest (average 11%)	74	105
Gross profit pre-tax	262	372
Corporate tax (40%)	105	149
Net profit	157	223
Rate of return (%) =	17.2	17.2
Repayment Period (years) =	4.2	4.2

Notes to table:

1 The format for this economic summary follows the UNIDO guidelines in the pubication ID/206.
2 The rate of return is calculated as the sum of net profit and interest divided by total investment outlay.
3 The repayment period is calculated as total investment outlay divided by the sum of net profit plus interest plus depreciation.
4 For both Thailand and Lao depreciation and interest are calculated at 6.7% and 11% respectively.
5 All opportunity studies assume the equity of the sponsor is 50% and borrowed capital, on which interest is payable, a further 50%.
6 In countries the total of corporate taxes have been estimated at 40%.
7 Exchange rate used = US$1.00 = Baht25/Kip705

POTENTIAL INVESTMENT OPPORTUNITY - VII

COFFEE AT PAKXONG

Background

This opportunity study begins with some background to the original investment in coffee production and processing, which it is now proposed to enhance.

The Pakxong Coffee Mill is operated by the Coffee Company of Pakxong under the direction of Mr Simek Sihavong (also a major coffee grower). The mill was established in 1985 with assistance from East Germany at a reported cost of US$ 5.0 million; it is equipped with 'Fortschritt' plant and machinery. In addition to milling facilities, there are substantial warehousing facilities for the storage of clean coffee packed in jute bags for both local and export marketing.

The mill has an installed capacity of some 3,000 tonnes per season but only processed 1,600 tonnes in the 1991 season. The balance of 3,400 tonnes from the local crop of 5,000 tonnes is presently being rough hulled at village level in some 50 modified rice mills, many of which are mobile. This is apparently because the Pakxong mill is not able to offer any price incentive to farmers who prefer to use the services of the mobile local mills.

The basic process carried out by the Pakxong mill is firstly to reduce the moisture content of the sun-dried cherry as delivered by the farmers. Typically it arrives at 18% to 20% moisture and this is reduced to 12% in two 50-Ton silo driers. The dried cherry is then cleaned and de-stoned before being de-husked in modified rice hullers, followed by polishing and size grading. The quality of finished clean coffee is not as good as it could be. Although many of the current difficulty lies in the poor quality of cherry as delivered by farmers, much can be done to improve the milling process by replacing and renovating key components. This is the essence of the current opportunity.

Under present conditions, the modified East German rice-hulling machines from Fortschritt do not work as well as specialised equipment. The final grader, which is not working properly, is only able to separate clean coffee into two categories. Both locally-produced Robusta and Arabica beans are delivered mixed to the mill and most coffee is exported as a mixed UG (ie, 'ungraded'), the greater part without any hand sorting of black beans and other defectives. As a consequence the coffee does not achieve good export prices, and only a small quantity of Arabica is marketed at the higher prices that this can currently command.

It is therefore proposed to upgrade and improve the milling operations by replacing the hulling machines, renovating the grader, and installing catadors to further refine the grader and selection process. It is felt that both the level of investment, as well as its basic nature, fit well with current internationally-funded activities to increase value added from coffee production and processing in southern Lao.

Marketing and Demand for Product

There are two separate markets for Lao coffee – the domestic and the export. A detailed description of these is given in the paper contained in Annex VII – the Potential Opportunity Investment Pack for this opportunity study. The improvement in coffee through grading and milling would be designed to meet the needs of the export market, as the local market will only marginally be able to absorb any quality improvement.

South-East Asian coffees compete with East African alternatives, and are generally regarded as inferior to the latter. The current export prices obtained for Lao coffee (say around US$ 800 per Ton FOB Savannakhet for UG) seem reasonable on this basis.

It must be remembered that Lao is competing in an extremely competitive world environment, in circumstances of increasing production (especially of Robusta, eg from Vietnam) and with the recent collapse of the International Coffee Agreement to regularise prices and stocks. Nevertheless, the market is essentially quality-driven and increases in quality will be associated with corresponding increases in price. It is impossible to say at present to what extent the quality improvement opportunity might actually succeed, and for the purpose of the financial analysis different quality/price scenarios have been modelled. Both supply and demand elasticities for coffee are historically low over the long term, but demand increases in recent years have come from the US, Japan and Korea, and Western and Eastern Europe.

It is suggested in the Annex that a series of export descriptions be developed for Lao coffee which is to be traded. Five Robusta and three Arabica grades should be sufficient, with appropriate differentials from a reference price in each case.

Supply of Raw Materials

Coffee has been grown in the Pakxong district of the Bolovens Plateau in Southern Laos for many years (since colonial times in fact), and production is currently a little over 5,000 tonnes per annum of clean coffee. A UNDP programme is currently aiming to improve both the quantity and quality of dried cherry being supplied to the mill and total production is forecast to reach between 10,000 tonnes and 14,000 tonnes by 1996. Detailed projections (including by Province) are given in Annex VII. About 85% of the crop is Robusta coffee and 15% is Arabica coffee.

Currently there are many problems associated with the quality of dried cherry being supplied for processing as farmers generally only pick once in a season, followed by drying on the ground. As a result of the activities by resident World Bank specialists in the areas of agronomy and extension, some farmers are now picking three times and drying on tables. Notwithstanding this, much of the sun-dried cherry has a high moisture content and is mixed Robusta and Arabica, containing stones and soil, and beans which are a mixture of ripe, over-ripe and under-ripe. By means of education and price incentives, it is planned under current projects to encourage farmers to improve harvesting methods and upgrade village hulling operations to achieve gradual improvements in dried cherry quality.

The immediate requirement is to ensure that the mill is equipped with appropriate machinery to cope with the expected flow and different qualities of coffee inputs. No early expansion in capacity is proposed, and the present need is to secure improvements in milling and grading to generate better prices and an increased income for both the mill and farmers.

Location and site

The investment is to be in equipment for the existing coffee mill in Pakxong operated by the Coffee Company of Pakxong.

Project Engineering

The broad purpose of the investment is to improve the crucial milling and grading operations to enable a variety of grades to be produced which will satisfy the needs of both the domestic and export markets. The improved grades and classification have been described in some detail in Annex VII, and referred to in the marketing section of this opportunity study. Improvements will require effective size grading in a renovated grader and density classification in new catadors.

The first step is to improve hulling performance by replacing the two existing Fortschritt mills with specialised equipment. The objective of this machine is to remove the cherry case and inner parchment leaving the coffee bean, known as clean coffee. This operation is also known as pelling or shelling.

A huller is basically a tube with a helical screw along its length. The material is fed in at one end, friction crushes the cherry and parchment, leaving the clean coffee. Control of friction is adjusted by gates at the discharge end of the tube which increase or reduce the mass of coffee in the screw funnel.

The next step is to renovate the existing Fortschritt grading equipment to allow at least three screen sizes of clean coffee to be achieved, ie 'above 18 screen', 'screen 15 to screen 18', and 'screen 12 to screen 15'. The grader consists essentially of a series of perforated trays with different sized holes and slots, with the largest size uppermost. The trays are set on a vibrating table and material fed in at the top gradually filters down and is discharged according to size from each screen. It should be possible to separate Arabica from Robusta as usually the round shape of the Robusta filters through the coffee mass.

The final stage of sorting is by means of catadors which separate clean coffee by density into weight categories. There are two basic types. The vertical type has a rising air current in which heavy objects fall and lighter objects are blown up and separated by means of funnels. Dust goes with the airflow. The horizontal type consists of a perforated tray set on an inclined vibrator with a bottom airflow. Light material is pushed to the outer edge while heavier material finds its lower level. Control is by flow boards at the end of the tray.

The mill does not use catadors at the present time and the investment proposal envisages the supply of three machines to secure the optimum grading for the forecast market profile.

The total cost of the foregoing renovation and equipment supply programme is estimated to be in the region of US$ 120,000, including delivery and installation. Information on suitable equipment suppliers is listed in the 'Potential Investment Opportunity Pack', but coffee milling and grading is a complex process and a detailed technical and marketing survey will be needed to assess the exact requirements.

Manpower and Management

It is envisaged that the existing management of the company will continue but there may be a need for a slight increase in the existing level of 27 operational staff as a result of the more complex grading operations. It is also envisaged that substantial on-site training will be required by a resident specialist following installation.

Project Scheduling

A period of 12 to 18 months will be required to include a detailed study of existing operations, preferably during the operating season, followed by equipment specification, quotation, supply and installation. A parallel assessment of repairs necessary to the grading machine will have to be carried out followed by the visit of a suitably qualified engineer from the suppliers.

Financial Analysis

Various uncertainties surround the financial and economic analysis of this opportunity. Although the investment costs for the proposed machinery are fairly easy to estimate (84 million Kip) and no problems should be encountered installing it in the existing mill, the only experience of operating costs in such an environment (ie, the Bolovens Plateau) are those obtained from the mill itself. Thus, the necessary 30 or so staff are assumed to currently earn Kip 25,000 per month (based on the recently adjusted minimum rates), and diesel costs Kip 350 per litre (20 litres are needed per hour.) Operating costs are therefore the sum of these at 84 million Kip, the basis for this figure is outlined below.

Of more importance, however, is the doubt which surrounds the achievement of better prices from better grades, which in turn is based on both quantity and quality improvements from smallholder farmers. Thus, a direct relationship exists between the final outcome of the project in terms of profitability on the one hand, and both the absolute price obtained for improved grades (as well as the proportion of final FOB price paid to the farmers) on the other.

The financial analysis summarised in the following table therefore assumes the following simplified factors: investment, labour and diesel costs are as already described; the mill works 150 eight-hour days per year, processing its full capacity of 3,000 tonnes of beans; of these beans, the improved grading and sorting means that 10% of throughput is now sold as Arabica; improved quality and grading achieves price increases of US$ 20 and US$ 30 per Ton for Robusta and Arabica respectively. No difference is assumed to occur in the proportion of FOB prices which the farmers receive. On this basis a rate of return of nearly 17% could be expected.

Risk and Uncertainty

The project is relatively insensitive to changes in (the relatively modest) investment costs, should identified technology prove to be more expensive than it currently appears; a doubling in costs only reduces the rate of return to 8%. A doubling of operating costs is more serious, sending the rate down to less than 4%. Of more concern to the project is the extent of price increases actually obtained. A price increase of US$ 10 per Ton for both coffees only just realises a positive rate of return. (The converse is of course true for higher prices – a doubling of incremental sales revenue gives a rate of return in excess of 50%, for example.)

It is, therefore, suggested that this exists as a possible investment opportunity if farmers' current quality and quantity of production can be stimulated by better pricing in the next few seasons; but that any further investigative work should be market-led, with the critical determinant of investment decision being the state of the world market for Lao coffee at that time. The extent of doubts about technical and production problems can be assessed from the IBRD Coffee project documents in Annex VII.

Table 1

MEKONG AREA OPPORTUNITY STUDIES

COFFEE AT PAKSONG

Financial Analysis summary (in year of full production)

	(Million Kip)	US$ (000)
Investment cost:	84	119.15
Production cost:		
Operating costs	18	25.53
Depreciation	6	8.51
Interest	5	7.09
Total production costs	28	39.72
Rate of return:		
Sales revenue	44	62.41
Operating cost	18	25.53
Depreciation	6	8.51
Operating profit	20	2.84
Interest (average 11%)	5	7.09
Gross profit pre-tax	16	22.70
Corpora.e tax (40%)	6	8.51
Net profit	9	12.77
Rate of return (%) =	16.8	16.8
Repayment Period (years) =	4.3	4.3

Notes to table:

1. The format for this economic summary follows the UNIDO guidelines in the pubication ID/206.
2. The rate of return is calculated as the sum of net profit and interest divided by total investment outlay.
3. The repayment period is calculated as total investment outlay divided by the sum of net profit plus interest plus depreciation.
4. For both Thailand and Lao depreciation and interest are calculated at 6.7% and 11% respectively.
5. All opportunity studies assume the equity of the sponsor is 50% and borrowed capital, on which interest is payable, a further 50%.
6. In countries the total of corporate taxes have been estimated at 40%.
7. Exchange rate used US$1.00 = Baht/25/Kip705

ANNEX VIII

POTENTIAL INVESTMENT OPPORTUNITY PACK-VIII

STICLAC CULTIVATION, LAC PRODUCT PROCESSING AND MARKETING

Introduction

This opportunity study concerns the production of seedlac in Isarn destined ultimately to support the domestic furniture producing market. It draws heavily on work already done by the Forest Products Research Division of the Royal Forestry Department.

Lac is the resinous protection secretion of a lac insect whose scientific name is Lacciffer Lacca Kerr, belonging to the family Lacciferidae; it is also found in India, China, Lao and Burma. The lac insect produces waxy and resinous matter and almost all of the lac is produced by the female after fertilisation. The male produces only small transparent amounts.

Thailand is the second largest lac producing country after India. It is difficult to quote average production as it varies from year to year. Averaged over the last 10 years, production has been around 7,000 tonnes per annum. The highest production was in the year 1974/75 at around 24,000 tonnes. The lowest production was in 1980/81 at about 600 tonnes, due to unfavourable weather conditions. (When the temperature rises over 40°C for more than six continuous days the resinous matter absorbs the heat and the lac insects begin to die.)

Presently there are about 20 lac enterprises in Thailand, almost all of them situated in the north with only one to two industries in the north-eastern area. The north produces nearly 85% of the Thai crop. All lac cultivation in Thailand is done by farmers, with RTG producing only small amounts for lac extension work.

The following sections follow the standard opportunity study format as far as possible, and there is a technical supporting paper in Annex VIII describing the cultivation methods for lac insects and other technical aspects of product manufacture.

Lac and Lac Products in Thailand

The cultivation of the lac insect, and the production of products from it, is a somewhat esoteric process, and not familiar to many potential investors. The following notes explain the various stages in the development of products from the lac insect.

Sticlac is the form in which the lac crop is obtained from trees. The lac encrustation is separated from the twigs either by breaking by hand or by scraping with a knife. Seedlac is the product obtained by washing crushed sticlac with water. Shellac is the product obtained in the form of flakes by stretching the fused resin which has been freed from infusible materials by melting it out. Lac is bleached by the use of hypochlorite solution to produce bleached lac. It is used in colourless polishes and nitrocellulose lacquers.

Normally 80% of lac is exported. About 20% is for domestic use. Normal village uses are various. Firstly, lac dye, which is fast on animal fibres such as wool and silk, is produced and has a bright red colour. Different attractive shades may be obtained by using different mordants. The silk cottage industry in the village uses sticlac for fast dying of silk. Lac must be collected before the insect has swarmed because at this period it contains the whole of the dye. In the years when the price of lac is high, synthetic dye is used instead of lac. Secondly is shellac; the utilisation of shellac in villages is for painting and furniture manufacture. Thailand produces many different grades of shellac, details of which are in the technical Annex.

The treatment of shellac varies with its quality and end use. The utilisation of bleached shellac is the same as shellac. Currently light-coloured furniture is popular in Thailand, and therefore bleached shellac is also well-known.

Lac and lac products have been graded A or B by the Industrial Standard Institute, Thailand, according to the quality of the products. Industrial specifications for each of these products are contained in the technical paper in Annex VIII. The justification for selecting the products by grades depends upon their utilisation. Products which are below grade B are not accepted by the market.

In Thailand, sticlac is not graded by type of host trees. Generally most lac is acceptable for manufacturing if the age of the sticlac is not more than two years. A factory will test the quality of sticlac by breaking by hand and heating it with a flame, then stretching the resin out. If the stretched resin is light yellow, it means that the sticlac is freshly cut; if the colour is dark red, the lac was cut within 1–2 years; if the lac has no resin at all and it burns while heating, it means that lac is too old. The price paid by the market therefore depends primarily on the age of the lac.

It is the production of seedlac intended to support the upper end of the domestic furniture market which the present opportunity study addresses.

Production would be from a seedlac factory supplied by farmers, but with its trees established nearby so as to control throughput volumes as necessary – in effect a spatially-extended 'nucleus-estate' type development.

Market and Demand for Specific Product

Thailand presently exports a large amount of seedlac, having about 20% of the world market. Figures are presented in Annex VIII. It also imports lac in years of low domestic production. It should be noted that, even in recent years of high production, all seedlac available for export was sold.

However, the Thai product is not preferred by major importers in relation to Indian material from Bihar. The Indian product is lighter in colour, and therefore requires less bleaching. This colour difference is a function of the strain of insect and, given that India will not allow export of its strains, the prospects for the Thai industry to change are presently limited. In the major importing countries (USA, UK, other Western European countries) natural polishes are increasingly being replaced by synthetic ones, and long-term world demand for seedlac and shellac will be constrained. For this reason, attention is now turned to the domestic market.

It is felt by the Consultant that the main market opportunity currently exists within the Mekong Basin area in the production of seedlac for the high quality end of the domestic furniture market. This market is still based on relatively cheap labour, and good French polishing with bleached or unbleached shellac retains value added in Thailand. The proposed investment would be for a factory located in Isarn to produce seedlac from local farmers and its own sticlac, for further later transformation elsewhere into shellac.

Historical experience has shown that variations in export prices (as Thailand is essentially a price-taker) translate into production changes by farmers in subsequent seasons, often causing factories to close temporarily. It is hoped that more organised production of seedlac for the domestic market would at least partly moderate this disequilibrium. This organisation requires local processing in the form of an established factory, based on co-ordinated sticlac supplies from smallholder farmers. It also requires forward linkages with shellac producers so that the increased supply of seedlac can be sold, and eventually used in local furniture manufacture.

Supply of Raw Material Inputs

In the north, lac is grown mainly in Chiengmai, Lampang, Lampoon, Phrae, Nan, Chiengrai, Phayao, Uttaradit, Tak and distributed in small amounts in other provinces in the north. In Isarn lac is grown in Mahasarakam, Khonkaen, Loei, Udon Thani, Sakhon Nakhon, Kalasin, Roi Et, Yasothon, Srisaket, Burirum, Surin, Nakhon Ratchasima and Ubon Ratchathani province. Generally it is scattered in all directions and in small amounts and, therefore, it takes time for collecting the raw materials and for transportation. Estimates of production by area are shown in Annex VIII, as are the types of trees from which the insect is extracted.

Sticlac supplies are also from Lao, and it is felt that this opportunity could facilitate increased cross-border trade and benefit small-scale Lao farmers. Lao has the advantage that many of its forest areas are particularly suitable for lac cultivation; these have disappeared from much of Thailand. In time Lao may develop a competitive advantage in sticlac production, and could justify the sort of investment which this study currently proposes for north-east Thailand.

Presently there are two ways of obtaining raw materials. Either the factory buys sticlac through commission agents or from the wholesalers (generally appointed from minor forest-products sellers in urban areas). The seedlac factory in Isarn currently obtains sticlac from a variety of producing Changwats, usually by trucks of about 13-tonnes capacity.

Approximate Location and Site

Lac cultivation and a factory for processing could be based almost anywhere in Isarn. The high value-to-weight ratio of sticlac means transportation is not a major cost in the value of the final product. Lac cultivation has the advantage of improving farmers' incomes, and in encouraging the use of trees rather than in deforestation. Land prices and proximity to potential supplies from Lao also suggest Isarn as being a better bet for investment. Drainage considerations would be a factor in minimising environmental damage.

Project Engineering

The plant capacity of a seedlac shop suggested below is based on a raw lac supply of 1,200 tonnes. Production would be aimed at 6 tonnes/day, with a daily working of one or two shifts for 150 days a year.

The plant would need a water supply of not less than 15,000 litres/day, plus a pool for water treatment, a power supply and a site of at least half a hectare.

Investment and capital costs for the seedlac factory are summarised below in the financial analysis, and shown in more detail in the technical Annex.

Sticlac is stored in a seedlac shop in a cool ventilated room. Within four months the sticlac must be processed into seedlac. (Any longer than this and the lac will be blocked, have a high percentage of insoluble matter, and the colour will turn darker.) Seedlac is stored on a clean floor, air dried and out of sunlight. It may be raked over and put in a container just before it is sold.

Details regarding the conversion process from sticlac to seedlac, and on to shellac and bleached shellac are given in Annex VIII.

The equipment needed in this process is the following:

cracking machines
screening machine
storage bins
washing machines
drying kilns
boiler and separating blowers

All of this equipment is available in Thailand.

There are no unusual or excessive environmental implications over and above those of food processing of processing sticlac, providing that drainage of the water used in the washing process is constructed properly. All that can be said at this stage is that this aspect must be borne in mind when considering investment at any particular location in Isarn.

Manpower and Management

Based on experience from existing factories, the following personnel would be needed:

1 manager
5 administrative/clerical staff
40 labourers

Project Scheduling

The construction period for the seedlac factory would be of the order of six months, plus a further three months for machinery delivery, installation and testing.

The construction of the factory should only be undertaken after a widespread extension effort to encourage the production of a sufficient volume of sticlac by small farmers. Demonstration of technology, possible groupings of farmers, and agreed pricing, should all be part of this package.

Financial Analysis

The financial analysis which follows is based on the detailed costs provided to the Consultant by the Royal Forestry Department, and included in Annex VIII. The table below uses this data in the UNIDO format to calculate a rate of return and payback period.

The investment cost in buildings, infrastructure (including own trees) and instruments is Baht 7.8 million. Operating costs total Baht 4.12 per annum, or Baht 6.86 per Kilo of seedlac, not including sticlac purchases. It is assumed the factory buys 1,200 tonnes of sticlac per year at Baht 25/Kilo, and turns this into seedlac at a rate of 2:1. The base case shown below assumes the factory sells all its output at costs plus 10%.

On this basis the rate of return is estimated at nearly 13%, and the repayment period is approximately five years.

Economic benefits accrue to Thailand in the form of extra supply of seedlac for the local furniture industry (offsetting some previous synthetic imports, against which must be set the export earnings foregone of course), increased rural incomes and general increased stability for the lac industry in Isarn. Benefits also accrue in the form of extra tree usage, and less cutting down of forests.

Risk and Uncertainty

The investment is relatively impervious to changes in investment costs; a doubling of costs still gives a rate of return of more than 5%. The margin obtained for seedlac over raw material costs and operating costs is critical, however; a 5% margin renders the investment unprofitable, a 20% margin gives a rate of return of nearly 40%. The management of the factory to ensure a 2:1 conversion rate is therefore essential, as is the agreeing of seedlac prices with purchasers in advance.

Environmental risks exist if the factory site is not properly located for drainage purposes.

Table 1

MEKONG AREA OPPORTUNITY STUDIES

SEEDLAC IN ISARN

Financial Analysis summary (in year of full production)

	(000 Baht)	US$ (000)
Investment cost:	7800	312
Production cost:		
Operating costs	35624	1425
Depreciation	523	21
Interest	429	17
Total production costs	36576	1463
Rate of return:		
Sales revenue	37530	1501
Operating cost	35624	1425
Depreciation	523	21
Operating profit	1383	55
Interest (average 11%)	429	17
Gross profit pre-tax	954	38
Corporate tax (40%)	382	15
Net profit	573	22
Rate of return (%) =	12.8	12.8
Repayment Period (years) =	5.1	5.1

Notes to table:

1. The format for this economic summary follows the UNIDO guidelines in the pubication ID/206.
2. The rate of return is calculated as the sum of net profit and interest divided by total investment outlay.
3. The repayment period is calculated as total investment outlay divided by the sum of net profit plus interest plus depreciation.
4. For both Thailand and Lao depreciation and interest are calculated at 6.7% and 11% respectively.
5. All opportunity studies assume the equity of the sponsor is 50% and borrowed capital, on which interest is payable, a further 50%.
6. In countries the total of corporate taxes have been estimated at 40%.
7. Exchange rate used US$1.00 = Baht25/Kip705

ANNEX I

POTENTIAL INVESTMENT OPPORTUNITY PACK-I

DAIRYING IN CHIANG RAI

Introduction

This opportunity study concerns the production of processed milk at a newly-established dairy farm near Chiang Rai in Northern Thailand.

Market, and Demand for Product

The major demand for processed milk is in the Bangkok area, but there are signs of a gradual increase in demand in regional towns and rural areas. While much of this demand is based on sweetened and flavoured milks, school milk programmes and advertising are awakening the population in general to the benefits to be derived from natural milk for improved health and nutrition.

It is currently estimated that the Thai milk production industry is only geared to supply some 30% of the demand for fresh milk. This is in an environment where demand is likely to increase by 10% – 15% annually, due mainly to changing food habits. For details of the level of current demand, projections of future trends and estimates of the proportion of demand met by local production see the market paper contained in Annex I.

Pasteurised rather than UHT milk has been selected as an opportunity for investment as it is more suitable for the small scale of operation in terms of capital and operating costs, plus the technical skills needed for operation and maintenance. Both processing and packaging costs are also lower than for UHT milk.

The product would be full-cream homogenised pasteurised milk, which has a better flavour than UHT milk and is nutritionally superior. It would be packed in both 0.5 and 1.0 litre plastic bottles (to be bought-in), and 250/1,000cc sachets. This would provide the widest retail and catering market opportunities.

The new international airport currently being completed north of Chaing Rai is expected to boost local development, and a rapid increase in the number of tourists visiting the area is expected. Based on current and estimated future demand for fresh pasteurised milk in the district, combined with the possibility of capturing some of the existing market in Chiang Mai and the replacement of some of the current UHT market, it is suggested that there is an opportunity to establish a modest milk processing facility at the Mae Chan dairy farm.

The processing plant would be designed initially to process 3 – 4 tonnes of milk daily, and represents a very real business opportunity with guaranteed supplies of high quality raw material to satisfy a growing local market. There is also potential for sales out of the district to other areas in Thailand and eventually, via the new airport, to overseas markets such as Singapore.

Supply of Raw Material Input

While milk processing is well established in Thailand, based largely on the present recombination of imported milk powder, there is a steady increase in the supply of fresh milk for the manufacture of both pasteurised and UHT milks.
Up to 30,000 litres of fresh milk are expected to be available from the Mae Chan farm each day, and it is suggested that the new processing operation should be located close enough to the milking parlours to enable milk to be pumped or simply tankered for processing. This will guarantee a very high quality raw material each day at minimal delivery costs.

Other materials such as detergents and packaging will need to be delivered on a regular basis from suppliers in Bangkok. They are currently being supplied to processing operations in the adjacent city of Chiang Mai and will not present any supply problems other than relatively high delivery costs.

Potable water and electricity will already be available on the dairy farm and the proposed packaged processing plant will only require connecting to these services to be operational. There is no independent steam boiler requiring fuel. Effluent disposal will be handled by the same settling tanks and lagoons being established for the dairy farm. There are therefore no environmental implications for the proposed development.

Approximate Location and Site

The Consultant has studied the milk production, processing and marketing situation both in Thailand as a whole and within the project areas of Northern and Northeast Thailand (the Mekong Basin). A detailed evaluation has been made of the published data, and discussions were held with relevant RTG ministries and institutions, and with several private companies and industrial sources. Field visits were made to the several areas to gain first-hand knowledge of the local problems and potential for development.

As a result of these investigations, it was concluded that no potential investment opportunities presented themselves for Isarn, as the existing small milk processing facilities at Khon Kaen, Sakhon Nakhon and Surin, combined with supplies of UHT milk delivered from Bangkok and Khorat, appear to be adequate to meet the current and near future level of demand. In fact, most of the fresh milk produced in the Khon Kaen and Sakhon Nakhon areas is delivered raw to Khorat and Bangkok for processing, as local demand is very low.

However, for the Chiang Rai district in Northern Thailand the situation is very different in that, firstly, a steadily increasing local demand for fresh milk is only satisfied by a small Thai-Danish cooperative plant at Pa Tan; this is some 52 kms from Chiang Rai and produces an average of only 600 litres per day of pasteurised milk. All other pasteurised milk is delivered daily from processing plants in Chiang Mai and a range of UHT milks come in from the same plants and as far away as Bangkok. Secondly, a new 2,000 head dairy herd is being established by a Bangkok-based businessman at Mae Chan, some 30 kms north of Chaing Rai; this is expected to be in production by the second half of 1992. It is planned that early production will be tankered to Bangkok and other areas for processing.

With professional expatriate management and the current very successful trial plantings of fodder crops (such as a high-protein Napier Grass) production is expected to be in the region of 30,000 litres per day of fresh milk.

While the new processing operation could be located anywhere in the Chiang Rai area with suitable infrastructure and services, for the purpose of the current opportunity it is proposed that it will be actually located on the Mae Chan Dairy Farm. The entrepreneur who is establishing the farm is keen to develop processing once farm production is well established. Further, location on the farm will show considerable benefits in reduced land and installation costs combined with simplified raw material supply. As the farm is only 30 kms north of Chiang Rai it is well positioned to supply both the town and the growing Golden Triangle area with finished products.

Location on the farm site would only incur nominal land costs but it is understood that in the Chaing Rai area land is in the region of Baht 100,000 to Baht 350,000 per rai, depending on location; at least 2 rai would be needed for the factory site.

Adequate refrigerated storage would appear to be available at both retail and domestic levels to ensure a straightforward distribution operation and secure a good 5 – 7 day shelf life.

Project Engineering

The suggested capacity for the plant of processing 3 - 4 tonnes of milk per day is based on a packaged 500 lph pasteurising and filling operation which will enable the production of 3 – 4 tonnes per day, 7 days a week, making a total of some 1,400 tones per year. Future expansion can be achieved by installing further packaged units of a similar size. An alternative would be to start with larger scale individual components which could be progressively expanded or added to. However, this would incur a much higher initial capital outlay and is not recommended unless future market studies closer to the investment date suggest that a much larger initial capacity can be justified.

The technology for producing pasteurised milk consists essentially of taking cold raw milk and heating it in a plate heat exchanger to around 72°C for 15 seconds in order to destroy harmful/spoilage organisms. During this process, after preheating, the milk is homogenised to break down the fat globules and distribute them evenly throughout the milk to prevent subsequent separation. After pasteurising, the milk is rapidly cooled to 4°C and automatically filled into plastic bottles and sachets for refrigerated storage and distribution.

For simplicity of installation and operation, a packaged unit is proposed which requires only connection to water and electrical supplies to be operational. Such equipment is manufactured in several European countries, and both Alfa-Laval and APV are represented in Thailand. To keep the initial costs as low as possible, local filling machines, which are technically quite adequate, have been included in the price.

A typical factory layout is shown in Diagram A, in Annex I. This is somewhat more complex than is needed in the first stage of operation and can be simplified by merging some of the areas. A flow diagram for the pasteurising process is shown in Diagram B, also in Annex I.

An indication of the range of plant and equipment needed is listed below, which includes installation and commissioning and 3 insulated delivery vehicles for marketing finished products. An example of a mini dairy plant produced by APV and microtherm heat-treatment equipment produced by Alfa Laval are also included in Annex I.

Equipment for 3-4 tonnes/day Milk Processing Factory

Milk reception
Pasteurising and homogenising
Buffer storage
CIP station
Control panel
SS pipes and fittings
Filling m/c plastic bottles
Filling m/c plastic sachets
Cold store
Laboratory
3 insulated delivery vehicles

The estimated cost of equipment is US$ 200,000.

Manpower and Management

Suggested staffing for the factory would be:

Manager
Foreman
3 operatives (male)
2 operatives (female) for packing
2 drivers.

Operatives and drivers could be costed at the minimum wage of some Bt80 per day; the foreman at Bt200 per day and a manager at Bt400,000 per year. Similar costs are applied to all other investment opportunities.

Project Scheduling

The total implementation and construction period would be in the region of 12 – 18 months to cover the preparation of plant and building quotations, equipment delivery, installation and commissioning, and building construction.

Financial Analysis

Building costs are likely to be somewhat variable, depending on site conditions, the type of building and its complexity. For the purpose of the study a simply-constructed building is proposed, some 8 x 15 metres, ie 120 sq.metres, at an estimated construction cost of Baht 4,000 sq.metre. There will also have to be provision for hard standing, drainage, etc. This gives an estimated all-in building cost of some US$ 200,000, and total investment costs of some US$ 400,000.

Given its scale, the financing of this investment is likely to be either entirely through private capital, or with some 50% of investment and operating costs borrowed from local commercial banks.

Estimated operating costs are summarised below.

Raw milk purchase price	Bt 7.0/litre
Wholesale selling price	Bt 19.0/litre (average)
Retail selling price	Bt 24.0/litre (average)
Khon Kaen dairies processing costs	Bt 3.3/litre + packaging
Chiang Rai College processing	Bt 3.7/litre + packaging
Plastic bottles (1 litre)	Bt 3.50 each
Plastic bottles (0.5 litre)	Bt 2.50 each
Plastic sachets (1 litre)	Bt 0.75 each
Plastic sachets (0.25 litre)	Bt 0.25 each

With 4 tonnes/day processing, say: 50% in 0.50 litre bottles, 10% in 1.00 litre bottles, 20% in 0.25 litre sachets and 20% in 1.00 litre sachets,

2,000 = 4,000 x 0.50 litre bottles @ Bt 2.50 =	Bt 10,000
400 = 400 x 1.00 litre bottles @ Bt 3.50 =	Bt 1,400
800 = 3,200 x 0.25 litre sachets @ Bt 0.25 =	Bt 800
800 = 800 x 1.00 litre sachets @ Bt 0.75 =	Bt 600
TOTAL Bt	12,800

Average packaging cost	Bt 3.20/litre
Average processing cost	Bt 3.50/litre
Total packaging and processing costs	Bt 6.70/litre
TOTAL COSTS:	Bt 13.70/litre

Total production costs (including interest and depreciation) are thus of the order of Bt20,948,000.

There is therefore a margin of some Bt 5.30 (ie Bt 19 – Bt 13.70) per litre. This accords with current estimates of profitability of current investors in the industry. The dairy is assumed to work 360 days per year giving an operating profit of some Bt2,402,000 per year.

Production costs, rate of return and repayment period estimates are shown in the following spreadsheet table. A rate of return of nearly 17% is suggested, and this would appear conservative when compared with rates suggested by informal industry contacts.

Risk and Uncertainty

The opportunity is more sensitive to changes in the estimated operating costs than in the scale of the investment cost. A 50% increase in total investment costs, for example, causes the rate of return to drop to 10.5%, but a 2 Baht per litre increase in total production costs (to 15.7 Baht) causes the investment to become unprofitable.

Table 1 MEKONG AREA OPPORTUNITY STUDIES:

DAIRYING AT CHIANG RAI

Financial analysis summary (year of full production)

	(000 Baht)	US$ (000)
Investment cost:	10000	400.00
Production cost:		
Operating costs	19728	789.12
Depreciation	670	26.80
Interest	550	22.00
Total production costs	20948	837.92
Rate of return:		
Sales revenue	22800	912.00
Operating cost	19728	798.12
Depreciation	670	26.80
Operating profit	2402	96.08
Interest (average 11%)	550	22.00
Gross profit pre-tax	1852	74.08
Corporate tax (40%)	740.8	29.63
Net profit	1111.2	44.45
Rate of return (%) =	16.6	16.6
Repayment period (years) =	4.3	4.3

Notes to table:

1. The format for the financial summary follows the UNIDO guidelines in the publication reference ID/206.

2. The rate of return is calculated as the sum of net profit and interest divided by total investment outlay.

3. The repayment period is calculated as total investment outlay divided by the sum of net profit plus interest plus depreciation.

4. For both Thailand and Lao depreciation and interest are calculated at 6.7% and 11% respectively.

5. All opportunity studies assume the equity of the sponsor is 50%, and borrowed capital, on which interest is payable, a further 50%.

6. Exchange rate used at February 1992: US41.00 = Bt25/US41 = Kip705

ANNEX I

POTENTIAL INVESTMENT OPPORTUNITY PACK-I

DAIRYING IN CHIANG RAI

The Market for Dairy Products: History and Current Situation

Dairy products have not been a customary part of the Thai diet. Their consumption has been promoted by the cheap supply of skimmed milk powder and butter oil from temperate dairy farming countries.

The first dairy products in Thailand were condensed milk and milk powder, which are easy to store. Then, in the mid-sixties, production of sweetened condensed milk started. The Thai taste is for very sweet items and the local sugar industry came in to supply the sugar required in sweetened condensed milk. Full cream products were copied also.

As a result of steeply rising butter fat prices in the mid-1970s, butter fat was replaced in Thailand by vegetable oil, which in fact is preferable to the Thai taste, butter oil having a stronger smell (coconut oil was originally used but later palm oil which is easier to use and cheaper).

Fresh milk production was initiated by the Dairy Farming Promotion Organisation of Thailand (DFPO), in co-operation with Danish parties and financial support. Pasteurised milk was first sold in plastic bags.

DFPO very soon received more milk than it could sell. The private sector dairies were forced to receive surplus quantities of fresh milk (10 kilos of milk per kilo of imported skimmed milk powder and later 20 kilos of milk).

The take-off point for ready-to-drink milk was the introduction of UHT treatment and aseptic filling in the beginning of the 1980s. DFPO started and the other dairies followed. In the mid-eighties RTG started a very successful drink milk campaign and the surplus of fresh milk became a deficit.

The present dairy market splits as follows (milk equivalents):

Cultured products	5%
Condensed milk	27%
Liquid milk	33%
Milk powder	17%
Other dairy products	18%

Milk powder and condensed milk are slightly decreasing in market share. Liquid milk demand is increasing by 10–20% per annum. UHT milk is already a larger product than pasteurised milk and sales are growing much faster. A majority of the liquid milk is flavoured and sold in 250-cc packagings. Drinking yoghurt is also becoming more popular.

In practice the milk quota system is not needed at present. The private sector dairies have started their own collection units. The majority of the dairy products are still based on imported skim milk powder. In 1988 and 1989 Thailand imported some 600,000 tons of milk equivalents per annum. Total fresh milk production in 1989 was in the order of 150,000 tons and total milk consumption some 13.5 kilos of milk equivalents per capita. This is a low per capita consumption in an international perspective.

In 1990 only three big dairy enterprises were left in the private sector after the closure and the merger of some dairies. Additionally, a new major enterprise was very recently announced and a couple of large private dairy farms are in the process of establishing their own dairies. Locally there would be appear to be scope for private and co-operative specialised dairies to keep pace with growing domestic milk production and consumption, eg pasteurised milk, yoghurt and, eventually, cheese.

Demand for ready-to-drink milk peaks in the hot season between March and May and drops to its lowest in the rainy season which follows. Conversely, raw milk production is lowest in the hot season and highest in the rainy season. Therefore, recombined products,and particularly long-life UHT milk, have a competitive advantage over fresh milk during the second quarter of each year.

The Demand for Milk and Milk Products in Thailand

Estimates of demand in 1989 for ready-to-drink milk are 153,000 tons. Of this it is estimated that 105,000 tons will be produced in Thailand, leaving a deficit of 48,000 tons to be made good by reconstituted milk. The deficit was expected to increase in 1990 but at the current rate of increase in domestic production the deficit should be eliminated by 1993, when a local surplus of 2,500 tons may be expected in the ready-to-drink supply. However, local production supplies a much smaller proportion of total demand for all milk and milk products. Statistics for 1987 reveal that 79,000 tons were produced locally whilst the liquid equivalent of 547,000 tons was imported in various forms. This means that locally produced milk in 1987 only supplied 12.6% of total national requirements for milk and milk products.

Most processors cannot get enough locally-produced raw milk. They are increasingly keen to do so since the world price of milk powder increased from US$ 900 per ton in 1987 to US$ 2,028 in 1989: currently skim milk powder is available at around US$ 1,600 per ton. RTG directives to processors to buy two volumes of locally-produced milk for every one volume of reconstituted milk produced and to increase use of local milk by 20% per year are now in abeyance because of the shortage of home-produced milk. At present, the place of locally-produced milk in the market to processors is assured since, at current world prices, local milk is now slightly cheaper than reconstituted milk and the directive is probably no longer necessary.

Strict government control of milk prices exists. It is implemented through the Dairy Farming Promotion Organisation (DFPO). This organisation started out as an experimental farm under a bilateral aid programme of the Danish Government in the 1960s when the Thai-Danish Dairy Farm at Muak Lek near Saraburi was set up to determine whether exotic cows would flourish in Thailand or not. It is run by a board of directors composed of 11 government nominees and one non-government officer. They review the costs of production each year and set a baseline price which is then paid to bulk suppliers (such as collection centres) by the major processors. Producer-processors set their own prices at retail or wholesale level but with the present state of demand there is no incentive for price-cutting.

The result is relatively expensive milk at retail outlets. However, this has not deterred consumers in the rising affluence of urban Bangkok, where most of the milk is consumed. Added stability for the price structure for the home industry has come from recent rises in the world price of milk powder.

As yet there has been no sign that any one product has saturated the market. Almost no cheese is produced but consumers are beginning to buy imported cheese in increasing quantity.

The processing industry is well-equipped in its present form to cater for the demand. Collection, processing and marketing is well-organised; however, with such a low market share for the home-produced product there is an urgent need for the scale of the producing industry to expand. Even without any further increase in demand, domestic output could grow 10 times greater than its present level before the market would be saturated.

Table 1 details the production and sale of ready-to-drink milk in recent years, Table 2 lists the producers of ready to drink milk (and their capacity in tonnes per day), Table 3 summarises the domestic contribution to total milk supply, Table 4 projects the number of cows, milk production and demand until 1997, and Table 5 shows similar projections for a range of dairy products.

Table 1 Production and Sale of Ready-to-drink Milk (000 litres)

	Production				Sale			
Year	Pasteurized	U.H.T.	Total	Growth	Pasteurized	U.H.T.	Total	Growth
1984	15,987	56,680	72,667	1.270	15,507	53,032	68,539	3.694
1985	16,190	57,400	73,590	5.755	15,947	55,124	71,071	4.646
1986	16,343	61,482	77,825	13.245	16,115	58,258	74,373	12.303
1987	17,627	70,506	88,133	19.107	17,433	66,090	83,523	19.610
1988	18,000	86,973	104,973	17.444	17,820	82,082	99,902	18.470
1989	19,726	103,559	123,285	6.740	19,700	98,654	118,354	6.555
1990	23,687	107,908	131,595	11.402	23,600	102,512	126,112	11.567
1991	27,700	118,900	146,600		27,700	113,000	140,700	

Note: Figures for 1990 and 1991 are projected

Sources: Ministry of Agriculture and Cooperatives and selected manufacturers

Table 2 Producers and Production Capacity of Ready-to-drink Milk 1990

	Production Capacity (tons/day)		
Producer	Pasteurized	Sterilized UHT	Total
1. DFPO	35	120	155
2. Nong Pho Ratchburi Dairy Cooperations	40	45	85
3. Chiangmai Dairy farm Co.,Ltd.	12	72	84
4. Chok Chai Dairy Farm Co.,Ltd.	25	35	60
5. Foremost Freezeland (Thailand) Co.,Ltd.	5	50	55
6. C.P. Meiji Co.,Ltd.	20	35	55
7. Thai Milk Industry Co., Ltd.	5	50	55
8. Nestle (Thailand) Co.,Ltd.		30	30
9. United Dairy Food C,.,Ltd.	20		20
10. Foremost Milk Food (Bangkok) Co.,Ltd.	15		15
11. Other 13 producers	85		85
	262	437	699

Note: Excluding factory of educational institutes and small scale dairy farm promotion projects

Source: From selected producers and own estimated.

Table 3 Domestic Contribution to Milk Products Supply

Year	Fresh	Flavoured	Condensed	Evaporated
Production (tons)				
1988	28,550	123,641	94,573	11,138
1989	36,436	129,631	98,112	18,485
1990	40,400	157,164	104,494	19,596
End Year Stocks (tons)				
1988	1,432	3,323	2,737	1,155
1989	1,735	5,357	2,051	1,181
1990	1,217	8,553	1,596	1,827
Sales (million Baht)				
1988	4.98	2.19	2.13	0.23
1989	5.80	2.39	2.71	0.44
1990	8.08	2.73	3.00	0.44

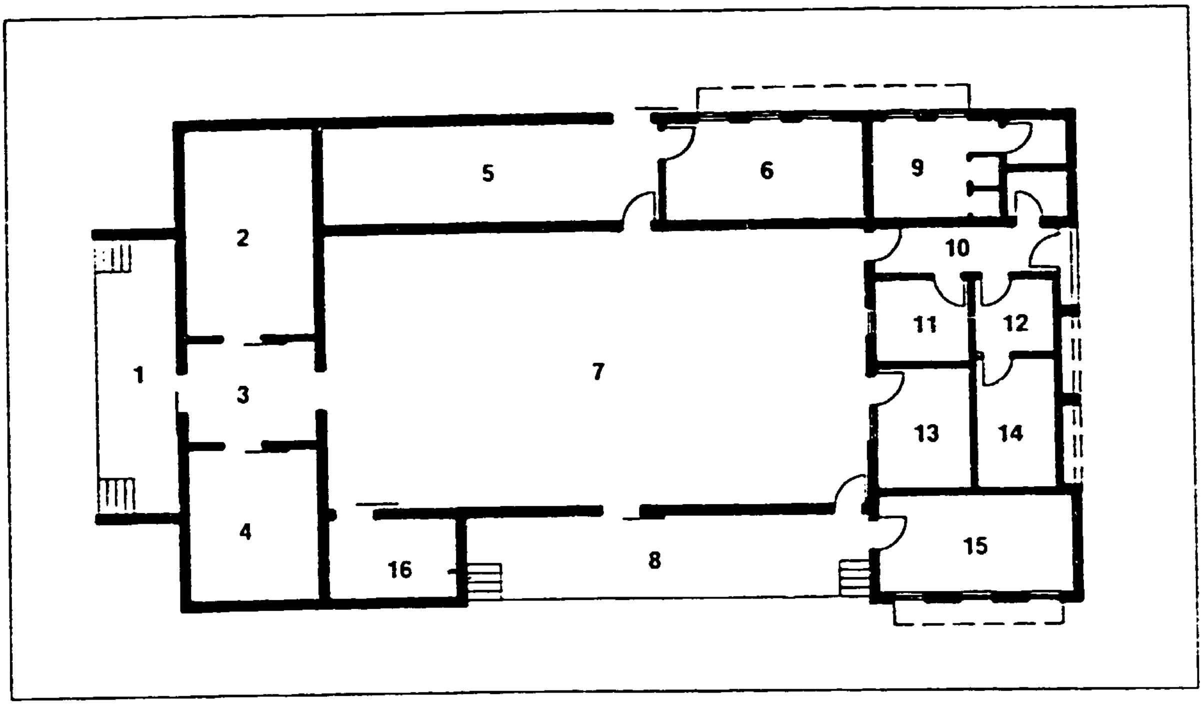
Source : Ministry of Industry Industrial Statistics

Table 4 Projected Dairy Cow Numbers, Production and Demand for Ready-to-Drink Milk, 1988 - 1997

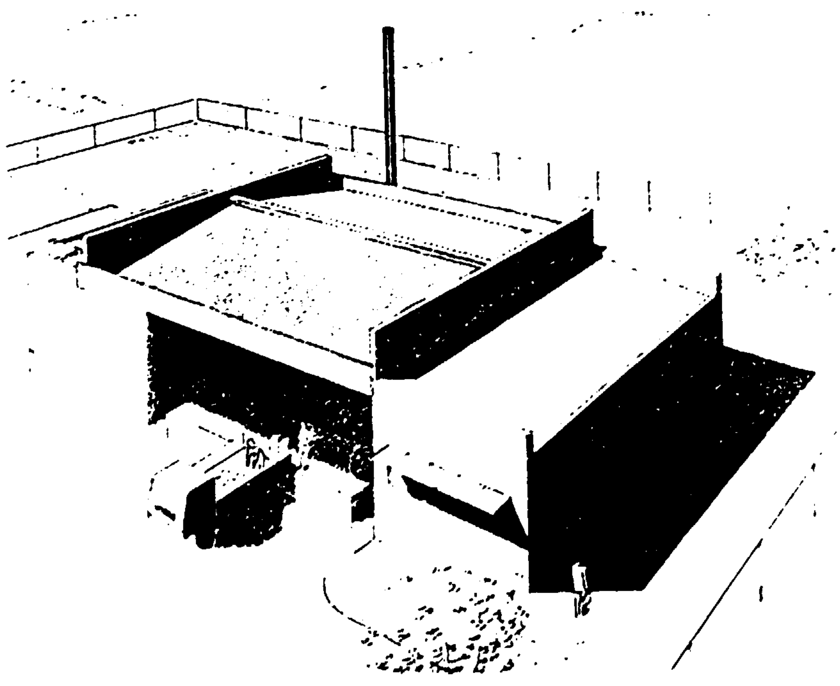
Year	Dairy Cows	Milk Production (000 tons)	Demand for R-t-D milk (000 tons)
1988	45,100	84.7	141.0
1989	50,000	105.0	153.0
1990	54,900	115.3	166.0
1991	66,400	139.4	177.0
1992	81,100	170.3	188.0
1993	95,000	199.5	197.0
1994	113,500	226.3	206.0
1995	132,500	278.3	211.0
1996	155,900	322.4	216.0
1997	186,400	376.4	220.0

Source: Landell Mills Ltd

DIAGRAM A



(1) Covered platform
(2) General store
(3) Corridor
(4) Cold store
(5) Service room
(6) Workshop and spare parts room
(7) Processing room
(8) Covered platform
(9) Staff amenities office
(10) Entrance
(11) Factory manager office
(12) Secretary office
(13) Laboratory
(14) General manager office
(15) Reception and accounts office
(16) Future production room



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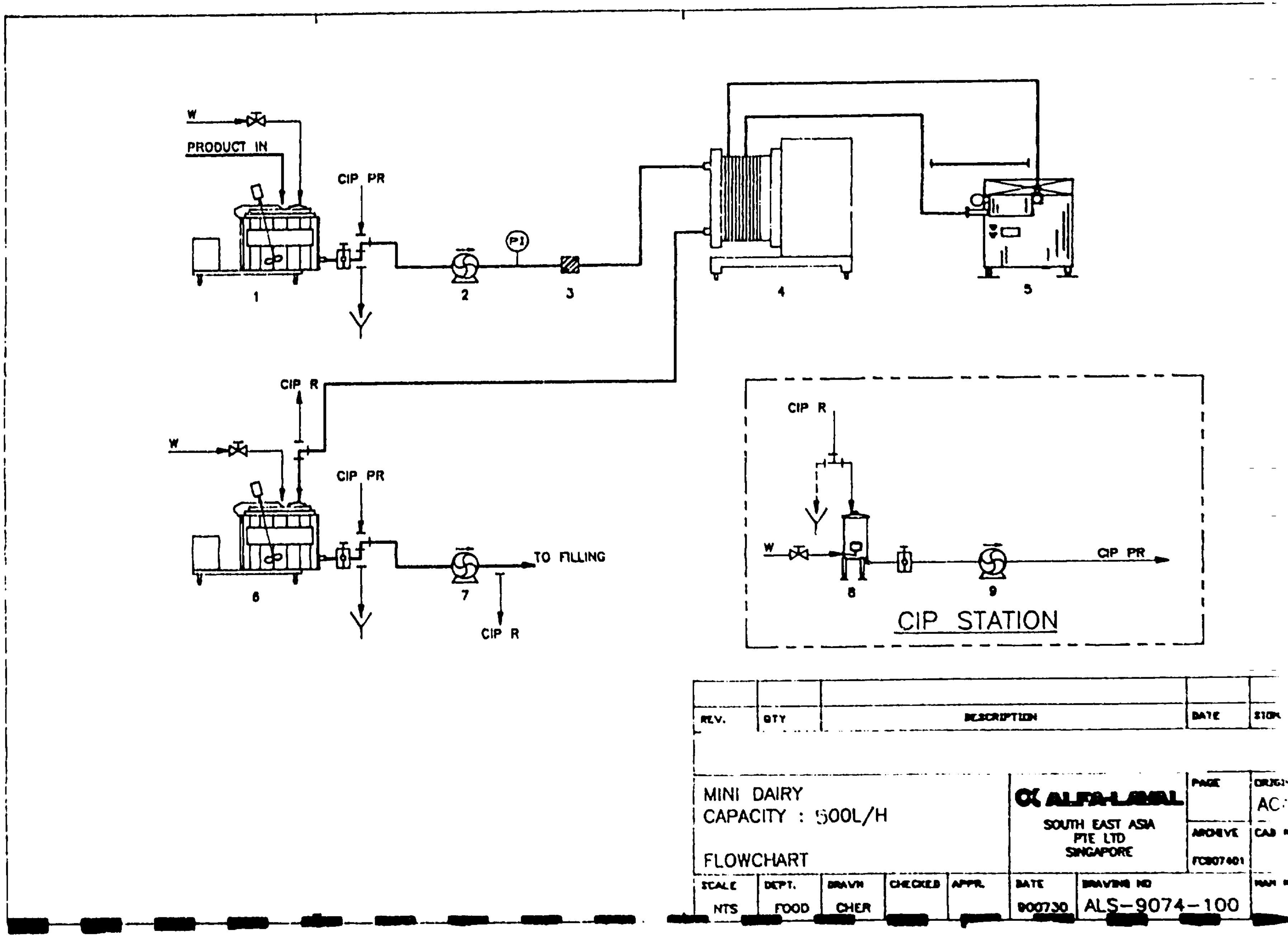
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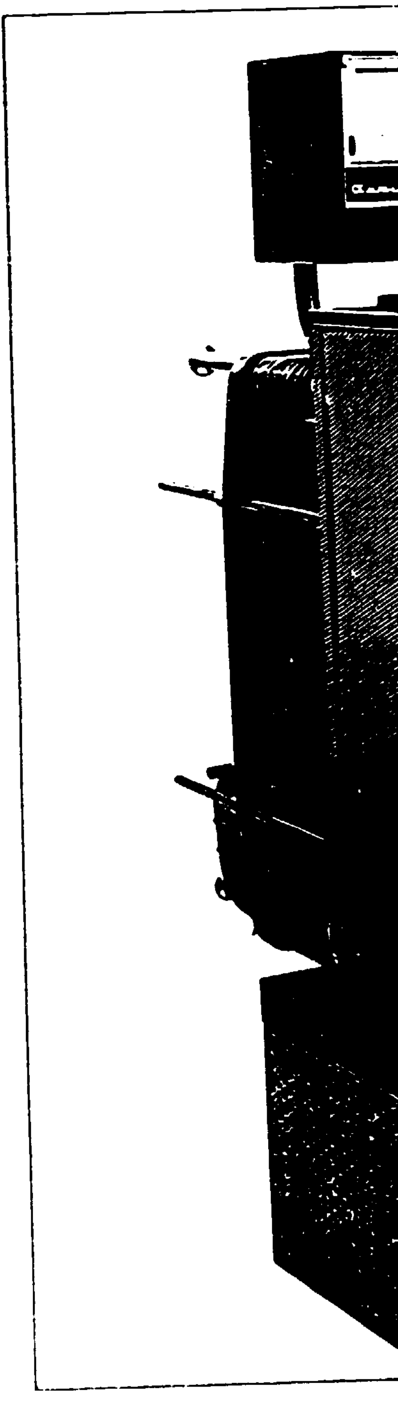
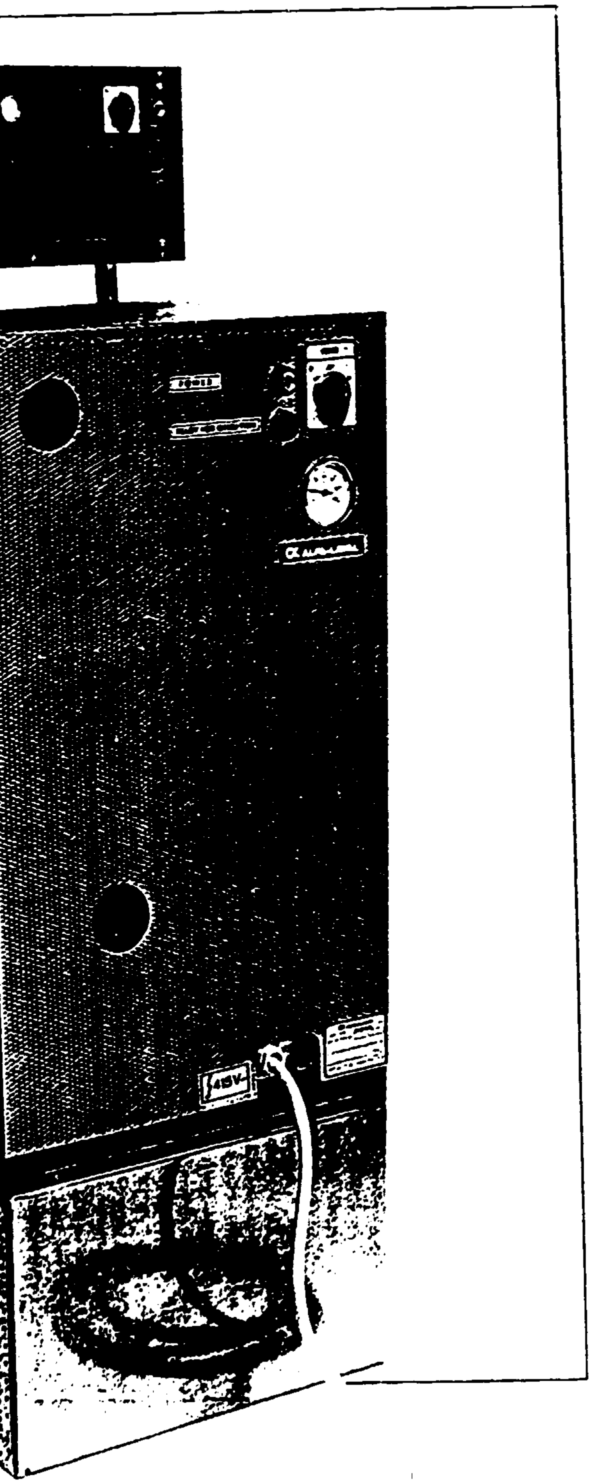


A-LAVAL

MICROTHERM for heat treatment of milk



Avantages du produit

Appareil Alfa-Laval type Microtherm:

- autorise un stockage prolongé du lait ainsi traité jusqu'à 7 jours
- tous les composants sont en acier inoxydable et en caoutchouc alimentaire, conformes aux normes FDA
- dispose d'un programme de traitement à contrôle automatique
- installation prémontée à fonctionnement immédiat
- nécessite peu d'éspace — environ 4 m²
- consomme très peu d'énergie — 1 kWh pour 200 litres de lait traité.

Product Benefits

The Alfa-Laval Microtherm:

- makes it possible to store cooled milk up to 7 days without spoilage
- has a processing system of stainless steel and rubber parts in FDA food quality
- has a completely automatic process control equipment
- is built to be an easily installed plug-in unit
- requires small floor space — only 4 m²
- has a very low energy consumption — only 1 kWh/200 litres of processed milk

Spécifications techniques

- Programme des températures: de +65°C à 80°C
- Température d'entrée du lait: de +4°C à 35°C
- Température de sortie du lait:
  - — Pour modèle sans refroidisseur: 5 à 6°C au dessus de la température d'entrée
  - — Pour modèle avec refroidisseur: 5 à 6°C au dessus de la température d'eau de refroidissement
- Voltage: 3 × 380V, 3 × 220V ou 1 × 220V — 50/60Hz
- Acier inox type AISI 316 et SIS 2343
- En option enregistreur de la température de traitement de lait et poste réfrigérant à plaques type P30

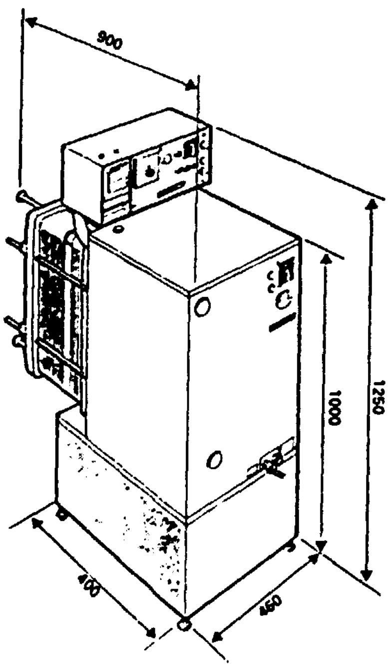
	P-300	P-[illegible]	P-900
Capacité en l/h	300	600	900
Puissance électrique en Kw	4.5	6.5	9.5

Technical Specification

Processing temperature: +65°C to 80°C

- Milk inlet temperature: +4°C to 35°C
- Milk outlet temperature:
  - — for models without recooler: 5 to 6°C above milk inlet temperature
  - — for models with optional recooler: 5 to 6°C above the temperature of the cooling water
- Voltage: 3 × 380V, 3 × 220V, or 1 × 220V — 50/60Hz
- Stainless steel AISI 316/SIS 2343
- Milk temperature recorder and P30 plate cooler as extra

	P-300	P-600	P-900
Capacity l/h	300	600	900
Electric power kW	4.5	6.5	9.5



(mm)

APV Paraflow plate heat exchangers

The introduction of the Paraflow plate heat exchanger by APV in 1923 made available for the first time a highly efficient continuous heat transfer unit with easily accessible surfaces for inspection, cleaning or replacement.
Since then, the Paraflow has become established in many sections of the food and beverage industries where heating, cooling, sterilisation and pasteurisation must be carried out under hygienic conditions. Cleaning in-place procedures have largely eliminated any need for manual attention.

Benefits of Paraflow processing

Savings in space. Paraflows require only a fraction of the space taken by tubular exchangers or open vessels.

Ease of extension. Capacity can be increased within frame limits simply by adding plates.

Resistance to corrosion. Plates are in stainless steel 316 for the majority of applications or in special stainless steels for acid and chloride bearing products. Other metals are available to suit particular processing requirements, including titanium for corrosive products such as ketchup.

Unimpaired flavour. The Paraflow's high heat transfer performance means short contact time. Heat sensitive products maintain their natural flavour.

Precise temperature control. The final product temperature can be accurately controlled to within ± 1°C if required.

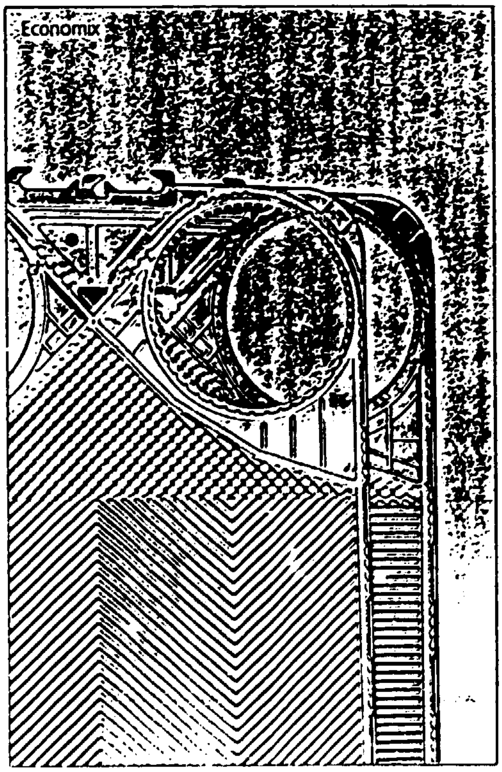
Economix thermal mixing. Certain types of Paraflow plates are available in compatible versions in which the trough geometry, and therefore the thermal characteristic, is different. By using a suitable mixture of the plates, greater flexibility may be provided to achieve a specified thermal and pressure drop duty in a single pass. This avoids the inconvenience of connections on the follower and ensures an economic combination of minimum surface area and minimum pumping costs.

Designed for cleaning in-place. The C.I.P. systems available from APV ensure maximum cleanliness with minimum disturbance of equipment.

Economies in cooling water. High Paraflow heat transfer performance means minimum cooling water rate for a given duty.

Ingredient saving. Not only does the fully enclosed heating system prevent the evaporation of valuable volatile substances but careful control of product temperature reduces degradation of ingredients, often providing significant economies in the use of expensive constituents such as thickeners.

Clip-in gaskets. Most Paraflows can be fitted with the APV Paraclip gasket, which incorporates a mechanical method of attachment and requires no adhesive to retain it in position on the plate. During regasketting it offers users substantial savings in time and money for no increase in initial cost.
An important advantage of Paraclip is that it makes full use of the unique interlocking ridge system, which performs such a vital role in maintaining plate pack alignment.
The Paraclip system can also be applied to certain plates in existing installations, conversion requiring only an on-site piercing operation.

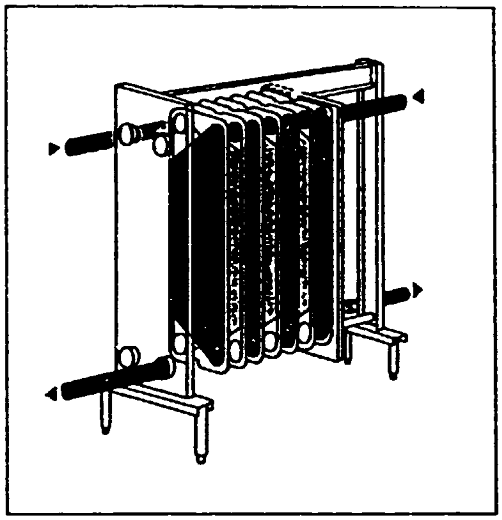


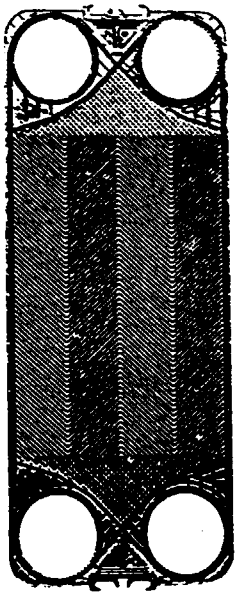
Operation

The APV Paraflow consists of a frame in which independent metal plates supported by rails are clamped between a head and follower. The plates are sealed at their outer edges and around the ports by gaskets which are so arranged that the liquid and the heating or cooling medium are directed alternately into the passages formed between plates.

High performance heat transfer. Troughs pressed into the plates produce the extreme turbulence and large surface area that provide the exceptionally high heat transfer performance combined with compactness, of the APV Paraflow.
The resultant rapid transfer of heat is further enhanced in most applications by arranging the liquids to flow counter-currently.
Depending upon type, some plates employ diagonal flow. Others are designed for vertical flow.
Heat transfer co-efficients of up to 3400-3900 kcal/m^{2}h deg C (700-800 Btu/ft^{2}h deg F) can be obtained and temperature differences between the product outlet and cooling water inlet can be as low as 1 or 2°C (2 or 3°F).

Plate length variants. Plates for several of the latest Paraflows can now be supplied in different lengths to provide a number of discrete variations in the aspect ratio. This in turn ensures that wherever possible a desired heat transfer duty can be achieved in a single frame, using a minimum number of plates. The net result is a reduction in capital expenditure and a shorter pay-back period

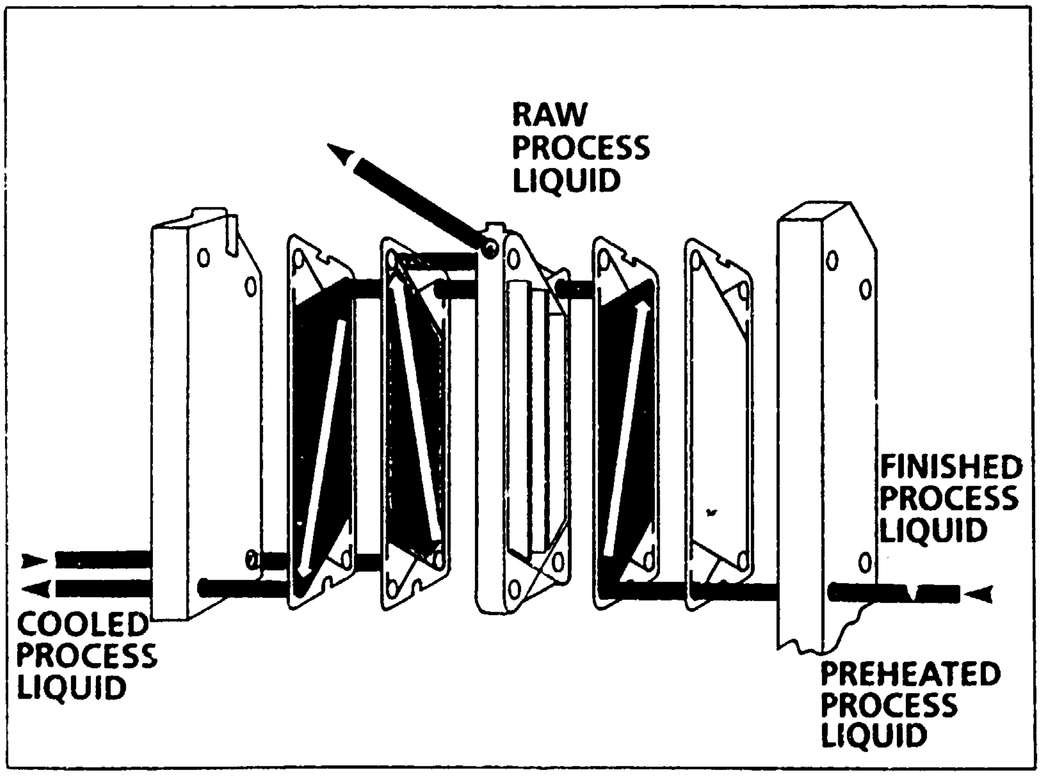




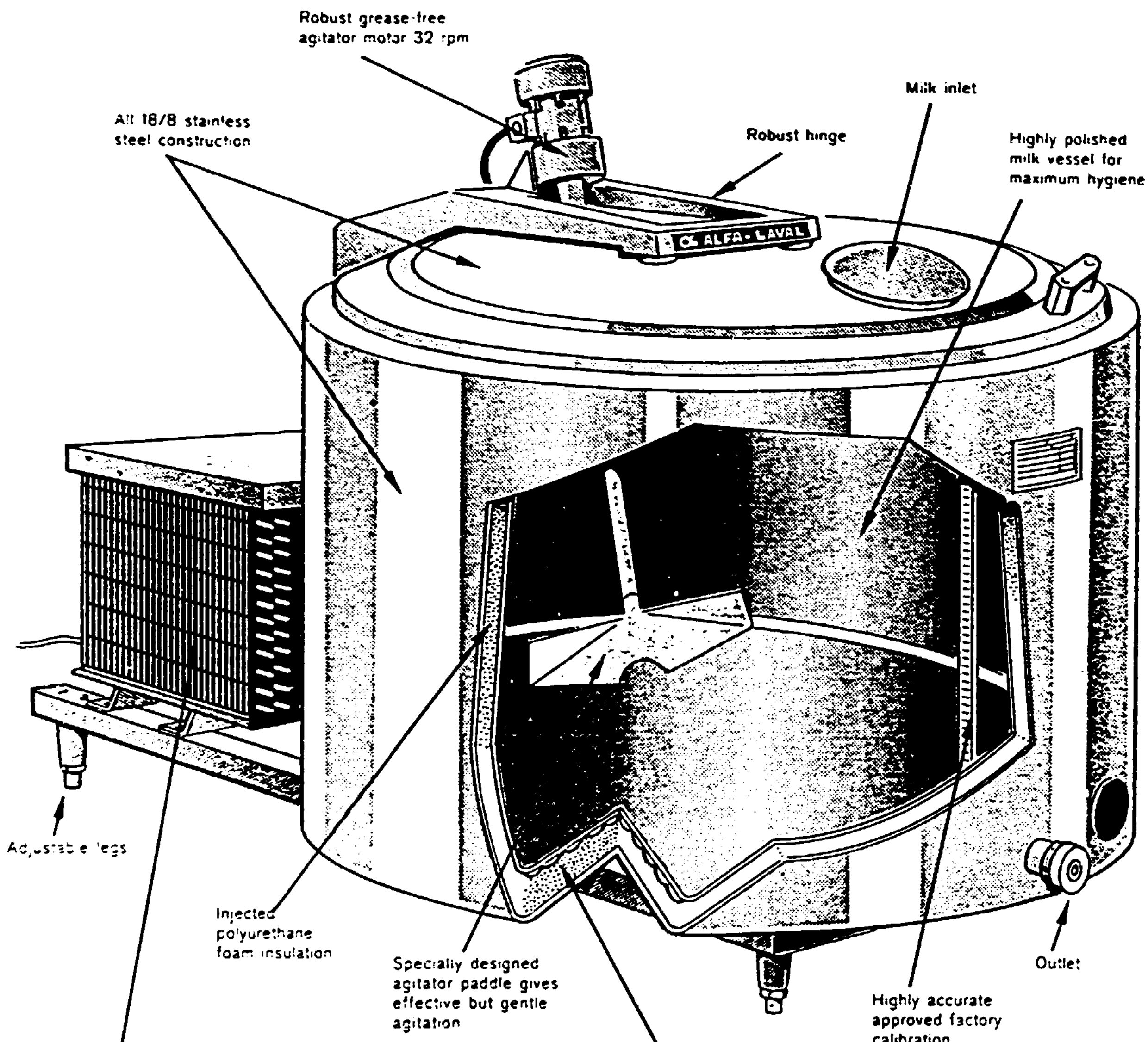
Intermixing of liquids is impossible. Gaskets are arranged to give a double seal between the liquid streams and make intermixing impossible. The interspace between the seals is vented to atmosphere, so that in the rare event of leakage there is a visual indication and an escape path for the pressurised liquid.

Energy saving by regeneration. Significant thermal economies can be achieved by using Paraflows to transfer heat between process liquid streams of widely different temperature. The subsequent reduction in heating or refrigeration requirements can provide energy savings in the region of 80-95 per cent.

Versatility of duty. Some Paraflow models can be divided into separate sections by the use of connector plates (below) to accommodate more than one heating or cooling stage.



The RFT-Tank



Factory installed condensing unit

The unit is delivered ready for use; it only need to be connected to the mains.

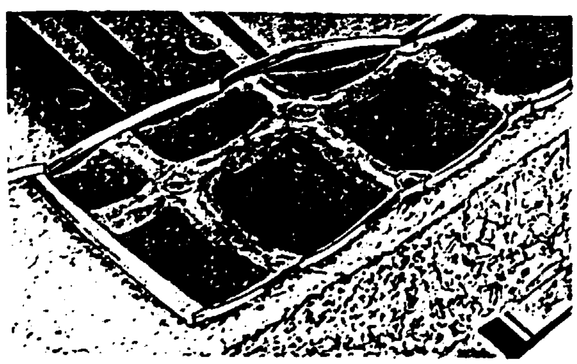
It is charged with the correct quantity of refrigerant, checked and tested.

The installation meets strict electrical standards and offer low installation costs.

Control box

The standard delivery contains an operating switch, thermostat, mechanical timer for agitation and other components required for proper control of cooling and storing.

Evaporator



The direct expansion system gives the most economical use of electricity.

Our evaporators are made of welded stainless steel, specially designed to get the optimum heat exchange between the milk and the refrigerant.

Each evaporator is individually leakage tested and undergoes special treatments to ensure many years of trouble free cooling.

ANNEX II

POTENTIAL INVESTMENT OPPORTUNITY PACK - II

MODEL FRUIT AND VEGETABLE PROCESSING PLANT FOR ISARN

Introduction

An outline of the problems and potentials associated with the future establishment of fruit and vegetable canning operations in Isarn is discussed at length in Annex 14. Similarly the background papers on Thai Agroindustrial Circumstances, Demand Considerations in North-east Thailand, and the Lessons of Entrepreneurial Experience have examined the current overall situation for agroindustry, including possibilities for fruit and vegetable processing. From these it has been concluded that many of the, as yet, undeveloped areas in this region of Thailand have strong potential for the establishment of medium-sized canning facilities, given entrepreneurial flair and technical competence. The map of Isarn at the start of this Main Volume suggests that possibilities for expansion may exist in the more eastern and southern Changwats, provided that local production can be stimulated.

As a consequence the following opportunity study has been developed as a generalised model, and is not location-specific. It may be used as a basis for the evaluation of a specific project, and modified to suit the actual capacity and range of raw materials and finished products envisaged for any new investment.

The Need for the Model

Field visits by the Consultant to a number of medium-sized canning operations in Isarn which have all been commissioned within the last three to four years have provided a clear insight into many of the technical and operational aspects affecting the viability of this type of enterprise. However, it is appropriate to mention at this point the wide variations in building design and equipment installed in these factories and noted by the Consultant. In some cases, both the buildings and processing facilities were so poor that failure of the venture seems inevitable. In one instance, a very expensive concrete and brick building had been constructed to house processing operations, which was totally unsuitable in terms of finishes and facilities for food processing operations. It had then been filled with poor quality plant and equipment without any clear thought given to product flow and handling. Not surprisingly, this enterprise has already failed due to overall lack of business expertise and technical competence.

Others have generally been much better, but there has been a universal lack of attention to factory flooring. A food processing plant is not a warehouse, and a simple concrete floor in the processing areas is not adequate. Many aggressive fluids are used which spill onto the floor, for example brine and cleaning and sterilising solutions. Fruit juices themselves tend to be acidic and corrosive. In all the factories visited there was evidence of serious breakdown in the floor structures in those areas most subject to splashing with these liquids and in some cases the concrete was close to disintegration. Subsequent repairs invariably will prove to be difficult, expensive and disruptive. It is also unhygienic and, most importantly, is unlikely to meet with customer and FDA approval for export to the USA and Europe when visits are made to factories by potential buyers and exporters. Instead of concrete, a good quarry tile of non-slip quality should be used with acid and alkali resistant grouting in those areas most subject to corrosive attack. (Floors should also be laid with adequate fall to give good drainage.) Walls in the processing area should also be tiled or coated with special paints that will allow regular washing down, but higher levels and roofing can be of a cheap and simple construction, with the minimum of framework to avoid the accumulation of dust. The factory should be light and airy to provide optimum working conditions and good visibility for plant hygiene and quality control. While the final autoclaving process to sterilise finished products will mask many unhygienic practices in the preparation of canned foods, in the long run problems will arise with both the work-force and the product quality which can be difficult to correct.

Much of the equipment used in local canning factories is made in Thailand and is both relatively cheap and well constructed. More specialised equipment such as sterilising retorts and can seamers, is probably best imported as failure at this stage of processing can have serious consequences. Locally made batch evaporators do not produce a good enough product for export in most instances and should be avoided. They have not been used in Europe and the USA for many years. They are cheap to instal but expensive to operate and tend to produce discoloured products with a degraded, cooked flavour; this has been a problem in some sectors of the Thai tomato paste industry. Continuous, multiple-effect evaporators are expensive in terms of capital costs and the manufacture of concentrated juices and pastes is not generally recommended for small to medium scale operations unless a very high value product can justify the investment costs.

While the processing of a single product reduces installation costs and simplifies management and raw material supply, it leaves an enterprise very exposed to the vicissitudes of weather, suppliers, transportation, market fluctuation and a host of other factors. It is also difficult to get year-round supplies of raw materials generally needed to cover factory operating overheads and depreciation. A simple, multi-product unit is therefore proposed for the model, which can make use of a variety of fruits and vegetables in season. For Isarn a choice might be made from the following, although this list is by no means comprehensive and the actual selection will depend on the locality and perceived export and domestic demands.

Raw Material	Season	Products
Mushrooms	Year round in sheds	Whole, sliced in brine
Baby corn	June to March	Canned, whole in brine
Bamboo shoots	July to October	Canned, whole in brine
Lychee	April to July	Canned, juice or syrup
Logan	June to August	Canned, juice or syrup
Mango	January to May	Sliced or puree
Papaya	Year round	Sliced
Tomato	3 crops with irrigation	Whole, chopped or juice

Seasonality may vary slightly with location and rainfall.

By judicious selection of a well-balanced mix it is possible to minimise equipment costs, as the same lines can be used for several products. It will also enable year-round operation apart, from an annual shut-down period for major maintenance and overhaul.

Prices of raw materials and finished products can vary widely depending on the area, seasonality, level of production and world market demands as they relate to supply, quality and brand. As a consequence, the figures used in the following text can only be indicative and would need to be adjusted for specific projects. The actual mix of products and volume of each can also have a major bearing on operating costs and revenue. It is still felt, however, that investment opportunities exist in these areas, along the general lines indicated by the model.

It should also be noted that although this study is developed from Isarn experience and costs, it could be equally suitable for parts of Lao.

The Product Mix

The model canning operation has been based on the following mix of raw materials, being those most widely available and with a good market demand.

PRODUCT	PER CENTAGE
Straw Mushrooms	40%
Baby Corn	30%
Bamboo Shoots	10%
Mango/lychee/papaya	20%

It is assumed that 80% of production will be in A1-15-ounce retail packs with the balance in A10 cans for the catering market. Fruits will be packed in syrup or natural juice. There is an increasing demand for the latter in the European and North American markets.

While bottled products are steadily increasing in popularity, this requires somewhat more skill in processing and is more expensive. This process is, therefore, normally reserved for high quality products only. It has not been included in the study but should be a subject for consideration by any interested entrepreneur. Suitable bottles are manufactured in Thailand but the caps may have to be imported.

Market, and Demand for Specific Product

The domestic and export demands for a range of fruit and vegetable products have been dealt with in the Annexes already mentioned. Essentially there is an outlet for any quality product for sale at reasonable cost. Many processors have hitherto only been able to deliver to the market on these terms intermittently, and the intention of the current opportunity is to overcome these problems. The level of output from the proposed investment would have no effect on the market price of the products overall.

Supply of Raw Material Inputs

Raw materials would be produced by outgrowers on a direct contract basis, with the enterprise providing seeds and planting material etc through its own extension service. The requirements for success in securing adequate supplies of good quality raw materials have been identified in various of the Annexes. The shed growing of mushrooms should be considered as a possibility to give year-round production of the required size and quality. For more technical details on straw mushrooms see the opportunity study for the production of them at Chumpae (PIOP III)

Other materials such as salt, sugar, detergents and sterilising compounds plus canning and packaging materials are readily available from domestic manufacturers and suppliers. Only the best quality materials should be used for export products, and the final presentation is particularly important.

A good supply of potable water is important and this can be a limiting factor in the selection of a suitable site for the factory as salinity is an increasing problem in some areas of Isarn. Electrical power and fuel will also be required. There should be no major effluent problems from this type of factory but some pre-treatment and a pond will be required.

Approximate Location and Site

The project is not location-specific, but various factors will need to be considered in selecting a suitable site. These include the availability and cost of land and services, the availability of labour, both for crop production and factory operation, the quality of roads and general infrastructure, water and power supplies, and suitability of locality for growing the required crops.

Land costs in Isarn are generally lower than in other parts of Thailand, although it may be well to plan on the basis of the figures quoted in the dairying opportunity for Chiang Rai and expect costs of anywhere between Baht 100,000 and Baht 350,000 per rai. It has already been suggested that future possibilities and growth areas may well be mainly within the southern and easternmost Changwats of Isarn.

Project Engineering

The suggested capacity for the factory is based on a maximum throughput of 10 tonnes per day of raw materials on two canning lines and one juicing line. A target annual throughput of 2,500 tonnes of fruit and vegetables is envisaged, ie some 7–8 tonnes per day for 330 days which will yield about the same tonnage of finished products. Although yields from raw materials to canning can fall by as much as 50% in some cases, the balance is made up with juice, sugar, brine and the weight of the cans. Total production of cartons is hoped to be in the region of 200,000 per year.

General purpose processing lines are required, incorporating raw material sorting, blanching, preparation, can filling and sealing stages to handle a variety of fruits and vegetables. Where possible, locally-fabricated equipment should be used to reduce initial costs, subject to the quality being adequate for the purpose. A flow diagram for the sequence of operations in the canning of baby corn is shown in the PIOP Annex II. In addition, a brief outline covering the technology of food processing is included in Annex 19.

A layout drawing for a typical medium-sized fruit and vegetable canning factory is also included in the PIOP. This includes provision for extension in the future by adding a third canning line and an evaporator for the manufacture of concentrated juices and pastes.

Investment costs can vary widely depending on the source of equipment and degree of automation. As labour costs are relatively low in Isarn, expensive labour-saving equipment is not necessary at this time (of the type provided by many European manufacturers): blanching can be carried out in simple open vats rather than on continuous machines; cans can be filled manually and sealed semi-automatically, for example. Based on discussions with several enterprises visited by the Consultant during field trips, an installed equipment cost of US$ 600,000 is thought to be adequate. A list of major components is shown below.

Typical list of major components for a fruit and vegetable canning operation:

1. Washing and feeding units
2. Inspection tables and scales
3. Trimming, sizing, peeling line
4. Blanchers
5. Elevators
6. Slicers
7. Juice extractors, pulpers, fillers
8. Can washer
9. Canning line
10. Check weighers
11. Brine, syrup preparation vats
12. Brine, syrup filler
13. Conveyor-exhauster
14. Can seaming machines
15. Crates and autoclaves/retorts
16. Accumulating tables and labelling machines
17. Carton sealer
18. Miscellaneous tables and conveyors, bins, trolleys

19. Pallets and forklifts
20. Laboratory and workshop equipment
21. Steam boiler and water treatment.

Building and civil engineering costs, including internal roads and hard standing, outbuildings, warehousing and effluent disposal will total a further US$ 600,000. (These costs came from the only available informal estimates the consultants could obtain. Whatever the size of enterprise, a marked reluctance to allow investment costs to be discussed was apparent.)

Manpower and Management

Total labour requirements tend to be very seasonal in this type of operation, as there are inevitably periods when raw material intake is low, while at other times there can be a flood of material at the times of peak harvest. A high degree of flexibility is therefore required in the work-force, and a core of workers is retained throughout the year who have experience in a wide range of preparation and processing operations. These will be supplemented with general workers who are recruited on a casual, seasonal basis. Minimum staffing may be as low as 50, rising to 150 during times of peak production, with an average of around 100 throughout the year.

A typical breakdown would be:

1	factory manager
3	line foremen
20	reception, preparation and blanching
60	canning line
6	can sealing and packaging
4	warehousing
4	drivers and miscellaneous
2	laboratory
3	engineers
10	extension officers

ie, some 113 in total, operatives and drivers could be costed at the minimum wage of some Bt80 per day, the foreman at Bt200 per day and a manager at Bt400,000 per year. Similar costs are applied to all other investment opportunities.

Project Scheduling

The total implementation and construction period would be in the region of 18 months to include the preparation of plant and building specifications and quotations, followed by equipment delivery, erection, commissioning and building works. During this period it will also be essential to sign up enough farmers to produce crops for the first season and organise planting materials, other inputs, and recruit a small team of extension officers.

A three-year period should be allowed to build up to full operating capacity but it is important to get off to a good start to minimise operating capital requirements. A reasonable schedule of throughput might be:

Year 1	1,000 tonnes
Year 2	1,800 tonnes
Year 3	2,500 tonnes

Implementation costs would need to include the following elements: funds for crop purchase; funds to support factory operations until an economic level of production is achieved; funds to support extension activities and farmer inputs; and marketing expenses. A lump sum amount of US$ 200,000 has been added to construction costs for these.

Financial Analysis

The total investment cost is, therefore, of the order of US$ 1,400,000 (ie, US$ 1,200,000 for construction, plus funds for extension etc). At full production, seven to eight tonnes of fruit and vegetables per day probably translates into an average of 675 cartons per day.

The following are estimates of raw material costs for the earlier suggested crops, based on 1991 market price data:

PRODUCT	RAW MATERIAL COSTS
Straw Mushrooms	20 Baht/Kilo
Baby Corn	15 Baht/Kilo
Bamboo Shoots	20 Baht/Kilo
Mango/lychee/papaya	17 Baht/Kilo

Overhead costs, electricity, water, labelling, cans and bottles, labour, and transport to market, etc, are estimated at an average of Baht 180 per carton, irrespective of type. This data is higher than was used in the straw mushroom opportunity study, expecting that the factory will be more complex to manage and maintain. In the case of straw mushrooms, for example, labour costs for sorting will be higher for production based on fields rather than sheds.

Typical FOB, Bangkok values per carton for these products canned might be as follows:

PRODUCT	VALUE PER CARTON
Straw Mushrooms	16 US$
Baby Corn	8 US$
Bamboo Shoots	8 US$
Mango/lychee/papaya	8 US$ (average)

If throughput and production were in the annual volume and proportion suggested earlier, total annual expenditure on product would be Baht 29,975,000, and total sales revenue would be some Baht 49,500,000, as the first table, below, suggests.

On these estimates of investment and operating costs and revenues, the rate of return is estimated at a highly positive rate of around 42% (second table).

Risk and Uncertainty

As presented, the opportunity appears fairly resilient to costs changes. A 20% increase in investment costs only causes the rate of return to fall to 26%, and a similar increase in operating costs only causes the rate to fall to 21%.

Isarn offers a potential for the setting up of a number of new fruit and vegetable canning operations along the lines of this opportunity study based on locally produced raw materials. But any new enterprise must be market-led, and entrepreneurs will need to establish good contacts with export agents and overseas importers to secure data on market demand and prices for a variety of finished products. These then need to be balanced with the producing ability of a particular location so that a specific capacity and mix can be used as the basis for a profit plan and equipment costs, etc.

Having decided to go ahead, the various requirements and conditions for a successful outcome which have been discussed in the preceding pages and in various Annexes must be met. They may be summarised as follows: good business sense and technical competence will be required as will effective communication with farmers and the ability to build up a trusting working relationship; the availability of sufficient funds for crop purchase and to support factory operations until a profitable level of production has been achieved; an ability to apply high standards of quality control at all stages of the operation is essential; and, in general, the establishment of appropriate processing technology in a suitable building to achieve the best value for money and enable a high quality of production to be achieved consistently at minimum cost. This requires considerable effort and research at the design stage and can only be achieved if the entrepreneur has sufficient appreciation of the technical and agroindustrial constraints and requirements.

MEKONG AREA APPORTUNITY STUDIES

MULTIPRODUCT MODEL PROCESSING PLANT

Throughput volumes, operating costs and sales revenue based on suggested annual throughputs

Product	Throughput (tons)	Total Operating Costs (Baht 000)
Straw Mushrooms	1000	14400
Baby corn	750	6750
Bamboo shoots	250	2625
Mango/lychee/papaya	500	6000
TOTAL	2500	29775

Product	Output (Cartons)	Sales Revenue (Baht 000)
Straw Mushrooms	72000	28800
Baby corn	54000	10800
Bamboo shoots	13500	2700
Mango/Lychee/Papaya	36000	7200
TOTAL	175500	49500

NOTES TO TABLE

1 Operatives and drivers could be costed at the minimum wage of some Bt80 per day, the foreman at Bt200 per day and a manager at Bt400,000 per year. Similar costs are applied to all other investment opportunities.

2 Total operating costs are based on standards for the typical list of components presented earlier, plus an estimate of raw materials costs (these can very seasonally and regionally).

Table 2 MEKONG AREA OPPORTUNITY STUDIES:

MULTIPRODUCT PROCESSING PLANT IN ISARN

Financial analysis summary (year of full production)

	(Baht 000)	US$ (000)
Investment cost:	35000	1400.00
Production cost:		
Operating costs	27375	1095.00
Depreciation	2345	93.80
Interest	1925	77.00
Total production costs	31645	1265.80
Rate of return:		
Sales revenue	49500	1980.00
Operating cost	29775	1191.00
Depreciation	2345	93.80
Operating profit	23030	921.20
Interest (average 11%)	1925	77.00
Gross profit pre-tax	21105	844.20
Corporate tax (40%)	8442	337.68
Net profit	12663	506.52
Rate of return (%) =	41.7	41.7
Repayment period (years) =	2.1	2.1

Notes to table:

1. The format for the financial summary follows the UNIDO guidelines in the publication reference ID/206.

2. The rate of return is calculated as the sum of net profit and interest divided by total investment outlay.

3. The repayment period is calculated as total investment outlay divided by the sum of net profit plus interest plus depreciation.

4. For both Thailand and Lao depreciation and interest are calculated at 6.7% and 11% respectively.

5. All opportunity studies assume the equity of the sponsor is 50%, and borrowed capital, on which interest is payable, a further 50%.

6. In both countries the total of corporate taxes have been estimated at 40%.

7. Exchange rate at February 1992 = US$1.00 = Bt25/US$1.00 = Kip705

ANNEX II

POTENTIAL INVESTMENT OPPORTUNITY PACK - II

MODEL FRUIT AND VEGETABLE PROCESSING PLANT FOR ISARN

The Marketplace for Thai Horticultural Produce

In Thailand, horticulture has developed around urban centres in the traditional manner as predicted by the Von Thunen theory. The rapid growths in GNP in many countries around the Pacific basin and within Thailand itself have led to demand for more, and a greater variety of, horticultural products. In recent years horticulture has begun to develop in dispersed areas where agro-climatic factors ensure quality or where new products may be developed.

The international market for horticultural products has been growing in value terms in recent years. Although reliable statistical evidence is lacking the market is likely to have been growing also in volume terms, fuelled by the rapid rise in disposable incomes. Reflecting this, in the decade to 1987, horticulture's share of Thailand's agriculturally - generated GNP has risen from 13% to 20.5%. Also, horticulture's share of total exports and of agriculture exports has risen from 2.3% or 4.0% to 4.4% or 7.3% respectively.

Within Thailand the internal network of small merchants is an immensely efficient way of supplying inputs and distributing produce. This network works on low margins and adequately meets the demand of most of the markets in Thailand, Malaysia and Singapore. However, new markets are developing. Rising incomes have introduced higher expectations of quality in many countries. However, hotels, specialist suppliers and supermarket chains cannot always obtain the quality of production they would like to sell, and likewise, exporters often cannot meet demand from the high quality markets which have developed in Malaysia, Singapore and Hong Kong and from more recent markets in Japan, Europe and the USA.

The table below presents the percentage shares of export markets of fruit and vegetables in 1987. The total value of these exports was 12,366 million Baht.

Market	%
Malaysia/Singapore	30
Hong Kong	17
Saudi Arabia	10
North America	5
Japan	5
West Germany	8
Others	25
Total	100

In value terms by category of fruit and vegetable item the picture in the same year was as follows.

Item	Million Baht 1981	Million Baht 1987	Growth Rate per annum
Fruit and nuts (08)	642	1,147	26%
Vegetables (07)	121	292	35%
Pickled fruit and Pickled vegetables (2001)	61	603	141%
Preserved vegetables (2002)	unknown	1,324	--

Source : OAE/Department of Customs & Excise Export Figures.

All horticultural exports should continue to exhibit high growth rates. Some 80 % of Thailand's export sales are in the Pacific Basin, an area with the highest growth rates in the world.

Thailand does have a strong private sector, relatively unfettered by government regulation or corruption. The country also enjoys political stability and investment is reaching the business sector at very high rates. These factors encourage the belief that Thailand has strong opportunities to expand its market share in the Pacific basin. The major impediment to this expansion is the lack of standards. It is likely that, to remain competitive in the key high quality, high value markets, RTG will need to enforce regulatory standards for exported horticultural products.

There are three distinct markets for Thai horticultural produce. These are, firstly, the traditional market for fruit and vegetables centred around urban centres in Thailand, secondly the long standing market for fruit and vegetables in Malaysia, Singapore, Hong Kong and other regional import centres, and thirdly the newly developed high quality markets for tropical fruit and vegetables in Japan, Canada, Australia, Saudi Arabia, the east coast of the United States and Europe. Similar markets are also developing in Malaysia, Singapore and Hong Kong. In addition, a small high quality market exists in Bangkok, and similar markets are also beginning to develop in other major urban centres in Thailand. These markets are considered in more detail below.

The Domestic Market

This is almost completely supplied from internal sources. The only major horticultural imports are vegetable seeds, apples, pears and chili. Expansion in this market depends on income effects because population growth in the country as a whole is very low. Consumption of horticultural products rise as incomes increase. The very poor cannot afford to purchase fruit and vegetables and depend largely on home production and foraging from the wild. For twenty years income in Thailand have been rising at an average of 6-7 % annually. Rapid growth rates are expected to continue into the foreseeable future provided political stability is maintained. Thailand thus has a considerable number of years ahead before the volume of horticultural products consumed is likely to stabilize.

Consumption of horticultural products also depends on traditional diets and culinary practices. Thai cuisine includes a reasonable proportion of vegetables and fruit and these products are consumed in relatively high quantities in urban and more prosperous rural areas. Traditional diets amongst the poorer sectors of the rural community are less varied and fruit and vegetable consumption is low. It is expected that as incomes rise, traditional diets will change.

Once incomes arrive at a level where all basic consumption needs are met, the rate at which the volume of fruit and vegetables is consumed slows rapidly. The value of total horticultural produce continues to rise because of demand for higher quality products and it has been observed in recent years in Thailand that quality markets are developing for a variety of horticultural products. This trend is expected to continue.

In other countries it has been observed that the growth in value of total horticultural consumption rises at least as fast and sometimes faster than the growth rate of GNP. It is, therefore, fairly safe to predict that the internal market for horticultural products will continue to grow in value terms by at least 6 % annually. This growth will be divided between an increase in volume and increase in quality requirements.

Traditionally, the Thai consumer had judged quality on flavour rather than in terms of appearance. In this respect Thai preferences are well met. The internal demand for quality, reflected by price differentials between goods within the same product group (e.g. different mango, durian or chili varieties) is a more recent occurrence. Supermarkets, hotels, restaurants and other specialist outlets are actively seeking high quality supplies for the internal market. Demand for exotics (e.g. apples, asian pears, kiwi fruit, strawberries) is also increasing.

The Thai consumer is still usually not prepared to pay higher prices to obtain non-seasonal goods, reflecting traditional seasonal tastes and the range and variety of production. Good fruit is available throughout the year. The developing quality market is expected to gradually contribute a proportionately higher percentage of the total internal value of Thai horticultural produce. It is not expected that any significant rise will occur in horticultural imports.

Traditional export markets

Thailand, by virtue of its wide range of agro-climatic zones, its relatively efficient private sector marketing system, its political stability, and its relatively low wage structure has a considerable comparative advantage, especially to neighbouring markets in Malaysia and Singapore. This market advantage is likely to be slowly eroded by its competitors in Indonesia and China within the two major product groups, tropical and sub-tropical fruits. Thailand's advantage will only last if it can continue to exploit its leadtime in private sector efficiency to reduce operating margins. New competitors could arise in Burma, Vietnam and Laos. The very rapid growth in export sales is likely to slow for traditional low quality goods. However, Thailand's business efficiency should ensure steady continued growth fuelled by population growth and rising incomes in the ASEAN area. The total growth of these markets will continue as populations and incomes in the Pacific region rise.

High quality markets, and the importance of Japan

These offer the best potential for rapid export growth in value terms. The continued development of an internal quality market is very important to this process. In recent years Thailand has gained new high quality markets in Japan, Australasia, Saudi Arabia and Western Europe. High quality markets have developed also in Hong Kong, Malaysia, Singapore and Taiwan. Unexploited market potential exists in Bahrain, other Middle Eastern States and South Korea. Thailand is competing for these markets locally with the Philippines and Malaysia and further afield with South Africa, Israel, Brazil, Mexico, etc. Other countries will also compete for these new markets. It is likely that some RTG regulations of export standards will be important in certain product lines. Market growth for processed products also offers very attractive potential for exploitation.

In the 1980's export markets for Thai fresh fruits were dominated (over 70%) by three destinations - Hong Kong, Singapore, and Malaysia. But it is a fourth Asian country (Japan) which offers the greatest long term potential. Penetrating the Japanese market is not easy - quality control is a sine qua non, as witness the fact that many fruit items from Thailand have been banned as a result of being unable to company with the phytosanitary rules of the Japanese Quarantine Act. Amongst the items so affected have been rambutan, mangosteen, melon, water melon, longan, avocados, loquat, litchi, plums, pomegranate, pomelo, orange and tangerines.

At present, further import restrictions are under consideration via Japan's Food Sanitation Law. The main thrust of Japanese restrictions relate to the possible presence of banned residues.

Thai producers are responding to Japan's needs - ivory mangoes, bananas and pineapples are sold in Japan and it is hoped that mangosteen and other mango varieties will be permitted soon.

As regards processed items, restrictions on orange juice will be lifted as of April 1992 (various other juices were permitted entry in 1991). However, from Thailand's standpoint Japanese potential focuses upon canned vegetables and especially bamboo shoots, mushrooms and baby corn. As Taiwan declines as a source of these products due to losing its cost advantage Thailand is poised to become the second largest supplier, after China.

Most of the canned vegetables imported by Japan are for commercial use. Some, however, such as canned sweet corn and asparagus, are also for household consumption.

As regards the absolute size of the Japanese market, canned vegetables imported by Japan in 1988 were valued at $216.42 million, as the table below shows.

Table 1 JAPANESE IMPORTS OF CANNED VEGETABLES

	Amount (Tons)				Value (1988)	
	1985	1986	1987	1988	Y1 million	$1,000
Total	83,918	100,499	144,075	166,948	27,823	216,417
Canned asparagus	1,482	1,478	968	2,944	980	7,572
China	107	42	106	2,194	638	4,940
Taiwan	1,060	1,401	809	644	302	2,314
Canned Beans	5,384	7,227	6,414	936	144	1,130
Canned bamboo shoots	38,503	44,079	73,116	85,051	13,719	106,219
China	8,148	14,639	38,564	58,728	9,716	75,097
Taiwan	23,162	2[illegible],270	17,212	15,147	2,559	19,882
Canned French mushrooms	13,747	12,446	11,297	16,376	3,738	29,053
China	12,804	11,607	9,216	13,309	2,908	22,562
Canned mushrooms	2,548	3,104	4,656	6,809	1,792	14,076
China	553	1,222	2,396	3,981	1,073	8,477
Canned sweet corn	16,226	24,680	38,315	45,635	5,845	45,852
United States	16,038	24,505	37,923	45,089	5,685	44,579
Canned young corn cobs	1,866	2,793	3,117	3,840	534	4,149
Canned vegetable soup	1,121	1,450	1,567	1,786	270	2,114
Other canned vegetables	3,041	3,243	4,625	3,571	800	6,252

Source: Ministry of Finance, Customs Statistics

Principal imports were canned asparagus at $7.57 million, canned bamboo shoots at $162.2 million, canned French mushrooms at $29.05 million and canned sweet corn at $45.85 million. Canned asparagus and bamboo shoot imports come mainly from Taiwan and China, canned French mushroom imports mainly from China, and canned sweet corn imports mainly from the U.S.

Unit import prices of canned vegetables showed a rising trend to 1988. The unit import price of canned asparagus, which dropped 4.2% from its 1987 level to reach $2,572 per ton, was the exception. The unit import price of canned sweet corn reached $1,005 (up 9.9%), that of canned French mushrooms reached $1,774 (up 53.8%), and that of canned bamboo shoots reached $1,249 (up 9.0%)

Table 2 IMPORT PRICES OF PRINCIPAL CANNED VEGETABLES

(Unit: Dollars per ton)

	1984	1985	1986	1987	1988
Canned Bamboo Shoots	823.93	819.39	882.67	1,146.18	1,248.89
Canned asparagus	2,326.53	2,234.14	2,125.17	2,685.95	2,572.01
Canned French Mushrooms	1,256.48	1,239.47	1,020.41	1,153.85	1,774.12
Canned sweet corn	975.70	926.11	892.18	914.52	1,004.76

Because of the lowering of prices brought on by the rise of the yen against the dollar, and because of increasing demand for dining out, the importance of canned vegetables, particularly canned asparagus and sweet corn, is expected to grow in the future.

The scope for import growth into the Japanese market is considerable, as the following data show. In many cases the proportion of total consumption accounted for by imports can grow substantially, and is likely to do so as Japan becomes an increasingly high-cost producer.

Table 3 JAPANESE SUPPLY AND DEMAND OF PRINCIPAL CANNED VEGETABLES

	Year	Domestic Production volume	Import volume	Export Volume	Domestic distribution volume
Canned asparagus	1985	6,645	1,482	2	8,125
	1986	5,529	1,478	1	7,006
	1987	5,344	968	1	6,311
	1988	3,456	2,944	1	6,399
Canned green peas	1985	2,683	20	-	2,703
	1986	2,464	1	-	2,465
	1987	2,533	41	-	2,574
	1988	2,259	150	-	2,409
Canned bamboo shoots	1985	47,735	38,503	-	86,238
	1986	41,251	44,079	-	85,330
	1987	36,455	73,116	-	109,571
	1988	43,192	85,051	-	128,243
Canned French Mushrooms	1985	5,986	13,747	-	19,733
	1986	5,645	12,446	-	18,091
	1987	5,659	11,297	-	16,956
	1988	6,061	16,376	-	22,437
Canned Sweet Corn	1985	33,665	16,226	-	49,891
	1986	36,473	24,680	-	61,153
	1987	37,490	38,315	-	75,805
	1988	41,369	45,635	-	87,004
Canned young corn cobs	1985	-	1,866	-	1,866
	1986	-	2,793	-	2,793
	1987	-	3,117	-	3,117
	1988	-	3,840	-	3,840
Totals	1985	96,714	71,844	2	168,556
	1986	91,362	85,477	1	176,838
	1987	87,481	126,854	1	214,334
	1988	96,337	153,996	1	250,332

Sources: Domestic production volume: Ministry of Agriculture, Forestry and Fisheries, Food and Marketing Bureau
Export volume: Customs Statistics

Horticulture, and the Role of Isarn

It needs to be realised that horticulture has developed in Isarn more slowly than in the rest of Thailand. The only exception to this is the area around Pak Chong in the southwest corner of Khorat, which has very fertile soils, a climate ameliorated by altitude and is within easy range of Bangkok. Also inhibiting Isarn's ability to become a major supplier is the fact that traditional skills are lacking and the marketing infrastructure is less developed than in other parts of the country.

Within the pattern of horticultural development in Thailand, the Northeast nonetheless can become a major producer of cheap fruit and vegetables for local and Bangkok markets and for the growing processing industry. This is essentially because of low production costs.

The major commercial opportunity is for dry season vegetable production in irrigated areas. It also is considered that steady growth can continue for production of rain fed fruit.

The principal fruits and vegetables identified as appropriate for consideration for canning by an Isarn-based small or medium scale enterprise are as follows

- mushroom
- bamboo shoots
- baby corn
- tomato
- mango
- papaya
- rambutan (with/without pineapple)
- lychee
- longan.

Not all of the above may be grown in Isarn but indications are that it will prove cost effective to secure supplies from outside Isarn where necessary. Indeed, present indications are that the demand for Thailand's canned fruit and vegetables clearly outstrips demand and will continue to do in the foreseeable future. Supply management is thus the key to success.

The principal items likely to be sourced within Isarn are

- bamboo shoots
- mango
- baby corn
- papaya
- tomato

Any enterprise will therefore need to base its operations on one or more of these items. Mushrooms are the subject of an individual opportunity study, and the following notes describe the situation with respect to the other crops.

Bamboo Shoots

Bamboo shoots produced in the Northeast must be consumed locally or processed locally for canning. It is not possible to transport fresh bamboo shoots out of the region as deterioration is rapid. There is also a market for bamboo shoots within Thailand (Thailand imports dried bamboo shoots to the value of 1 million ECU annually).

The market for canned bamboo shoots has been expanding rapidly. Production in Taiwan, a major market for bamboo shoots and also the largest regional exporter, has fallen with rising labour costs. Regional demand is high. Thailand's major competitor is mainland China. The market will continue to grow but Thailand must ensure it meets customer quality requirements.

Mango

Irrigated mango, of high quality varieties, is seen as having considerable potential. The mango harvesting season in the Northeast is later than in the Central Region but earlier than in the North. The total consumption of mangoes within Thailand is very large and prices are expected to remain high for good quality fruit. At the same time there is increasing demand for canned mango worldwide.

Papaya

An estimated 23,500 tons of papaya are annually imported to the Northeast for local consumption. Most of the existing papaya production in the Northeast is rain fed and bearing ceases between November and May. The bulk of imports to the region occur at this time. Throughout Thailand, papaya yields are falling as a result of ringspot virus. Exports have fallen considerably since 1984 mainly because production cannot meet internal demand. Well managed commercial plantations, in which ringspot virus can be controlled by spray and eradication programmes will be essential if the product's substantial potential for canning is to be exploited.

Baby Corn

Thailand is the world's largest supplier of baby corn. Export growth is very large and no significant competitor to Thailand has yet appeared. Local demand within Thailand is also growing. Prices in the Northeast are significantly lower than in the Central Plains, the major producing area, and more companies are expected to establish processing facilities in the Northeast.

Tomato

Despite the existence in the Northeast Thailand of various tomato paste processing units, any proposed multiproduct plant should include this item in its output mix, but only as a supplementary item. It is assumed that any such plant will be well run and effective in its marketing; hence, it should be able to offer competitive prices to farmers and/or otherwise encourage farmers to produce for it, and to plant the correct variety. As regards variety and quality requirements, it can be noted that tomatoes grown in Italy and California have total solids of 4.5-5 Brix, which in practice means that 6 tons of fresh tomatoes will yield 1 ton of tomato paste after processing. The local Northeast tomatoes have about 3 to 4 Brix, so that at least 8 tons are needed to produce one ton of paste. It has also been found that varieties of tomato grown from imported seeds are susceptible to pests and disease under local conditions. Considerable adaptive agricultural research is thus required to select suitable varieties of tomato for processing and to identify proper cultivation techniques. Another important consideration is that the tomato varieties needed for tomato paste are different from the ones consumed fresh or used to produce solid pack tomato.

The general processing plant model identified in the opportunity study should have an advantage over its competitors in that the established tomato paste processing plants were built using locally-made machines copied from Italian and US equipment. However, the locally-made evaporators do not perform well, and the concentration of the paste produced is around 24 to 26 Brix instead of 32 to 35 Brix as in Taiwan, Italy, and the USA. This means that the price of transportation and packaging material is relatively high per unit of tomato. The locally-made machinery for tomato paste processing also produces a product of inferior colour as the time required to concentrate in the evaporators is longer than in foreign evaporators.

Most tomatoes presently produced in the Northeast are used in paste manufacturing factories, close to the growing areas. Thai Fruit Canners Ltd. have recently developed a substantial export trade, but most paste (in bulk pack) is transported to fish canning factories which are located in the central region or in the south of the country.

Apart from tomato paste, production of tomato ketchups and tomato sauce are other outlets for tomatoes in Thailand. Only small quantities of juice and canned whole tomato are produced. Tomato paste exportation involves operating in a highly competitive commodity market so this type of operation is not recommended for a small or medium scale enterprise.

It is not expected that the proposed plant, despite its assumed ability to outperform older installations, will be able to secure much revenue from tomato paste exports. At present, world markets are depressed with the results of a 1990 glut exacerbated by already high stock levels (the current, low, price for industrial, 31% paste is only US$ 33-34 cent/lbs.

In their canned form, all of the foregoing crops, except tomato paste are primarily destined for export rather than the domestic market. The scale of exports can be seen from the following data.

Table 4 Exports of Selected Canned Fruits and Vegetables, 1987-1990

Volume

Product	1987 (tons)	1988 (tons)	1989 (tons)	1990 (tons)
Rambutan	1630	2313	1698	1604
Lychee	474	1546	5879	3725
Longan	1954	8199	3227	8554
Rambutan with Pineapple	1944	2742	3346	3835
Mango	1332	2256	2939	4254
Papaya	416	722	715	1344
Young corn	17218	233956	33326	26795
Bamboo shoots	50209	31868	31730	42639
Mushroom	531	1064	3766	6668
Tomatoes (whole)	na	945	8048	9745
Tomatoes (paste*)	na	na	na	3820

Value

Product	1987 (Baht million)	1988 (Baht million)	1989 (Baht million)	1990 (Baht million)
Rambutan	41.98	60.65	45.17	41.73
Lychee	15.73	51.06	186.84	132.12
Longan	73.10	256.50	112.83	254.48
Rambutan with Pineapple	55.11	72.45	90.88	104.76
Mango	32.71	51.15	67.98	95.22
Papaya	7.98	13.82	13.88	28.18
Young corn	334.86	451.33	710.92	536.79
Bamboo shoots	929.25	538.20	460.62	693.05
Mushroom	12.50	26.64	122.59	239.75
Tomatoes (whole)	na	12.86	124.38	132.75
Tomatoes (paste*)	na	na	na	74.96

na = not available

* = Forms other than whole or pieces and juice

From the above data the following indicative FOB values (in Baht per kilo) can be derived

Item	FOB Value
1. Rambutan	26.04
2. Lychee	35.00
3. Longan	29.75
4. Rambutan with	27.32
Pineapple	22.38
5. Mango	20.97
6. Papaya	20.35
7. Young corn	20.04
8. Bamboo shoots	16.25
9. Mushroom	35.96
10. Tomatoes (whl/pcs)	13.62
11. Tomato paste	19.62

From the same data it is possible to identify the principal destinations of these items as follows;

Item No	EEC	N.AMERICA	JAPAN	S.E.ASIA	AUSTRALIA
1.	X	X		X	
2.	X	X		X	
3.		X		X	
4.	X		X		X
5.	X			X	X
6.	X		X	X	
7.	X	X	X		X
8.	X	X	X		
9.		X		X	
10.					X
11.		X	X		

Product Market Conditions

With respect to international demand conditions for these items, the following circumstances are observable.

As regards mango, given that those varieties sought by the market are produced, rising demand exists for desired forms (sliced, puree, dried , pickled) in most markets. The market is a competitive one with many other sources of supply, however.

For papaya demand is strong, especially for red-fleshed varieties. The market potential has been scarcely tapped at present but is expected to benefit from growing consumer awareness prompted by wider availability of the fresh product.

Bamboo shoots are tending to emerge as the next 'in' exotic vegetable, following baby corn. If this trend is consolidated then substantial growth is possible.

Baby corn sales are now dominated by the fresh product, but catering demand, including use in prepared meals/salads is likely to remain strong. However, the supply/demand balance is less favourable to suppliers than in the past, so pressure on price can be expected, especially as other low cost sources seek to enter the market.

Retail prices for canned fruit in the domestic market can exhibit considerable variations according to the pricing policy of the store of different outlets. Highest priced items are longans which usually sell for in excess of 40 Baht per standard can (565 grams, drained weight 230- 275 grams), and sometimes in excess of 50 Baht. Variations in price may be influenced by the presence or absence of a ring-pull can and the heaviness of the syrup used. The image of the brand may also influence the retail price.

Next in cost terms are litchees, usually in the 35-45 Baht range, and then rambutan (with or without pineapple) in the 30-40 Baht range. At the lower end of the price spectrum are the tropical fruit cocktails usually around 20 Baht.

No canned papaya was observed, and this is not surprising as the fresh product is available in Thailand throughout the year. It is worth noting that the principal canned fruit -pineapple - is significantly cheaper that the fruits mentioned above, being on a unit equivalent basis as a par with the tropical fruit cocktails.

Canned vegetables on the domestic market are the exception rather than the rule, reflecting the all year abundance of fresh produce. This applies with particular force to bamboo shoot and mushrooms. Canned young corn is readily available, being sold usually in the 10-20 Baht range (per standard can), with price varying by size of cob in many cases. Retail prices reflect a 20% average mark-up over wholesale prices.

Tropical Fruit Processing Line

Fruiting Seasons in Thailand

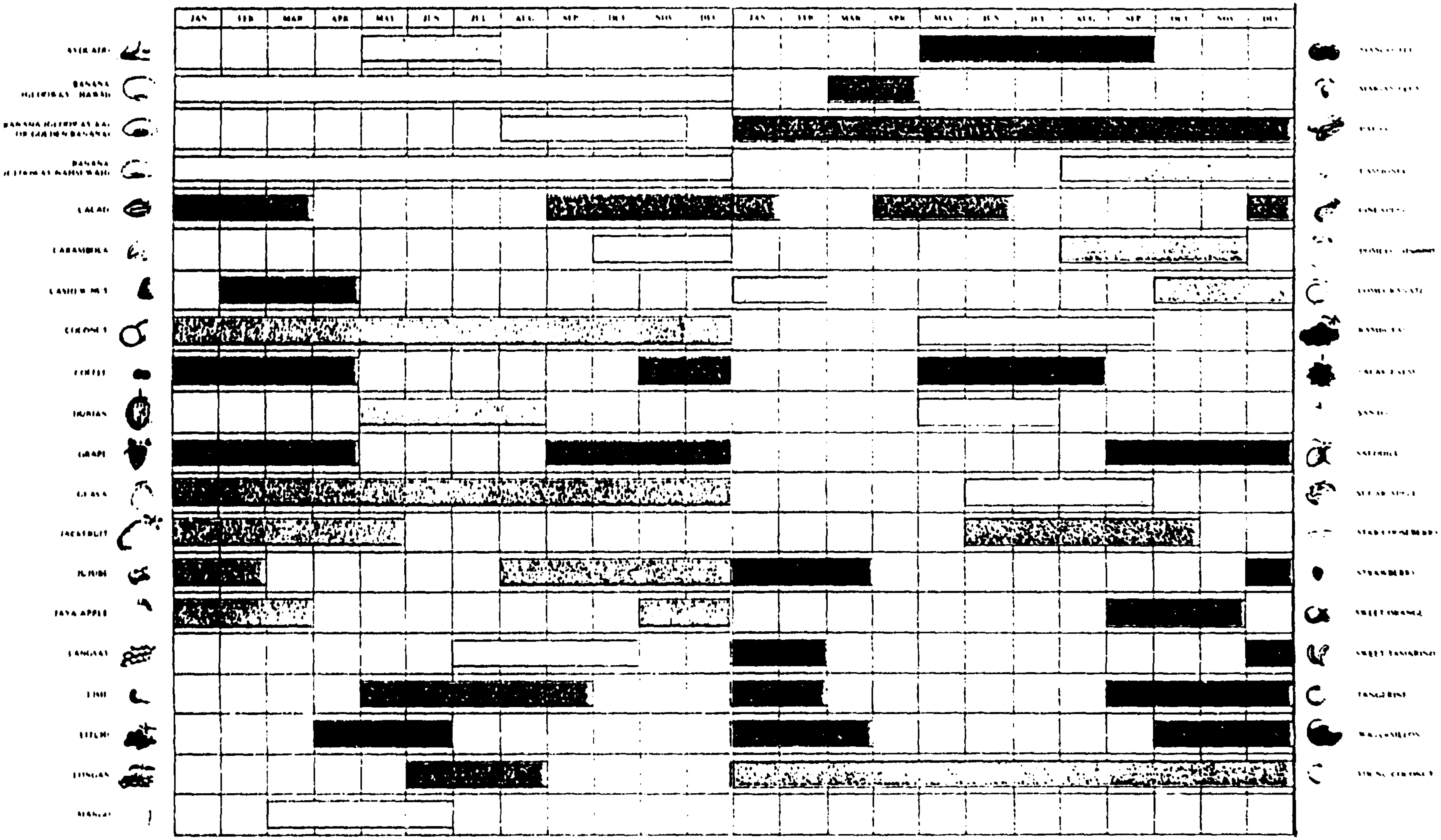
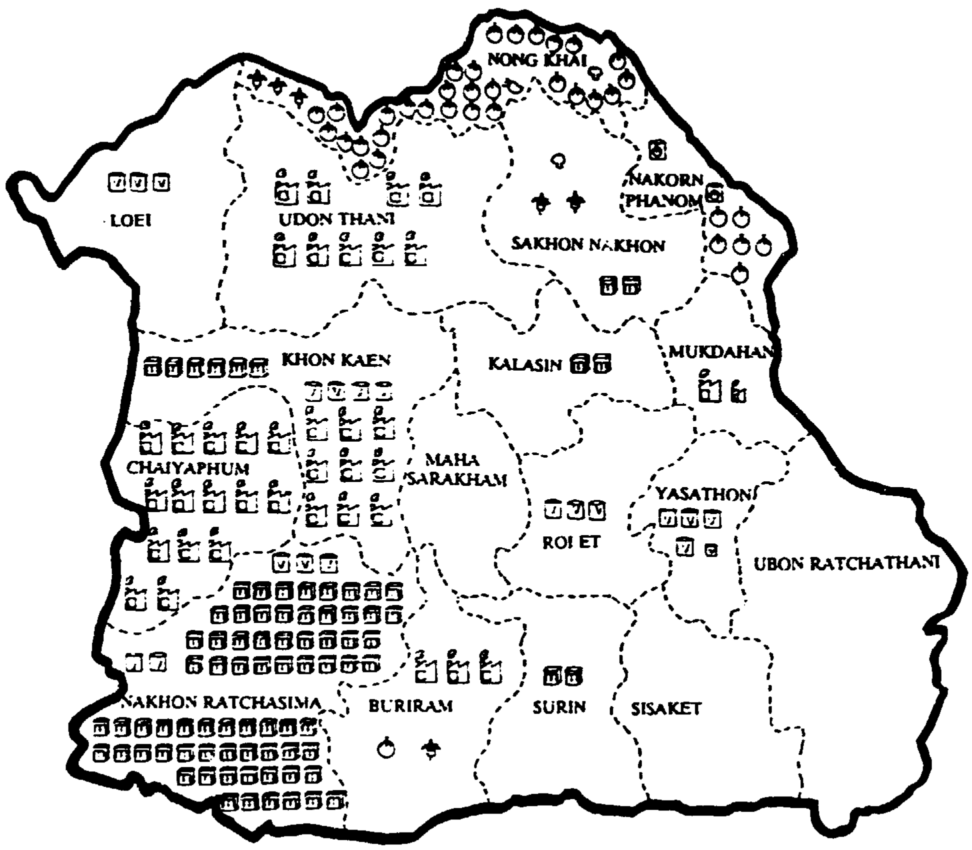


FIGURE: LOCATION AND CAPACITY OF CANNED FRUIT AND VEGETABLE, MILK INDUSTRIES AND SUGAR MILLS.

NORTHEASTERN THAILAND 1991



LEGEND

- = 1 TON/MILK OF MILK
- = 10,000 TON/YEAR OF CANNED TOMATO
- = 1,000 TON/YEAR OF CANNED FRUIT AND VEGETABLE
- = 1,000 TON/YEAR OF CANNED STRAW MUSHROOMS
- = 1,000 TON/YEAR OF CANNED MANGO
- = 1,000 TON/YEAR OF BABY CORN
- = 10,000 TON/YEAR OF CONDENSED TOMATO JUICE
- = 1,000 TON/DAY OF SUGAR MILLS

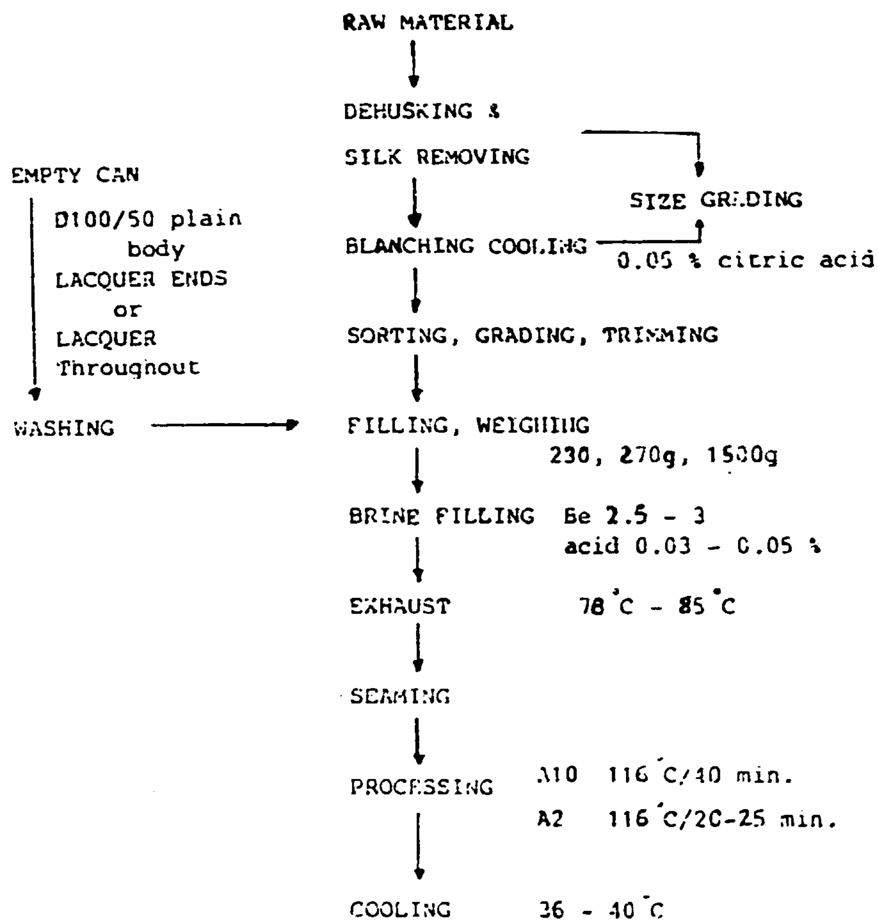
Sources 1 For sugar mills, office of cane and sugar board

2 All others, Small-scale industry development project

PROJECT: OPPORTUNITY STUDIES: AGRO-INDUSTRY
(UNIDO PROJECT NO. US/RAS/90/039)

DIAGRAM A

YOUNG SWEET CORN CANNING FLOW CHART



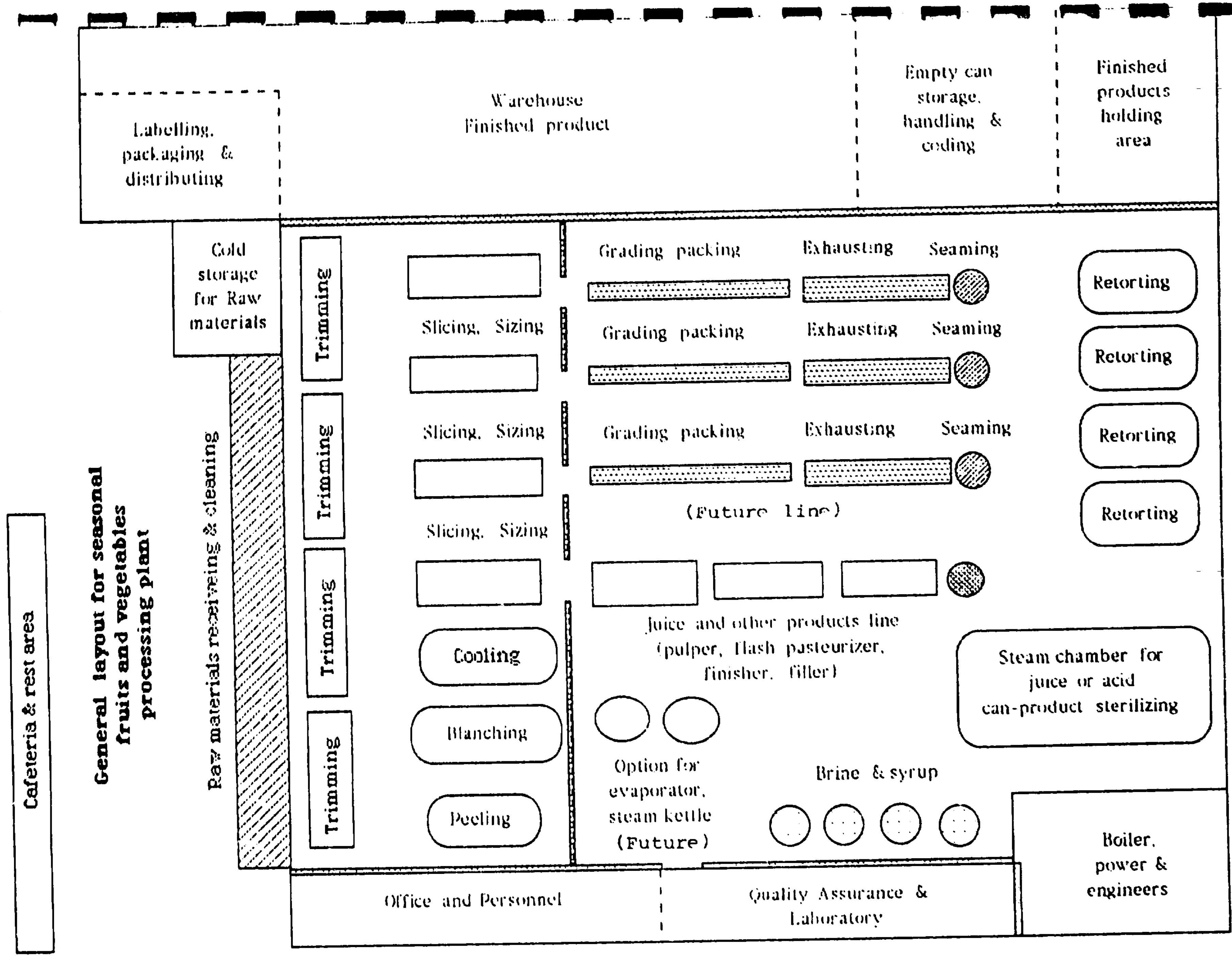


DIAGRAM B

General layout for seasonal fruits and vegetables processing plant

ANNEXE III

POTENTIAL INVESTMENT OPPORTUNITY PACK - III

STRAW MUSHROOMS AT CHUMPAE

Background

This opportunity study begins with some background to the original investment, the enhancement of which is now proposed.

E-Sun Foods is an existing fruit and vegetable canning factory under private ownership which has been selected for technical assistance. The investment is to be in growing sheds for the high-volume production of straw mushrooms to improve operational efficiency and increased profitability by securing an increased throughput of high quality raw material. The main investment costs would be borne by farmers, with the aim of improving the throughput of the factory: thus, the opportunity is presented as being of economic benefit to the region (extra jobs, larger incomes, etc) and financial benefit to the factory; as a result it does not follow a standard format for financial profitability. A separate financial analysis for the position of the factory then follows.

E-Sun foods was originally established in 1986/87 as a Thai and Taiwanese joint venture, with Taiwanese technology and a Taiwanese marketing manager. However, after three years the company ran into serious operating problems due to a combination of poor quality and irregular supplies of raw materials and a very saline water supply. The company was subsequently taken over in 1989 by a local businessman at a cost of Baht 18 million (US$ 720,000); he did not want to see the factory collapse and he wished to promote the cultivation of high-value crops by local farmers. The contact address for E-Sun foods and some examples of their produce are included in Annex III.

The original plan was to process only one product (straw mushrooms) based on the local availability of mung bean husks for cultivation. Straw mushrooms enjoy a strong demand on world markets, particularly in Singapore, Hong Kong, Japan and Taiwan.

During 1989 and 1990 the company was canning some 4–5 tonnes per day against an installed capacity of 15 tonnes per day (on an eight-hour working day basis). In 1991 competition from Indonesia created intense marketing problems. The company appears to be unable to contract forward because they are uncertain of raw material supply, and conversely they cannot contract with farmers and middlemen as they are uncertain of their market. As a consequence of this situation their production of canned straw mushrooms is spiralling downwards and farmers in the area are becoming disillusioned. To make up production, the company are attempting to process baby corn, but there are quality and supply problems with these and they cannot get bamboo shoots from local farmers as an alternative.

The opportunity therefore exists to increase the supply of straw mushrooms to the factory from production based in sheds rather than the traditional manner. It is assumed that the regular supply of the required type and quality of raw material will in fact largely solve the current marketing problems.

Market, and Demand for Product

E-Sun Foods Industries Ltd claim that the best market in terms of straw mushrooms is for large mushrooms, but these presently only represent 2% of the supply from farmers. Also the peeled black variety is preferred by customers, whereas their supplies are primarily of the white variety. The company make a wide range of canned mushroom products in both 15-ounce and A10 catering packs, including whole and sliced/peeled, and unpeeled in brine. The major production is in 15-ounce retail cans which are packed 24 to the carton for export.

Statistics regarding the domestic consumption and export volumes of straw mushrooms are complicated to analyse because these are typically combined with all other mushrooms. However, the volume and value of all mushrooms exported from Thailand has increased dramatically in recent years, with 12 and 20 fold increases respectively.

Year	Volume (tonnes)	Value (Baht million)
1987	531	12.5
1988	1,064	26.6
1989	3,766	122.6
1990	6,668	239.8

Declining exports by Taiwan have been increasingly replaced by the Thai product, principally for the USA and European markets. Overall, world market demand is growing by some 7.5% (ITC).

Domestically, a 420-gram gross weight can is sold for around Baht 30 in Bangkok.

The intention of the opportunity in the long-term would be to minimise bulk packaging, and maximise smaller and more specialist packs for particular customers.

Supply of Raw Material Inputs

Current production of canned straw mushrooms is inhibited due to lack of consistency or quality control in the raw material supply. Many producers prefer to market through the traditional fresh produce marketing channels. At present it is thought that some 3,000 local families supply mushrooms through middlemen (who may also sell them on the fresh market if the price is better); there are no contractual arrangements either end of the marketing chain. Middlemen just buy what the farmers give them and there is no attempt at quality control. There are some 35 middlemen who act as contractors, and supply farmers with fertilisers, supplies and credit.

Mushrooms are grown in a traditional way in the paddy after the rice harvest between February and August. Raised beds, some 1 metre x 5 metre, are built up in the fields using mung bean husks as a base. After sowing the spawn, they are covered with plastic sheets and straw.

The problems resulting from this method include low production and productivity, labour intensity, poor quality and size control, heavy contamination with moulds and dirt, and a relatively short growing season.

The management of E-Sun Foods Industries Ltd consider that, in order to achieve efficient operation and good profitability, they need to secure regular supplies of large black straw mushrooms of a reasonably uniform size at an average rate of 10 tonnes per day. They would like to experiment with shed production, but do not have the technical know-how at the moment, and are unsure how to go about investing. The company are willing to finance the initial construction of trial sheds and, based on results, would provide advice and extension services to farmers. This would be critical to the project's success. In addition to providing benefits to E-Sun Foods Industries Ltd, this project, if correctly designed, will provide improved year round income to local farmers and could be replicated elsewhere in Isarn.

Approximate Location and Site

The investment in shed cultivation is to be within the region of the existing

E-Sun factory site at Chumpae.

Project Engineering

It is uncertain whether the technology for the commercial shed growing of straw mushrooms presently exists in Thailand. There is however some know-how in various microbiology and horticultural departments of local universities and agricultural colleges. It is possible that this accumulated experience can be extended to the commercial and industrial requirements for efficient and profitable production. During visits to several other canning operations in Isarn by the Consultant the idea of shed growing was raised, and one company at least is hoping to get the know-how from Taiwan. The technology is not complex, and the costs per shed (see below) are relatively modest. To give the required output (see below) the sheds should be large enough to allow for the establishment of 150 square metres of beds, of which half would be cultivated and half in rotation at any one time.

Manpower and Management

It is envisaged that the existing management of the company would continue. Extra manpower requirements at the factory would depend on the realised scale of throughput, and more full-time employment would be available to farmers.

Project Scheduling

Having identified the technology, implementation is likely to be possible virtually immediately, although some time for encouraging farmers to make investments is unavoidable.

Financial Analysis

The investment opportunity is analysed in two steps, first with the costs of sheds, and then with the benefits of extra production. The costs and benefits of developing shed production between the farmers and factory would be divided as follows: the company would absorb research and development costs in establishing the agronomic practices and would benefit from greater levels of throughput and more continuous raw material supply. Farmers would incur the costs of shed construction (perhaps financed with loans from Bank of Agriculture and Cooperatives under the 'Poor Farmer Scheme') but would benefit from greater production volumes and guaranteed sales.

Bearing in mind the anticipated high yields and productivity to be secured by shed growing, the unit costs of production will be well within current levels. Raw material input costs to the factory have, therefore, been assumed to be the same as at present, at Baht 20 per kilo.

The assumption is that E-Sun Foods Industries Ltd would process 10 tonnes per day of straw mushrooms for nearly nine months of the year, with the possible processing of modest quantities of other crops such as baby corn and bamboo shoots for the balance. However, these have not been taken into account in the calculations as their availability is by no means certain. In effect, therefore, this will be considered as a one-product operation with any other modest production to be treated as a bonus.

The following production data and operating costs were provided by the management of E-Sun Foods Industries Ltd. (Some comparative costings were also secured from another canning operation in the district who operate at a similar capacity.) Ten tonnes of mushrooms per day is equivalent to 900 cartons (of 24 cans each) of 15-ounce cans, each containing 54% of the weight as raw material. Costs for overheads, labelling, labour, electricity, cans and cartons were estimated at Baht 192 per carton (based on adjusted cost data from Annex II, for the model fruit and vegetable plant), and it is assumed that the factory would be in operation for 270 days per year. The cost of a shed to a grower has been estimated at Baht 25,000 (US$ 1,000) following informal contacts by the Consultant with Taiwanese producers. Each shed is assumed to produce 10 Kilo of mushrooms per day, and 1,000 sheds are assumed to be supplying the factory. The cost of the extension effort is assumed to be a lump sum of Baht 10 million, although in practice this would be averaged over several years.

On this basis, the return on the entire project is some 20.3% – see the first table below.

In financial terms, at current prices each farmer would expect to earn Baht 200 per day, or some Baht 40,000 per year at full production (this is some four to five times the current estimated opportunity cost of labour in the area). This gives a total annual estimted income from the sheds of Baht 40,000 x 1,000 = Baht 40 million per year.

The financial position of the factory is summarised in the third table. Costs incurred by the factory include the establishment of trial research sheds (assumed to be 10 in the first instance, at US$ 1,200 each) plus the extension effort. On this basis the financial return to the R&D effort is very high, at an estimated 62%.

Risk and Uncertainty

There are few sources of risk to either farmers or the factory, as long as the product can continue to be marketed. The support of the factory to secure sufficient numbers of interested farmers in the early days would be essential, however. The only technical doubt on the production side concerns the availability in sufficient quantity of mung bean waste, cotton husks etc, but the extent of this risk is impossible to quantify at present; the shipping of mung bean waste from other areas of the country may have to be investigated.

TABLE 1 MEKONG AREA OPPORTUNITY STUDIES:

STRAW MUSHROOMS AT CHUMPAE

Financial analysis summary

	(000 Baht)	US $
		25.00
Investment cost:	38,000	1,520
Production cost:		
Operating costs	58,000	2,320
Depreciation	2,546	102
Interest	2,090	84
Total production costs	62,636	2,505
Rate of return:		
Sales revenue	72,000	2,880
Operating cost	58,000	2,320
Depreciation	2,546	102
Operating profit	11,454	458
Interest (average 11%)	2,090	84
Gross profit pre-tax	9,364	375
Corporate tax (40%)	3,746	150
Net profit	5,618	225
Rate of return (%) =	20.3	
Repayment period (years) =	3.7	

Notes to table:

1. The format for this economic summary follows the UNIDO guidelines in the publication reference ID/206.
2. The rate of return is calculated as the sum of net profit and interest divided by total investment outlay.
3. The repayment period is calculated as total investment outlay divided by the sum of net profit plus interest plus depreciation.
4. For both Thailand and Lao depreciation and interest are calculated at 6.7% and 11% respectively.
5. All opportunity studies assume the equity of the sponsor is 50%, and borrowed capital, on which interest is payable, a further 50%.
6. In both countries the total of corporate taxes have been estimated at 40%.

TABLE 2 MEKONG AREA OPPORTUNITY STUDIES:

STRAW MUSHROOMS AT CHUMPAE

Farm Budget: Financial summary (at full production)

	(000 Baht)	US $
		25.00
Investment cost:	25,000	1,000
Production cost:		
Operating costs	10,900	436
Depreciation	1,675	67
Interest	1,375	55
Total production costs	13,950	558
Rate of return:		
Sales revenue	54,000	2,160
Operating cost	10,900	436
Depreciation	1,675	67
Operating profit	41,425	1,657
Interest (average 11%)	1,375	55
Gross profit pre-tax	40,050	1,602
Corporate tax (40%)	N/A	0
Net profit	40,050	1,602
Rate of return (%) =	165.7	
Repayment period (years) =	0.6	

Notes to table:

1. The format for this economic summary follows the UNIDO guidelines in the publication reference ID/206.
2. The rate of return is calculated as the sum of net profit and interest divided by total investment outlay.
3. The repayment period is calculated as total investment outlay divided by the sum of net profit plus interest plus depreciation.
4. For both Thailand and Lao depreciation and interest are calculated at 6.7% and 11% respectively.
5. All opportunity studies assume the equity of the sponsor is 50%, and borrowed capital, on which interest is payable, a further 50%.
6. In both countries the total of corporate taxes have been estimated at 40%.
7. This budget is based on 1000 sheds , each producing 10Kg of mushrooms per day
8. The farm gate price is assumed to be the same as the factory gate price (ie Bt 20/Kg)
9. The format for opportunity studies has been folowed for purposes of consistency, but any further analysis should involve the construction of detailed farm budgets

TABLE 3 MEKONG AREA OPPORTUNITY STUDIES:

STRAW MUSHROOMS AT CHUMPAE

Factory financial analysis summary

	(000 Baht)	US $ 25.00
Investment cost:	13,000	520
Production cost:		
Operating costs	58,000	2,320
Depreciation	871	35
Interest	715	29
Total production costs	59,586	2,383
Rate of return:		
Sales revenue	72,000	2,880
Operating cost	58,000	2,320
Depreciation	871	35
Operating profit	13,129	525
Interest (average 11%)	715	29
Gross profit pre-tax	12,414	497
Corporate tax (40%)	4,966	199
Net profit	7,448	298
Rate of return (%) =	62.8	
Repayment period (years) =	1.4	

Notes to table:

1. The format for this economic summary follows the UNIDO guidelines in the publication reference ID/206.
2. The rate of return is calculated as the sum of net profit and interest divided by total investment outlay.
3. The repayment period is calculated as total investment outlay divided by the sum of net profit plus interest plus depreciation.
4. For both Thailand and Lao depreciation and interest are calculated at 6.7% and 11% respectively.
5. All opportunity studies assume the equity of the sponsor is 50%, and borrowed capital, on which interest is payable, a further 50%.
6. In both countries the total of corporate taxes have been estimated at 40%.

ANNEXE III

POTENTIAL INVESTMENT OPPORTUNITY PACK - III

STRAW MUSHROOMS AT CHUMPAE

E-SUN®

WHOLE UNPEELED

STRAW MUSHROOMS

WATER AND SALT

NET WT. 6 LBS. 5 OZS. (2,870 GMS.)

DRAINED WT. 4 LBS. 1 OZS. (1,840 GMS.)

25700

E-SUN

上等鮮草菇

INGREDIENTS:
STRAW MUSHROOMS
WATER AND SALT

PRODUCT OF THAILAND

PACKED BY
E-SUN FOODS INDUSTRY CO.,LTD.
FAX: 2367970

ผก.216/2529

E-SUN®

WHOLE PEELED

STRAW MUSHROOMS

WATER AND SALT

NET WT. 6 LBS. 5 OZS. (2,870 GMS.)
DRAINED WT. 4 LBS. 1 OZS. (1,840 GMS.)

E-SUN

上等鮮草菇

INGREDIENTS:
STRAW MUSHROOMS
WATER AND SALT

PRODUCT OF THAILAND

PACKED BY
E-SUN FOODS INDUSTRY CO.,LTD
FAX: 2367970

มก.216/2529

Roland®

SERVING SUGGESTION

CUT
BABY CORN

NET WT. 6 LB. 6 OZ. (2900 G.) DR. WT. 53⅓ OZ. (3 LB. 5⅓ OZ.)-1500 G.

Suggestions

This tasty, new miniature Corn-on-the-Cob is eaten whole! Serve in the following ways.

- Heat with butter and parsley or with a cream sauce, and serve as a vegetable
- Add to hot casseroles or serve cold as a salad
- Use as a garnish for meat and vegetables
- Eat as is for a low-calorie healthy snack

INGREDIENTS: BABY CORN, WATER, SA[illegible]

PACKED FOR [illegible] ROLAND FOOD [illegible] NEW YORK, N.Y. 10010

PRODUCT OF TAIWAN

0 41224 45116 2

ANNEX IV

POTENTIAL INVESTMENT OPPORTUNITY PACK

MEDIUM DENSITY FIBREBOARD

Introduction

At the Thai Review Meeting in Bangkok, Medium Density Fibreboard (MDF) manufa- re was identified as a potential investment opportunity, based on the assumeu availability of adequate supplies of waste wood timber in the project areas.

Subsequently the Consultant identified an existing factory in Isarn using bagasse, the waste cane from sugar mill operations, as a raw material to the production process. This had an immediate appeal as there ware several large sugar mills operating in Isarn and bagasse is a low-cost and conveniently available raw material. While most bagasse is consumed as a boiler fuel to operate sugar mills, there is frequently a surplus to this requirement unless the normal production of plantation white sugar is further refined at the end of the season which requires extra fuel.

However, as a result of the Consultant's detailed evaluation of the production process, it has become clear that MDF does not represent a realistic investment within the terms of reference of the current study as the likely investment costs are very high, in the region of US$15 - 20 million, and the manufacturing technology of MDF from bagasse is not fully established.

Notwithstanding this, there is undoubtedly an opportunity for a major investor who is willing to persevere with the technology or who is willing to pay a licensing fee for advice from current manufacturers. Adequate supplies of bagasse would appear to be available in Isarn and there is a strong export demand for the MDF. The following notes provide an outline of the current status of the production of MDF from bagasse. they are largely derived from meetings with timber product specialists in Bangkok and the present sole manufacturer in Thailand (Khon Kaen Wood).

The Product and Its Market

MDF is a fibreboard with a density between 500- 850 kilos/m^3 but most of the MDF manufactured is produced with a density between 700 - 750 kilos/m^3. The product was an instant success when it was first developed in the USA and launched in 1966. It is a natural substitute for natural wood. Unlike paper pulp and other products derived from wood, which require large quantities of water and produce large volumes of unpleasant effluent, MDF is produced by a 'dry process' and is therefore environmentally friendly.

Manufacture consists of breaking down woody materials into their individual fibres which are resin coated, dried and formed into a mat which is cut and pressed into panels 8mm - 40mm thick. Production costs are roughly the same as for particle board, but the end product is far superior. It is completely homogeneous with no identifiable grain or variations in surface hardness. It is machineable and has excellent edge properties as well as screw holding and dimensional stability.

These characteristics give MDF a continuously growing market and explain why it is popular for high quality furniture and kitchen cabinets, wall panelling, toys and similar wood-based products. Export prices from Thailand are understood to be in the region of US$250 FOB cubic metre, and in Europe the price is about 30% higher than particle board.

Japan is a growing market for MDF, as its quality demands are very high. Statistics detailing growth in the markets for MDF are contained in Annex IV.

Current Manufacturing Operations

As of 1988 there were 68 MDF factories in the world and it was projected that for 1990 there would be about 87 MDF factories. The first and only MDF factory using bagasse as raw material was established by the Khon Kaen MDF Board Company based on their sugar mill in the Nam Phong district of Khon Kaen Changwat in 1986. Subsequently, similar operations have been established in Turkey and Pakistan but considerable technical difficulties have been encountered. It is understood that the Turkish plant is closed down and the Pakistan operation has only been able to continue following an agreement with the management at Khon Kaen to provide technical assistance. The Chinese are also apparently asking for technical assistance and an Indonesian investor is looking for a joint venture partner.

The Khon Kaen operation was initially established at a cost of some Baht 400 million (approximately US$15 million) based on a turnkey contract with Sund Defribrator AB of Sweden. A further Baht 100 million was needed over the following years for major modifications and improvements. The factory processes some 250 tonnes of bagasse each day and produces 80 cubic metres per day of MDF. Hitherto, this was all sold locally but now the company is fully integrated with the completion of a large furniture factory on the site which produces a wide range of quality furniture for export to Europe; they have recently signed a contract to supply hotel furnishings to a Japanese client.

The company is now expanding its MDF capacity to 250 cubic metres per day. New techniques are being introduced to enable the manufacture of a much wider range of panels and boards. This has been a very successful operation but the level of financial investment and technical expertise needed to achieve the present situation should not be underestimated. Some notes detailing the actual production process for MDF are included in the 'Potential Investment Information Pack' in Annex IV.

Future potential

There are 6 sugar mills currently operating in North East Thailand which are listed below and shown on the map of Isarn at the start of the Main Volume

Buriram Province	1 factory	-	Buriram
Mukdahan Province	1 factory	-	Saga Rang
Udon Thani Province	2 factories	-	Rerm Udon
		-	Kumpawapi
Khon Kaen Province	1 factory	-	Khon Kaen
Chaiyaphum Province	1 factory	-	United Farmer & Industry

The Khon Kaen factory is, of course, already producing MDF and United Farmer and Industry at Chaiyaphum are currently constructing a particle board factory. It is also understood that a large MDF factory with a capacity of 500 tonnes per day of raw material is being constructed east of Bangkok which will use para-rubber and eucalypt as raw material.

Financial Analysis

During the course of the current study it was impossible for the Consultant to obtain detailed information regarding equipment required and installation and operating costs for reasons of confidentiality; Khon Kaen Wood were reluctant to divulge the fruits of their experience. For this reason, no detailed financial and economic analysis has been attempted. Clearly, however, MDF from bagasse has a good future when once the manufacturing technology is generally available. What information is available on MDF obtainable in Thailand is presented in Annex IV.

ANNEX IV

POTENTIAL INVESTMENT OPPORTUNITY PACK

MEDIUM DENSITY FIBREBOARD

Introduction

Thailand has been a significant world source of supply for timber/timber products but currently domestic demand and more importantly the ban on logging (for environmental reasons) has significantly altered the position (see table 1).

In global terms MDF is not a prominent item, though output has advanced significantly from 1.5 million m^3 (1980) to 4.0 million m^3 (1988) and hence more than doubled its share of global output from 1.56% to 4.0% (Table 2). More recent data is not available but indications are that production (and consumption)) is on a strong upward trend. As Table 3 reveals, MDF demand is dominated by the USA, though collectively Western Europe also is a significant market.

MDF has been a niche market but indications are that it is set to become a significant element in the market place for plywood and board. This reflects a number of developments:-

- manufacturers' interest in and ability to handle sawn timber substitutes.
- the increasing cost of sawn timber.
- consumer resistance to sawn timber on environmental grounds.
- governmental policies that restrict logging.

MDF is especially well placed to capitalise on these developments because:-

- its inherent technical attributes enable it to command premium prices.
- it is very well regarded environmentally speaking i.e. the raw material is effectively 'waste' wood.
- it is cheap to produce (in raw material terms) and the high cost of the relevant technology is likely to fall.

Bagasse-based MDF scores exceptionally well on all the above counts.

TABLE 1

Exports and Imports of Wood product in Thailand, 1981 - 1988

	1981		1982		1983		1984		1985		1986		1987		1988	
	Q kgs	V mil	Q kgs	V mil	Q kgs	V mil	Q kgs	V mil	Q kgs	V mil	Q kgs	V mil	Q kgs	V mil	Q kgs	V mil
Plywood																
Ex	621,761	5.5	1,026,897	6.6	34,897	0.9	31,119	1.5	44,397	1.4	3,037,903	35.3	45,826,580	583.5	7,340,884	104.8
Imp	842,793	12.1	1,156,114	17.4	1,195,578	21.5	872,107	14.4	819,343	11.9	691,560	9.6	944,836	15.3	247,393	5.1
Particle Board																
Ex	349,272	17.6	459,927	20.8	397,285	12.0	568,523	23.2	122,141	5.1	1,353,007	22.6	3,603,073	56.4	6,653,342	57.0
Imp	856,967	12.3	822,069	13.0	437,336	9.0	335,049	9.6	463,949	9.8	317,531	10.8	1,518,067	26.7	2,896,740	34.2
Hardboard																
Exp	5,444,391	29.6	6,962,131	37.1	10,805,314	39.5	14,258,762	67.2	17,272,324	86.5	24,336,368	114.2	20,178,851	104.1	-	-
Imp	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-
Other fibre boards																
Exp	329,843	3.2	28,787	3.7	1.0	1.0	43,069	3.4	12,833	0.6	58,733	0.5	2,242,670	19.8	2,877,224	23.4
Imp	1.483,924	24.5	639,245	13.5	21.9	21.9	930,190	15.2	1,112,082	17.8	956,475	15.5	1,230,959	19.0	200,494	6.7

Source: Forest statistics of Thailand, 1988, Forest Statistics section, R.F.D.

Q = Quantity (kgs) V = Value (Million Baht)

Table 2 Production of Hardboard, Particle board, plywood and MDF

Product/Country	1980		1988	
	mil m^3	mil m^3	mil m^3	mil m^3
(Hardboard)				
North America	2.1		1.8	
Europe	1.9		2.8	
USSR	1.6		2.1	
South America	0.7		0.7	
Asia	1.0		1.1	
Pacific	0.2		0.2	
Africa	0.1		0.1	
TOTAL	8.0	8.34	8.9	7.83
(Particle board)				
North America	7.5		12.0	
Europe	22.5		24.5	
USSR	5.1		7.8	
South America	1.5		2.0	
Asia	2.0		2.2	
Pacific	0.8		1.0	
Africa	0.4		0.5	
TOTAL	39.8	41.50	48.0	42.25
(Plywood)				
North America	17.2		21.0	
Europe	3.5		3.3	
USSR	2.0		2.3	
South America	1.5		2.0	
Asia	14.4		18.0	
Pacific	0.2		0.2	
Africa	0.5		0.6	
WORLD TOTAL	39.3	40.98	47.4	41.72
TOTAL WORLD MDF	1.5	1.56	4.0	3.52
TOTAL WORLD OSB	1.5	1.56	4.0	3.52
TOTAL WORLD INSULATING	5.8	6.05	5.3	4.66
GRAND WORLD TOTAL	95.9	100.00	113.6	100.00

Statistical data on wood based Panels, SUNDS DEFIBRATOR, PANELBOARD INDUSTRY & TRADE

Table 3 MDF Consumption by country 1980 - 1988

(1,000 cum/year)

Country	1981		1985		1988	
	Total	m³/yr	Total	m³/yr	Total	m³/yr
USA	850.0	3.3	1,200.0	4.6	1,500.0	5.8
UK	20.0	0.3	93.0	1.7	125.0	2.2
Germany	28.0	0.4	50.8	0.8	90.0	1.5
France	7.5	0.1	25.6	0.5	40.0	0.7
Netherlands	4.5	0.3	21.2	1.4	40.0	0.7
Belgium	1.0	0.1	8.0	0.3	17.0	1.7
Italy	50.0	0.8	151.8	2.7	240.0	4.2
Spain	45.0	1.2	93.0	2.4	140.0	3.6
Sweden	6.0	0.7	26.3	3.3	35.0	4.4
Denmark	-	-	6.0	1.2	12.0	2.4
Ireland	-	-	15.0	0.4	25.0	0.7
Switzerland	-	-	8.1	1.2	15.0	2.3
Greece	-	-	5.4	0.4	10.0	1.0
Austria	-	-	3.6	0.3	7.0	0.9
Others	n/a	n/a	34.2	n/a	n/a	n/a
TOTAL	1,012.0	1,742.0	-		2,296.0	

Source: Interbank and Sunds defibrator

The Manufacture of MDF from Bagasse

While detailed technical and financial data for the process is not available, the following notes outline the process in general terms.

Bagasse is a good raw material for the manufacture of MDF as it produces fibres in the region of 1.3mm long which is better than eucalyptus but not so good as other traditional timbers. But the raw material is relatively cheap, although the problems of storing sufficient bagasse at the end of the sugar milling season to keep the MDF factory operating until the next season should not be underestimated. The variations in quality of cane and bagasse also create manufacturing problems.

In the manufacturing process the first requirement is to remove the pith from the bagasse which is about one third of the bagasse by weight. It is usually removed in a vertical hammer-mill de-pither and the pith is used for fuel. Defibration follows, in which process the de-pithed bagasse is conveyed to a horizontal preheater-defibrator in which it is steamed at 150° - 160°C to soften the lignin. It is then ground to separate the bagasse into fibre bundles.

Resin blending follows. Resin constitutes about 13% by weight of the MDF while a paraffin emulsion at 1% is added to resist humidity. The paraffin emulsion is mixed with the bagasse as it leaves the defibrator and the resin is mixed with the fibre in the tube of the blender by blow line injection.

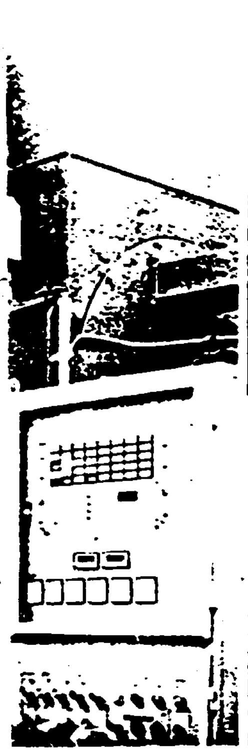
Next comes fibre drying, in which the fibre mixture now passes to a flash tube drier where drying is completed in only 2 seconds. This is to prevent the UF glue polymerizing with the fibres which would reduce its strength. This is followed by fibremat formation. The dried fibre is sent to a doffing roll bin which acts as a storage and regulating facility to control the quantity of fibre to be sent to the fibremat forming machine. Fibre from the bin passes to the pendistor in the form of a long thread. Thickness and weight are inspected and the bulky fibremat passes to the belt precompressor to form a more compact and higher density fibremat. This is then cut to 4 x 16 ft lengths and passes to the press loader to await hot pressing.

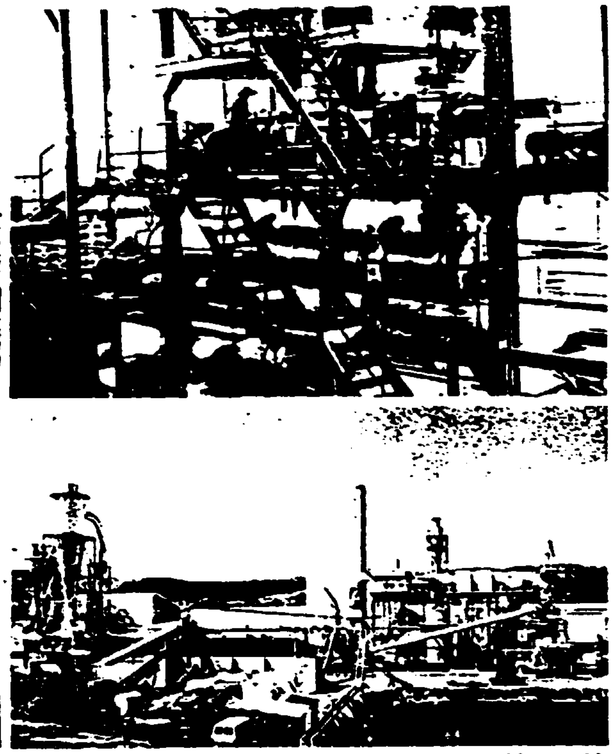
After this comes hot pressing. Five fibremats then pass to the pressuriser of the pressing machine where they are located on the heated platens. The machine raises the platens simultaneously for pressing at about 160°C, using steam. The five sheets of MDF are discharged and five more sheets are loaded from the press loader, ie. a continuous batch process.

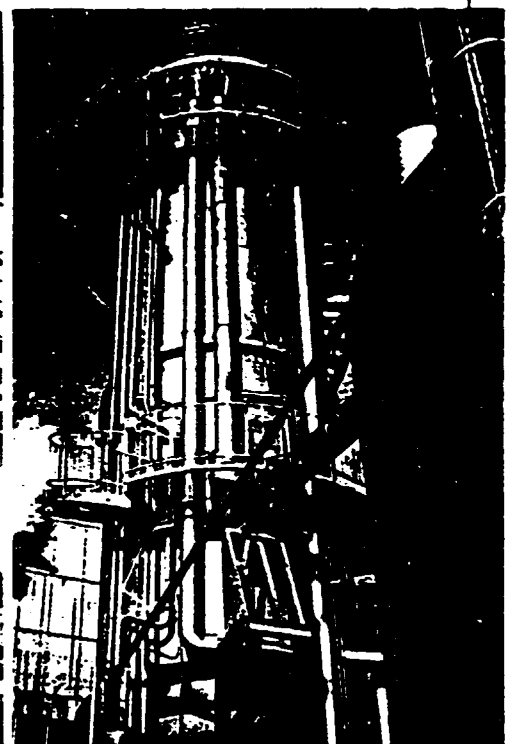
Conditioning is the penultimate stage; MDF from the press has a high surface temperature and low humidity and now passes to a cooling wheel to reduce the temperature and raise the humidity. From here it passes to a storage shed for 48 hours to stabilise the temperature and humidity.

Lastly comes sanding and sizing. After storage, the MDF is sanded by a wide belt sander to smooth the surface and produce a standard thickness. The hot pressed MDF is slightly larger than 4 x 16 ft and the edges are rough. It has to be cut into 4 x 8 ft lengths and in the sizing unit the five boards from hot pressing become 10 standard MDF boards with smooth edges.

The MDF boards are then inspected and classified into different grades and are taken by fork lift on pallets to the store. This is temperature and humidity controlled to give the board dimensional stability.







Khon Kaen MDF Co., Khon Kaen, Thailand. The world's first MDF plant based solely on sugar cane bagasse. Capacity 25 000 m³/year. Start-up year 1985. ▲ ▲

Nelson Pine Industries Ltd., Nelson, New Zealand. Fiber preparation, fiber drying and forming for MDF. Capacity 110 000 m³/year. Start-up year 1986.

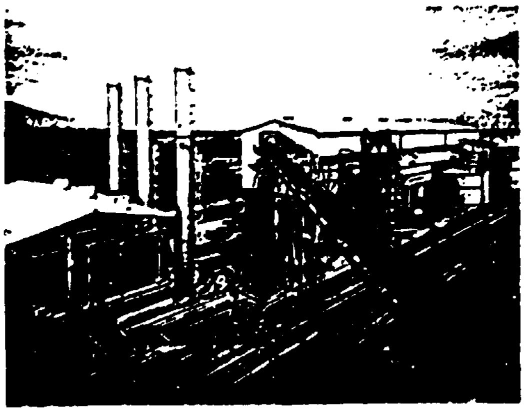
Oji Paper Co. Ltd., Ebetsu, Hokkaido, Japan. Oxygen delignification plant. Capacity 750 tpd. Start-up year 1984.

China are equipped by Sunds Defibrator.

Based on our ability to deliver complete plants designed specifically for the raw materials and conditions of a tropical climate, Sunds Defibrator has delivered high-yield pulp plants and chemical fiber lines as well as MDF and hardboard installations to customers in Thailand, Malaysia and Indonesia for the processing of tropical woods and annual plants.

In Thailand Sunds Defibrator has introduced new technologies in the MDF field. The

PT Kertas Leces, Probollinggo, East Java, Indonesia. Complete fiber lines based on annual plants for Leces No. III and IV Projects. Combined capacity 600 tpd. Start-up years 1985 and 1987.



worlds first plant for producing MDF from 100% bagasse as raw material was supplied a few years ago. Most recently the company was contracted to supply an MDF plant based on rubberwood.

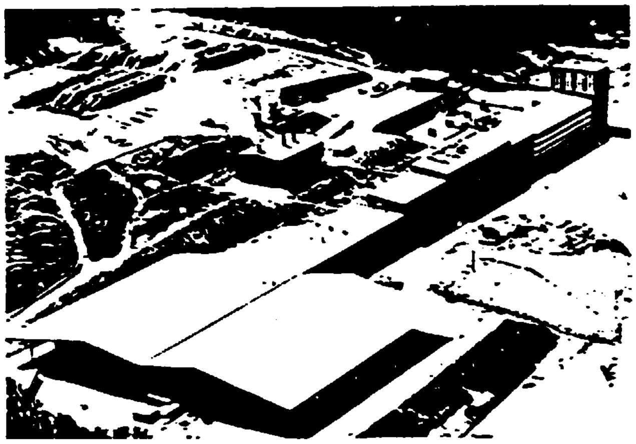
Based on many years of experience in Australia and wide understanding of local conditions, Sunds Defibrator Pty Ltd, located near Melbourne, holds a strong position in the MDF and high-yield pulping markets.

New Zealand based Sunds Defibrator Ltd is recognized as the leader in MDF technology and high-yield pulping, particularly when radiata pine is processed as the raw material. With a delivery in New Zealand of oxygen delignification and chemical bleaching, following three similar orders in Chile, the company has consolidated its position also as the leader in processing of radiata pine kraft pulp.

The experience gained by the New Zealand company through close co-operation with local customers has resulted in the development of several process improvements in the chemical pulping and fiberboard fields while increasing productivity and profitability.

Total Package Solutions

No matter which product or process you eventually choose, Sunds Defibrator has the technical knowhow to fulfill all of your requirements and the capacity to deliver complete turnkey plants in the quickest possible time. We back our promises with over 50 years experience as the world's leading fiber processing specialist.

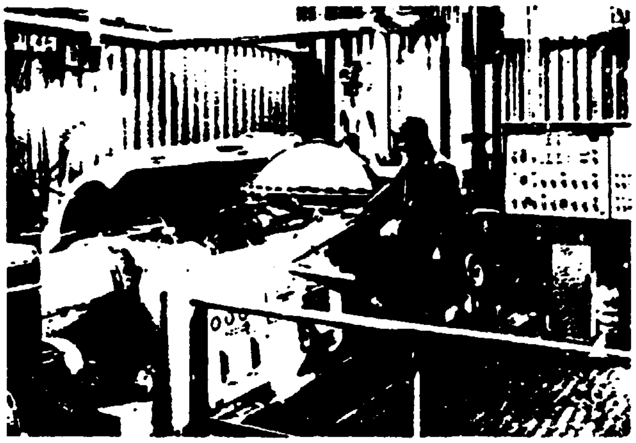


PROJECT EVALUATION

You naturally want the most productive and most economical installation possible. Our engineers will help you choose the appropriate process for your raw materials and the end-product with the best market potential.

LABORATORY TESTS

Our unique laboratory facilities are at your disposal to provide comprehensive testing of your raw materials to discover the best process for your plant.



MACHINES & EQUIPMENT

We place the most stringent demands for top performance on all the machines and equipment we use. This applies to everything we manufacture in our workshop in Sweden as well as the components we purchase from other suppliers.

TRAINING

We offer complete training programs designed to give your staff the self assurance to make sound operational decisions that will help achieve maximum capacity for your plant from the very beginning.

CONSTRUCTION & START UP

From the very first day of construction until your plant is fully operational, your project is under the close supervision of our qualified engineering teams. They know how to work together with local contractors to get the job done, often in record time.

GUARANTEE

Our long years of experience not only gives us the confidence to guarantee the equipment we manufactured, we even guarantee the process and the production capacity as well as the quality of the end product.

Hardboard No Resin Binders Required

This product has been around for a long time, ever since the 1920s in Europe and the USA. With good reason. It is an ideal substitute for more expensive building materials.

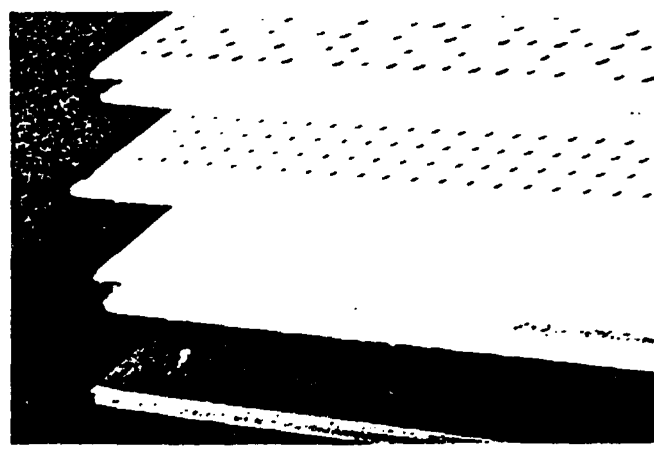
An economical "wet process" is used to manufacture hardboard panels. This process does not normaly require resin binders if it includes post heat treatment and humidification.

Exposed fibers mixed with water are formed into a mat which is cut and pressed under high heat and pressure into panels 2.5 to 6 mm thick with a density of about 1000 kg/m^3.

Hardboard has built-in resistance to moisture and decay. And just as regular wood, it can be painted, sanded, drilled or sawed.

It is a versatile product, used indoors and out for walls, floors, ceilings or roofs. It is used for doors and furniture. It is even used as an interior lining in buses, railway cars and automobile doors.

Insulation Board No Resin Binder Required



This product is making a comeback. With good reason. It has excellent properties for controlling temperature and noise.

The wet process, normally free of resin binders, is also used for producing insulation board. These panels are lightweight and porous with a density of only 250 kg/m^3 since the mat is just dried in a multi-opening dryer.

Insulation board, manufactured in sizes from 9 to 25 mm thick, is a highly competitive choice as a building material especially for interior walls and ceilings.

Asphalt board is insulation board impregnated with asphalt. This makes it very moisture resistant and suitable for exterior applications.

MDF Medium Density Fiberboard

This product was an instant success when first introduced in 1966. With good reason. It is a natural substitute for natural wood.

MDF is manufactured by a "dry process" perfected by Sunds Defibrator. The exposed fibers are resin coated, dried and formed into a mat which is cut and pressed into panels 8 to 40 mm thick with a density of about 720 kg/m^3.

Production costs for MDF are roughly the same as for particleboard but the end product is far superior.

MDF is completely homogeneous with no identifiable grain or variations in surface hardness. It is machinable and has excellent edge properties as well as screw holding ability.

These wood-like characteristics in a top-of-the-line panel made from low cost waste materials give MDF a continuously growing market. This explains why MDF is now a prefered material for high quality furniture as well as for kitchen cabinets, wall paneling, toys and similar wood based products.

Moreover, the MDF manufacturing process has environmental advantages since there is no liquid waste.

MDF is a product with a future. Why not make it part of your future as well.

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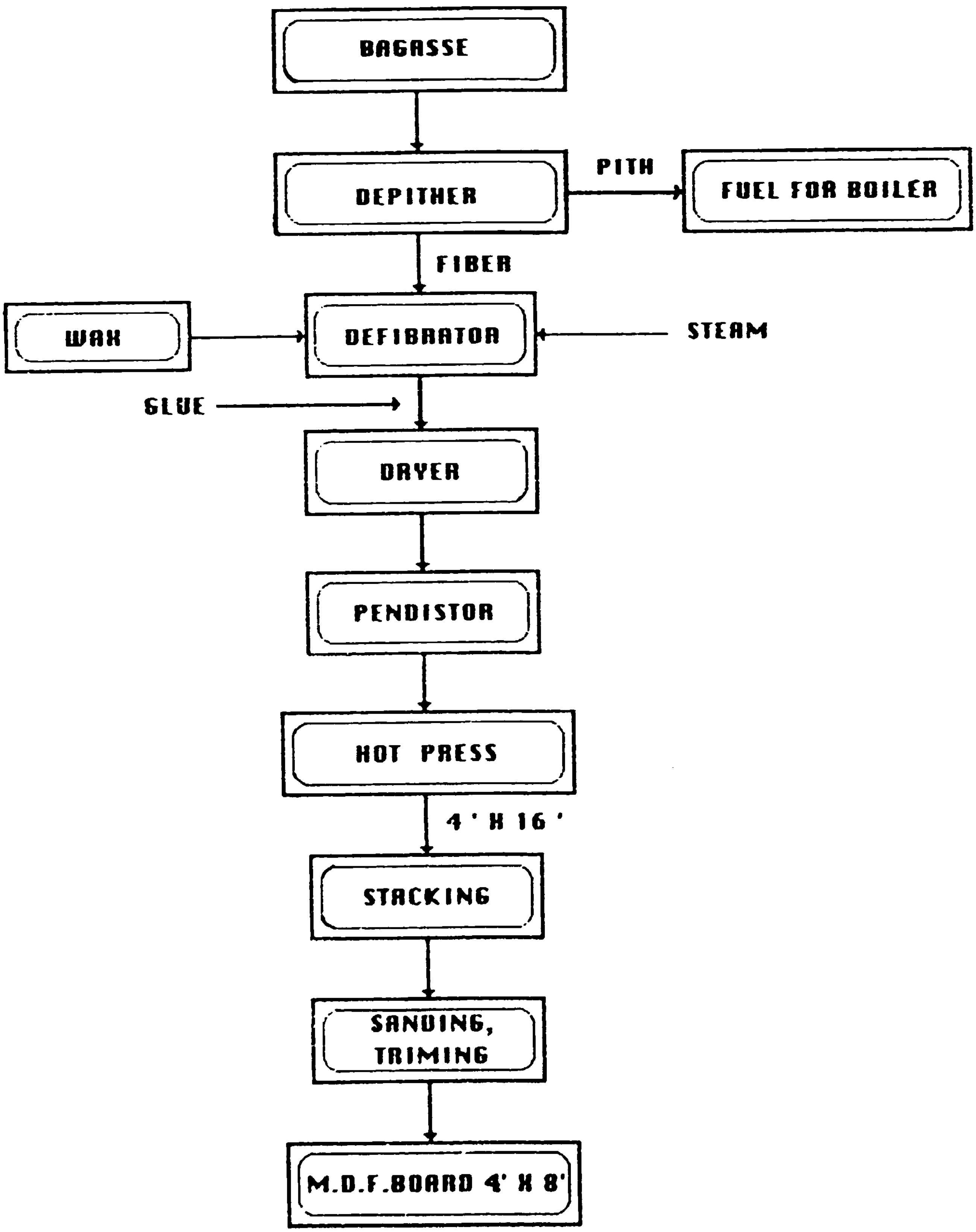
DIAGRAM A

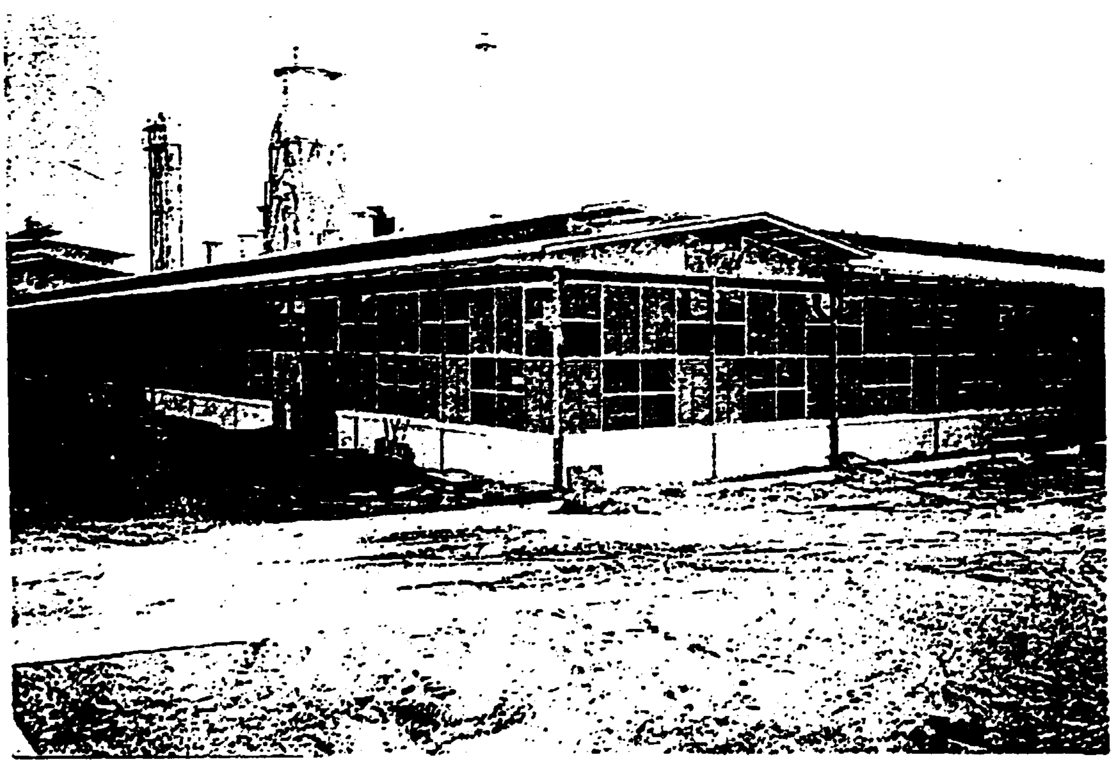
FLOW CHART M.D.F



The First Bagasse MDF Board Plant

Khon Kaen MDF Board Co Ltd Bangkok, Thailand

Author:
Peter H. Wiecke
Sunds Defibrator AB, Sundsvall, Sweden



SUNDS DEFIBRATOR

Leading the world in fiber processing

ABSTRACT

The Khon Kaen Medium Density Fiberboard Plant is the first plant of this type, using bagasse prepared in a pressurized refiner as rawmaterial.

The process is of great commercial interest, as it provides a practical use for a fibrous rawmaterial available in semi tropical areas, which are usually short on conventional wood resources.

The plant recently started commercial operation, and produces medium density fiberboard for the furniture and cabinet making industry in densities from 600 to 850 kg/m^3 and thickness from 6 to 25 mm.

The process flow from rawmaterial receipt to finished panel product of this 72 t/d dry process medium density fiberboard mill is described.

INTRODUCTION

The management of Khon Kaen Sugar Mill Co. Ltd., in Khon Kaen Thailand started in 1982 to investigate further uses and applications for the bagasse residue produced in their sugar mill. They became acquainted with medium density fiber board (MDF) in Europe and initiated a research and feasibility study on the production of MDF using their bagasse as rawmaterial. This research study was undertaken in the laboratories of Sunds Defibrator (SD) in Sweden, and resulted in the decision to go ahead with the construction of a 70 t/d MDF plant in 1983. Plant construction started in 1984 and the first board was made in the fall of 1985.

A separate company under the name Khon Kaen M.D.F. Board Co. Ltd. (KKMDF) was formed for this venture, with its head office in Bangkok. The plant is located adjacent to the Khon Kaen Sugar Mill near Nam Pong, and uses the bagasse generated by the mill as well as bagasse purchased from nearby mills.

The plant is in commercial operation since the beginning of this year.

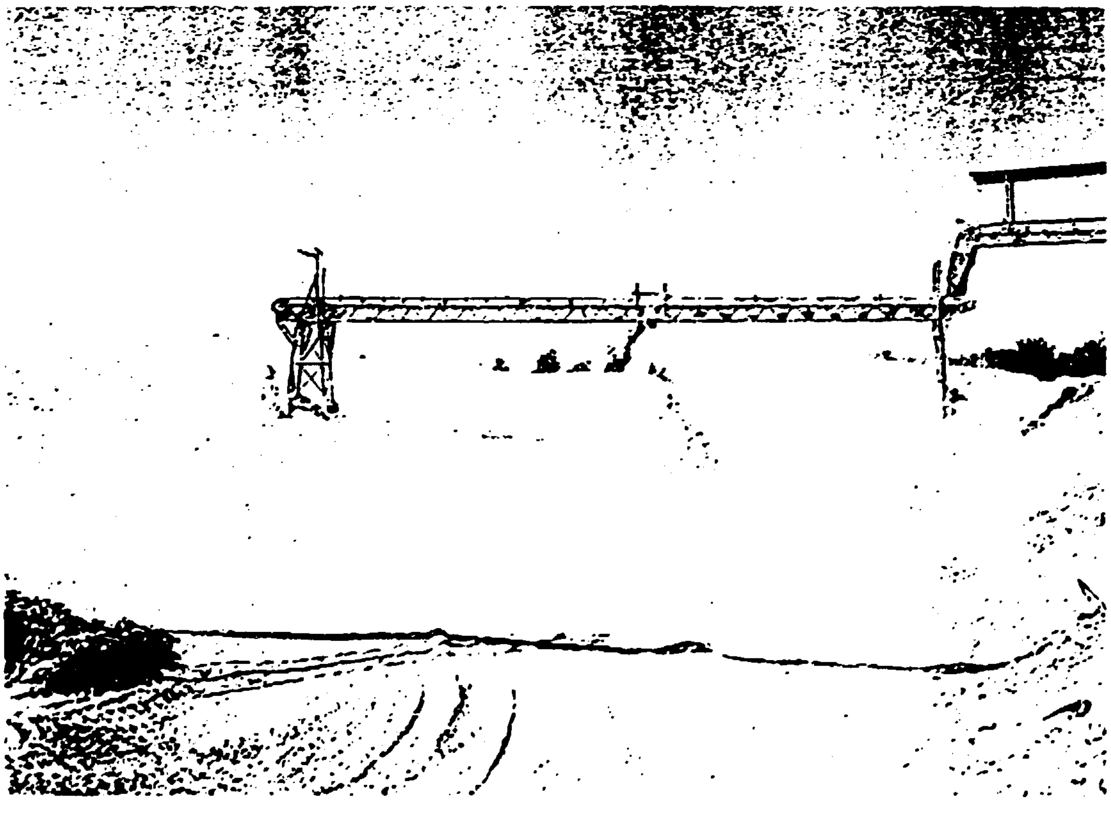
Since this is the first MDF plant using bagasse, wide interest for the process and the operation of this plant has been expressed. This paper tries to answer some of these questions.

BAGASSE STORAGE

Since the harvest season for bagasse in the Nam Pong area lasts from about December to April and the plant is designed to operate the full year around, storage of bagasse for the period outside the harvesting season is crucial. Bagasse storage is a problem well known throughout the industry using this fibrous rawmaterial. The question of wed versus dry storage was addressed during the research study.

The feasibility investigation showed that for a dry process MDF plant wet storage would impose costs for the storage and subsequent processing which would make it difficult to be competitive in the international market. The research study investigated the use of dry stored bagasse for this particular process, which lead to the following process steps.

The moist bagase (e.g. as it comes from the sugar mill during the crushing season) is depithed before it is placed in storage. The pith is returned to the sugar mill for burning. Storage piles, 7 to 10 m high, are created and compacted by bulldozer in the storage yard. The bagasse is covered during the rainy season. Piror to its use, the bagasse stays in storage for a minimum of 3 to 4 months.



The actual process flow is as follows:

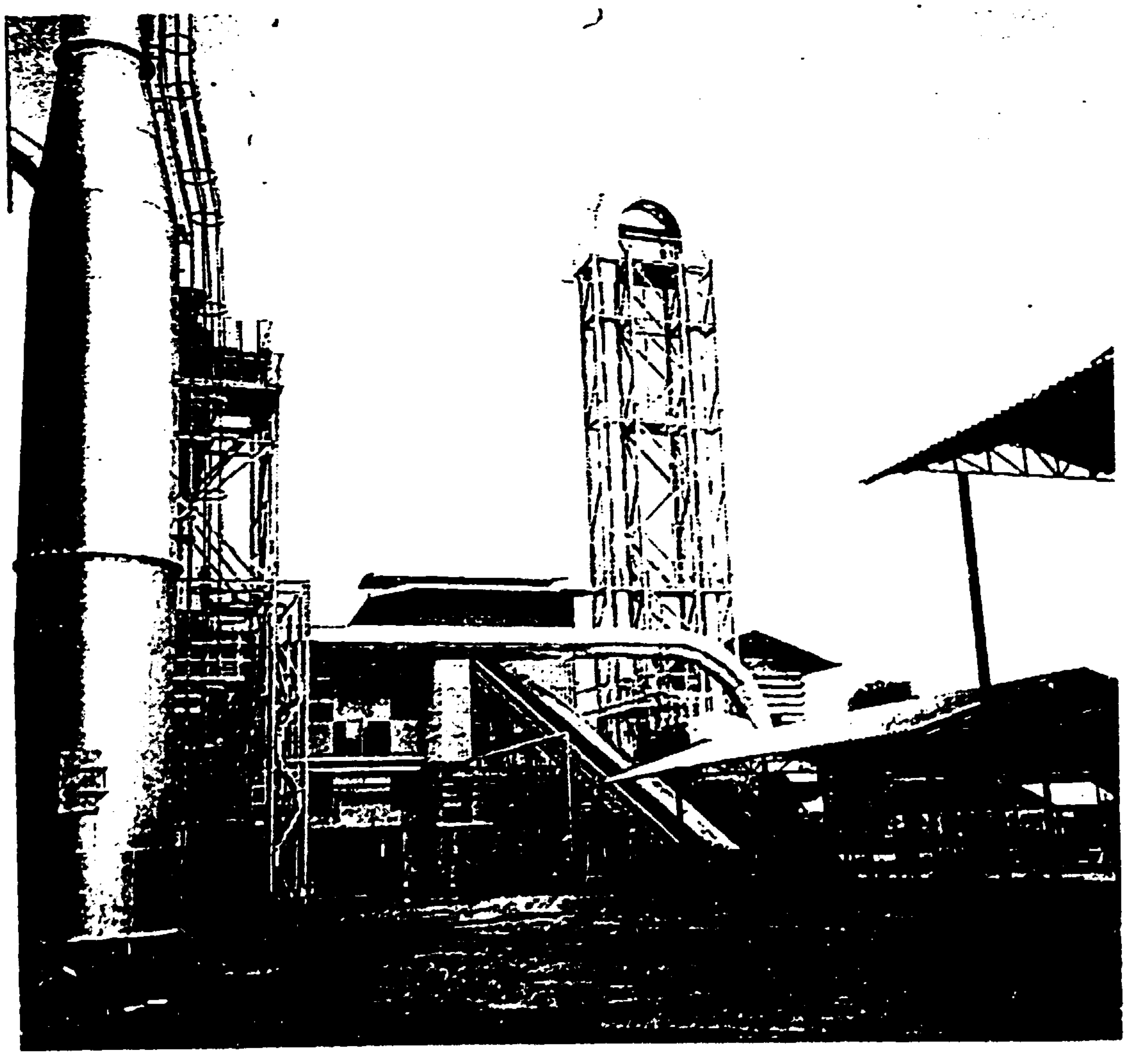
The freshly crushed and squeezed sugarcane bagasse arrives by conveyor from the sugar mill and is discharged on the raw bagasse pile. This intermediate storage pile is meant to be a buffer between the sugar mill operation and the depithers. The bagasse is fed by front end loader to a feed pocket or hopper, and carried from the hopper at a metered rate over belt conveyors to an overflow conveyor. Under the overflow conveyor pin drum feeders provide a constant feed to depithers. The depithers fulfill two main functions. Firstly, as the name implies, they separate pith resident in the bagasse. Secondly, they tend to break up the strands of bagasse into lenghts suitable for transport and processing in the MDF plant.

Between 20 and 33 % of weight of the bagasse is removed by the depithers in form of pith. The pith has no value in MDF board production, and only a small amount can be tolerated. The pith is sent to the sugar mill and MDF plant boilers for burning; the cleaned bagasse is put into treated bagasse storage.

FIBER PREPARATION AND DRYING

Compared with wood chips, bagasse is a bulky, stringly, not free flowing material and difficult to handle in the MDF process. For this reason the fiber preparation differs from the conventional process. In addition, the chemical composition of bagasse, and the decomposition taking place during its storage require special considerations in the process.

The equipment specially tailored for this process are the bagasse reclaim hopper, the overflow conveyor and pin drum feeder, the preheater plugfeed screw, the preheater, and the refiner feed screw. Once the bagasse is fiberized in the refiner, the process becomes quite similar to the one experienced using wood cellulose type rawmaterial.



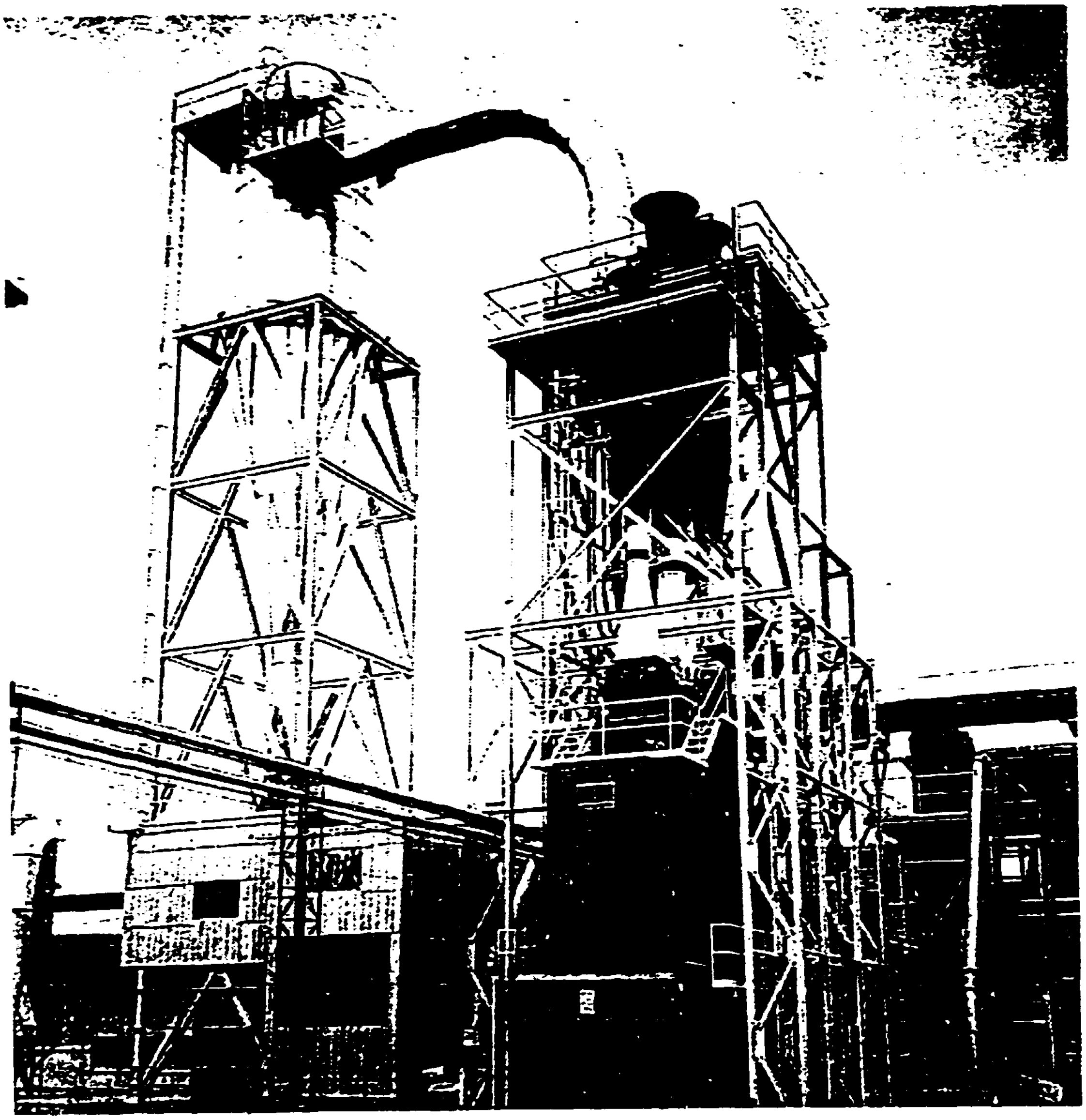
The actual process is as follows:

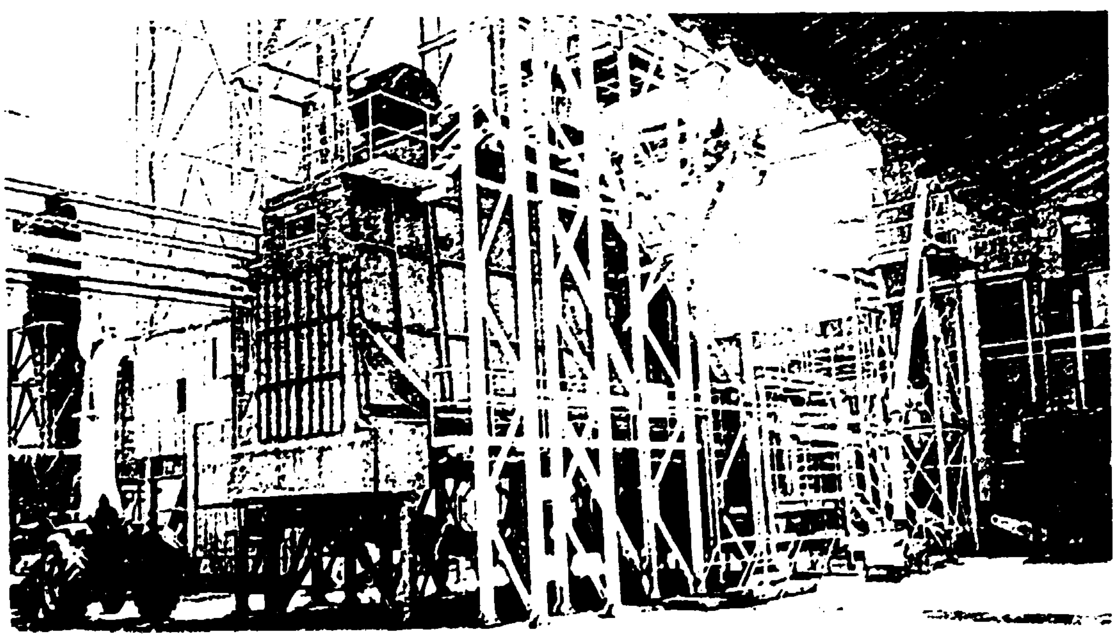
The depithed bagasse is reclaimed by a bucket loader and placed into the bagasse feed bin. The bin provides a continous flow of bagasse to the overflow conveyor through two connecting belt conveyors. The belt conveyors are provided with magnets to remove tramp metal from the bagasse. The overflow conveyor is a scraper conveyor and its function is to keep the infeed chute to the pin drum feeder filled with bagasse at all times. The overflow from this conveyor is taken back to the bagasse metering bin by belt conveyor.

The speed of the pin drum feeder, which is located below the overflow conveyor, determines the feed rate through the refining system. From the pin drum feeder a short stainless steel screw conveyor carries the bagasse to the plugfeed screw. Here spray nozzles can add water to the bagasse, should it be too dry.

The plugfeed screw is a large diameter, high compression screw, expecially developed for bagasse. The screw, which is 17 inches in diameter at its inlet, is tapered and compresses the bagasse in its conical section. The throat of the plugfeed screw is provided with weep holes to allow excess moisture in the bagasse to be expelled during the compression in the screw. The incoming moisture of the bagasse may vary between 115 to 80 %, dry basis, depending on storage time and location in the pile. Water content in excess of 85 to 95 % is expelled in the plugfeed screw through the weep holes.

The purpose of the plugfeed screw is to compress the fiber to form a pressure tight plug against the steam pressure within the preheater and the atmospheric pressure at the infeed of the plugfeed screw. If the plug is not tight the pressure will relieve itself spontaneously resulting in a blow back. It is difficult to form a tight plug with bagasse especially during startup. For this reason a pneumatically operated blow back damper has to be activated during startup together with auxiliary steam injection into the throat section of the plugfeed screw. Once the plug is established, resistance to the turning of the plugfeed screw increases very rapidly, and the blow back damper has to be withdrawn and the additional steam injection be turned off. The plugfeed screw runs at a constant speed and the current drawn by the screw is continously monitored. When the current consumption drops the blow back damper is moved into position, to ride on the plug and ensure that it remains tight.





The plugfeed screw and the blow back damper are mounted on a vertical stand pipe into which the plugfeed screw discharges the bagasse. From the stand pipe the bagasse drops into the horizontal preheater. The preheater is pressurized with 7 bar saturated steam and a screw moves the bagasse through the preheater. Bagasse being the type of rawmaterial that it is, varies in bulk density from 40 to 150 kg/m^3 depending on age and moisture. The design of this screw for this type of material and the required dwell time is therefore quite critical. The preheating time for bagasse is between 2 and 3.5 minutes.

From the preheater the bagasse flows through a vertical stand pipe into the refiner feed screw which carries the bagasse into the refiner. Molten paraffin is added to the bagasse in the feed screw. The refiner is a Sunds Defibrator L36 machine with 450 kW 1000 rpm main motor. Bagasse refines relatively easily with normal power input of about 60 to 80 kW per ton. Fiber quality is good, with very low shive content.

Fiber together with steam is expelled from the pressurized refiner through a blow valve and a blowline directly into a flash tube dryer. The blowline diameter is 4 inches, a three way valve allows the startup fiber to be diverted to a startup cyclone to get rid of the excessively wet and dark startup fiber.

Urea formaldehyde resin is added in this blowline at a metered rate, by injecting the resin mixture through a nozzle into the blowline directly at the blow valve.

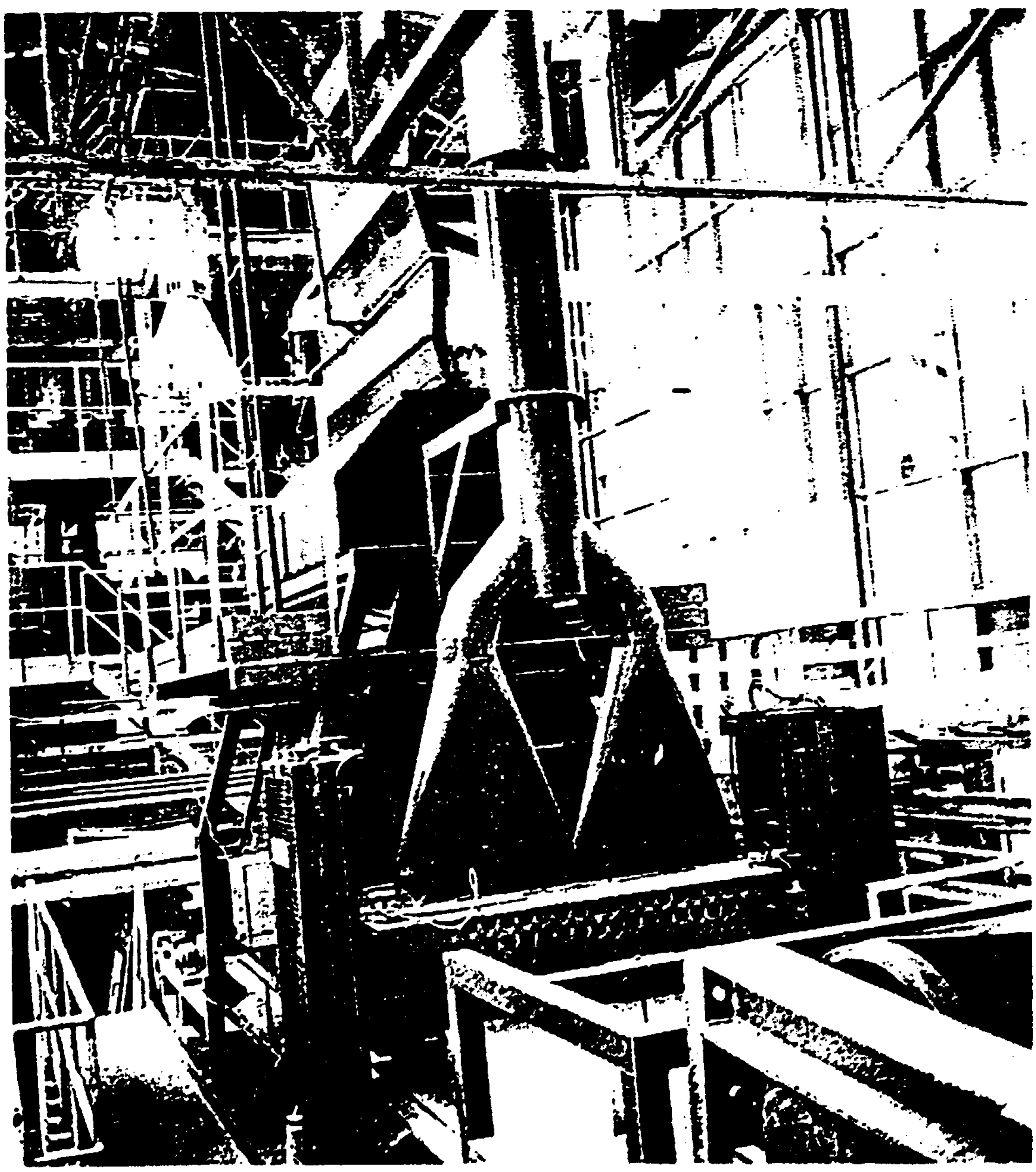
The 100 meter long flash tube dryer is heated by steam to air heat exchangers and operates with a inlet temperature of about 160 degrees C. The resinated bagasse fiber enters the dryer through the blowline and the first vertical section of the dryer tube. Evaporation of moisture occurs very rapidly, and the total dwell time of the fiber in the dryer tube is about 3 1/2 seconds. In the cyclone at the end of the dryer tube the fiber separated from the drying air, and discharges through a rotary air lock onto a belt conveyor. The exit temperature is about 75 degrees, the fiber has been dried to a moisture content of about 11 to 12 % (dry basis). Fire detectors supervise the dryer discharge, and reverse the conveyor in case sparks are detected.

The following weigh belt conveyor totalizes the fiber flow and also controls the resin and wax addition to the fiber. From the weigh scale the fiber is conveyed pneumatically to the fiber bin.

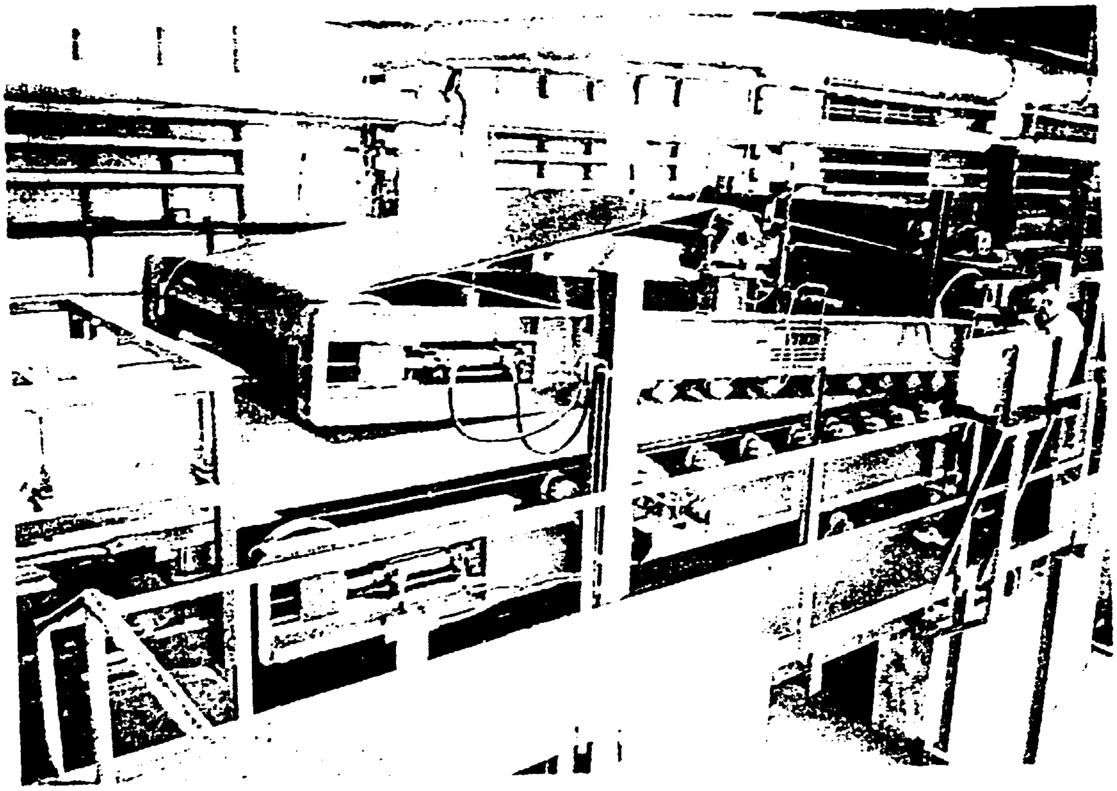
The 60 m^3 capacity fiber bin acts as a buffer and storage device between the fiber preparation and the forming and pressing line.

MAT FORMING AND PRESSING

Fiber is metered at a controlled rate out of the bin and conveyed by air to the single head Pendistor station. The Pendistor air felter lays a continuous fiber mat down onto a plastic wire screen, assisted by vacuum on the underside of the screen belt. To insure uniformity of fiber deposition, the fiber mat height is controlled continuously as the mat leaves the forming box. Pulsating flow controlled air jets distribute the fiber over the total width of the forming station. After the forming head a scalper roll shaves off the top layer of the fiber mat to remove any inconsistencies on the surface of the mat formation. Behind the scalper roll, a weigh plate monitors the mat weight, as the mat moves down the line and automatically adjust the scalper height for constant mat weight.

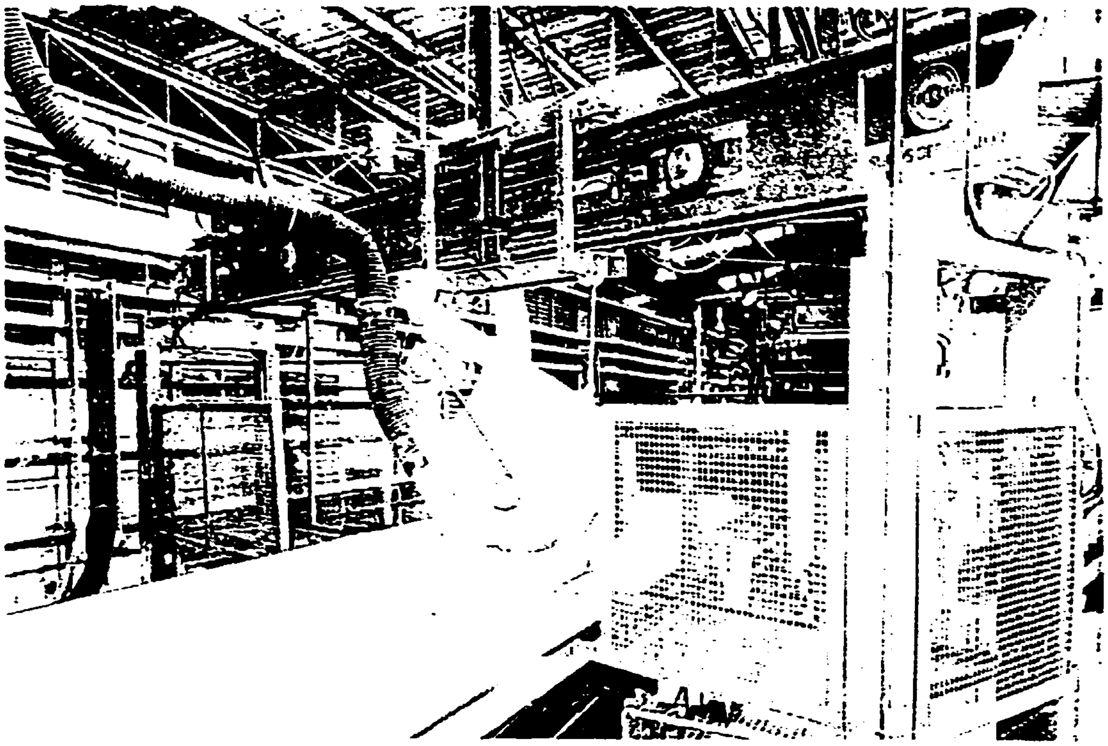


The fiber density leaving the forming station is about 40 to 50 kg/m^3, which results in a mat height of about 390 mm for pressed board of about 19 mm. In order to consolidate the mat suitable for insertion into the hot press it has to be precompressed. A belt type precompressor consolidates the mat and increases its density about 5 times. The continuous fiber ribbon is trimmed on its edges, and cut into 16 ft length. The forming line is caulless, that is, the mats are transported into the press only on belt conveyors.

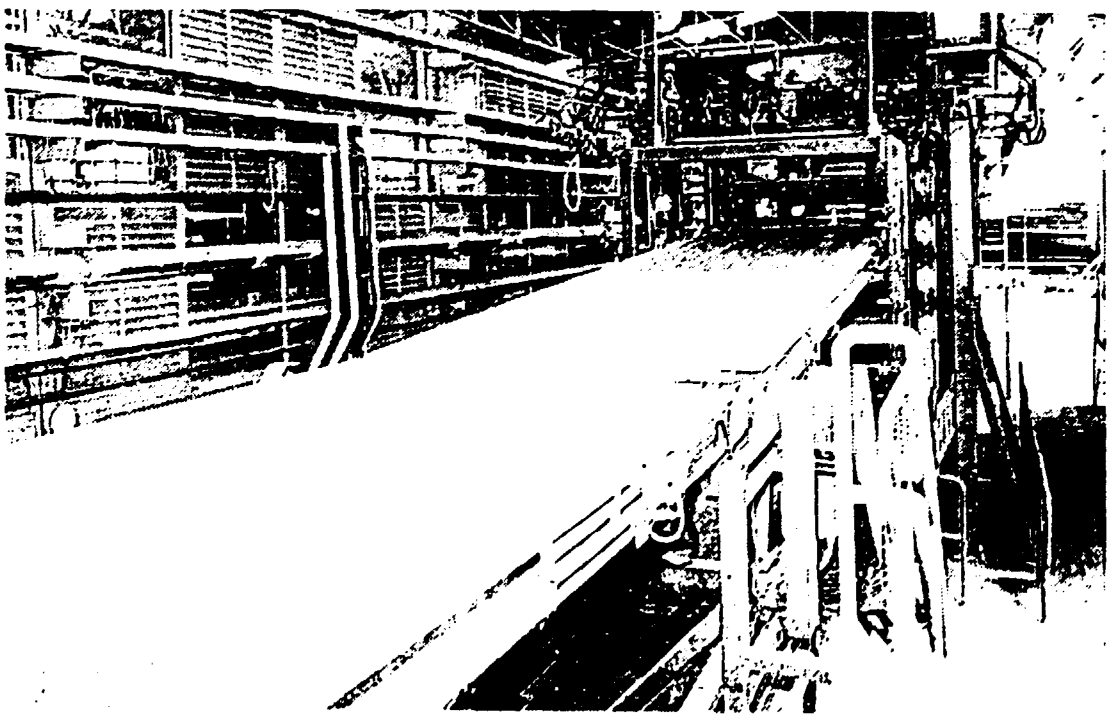


Following the saws, a gap is created between the mats through a speed-up section, to allow the loading of individual mats into the press loader. The speed-up section incorporates the reject station for discharging of unwanted mats. The fiber removed by the scalper roll, the trim saws and the reject station is returned to the fiberbin.

After the tipple conveyor has charged the 5 openings of the loader, the loader enters the hot press and during its retraction cycle deposits the mats in the hot press.



The nominal 4 x 16 ft hot press has 5 openings. The press is steam heated and utilizes on the oil hydraulic closing system. The pressing temperatures are between 155 and 170 degree C and the maximum specific pressure on the mat surface available is 35 kg/cm^2. The press operates with a rapid initial closing cycle and a time-distance control system for the final compression stage. The pressing time for 19 mm board is about 7 to 7 1/2 minutes; loading and unloading time is about 35 seconds.



MAT FORMING AND PRESSING

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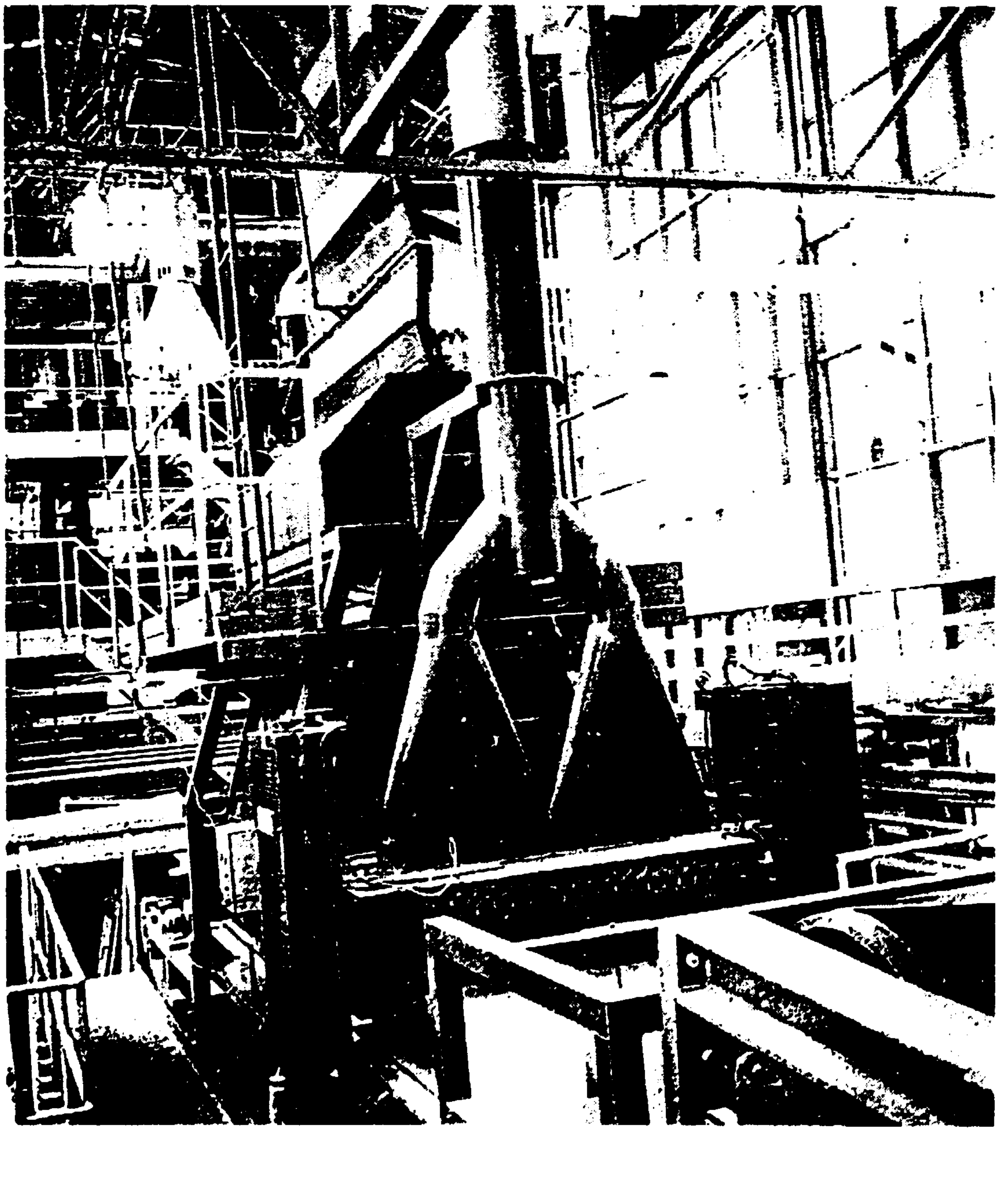
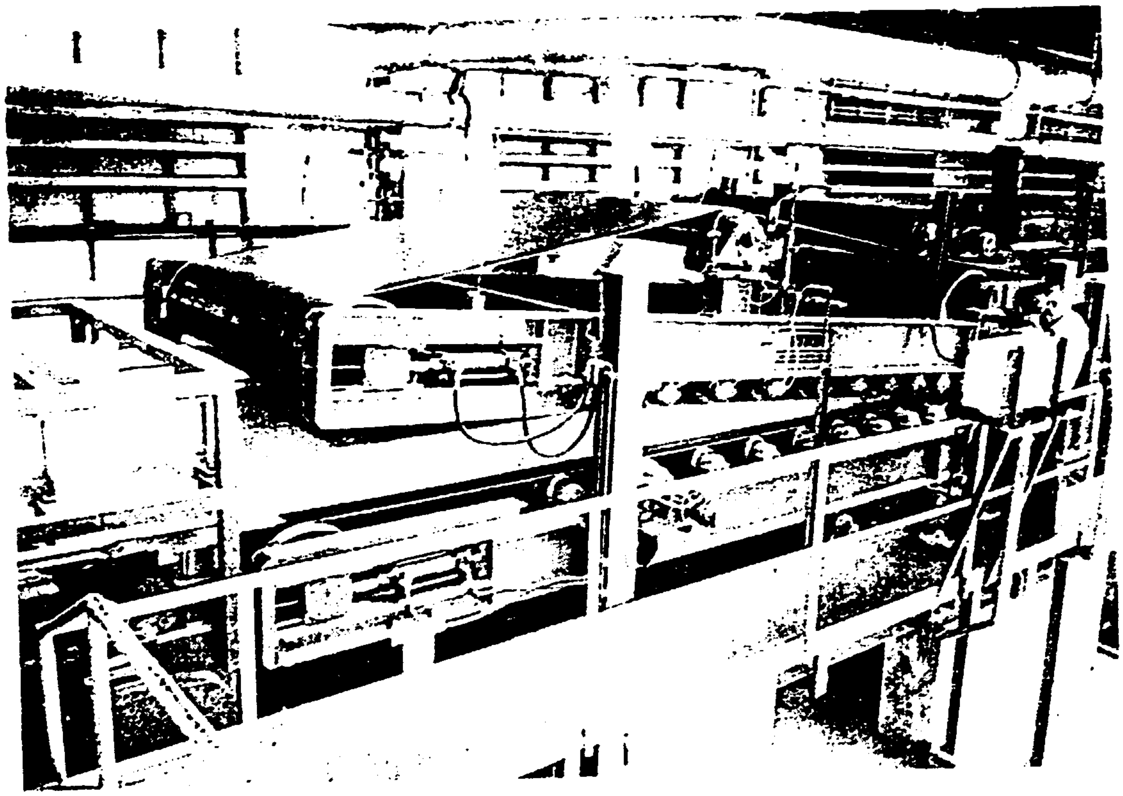


The fiber density leaving the forming station is about 40 to 50 kg/m^3, which results in a mat height of about 390 mm for pressed board of about 19 mm. In order to consolidate the mat suitable for insertion into the hot press it has to be precompressed. A belt type precompressor consolidates the mat and increases its density about 5 times. The continuous fiber ribbon is trimmed on its edges, and cut into 16 ft length. The forming line is caulless, that is, the mats are transported into the press only on belt conveyors.



Following the saws, a gap is created between the mats through a speed-up section, to allow the loading of individual mats into the press loader. The speed-up section incorporates the reject station for discharging of unwanted mats. The fiber removed by the scalper roll, the trim saws and the reject station is returned to the fiberbin.

After the tipple conveyor has charged the 5 openings of the loader, the loader enters the hot press and during its retraction cycle deposits the mats in the hot press.

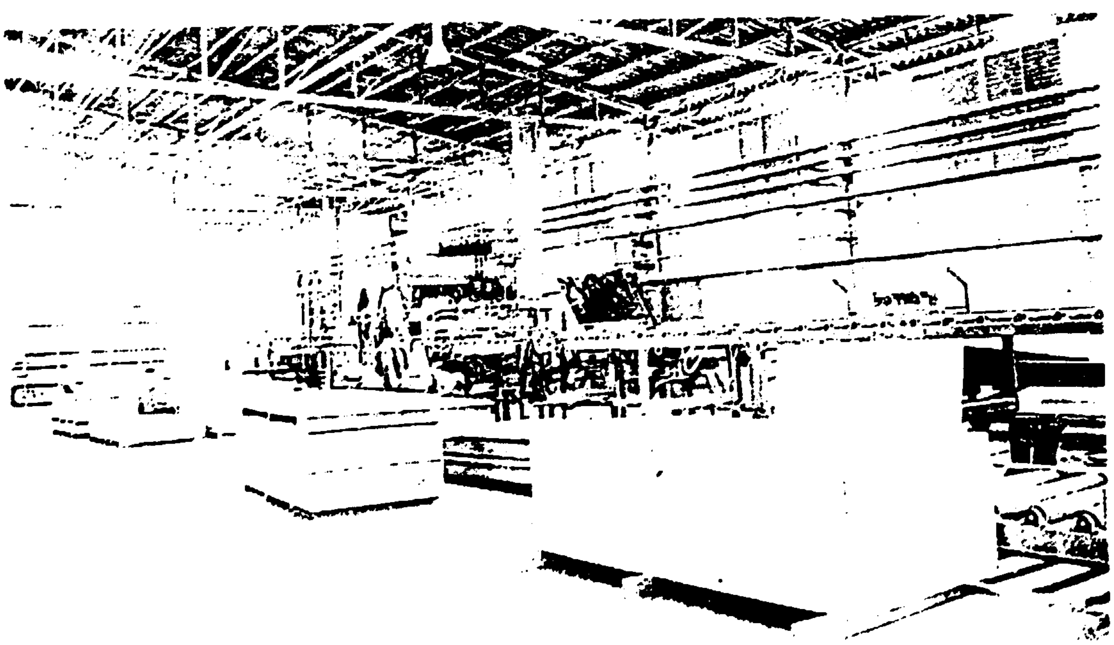
When the press cycle is completed the press opens and the loader again enters the press, pushing out the pressed board with the nose pieces of the individual trays and depositing the next mat load onto the platens as it retracts. The unloader cage receives the pressed boards.

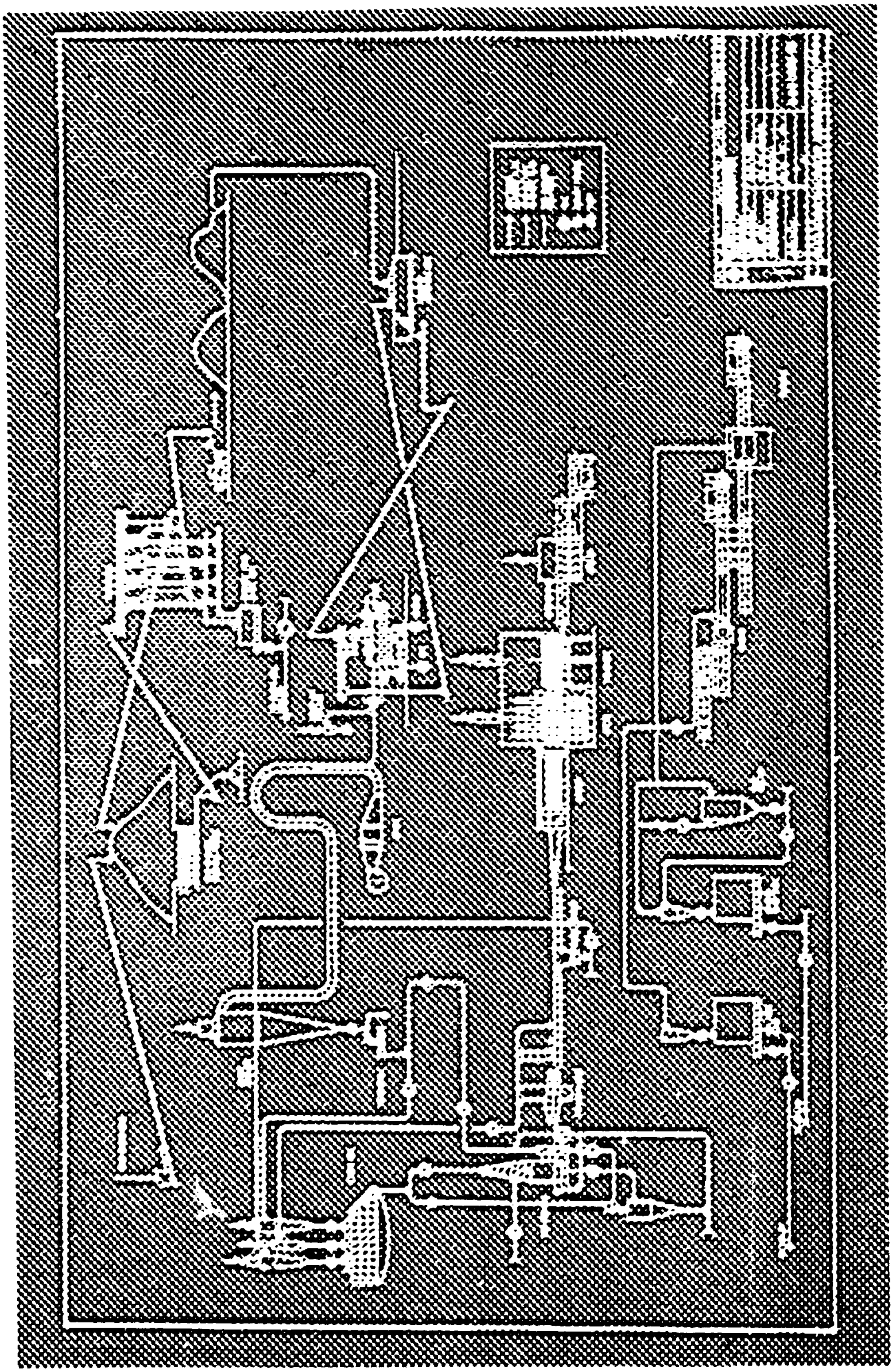
Unloaded boards are, weighed in the following weigh conveyor and stacked at the outfeed of the cooling line. From the stacker the boards are taken into the intermediate storage to complete the curing and equalizing of the board.

FINISHING

After two days of storage the boards enter the finishing line. The first step in the finishing operation is the sanding of the board to a final caliper. This is done in a 4-head sanding machine where both top and bottom surfaced of the board are sanded. After the sander, boards go directly into a trim saw which cuts the panels into their finished 4 x 8 ft size. The boards are stacked and strapped ready for shipment. Sander dust and saw trim are sent to the boiler for burning.

This completes the process description.





GENERAL TECHNICAL DATA

Plant capacity	72 ton/day
Board density	600 to 850 kg
Board thickness	6 to 25 mm
Press size	4 x 16 ft - 5 openings
Press pressure	35 kg/cm^2
Depithers	No: 3 Capacity: 200 tons/day
Bagasse feed hopper	Capacity: 40 m^3
Pressurized refiner system:	
Plugfeed screw	diameter 17 inches (432 mm)
Preheater	diameter 36 inches (900 mm) length 24 feet (7.4 m)
Refiner	L36, disc diameter 36 inches (914 mm)
Maximum operating pressure	12 atm
Main motor	450 kW, 1000 rpm
Flash tube dryer:	
Evaporative capacity	4266 kg/h
Fiber bin	60 m^3
Forming station:	type Pendistor
Forming width	1500 mm
Forming length	1750 mm
Total installed motor load	2250 kW
Boiler plant:	capacity 14 tons/h
Operating pressure	18 bar
Fuel	pith, sander dust, saw trim, oil

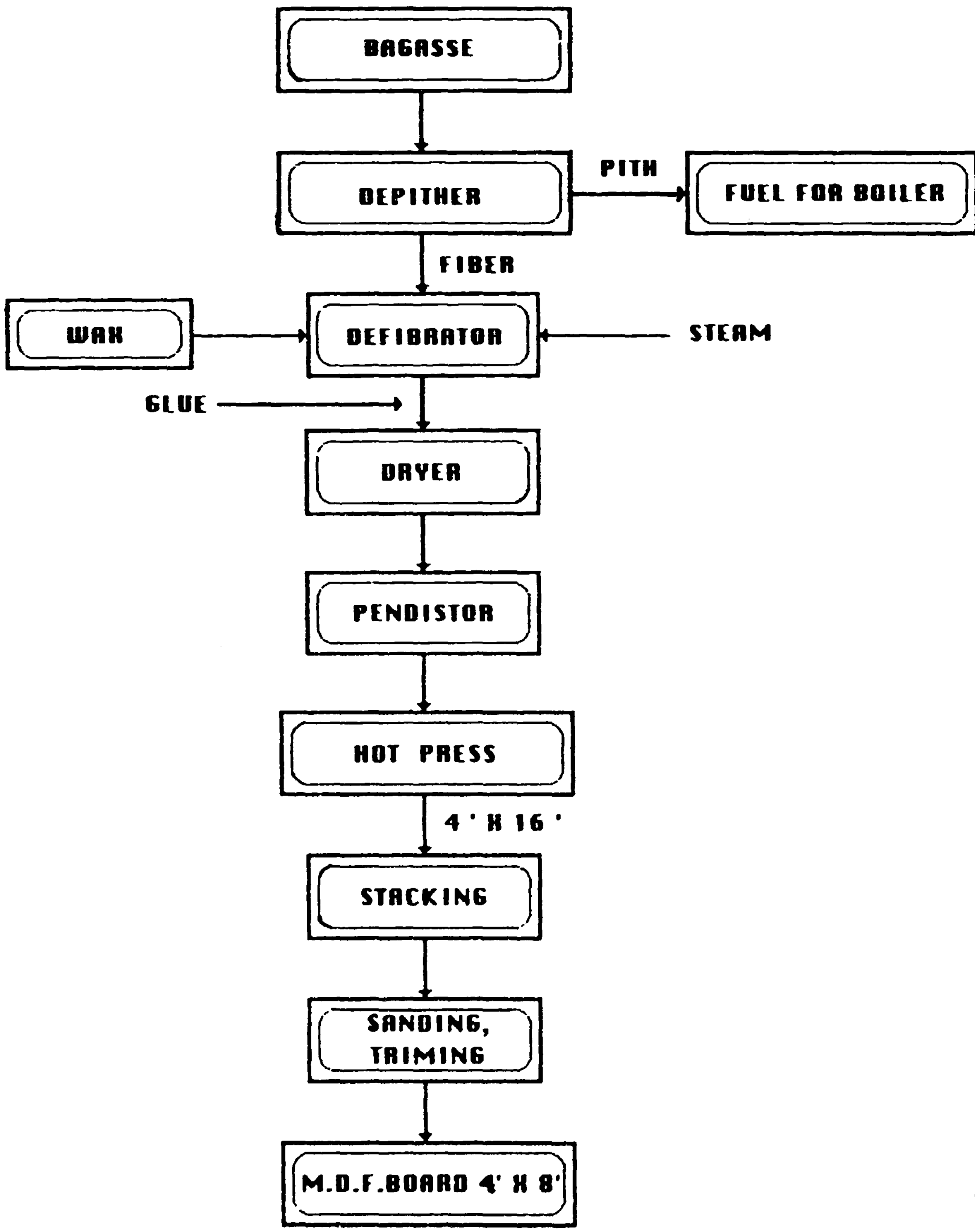
Consumption figures
(all data given for 19 mm board, per ton of finished product)

Depithed bagasse (dry basis)	1100 kg
Resin (solids)	110 kg
Paraffin (molten)	5 - 15 kg
Steam	3000 kg
Power	450 kW
Water (excluding steam generation)	200 liter
Compressed air	120 m^3
Covered building area	4670 m^2

The manufacturing program of the SUNDS DEFIBRATOR Board Division includes such wellproven technology as:

- ☐ Complete SUNDS DEFIBRATOR plants for the production of particleboard, MDF, hardboard, OSB and waferboard.
- ☐ Complete SUNDS DEFIBRATOR fiber production units: Pressurized or non-pressurized systems for defibrizing all kinds of wood and annual fibers.
- ☐ FAHRNI formes for particleboard, OSB/waferboard.
- ☐ SUNDS DEFIBRATOR dry-fiber formers.
- ☐ KMW wet-fiber formers.
- ☐ MOTALA single- and multi-opening presses and press lines for the production of MDF, hardboard, particleboard, OSB and waferboard.
- ☐ MOTALA prepresses —continuous pre-compressors or platen prepresses for compression of fiber/particle mats.
- ☐ Charging systems for press lines with or without cauls, metal screens, synthetic screens and steel belts for mat transportation.
- ☐ Embossing plants for further processing of hardboard, softboard, bitumen impregnated softboard, MDF, particleboard, plywood and blockboard.
- ☐ Installation, operator training and start-up assistance.
- ☐ Rebuilding and upgrading of existing plants, forming and pressing lines to increase capacity and product modification.
- ☐ Continuing services such as: operator retraining, spare parts, etc.
- ☐ R & D center at your service.
  SUNDS DEFIBRATOR has two world leading research and development centers for fiber process and technology.

FLOW CHART M.D.F



ANNEX V

POTENTIAL INVESTMENT OPPORTUNITY PACK-V

CASHEW NUTS FROM VIENTIANE

Introduction

During the Consultants' first visit to Vientiane, a meeting was held at the Ministry of Agriculture and Forestry when it was pointed out that some 70,000 cashew trees had been planted between three and five years ago under an initiative from the Ministry. The trees were of local and Vietnamese varieties and had been established by small farmers in the expectation of valuable export markets being developed. However, yields had been low and the nuts were rather small and apparently not of a good export quality. The trees were somewhat neglected as a consequence.

It was understood that a US company had apparently paid for the crop to be harvested earlier in the year but not all nuts had been sold and there were some six tonnes of nuts in local storage. It was suggested that these trees could form the basis of a modest project to improve and expand production and processing for both the local and export markets.

The Consultant subsequently visited the cashew planting area close to Vientiane and found that, while most of the trees appeared to be healthy, there was some die-back and the trees were either planted too close or needed thinning out and pruning. The groves were full of weeds and lack of maintenance was clearly a major problem. At a subsequent wrap-up meeting at the Mekong Secretariat, it was agreed that cashew nut processing could be identified as an investment opportunity.

On return to Bangkok, discussions were held with cashew nut specialists at Kasetsart University and the Mah Boonkrong Company (who have extensive cashew plantings in Thailand). This was followed by field visits to Cashew Research at Si Sa Ket Horticultural Research Centre and to Buriram Agricultural College. At the latter institution it was discovered that a specialist from the college and a local farmer had visited Vientiane earlier in the year and had prepared a detailed report on the status of the trees there. Apparently a project had already been established along the lines proposed by the Consultant, following a commercial agreement between the Thangone Feed Mill Corporation within the Ministry of Agriculture and Orient Expressions Ltd of Pennsylvania, USA. This project is now known as the Lao Cashew Project (LCP). A copy of the project document was obtained on a subsequent visit to Vientiane.

As this project appears to already be in existence it clearly cannot be identified as a potential new investment within the terms of reference of the present study. It may, however, still be of future interest to investors should the present arrangement fail to proceed as planned. For this reason the following notes are not presented in the standard opportunity study format, but are provided as general background for any future studies that may emerge and for any local entrepreneurs who may wish to assist in expanding this potentially viable industry.

The Market for Cashew Nuts

The world market situation for cashew nuts is briefly described in the paper in Annex V. The base price of cashew (the S320) seems set to rise in the short to medium term. The USA is the major importer but, as with most commodities, the prime determinant of price is quality. It is almost certain that Lao could sell as much as it could produce, through Orient Expressions, given that quality can be achieved and maintained.

Laos Cashew Nut Plantings and Estimated Production

Tables 1 to 3 in Annex V show: the estimated cashew nut plantings in Vientiane Province and Municipality as at March 1991 (this indicates an actual total of only 40,690 trees with a potential yield now of 123.75 tonnes of nuts), Lao cashew planning factors upon which projected returns to the project are based, and a costing worksheet which outlines basic purchasing prices and processing costs for export. Also included in Annex V is a paper on the world market situation for cashew, the Lao Cashew project document itself, and some technical literature on cashew cultivation.

The long term objectives of the Project are:

- to establish Lao cashews as a viable export crop based on internationally accepted standards
- to establish Lao cashews as a long-term development crop within the Lao PDR agriculture and economic plans
- to improve the quantity and quality of the crop
- to develop the technologies and expertise required to ensure the export capabilities of Lao PDR
- to develop the Lao cashew industry to be able to support the shipment of one container a month from Lao PDR by the year 2000. (This objective requires the shipment of some 415 tonnes of cashew nuts per year which would need the establishment of some 240,000 trees.)

Cashew Nut Processing

The cashew nut is a kidney-shaped nut that grows at the end of a curiously shaped fleshy portion known as the cashew apple. The shell of the nut is in three layers. The outer and inner layers are dry but the middle layer contains a dark caustic oil called Cashew Nut Shell Liquid (CNSL). This oil is driven off in dry roasting, but can be extracted and has various industrial uses including paint, varnishes and lacquers.

In small-scale processing, after separating the nut from the fleshy part, the nuts are roasted to drive off the caustic CNSL and then opened individually on hand shelling machines. It is understood that using these machines, one operator can shell approximately six Kilo of nuts per day. Automatic equipment is produced by Peabody in the UK and there are also manufacturers in Italy and Switzerland, but large volumes of nuts are required to justify investment in this equipment. Mah Boonkrong in Thailand consider 500,000 trees yielding some 2,500 tonnes per year at maximum production is the minimum economic size. This needs substantial financing, in the order of US$ 5–10 million for the establishment of the factory and the one-time purchase of the crop for year-round processing.

The astringent Cashew Apple may also be processed into juice, jams, candy and chutney, etc. The Mysore Central Food Technological Institute has carried out substantial development work in this area. Large quantities of fruits are processed into juice in Brazil but generally speaking it is not practical to process the crop for both juice and nuts as there are different requirements for each; eg, the fruits need to be picked fresh each day for juice extraction, whereas for nuts the fruits are allowed to ripen and fall on the ground where they are collected only periodically.

Current status of the Lao Cashew Project

It is understood that within the terms of the joint venture agreement, the Thangone Feed Mill Corporation has already sent some 30 employees together with 30 farmers to Buriram College in Thailand for training, and that the Municipality of Vientiane has purchased 30 hand shelling machines from Khon Kaen for the establishment of a central processing facility.

The Chance of Investment Success

While the general formulation and intentions of the project are good, for it to succeed it is essential that the following matters should be given particular attention. Firstly, the future success of the project relies on the early increase in production and productivity from increased plantings of cashew trees and improved husbandry and maintenance. This will need considerable expertise and effective extension work, combined with an adequate return to farmers for their efforts.

Secondly, current and anticipated yields per tree are not particularly good, due mainly to the varieties planted. Small low-yielding trees will need to be removed and selective pruning carried out.

Thirdly, discussions should be held with Sisaket Research and other institutions to select the most suitable varieties for future planting, possibly SK 60-1 or SK 60-2 and the composite variety Si Sa Ket SK-A which is derived from 10 selected clones. These can be expected to produce both higher yields and larger nuts although, without trials, their exact performance cannot be prejudged. However, trials take a long time and new plantings might best be based on a range of selected varieties.

ANNEX V

POTENTIAL INVESTMENT OPPORTUNITY PACK-V

CASHEW NUTS FROM VIENTIANE

Table 1

Lao Cashew Project Briefing, March 11 1991

Cashew nut estimated production, 28 November 1990, updated 9 March 1991

Site	Number of plant	Maturity (years)	Estimated (Y/P) kilos	Production (tonnes) pods
Vientiane Province				
1) Thong Kheng village	2,000	5	3	6.00
2) Nong Kaleo village	250	3	3	0.75
3) Phoxay village	600	3	3	1.80
4) Huang Kao village	250	3	3	0.75
5) None Khok village	220	3	2	0.44
6) Done Xay village	9,000	5	3	27.00
Sub total:	12,320			36.74
Vientiane Municipality				
20) Nong Vieng Kham village	3,000	5	3	9.00
21) Dongdok village	2,700	5	3	8.10
22) Thangone village	700	5	5	3.50
23) Thasomo village	250	5	5	1.25
24) Phakhao village	150	5	3	0.45
25) Xaysetha village	1,750	5	3	5.25
26) Sikhot village	800	3	3	2.40
27) Banthin village	12,700	5	3	38.10
28) Dong Ha Khai village	320	5	3	0.96
29) Hatsiao village	5,000	5	3	15.00
30) Thongmang village	1,000	5	3	3.00
Sub total:	28,370			87.01
Total:	40,690			123.75

Table 2 Lao Cashew Project Briefing, 11 March 1991
28 November 1990, Updated: 9 March 1991

Lao Cashew Planning Factors

Planning Ratios

1,250 pods will produce 1 kilo or 2.2 lbs of shelled nuts
235 pods weigh 1 kilo or 2.2 lbs approximately
5.3 kilos of pods are required for 1 kilo of shelled nuts
5.3 lbs of pods are required for 1 lb of shelled nuts
1 short tonne of pods will produce approximately 375 lbs of shelled nuts

20' Container:

Maximum weight	44,500 lbs
Maximum cube	1,147 cu ft

20' Container:

Inside dimensions	19.5'L x 7.67'W x 7.67'H:	1,147 cu ft

50lb cartons:

Max cartons	25" L x 13" W x 7.75"H:	693 cu ft

1 x 20' Container: 34,650 lbs of kernals

1,000 pods as an average yield per tree for planning:

- One tree would produce 4.26 kilos or 9.37 lbs of pods
- One tree would produce 0.8 kilo or 1.76 lbs of shelled nuts
- 1 x 20' container would require the yield of 19,688 to 20,000 trees
- 1 x 20' container would require the processing of 80 - 85 tonnes of pods
- Moisture level of the cashew pods as they fall off the trees is approximately 22% - 25%.
- Moisture levels of the chashew pods should be in the range of 8% - 9% for storage

Table 3 Lao Cashew Project, 11 March 1991
Cashew Costing Work Sheet, 9 March 1991

Vientiane, Lao	20' Container 34,650 lbs (kernels) 15,750 kilos
1 Procurement of the pods: @ Kip 120/kilo @ US$0.078/lb (Ratio 5.3 : 1)lb	Kip 10,016,990 US$14,310
2 Transportation cost to processing site: @ Kip 8/kilo @ US$0.005/lb	Kip 642,758 US$918
3 Receiving and processing cost: @ Kip 80/kilo @ US$0.052/lb	Kip 6,678,000 US$9,550
Factory Production Cost:	Kip 17,337,748 US$ 24,775
Cost per kilo:	Kip 1,101 US$1.57
Cost per lb:	Kip 500 US$0.72
4) Packaging costs: @Kip 20/kilo @ US$0.013/lb	Kip 315,000 US$450
Bags/cartons CO2 @ Kip 1,050/22.73 kilos @ US$1.5/50lbs	Kip 728,000 US$1,040
5 Loading cost included in packing cost above FOB Factory Vientiane Area, Lao:	Kip 18,380,748 US$26,265
Cost per kilo:	Kip 1,167 US$1.67
Cost per lb:	Kip 530 US$0.76
6 Inland Freight to Vientiane Export Terminal Lao	
7 Vientiane terminal charges: Loading/unloading Storage Documentation Licensing Consular invoice Certificate of origin Fees/custom duties/stamps Export taxes Ferry charges	

The World Market Situation

The financial price obtained, and economic value to the country, of cashews grown and produced in Lao depend in large measure on the world price of cashews, since they are a widely-traded commodity. Orient Expressions of the USA will have based their involvement with market conditions of supply, demand and resultant price in mind. These notes summarise some of the major features of the current world market situation.

Firstly, however, it must be said that a major problem exists with the analysis of the Lao Cashew Project, in that final returns depend first and foremost on the quality of the product. The world marker price for cashews is the W320 price; it is impossible to predict what discount would eventually apply to Lao cashews as a function of their quality. It would seem reasonable to assume a 25% average discount over base prices, and this figure has been used in the text of the opportunity study.

Throughout 1989 prices for cashew kernels exhibited a declining tendency and finally reached in December a low of US$2.15/lb fob for W320's. Excellent crops in two of the main origins, India and Brazil, above-average crops in other minor producing countries,and a slack demand in the major consuming countries caused prices to decline to this level.

The market turned when it became clear that the 1989/90 crops, both in Brazil and India, were smaller than the previous season, respectively 30% and 15% less. Also, the situation in the East African origins was reportedly unfavourable. On top of this, imports during the first half of 1990 in nearly all consuming countries improved to a considerable extent. As a result, prices started to move up sharply and ultimately reached a high of US$2.55/lb fob. This trend has continued in 1991 with prices approaching US$ 3.00 as strong demand persists. The market peaked at US$ 3.05 in July 1991, the highest level since 1988.

As a consequence of the low prices experienced during the last months of 1989 and the early months of 1990, consumption in most importing countries was more than maintained, as the table below shows.

Table 4 Imports of Cashew Kernels

	1984	1985	1986	1987	1988	1989	1990	1990	1991
USA	1664	211	1916	1885	1676	1825	2401	1047	1024
Canada	149	143	136	121	114	166	197	85	78
UK	122	122	145	161	186	214	225	106	87
Germany	83	133	146	214	149	144	165	75	83
Netherlands	99	105	100	109	127	135	171	83	85
France	30	34	39	37	44	47	53	28	29
Belgium	17	18	16	12	16	13	16	10	11
Switzerland	--	--	--	--	8	8	7	4	5
Austria	1	2	2	3	2	3	3	1	2
Japan	106	104	150	121	164	167	190	95	108
Australia	157	118	118	91	120	120	124	51	44
USSR	5	302	210	136	261	261	433	285	30

Units: in 1000 cartons

--: not available

The USA, being the world's largest consumer with 55 to 60% of the total world imports, is a highly price-responsive market. This is demonstrated by the import statistics, which show that during the first 6 months of 1990 the USA imported a record high of 1,047,282 cartons, an increase of 31.2% compared to the same period of 1989. This level of imports was sustained in subsequent months, with January-June 1991 imports only 2% less than for the same period in the previous year, at 1,024,387 cartons.

Cashew imports into the largest European market (the United Kingdom) have also showed a sustained increase in recent years, with imports nearly doubling in the five years to 1990.

The supply/demand situation suggests continued high prices, with demand remaining strong and supplies adversely affected by Brazilian and Indian production shortfalls. Actual production in recent years and forecast production for the 1990/91 crop is summarised below.

Likely Lao production is of course only a tiny fraction of this total, and thus the country would remain a price-taker in world terms.

Table 5 Cashew Production by Country

	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1979/80-88/89 10-year ave	1989/90 Estimate	1990/91 Forecast
India	90,000	125,000	135,000	120,000	125,000	130,000	150,000	124,000	130,000	140,000
Brazil	90,000	60,000	115,000	120,000	75,000	130,000	160,000	97,000	130,000	90,000
Mozambique	18,000	25,000	30,000	35,000	40,000	40,000	15,000	43,800	20,000	15,000
Tanzania	32,000	47,000	32,000	18,000	16,000	24,000	37,000	34,600	15,000	15,000
Kenya	7,700	18,500	8,500	10,200	8,500	12,400	12,400	12,470	7,000	15,000
Others	12,000	12,000	12,000	12,000	12,000	12,400	15,000	12,300	27,000	30,000
TOTAL	249,700	287,500	332,500	315,200	276,500	348,400	389,400	324,170	329,000	305,000

Units: tons, raw seed basis.

LAO

CASHEW

PROJECT

1991

LAO CASHEW PROJECT BRIEFING
MARCH 11, 1991

LAO CASHEW PROJECT

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THA NGONE FEED MILL
LAOTIAN CASHEWS, LTD. - ORIENT EXPRESSIONS, LTD.

LAO CASHEW PROJECT BRIEFING
MARCH 11, 1991

CASHEW NUT ESTIMATED PRODUCTION

NOVEMBER 28, 1990
UPDATED: MARCH 9, 1991

Site	Number of Plant	Maturity (years)	Estimated (Y/P) Kilos	Production (Tons) Pods
VIENTIANE PROVINCE				
1. Thong Kheng Village	2000	5	3	6.00
2. Nong Kaleo Village	250	3	3	0.75
3. Phoxay Village	600	3	3	1.80
4. Muang Kao Village	250	3	3	0.75
5. None Khok Village	220	3	2	0.44
6. Done Xay Village	9000	5	3	27.00
SUB-TOTALS	12,320			36.74
VIENTIANE MUNICIPALITY				
20. Nong Vieng Kham Village	3000	5	3	9.00
21. Dongdok Village	2700	5	3	8.10
22. Thangone Village	700	5	5	3.50
23. Thasomo Village	250	5	5	1.25
24. Phakhao Village	150	5	3	0.45
25. Xaysetha Village	1750	5	3	5.25
26. Sikhot Village	800	3	3	2.40
27. Banthin Village	12700	5	3	38.10
28. Dong Ma Khai Village	320	5	3	0.96
29. Hatsiao Village	5000	5	3	15.00
30. Thongmang Village	1000	5	3	3.00
SUB-TOTALS	28,370			87.01
GRAND TOTAL	40,690			123.75

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LAO CASHEW PROJECT BRIEFING
MARCH 11, 1991

NOVEMBER 28, 1990
UPDATED: MARCH 9, 1991

LAO CASHEW PLANNING FACTORS

PLANNING RATIOS

1,250 PODS will produce 1 KILO or 2.2 LBS of SHELLED NUTS

235 PODS weigh 1 KILO or 2.2 LBS approximately

5.3 KILOS of PODS are required for 1 KILO of SHELLED NUTS

5.3 LBS of PODS are required for 1 LB of SHELLED NUTS

1 SHORT TON of PODS will produce approximately 375 LBS of SHELLED NUTS

20' Container:	Max weight	44,500 lbs
	Max cube	1,147 cuft
20' Container:	Inside dimemsions:	
19.5'L X 7.67'W X 7.67'H =		1,147 cuft
50lb cartons:	Max Cartons	693
(25"L X 13"W X 7.75"H)		
1	20' Container	34,650 lbs of kernels

1,000 PODS as an AVERAGE YIELD per TREE for planning:

* ONE TREE would produce 4.26 KILOS or 9.37 LBS of PODS
* ONE TREE would produce .8 KILO or 1.76 LBS of SHELLED NUTS
* 1 - 20' container would require the yield of 19,688 to 20,000 trees
* 1 - 20' container would require the processing of 80 to 85 tons of pods
* Moisture level of the cashews pods as they fall off the trees is approximately 22 to 25%
* Moisture levels of the cashews pods should be in the range of 8-9% for storage

THA NGONE FEED MILL
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THAI CASHEW EXPORT 29 NOV 90

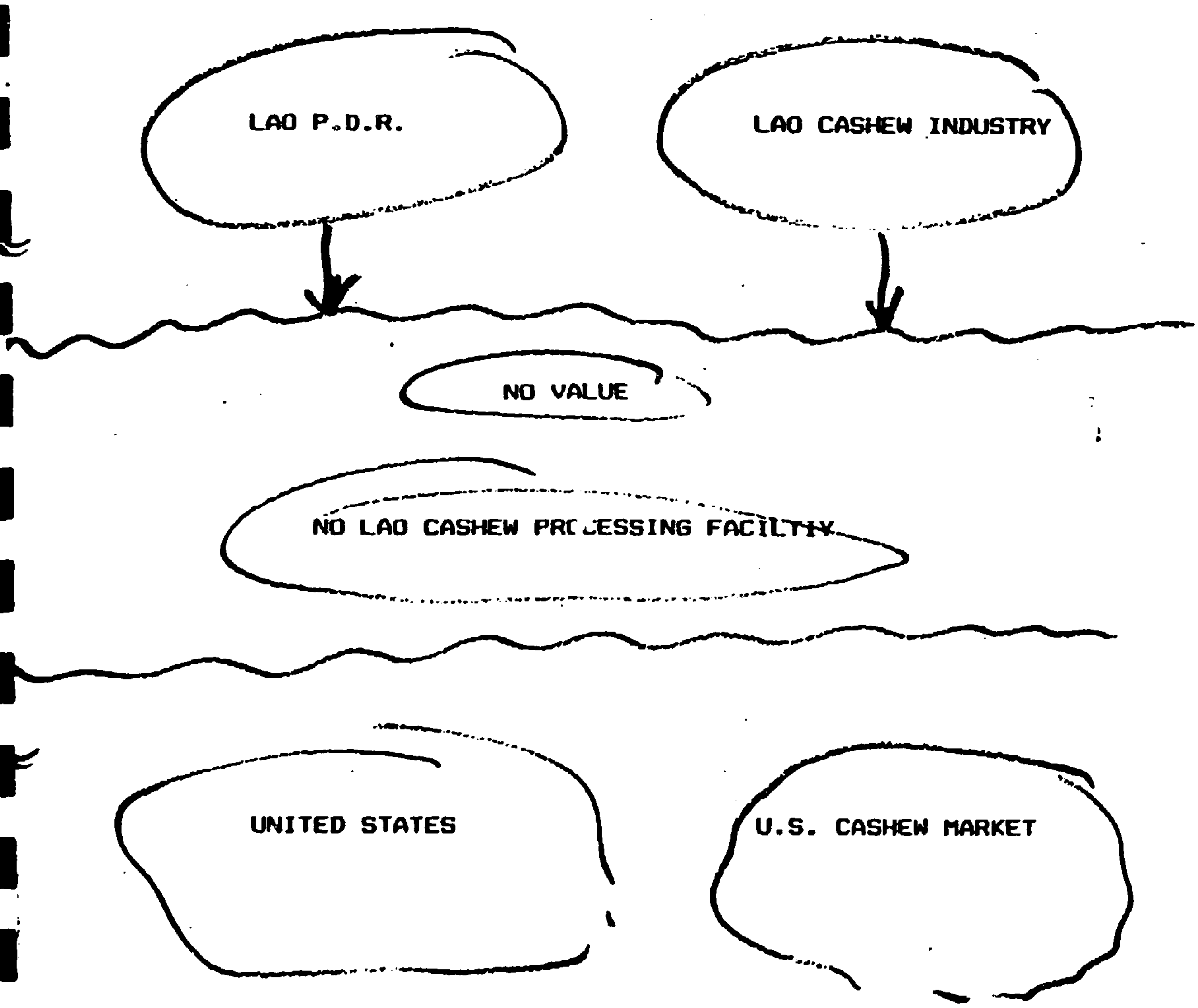
		1984	1985	1986	Total
Cashew not shell	$ B	39,600,000	14,146,000	82,779,000	136,525,000
	Tonn	2,305	802	4,135	7,242
Avg price	$ B / T	17,180	17,638	20,017	18,852
	$ B / lb	7.81	8.02	9.10	8.57
	$ U / lb	0.31	0.32	0.36	0.34
	$ KIP/T	401,041	493,875	560,535	527,851
Cashew shell	$ B	42,493,000	2,523,000	50,037,000	95,053,000
	Tonn	2,373	104	1,106	3,583
Avg price	$ B / T	17,907	24,260	45,241	26,529
	$ B / lb	8.14	11.03	20.56	12.06
	$ U / lb	0.33	0.44	0.82	0.48
	$ KIP/T	501,392	679,269	1,266,759	742,809
Price ratio		1.04	1.38	2.26	1.41

Cost estimation :	Kip/T	$ U/T	$ U/LBS
Initial cost (THAI)	742,809	1,061.16	0.482
Thangone -Nongkhai	4,760	6.80	0.003
Nongkhai-BKK	35,000	50.00	0.023
Cost I	703,049	1,004.36	0.457
Process.cost	80,000	114.29	0.052
Packing	20,000	28.57	0.013
Cost II	603,049	861.50	0.392
Cost of pod (ratio 5.3 :1)	113,783	162.55	0.074
Cost fr.farm to millgate	8,000	11.43	0.005
Price of pods :	105,783	151.12	0.069
% profit :	0.05	0.05	0.05
Farm gate price :	100,494	143.56	0.065

Farmer Income :		
No ofplans per ha :	210	210
Yield per plant (pods):	1,500	1500
No of pogs per kg :	235	235
Yield per ha KGS :	1,340	1.340
Price per kg KIP :	100.49	0.14
Income per ha per year :	134,704	192

LAO CASHEW PROJECT BRIEFING
MARCH 11, 1991

CURRENT LAO CASHEW INDUSTRY



LAO CASHEW PROJECT BRIEFING
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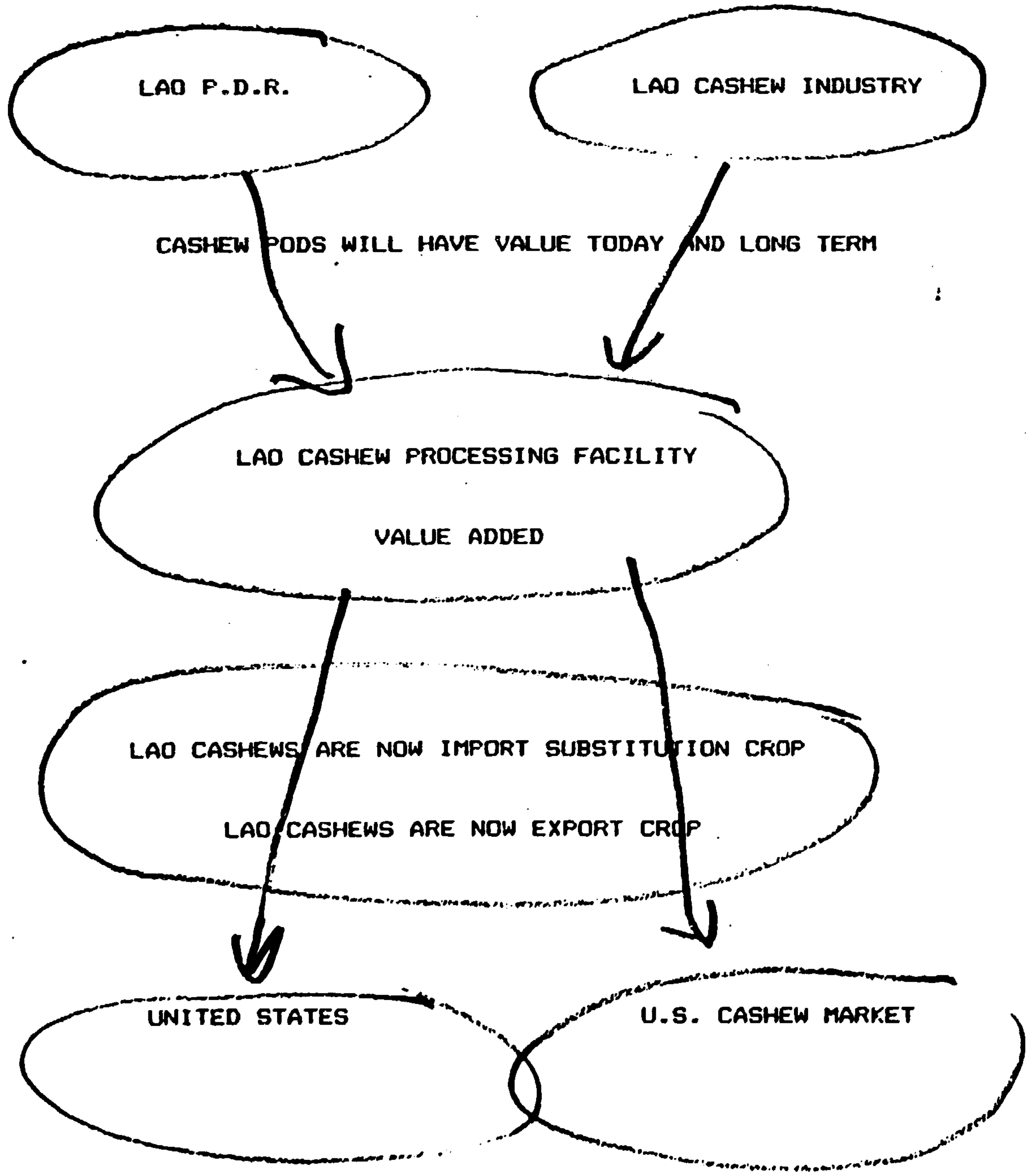
LAO CASHEW INDUSTRY

AND

LAO CASHEW PROJECT



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LAOTIAN CASHEWS, LTD. - ORIENT EXPRESSIONS, LTD.

LAO CASHWEW PROJECT
MARCH 11, 1991

CASHEW COSTING WORK SHEET
MARCH 9, 1991

VIENTIANE, LAOS

20' CONTAINER
34,650 LBS (KERNELS)
15,750 KILOS

---

1) Procurement of the pods:

@ KIP 120/kilo
@ $.078/lb
(RATIO 5.3 TO 1) — 10,016,990 KIP / $14,310 USD

2) Transportation cost to processing site:

@ KIP 8/kilo
@ $.005/lb — 642,758 KIP / $918 USD

3) Receiving & processing cost:

@ KIP 80/kilo
@ $.052/lb — 6,678,000 KIP / $9,550 USD

FACTORY PRODUCTION COST	17,337,748 KIP $24,775 USD
COST PER KILO:	1,101 KIP $1.57 USD
COST PER LB:	500 KIP $0.72 USD

THA NGONE FEED MILL
LAOTIAN CASHEWS, LTD. - ORIENT EXPRESSION, LTD.

VIENTIANE, LAOS

4) Packaging cost:

@ KIP 20/kilo	
@ $.013/lb	315,000 KIP
	$450 USD
Bags/cartons	
CO2	
@ KIP 1050/22.73kilos	
@ $1.50/50lbs	728,000 KIP
	$1040 USD

5) Loading cost: Included in Packing cost above.

FOB FACTORY VIENTIANE AREA, LAOS	18,380,748 KIP
	$26,265 USD
COST PER KILO:	1,167 KIP
	$1.67 USD
COST PER LB:	530 KIP
	$0.76 USD

6) Inland freight to Vientiane Export Terminal, Laos: ______ ______

7) Vientiane terminal charges: ______ ______

Loading/unloading
Storage
Documentation
Licensing
Consular invoice
Certificate of Origin
Fees/custom duties/stamps
Export taxes
Ferry charges

LAO CASHWEW PROJECT
MARCH 11, 1991

8) Letter of credit charges: ________ ________

1/4 of 1% of value

9) Financing charges: ________ ________

Cost of money

10) Laotian Freight Forwarding charges: ________ ________

11) Lao Profit Tax ________ ________

FOB NONG KHAI, THAILAND

COST PER KILO:

COST PER LB:

LAO CASHEW PROJECT BRIEFING
MARCH 11, 1991

LAO CASHEW PROJECT

NEAR TERM OBJECTIVES - 1991 HARVEST

---

* TO DETERMINE ABILITY TO CONTRACT FOR ENTIRE CURRENT YEAR CROP AND FUTURE CROPS

* TO DETERMINE INTERNATIONAL COMPETITIVENESS OF LAO CURRENT YEAR (1991) MARKET PRICE OF CASHEW PODS

* TO DETERMINE THE QUANTITY OF CURRENT YEAR (1991) CASHEWS FOR LOCAL AND INTERNATIONAL MARKETS

* TO DETERMINE THE QUALITY AND GRADE OF CURRENT YEAR (1991) CASHEWS FOR LOCAL AND INTERNATIONAL MARKETS

* TO ESTABLISH AND OPERATE A LAO CASHEW PROCESSING FACILITY OF INTERNATIONAL EXPORT STANDARDS TO ADD VALUE TO CURRENT YEAR (1991) AND FUTURE YEARS CASHEW CROPS

* TO DETERMINE THE SIZE AND VALUE OF THE LOCAL CASHEW MARKET FOR IMPORT SUBSTITUTION

* TO EXPORT TO UNITED STATES A CONTAINER OF 34,650 LBS OF QUALITY LAO CASHEWS TO PROVE EXPORT CAPABILITY AND ACCEPTABILITY

* TO PROVIDE VALUE TO THIS YEAR'S CROP TO STOP THE DESTRUCTION OF OF CASHEW TREES AND THE LAO CASHEW INDUSTRY

LAO CASHEW PROJECT BRIEFING
MARCH 11, 1991

LAO CASHEW PROJECT

LONG TERM TERM OBJECTIVES - 1991 TO 2000 HARVESTS

---

* TO ESTABLISH AN INTERNATIONAL QUALITY LAO CASHEW INDUSTRY

* TO ESTABLISH LAO CASHEWS AS A VIABLE EXPORT CROP FOR LAO P.D.R.

* TO ESTABLISH LAO CASHEWS AS A LONG TERM DEVELOPMENT CROP WITHIN THE LAO P.D.R. AGRICULTURE AND ECONOMIC PLANS

* TO IMPROVE THE QUANTITY AND QUALITY OF THE CURRENT LAO CASHEW CROP

* TO DEVELOP THE TECHNOLOGIES AND EXPERTISE REQUIRED TO ENSURE THE EXPORT CAPABILITIES OF LAO P.D.R.

* TO DEVELOP THE LAO CASHEW INDUSTRY TO BE ABLE TO SUPPORT THE SHIPMENT OF ONE CONTAINER A MONTH FROM LAO P.D.R. BY THE YEAR 2000

LAO CASHEW PROJECT BRIEFING
MARCH 11, 1991

LAO CASHEW PROJECT

NEAR TERM VALUE - 1991 HARVEST

---

* TO THE FARMERS: 14,850,000 KIP
  $21,214 USD

  AT LEAST 123.75 LONG TONS OF PODS

  @ KIP 120,000/TON
  @ $171/TON

  @ KIP 120/KILO
  @ $.078/LB

  @ KIP 600/TREE
  @ $0.86/TREE

* FURTHER DEVELOPMENT OF CURRENT INVESTMENT IN CASHEW TREES

* DEVELOPMENT OF LAO CASHEW PROCESSING FACILITY WHICH INSURES VALUE TO CASHEW INDUSTRY IN LAO P.D.R.

* CASH TO IMPROVE CURRENT TREES

LAO CASHEW PROJECT BRIEFING
MARCH 11, 1991

LAO CASHEW PROJECT

LONG TERM VALUE - 1991 TO 2000

* TO THE FARMERS: 175,000,000 KIP/YEAR
$250,000 USD/YEAR

AT LEAST 1,462 LONG TONS OF PODS/YEAR

- @ KIP 120,000/TON
- @ $171/TON

- @ KIP 120/KILO
- @ $.078/LB

- @ KIP 600/TREE
- @ $0.86/TREE

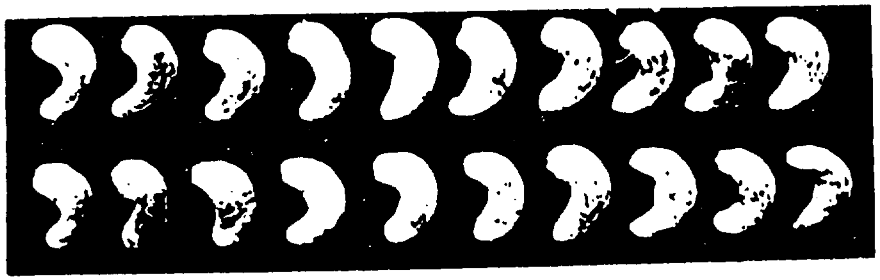
* WILL REQUIRE THE PLANTING OF AT LEAST 240,000 ADDITIONAL CASHEW TREES

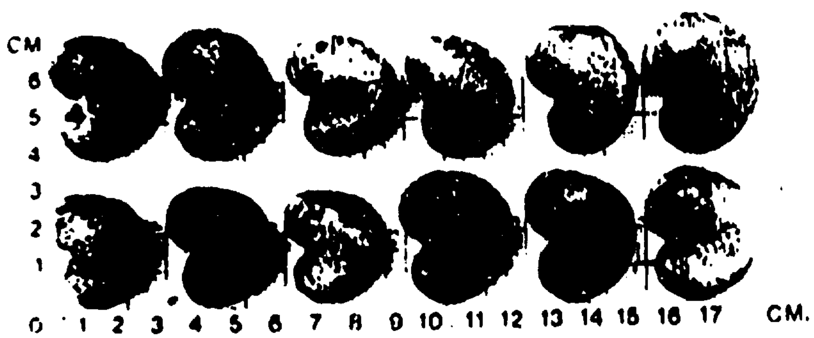
* WILL REQUIRE 1200 ADDITIONAL HECTARES OF CASHEW PLANTATIONS

* WILL DEVELOP A MAJOR EXPORT CASH CROP FOR LAO P.D.R.

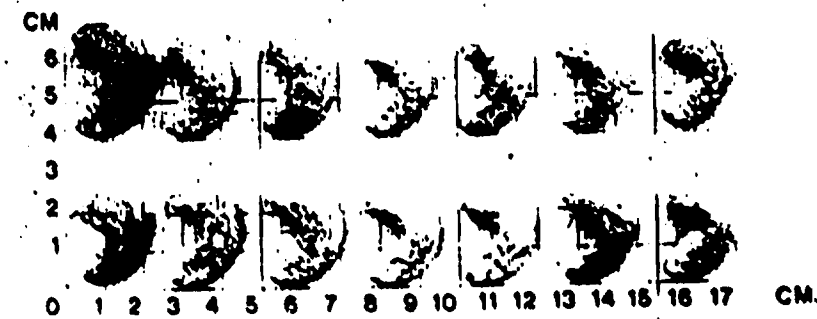
* WITH IMPROVED AGRICULTURE TECHNIQUE VALUE OF PRESENT AND FUTURE TREES WILL INCREASE

THA NGONE FEED MILL
LAOTIAN CASHEWS, LTD. - ORIENT EXPRESSIONS, LTD.





เมล็ดลูกผสมรวม SK-ค



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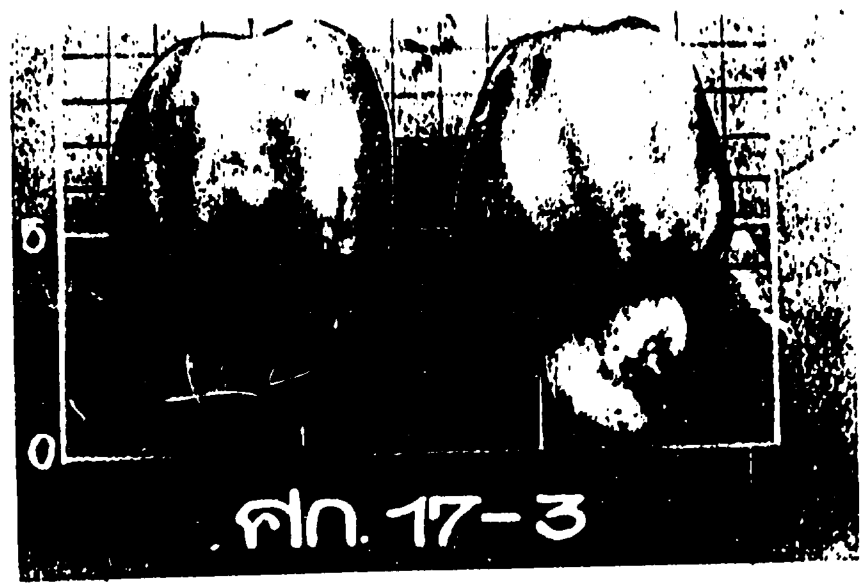
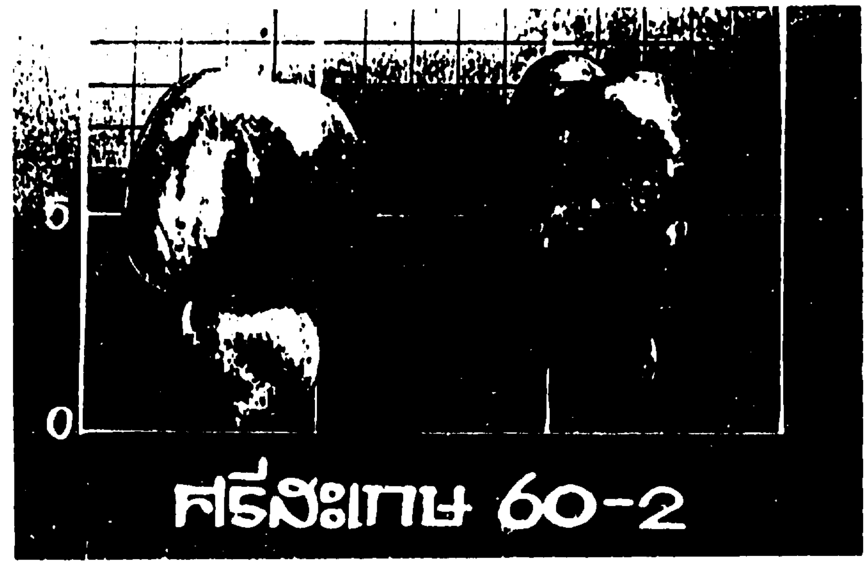
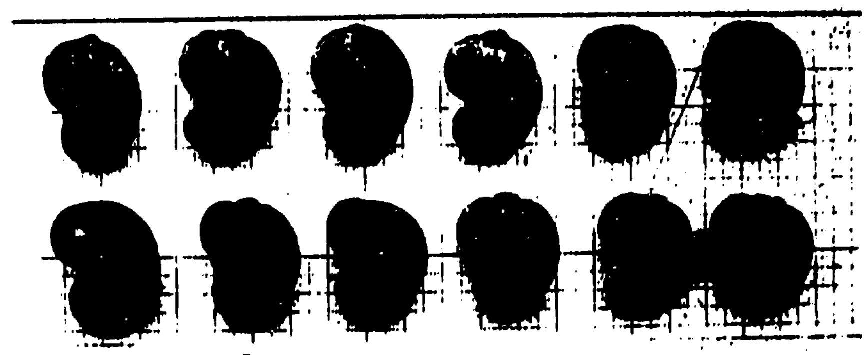


โรคและแมลง

1. **เพลี้ยไฟ** เพลี้ยไฟเป็นแมลงที่มีขนาดเล็ก ตัวอ่อนสีเหลืองและตัวเต็มวัยเป็นสีดำ ลำตัวยาวประมาณ 2-4 มิลลิเมตร ขยายพันธุ์ได้เร็วในสภาพอากาศร้อนและแห้งแล้ง เพลี้ยไฟตัวอ่อนและตัวเต็มวัย จะเข้าทำลายใบอ่อน ยอดอ่อน ช่อดอกและผลอ่อน ทำให้ยอดแคระแกรน ช่อดอกแห้ง เมล็ดรูปร่างแคระแกรนเป็นเลก็ดบิดเบี้ยว หมั่นตรวจสอบโดยเคาะช่อดอกลงบนกระดาษสีขาว ป้องกันกำจัดโดยพ่นสารเคมี เช่น โอเมทโทเอท (โฟลิแมท 50% EC) 20 ซีซี.ต่อน้ำ 20 ลิตร และพอสซ์ 20 ซีซี/น้ำ 20 ลิตร เมื่อตรวจพบว่ามีเพลี้ยไฟ 5 ตัวต่อช่อ



ศรีสะเกษ 60-1



ศรีสะเกษ 60-2

เพื่อทำให้เจริญเติบโตดีและเพิ่มผลผลิต เมื่ออายุ 1-3 ปี ควรให้ปุ๋ยเกรด 12-24-12 อัตรา 0.5-1.0 กก./ต้น/ปี เมื่ออายุ 4-6 ปี ปุ๋ยเกรด 15-15-15 อัตรา 1.5-2.0 กก./ต้น/ปี เมื่ออายุ 7 ปีขึ้นไปปุ๋ยสูตร 12-12-17 หรือ 13-13-21 อัตรา 2-3 กก./ต้น/ปี แบ่งใส่ 3 ครั้ง ๆ แรกต้นฤดูฝน (พฤษภาคม-มิถุนายน) ปลายฤดูฝน (สิงหาคม-กันยายน) และกำลังติดผล (ธันวาคม-มกราคม)

6. **การตัดแต่งกิ่ง** การตัดแต่งกิ่งมีความจำเป็นและสำคัญ โดยเฉพาะในช่วง 1-3 ปี หลังปลูก เพื่อให้ได้ทรงพุ่มที่เหมาะสม สะดวกในการดูแลรักษาพ่นสารเคมีปราบศัตรูพืชและเก็บเกี่ยว ควรตัดแต่งกิ่งให้ลำต้นเหลือลำต้นเดียว โดยในปีแรกควรตัดแต่งกิ่งแขนงให้สูงจากพื้นดินไม่เกิน 50 ซม. ปีที่ 2 ควรตัดไม่เกิน 90 ซม. และปีที่ 3 ควรตัดไม่เกิน 1.50 เมตร ตั้งแต่ปีที่ 4 เป็นต้นไปควรตัดแต่งภายในทรงพุ่ม ตัดกิ่งแขนงเล็กที่แห้งตาย กิ่งเป็นโรคหรือถูกแมลงทำลาย

ศรีสะเกษ 60-1

2. **มวนยุง ยุงชา หรือมวนชา** ตัวอ่อนตัวเต็มวัยดูดกินน้ำเลี้ยงยอดและช่อดอก ทำให้แห้งไม่ติดผล รอยทำลายจะเป็นรอยช้ำสีน้ำตาล การป้องกันกำจัดตัดแต่งกิ่งหรือยอด หรือช่อดอกที่แห้งมีรอยช้ำออกทำลายเสีย แล้วพ่นด้วยสารฆ่าแมลงคาร์บาริล (เซฟวิน 85% WP) อัตรา 20 กรัมต่อน้ำ 20 ลิตร ถ้ายังพบรอยทำลายอีก พ่นซ้ำทุก ๆ 7-10 วัน ตามความจำเป็น โดยเฉพาะช่วงฤดูการออกช่อดอก

3. **เพลี้ยแป้งและเพลี้ยอ่อน** พบตามใบอ่อน ยอดอ่อน ช่อดอกและผลอ่อน เป็นกลุ่มสีขาว จะดูดน้ำเลี้ยงทำให้ใบหงิกงอ เหี่ยว ช่อดอกไม่ติดผล เพลี้ยแห้งปกติจะพบอยู่ร่วมกับมด โดยมดเป็นพาหะนำเพลี้ยแห้งไปสู่บริเวณอื่น ๆ ของพืช ส่วนเพลี้ยอ่อนจะผลิตสารคล้ายน้ำหวานซึ่งเหมาะแก่การเจริญเติบโตของราดำ เพลี้ยแห้งจะถูกทำลายโดยแมลงช้าง เพลี้ยอ่อนจะถูกทำลายโดยด้วงเต่าลาย การกำจัดและป้องกันเพลี้ยแป้งและเพลี้ยอ่อน พ่นด้วยสารโมโนโครโตฟอส เช่น อาโซดริน 60% WSC อัตรา 10-15 ซีซี./น้ำ 20 ลิตร หรือมาลาไธออน อัตรา 40 ซีซี./น้ำ 20 ลิตร ผสมสารจับใบในช่วงที่มีการระบาด พ่น 2 ครั้ง ห่างกัน 15 วัน

4. **หนอนเจาะลำต้น** เป็นตัวอ่อนของด้วงหนวดยาว เข้าทำลายต้นมะม่วงหิมพานต์ สังเกตได้โดยจากรอยยางไหลและมีขี้หนอนเป็นขุยออกมาอยู่ที่ปากรูด้านล่าง หนอนจะชอนไชกินใต้ผิวเปลือกไปทุกทิศทาง ทำให้ต้นทรุดโทรม ใบเหลืองและร่วงตายในที่สุด ป้องกันโดยการใช้ไดโครวอส (DDVP 50% EC) หรือ โซดรินหรือทามารอน ในอัตรา 10 ซีซี./น้ำ 1 ลิตร แล้วใช้ดินน้ำมันหรือดินเหนียวอุดปากรู หรืออาจจะเอาตัวหนอนออกมาทำลาย (17)

5. **ด้วงงวงเจาะก้านยอดดอก** ตัวแก่จะใช้งวงเจาะต้นอ่อนหรือช่อดอกเพื่อวางไข่และเจริญเป็นหนอนอยู่ภายใน ทำให้ช่อดอกเหี่ยวหักพับ การป้องกันโดยตัดแต่งกิ่งหรือยอดที่เหี่ยวออกทำลายเสีย ถ้าระบาดมากควรพ่นด้วยโมโนโครโตฟอส เช่น อโซดริน ในอัตรา 20 ซีซี./

น้ำ 20 ลิตร หรือคลอร์ไพริฟอส (ลอร์สแบน 40% EC) อัตรา 30 ซีซี./น้ำ 20 ลิตร

6. โรคแอนแทรคโนส เกิดจากเชื้อรา *Collectotrichum glocosporioider* พบในระยะมะม่วงหิมพานต์ออกผลในเดือนกุมภาพันธ์-พฤษภาคม จะมีลักษณะเป็นแผลสีน้ำตาล แล้วค่อยขยายใหญ่ขึ้นลุกลามไปทั้งผลแท้และผลปลอม ผลจะเน่าและร่วงหล่น ป้องกันกำจัดฉีดพ่นด้วยสารเบนโนมิล (เบนเลท) ในอัตรา 6-12 กรัม/น้ำ 20 ลิตร หรือ แมนโคเซบ อัตรา 30-40 กรัม/น้ำ 20 ลิตร

7. โรคช่อดอกแห้ง ลักษณะอาการที่ก้านช่อดอกจะแห้งเป็นแผลสีดำ คล้ายลักษณะอาการช่อดอกแห้งของมะม่วงเกิดจากเชื้อรา *Botryodiplodia sp.* การป้องกันการกำจัดโดยการพ่นสารป้องกันเชื้อรา เช่น เบนโนมิล อัตรา 6-12 กรัม/น้ำ 20 ลิตร บริเวณช่อดอกเมื่อเริ่มแทงช่อดอก

การเก็บเกี่ยว

มะม่วงหิมพานต์จะเริ่มให้ผลผลิตครั้งแรกเมื่ออายุ 2-3 ปี ช่อดอกจะเริ่มออกตั้งแต่เดือนธันวาคม ไปถึง เดือนกุมภาพันธ์ ทั้งนี้ขึ้นอยู่กับพันธุ์มะม่วงหิมพานต์ที่นำมาปลูกว่าเป็นพันธุ์เบา พันธุ์กลางหรือพันธุ์หนัก การเก็บเกี่ยวในช่วงเดือนกุมภาพันธ์-พฤษภาคม ผลมะม่วงหิมพานต์แก่ไม่พร้อมกัน ต้องเก็บเกี่ยวไม่น้อยกว่า 5 ครั้งในแต่ละต้นและในแต่ละพันธุ์ ห่างกันประมาณ 1 สัปดาห์ การเก็บเกี่ยวควรเก็บเมล็ดที่แก่และร่วงหล่นบนพื้นดิน แล้วปลิดผลปลอมออกก่อนนำไปตากแดดในแสงแดดอย่างน้อย 3-5 วันเพื่อลดความชื้นภายในเมล็ดออก ทำการคัดเมล็ดจมน้ำและเมล็ดลอยน้ำออกจากกัน และคัดเมล็ดที่เล็กไม่สมบูรณ์ออก การคัดเมล็ดที่จมน้ำไว้เพื่อนำไปเป็นเมล็ดพันธุ์ดี

ปุ๋ยคอก 1-2 บุ้งกี๋ (5-10 กก.) และหินฟอสเฟต 250 กรัม ลงในหลุมก่อนปลูก

4. ระยะปลูก ระยะปลูกระหว่างต้นและระหว่างแถว 6x6 เมตร จำนวน 45 ต้น/ไร่ เมื่ออายุประมาณ 6-8 ปี ทรงพุ่มจะเริ่มชิดกัน ให้ตัดต้นระหว่างต้นออก เหลือระยะปลูก 6x12 เมตร จำนวน 22 ต้นต่อไร่ และเมื่ออายุ 11-12 ปี ให้ตัดต้นระหว่างแถวออกเหลือระยะ 12x12 เมตรจำนวน 11 ต้น/ไร่ การตัดต้นออกทิ้งอาจจะไม่ต้องสลับกันทุกต้น ควรตัดต้นที่เจริญเติบโตดี ให้ผลผลิตสูงไว้ ตัดต้นที่ไม่ดีออก

การปฏิบัติรักษา

1. การให้น้ำ มะม่วงหิมพานต์ที่ยังเล็กอยู่ ควรให้น้ำในปีแรกของการปลูก โดยเฉพาะในฤดูแล้ง จะช่วยให้การเจริญเติบโตดีขึ้น

2. การกำจัดวัชพืช ระยะ 1-3 ปี หลังปลูก ควรทำการดายหญ้าพรวนดินรอบโคนต้น เพื่อทำลายวัชพืชที่แย่งน้ำและอาหาร และเป็นแหล่งอาศัยของแมลงศัตรูมะม่วงหิมพานต์ด้วย

3. การค้ำยัน ควรผูกต้นมะม่วงหิมพานต์กับหลักไม้ หรือหลักไม้ไผ่ขนาดเล็ก จะช่วยยึดให้ต้นตรงไม่ให้ล้มเอนเอียง

4. การปลูกพืชแซม เพื่อเป็นการช่วยให้เกษตรกรมีรายได้ ในระยะ 3 ปีแรก ก่อนที่มะม่วงหิมพานต์จะเริ่มได้ผล พืชแซมที่ควรปลูกได้แก่ ข้าวไร่ ข้าวโพด ถั่วลิสง ถั่วเขียว พริกขี้หนู ฯลฯ โดยปลูกเฉพาะระหว่างแถวเท่านั้น สำหรับพืชที่ปลูกในปีที่ 1 ปลูกห่างจากต้นมะม่วงหิมพานต์ 1 เมตร ปีที่ 2 ปลูกห่าง 1.50 เมตร และปีที่ 3 ปลูกห่าง 2.0 เมตร ปีที่ 4 เป็นต้นไปไม่ควรปลูกพืชแซม

5. การใส่ปุ๋ย การปลูกมะม่วงหิมพานต์ควรใส่ปุ๋ยคอกผสมปุ๋ยเคมี

การปลูกมะม่วงหิมพานต์

1. **ฤดูปลูก** ควรปลูกต้นฤดูฝนประมาณเดือน มิถุนายน ถึง กรกฎาคม **ดีที่สุด** เพราะต้นมะม่วงหิมพานต์จะได้รับน้ำฝนนานกว่าจะสิ้นฤดูฝน ทำให้สามารถเจริญเติบโตได้เร็ว แต่อาจปลูกได้ในเดือนสิงหาคม-กันยายน ถ้าหากมีฝนตกและความชื้นยังพอมีอยู่

2. **การเตรียมพันธุ์**

เมล็ดพันธุ์ ควรเป็นเมล็ดพันธุ์มะม่วงหิมพานต์พันธุ์ดีที่ทางราชการรับรองพันธุ์ เช่น ศรีสะเกษ-เอ หรือพันธุ์ของบริษัทเอกชน เมล็ดพันธุ์ที่ดีจะต้องเป็นเมล็ดพันธุ์ที่เก็บเกี่ยวในปีนั้นมีรูปร่างสมบูรณ์ น้ำหนักเมล็ด 5 กรัมขึ้นไปและเป็นเมล็ดที่จมน้ำ หรือเมล็ดที่มีความถ่วงจำเพาะสูงเท่านั้น เพราะเมล็ดพันธุ์ที่มีดังกล่าวจะให้ต้นมะม่วงหิมพานต์ที่เจริญเติบโตได้ดี ให้ผลผลิตทุกปี ผลผลิตสูงและอายุการให้ผลยาวนาน ไม่ควรใช้เมล็ดลอยน้ำ เมล็ดพันธุ์ควรแช่น้ำ 1-2 วัน ก่อนนำไปเพาะในถุงหรือปลูกลงดิน จะช่วยให้งอกเร็วขึ้น

ต้นพันธุ์ดี เป็นต้นขยายพันธุ์ที่เปลี่ยนยอดพันธุ์รับรองหรือพันธุ์ดีบนต้นตอมะม่วงหิมพานต์ ต้นตอควรเป็นพันธุ์พื้นเมืองที่ทนทานต่อหนอนเจาะลำต้นหรือมีลักษณะต้นเตี้ย เมล็ดที่ใช้เพาะต้นตอควรมีความถ่วงจำเพาะสูง การเปลี่ยนยอดอาจจะใช้วิธีแบบเสียบข้างหรือต่อยอดแบบเสียบลิ่ม ต้นพันธุ์ที่ดีนำไปปลูกควรจะมีสภาพแข็งแรง และสมบูรณ์ดี

3. **วิธีปลูก** ถ้าปลูกด้วยต้นกล้า ไม่ควรมีอายุเกิน 4 เดือน เพราะถ้าหากอายุมากกว่านี้รากจะขดพันกันในก้นถุง เมื่อนำไปปลูกระบบรากกระจายน้อย ทำให้อาจโค่นล้มง่าย ถ้าปลูกด้วยเมล็ดนิยมปลูกหลุมละ 2-3 เมล็ดเมื่ออายุ 1-2 เดือน จึงถอนให้เหลือ 1 ต้นต่อหลุม

การเตรียมหลุมปลูก ขนาดหลุมปลูก 50×50×50 ซม. ควรคลุมดินด้วย

ผลผลิตของมะม่วงหิมพานต์ จะเพิ่มขึ้นตามอายุมะม่วงหิมพานต์ที่มากขึ้นและตามความสามารถในการให้ผลผลิตของแต่ละพันธุ์ และการบำรุงรักษามะม่วงหิมพานต์มีอายุการให้ผลนานถึง 25 ปี โดยเฉลี่ยอายุ 3-5 ปี ผลผลิตจะได้ประมาณ 3-5 กก.ต่อต้น อายุ 6-10 ปี จะให้ผลผลิตประมาณ 5-20 กก. และอายุ 11 ปีขึ้นไป จะให้ผลผลิตประมาณ 10-60 กก.

การกะเทาะเมล็ด

การกะเทาะเมล็ดปกติแล้วมะม่วงหิมพานต์ จะมีเปอร์เซ็นต์กะเทาะประมาณ 25% กล่าวคือ เมล็ดดิบจำนวน 4 กิโลกรัม กะเทาะได้เมล็ดเนื้อใน 1 กิโลกรัม

การกะเทาะเมล็ด ทำได้หลายวิธีด้วยกัน แต่วิธีที่ปลอดภัยต่อผู้บริโภคและลดอันตรายจากน้ำมัน จากเปลือกที่จะซึมเข้าไปอยู่ในเมล็ดเนื้อในมะม่วงหิมพานต์ มีหน่วยงาน เช่น กรมวิชาการเกษตร มหาวิทยาลัยเกษตรศาสตร์ มหาวิทยาลัยขอนแก่น โรงเรียนสารพัดช่างอุดรธานี สำนักงานเกษตรภาคตะวันออกเฉียงเหนือ ได้ทำการวิจัยเครื่องกะเทาะเมล็ดมะม่วงหิมพานต์ ซึ่งเหมาะสมสำหรับใช้เป็นอุตสาหกรรมในครัวเรือน ราคาถูก ประกอบง่าย มีประสิทธิภาพดีพอสมควร มีอยู่ 9 แบบคือ

1. เครื่องกะเทาะเมล็ดแบบใบเลื่อย ใช้มือหมุน ใช้งานวันละ 8 ชั่วโมง จะใช้เมล็ดทั้งเปลือกประมาณ 8-10 กิโลกรัม กะเทาะได้เนื้อในประมาณ 2-3 กิโลกรัม/คน/วัน

2. เครื่องกะเทาะเมล็ดแบบใบเลื่อยชนิดไฟฟ้า ปฏิบัติงานวันละ 8 ชั่วโมง จะใช้เมล็ดทั้งเปลือกประมาณ 15 กิโลกรัม กะเทาะได้เมล็ดเนื้อในประมาณ 3-5 กิโลกรัม/คน/วัน เครื่องกะเทาะดังกล่าวนี้ปฏิบัติงานได้ครั้งละ 6 คน

3. เครื่องปอกและเครื่องทอดมะม่วงหิมพานต์ สามารถปอกเปลือกเฉลี่ยได้ 0.5 กิโลกรัม/ชั่วโมง โดยได้เมล็ดเต็มไม่แตกเหลือ 73-98 เปอร์เซ็นต์

4. เครื่องกะเทาะแบบแรงเหวี่ยง ผลิตโดยคณะวิศวกรรมศาสตร์ มหาวิทยาลัยเกษตรศาสตร์

5. เครื่องกะเทาะเมล็ดแบบเท้าเหยียบแล้วใช้มือผลัก ผลิตโดยกองเกษตรวิศวกรรม กรมวิชาการเกษตร

6. เครื่องกะเทาะแบบมือโยกกดลง ผลิตโดยโรงเรียนสารพัดช่าง อุดรธานี

7. เครื่องกะเทาะแบบมือโยกกดลง ผลิตโดยสำนักงานผลิตโดยสำนักงานเกษตรภาคตะวันออกเฉียงเหนือ

8. เครื่องกะเทาะกดลงแล้วบิด (แบบ วศก.มข.2) เครื่องกะเทาะนี้มีความเหมาะสมให้เกษตรกรใช้ เพราะจุดคุ้มทุนต่ำสุด ระยะคืนทุนสั้นที่สุด และผลกำไรสูงสุด

9. เครื่องกะเทาะแบบ กวศ. 1 มีแกนกระทุ้งและสปริงเพิ่มจากแบบ วศก.มข.2 ใบมีดกดตั้งฉากกับเมล็ด ทำให้แม่นยำในการผ่า สามารถบิดเปลือกออกได้ง่าย สามารถสร้างและซื้ออะไหล่ได้ง่าย ต้นทุนต่ำ ระยะคืนทุนต่ำกว่ากำไรสูง สามารถฝึกหัดได้ง่าย

นอกจากเครื่องกะเทาะแบบดังกล่าว ยังมีโรงงานกะเทาะแบบเบ็ดเสร็จ โดยผลิตในต่างประเทศ เช่น ประเทศอังกฤษ อิตาลี บราซิล สวิตเซอร์แลนด์ และญี่ปุ่น เป็นเครื่องกะเทาะที่มีขนาดตั้งแต่ 1,250 ตันขึ้นไปถึง 10,000 ตัน บริษัทเอกชนกำลังสนใจที่จะตั้งโรงงานเครื่องกะเทาะดังกล่าว เช่น บริษัทมาบุญครองศิริชัยมะม่วงหิมพานต์ จำกัด ฯลฯ

ผลผลิตและคุณภาพ มะม่วงหิมพานต์พันธุ์ศรีสะเกษ 60-2 เป็นพันธุ์ดีให้ผลผลิตสูง ผลผลิตรวม 11 ปี (อายุ 3-13 ปี) 141.30 กิโลกรัม เฉลี่ย 12.85 กิโลกรัมต่อต้นต่อปี สูงกว่าพันธุ์พื้นเมืองมาก น้ำหนักเมล็ดเฉลี่ย 7.24 กรัม จำนวน 138 เมล็ดต่อกิโลกรัม เปอร์เซ็นต์เมล็ดดี 75.81 เปอร์เซ็นต์ จำนวนเมล็ดเนื้อใน 250 เมล็ดต่อน้ำหนัก 1 ปอนด์ จัดอยู่ในเกรด 3 ของมาตรฐานโลก

การรวบรวมพันธุ์มะม่วงหิมพานต์ จากประเทศผู้ผลิตรายใหญ่ของโลกจำนวน 105 พันธุ์ นำมาปลูกศึกษาคัดเลือกพันธุ์ ได้ต้นพันธุ์ที่ดีเด่น 19 ต้นในจำนวนนี้มี 7 ต้น ซึ่งลักษณะดีเด่นกว่าพันธุ์ศรีสะเกษ 60-1 และศรีสะเกษ 60-2 เมื่อเปรียบเทียบอายุเท่ากัน เช่น สายพันธุ์ ศก. 34-13 คุณภาพใกล้เคียงกันแต่ผลผลิตสูงกว่า 2 เท่า สายพันธุ์ ศก. 37-W2, ศก. 17-3, ศก. 26-6 ผลผลิตใกล้เคียงกับพันธุ์รับรอง แต่เมล็ดเนื้อในจัดอยู่ในเกรด 1 จนถึงเกรดใหญ่พิเศษ ซึ่งจะใช้เป็นพันธุ์ดีให้เกษตรกรในอนาคต เพื่อผลิตพันธุ์แนะนำ "ศรีสะเกษ-เอ" ซึ่งเป็นเมล็ดพันธุ์ลูกผสมรวม (composite SK-A) จำนวน 200,000 กิโลกรัม ระหว่างปี 2527-2534 สำหรับให้เกษตรกรปลูกเนื้อที่ 135,000 ไร่ และสร้างแปลงผลิตยอดพันธุ์ดี (Bodwood nursery) จำนวน 25 ไร่ โดยใช้มะม่วงหิมพานต์ 5 สายพันธุ์ คือ ศรีสะเกษ 60-1, ศรีสะเกษ 60-2, ศก. 12-13, ศก. 18-16 และกส. 19-5 โดยมีเป้าหมายการผลิตยอดพันธุ์ดีจำนวน 900,000 ยอด สำหรับเปลี่ยนยอดพันธุ์มะม่วงหิมพานต์พันธุ์พื้นเมืองของเกษตรกรให้เป็นพันธุ์ดี ที่ให้ได้ผลผลิตสูงและคุณภาพดี จำนวน 15,000 ไร่ (อัตรา 60 ยอดต่อ 1 ไร่)

ผลผลิตและคุณภาพ มะม่วงหิมพานต์พันธุ์ศรีสะเกษ 60-1 พันธุ์เบาให้ผลผลิตสูง ออกผลทุกปี ผลผลิตรวม 11 ปี (อายุ 3-13 ปี) 157.49 กิโลกรัม เฉลี่ย 13.77 กิโลกรัมต่อต้นต่อปี ซึ่งสูงกว่าพันธุ์พื้นเมืองมาก น้ำหนักเมล็ดเฉลี่ย 6.32 กรัม จำนวน 158 เมล็ดต่อกิโลกรัม เปอร์เซ็นต์เมล็ดดี 87 เปอร์เซ็นต์ จำนวนเมล็ดเนื้อในเฉลี่ย 265 เมล็ดต่อน้ำหนัก 1 ปอนด์ จัดอยู่ในเกรด 3 ของเกรดมาตรฐานโลก

ศรีสะเกษ 60-2

ลักษณะของต้น ทรงพุ่มโปร่งเป็นรูปครึ่งวงกลม (dome shape)

ใบ เป็นรูปไข่ (obovate) สีของใบบนสีเขียวเข้ม ด้านใต้ใบสีเขียวอ่อน ใบยาว 14-19.7 เซนติเมตร ใบกว้าง 8.3-10.4 เซนติเมตร ความยาวของก้านใบ 1.5-2.8 เซนติเมตร

ดอก ช่อดอกแบบ panicle ยาว 11.3 เซนติเมตร กลีบดอกมี 5 กลีบ ยาว 11.2-13 มิลลิกรัม มีริ้วยาวสีชมพู พื้นสีครีม เมื่อบานเต็มที่ริ้วจะขยายตัวกว้างขึ้นเปลี่ยนเป็นสีแดง สีดอกอ่อนกว่าศรีสะเกษ 60-1 กลีบเลี้ยง 5 กลีบ ยาว 4-5.5 มิลลิเมตร จำนวน stamen ของดอกกะเทยมี large stament 1 อัน amall stamen 5 อัน มีรังไข่แบบ superior ovary style สีครีม ยาว 0.9-1.0 มิลลิเมตร

ผล ผลแท้หรือเมล็ด (nut) มีสีน้ำตาลปนแดง เมล็ดมีขนาดใหญ่หนากว่า ศรีสะเกษ 60-1 น้ำหนักเมล็ดเฉลี่ย 7.24 กรัม เปลือกหนา 0.38 เซนติเมตร ยาว 3.2-2.3 เซนติเมตร กว้าง 2.2-2.9 เซนติเมตร หนา 1.8-2.3 เซนติเมตร ผลปลอมมีรูปร่างยาว-รี สีชมพูปนเหลือง (7A/9) และ (6A/7) มีขนาด 4.6-5.3 เซนติเมตร เส้นผ่าศูนย์กลาง 4.7-5.7 เซนติเมตร มีเปอร์เซ็นต์ความหวาน 17.46 องศาบริกซ์ น้ำหนักผลปลอมเฉลี่ย 66 กรัม

ประโยชน์

มะม่วงหิมพานต์ มีประโยชน์มากมาย แต่จะกล่าวเพียงย่อ ๆ คือ "เมล็ดใน" ใช้เป็นอาหารคาวหวาน มีคุณค่าทางอาหารสูง โปรตีนร้อยละ 21 ไขมันร้อยละ 47 แป้งร้อยละ 22 และมีวิตามินอื่น ๆ มีคุณค่าแก่ร่างกายมาก

"เยื่อหุ้มเนื้อใน" ใช้เป็นส่วนประกอบของอาหารสัตว์

"เปลือกเมล็ด" เปลือกหุ้มเมล็ดยังสามารถสกัดนำเอาของเหลวที่เรียกว่า CNSL (Cashew Nut Shell Liquid) ซึ่งมีส่วนประกอบของกรดอนาคาร์ดิค 90% คาร์ดอล 10% เป็นพิษต่อผิวหนังมนุษย์และสัตว์นำมาทำประโยชน์ทางด้านอุตสาหกรรมนานาชนิด เช่น ทำผ้าเบรค แผ่นคลัชดุม ผลิตสีป้องกันความร้อน และน้ำมันกันการกัดกร่อน ฉนวนหุ้มสายไฟ ใช้เคลือบเงาไม้หรือเครื่องจักรที่ใช้ทำงานหนัก และยางเทียม เป็นต้น

"เปลือกลำต้น" ใช้ทำยาแผนโบนราณ แก้โรคความดันโลหิตสูง และท้องร่วง นอกจากนี้ยังใช้ย้อมผ้า ยางจากลำต้นใช้ทำกาวติดแน่นพิเศษ

"ลำต้น/กิ่ง" ทำฟืนและถ่าน

"ยอดอ่อน" ใช้เป็นผัก

"ผลปลอม" หรือก้านของผลที่มีรูปร่างคล้ายชมพู่ มีทั้งสีเหลือง ส้ม ชมพู หรือแดง แล้วแต่พันธุ์ เนื่องจากผลปลอมนี้มีส่วนประกอบที่เป็นน้ำ 87% ซึ่งในน้ำคั้นมะม่วงหิมพานต์มีวิตามินค่อนข้างสูง หรืออาจพอ ๆ กับผลไม้ตระกูลส้ม จึงน่าจะทดลองทำเครื่องดื่มจากผลปลอมกันบ้าง

นอกจากนี้ยังมีส่วนประกอบอื่น ๆ ทั้งคาร์โบไฮเดรท ซึ่งมีร้อยละ 12 สารเยื่อใยต่าง ๆ ซึ่งถ้าปรับรสให้ดีอาจใช้ผสมกับผลไม้อื่น ๆ ที่มีรสเปรี้ยวเช่น สับปะรด หรือมะม่วง มะขาม เป็นผลไม้กวน จัดว่ามีรสชาติ

พอควร ปัญหาที่สำคัญของผลปลอมที่ทำให้ไม่ค่อยเป็นที่นิยมกันนัก คือ มีรสฝาด บางคนอาจแพ้ระคายเคืองคอ นอกจากนี้ยังมีกลิ่นเฉพาะที่คนบางคนอาจไม่ยอมรับ การลดรสฝาดหรือกลิ่นทำได้โดย กำจัดสารแทนนินที่เป็นต้นเหตุด้วยเจลาติน หรือ พีวีพี ที่ทางศูนย์วิจัยพืชสวนศรีสะเกษ ได้ทดลองแล้วพบว่า พีวีพี จะให้ผลผลิตในการลดรสฝาดได้ดีมาก นอกจากนั้นก็อาจใช้นึ่งหรือแช่ผลปลอมในน้ำเกลือเข้มข้น 3% ประมาณ 3-5 วัน ก่อนจะนำไปทำเป็นผลิตภัณฑ์ชนิดอื่น ๆ ต่อไป ทางเลือกอีกทางหนึ่งคือ เลือกพันธุ์ที่ไม่มีรสฝาดหรือเลือกผลที่แก่จัด

เพื่อมีการใช้ประโยชน์จากผลปลอมกันมากขึ้นแทนการทิ้งไปโดยสูญเสียเปล่าอย่างที่เป็นอยู่ และยังอาจช่วยเพิ่มรายได้แก่เกษตรกรผู้ปลูกหรือผู้ที่จะทดลองนำผลปลอมไปทำประโยชน์ จึงขอเสนอตำราการทำผลิตภัณฑ์จากผลปลอมชนิดต่าง ๆ ซึ่งได้มีผู้ทดลองหรือเสนอไว้ เพื่อผู้ในใจจะได้ทดลองทำโดยอาจนำไปดัดแปลงหรือปรับปรุง แต่ให้ดีกว่าโดยเฉพาะรสชาติ เพื่อให้เป็นที่ถูกปากยิ่งขึ้นต่อไป

พืชสวนศรีสะเกษ ได้คัดเลือกพันธุ์ที่เข้าหลักเกณฑ์มาตรฐานที่ตั้งไว้ จำนวน 8 สายพันธุ์คือ ศก. 5-1, ศก. 5-10, ศก. 11-18, ศก. 12-13, ศก. 18-16, กส. 19-15, ขก. 12-1 และ ขก. 15-4 ซึ่งสายพันธุ์เหล่านี้ให้ผลผลิตสูงกว่าพันธุ์พื้นเมืองโดยเฉลี่ย 40%

สำหรับสายพันธุ์ ศก. 5-1 และ ศก. 5-10 กรมวิชาการเกษตรได้ประกาศรับรองพันธุ์ และได้ตั้งชื่อใหม่เพื่อเป็นการเฉลิมพระเกียรติเนื่องในวโรกาส 60 พรรษา ของพระบาทสมเด็จพระเจ้าอยู่หัวว่ามะม่วงหิมพานต์พันธุ์ "ศรีสะเกษ 60-1" และ "ศรีสะเกษ 60-2" ตามลำดับ เมื่อวันที่ 20 กรกฎาคม 2530

ศรีสะเกษ 60-1

ลักษณะต้น ทรงพุ่มแน่นทึบ เป็นรูปครึ่งวงกลม (dom shepe)

ใบ เป็นรูปไข่ (oblong) สีใบด้านบนใบสีเขียวเข้ม ด้านใต้ใบสีเขียวอ่อน ความยาวของใบ 16.7-20 เซนติเมตร ความกว้างของใบ 9.5-12.5 เซนติเมตร

ดอก ช่อดอกแบบ panicle ยาว 17.0-23.5 เซนติเมตร กลีบดอกมี 5 กลีบ มีริ้วตามยาวสีชมพู พื้นสีครีม ดอกบานเต็มที่ริ้วสีชมพูขยายตัวออกเปลี่ยนเป็นสีแดงเข้ม ยาว 12-13.2 มิลลิเมตร กลีบเลี้ยงมี 5 กลีบ สีเขียวอ่อนยาว 5-6 มิลลิเมตร จำนวน stamen ของดอกกะเทยมี large stamen 1-2 อัน จำนวน small stament 6-8 อัน รังไข่แบบ superior ovary style สีครีมยาว 0.9-1.0 มิลลิเมตร

ผล ผลแท้หรือเมล็ด (nut) น้ำหนักเมล็ดเฉลี่ย 6.32 กรัม ยาว 3-3.0 เซนติเมตร กว้าง 2.2-2.5 เซนติเมตร หนา 1.5-1.9 เซนติเมตร เปลือกหนา 0.32 เซนติเมตร มีสีเทา ผลปลอม (Apple) มีรูปร่างป้อม-รี สีแดงเข้ม (8a/11) เนื้อมีรสหวาน เปอร์เซ็นต์ความหวาน 14.35 องศาบริกซ์ สูง 4.4-5.5 เซนติเมตร เส้นผ่าศูนย์กลาง 3.5-4.3 เซนติเมตร น้ำหนักผลปลอมเฉลี่ย 52.47 กรัม

พันธุ์ ใช้สีของผลปลอมซึ่งเป็นตัวกำหนด ซึ่งมีอยู่ 3 สีคือ สีเหลือง สีแดง และสีแดงปนชมพู ปัจจุบันประเทศที่ปลูกมะม่วงหิมพานต์ ทำการจำแนกพันธุ์โดยใช้ลักษณะประจำพันธุ์ ผลผลิตสูง คุณภาพได้มาตรฐานและลักษณะอื่น ๆ ดี

พันธุ์มะม่วงหิมพานต์ที่ปลูกในประเทศไทย ส่วนมากเป็นพันธุ์พื้นเมืองไม่ได้ทำการคัดเลือกพันธุ์ มีขนาดเมล็ดเล็ก คุณภาพเมล็ดเนื้อในต่ำกว่ามาตรฐาน แม้ระยะหลังมีการปลูกพันธุ์ของบริษัทเอกชนและพันธุ์ที่ได้จากการประกวด แต่เป็นพันธุ์ที่ทางราชการยังไม่ได้รับรองพันธุ์ ดังนั้นกรมวิชาการเกษตรจึงได้ดำเนินการคัดเลือกพันธุ์ตั้งแต่ปี 2519 เป็นต้นมา โดยเน้นพันธุ์มะม่วงหิมพานต์ที่เหมาะสมสำหรับปลูกในภาคตะวันออกเฉียงเหนือ

หลักเกณฑ์การคัดเลือกพันธุ์

1. ให้ผลผลิตสูงและติดผลสม่ำเสมอทุกปี
2. ขนาดเมล็ดใหญ่ จำนวนน้อยกว่า 200 เมล็ดต่อกิโลกรัม (น้ำหนัก 5 กรัมขึ้นไป)
3. คุณภาพเมล็ดเนื้อในดี อยู่ในเกรด 4 ของมาตรฐานโลก หรือดีกว่า (จำนวนเมล็ดเนื้อในเกรด 4 ของตลาดโลกเท่ากับ 320 เมล็ดต่อน้ำหนัก 1 ปอนด์)
4. มีเปอร์เซ็นต์การกะเทาะ (shelling percentage) มากกว่า 25%
5. มีเปอร์เซ็นต์เมล็ดดีสูง (ความถ่วงจำเพาะมากกว่า 1) มากกว่า 75%
6. มีลักษณะอื่น ๆ ดี เช่น เป็นพันธุ์เบา ทนทานต่อโรคและแมลงที่สำคัญ และลักษณะทรงพุ่มดี

ผลการคัดเลือกพันธุ์

การดำเนินงานคัดเลือกพันธุ์ตั้งแต่ปี 2519 เป็นต้นมา ศูนย์วิจัย

[illegible]

น้ำมะม่วงหิมพานต์

นำผลมะม่วงหิมพานต์ที่ล้างสะอาดแล้วมานึ่งในหม้ออบไอน้ำประมาณ 5-10 นาที ทำให้เย็นแล้วคั้นด้วยเครื่องคั้นน้ำผลไม้ กรองด้วยผ้าขาวบางที่สะอาด ถ้ามีรสฝาดมากให้เติม พีวีพี 0.14% หรือเติมเจลาตินเล็กน้อยกวนให้เข้ากัน ตั้งทิ้งไว้ 15 นาที แล้วกรองอีกครั้ง จะได้น้ำมะม่วงหิมพานต์ใส เติมน้ำตาลในอัตรส่วนน้ำตาล 60 กรัม/น้ำมะม่วงหิมพานต์ 1 ลิตร จะได้น้ำมะม่วงหิมพานต์ที่มีรสหวาน เติมกรดซิตริก หรือน้ำมะนาวเล็กน้อย ถ้าต้องการรสเปรี้ยว หรือ เติมเกลือเล็กน้อยให้รสกลมกล่อมขึ้น การบรรจุขวดทำได้ 2 วิธี คือ นำน้ำมะม่วงหิมพานต์ที่เตรียมไว้มาทำให้ร้อนที่ 90-95 องศาเซลเซียส นาน 30 นาที แล้วทำให้เย็น นำน้ำคั้นที่ได้ทำให้ร้อนประมาณ 70 องศาเซลเซียส เติมสารกันเสีย (โซเดียมเบนโซเอท) ไม่เกิน 1 กรัม/น้ำคั้น 1 ลิตร บรรจุในขวดที่สะอาดและปิดจุก

น้ำคั้นผลปลอมมะม่วงหิมพานต์ชนิดเข้มข้น

ใช้กรรมวิธีการเดียวกับทำน้ำคั้น แต่เพิ่มความหวานโดยใส่น้ำเชื่อมที่ใช้น้ำตาล 1.5 กก./น้ำ 1 ลิตร ที่ต้มและกรองแล้ว เติมลงในน้ำคั้นที่เตรียมไว้ และปรับรสชาติโดยเติมกรดซิตริก หรือน้ำมะนาวและเกลือทำให้ร้อนที่ 70 องศาเซลเซียส ใส่โซเดียมเบนโซเอทแล้วบรรจุขวดที่สะอาดก่อนดื่มให้ผสมน้ำประมาณ 5 เท่า

มะม่วงหิมพานต์กวน

ใช้กากผลปลอมมะม่วงหิมพานต์ที่คั้นน้ำออกแล้ว 1 กก. นำไปตั้งไฟเคี่ยวจนกระทั่งน้ำงวด เติมน้ำตาล 1 กก. เกลือ 1 ช้อนชา และกรดซิตริก 1 ช้อนโต๊ะ กวนต่อไปจนแห้ง บรรจุในภาชนะที่สะอาด

แยมมะม่วงหิมพานต์

แช่ผลมะม่วงหิมพานต์ในน้ำเกลือที่มีความเข้มข้นร้อยละ 2 ประมาณ 3-5 วัน ล้างน้ำให้สะอาด แล้วนำไปนึ่งในหม้ออบไอน้ำนานประมาณ 10-15 นาที ตัดแต่เอาส่วนที่เสียหรือมีตำหนิออกด้วยมีด แล้วตัดหรือบดเป็นชิ้นเล็ก ๆ เติมน้ำตาล 1 กก./เนื้อมะม่วงหิมพานต์ 1 กก. ต้มจนกระทั่งได้ความข้นพอเหมาะแล้ว เติมกรดซิตริกประมาณ 1 ช้อนชา บรรจุในขวดหรือกระป๋อง[illegible]

มะม่วงหิมพานต์แช่อิ่ม

แช่ผลปลอมมะม่วงหิมพานต์ที่ล้างสะอาดแล้ว ในน้ำเกลือที่มีความเข้มข้น 2% หนึ่งคืน แล้วเพิ่มปริมาณเกลือขึ้น 2% ทุกวัน จนกระทั่งน้ำเกลือมีความเข้มข้นประมาณ 10% เติมโปแตสเซียมเมตาไบซัลไฟท์ในอัตรา 700 มิลลิกรัม/น้ำเกลือ 1 กก. ปล่อยให้ผลปลอมมะม่วงหิมพานต์แช่อยู่ในสารละลายนี้ประมาณ 2-3 วัน นำผลมะม่วงหิมพานต์มาล้างน้ำให้สะอาด นำไปลงในน้ำเดือดประมาณ 5 นาที แล้วนำไปอบประมาณ 5 นาที ในหม้ออบไอน้ำ ทำให้เย็นโดยล้างด้วยน้ำสะอาด แล้วเจาะให้เป็นรูพรุน โดยใช้ไม้แหลมหรือซ่อม เตรียมน้ำเชื่อมข้น 30% โดยละลาย

ลักษณะทางพฤกษศาสตร์

มะม่วงหิมพานต์ เป็นไม้ผลยืนต้นประเภทไม้ผลัดใบ ลักษณะของทรงพุ่มกว้าง มีการแตกกิ่งก้านสม่ำเสมอ และมักจะแผ่กิ่งลงต่ำกว่าไม้ชนิดอื่น ขนาดทรงพุ่มประมาณ 6-12 เมตร สูงประมาณ 8-12 เมตร ระบบรากมีรากแก้วฝังลึกมากกว่า 5 เมตร และรากแขนงแผ่กว้างออกด้านข้าง 1-1.5 เท่าของขนาดทรงพุ่ม ลำต้นเป็นไม้เนื้ออ่อน เปลือกหนาสีน้ำตาลเทา ภายในเปลือกมีน้ำยางสีขาว ซึ่งจะเปลี่ยนเป็นสีดำเมื่อถูกอากาศ บางทีเรียกว่า "มิลกี้" (Milky) เนื้อไม้มีสีเทาถึงน้ำตาลแดง ภายในจะมีน้ำยางข้นเหนียวสีเหลือง ใบหนาเป็นมันรูปไข่ ขนาดของใบแตกต่างกันในแต่ละพันธุ์ยาวประมาณ 4-8 นิ้ว กว้าง 2-4 นิ้ว เส้นใบเรียงสลับกัน ดอกเกิดเป็นช่อปลายกิ่งที่สมบูรณ์ ส่วนใหญ่อยู่รอบนอกของทรงพุ่ม ช่อดอกยาว 6-10 นิ้ว ประกอบด้วยช่อดอกย่อย 8-11 ช่อ ในแต่ละช่อมีทั้งดอกตัวผู้ ดอกตัวเมียและดอกกะเทย เฉลี่ยประมาณ 300 ดอก ซึ่งดอกชนิดหลังนี้มีประมาณ 4% และอยู่ปลายช่อเป็นส่วนใหญ่ ดอกกะเทยหรือดอกสมบูรณ์เพศที่ได้รับการผสมเกสรแล้วจะให้ผลปลอม (Apple) ซึ่งมีลักษณะฉ่ำน้ำ ขนาดและสีของผลปลอมจะแตกต่างกันในแต่ละพันธุ์ สีของผลปลอมส่วนใหญ่มีสีแดง หรือสีเหลือง ส่วนผลแท้คือเมล็ด (seed) มีรูปร่างคล้ายไต มีเปลือกหนาและแข็งห่อหุ้ม ภายในเปลือกจะมีกรดน้ำมันซึ่งประกอบด้วยกรดอนาคาร์ดิค (anacardic acid) 90% และคาร์ดอล (cardol) 10% ถัดจากเปลือกเป็นเยื่อหุ้มเนื้อใน (testa) ซึ่งจะมีสีน้ำตาลแดง ส่วนในสุดของเมล็ดคือเมล็ดเนื้อใน (kernel) ซึ่งเป็นประโยชน์ที่สุดในแง่การค้า

พันธุ์

พันธุ์มะม่วงหิมพานต์ทั่วโลก มีไม่ต่ำกว่า 400 พันธุ์ เดิมการจำแนก

ในประเทศอินเดียและอาฟริกาตะวันออก สำหรับประเทศไทยนั้นสันนิษฐานว่า พระยารัษฎานุประดิษฐ์ มหิศรภักดี เป็นคนแรกที่นำเมล็ดมะม่วงหิมพานต์มาปลูกที่จังหวัดตรังเมื่อพ.ศ. 2444 ซึ่งปัจจุบันได้แพร่กระจายปลูกทั่วประเทศโดยเฉพาะภาคใต้และภาคตะวันออกเฉียงเหนือ จากสถิติของกรมส่งเสริมการเกษตรในปีพ.ศ. 2530/31 มีพื้นที่ปลูกรวม 352,590 ไร่ แยกเป็นภาคดังนี้ ภาคใต้ 149,340 ไร่ ภาคตะวันออกเฉียงเหนือ 142,959 ไร่ ภาคกลาง 2,523 ไร่ ภาคตะวันออก 29,937 ไร่ และภาคตะวันตก 12,375 ไร่ และผลผลิตรวมทั้งประเทศ 41,894 ตัน ผลผลิตเฉลี่ย 260 กิโลกรัมต่อไร่ ปัจจุบันพื้นที่ปลูกเพิ่มมากขึ้น เพราะนอกจากทางราชการได้ส่งเสริมให้ปลูกแล้ว ยังมีบริษัทเอกชนหลายบริษัท ให้การส่งเสริมการปลูกแบบครบวงจรอยู่

มะม่วงหิมพานต์ เป็นพืชที่ค่อนข้างทนทานต่อความแห้งแล้ง ต้องการสภาพภูมิอากาศแห้งแล้งอย่างน้อย 4-6 เดือนต่อปี โดยเฉพาะช่วงก่อนออกดอกและเก็บเกี่ยวผลผลิต ปลูกได้ในระหว่างเส้นรุ้ง 20 องศาเหนือ และ 20 องศาใต้ บริเวณที่มีปริมาณน้ำฝน 20-150 นิ้วต่อปี ความสูงของพื้นที่ตั้งแต่ระดับน้ำทะเลถึง 2,000 ฟุต ไม่ชอบอากาศหนาวเย็น ปลูกขึ้นได้ง่ายเจริญเติบโตเร็ว ดูแลรักษาง่าย ปลูกได้ในดินทุกชนิดแม้กระทั่งดินทรายและดินลูกรัง แต่ควรเป็นดินร่วนปนทราย หน้าดินลึกอย่างน้อย 1 เมตร มีการระบายน้ำได้ดี ไม่ควรปลูกบริเวณที่มีน้ำท่วมขัง การระบายน้ำเลว ดินเหนียวจัด ดินเค็มจัด ดินเกลือ ดินด่างจัดและดินเปรี้ยวจัด และดินที่มีหน้าดินตื้นเป็นดินดาน หินดาน

น้ำตาล 300 กรัมในน้ำ 700 ซีซี. เติมกรดซิตริก 0.1% แล้วต้มเดือด 10 นาที แช่ผลปลอมมะม่วงหิมพานต์ในน้ำเชื่อมที่เตรียมไว้ 1 คืน วันรุ่งขึ้นรินน้ำเชื่อมออกมาเติมน้ำตาลให้ได้ความเข้มข้นเพิ่มขึ้นเป็น 35% ต้มให้เดือดนาน 5 นาที แล้วเทกลับลงไปบนผลมะม่วงหิมพานต์ ทำเช่นเดียวกันทุกวัน โดยค่อย ๆ เพิ่มความเข้มข้นของน้ำเชื่อมขึ้นวันละ 5% จนกระทั่งน้ำเชื่อมมีความเข้มข้น 50% แล้วจากนั้นจึงค่อย ๆ เพิ่มความเข้มข้น 2 วัน/ครั้ง จนได้ 70 เปอร์เซ็นต์ แล้วแช่ต่อไปอีก 5-6 วัน นำผลมะม่วงหิมพานต์ที่แช่อิ่มแล้วไปอบแห้งในตู้อบ หรือจะนำไปตากแดดก็ได้ บรรจุในภาชนะที่สะอาด

ผลปลอมมะม่วงหิมพานต์บรรจุกระป๋อง

นำผลปลอมที่เนื้อแน่นลวกใน 0.5% NaOH ที่กำลังเดือดนาน 5 นาที ทำการปลอกเปลือก และล้างน้ำ โดยผ่านขั้นตอนตามลำดับดังนี้ จุ่มใน 0.2 ของกรดซัลฟูริคที่กำลังเดือดนาน 5 นาที ล้างน้ำ และ เอาเปลือกเหนียวชิ้นเล็ก ๆ ออกและนำไปอบไอน้ำ 5 นาที ผลปลอมที่ได้ไม่ควร และนำมาบรรจุกระป๋องที่ผ่านการฆ่าเชื้อ เทน้ำเชื่อม 40% ที่ร้อนลงในกระป๋องที่มีผลปลอมมะม่วงหิมพานต์ และ วางกระป๋องอยู่ในอ่างที่มีน้ำร้อนปิดผนึกฝากระป๋อง และผ่านน้ำเย็น ระวังอย่าให้มีการปนเปื้อนของจุลินทรีย์ นำไปเก็บในที่แห้งและเย็น

ผลปลอมมะม่วหิมพานต์ดองเค็ม

ผลปลอมที่ยังไม่แก่จัดยังมีสีเขียว นำมาล้างแล้วหั่นเป็นชิ้นให้ได้ 4 ชิ้น/ผล แช่ในน้ำเกลือ 5% ทิ้งไว้ 1 วัน แล้วเปลี่ยนน้ำเกลือ 5% ใหม่ทำเช่นนี้ครบ 3 วัน ในวันที่ 4 ทำการล้างน้ำเกลือ นำไปประกอบอาหารอื่น ๆ หรือ ผสมเครื่องเทศปรุงกลิ่นรสต่อไป

ลูกกวาดผลปลอมมะม่วงหิมพานต์

ล้างผลปลอมให้สะอาด แล้วแช่ในน้ำเกลือ 3% นาน 1 วัน เทน้ำเกลือเก่านี้ออก เตรียมน้ำเกลือ 3% ใหม่ ทำเช่นนี้ประมาณ 3 ครั้ง เทน้ำเกลือออกแล้วใส่ โปแตสเซียมเมตาไบซัลไฟท์ ในอัตรา 600 มก. ต่อน้ำหนักผลปลอม 1 กก. แช่ไว้ 2-3 วัน นำผลปลอมมาล้างออกโดยผ่านไอน้ำเดือดนาน 5 นาที ตามด้วยการผ่านไอน้ำ โดยนึ่งในหม้อนึ่งความดัน 0.35 กก.เป็นเวลา 5 นาที (ผลปลอมที่ผ่านออกมาไม่ควรเละ) ใช้น้ำเชื่อม 30% ที่ผสมกับกรดซิตริก 0.1% และโปแตสเซียมเมตาไบซัลไฟท์ 500 มก. ต่อน้ำหนักผลปลอม 1 กก. เทน้ำเชื่อมลงบนผลปลอมจนท่วม กดให้ผลจม ใช้แผ่นแสตนเลส แผ่นแก้วหรือไม้กดแล้วปิดฝาเก็บไว้ 1 วัน วันรุ่งขึ้นรินน้ำเชื่อมออก เอาน้ำเชื่อมไปเติมน้ำตาลให้ความหวานเพิ่มเป็น 35% เคี่ยวนาน 10 นาที รินให้ท่วมผลปลอม ทำเช่นนี้ 6-7 ครั้ง โดยให้เพิ่มน้ำตาลอีกครั้งละ 5% จนน้ำตาลถึง 70% แล้วนำมาเก็บไว้ 7-10 วัน ให้น้ำตาลอิ่มตัว จึงเทน้ำเชื่อมออก และนำผลปลอมอิ่มตัวด้วยน้ำตาลมากดให้แบนในแบบพิมพ์และนำไปเก็บในที่แห้งและเย็น

น้ำส้มสายชูผลปลอมมะม่วงหิมพานต์

นำน้ำคั้นจากผลมะม่วงหิมพานต์มาเติมน้ำตาล เพื่อปรับให้มีความหวาน 15% ต้มพาสเจอร์ไรส์แล้วทำให้เย็นใส่เชื้อยีสต์ (Saccharomyces cerevisiae) ทิ้งไว้พัก 4-5 วัน เติมหัวเชื้อน้ำส้มสายชู Acetobecter sp. ในน้ำคั้นในอัตรา 1:3 นำไปไว้ในขวดปากกว้างประมาณ 15 วันกรองแล้วต้มฆ่าเชื้อที่ 60 องศาเซลเซียส นาน 30 นาที จะได้กรดน้ำส้มสายชูที่มีประมาณ 5-6 %

[redacted]

*ประเสริฐ อนุพันธ์**

มะม่วงหิมพานต์ เป็นผลไม้ยืนต้นชนิดหนึ่งที่เป็นความหวังใหม่ในแผนพัฒนาเศรษฐกิจและสังคมแห่งชาติฉบับที่ 6 ที่ทั้งภาครัฐบาลและภาคเอกชนกำลังส่งเสริมพัฒนาเป็นพืชเศรษฐกิจที่สำคัญชนิดหนึ่งของประเทศ เพื่อการส่งออก สามารถปลูกได้ดีในภาคตะวันออกเฉียงเหนือและภาคอื่น ๆ ของประเทศจึงเป็นพืชอีกชนิดหนึ่งที่ใช้ปลูกทดแทนมันสำปะหลังในภาคตะวันออกเฉียงเหนือและกำลังปลูกในโครงการน้ำพระทัยจากในหลวง เพื่อพัฒนาภาคตะวันออกเฉียงเหนือ ตามแนวพระราชดำริหรือโครงการอีสานเขียว โครงการเร่งรัดการปลูกไม้ผลเพื่อการกระจายรายได้ในภาคตะวันออกเฉียงเหนือ โครงการสี่ประสานและโครงการอื่น ๆ อีกมาก การปลูกมะม่วงหิมพานต์มีข้อดีหลายประการนอกจากจะเพิ่มรายได้ให้แก่เกษตรกรแล้ว สามารถส่งไปขายยังต่างประเทศ นำรายได้เข้าประเทศ เนื่องจากปริมาณการผลิตของตลาดโลกยังต่ำกว่าความต้องการมาก ราคาของผลผลิตทั้งเมล็ดดิบและเมล็ดเนื้อในอยู่ในเกณฑ์ดี และการตลาดไม่มีปัญหา ฤดูกาลเก็บเกี่ยวไม่ซ้ำกับพืชอื่น ทำให้เกษตรใช้แรงงาน ให้เป็นประโยชน์มากขึ้น เมล็ดเก็บไว้ได้นานและยังเป็นการเพิ่มการปลูกป่า จะทำให้สภาพภูมิอากาศและสิ่งแวดล้อมดีขึ้นด้วย

มะม่วงหิมพานต์ มีถิ่นกำเนิดทางภาคตะวันออกเฉียงเหนือของประเทศบราซิล จากนั้นแพร่กระจายไปสู่แถบตอนบนของอเมริกาใต้ อเมริกากลางและเม็กซิโก ในศตวรรษที่ 16 ชาวปอร์ตุเกสได้นำไปปลูก

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* ผู้อำนวยการศูนย์วิจัยพืชสวนศรีสะเกษ

ไวน์ผลปลอมมะม่วงหิมพานต์

การหมักไวน์ผลไม้ที่จะได้ผลดี ขึ้นอยู่กับตัวของผลไม้เองเชื้อ Yeast สภาพแวดล้อมและระยะเวลาในการหมัก โดยล้างผลปลอมมะม่วงหิมพานต์ให้สะอาด นำมาสับให้ละเอียดและคั้นน้ำเติมน้ำ 2 เท่าของน้ำหนักผลปลอม วัดความหวานและปรับความหวานให้ได้ประมาณ 20% ปรับ pH ของน้ำคั้นให้เป็น 4 ด้วยกรดซิตริก ต้มให้เดือดทิ้งให้เย็นจึงใส่เชื้อยีสต์หมักที่อุณหภูมิห้องโดยตั้งทิ้งไว้จนเกิดฟองอากาศเกิดขึ้นทิ้งไว้ 2-3 สัปดาห์ จนไวน์เริ่มใสจึงใช้สายยางดูดส่วนใสตอนบนลงในขวดหมักไวน์ ตั้งทิ้งไว้จนไวน์ในขวดหมักใสซึ่งใช้เวลาประมาณ 2 เดือน ต้มฆ่าเชื้อที่ 60 องศาเซลเซียสนาน 30 นาทีบรรจุขวดที่สะอาดและแห้งดีแล้ว ไวน์ที่ได้จะมีแอลกอฮอล์ประมาณ 60%

การตลาดและราคา

1. เมล็ดดิบหรือเมล็ดทั้งเปลือก ราคาขายในตลาดท้องถิ่น โดยขายให้โรงงานกะเทาะเมล็ดภายในประเทศ และเพื่อจำหน่ายยังตลาดต่างประเทศ เช่น จีนแดง อินเดีย เป็นจำนวนมาก ราคากิโลกรัมละ 12-25 บาท ทั้งนี้ขึ้นอยู่กับขนาดและคุณภาพภายนอกของเมล็ดดิบ

2. เมล็ดเนื้อใน ราคาขายในท้องถิ่น เมล็ดประกบคู่ราคากิโลกรัมละ 150-200 บาท เมล็ดเนื้อชนิดซีกกิโลกรัมละ 105-120 บาท จะเห็นว่าราคาเมล็ดเนื้อใน ขึ้นอยู่กับขนาดของเมล็ดเนื้อในที่ได้มาตรฐาน หรือไม่ว่าเป็นเมล็ดเนื้อในชนิดเต็ม ชนิดครึ่งซีก ชนิดหักเป็นท่อน หรือป่น สำหรับเมล็ดชนิดเต็ม จะต้องดีเท่าเกรด 4 หรือดีกว่า จึงจะส่งไปขายตลาดต่างประเทศได้ การนำเข้ามี 2 ลักษณะคือ นำเข้าเมล็ดดิบและ

เมล็ดกะเทาะเปลือกหรือเมล็ดเนื้อใน เมล็ดดิบจะนำเข้าป้อนโรงงานกะเทาะเมล็ด และเป็นพันธุ์ การส่งออกส่วนมากเป็นชนิดไม่กะเทาะเปลือก สำหรับน้ำมันจากเปลือก (CNSL) ไทยส่งขายให้ญี่ปุ่นและเกาหลี ราคาประมาณ 300 เหรียญสหรัฐ

กลุ่มไม้ยืนต้นอุตสาหกรรม
กองส่งเสริมพืชสวน

ปฏิทิน

การปลูกมะม่วงหิมพานต์

รายการ \ เดือน	ม.ค.	ก.พ.	มี.ค.	เม.ย.	พ.ค.	มิ.ย.	ก.ค.	ส.ค.	ก.ย.	ต.ค.	พ.ย.	ธ.ค.
ปลูก						■	■					
ใส่ปุ๋ย						■			■			■
ตัดแต่งกิ่ง					■							
เก็บเกี่ยว		■	■	■								
พ่นยา	■	■				■	■					■

ติดต่อได้ที่

ศูนย์วิจัยพืชสวนศรีสะเกษ
อำเภอเมือง จังหวัดศรีสะเกษ 33000
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พิมพ์ที่วิทยาการพิมพ์-ออฟเซ็ท 241-245 ถ.พิชิตรังสรรค์ อ.เมือง จ.อุบลฯ โทร.242721

กลุ่มไม้ยืนต้นอุตสาหกรรม
กองส่งเสริมพืชสวน

คำแนะนำการปลูก

มะม่วงหิมพานต์

จัดทำโดย

ศูนย์วิจัยพืชสวนศรีสะเกษ
สถาบันวิจัยพืชสวน
กรมวิชาการเกษตร
กระทรวงเกษตรและสหกรณ์

ANNEX VI

POTENTIAL INVESTMENT OPPORTUNITY PACK-VI

SUGAR AT SAVANNAKHET

Introduction

Until recently Lao has had to import all its requirements for crystal sugar to satisfy the domestic requirement. This amounts to approximately 10,000 tonnes per year, made up of sugars from Vietnam and refined white sugar from Thailand.

However, in 1983 a plan was developed to construct a sugar mill and this finally resulted in the establishment of the Pak Sap Sugar Mill, 30 kilometres north-east of Vientiane. This was commissioned in 1990 after three years' delay. The installation was initiated by the Vientiane Municipality within the Ministry of Agriculture and Forestry under a World Bank Agricultural Production Support Project, as part of a plan to increase agricultural production. The main targets were rice, animal feed and sugar with a view to reducing imports. The original plan was to construct a small sugar mill with an annual output capacity of 1,000 tonnes of plantation white sugar per year, but this was uprated during the design stages to 2,000 tonnes per annum as being more economic.

The mill was designed and installed by an Australian company, Batstone Technology Pty Ltd, and is considered to be of good quality in terms of technology and installation. It was constructed as a turnkey project at a total cost of US$ 2.3 million which was financed by a World Bank soft loan to include land preparation and transport.

Major problems have arisen in getting the mill into production due to lack of sugar cane for processing. The enterprise has not had sufficient operating capital to establish more than 30 hectares of their own cane and this is now to become a nursery to supply outgrowers. After much effort smallholders have been persuaded to plant some 100 hectares which will be ready for the February 1992 season; yields are expected to be in the region of 40 tonnes/hectare, thus giving a total production of 4,000 tonnes for the season. However, the factory needs at least 20,000 tonnes to reach its design capacity of 2,000 tonnes per annum of sugar, and the disappointing response by farmers will therefore have serious implications for the future cash flow and profitability of the mill.

Some 300 hectares have been allocated for cane production, and the practice has been for the mill to clear and plough the land ready for planting, and to provide planting material and technical assistance; the owners of the land supply the labour for planting, maintenance and harvesting. But the plans have been frustrated by the lack of working capital and irrigation facilities.

Establishing large areas of cane is expensive as it costs around Kip 100,000 per hectare for clearing only. Roads and culverts in the area also need substantial repairs and upgrading, and accommodation on the site is limited and needs to be expanded to allow field and factory staff to make their permanent homes on the site.

In spite of the foregoing problems with this particular project, given better financing and extension services to encourage local farmers, the expansion of sugar processing activities in Lao is seen by the Consultant to be a logical progression in order to increase the level of import substitution, improve cash returns to smallholder farmers and promote institution-building. The following opportunity study proposes the replication of the Pak Sap mill in Savannakhet to supply the local market (ie, southern Lao).

Some technical improvements have been made to the latest design of the mini sugar mill as supplied to Pak Sap by overcoming a bottleneck in the shredder to give an increased cane throughput of 250 tonnes of cane per day (TCD). Operating costs have been reduced by replacing the membrane filters with a fine screening and flotation (flocculation) system. The potential output of the redesigned mill now becomes 2,500 tonnes in a 100-day operating season.

Before suggesting the replication of the current mill, the Consultant has given consideration to an alternative lower technology vacuum pan method commonly employed in India. However, installation costs are no lower and it gives a lower percentage of sugar recovery – it is, therefore, not recommended.

Market, and Demand for Specific Product

In the cane industry, the most common alternative to the construction of a fully-fledged refinery has been the production of what is variously known as mill, or plantation white, sugar, or crystal sugar. This omits the final refining stage following affination and produces a perfectly acceptable product for direct marketing at a somewhat lower cost.

This plantation white sugar would compete with various imported products, namely Thai refined white sugar and Vietnamese brown and white sugars. It is suggested that a market for the domestically-produced Lao sugar would exist if it could be sold at a lower price than the Thai import; essentially it would compete with the Vietnamese product in the south of the country. (This is discussed in more detail in the paper in Annex VI.)

The suggested capacity for the plant is based on a maximum throughput of 250 TCD which, assuming average yields, will produce around 2000–2,500 tonnes of plantation white sugar per year. This compares with current national consumption of around 10,000 tonnes per year; it is therefore considered that the economy could absorb this level of output.

POL extraction in the crusher should exceed 93% with overall recovery in the region of 82%. The plant has been sized at this capacity as this is very much the smallest size of mill for economic operation, but will still satisfy some 25% of national demand when fully operational.

Supply of Raw Materials Inputs

The factory will require the supply of 25,000 tonnes of cane in a normal 100-day operating season. At an assumed (modest) yield of 40 tonnes of cane per hectare this will need the planting of something like 625 hectares. In practice this will represent the major component of the project, requiring the energetic promotion of smallholder participation, adequate funding for land clearing and the supply of high quality, disease-resistant planting material which will give satisfactory yields and sugar content under local conditions.

Other materials such as detergents, chemicals, lime for neutralising and packaging materials will need to be supplied on a regular basis. Some, such as poly bags, may have to be imported. The operations of the existing Pak Sap mill should establish sources for these, and joint purchasing, if this can be arranged, may lead to lower costs.

Modest quantities of potable water and around 350 kilowatts of electrical power will be required each day which will presumably present no problems in Savannakhet. Fuel for the operation of the factory is provided by bagasse and only a relatively small pond will be needed for handling the effluent. There are therefore no adverse environmental implications of the project.

Location and Site

Savannakhet has been selected as the location for the new mill as it is the second largest and most densely populated town and province in Lao. The produced sugar will be sold here and further south towards Pakxe. It also has a history of supplying cane to an earlier Vietnamese sugar mill and local farmers can still grow cane for domestic consumption. Both land and rainfall are thought to be suitable for cane growing and according to the Savannakhet branch of the Ministry of Agriculture and Forestry, local farmers are keen to move into cane production. In fact a co-operation agreement has been signed recently to grow cane locally for supply to the existing mill across the river in Mukhdahan.

From the point of view of availability of suitable land, a site to the north of the town is suggested, but, as there appears to be little agriculture in this area at the present time, the availability of local farmers and labour will need to be confirmed.

Project Engineering

The technology for the production of plantation white sugar consists essentially of crushing cane between steel rollers, the juice being pumped to holding tanks while the bagasse is elevated to the boiler where it is burnt to generate the steam needed to operate the factory. After filtering, clarifying and neutralising with lime, the juice is concentrated in a triple effect evaporator and is subsequently crystallised in a vacuum tank. It then passes through a series of washing, recrystallising and centrifuging stages before finally passing along a vibrating drier-conveyor for packaging. Some 500 tonnes of molasses will also be derived as a by-product which can be fermented or used for animal feed etc.

The Batstone equipment proposed for the mill comes in partially assembled modules in shipping containers and as a consequence is relatively quick and easy to assemble on site with little risk of commissioning problems. A layout drawing of the mill and a flow chart for the process are included in the 'Potential Investment Opportunity Pack' – Annex VI.

The estimated current cost of the installation is US$ 1 million including erection and commissioning. Full equipment lists and specification are detailed in the PIOP Annex VI. In addition the project will need the supply of five or six large trucks for hauling the cane at a cost of, say, US$ 250,000 depending on size and source of supply.

A simple shed design of factory building will be adequate for this operation. The building will be around 10 metres x 35 metres and should be located on a hectare of land. The total cost for outbuildings, fencing around the compound, internal roads and hard standing and a settling pond would be in the region of US$ 270,000.

Manpower and Management

Suggested staffing for the factory would be:

- 1 factory manager
- 1 foreman/technician
- 2 mechanical electrical engineers
- 1 laboratory technician
- 8 can unloaders and feeders
- 8 plant operatives
- 6 drivers

The manager will need to be experienced in all aspects of factory and plantation operations and it is suggested that an expatriate specialist should be employed for the first 12 months to direct operations and train a local manager. Some overseas training of other technical and maintenance staff would also be desirable. This replicates the development of the Vientiane mill.

Additional staff will be required to operate the nursery and the sugar mill estate together with extension workers for liaison with local farmers, plus engineering staff for the maintenance of vehicles and farm equipment.

Project Scheduling

The total implementation and construction period would be in the region of 18 months to cover the preparation of plant and building specifications and quotations, and allowing for equipment delivery, erection, commissioning and site works.

During this period it will be essential to initiate the planting of cane for the first year's operation of the mill as the crop will need some 15 months growing time following land clearing operations.

Bearing in mind the historical problems associated with establishing cane for the Pak Sap mill, a practical schedule needs to be drawn up for the gradual build up of factory operations to achieve full capacity. It is suggested that a five-year programme is realistic and adequate funds need to be provided to support the operation of the factory and for land clearing until profitable working is achieved. A plan along the lines outlined below might be realistic.

Year	Cane (tonnes)	Area requirement (hectares)
1	5,000	125
2	10,000	250
3	15,000	375
4	20,000	500
5	25,000	625

Financial and Economic Analysis

Implementation costs include the provision of expatriate management (Kip 36 million) (based on the IBRD consultant rate for the new Pak Sap manager), funds to support factory operations until an economic level of throughput is achieved, funds for the clearing and preparation of land for planting at Kip 100,000/ha, and Kip 350,000/ha for planting and maintenance of the mill plantation up to harvesting. These costs are based on the Pak Sap experience. It is assumed that the enterprise will clear and plant 100 hectares of their own land each year to give them a total plantation size of 500 hectares by year 5.

Operating costs (including electricity, lime and other chemicals, poly bags, etc) are based on the current levels estimated by the Pak Sap Mill, except that wage rates for local staff have been doubled. These rates are based on the published GOL minima (see Annex 16). Production costs are summarised in Annex VI. The only costs obtainable were from informal records discussed with junior management at one meeting at Pak Sap. Sugar cane would be purchased at Kip 10,000 per Ton from farmers, and its wholesale ex-factory price is Kip 350 per Kilo (to compete with Vietnamese imports).

The financial analysis is summarised in the following table. For simplicity, costs are shown to be those at full operation, as is the throughput of the factory (ie, by year 5).

As well as being financially profitable (on the base annual full development costs, a rate of return of 17% is suggested), economic benefits accrue in the form of income-earning opportunities for a relatively large number of farmers (several hundred), jobs at the sugar mill (around 100) and import substitution.

Risk and Uncertainty

As regards sources of risk, the potential for success of the investment will depend on smallholder farmers being recruited at an early stage and a programme developed for the progressive expansion of cane planting in the Savannakhet district. This will require adequate funds for land clearing and preparation, a guaranteed price to farmers which will show an adequate return for effort, the development of suitable varieties of sugar cane and the recruitment of a skilled and enthusiastic team of extension workers to be attached to the enterprise.

A rise in operating costs by 20% due to problems of supply quantity or management failure would cause the rate of return to fall to less than 13%, and a fall in the wholesale price of sugar by 20% would cause the rate to drop to just over 11%; it therefore seems that, if management problems can be overcome, the opportunity has a good chance of success.

The recruitment of an experienced expatriate for the first year's operation of the enterprise and a farming/agronomic expert during the initiation phase of establishing cane both on the enterprise plantation and among local farmers would also be essential.

The provision of adequate finances to support the factory operations during the early years until a profitable level of operation is achieved is vital, as demonstrated by the Pak Sap experience.

Table 1

MEKONG AREA OPPORTUNITY STUDIES

SUGAR AT SAVANNAKHET

Financial Analysis summary

	(Million) Kip	US$ (000)
Investment cost:	1345	1908
Production cost:		
Operating costs	449	637
Depreciation	90	128
Interest	74	105
Total production costs	613	670
Rate of return:		
Sales revenue	875	1241
Operating cost	449	637
Depreciation	90	128
Operating profit	336	477
Interest (average 11%)	74	105
Gross profit pre-tax	262	372
Corporate tax (40%)	105	149
Net profit	157	223
Rate of return (%) =	17.2	17.2
Repayment Period (years) =	4.2	4.2

Notes to table:

1. The format for this economic summary follows the UNIDO guidelines in the pubication ID/206.
2. The rate of return is calculated as the sum of net profit and interest divided by total investment outlay.
3. The repayment period is calculated as total investment outlay divided by the sum of net profit plus interest plus depreciation.
4. For both Thailand and Lao depreciation and interest are calculated at 6.7% and 11% respectively.
5. All opportunity studies assume the equity of the sponsor is 50% and borrowed capital, on which interest is payable, a further 50%.
6. In countries the total of corporate taxes have been estimated at 40%.
7. Exchange rate used = US$1.00 = Baht25/Kip705

ANNEX VI

POTENTIAL INVESTMENT OPPORTUNITY PACK-VI

SUGAR AT SAVANNAKHET

Sugar in Lao

This paper summarises what can be gleaned about the nature of the market and demand for sugar in Lao. Reliable data on sugar cane production and its subsequent production are not available. The crop does not have the advantage of coffee, for example, in being a major target of new internationally-funded projects, in which case external efforts to establish baseline data would have been made. Similarly, in the case of import statistics, substantial informal traffic in food and small consumer items across the Mekong renders import data as a basis for estimating consumption extremely doubtful. How prominently sugar actually figures in informal trade is open to debate - see below.

Ministry of Agriculture estimates of areas and production of sugar cane in recent years are shown below

Year	Area (ha)	Production (tons)
1984	1437	54525
1985	2640	73035
1986	2590	72328
1987	3843	103853
1988	3936	107091
1989	3826	126047
1990	3538	96360

The value of these figures must be questionable, given the dramatic area changes in 1984-85 and 1986-87, and the fact that the droughts of 1987 and 1988 appear to have no influence on production. The overall implication of the figures, taken at face value, is that the area of cane and the volume of production have both been rising in recent years.

Most cane is turned into a sugar on the farm, or sold for juicing.

As only negligible contributions were made by the output from the remaining Vietnamese factories, then the volume of imports represents present effective demand for white (or nearly white) sugars. Currently, annual imports are estimated to be about 10,000 tons. Of this, according to Thai trade figures, Lao imported some 2762 tons in 1990, and 3524 tons in the first half of 1991. These imports were at average values of Baht 980 and Baht 750 per tonne respectively. The balance of imports of sugar primarily come from Vietnam; this sugar is of a different type, the consequences of which in market terms are discussed later.

Demand and Market Size

Since such local production of raw milled sugar apparently ceased in the late 1980's, customer demand for sugar from industry (mainly soft drinks) and retail outlets is satisfied by imports. Annual statistics on imports also vary greatly; in 1989 it was recorded that 17,995 tons were imported. The amount that is imported unofficially is not known. There may be reason to argue that it is not too large as sugar, being of low unit value, is not as suitable for informal trading as other items.

It is assumed that the 1989 import total was inflated by trades building up stocks as imports were liberalized (1988 imports were only 2451 tons). There also may have been an over estimation of post-liberalization demand by buyers.

It is however most unwise to read more into the import data except to conclude that current annual demand is probably around 10,000 tons. (Since sugar is freely available from Thailand and Vietnam, normal stock levels, especially for retail sale will not be large).

Retail demand for sugar is complex, involving several forms of the product. Fully refined sugar (including cubes) comes from Thailand, low grade granulated white sugar and granulated brown sugar come from Vietnam, and block brown sugar is produced locally.

Retail market offerings observed in late 1991, suggest that white sugar may have around 50% of the market. A rise to two thirds of the total market share may be reasonable as incomes rise.

End users of imported sugar include the wealthier residents of Vientiane and other towns, other urban dwellers and most of those above subsistence levels. No hard data on the breakdown of the demand for different types is available by income category. A substantial share of demand is associated with coffee drinking, especially in southern Lao. On the basis of fragmentary data, demand by region might be

Region	Market share (%)
Northern Lao	5-10
Vientiane	30-35
Savannakhet	10-15
Southern Lao	30-35
Other	5-10

Because the market in Vientiane is more sophisticated and access, respectively, to Thailand easier and Vietnam harder fully refined sugar from Thailand achieves its greatest penetration in Vientiane. Vietnamese sugar is found more in the south of Lao, being both closer to Vietnam and preferred on grounds of cost. The structure of sugar availability by type is also a function of the simple logistics of supply as much as consumer preference.

Average per capita consumption of sugar is estimated to be 2-kilos per year, perhaps slightly more if other forms in beer, soft drinks are included. This implies a total national annual consumption of some 8500-13500 tons per year (based on a population of 3.5-3.75 million), and roughly accords with the range of import figures.

It should be noted that in 1990 some 100,000 tons of sugar cane were produced by farmers, all of which presumably was converted to muscavado or other brown sugar or to juice. On the assumption that the realised sugar content was about 5 per cent (one half of the sugar content that could be extracted by a modern mill from reasonable quality cane as is able to be produced in Lao) then nationwide a further 5,000 tons of sugar were consumed.

Over time some of this demand will be replaced by the milled product. For forecast purposes this merely reinforces the conclusion that 10,000 tons represents can be regarded as the minimum size of the market for milled sugar. Given the strength of demand for soft drinks and the likely switching to milled sugars, demand is likely to exhibit a trend more in line with changes in purchasing power rather than population growth.

Looking into the early years of the next century a case for a 60 per cent increase in total national consumption might reasonably be argued to over 15,000 tons per annum, of which the new mill proposed for Savannakhet in the opportunity study is only likely to satisfy 15% of this demand.

Whatever demand scenario is adopted, however, it leaves ample scope for the proposed project and, given suitable cane supply conditions, the opportunity to replicate the proposed mill several times over.

Sales Forecasts and Marketing

In the absence of any local supply, coupled with the fact that past local supply was not of comparable quality, it can only be guessed as to the buyer reaction to the emergence of a local source of supply of milled sugar. Some attempt must be made to consider the major industrial user of sugar in the country in this context, however, even though this user would be unlikely to purchase milled sugar from the proposed new mill at Savannakhet.

Industrial use is dominated by the sole soft drink manufacturer - Pepsi Cola. The only other significant industrial use is in beer manufacture, which involves a lower grade of sugar.

Pepsi are witnessing a major expansion in demand, as reflected in their recent actual and planned sugar purchases and outputs at their Vientiane factory

Year	Sugar (tons)	Output (million cases)
1989	300	0.3
1990	700	0.6
1991	1000	0.9
1992	1300	1.2
1995	2200	2.0

In order to meet the growth in product demand the Vientiane factory is to be re-equipped in 1993 to uprate its capacity by some 50%, to over 3 million cases (of 24 bottles each) per year. This is to be achieved with a new bottling line, and with the existing one relocated to Pakxe. Pakxe was selected for its strategic location and its role in promoting development in southern Lao.

Pepsi requires sugar with a pol of 70 and a polarity of 98; it seems doubtful that this can be met by existing or planned mills in Lao, including the proposed mill at Savannakhet. Annual contracts are currently negotiated with reliable local suppliers, and prices currently are in the range $US 390-430 FOB, plus a 10% import tax. Pepsi maintains an inventory of some 70 tons at all times.

As regards prices, the Thai refined sugar retails at 450-500 Kip per kilo, the Vietnamese at about 100 Kip per kilo less than this. The difference between the brown and white Vietnamese prices is only 50-75 Kip per kilo, with the whiter sugar being perceived as sweeter. Retail prices reflect a 30% mark-up over wholesale prices, with the larger retailers making up their own plastic packs and sachets. Wholesalers bear both the 10% import tax, plus a 5% turnover tax.

Marketing, Prices and the Savannakhet Mill

A Savannakhet-based mill will be exposed to competition from both Thailand and Vietnam. Moreover, the closeness of Mukdahan and the upgrading of the Danang road both make such competition particularly fierce. Transport costs also dictate that the mill seek to dispose of its product as locally as possible, perhaps increasingly along the road to Pakxe as this is improved, rather than trying to compete with the Vientiane mill.

Ultimately, quality will determine sales and price, and here the best option is to compete against the more vulnerable competitor, ie Vietnam, whose scope for price-cutting is weakest. The market to capture for the mill would be presently that occupied by the Vietnamese white sugar, although some effort could be made to encourage current consumers of Thai white to 'trade-down' to the plantation white produced by the mill; in this respect appropriate packaging and marketing are essential.

Very rough estimates (based on population density and per capita consumption) suggest that all the output of the mill could be absorbed in the south. No complex market analysis seems necessary, there are no complicating factors of seasonal demand, nor are there any major problems with product perishability. Pricing should be competitive, based on the price obtaining for Vietnamese white, and bearing in mind that supplies from other sources are always likely to be available. Over time a price differential may be established, based entirely on the relative quality of the product. Establishing a consumer preference within southern Lao for the mill's sugar would eventually (and ideally) lead to retailers paying wholesalers a slight premium for the product.

ANNEX VII

POTENTIAL INVESTMENT OPPORTUNITY PACK-VII

COFFEE IMPROVEMENT AT PAKSONG

Background

This opportunity study begins with some background to the original investment in coffee production and processing, which it is now proposed to enhance.

The Pakxong Coffee Mill is operated by the Coffee Company of Pakxong under the direction of Mr Simek Sihavong (also a major coffee grower). The mill was established in 1985 with assistance from East Germany at a reported cost of US$ 5.0 million; it is equipped with 'Fortschritt' plant and machinery. In addition to milling facilities, there are substantial warehousing facilities for the storage of clean coffee packed in jute bags for both local and export marketing.

The mill has an installed capacity of some 3,000 tonnes per season but only processed 1,600 tonnes in the 1991 season. The balance of 3,400 tonnes from the local crop of 5,000 tonnes is presently being rough hulled at village level in some 50 modified rice mills, many of which are mobile. This is apparently because the Pakxong mill is not able to offer any price incentive to farmers who prefer to use the services of the mobile local mills.

The basic process carried out by the Pakxong mill is firstly to reduce the moisture content of the sun-dried cherry as delivered by the farmers. Typically it arrives at 18% to 20% moisture and this is reduced to 12% in two 50-Ton silo driers. The dried cherry is then cleaned and de-stoned before being de-husked in modified rice hullers, followed by polishing and size grading. The quality of finished clean coffee is not as good as it could be. Although many of the current difficulty lies in the poor quality of cherry as delivered by farmers, much can be done to improve the milling process by replacing and renovating key components. This is the essence of the current opportunity.

Under present conditions, the modified East German rice-hulling machines from Fortschritt do not work as well as specialised equipment. The final grader, which is not working properly, is only able to separate clean coffee into two categories. Both locally-produced Robusta and Arabica beans are delivered mixed to the mill and most coffee is exported as a mixed UG (ie, 'ungraded'), the greater part without any hand sorting of black beans and other defectives. As a consequence the coffee does not achieve good export prices, and only a small quantity of Arabica is marketed at the higher prices that this can currently command.

It is therefore proposed to upgrade and improve the milling operations by replacing the hulling machines, renovating the grader, and installing catadors to further refine the grader and selection process. It is felt that both the level of investment, as well as its basic nature, fit well with current internationally-funded activities to increase value added from coffee production and processing in southern Lao.

Marketing and Demand for Product

There are two separate markets for Lao coffee – the domestic and the export. A detailed description of these is given in the paper contained in Annex VII – the Potential Opportunity Investment Pack for this opportunity study. The improvement in coffee through grading and milling would be designed to meet the needs of the export market, as the local market will only marginally be able to absorb any quality improvement.

South-East Asian coffees compete with East African alternatives, and are generally regarded as inferior to the latter. The current export prices obtained for Lao coffee (say around US$ 800 per Ton FOB Savannakhet for UG) seem reasonable on this basis.

It must be remembered that Lao is competing in an extremely competitive world environment, in circumstances of increasing production (especially of Robusta, eg from Vietnam) and with the recent collapse of the International Coffee Agreement to regularise prices and stocks. Nevertheless, the market is essentially quality-driven and increases in quality will be associated with corresponding increases in price. It is impossible to say at present to what extent the quality improvement opportunity might actually succeed, and for the purpose of the financial analysis different quality/price scenarios have been modelled. Both supply and demand elasticities for coffee are historically low over the long term, but demand increases in recent years have come from the US, Japan and Korea, and Western and Eastern Europe.

It is suggested in the Annex that a series of export descriptions be developed for Lao coffee which is to be traded. Five Robusta and three Arabica grades should be sufficient, with appropriate differentials from a reference price in each case.

Supply of Raw Materials

Coffee has been grown in the Pakxong district of the Bolovens Plateau in Southern Laos for many years (since colonial times in fact), and production is currently a little over 5,000 tonnes per annum of clean coffee. A UNDP programme is currently aiming to improve both the quantity and quality of dried cherry being supplied to the mill and total production is forecast to reach between 10,000 tonnes and 14,000 tonnes by 1996. Detailed projections (including by Province) are given in Annex VII. About 85% of the crop is Robusta coffee and 15% is Arabica coffee.

Currently there are many problems associated with the quality of dried cherry being supplied for processing as farmers generally only pick once in a season, followed by drying on the ground. As a result of the activities by resident World Bank specialists in the areas of agronomy and extension, some farmers are now picking three times and drying on tables. Notwithstanding this, much of the sun-dried cherry has a high moisture content and is mixed Robusta and Arabica, containing stones and soil, and beans which are a mixture of ripe, over-ripe and under-ripe. By means of education and price incentives, it is planned under current projects to encourage farmers to improve harvesting methods and upgrade village hulling operations to achieve gradual improvements in dried cherry quality.

The immediate requirement is to ensure that the mill is equipped with appropriate machinery to cope with the expected flow and different qualities of coffee inputs. No early expansion in capacity is proposed, and the present need is to secure improvements in milling and grading to generate better prices and an increased income for both the mill and farmers.

Location and site

The investment is to be in equipment for the existing coffee mill in Pakxong operated by the Coffee Company of Pakxong.

Project Engineering

The broad purpose of the investment is to improve the crucial milling and grading operations to enable a variety of grades to be produced which will satisfy the needs of both the domestic and export markets. The improved grades and classification have been described in some detail in Annex VII, and referred to in the marketing section of this opportunity study. Improvements will require effective size grading in a renovated grader and density classification in new catadors.

The first step is to improve hulling performance by replacing the two existing Fortschritt mills with specialised equipment. The objective of this machine is to remove the cherry case and inner parchment leaving the coffee bean, known as clean coffee. This operation is also known as pelling or shelling.

A huller is basically a tube with a helical screw along its length. The material is fed in at one end, friction crushes the cherry and parchment, leaving the clean coffee. Control of friction is adjusted by gates at the discharge end of the tube which increase or reduce the mass of coffee in the screw funnel.

The next step is to renovate the existing Fortschritt grading equipment to allow at least three screen sizes of clean coffee to be achieved, ie 'above 18 screen', 'screen 15 to screen 18', and 'screen 12 to screen 15'. The grader consists essentially of a series of perforated trays with different sized holes and slots, with the largest size uppermost. The trays are set on a vibrating table and material fed in at the top gradually filters down and is discharged according to size from each screen. It should be possible to separate Arabica from Robusta as usually the round shape of the Robusta filters through the coffee mass.

The final stage of sorting is by means of catadors which separate clean coffee by density into weight categories. There are two basic types. The vertical type has a rising air current in which heavy objects fall and lighter objects are blown up and separated by means of funnels. Dust goes with the airflow. The horizontal type consists of a perforated tray set on an inclined vibrator with a bottom airflow. Light material is pushed to the outer edge while heavier material finds its lower level. Control is by flow boards at the end of the tray.

The mill does not use catadors at the present time and the investment proposal envisages the supply of three machines to secure the optimum grading for the forecast market profile.

The total cost of the foregoing renovation and equipment supply programme is estimated to be in the region of US$ 120,000, including delivery and installation. Information on suitable equipment suppliers is listed in the 'Potential Investment Opportunity Pack', but coffee milling and grading is a complex process and a detailed technical and marketing survey will be needed to assess the exact requirements.

Manpower and Management

It is envisaged that the existing management of the company will continue but there may be a need for a slight increase in the existing level of 27 operational staff as a result of the more complex grading operations. It is also envisaged that substantial on-site training will be required by a resident specialist following installation.

Project Scheduling

A period of 12 to 18 months will be required to include a detailed study of existing operations, preferably during the operating season, followed by equipment specification, quotation, supply and installation. A parallel assessment of repairs necessary to the grading machine will have to be carried out followed by the visit of a suitably qualified engineer from the suppliers.

Financial Analysis

Various uncertainties surround the financial and economic analysis of this opportunity. Although the investment costs for the proposed machinery are fairly easy to estimate (84 million Kip) and no problems should be encountered installing it in the existing mill, the only experience of operating costs in such an environment (ie, the Bolovens Plateau) are those obtained from the mill itself. Thus, the necessary 30 or so staff are assumed to currently earn Kip 25,000 per month (based on the recently adjusted minimum rates), and diesel costs Kip 350 per litre (20 litres are needed per hour.) Operating costs are therefore the sum of these at 84 million Kip, the basis for this figure is outlined below.

Of more importance, however, is the doubt which surrounds the achievement of better prices from better grades, which in turn is based on both quantity and quality improvements from smallholder farmers. Thus, a direct relationship exists between the final outcome of the project in terms of profitability on the one hand, and both the absolute price obtained for improved grades (as well as the proportion of final FOB price paid to the farmers) on the other.

The financial analysis summarised in the following table therefore assumes the following simplified factors: investment, labour and diesel costs are as already described; the mill works 150 eight-hour days per year, processing its full capacity of 3,000 tonnes of beans; of these beans, the improved grading and sorting means that 10% of throughput is now sold as Arabica; improved quality and grading achieves price increases of US$ 20 and US$ 30 per Ton for Robusta and Arabica respectively. No difference is assumed to occur in the proportion of FOB prices which the farmers receive. On this basis a rate of return of nearly 17% could be expected.

Risk and Uncertainty

The project is relatively insensitive to changes in (the relatively modest) investment costs, should identified technology prove to be more expensive than it currently appears; a doubling in costs only reduces the rate of return to 8%. A doubling of operating costs is more serious, sending the rate down to less than 4%. Of more concern to the project is the extent of price increases actually obtained. A price increase of US$ 10 per Ton for both coffees only just realises a positive rate of return. (The converse is of course true for higher prices – a doubling of incremental sales revenue gives a rate of return in excess of 50%, for example.)

It is, therefore, suggested that this exists as a possible investment opportunity if farmers' current quality and quantity of production can be stimulated by better pricing in the next few seasons; but that any further investigative work should be market-led, with the critical determinant of investment decision being the state of the world market for Lao coffee at that time. The extent of doubts about technical and production problems can be assessed from the IBRD Coffee project documents in Annex VII.

Table 1 MEKONG AREA OPPORTUNITY STUDIES

COFFEE AT PAKSONG

Financial Analysis summary (in year of full production)

	(Million Kip)	US$ (000)
Investment cost:	84	119.15
Production cost:		
Operating costs	18	25.53
Depreciation	6	8.51
Interest	5	7.09
Total production costs	28	39.72
Rate of return:		
Sales revenue	44	62.41
Operating cost	18	25.53
Depreciation	6	8.51
Operating profit	20	2.84
Interest (average 11%)	5	7.09
Gross profit pre-tax	16	22.70
Corporate tax (40%)	6	8.51
Net profit	9	12.77
Rate of return (%) =	16.8	16.8
Repayment Period (years) =	4.3	4.3

Notes to table:

1 The format for this economic summary follows the UNIDO guidelines in the pubication ID/206.
2 The rate of return is calculated as the sum of net profit and interest divided by total investment outlay.
3 The repayment period is calculated as total investment outlay divided by the sum of net profit plus interest plus depreciation.
4 For both Thailand and Lao depreciation and interest are calculated at 6.7% and 11% respectively.
5 All opportunity studies assume the equity of the sponsor is 50% and borrowed capital, on which interest is payable, a further 50%.
6 In countries the total of corporate taxes have been estimated at 40%.
7 Exchange rate used US$1.00 = Baht/25/Kip705

ANNEX VII

POTENTIAL INVESTMENT OPPORTUNITY PACK-VII

COFFEE IMPROVEMENT AT PAKSONG

The Production of, and Demand for, Lao Coffee

Coffee drinking is widespread in Lao; in the coffee producing areas all classes of society drink coffee, It also is an important source of foreign exchange, and thus the demand for coffee has both domestic and export elements. This paper summarises the major circumstances of coffee supply in Lao at the present demand, before considering the demand aspects in more detail.

The Production Environment

Lao farmers produced an estimated 7,800 tons of coffee beans in 1988, with most coffee being cultivated in Champasak and Saravane provinces. About 80% of the coffee produced on the Bolovens Plateau (in Champasak) listed reported to be Robusta, 15% Arabica, and the remainder "mixed". Lao traders in Pakse indicated they were exporting an estimated 1,000 tons of Lao coffee to Thailand annually, with significant quantities passing through informal market channels in southern Laos. The GOL also purchased significant quantities of coffee to repay debts owed to the Soviet Union and Eastern European countries under barter agreement.

In 1989 ADB data suggested the following areas of coffee and volumes of production;

Area and Output of Coffee 1989

Province	Area (ha)	Output (tons)
Phongsaly	80	30
Oudomxay	50	11
Luang Prabang	1013	60
Houaphanh	30	10
Xayaburi	11	6
Xieng Khuans	17	3
Khammeane	20	9
Saravan	5629	800
Sekong	2000	483
Champassek	17286	4035
Lao PDR	26132	5437

By 1990 output of coffee had fallen, according to FAO to 5240 tons. Barter agreements now are being terminated (see below), and with firm plan in place to boost output the sector appears about to enter a new era.

Information recently provided to IBRD at provincial level indicated that the total coffee area now exceeds 26,000 hectares, of which about 10% is non bearing. Total annual production is estimated at between 5,400 and 6,000 tons a year.

The present programme of coffee replacement under the Upland Agriculture development Project (UADP) is expected to provide new planting material from 1993 and the first new plantings under this scheme will come into production in 1996. Increased yield from existing coffee is expected to start from 1992 when the extension services being assisted by the scheme are in place.

Coffee Production Projections
(tons)

Yield	1991	1992	1993	1994	1995	1996
Low	5,400	5,440	5,600	6,715	7,100	7,500
Medium	5,400	5,440	6,000	7,500	10,000	10,500
High	5,400	5,440	6,235	8,000	10,635	14,000

These projections assume continued 'low' yields reaching a maximum of 250 kilo/ha (current average for all coffee) by 1995, 'medium' yields assumes yields increasing from an average of 250 kilo/ha to 350kilo/ha by 1995.

UADP projections by Province are set out below;

	1991	1992	1993	1994	1995	1996
Champasak						
Traditional	4,040	4,024	3,840	3,620	3,430	3,255
Project coffee		16	240	910	1,560	2,785
Sub total	4,040	4,040	4,080	4,530	4,990	6,030
Saravanne						
Traditional	950	1,084	1,500	2,110	2,500	2,900
Project coffee		16	185	630	1,560	3,480
Sub-total	950	1,000	1,685	2,740	4,060	6,380
Sekong						
Traditional	400	350	320	280	210	170
Project coffee		50	150	450	1,375	1,460
Sub-total	400	400	470	730	1,585	1,630
Total	5,390	5,440	6,235	8,000	10,635	14,040

The 1992 crop is expected to the same or lower as in 1991 since part of Champassak expects only 25 30% off the normal crop due to unusual weather conditions which have effected flowering and fruit setting.

There are encouraging signs of improvement in the quality of processing at farm and village level. This is most probably as a result of competition from greater private sector involvement in purchasing during the past year. As much as 20% of farmers now do 3 rounds of harvesting instead of only the one round when all cherries (ripe and under-ripe) are picked. Similarly, a small proportion (about 10%) are said to have constructed proper drying tables with bamboo matting (however, the remainder still dry coffee cherry on the ground thus spoiling the quality). All coffee cherry is bagged after only 10-20 days; as a result a large proportion is very much under-dried.

Rough hulling standards at village level are still very poor mainly because cherry is hulled very much under-dried and is put through a standard rice huller instead of a coffee huller. The deterioration of coffee quality starting at farm and village level is therefore still a very serious problem. Three main factors are responsible. Firstly, the present buyers have little understanding of the relation between fully dry cherry (12% MC) and coffee quality. Secondly, there are now 8 officially licensed buyers and exporters on the Bolovens Plateau but as one (the former Coffee Company of Paksong) is pre-eminent there is still very limited competition to stimulate production of fully dried coffee which has been properly hulled. Thirdly, farmers react to the situation by paying minimum attention to harvesting, drying and hulling and endeavour to sell coffee as wet and as heavy as possible.

IBRD reports some encouraging signs in respect of final processing are emerging from liberalising the market. Samples of export coffee seen from private exporters had been sorted to remove black beans, thus considerably improving the quality. IBRD also reported that a small new mill was being built in Saravan which will be equipped with correct hulling and size grading equipment; the Consultant was neither able to confirm this, nor the existence reported earlier of a 'Saravan Coffee Trading Company'.

Many of the old problems besetting coffee processing remain the same. The include the fact that only one mill (Paksong) has size grading equipment, but the grading standards are not rigorous. In addition, the coffee is poorly dried and faded and judging by the high proportion of beans over screen 18 noted by IBRD there is some mixing of robusta and arabica. Also, one mill at four Kilometres from Pakse has some grading equipment which is not used at present. This mill, in common with another small mill in Pakse, cleans coffee by passing it twice through a coffee huller and then bagging it as clean U.G. coffee.

There are about 40-50 other plants (some in Pakse, Saravan, Paksong and Thatheng) which consist of a standard rice huller. The coffee is passed through twice to produce a cleaned U.G. product which is then bagged and exported.

Hence, the majority of coffee is still exported as U.G. and for the greater part without any hand sorting of black beans and other defectives.

Marketing

Poor financial accounting of the coffee trade, and lack of comprehensive statistics on production, trade and export prices clearly constrain development of the coffee subsector. Under the UADP project, technical assistance is to be provided for the establishment of a system to collect and analyze information on coffee production, pricing and marketing, the development of a coffee pricing and marketing strategy more responsive to quota market structures, and a quality improvement program.

Formerly, coffee could only be legally procured at farm level by State and provincial trading companies and licensed traders. Farmgate coffee prices were set through periodic negotiations between the state and provincial trading companies and farmers. All companies, in turn, were obliged to sell a percentage of the coffee they procured the SLIE to fulfil its barter contracts with the Socialist bloc, at prices which were negotiated every five years. Only recently have licenses been issued to private traders, recognising the fact that the coffee has been sold to private traders, mainly for export to countries outside the previous International Coffee Agreement (ICA), and largely through Thailand and Singapore.

GOL has recently applied for membership in the International Coffee Organization (ICO), although the International Coffee Agreement has expired and a new agreement is not expected in the near future.

Where exports are concerned Societe Lao Import Export (SLIE) formerly held a monopoly. Today, it retains responsibility for the former COMECON trade but otherwise is not likely to be very active in the future in the face of growing private sector competition. COMECON barter trade is greatly diminished and could well cease soon. It is now confined to the dwindling offerings of mixed beans (90% Robusta, plus some Arabica) that were acceptable to COMECON. For 1991 only 700 tons will be exported, all to the USSR and all shipped via Vietnam.

SLIE now claims to export mainly to Singapore (its 1991 overall sales target is 2000 t of which 1300 t has been exported and 500 t is in store ready for dispatch). Exports are ungraded Robusta (ungraded by SLIE, that is, whose role in that area is confined to repacking into 60 or 80 kilo jute bags to meet buyers' needs. These currently command a FOB (Savannakhet) price of US$ 765 per ton. SLIE purchases coffee from individual farmers, dealers or farm collectives at the equivalent of US$ 700-720 per ton. Mixed coffee fetches about 10% less). It is understood that for 1991/92 SLIE, having effectively wound down the former barter trade (in the face of dwindling buyer invest and dwindling availability of mixed coffee), will focus its buying activity upon those farmer that still have to repay past credit.

SLIE activity also is being affected by the government's desire that licensed buyers provide credit and technical assistance to growers. In neither area is SLIE well-equipped.

Emerging to supplant SLIE as the No 1 buyer is the Societe Lao-USSR Joint Venture (formerly the Coffee Company of Paksong). It operates the former East German mill at Paksong. The joint venture aims to build up sales, exclusively to the USSR, unless world prices dictate otherwise, to 4,000 tpa (or 80% of mill capacity).

For 1991 indicative average prices for robusta are about 330 Kips/kilo at farm gate and 375 Kips/kilo ex village huller, but there is considerable variation depending on the level of competition. The estimated farm gate price allows for 15-18 Kips/kilo rough hulling costs and 4% local agricultural tax. The farm gate price for robusta is therefore estimated at 57% of the FOB price.

The farm gate price for arabica is estimated to be 466 Kips/kilo which is about 63% of the FOB port price.

Export prices for robusta are estimated by IBRD at between 525 Kips/kilo and 615 Kips/kilo the average being 578 Kips/kilo. This is about 20% lower than the comparative Uganda Standard screen 15 robusta (sun dried robusta) which currently sells at the equivalent of 725 Kips/kilo. The arabica selling price is estimated at 738 Kips/kilo. This is about 57% of the potential price for arabica which has been pulped and washed at farm level which at present sells at the equivalent of 1,300 Kips/kilo.

In summary, robusta coffee achieves only 80% and arabica only 57% of the price potentially obtainable for properly processed coffee. This is the fundamental rationale for the opportunity to improve the grading and packaging of coffee from southern Lao.

Coffee (roasted beans in powder farm) retails on the domestic market (Pakse) at 1000 Kips/kilo If purchased direct from the roaster a price of 900 Kip applies. Roasters in southern Lao pay about 500 Kips/kilo for 50-70 kilo sacks of green beans (in Vientiane the cost is higher, by 30 Kip, to reflect transport costs.

The Nature of Demand

Two totally separate markets (domestic and export) exist for Lao coffee. The former tends to be neglected since the undoubted long-term potential lies in the foreign exchange earning potential of the sector.

Nonetheless, at present around one third of output is destined for local consumption, most of which passes through small roasters who create a coarsely powdered, over-roasted product (to which sugar, rum and/or sesame seed may be added to meet local tastes).

Until recently most coffee consumed in Vientiane (the focus of consumption, although per capita consumption in coffee growing areas matches that of the capital) was roasted en masse by a large state-owned roaster there. . owever, its output was inefficient leading to poorly packaged stale, coagulated powder. Now Vientiane, as elsewhere, is served by an array of small scale roasters (10-20 tpa) of which Pakse alone has 20. These roasters offer freshly roasted coffee to callers and/or restaurants and retail outlets.

Laotians are also beginning to acquire a taste for Nescafe imported from Thailand. Although the level of this demand is small, growth can be expected if incomes rise. Official trade figures are shown below;

Exports by Thailand to Lao of Instant Coffee

Year	Volume (kilos)	Value (baht)
1990	244	81,203
1991 (Jan-Jun)	750	298,278

There also exists an as yet untapped niche market within Lao, the 'gift wrapped' sale of small premium-priced packs of beans (green or roasted) or ground coffee. This market will emerge once tourism expands (but only given a concomitant advance in bean/roasting quality - though the unique flavour of the latter may still be a selling point). This market will never be large but could be augmented by an equally small volume of exports aimed at supplies to the delicatessen and gourmet foods trade.

Market Trends

Rising disposable income levels are unlikely to significantly increase domestic coffee consumption. Indeed, local coffee's share of the market is likely to diminish (even after allowing for population growth) as instant coffee comes with the reach of more consumers.

Rising quality standards for green beans should significantly enhance the marketability of exports. This is essential, bearing in mind the projected developments in the world coffee market.

Worldwide consumption of coffee has been expanding fairly steadily throughout the 1980s although the pattern of growth has been mixed. Among ICO member countries, disappearance (the ICO's proxy for consumption) seems to have responded current low prices and to have grown (by perhaps 2.3 per cent in 1989) much higher than the 1.3 per cent averaged for the past ten years.

Consumption of coffee in North America, which is still the most important single market, accounting for approximately 26 per cent of world consumption, is beginning to show signs of revival after stagnating throughout the 1980s.

Demand in the late 1980s continued to grow strongly in Japan and in parts of Western Europe (most notably in- Austria, Spain and West Germany), and also in some non-ICO member countries such as Chile. Growth had also been experienced in some of the countries of Eastern Europe but it was not widespread and far from uniform.

Given the low price of green beans, consumption could have been expected to grow even more rapidly than it has but, in most consuming countries, retail prices have not fallen in line with green coffee prices and in many countries have hardly fallen at all. Many roasters have, however, taken the opportunity to upgrade the quality of their blends. As a result, there has been an increase in roaster demand for arabica, and a corresponding decrease in the demand for robustas.

The above trend is likely to persist for the foreseeable future, though produces are looking to the impending resurrection of the ICO to firm up market prices. A different pattern of demand will evolve in Eastern Europe where hard currency to buy coffee will continue to be in short supply. In these markets price will be the overriding consideration, and robustas and lower quality coffees will be sought.

Trends in both production and consumption since the price collapse in mid-1989 (see below) show that the price elasticity of both supply and demand of coffee is low, at least over the period in question. However, there does seem to be a downtrend on the supply side, at least outside Brazil (where weather conditions can be expected to cause large fluctuations in crops); while in the market, demand remains strong, especially for higher quality arabicas.

Recent Indicative World Coffee Prices

(cents/lb)

	ICO Composite Price (Green Beans)	Ground Roast (USA) (All packs)
1991 (May)	70.3	284.2
1990	71.5	278.5
1989	91.7	296.5
1986	171.0	357.3

It should be noted that Lao was never a member of the ICA, so that ICA market, which imports about 85% of world coffee, has been closed to it. In late 1988, GOL applied for membership of the International Coffee

Organization (ICO). However, in early June 1989, talks among the ICA members on renewal of the Agreement broke down and it was decided that the ICA will be extended until September 1991 without the quota system. This news caused a sharp fall in coffee prices in the quota market. At present, the world coffee market is free which implies that LPDR can export any amount of coffee to what was the quota market.

Demand Forecast

All coffee produced by Laos of exportable quality can be sold, but not necessarily at a profit. Similarly, all other coffee produced can be disposed of within Laos but only because consumer quality expectations are so low.

It follows that each and any improvement in export quality should result in higher price received and, at least initially, in significantly enhanced margins also (reflecting the low initial base on which quality advances are based).

If it is correct to assume that domestic demand in the order of 1500 tpa then it is most unlikely for the foreseeable future to exceed 2,000 tpa no matter what quality advances occur on that front. This total includes any tourism sales, which at best will total only a few tons annually in the foreseeable future (10 tons per year would require 100,000 tourists per year of which on average one in ten person purchased 1 kilo of coffee).

Under such a scenario, exports could rise from less than 4000 tpa to over 12,000 tpa. After although for full realisation of the world price potential, export revenues - at current price-would increase approximately four fold.

Sales and Marketing Strategy

It has been argued that, in order to help Lao to operate effectively on world market, a Lao Coffee Association (LAOCA) be formed. The nature of the proposed LAOCA is detailed at the end of this paper.

From a marketing standpoint such an organization as proposed will add little, in the sense that its benefits will be offset by its costs, the latter centring on inevitable bureaucracy and associated inflexibility.

Basically any LAOCA-type organization should not be imposed upon the sector, thus stifling and not stimulating initiative. Any organization must be generated by the sector, ie. by the private sector participants, who are either forced by market circumstances to take joint action or are stimulated by a realisation of mutual benefits so to do. It then follows that LICA will be financed by the sector as an acceptable expense rather than funded by taxing the sector.

Of much greater commercial merit will be the activities proposed for a coffee marketing specialist (coffee liquorer) under UADP, provided that the individual exporters - not LAOCA as presently envisaged - realise and exploit the sales potential of his work.

In that regard it needs to be stressed that for the internal marketing of coffee the grading/classifying system needs to be basic and simple, otherwise it simply will not be implemented. It is suggested that there should be three grades of robusta based on the number of defects in a sample - black beans, insect damaged, white and faded beans, chips, stones and debris counting as one defect each.

The system of minimum reference prices should be established along the following lines for fully dried, rough hulled robusta

Robusta Rough hulled grade	Minimum reference Price differential
R-10 (10% defects)	100% of reference price
R-20 (20% defects)	80% of reference price
Subgrade (more than 20% defects)	60% of reference price.

Dry processed arabica Rough hulled grade	Minimum reference price differential
A-1 (5% defects)	100% of reference price
A-2 (10% defects)	90% of reference price
Subgrade (more than 10% defects)	60% of reference price

Washed arabica Parchment coffee	Minimum reference price differential
P-1 (5% defects)	100% of reference price
P-2 (10% defects)	90% of reference price
Subgrade (more than 10% defects)	60% of reference price

The external marketing structure will be essentially creating a series of labels and descriptions for the main types of coffee which makes for more efficient marketing. The primary aim would be to present as much clean, hand-sorted coffee free of defectives on the markets which has been size graded and density grades both of which enhance the value. A category for UG (ungraded) robusta should be included since some buyers specifically demand ungraded coffee.

The suggested descriptions for robusta are

Lao grade 1 - above 18 screen, size graded and catadored.
Lao grade 2 - screen 15, below screen 18, graded, catadored
Lao grade 3 - screen 12, below screen 15, graded, catadored
Lao UGR - ungraded but catadored
Lao BHP - brokens and hand pickings, sold locally

The actual prices would depend on market conditions at any time, and on the number of defectives still remaining in the bulk.

Arabica production is essentially 'unwashed', and in the immediate future 3 grades would be adequate for market presentation. These could be

Grade 1	- AA, A, B grades, catadored
Grade 2	- C, PB, E and F grades
Unwashed UG	- catadored only.

The structure and objectives of the Lao Coffee Association are described next. This is followed by terms of reference for a coffee liquorer; together these provide a picture of the needs to be addressed in the future development of the coffee industry in Lao.

Lao Coffee Association (LAOCA)

Structure and objectives:

The LAOCA would be a private sector coffee organisation operating under three basic principles:

1. Composition: An institution owned and operated by those participating in the coffee industry.

2. Functions: Its function would be that of developing, promoting and regulating the coffee industry.

3. Financial Status: LAOCA would be financially independent.

Composition

This would be an association of all those who participate in the coffee industry through which the industry regulates its own affairs within a framework of government development policy. The majority voice would therefore belong to coffee producers, coffee processors and exporters with a minority participation by government. Overall policy of LAOCA would be set by its directors the majority of whom would be elected from among private sector producers, processors and exporters of coffee. The permanent staff structure would be light - not more than 8 senior staff plus secretarial support staff. LAOCA would have its office in Pakse i.e. close to the main producing, processing and exporting activities.

Functions

The major activities would be:

- deciding the strategy and policies for coffee development within the free market system.
- operating the regulatory mechanism to implement policies which had been agreed upon by the association.
- providing know-how to the industry with an emphasis on processing, quality control and marketing.

The objectives and activities for LAOCA would be agreed upon in the first coffee conference to be held. Subsequently there would be an annual coffee conference to agree on the operating policies. The functions of LAOCA would among others cover the following:

- internal pricing and marketing structure. This would be essentially a description of internal quality grades and the corresponding reference price expected to be paid to producers or village processors
- external marketing structure. This would consist essentially of descriptions of the grades and qualities desirable for exporting
- providing a quality control services for internal and exported grades
- maintaining and publishing statistics on production and marketing
- compliance with GOL fiscal policies
- providing part or all of the coffee extension services. If only part of the extension would be covered then this would be primary and final processing aspects
- licensing of coffee buyers/exporters, and ICO matters.

Financial status

This would be based on financial independence. The source of income would be an equitable levy on both internal and external markets. Financial independence will ensure the autonomy which is needed for efficient operation of the services. The levy should at no time be seen as a burden on the coffee industry and would be reviewed and agreed upon annually by the annual coffee conference. As a guideline the coffee levy should be not more than 0.5% - 0.75% of the value at the point of sale. In order not to create disincentives in the industry it may be necessary to reduce the tax rate on coffee production. Normally LAOCA assets would consist of office equipment and vehicles and it would not own or deal in property. Its constitution would exclude it from borrowing other than a limited overdraft facility which would be approved annually. Bearing in mind that the total production in the near future is not likely to exceed 10,000 tons, then in the first 2-3 formative years the staffing and services would have to be limited.

Technical assistance would be necessary for at least two years to set up services such as the Quality Control Service and coffee extension service.

Operation

The overall responsibility for the affairs of LAOCA would be with a Board of Directors who would be elected from within the industry for a determined period. Board meetings would normally be twice a year. Day to day management would be provided by a management unit of permanent staff. The initial structure for the Board should be approved by the first coffee conference would be along the following lines:

	Board Members
Coffee producers (private and village groups)	4
Village primary processors	2
Final processors	1
Coffee buyers and exporters	2
Ministry of Agriculture - Research)	
Ministry of Finance)	
Ministry of Commerce)	4
Central Bank)	
LAOCA manager (co-opted)	1
Total board members	14

LAOCA Management Structure

General Manager

Administration and Finance	Marketing	Quality Control
Coffee levy ICO matters Fiscal matters Statistics	Market intelligence Marketing policy Transport policy Planting policy T A Marketing and liqouring specialist	T A Coffee Engineer Quality Control Service Reference prices Hullery/pulpery design Wet processing technique Extension services
1 x Manager 1 x Assistant	1 x Manager 1 x Assistant	1 x Manager 2 x Assistants
2	2	3

Managerial staff	4
Assistants	4
Secretarial/drivers	4
Total strength	12

Implementation timetable

LAOCA has a central role in a quality improvement programme for Laos coffee and the future development of the industry. The following timetable is suggested.

1991 Hold the first Coffee Conference with delegates drawn in roughly the same proportion as suggested above for the Board. Draw up a constitution for LAOCA; finalise the funding of operations budgets; arrange registration as a legal entity; approach international agencies requesting specialists in processing and quality control who will assist in setting up the LAOCA functions.

1992 Engage the two T.A. specialists; assume licensing responsibility; define internal price structure and external marketing descriptions; establish quality control service; introduce know-how for processing at village level and final processing; establish credit requirements for annual crop financing.

1993 Extend functions to include extension services for processing.

1994 Examine the advantages of a Coffee Auction System for top grades of robusta and arabica. If justified set up a coffee auction system.

Coffee Marketing Specialist: (Coffee liquorer)

Terms of reference and job description

General

The coffee marketing specialist will work within the Lao Coffee Association (LAOCA) and will supervise the setting up of a Quality Control Service for the Lao coffee industry. This will entail establishing appropriate sampling and quality evaluation service at in the main coffee production zone. The marketing specialist will specify the sampling and liquoring and other equipment required for evaluating samples of rough hulled robusta and arabica coffee and export samples of graded coffees. Additional duties will be setting up of appropriate market information service for coffee within LAOCA.

Specific duties and functions

These will include the following

1. Provide specifications for quality assessment equipment including sampling equipment, moisture meters, sample roasters, liquoring accessories and office equipment

2. For internal marketing determine a set of quality standards 2-3 grades) for rough hulled coffee delivered by producers (both arabica and robusta); evolve the policy for determining a corresponding scale of indicator prices and the periodic review of the differential scale thus established

3. Supervise on the job training of Lao national staff for sampling, liquoring and quality assessment and advise on suitable overseas training with the object of creating a fully trained staff for the Quality Control Service

4. Establish procedures whereby the Quality Control Service provides appropriate advice to producers and processors on the correct methods for primary processing of coffee

5. For external marketing advise final processing mills on the appropriate grading and sorting methods to produce acceptable quality grades for export markets and devise a series of appropriate export types and descriptions for Lao coffee as the basis of export certificates.

6. Advise the Lao coffee industry on the most appropriate methods of financing the operating costs of LAOCA.

7. Advise the coffee industry on the introduction of separate quality grades for washed coffees and the possible introduction of an auction system for top quality grades.

Qualifications

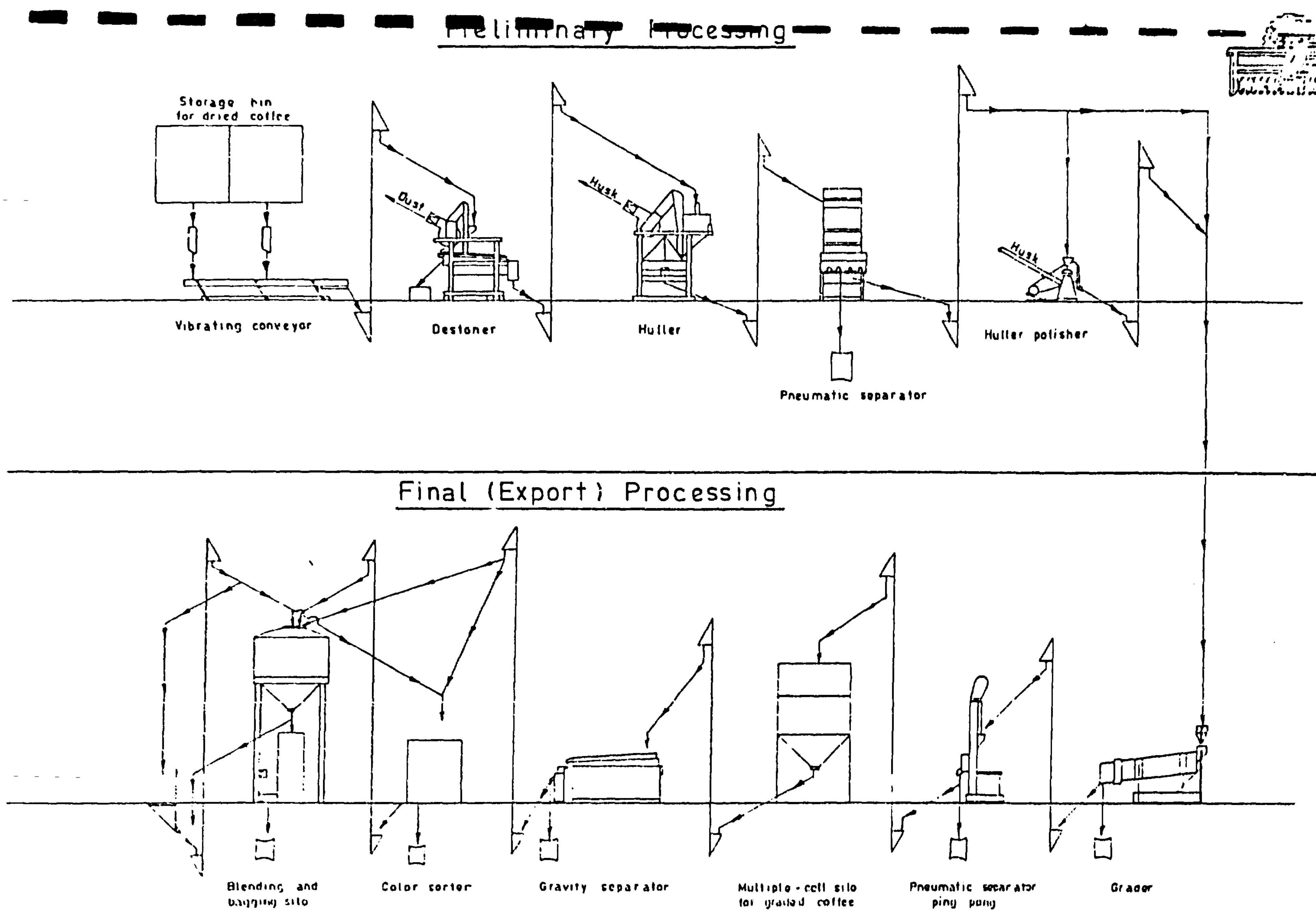
A minimum of seven years experience in coffee sampling, liquoring and quality assessment with preferably some commercial experience in coffee trading and exporting. Should be able to demonstrate an understanding of international markets for robusta and arabica coffees. A good working knowledge of either English or French is required.

Duty Station

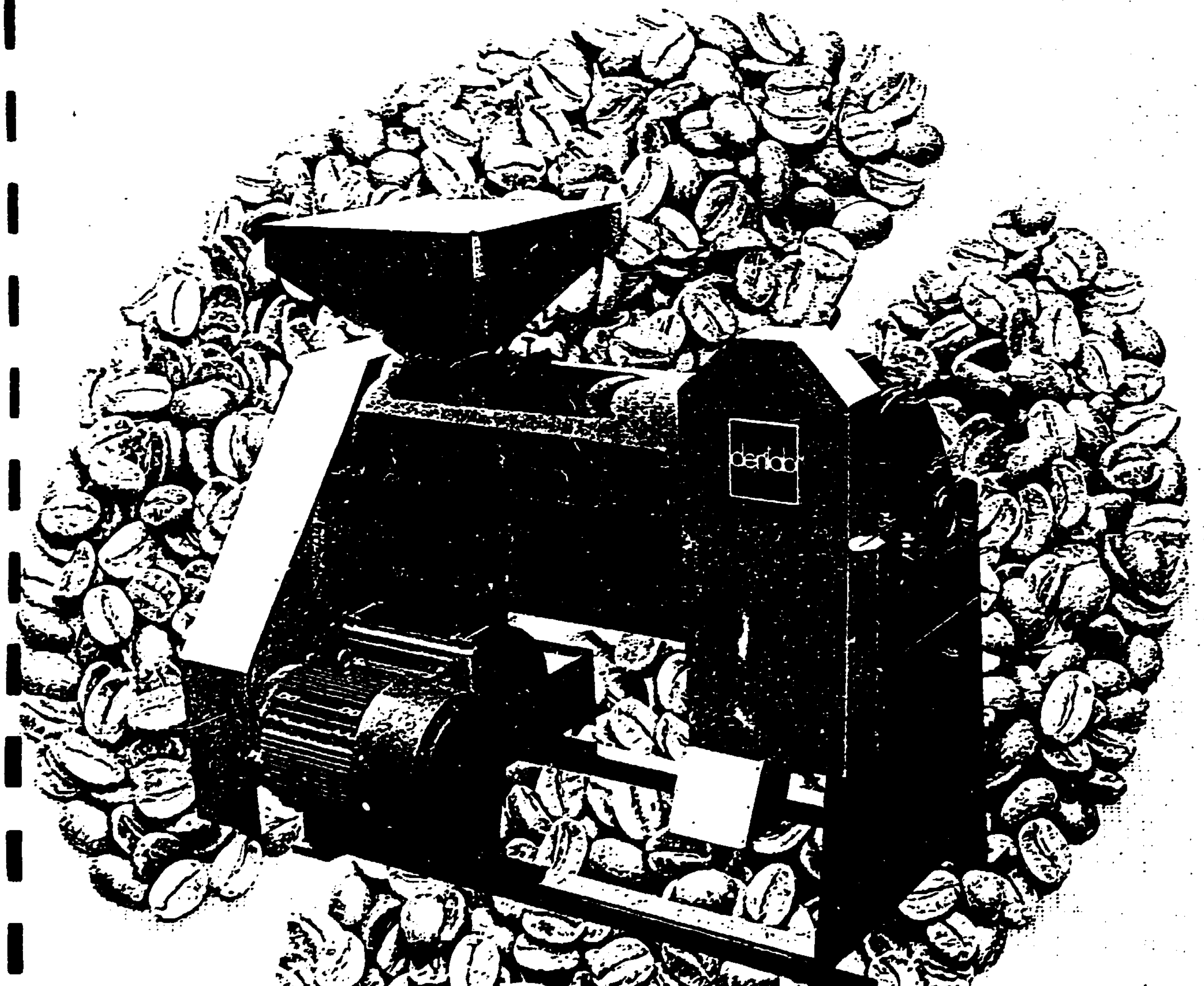
The coffee liquorer would be stationed at Pakse and would be required to travel from time to time in the coffee production zones in Saravanne and Sekong provinces.

Terms of Service

A two year contract with the possibility of renewal.


Preliminary Processing
Storage bin for dried coffee
Vibrating conveyor
Dust
Destoner
Husk
Huller
Pneumatic separator
Husk
Huller polisher
Final (Export) Processing
Blending and bagging silo
Color sorter
Gravity separator
Multiple-cell silo for graded coffee
Pneumatic separator ping pong
Grader

coffee hulling



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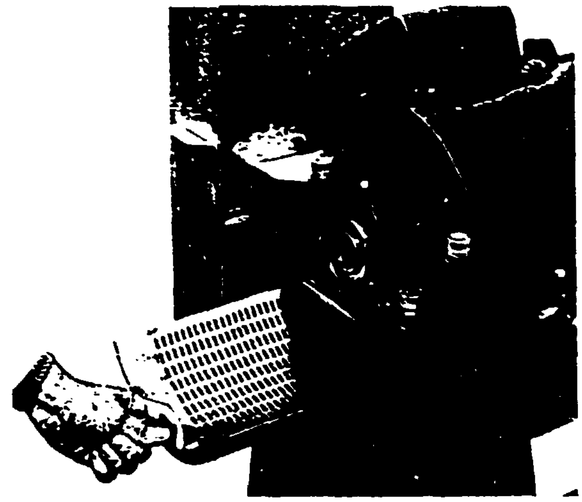
A proven range of Coffee Hullers suitable for the smallholder and large processor alike. Using the most up-to-date manufacturing techniques the AH Hullers are precision made machines, yet still retain their robustness, so essential in meeting the demands of today's world. This combination of precision and robustness offers unparalleled throughputs with quality.

All Hullers are fitted with hulling knives and screen clamps in stainless steel for long life and increased hulling efficiency.

The quick-change screen facility is unique and allows screens to be quickly changed or checked.

Units are available for either electric motor or close coupled diesel engine; additionally the AH-4 Huller can be fitted with a petrol engine, giving the whole range complete versatility. The complete range of machines is also suitable for maize.



Denlab's unique screen changing facility

TECHNICAL SPECIFICATION SHIPPING

MODEL No.	POWER REQ'D. H.P.	SPEED R.P.M.	PARCH-MENT COFFEE kgs	DRY CHERRY COFFEE kgs	BASIC HULLER	HULLER c/w ELECTRIC MOTOR	HULLER c/w DIESEL ENGINE
AH-0	30	432	1800	1200	3.791 m^3 / 800 kgs	3.791 m^3 / 1000 kgs	4.800 m^3 / 1250 kgs
AH-1	15	540	800	540	2.44m^3 / 460 kgs	2.44m^3 / 620 kgs	2.88m^3 / 750 kgs
AH-2	10	552	500	340	1.21m^3 / 390kgs	1.21m^3 / 550kgs	1.6m^3 / 650kgs
AH-4	5	576	210	140	0.665 m^3 / 100 kgs	0.665 m^3 / 155 kgs	0.770 m^3 / 190 kgs

AH–4 Huller petrol model (transportable)

AH–0 Huller with electric drive

denlab

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Telex: 995452 Denlab G Fax: (0621) 857733

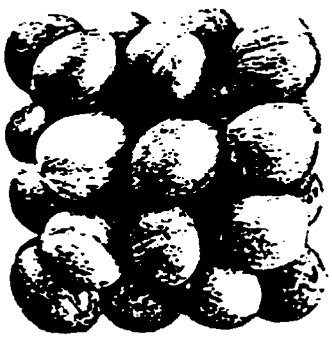
KSE 510

Compact Huller Unit for Dry Cherry Coffee

Groupe Décortiqueur Compact à Café en Cérises Sèches

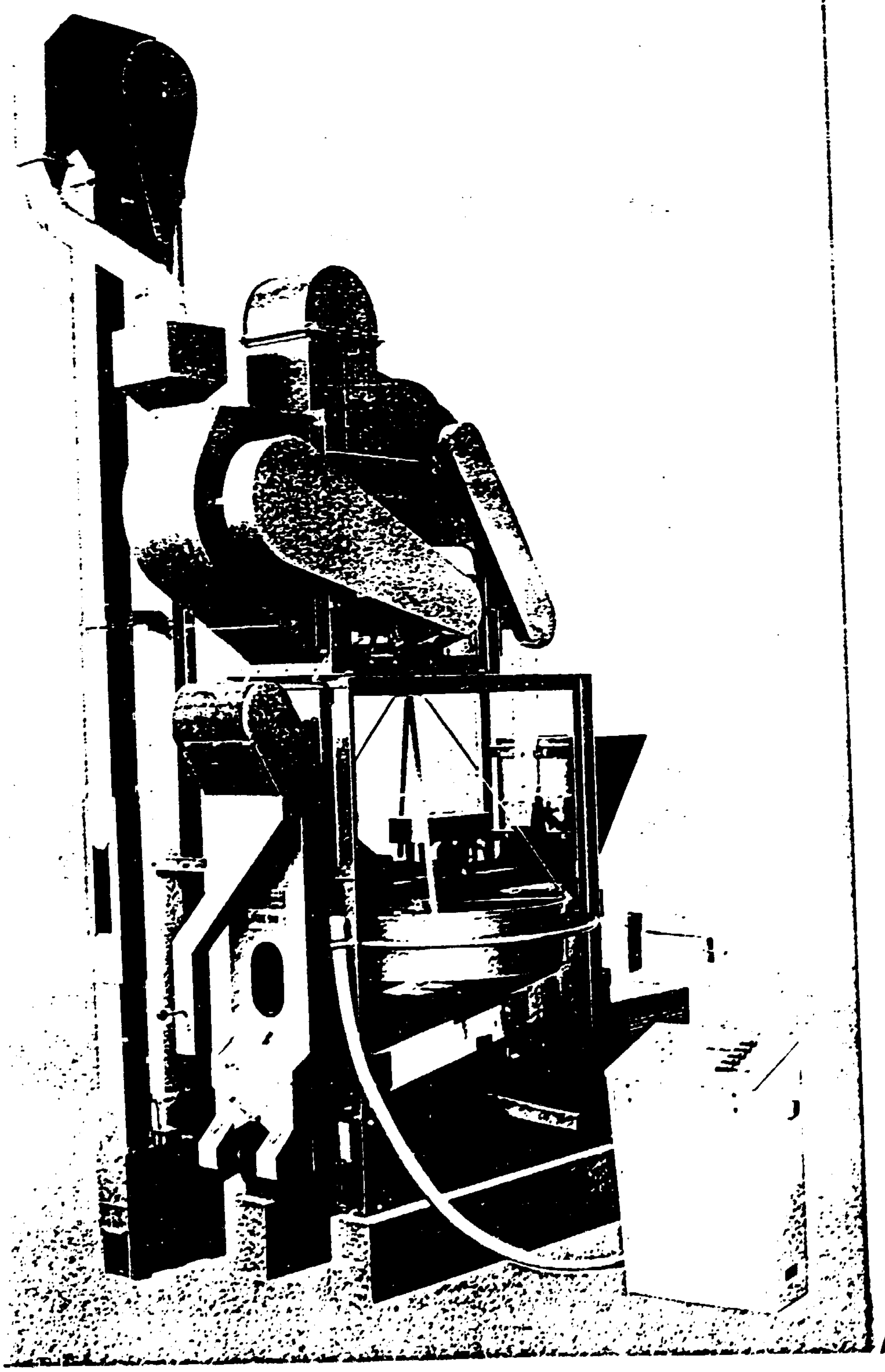
KAACK
Maschinen

Leaflet
Prospectus No. 8638

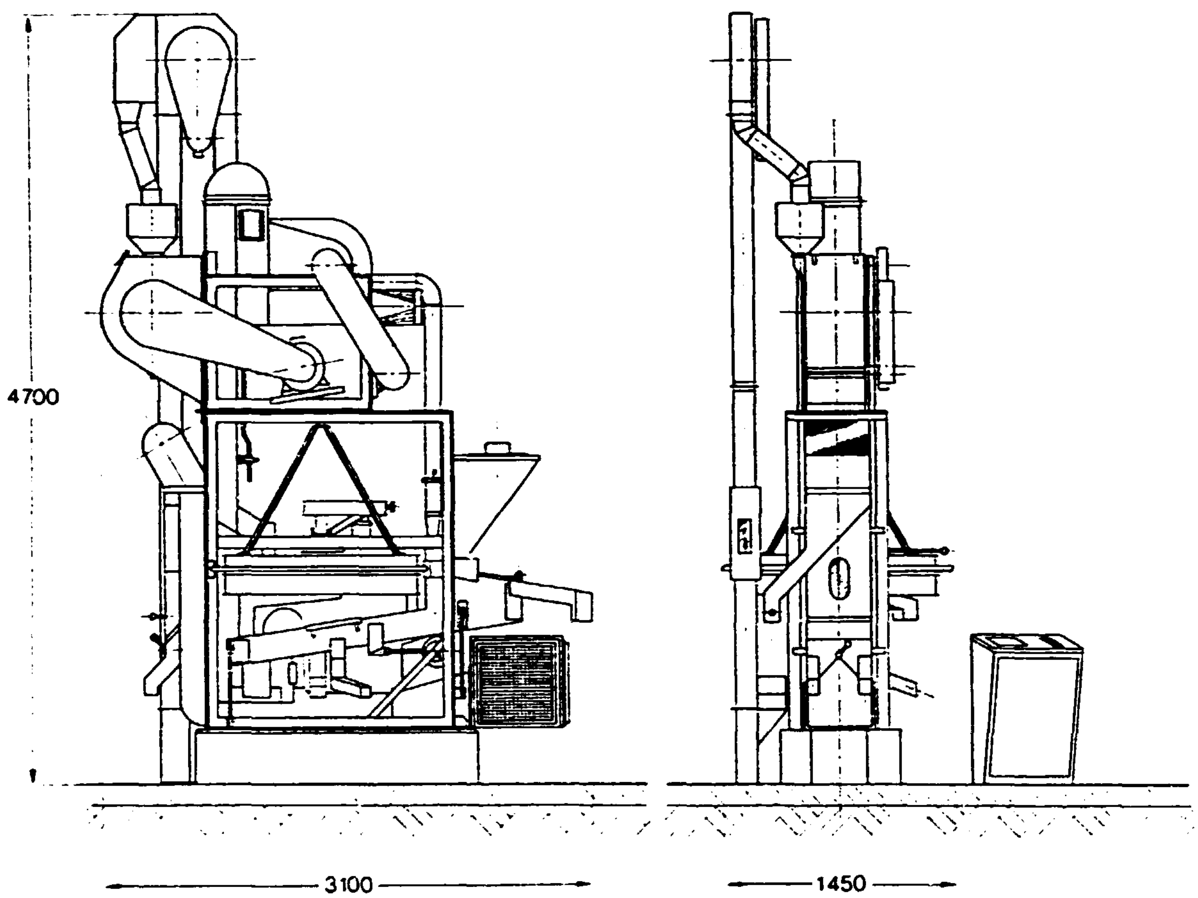


Cherry Coffee
Café en cerises

Hulled Coffee
Café décortiqué/déparcheminé



Technical data	Données Techniques	KSE 510
Output (Hulled coffee, based on perfectly dried cherry coffee)	**Débit** (Café décortiqué, sur base de café en cerises parfaitement séché)	**800-1200 kgs/h**
Power requirement	Puissance requise	10-12 kw
Weight - gross net	Poids - brut - net	1900 kgs 1400 kgs
Shipping space	Cubage	11,5 m³



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KAACK
Maschinen

CURRENCY AS AT 12/01/92

TYPE	AMOUNT	EXCHANGE RATE	GBP
US$	500.00	1.77	282.49
PAK RUPEES	51.00	43.00	1.19
SWEDISH KRONER	10.00	10.47	0.96
DUTCH GUILDERS	30.00	3.22	9.32
SWISS FRANCS	230.00	2.54	90.55
TRINIDAD $	264.00	7.75	34.06
BELGIAN FRANCS	1800.00	59.20	30.41
FRENCH FRANCS	1300.00	9.97	130.39
LUXEMBOURG FRANCS	100.00	58.80	1.70
TANZANIA SHILLINGS	200.00	477.14	0.42

STERLING TOTAL IN SAFE 581.48

TRAVELLERS CHEQUES IN SAFE

NAME	CURRENCY	AMOUNT	RATE	GBP
C KNEE	FFR	200.00	9.76	20.49
D WAYMARK	US$	1000.00	1.82	548.85

TRAVELLERS CHEQUES TOTAL GBP 569.33

TOTAL IN SAFE 1150.81

POTENTIAL INVESTMENT OPPORTUNITY - VIII

SEEDLAC (THAILAND AND LAO)

Introduction

This opportunity study concerns the production of seedlac in Isarn destined ultimately to support the domestic furniture producing market. It draws heavily on work already done by the Forest Products Research Division of the Royal Forestry Department.

Lac is the resinous protection secretion of a lac insect whose scientific name is Lacciffer Lacca Kerr, belonging to the family Lacciferidae; it is also found in India, China, Lao and Burma. The lac insect produces waxy and resinous matter and almost all of the lac is produced by the female after fertilisation. The male produces only small transparent amounts.

Thailand is the second largest lac producing country after India. It is difficult to quote average production as it varies from year to year. Averaged over the last 10 years, production has been around 7,000 tonnes per annum. The highest production was in the year 1974/75 at around 24,000 tonnes. The lowest production was in 1980/81 at about 600 tonnes, due to unfavourable weather conditions. (When the temperature rises over 40°C for more than six continuous days the resinous matter absorbs the heat and the lac insects begin to die.)

Presently there are about 20 lac enterprises in Thailand, almost all of them situated in the north with only one to two industries in the north-eastern area. The north produces nearly 85% of the Thai crop. All lac cultivation in Thailand is done by farmers, with RTG producing only small amounts for lac extension work.

The following sections follow the standard opportunity study format as far as possible, and there is a technical supporting paper in Annex VIII describing the cultivation methods for lac insects and other technical aspects of product manufacture.

Lac and Lac Products in Thailand

The cultivation of the lac insect, and the production of products from it, is a somewhat esoteric process, and not familiar to many potential investors. The following notes explain the various stages in the development of products from the lac insect.

Sticlac is the form in which the lac crop is obtained from trees. The lac encrustation is separated from the twigs either by breaking by hand or by scraping with a knife. Seedlac is the product obtained by washing crushed sticlac with water. Shellac is the product obtained in the form of flakes by stretching the fused resin which has been freed from infusible materials by melting it out. Lac is bleached by the use of hypochlorite solution to produce bleached lac. It is used in colourless polishes and nitrocellulose lacquers.

Normally 80% of lac is exported. About 20% is for domestic use. Normal village uses are various. Firstly, lac dye, which is fast on animal fibres such as wool and silk, is produced and has a bright red colour. Different attractive shades may be obtained by using different mordants. The silk cottage industry in the village uses sticlac for fast dying of silk. Lac must be collected before the insect has swarmed because at this period it contains the whole of the dye. In the years when the price of lac is high, synthetic dye is used instead of lac. Secondly is shellac; the utilisation of shellac in villages is for painting and furniture manufacture. Thailand produces many different grades of shellac, details of which are in the technical Annex.

The treatment of shellac varies with its quality and end use. The utilisation of bleached shellac is the same as shellac. Currently light-coloured furniture is popular in Thailand, and therefore bleached shellac is also well-known.

Lac and lac products have been graded A or B by the Industrial Standard Institute, Thailand, according to the quality of the products. Industrial specifications for each of these products are contained in the technical paper in Annex VIII. The justification for selecting the products by grades depends upon their utilisation. Products which are below grade B are not accepted by the market.

In Thailand, sticlac is not graded by type of host trees. Generally most lac is acceptable for manufacturing if the age of the sticlac is not more than two years. A factory will test the quality of sticlac by breaking by hand and heating it with a flame, then stretching the resin out. If the stretched resin is light yellow, it means that the sticlac is freshly cut; if the colour is dark red, the lac was cut within 1–2 years; if the lac has no resin at all and it burns while heating, it means that lac is too old. The price paid by the market therefore depends primarily on the age of the lac.

It is the production of seedlac intended to support the upper end of the domestic furniture market which the present opportunity study addresses.

Production would be from a seedlac factory supplied by farmers, but with its trees established nearby so as to control throughput volumes as necessary – in effect a spatially-extended 'nucleus-estate' type development.

Market and Demand for Specific Product

Thailand presently exports a large amount of seedlac, having about 20% of the world market. Figures are presented in Annex VIII. It also imports lac in years of low domestic production. It should be noted that, even in recent years of high production, all seedlac available for export was sold.

However, the Thai product is not preferred by major importers in relation to Indian material from Bihar. The Indian product is lighter in colour, and therefore requires less bleaching. This colour difference is a function of the strain of insect and, given that India will not allow export of its strains, the prospects for the Thai industry to change are presently limited. In the major importing countries (USA, UK, other Western European countries) natural polishes are increasingly being replaced by synthetic ones, and long-term world demand for seedlac and shellac will be constrained. For this reason, attention is now turned to the domestic market.

It is felt by the Consultant that the main market opportunity currently exists within the Mekong Basin area in the production of seedlac for the high quality end of the domestic furniture market. This market is still based on relatively cheap labour, and good French polishing with bleached or unbleached shellac retains value added in Thailand. The proposed investment would be for a factory located in Isarn to produce seedlac from local farmers and its own sticlac, for further later transformation elsewhere into shellac.

Historical experience has shown that variations in export prices (as Thailand is essentially a price-taker) translate into production changes by farmers in subsequent seasons, often causing factories to close temporarily. It is hoped that more organised production of seedlac for the domestic market would at least partly moderate this disequilibrium. This organisation requires local processing in the form of an established factory, based on co-ordinated sticlac supplies from smallholder farmers. It also requires forward linkages with shellac producers so that the increased supply of seedlac can be sold, and eventually used in local furniture manufacture.

Supply of Raw Material Inputs

In the north, lac is grown mainly in Chiengmai, Lampang, Lampoon, Phrae, Nan, Chiengrai, Phayao, Uttaradit, Tak and distributed in small amounts in other provinces in the north. In Isarn lac is grown in Mahasarakam, Khonkaen, Loei, Udon Thani, Sakhon Nakhon, Kalasin, Roi Et, Yasothon, Srisaket, Burirum, Surin, Nakhon Ratchasima and Ubon Ratchathani province. Generally it is scattered in all directions and in small amounts and, therefore, it takes time for collecting the raw materials and for transportation. Estimates of production by area are shown in Annex VIII, as are the types of trees from which the insect is extracted.

Sticlac supplies are also from Lao, and it is felt that this opportunity could facilitate increased cross-border trade and benefit small-scale Lao farmers. Lao has the advantage that many of its forest areas are particularly suitable for lac cultivation; these have disappeared from much of Thailand. In time Lao may develop a competitive advantage in sticlac production, and could justify the sort of investment which this study currently proposes for north-east Thailand.

Presently there are two ways of obtaining raw materials. Either the factory buys sticlac through commission agents or from the wholesalers (generally appointed from minor forest-products sellers in urban areas). The seedlac factory in Isarn currently obtains sticlac from a variety of producing Changwats, usually by trucks of about 13-tonnes capacity.

Approximate Location and Site

Lac cultivation and a factory for processing could be based almost anywhere in Isarn. The high value-to-weight ratio of sticlac means transportation is not a major cost in the value of the final product. Lac cultivation has the advantage of improving farmers' incomes, and in encouraging the use of trees rather than in deforestation. Land prices and proximity to potential supplies from Lao also suggest Isarn as being a better bet for investment. Drainage considerations would be a factor in minimising environmental damage.

Project Engineering

The plant capacity of a seedlac shop suggested below is based on a raw lac supply of 1,200 tonnes. Production would be aimed at 6 tonnes/day, with a daily working of one or two shifts for 150 days a year.

The plant would need a water supply of not less than 15,000 litres/day, plus a pool for water treatment, a power supply and a site of at least half a hectare.

Investment and capital costs for the seedlac factory are summarised below in the financial analysis, and shown in more detail in the technical Annex.

Sticlac is stored in a seedlac shop in a cool ventilated room. Within four months the sticlac must be processed into seedlac. (Any longer than this and the lac will be blocked, have a high percentage of insoluble matter, and the colour will turn darker.) Seedlac is stored on a clean floor, air dried and out of sunlight. It may be raked over and put in a container just before it is sold.

Details regarding the conversion process from sticlac to seedlac, and on to shellac and bleached shellac are given in Annex VIII.

The equipment needed in this process is the following:

- cracking machines
- screening machine
- storage bins
- washing machines
- drying kilns
- boiler and separating blowers

All of this equipment is available in Thailand.

There are no unusual or excessive environmental implications over and above those of food processing of processing sticlac, providing that drainage of the water used in the washing process is constructed properly. All that can be said at this stage is that this aspect must be borne in mind when considering investment at any particular location in Isarn.

Manpower and Management

Based on experience from existing factories, the following personnel would be needed:

1 manager
5 administrative/clerical staff
40 labourers

Project Scheduling

The construction period for the seedlac factory would be of the order of six months, plus a further three months for machinery delivery, installation and testing.

The construction of the factory should only be undertaken after a widespread extension effort to encourage the production of a sufficient volume of sticlac by small farmers. Demonstration of technology, possible groupings of farmers, and agreed pricing, should all be part of this package.

Financial Analysis

The financial analysis which follows is based on the detailed costs provided to the Consultant by the Royal Forestry Department, and included in Annex VIII. The table below uses this data in the UNIDO format to calculate a rate of return and payback period.

The investment cost in buildings, infrastructure (including own trees) and instruments is Baht 7.8 million. Operating costs total Baht 4.12 per annum, or Baht 6.86 per Kilo of seedlac, not including sticlac purchases. It is assumed the factory buys 1,200 tonnes of sticlac per year at Baht 25/Kilo, and turns this into seedlac at a rate of 2:1. The base case shown below assumes the factory sells all its output at costs plus 10%.

On this basis the rate of return is estimated at nearly 13%, and the repayment period is approximately five years.

Economic benefits accrue to Thailand in the form of extra supply of seedlac for the local furniture industry (offsetting some previous synthetic imports, against which must be set the export earnings foregone of course), increased rural incomes and general increased stability for the lac industry in Isarn. Benefits also accrue in the form of extra tree usage, and less cutting down of forests.

Risk and Uncertainty

The investment is relatively impervious to changes in investment costs; a doubling of costs still gives a rate of return of more than 5%. The margin obtained for seedlac over raw material costs and operating costs is critical, however; a 5% margin renders the investment unprofitable, a 20% margin gives a rate of return of nearly 40%. The management of the factory to ensure a 2:1 conversion rate is therefore essential, as is the agreeing of seedlac prices with purchasers in advance.

Environmental risks exist if the factory site is not properly located for drainage purposes.

Table 1

MEKONG AREA OPPORTUNITY STUDIES

SEEDLAC IN ISARN

Financial Analysis summary (in year of full production)

	(000 Baht)	US$ (000)
Investment cost:	7800	312
Production cost:		
Operating costs	35624	1425
Depreciation	523	21
Interest	429	17
Total production costs	36576	1463
Rate of return:		
Sales revenue	37530	1501
Operating cost	35624	1425
Depreciation	523	21
Operating profit	1383	55
Interest (average 11%)	429	17
Gross profit pre-tax	954	38
Corporate tax (40%)	382	15
Net profit	573	22
Rate of return (%) =	12.8	12.8
Repayment Period (years) =	5.1	5.1

Notes to table:

1. The format for this economic summary follows the UNIDO guidelines in the pubication ID/206.
2. The rate of return is calculated as the sum of net profit and interest divided by total investment outlay.
3. The repayment period is calculated as total investment outlay divided by the sum of net profit plus interest plus depreciation.
4. For both Thailand and Lao depreciation and interest are calculated at 6.7% and 11% respectively.
5. All opportunity studies assume the equity of the sponsor is 50% and borrowed capital, on which interest is payable, a further 50%.
6. In countries the total of corporate taxes have been estimated at 40%.
7. Exchange rate used US$1.00 = Baht25/Kip705

ANNEX VIII

POTENTIAL INVESTMENT OPPORTUNITY PACK-VIII

STICLAC CULTIVATION, LAC PRODUCT PROCESSING AND MARKETING

This Annex provides technical material referred to, but not included in, the opportunity study on seedlac production from sticlac in Isarn.

It begins with a summary of the method of lac cultivation in Thailand, details the range of products which are produced, describes the method of production, provides estimates of factory costs, and concludes with some figures regarding production in different areas and exports and imports of lac products in recent years.

Lac Cultivation in Thailand

Collecting season: normally there are two broods of lac in a year, that is May - June and November - December. The lac is, however, cropped only once in a year (during September - December) and sold to the manufacturer.

Host trees of lac insects: there are a large number of trees and shrubs which are the hosts of the lac insect. The major lac host tree in Thailand is the rain tree (Samania Saman Merr). Other suitable lac host trees are:

1. Zigyphus Mauretiana Lank
2. Albizzia Lucida Benth
3. Combretum quadragulare Kurz
4. Acacia decurreus Willd
5. Ficus sp.

Cultivation, collecting and storage: the lac host trees should be pruned in advance 1 - 2 years before inoculation with the brood lac. The brood lac to be used for the infection of the new trees should be healthy and non-pest infected. The brood lac selected should then be cut into a length of about six inches and tied with string at the end of the twig and covered with a straw basket. Brood lac should be tied on the tree longitudinally, vertically or laterally as near as possible to the branch to which the young are to settle. This should be left on the trees about one week, then moved to another branch. The brood lac should be left on the tree no longer than three weeks, to avoid over-infection. The lac insect will complete its generation within six months, at which point the lac can be cropped or left on the tree for self infection six months more and cropped when it matures. The rotation of the trees should be three years.

Appropriate methods for collecting lac: lac is cropped from trees both for use as brood and for use in industry. The method of collecting is different and depends on the purpose. For use as brood, lac should be left on the tree until the lac is ready to swarm. It is very harmful to cut the lac before or after it matures. Premature cutting of the lac is very harmful because the female insects are cut off from their food supply and the female becomes weak. Late cutting is also harmful because the young larvae will be lost before the lac is cut. The most appropriate method for cutting brood lac is by examination of the orange yellow spot area of the female lac cell. With the appearance of cracks in the encrustation, the encrustation can be pulled off from the host twig with ease. For selling for industrial uses, lack should be cut just a short time before swarming is due to occur.

Precautions to be observed in collection and storage: after lac is cut, it should be scraped from the twig as soon as possible by means of knives. To avoid blocking, lac should be spread on a clean floor, air dried and away from direct sunlight. The lac may be spread in layers about four inches deep to prevent it from sticking together when freshly cut. The lac may be raked over once a day until it is dry, then raked once in three to four days. If the lac is already blocked, it should be broken at once. The blocky lac makes processing difficult and the lac also loses chemical and physical properties and the price goes down. Lac should be stored in a cool and ventilated room and should be fumigated by carbon bi-sulphide against insect attack. Lac can deteriorate in storage, particularly in hot areas, and should be sold as soon as possible after manufacture. If it needs to be stored, the lac in the container should be frequently turned upside down.

Lac Products and Specifications

Sticlac is the form in which the lac crop is obtained from trees. The lac encrustation is separated from the twigs either by breaking by hand or by scraping with a knife. Seedlac is the product obtained by washing crushed sticlac with water. Shellac is the product is obtained in the form of flakes by stretching the fused resin which has been freed from infusible materials by melting it out. Lac is bleached by the use of hypochlorite solution to produce bleached lac. It is used in colourless polishes and nitrocellulose lacquers.

Specifications for these products are as follows:

Table 1 **Seedlac**

Specification	Standard Value	
	Grade A	Grade B
1. Hot alcohol insoluble impurity not more than (%)	3.0	3.0
2. Ash not more than (%)	1.0	1.0
3. Water soluble matter not more than (%)	1.0	1.0
4. Moisture content not more than (%)	2.0	2.0
5. Bleached ability not more than	125.0	145.0*
6. Life not less than (minutes)	30.0	25.0

* cm^3

Shellac

Specification	Standard Value
1. Hot alcohol insoluble impurity not more than (%)	1.0
2. Ash not more than (%)	0.5
3. Water soluble matter not more than (%)	1.0
4. Moisture content not more than (%)	2.0
5. Life not less than (minutes)	20.0
6. Wax not more than (%)	5.5
7. Rosin	none
8. Copal	none
9. Flow test not less than (mm)	35.0

Bleached Shellac

Specification	Standard Value	
	Regular	Refined
1. Hot alcohol insoluble impurity not more than (%)	1.0	0.2
2. Ash not more than (%)	1.0	0.5
3. Water soluble matter not more than (%)	1.0	0.3
4. Moisture content not more than (%)	5.0	6.0
5. Wax not more than	5.5	0.2
6. Rosin	none	none
7. Copal	none	none

Methods of Production

After scraping lac from the twig, dust and stick should be collected by hand. Then the sticlac is twice crushed by the lac crusher. The sticlac is now ready for the washing process by washing machine. The washed lac is dried by drying machine. Lac can be washed with plain water or soda ash can be added to make it clearer. The removal of particles such as dust and small leaves by separating blower takes place, leaving seedlac ready for packing.

Seedlac is converted to shellac by a steaming process. Seedlac is put in a sieve, and under the sieve is a tray into which the shellac will pass after melting by a steaming process of about 40 - 50 lb/sq.inch of pressure for 1.5 hours. This material is called shellac. After removing the hot shellac tray from the steaming process, the tray is placed in water and the shellac is pulled off the shellac tray. 'False shellac' can be made by heating shellac over a fire (if a yellow colour is needed it is mixed with a yellow arsenic sulphide). The molten shellac is transferred through the cooling rollers of the sheeter and passed along a belt conveyor to obtain a sheet of shellac. The shellac is dried by air heater, broken into small chips and kept in an air conditioned room at a temperature of 10° - 20°C. For cheaper shellac, sticlac or kiri (residue from pure shellac) mixed with seedlac instead of pure seedlac can be used.

For bleached shellac (the subject of the opportunity study) seedlac should be dissolved in a hot solution of soda ash at a temperature of 70° - 80°C and boiled for about one hour. After all the lac is dissolved, the lac solution is filtered through a nylon cloth in order to remove the impurities and allowed to cool. The bleach liquor is added until the lac solution is fairly well bleached. The dilute sulphuric acid is slowly added to the solution until neutral. Some bleached shellac is in a fine granular size then it is filtered through a muslin bag and thoroughly washed in cold water. The precipitated bleached shellac is squeezed out, dried and crushed into powder and kept in a cool place.

Efficiency of the Process

In the factory the conversion efficiency of the processing just described is as below:

From sticlac to seedlac:	100 : 50
From seedlac to shellac:	100 : 80
From seedlac to bleached shellac:	100 : 90

Cost of Production

The following are estimates of costs of production from the beginning of cultivation of sticlac on-farm to the transformation into the finished product. They are based on data presented by the Royal Forestry Department to the Consultant; they have been summarised in the opportunity study and form the basis of the financial analysis following the UNIDO format.

Unit production costs of sticlac (based on a lac host tree, Samania Saman Merr., in 1 Rai at about 16 trees per Rai) are estimated as follows.

(i) 2/3 brood lac cost:

Brood lac is used at 80kilos/Rai. After the inoculation brood lac can be sold as sticlac recovering 1/3 brood lac cost. Brood lac is assumed to be 25 Baht/kilo, and therefore 2/3 brood lac cost = 2/3 (80 x 25) = 1,333 Baht

ii) Labour cost

Labour involves selection of brood lac, covering with a basket, tying of brood moving brood lac from tree to tree; say 8 men x 3 days x 60 Baht = 1440 Baht/Rai. Weeding twice per year; say 4 men x 4 days x 60 Baht = 960 Baht/Rai. Cropping; say 8 men x 1 day x 60 Baht = 480 Baht/Rai. Total Labour cost is thus 2,880 Baht/Rai

iii) Yield = 320 kilos/rai

Therefore unit production costs are:

- If the farmers have to buy rood lac:
  Unit production cost:
  1,333 + 2,880 divided by 320 = 13.16 Baht/kilo

- If the farmers have their own brood lac (either from their own farm or from RTG):
  Unit production cost:
  2,880 divided by 320 = 9.00 Baht/kilo

Unit production cost of seedlac from sticlac is estimated as follows:

Personnel Requirements:

Seedlac shop:	Administration:	1
	Staff:	5
	Workers (temporary):	40

Investment Cost of Mill Production:

Seedlac factory (based on raw lac 1,200 metric tonnes)

Instruments:	5,8000,000 Baht
Building and infrastructure:	2,000,000 Baht

Mill capacity

Production target:	6 metric tonnes/day
Daily working shift:	2-3 shifts
Yearly working day:	150 days.

Operating Costs

The following production cost is based on seedlac production of about 600 metric tonnes/year. Normal working is 2 - 3 shifts, depending on raw materials supply. The production cost of seedlac is:

Fuel for boiler

1 day cost	1,200 Baht
50 days cost	60,000 Baht
Total:	61,200 Baht

Chemicals
Sticlac 1,500 kilos use soda ash 5 kilo
Soda ash 1 kilo cost 18.00 Baht
Chemicals cost 4,000 kilo x Baht = 72,000 Baht.

10% depreciation cost of instruments = 580,000 Baht

Interest on raw materials
Sticlac cost four months @ 15% per annum
Sticlac is assumed to be 25 Baht/kilo
= (1,200,000 x 25 x 0.15/year x 4/12m) = 1,500,000 Baht

Maintenance cost

Annual repair required:	400,000 Baht
During the operation minor repair:	200,000 Bath
Total:	600,000- Baht

Transportation

Normally 1 truck contains approximately 13 metric tonnes but sometimes the amount is less; therefore the average delivery cost of 10 metric tonnes per truck. 1 truck costs 1,500 Baht. Therefore transportation cost = 180,000 Baht.

	Baht
Labour cost	
Mill (3 shifts)	
30 men x 50 days x 200 Baht/d (0800 - 2200 hours)	300,000
(2 shifts)	
30 men x 50 days x 150 Baht/d	225,000
All purpose	
10 men x 50 days x 100 Baht/d	50,000
Total labour cost:	675,000
Electricity and water	300,000
Miscellaneous	200,000
Total production cost:	4,118,200

The unit production cost is therefore Baht 4,118,200 divided by 600,000 kilos of seedlac, or 6.86 Baht/kilo. (The cost does not include sticlac and seedlac cost)

Factory Profitability

An analysis of factory profitability assuming that it buys sticlac from farmers at 1991 prices and is able to obtain a modest 10% profit on its seedlac sales therefore suggests the following:

Earnings

Sticlac is assumed to be 25 Baht/kilo (average 1991)
Unit cost of seedlac production:
2 kilos sticlac + 6.86 Baht = (2 x 25) + 6.86 Baht = 56.86 Baht/kilo

Factory price of seedlac:
Unit cost + 10% profit = 56.86 + 5.69 = 62.55 Baht/kilo

The total earning of the factory in one year:
Seedlac factory: 62.55 Baht x 600 tonnes =
37.53 Million Baht

Costs

	Baht/year
1. Land Rent	200,000
2. Building etc. maintenance:	
Total initial investment:	2,000,000
10% depreciation cost	200,000
Maintenance of building	70,000
Incidental costs:	100,000
Total:	2,370,000
3. Total Production cost:	4,118,200
4. Raw material cost:	
Sticlac 1,200,000 kilo x 25 Baht	30,000,000
5. Ma..agement:	
Salaries	
Manager (1)	96,000
Staff (5)	240,000
Total:	336,000
6. Packaging Materials	300,000
7. Miscellaneous	300,000
TOTAL:	37,624,200

Annual Net Profit is therefore:

Earnings (Baht 37.53 million) less total costs of Baht 35.62 million or Baht 1.91 million. This represents an annual undiscounted payback of 5.36% per unit of investment.

Exports and Imports of Lac Products in Recent Years

The following table summarises Thailand's position with respect to the import and export of lac products in the last decade or so.

Table 2 Exports and Imports of Lac Products

(Quantities and Values)

	Export		Import	
Year	Quantity (tonnes)	Value (1,000 baht)	Quantity (tonnes)	Value (1,000 baht)
1979	7,359	89,884	15	292
1980	5,526	111,432	7	282
1981	2,642	8,497	3	247
1982	6,361	141,363	3	224
1983	9,423	278,714	10	49
1984	9,628	479,452	68	258
1985	6,258	582,090	8	1,523
1986	8,055	395,112	5	1,668
1987	7,685	287,184	2	1,075
1988	3,483	121,616	8	1,353

Source: Department of customs

Production of Lac in Thailand

The following table highlights lac production by region in value and volume terms.

Table 3 Estimate of Lac Production in Thailand

Year	Production (stick lac) (1,000 kilos)			Value	
	North	Northeast	Total	Baht/kilo	Total (1,000 Baht)
1979/80	3,800	-	3,800	-	-
1980/81	400	400	800	-	-
1981/82	3,500	400	3,900	-	-
1982/83	11,000	1,500	12,500	6.50 - 10	103,125
1983/84	1,000	300	1,300	24 - 27	33,150
1984/85	7,000	1,000	8,000	28 - 80	432,000
1985/86	14,000	1,500	15,500	15 - 35	348,750
1986/87	9,000	1,000	10,000	11 - 17	140,000
1987/88	4,000	800	4,800	16 - 25	98,400
1988/89	3,500	1,000	4,500	8 - 12	45,000
1989/90	6,550	700	7,250	6.50 - 9.50	58,000
1990/91	5,250	650	5,900	9 - 11	59,000

Source: Thai Lac Association
Note: The figures are likely to be underestimates, as not all lac passes through the hands of the Thai Lac Association.

A. F. SUTER & Co. LTD.

SWANLAC

LAC

Even today many people regard LAC as some vague form of lacquer, varnish or gum which may be synthetic, an abbreviation or perhaps a trade name.

In fact the word LAC derives from the Sanskrit word LAKH meaning one hundred thousand, presumably adopted because of the myriads of insect LACCIFER LACCA toiling to secrete the resin: some 150 000 of them are involved in the production of sufficient matter to result in one kilogram of Shellac. LAC is the only known animal resin, all others of vegetable origin. LAC is not generally cultivated but is classed as a minor forestry product and is likely to remain as such.

LAC is harvested in INDIA (Madhya Pradesh, Bihar and Orissa in the main), THAILAND, CHINA and BURMA in this order of importance. Although known for some twenty five centuries, importation of LAC into Europe did not occur until about two hundred years ago. At the beginning of the nineteenth century CHARLES HATCHETT, an Englishman making an analysis which compares very favourably with that of the present day, states the chemical composition of Shellac to be as follows:

RESIN	90.90%
WAX	4.00
GLUTEN	2.80
IMPURITIES	1.80
COLOURING EXTRACT	0.50

These proportions naturally vary somewhat according to the different species of host tree, strain of insect, climate and geographical location but the basic resinous character needs no further emphasis. From the viewpoint of pure chemistry the exact constitution of LAC resin has not yet been fully elucidated but at present it is thought to be a mixture of the interaction products (lactones,lactides,intra-esters and ethers) of a number of polyhydroxy-polycarboxylic resin acids both aliphatic and aromatic, amongst which ALEURITIC, BUTOLIC, KERROLIC and SHELLOLIC have been identified and named. These compounds may derive from a single chemical entity or may be a solid solution one with another before separation: the former appears the more likely in view of the relatively consistent behaviour and uniform analysis of LAC resin.

LAC Wax has a somewhat obscure role in the process of resinosis but evidenc suggests that it acts as that which may be best described as an anti-constipant assisting the insect in its secretory efforts. Despite the small quantity available, LAC wax constitutes a valuable by-product; it consists mainly of straight-chain alcohols and esters, the mixture being fractionated by ethyl alcohol. In the pure form the colour ranges from dark brown to straw according to the method of separation. In comparison with the natural waxes in industrial use today, the melting point, gloss and hardness values fall only slightly below those of Carnauba wax. Conventional solvents may be employed but emulsification is not easily achieved.

LAC PRODUCTION is cyclic and commences with the insect itself feeding parasitically upon the sap of very young and tender shoots of some sixty different species of tree, some of which are modified for the purpose by judicious pruning and lopping. In India the principal trees are BUTEA, CAJANUS, FICUS, SCHLEICHERA,XYLOPYRA and ZIZYPHUS. After digestion of the sap and subsequent metabolism, some part is exuded through dorsally situated ducts eventually to form an outer crust or 'shell' for protection against heat, excessive moisture and predators. Hardening of the resin takes place immediately upon contact with air, secretion continuing till all the insects are enclosed in separate cells which finally fuse together forming a cylinder completely encasing the young shoot: the insects then propagate in these cells, fertilisation by the wingless male taking place through pores in the cell surface at an average rate of twenty five hundred per diem for two days only, death ensuing. Eventually the female within the cell produces a thousand or more grubs and dies, whereupon her orphaned family feed on her body till swarming time when they seek fresh quarters upon some new shoot which will have sprung up during the incubation period: thus begins a new cycle and so on ad infinitum, there being usually two crops per annum from any one particular host-tree. In order to preserve trees from total destruction, 'live' shoots are cut from already infected tre-- and tied to virgin plants in other parts of an orchard. These cuttings are known as 'broodlac'.

LAC (Continued)

The matter left behind by the insects is cut from the trees by the cultivator, sold as such and is known as STICKLAC. Alternatively it may be crushed, separated from twigs and other impurities, washed free from much of the natural red dyes, sieved, dried and sold as SEEDLAC. This lacmatter was previously processed into SHELLAC by heating in a long muslin sleeve before an open hearth: one end of the sleeve was pegged so that rotation of the free end caused the melting resin within to undergo a crude form of filtration through the material of the sleeve whence it was scraped and either allowed to cool and harden into discs of some two to three inches diameter known as BUTTONLAC, or stretched into wafer-thin sheets, which after cooling were broken into small flakes, well-known in industry as SHELLAC. Nowadays, most Seedlac is refined in factories either by thermal or solvent processes. Further modification may be carried out such as bleaching, dewaxing, decolourisation, esterification, hydrolysis, partial conversion into hard LAC resin, blending with synthetics and/or other natural resins, likewise with synthetic and/or natural waxes.

PROPERTIES of LAC determining its wide industrial use may be summarised as follows: Hardness coupled with a measure of elasticity: high mechanical strength and abrasion resistance: good adhesion and bonding: solubility in alcohols and aqueous alkalis giving uniform films possessing high gloss: general insolubility in hydrocarbons: high mould fidelity and good filler tolerance coupled with low coefficients of contraction, expansion and thermal conductivity: excellent anti-tracking properties with low dielectric constant and high dielectric strength: thermoplastic and partial thermosetting propensities.
The physical properties of LAC resin depend upon the relative proportions of two fractions, namely HARD LAC RESIN (HLR) and SOFT LAC RESIN (SLR). The former has most of the desirable characteristics. Obviously then, the whole LAC may be improved by either removing the SLR fraction or converting at least part of it into HLR, simultaneously eliminating impurities, wax and colouring matter (water- and alcohol-soluble dyes) by sedimentation, filtration and chemical reduction respectively. This process has been performed and the improvement in the product is marked to a greater or lesser degree depending upon the method of application of the resultant HLR. It will readily be seen that this combination of qualities in one substance is truly remarkable, explaining the efforts over many years, albeit so far not totally successful, to produce a synthetic Shellac: incidentally the results of this work, both positive and negative, have led to the founding of the modern synthetic resin and plastics industries.

APPLICATIONS of LAC, in consequence of these properties, are literally legion: thus LAC resin is to be found in one form or another in the following industries: Electrical, paint and varnish notably the basic resin for french polishing, lacquer and distemper, conservation, restoration, furniture, metal, foil and paper, leather, flooring, decorating, moulding, hatting and textile dressing, abrasive wheels and cloth, brake linings, rubber hardening, foundry work and pattern making, pyrotechnics and explosives, munitions, scientific instruments, laboratory work, electric lamp capping, sealants and adhesives for glass, metal and wood etc., knotting, sealing wax, photography and dry-mounting, photoprinted circuitry and cold-top enamels, pharmaceutical and toilet preparations, pill coating, petroleum fuel tank protection and gaskets, pottery and toy manufacture, dental engineering, confectionery coatings, coffee bean burnish, fruit and vegetable coatings, ballet-shoe stiffening, lapidary and glass mountings and many more present and future uses to be developed by further research and study.

Thus the versatility of LAC, not far behind that of rubber, demonstrates that even in this man-made materials, natural products undoubtedly continue to have their place.

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NATURAL PRODUCTS

SHELLACS AQUEOUS ALKALI & SPIRIT SOLUBLE

Swanlac Bleached Lacs

Dewaxed (Transparent)	BS 1284:1960
Waxy (White)	BS 1284:1960
Extra Waxy	

Shellacs, Machine and Native Made

Dewaxed and Decolourised
Orange and Lemon
Button
Garnet
Seedlac & Sticklac
Lac Dye

RESINS

Accroides or Yacca
Benzoin
Copals Spirit Manilla
Damars
Kauri
Mastic
Rosins
Sandarac

RESINS

Dragon's Blood
Gamboge
Myrrh
Olibanum (Frankincense)

OLEO RESINS

Elemi
Venice Turps Sub.

WAXES

Beeswax
Bleached Lacwax
Candelilla
Carnauba
Ceresine & Ozokerite
Earth
Japan
Microcrystalline
Montan
Ouricoury
Paraffin
Synthetic Spermaceti

GUMS

Acacia or Arabic
Ghatti
Guar
Karaya
Locust Bean
Tragacanth
Xanthan

These NATURAL MATERIALS have the following applications: –

ABRASIVES
ADHESIVES BINDERS & CEMENTS
AGRICULTURE & FERTILIZERS
ART CONSERVATION & RESTORATION
AUTOMOTIVE
BRUSHES
CERAMICS
CHEMICAL SYNTHESIS
CONSTRUCTION
COSMETICS PERFUME & INCENSE
DENTAL MEDICAL & VETERINARY
DYES STAINS & COLOURS
EDUCATIONAL
ELECTRICAL & ELECTRONIC
FLOOR FINISHES
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PHARMACEUTICALS
PHOTOGRAPHY & REPROGRAPHY
PLASTICS
POLISHES
PROOFING & SEALING
PYROTECHNICS CANDLES & MATCHES
RUBBER
SOAP & FATS
STATIONERY & SEALING WAX
TEXTILES
TOBACCO
VEGETABLE & FRUIT PRESERVATION
WOOD FINISHES & TREATMENT

As well as being financially profitable (on the base annual full development costs, a rate of return of 17% is suggested), economic benefits accrue in the form of income-earning opportunities for a relatively large number of farmers (several hundred), jobs at the sugar mill (around 100) and import substitution.

Risk and Uncertainty

As regards sources of risk, the potential for success of the investment will depend on smallholder farmers being recruited at an early stage and a programme developed for the progressive expansion of cane planting in the Savannakhet district. This will require adequate funds for land clearing and preparation, a guaranteed price to farmers which will show an adequate return for effort, the development of suitable varieties of sugar cane and the recruitment of a skilled and enthusiastic team of extension workers to be attached to the enterprise.

A rise in operating costs by 20% due to problems of supply quantity or management failure would cause the rate of return to fall to less than 13%, and a fall in the wholesale price of sugar by 20% would cause the rate to drop to just over 11%; it therefore seems that, if management problems can be overcome, the opportunity has a good chance of success.

The recruitment of an experienced expatriate for the first year's operation of the enterprise and a farming/agronomic expert during the initiation phase of establishing cane both on the enterprise plantation and among local farmers would also be essential.

The provision of adequate finances to support the factory operations during the early years until a profitable level of operation is achieved is vital, as demonstrated by the Pak Sap experience.