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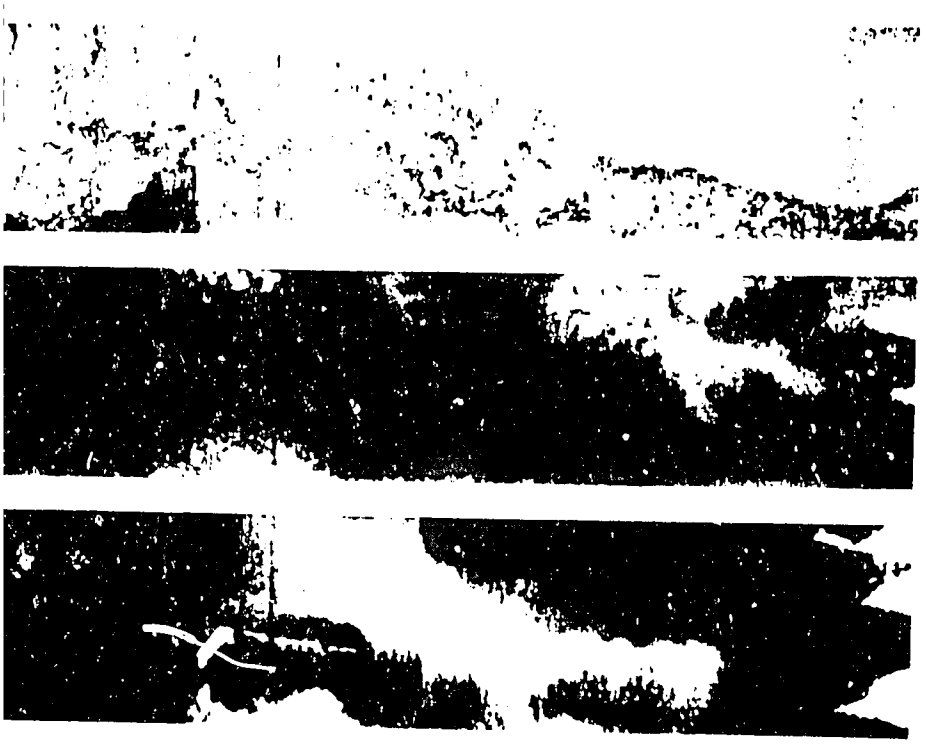
FEASIBILITY STUDY FOR AN INTEGRATED PAPAYA PLANTATION AND PROCESSING PLANT FOR THE PRODUCTION OF REFINED PAPAIN IN THE GAMBIA



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EXECUTIVE SUMMARY

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INTRODUCTION

In accordance with the F.A.P.E. Terms of Reference, dated 1st November, 1993, this feasibility study reviews the market, technical and financial evaluation for the establishment of an integrated papaya plantation and processing plant in The Gambia for the production of refined papain for export. The report was prepared by Mr. C.F. Street and Mr. Philip John (Annex II).

METHODOLOGY

For the market survey, the assessments of historical/projected production and prices and the conclusions and recommendations were based on faxed questionnaires and telephone interviews with importers, distributors and papain enzyme manufacturers in the USA, EEC, Japan and the processors in India and Zaire (Annex I). Official statistical data on exports and imports of enzymes were also reviewed; however, as refined papain is aggregated with other enzyme extracts, and not separately published, these resources were of limited use.

A field study was conducted by Mr. Philip John in The Gambia from 31st October to 14th November, to assess the local conditions and costs for papaya cultivation (Annex I). Technical data on processing methods and operating costs were developed by Mr. John in consultation with equipment manufacturers and processors of refined papain in India.

PROJECT RATIONALE

Refined papain is a proteolytic enzyme, processed from the dried milky latex found beneath the skin of the papaya fruit and has a wide range of applications in the food industry. The major producers of refined papain are Zaire and India. Over the last two years, Zaire's production has been severely curtailed due to political upheaval and civil unrest. Production in India, which, like Zaire, is totally reliant on outgrowers for latex supply, has also suffered a decline in production as a result of raw material shortages. Consequently, world market prices have escalated due to a world market deficit, currently estimated at 130 tonnes.

Papinex Limited, is being established to take advantage of the ongoing shortfall in world market supply; and its proposed integrated papaya plantation/processing facility, will have the unique advantage of not being totally reliant on fluctuating latex supplies from outgrowers.

The financial feasibility and sales prospects for this project are extremely favourable. It is recommended however, that a study be conducted on the by-products of the papaya fruit namely frozen papaya puree, papaya juice and tropical fruit wine, which will further enhance the profitability of the project.

PROJECT BACKGROUND

The project was initiated by Mr. John Moore, an American entrepreneur in partnership with Mr. Charbel Elhajj, a Gambian national. They have established Papinex Limited in The Gambia to develop this venture which will utilise Indian technical expertise.

The competitive advantages offered by The Gambia for the proposed project include:

- *excellent climate and conditions for the cultivation of papaya;*
- *availability of a prime land site with sufficient supply of underground water for irrigation;*
- *availability of an experienced local labour force at comparable wage levels to Zaire and India;*
- *reliable and frequent air and sea transport to Europe for the export of finished product and import of essential materials;*
- *a Government that is politically and economically stable, which encourages private sector development.*

PROJECT DESCRIPTION

Papinex Limited proposes to cultivate approximately 200 ha of papaya for latex extraction and to establish a manufacturing facility for the production of refined papain. The process will use a low temperature vacuum evaporation and drying system, which is a well established technology for developing countries. For a plantation of 200 ha the optimum latex yield per annum, (based on 2,000 trees per hectare producing 1.25 kg of latex per tree) is approximately 500 tonnes. When processed, this converts into approximately 50 tonnes of refined papain. Latex yields from the papaya fruit commence approximately nine months after initial planting and continue for an additional 15 months. It will therefore be necessary to implement a replanting schedule every 24 months, which is reflected in the output of refined papain (Annex III).

SITE LOCATION

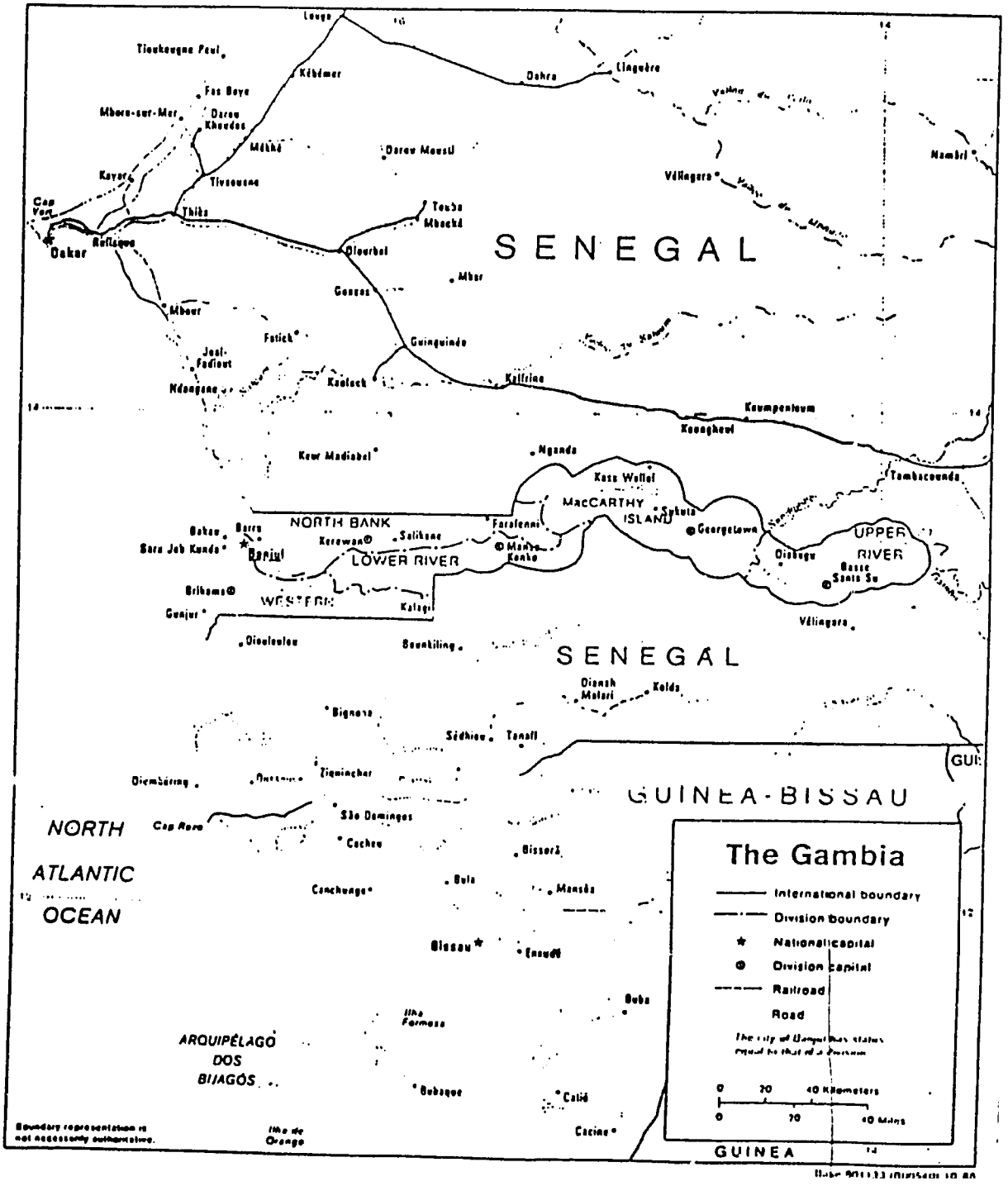
Papinex Ltd has acquired a 209 ha plantation, formerly owned by Citro Products (Gambia) Ltd. The site is located on the outskirts of the capital city, Banjul, and is approximately 12 kms from the international airport.

PROJECT COST

The total project cost is projected at US$3,500,000. Papinex Ltd., will be capitalised at US$1,000,000 and the balance of the required project financing will be placed with development institutions.

ECONOMIC BENEFITS TO THE GAMBIA

- *the generation of foreign exchange earnings,*
- *the employment of approximately 533 Gambian nationals,*
- *technology transfer and local personnel training,*
- *implementation of the Government's policy to promote the agricultural sector with special emphasis on exports.*



1 COUNTRY ANALYSIS

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1.1 LOCATION

The Gambia is one of the smallest countries in Africa, situated in the extreme western tip of the continent and occupying a narrow strip of land, approximately 480 km long, on both sides of The Gambia River. The country, whose width does not exceed 50 km, is bordered to the north and south by Senegal, and to the west by the Atlantic Ocean.

1.2 POPULATION

Since the 1970's The Gambia has witnessed an increasing rate of population growth which is currently estimated at 3.4 per cent per annum, of which about 2.9 per cent per annum is due to natural increase and 0.5 per cent per annum to immigration from neighbouring countries. In 1990, total population was estimated at 890,000, corresponding to a density of about 85 per km^2. Given current demographic trends, the population could exceed 1.2 million by the year 2000.

The population of the Greater Banjul Area (GBA) is approximately 210,000 and if present trends continue, it will increase by an additional 85 per cent to reach approximately 400,000 by the year 2000.

1.3 POLITICAL ASPECTS

Formerly a British colony, The Gambia was granted internal self-government in 1963 and independent status in 1965. The country became a sovereign republic within the British Commonwealth of Nations in 1969.

Cordial relations and close co-operation are maintained with The Gambia's immediate neighbour, Senegal, which crystallised into a confederate arrangement known as the Senegambia Confederation in 1982. This Confederation was subsequently dissolved with the mutual consent of both partners but privileged relations continue to exist between the two countries.

The Gambia has enjoyed continuous political stability since independence under a democratic, multi-party political system and the present constitution, dates from 1970. Executive power is vested in the president who is head of state and commander-in-chief of the armed forces. General elections through secret ballot, are held every five years to elect the president and 36 candidates who constitute the country's House of Parliament.

The largest party in the country is the People's Progressive Party which, following the 1992 elections, occupies 25 seats in the House of Parliament. Its leader, Sir Dawda K. Jawara, was the country's first Prime Minister and has remained The Gambia's President since 1970.

1.4 ECONOMIC ASPECTS

With a per capita income estimated in 1990 at US$264, The Gambia is one of the world's least developed countries. The economy is based on agriculture, with groundnuts constituting the major source of foreign exchange and accounting for 85–90 per cent of domestic exports. About two thirds of the population are employed in the agricultural sector, producing mainly groundnuts, millet, sorghum, rice and livestock rearing. Agriculture contributes about 30 per cent of GDP. The principal manufacturing activity is in groundnut processing and a few other modest, resource-based processing industries, all located in the Banjul area. The country is heavily dependent on trade, importing about one third of its food, all of its fuel, capital goods and most other manufactured products.

Outside of agriculture, the most important features of the economy are a rapidly growing tourism industry, employing about 6,000 Gambians during the high season from October to April; and a well developed commercial sector that has historically been involved in re-export trade to other countries in the subregion.

2 MARKET STUDY FOR REFINED PAPAIN

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2.1 PAPAIN, ITS FORMS AND USES

2.1.1 Background

Papain is the dried latex obtained from the papaya fruit. The papaya tree, indigenous to Central America is widely cultivated throughout the tropics. Traditionally the leaves were used to tenderise meat, long before the active principle in the papaya fruit was recognised to be a proteolytic enzyme which can break down and dissolve protein. More than 60 years ago, the discovery that an enzyme obtained from the papaya latex could be used to improve the clarity of chilled beer, stimulated an industry to produce papain which has developed wide ranging uses in specialised areas of food processing.

2.1.2 Crude Papain

Historically, the earliest commercial drying of papaya latex was sun-drying or kiln drying. These methods, particularly sun drying, where exposure to ultraviolet in sunlight reduces proteolytic activity, produce an inferior quality product. The material is often darkly coloured and is frequently malodorous as a result of microbial growth. Crude papain is ground into a coarse granular form for export and usually requires purification in order to produce a more stable product free of extraneous materials, and with an acceptable shelf-life and microbial count.

As the food processing industry has developed more stringent specifications on the use of crude papain, including laboratory testing of the proteolytic activity, bacterial count and solubility, most consumers prefer a refined product that meets these standards and can be used directly in many applications.

2.1.3 Refined Papain

The production of refined papain using low vacuum and spray drying methods was developed during the 1960's. The end product is a fully soluble fine white powder with a low bacterial count and a high proteolytic activity which is between two and four times that of crude papain.

2.1.4 Uses of Papain

The principal uses of papain are:

- in the brewing industry it is used in the chill proofing of beer to prevent the formation of haze during cold storage;
- in the pet food industry it is used for pre-digestion of meat products;
- in the meat industry it is used as a tenderising agent, either sprinkled onto meat or by injection into animals prior to slaughter;

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- in the food additives industry it is used to increase the yield of yeast extract from spent yeast and for the production of protein hydrolysates which are both widely used in the manufacture of savory foods such as soups, sauces, spreads, canned and frozen foods etc.

Minor uses of papain include:

- in the pharmaceutical industry it is used in the production of digestive aids either as powder formulations or in tablets;
- in microbiology it is used for the production of peptones from meat and casein for the manufacture of sera and vaccines;
- in the animal feeds industry it is used for preparing a specialised fish protein concentrate.

Small quantities of papain are also used in leather bating to improve mobility and softness, in the textile industry for degumming silk and in the cosmetic industry for skin cleansing formulations.

2.2 COMPETITION

2.2.1 Zaire

The production of refined papain was started in Zaire in 1970 by Mr. Boudart, a Belgium, who patented a spray drying technique. Boudart established outgrower plantations and a processing facility for the production of refined papain in the eastern province of Kivu. Having dominated the world market for approximately fifteen years, the company was sold to Enra S.A. in 1985.

Enra S.A., Zaire, is a private company owned by Mr, Bemba Salona, a Zarois citizen. In 1990 they were producing up to 110 MT, however, Zaire over the last two years has been ravaged by violent political conflict and economic ruin. Many of the papaya plantations have been destroyed with no evidence of replanting. Production in 1993 has declined to approximately 35 tonnes.

With little prospect of economic revival it is unlikely that Zaire will emerge as significant competition in the near future.

2.2.2 India

In the early 1980's, several companies in India set up processing facilities for refined papain, but were reliant on outgrower smallholdings for delivery of latex. During 1990 India was producing up to 140 MT, however production has shown a decline over the last three years, as obtaining sufficient quantities of refinable latex has become increasingly difficult; as outgrowers have abandoned the labour intensive papaya cultivation and latex collection in favour of other readily marketable crops for domestic consumption. The high cost of

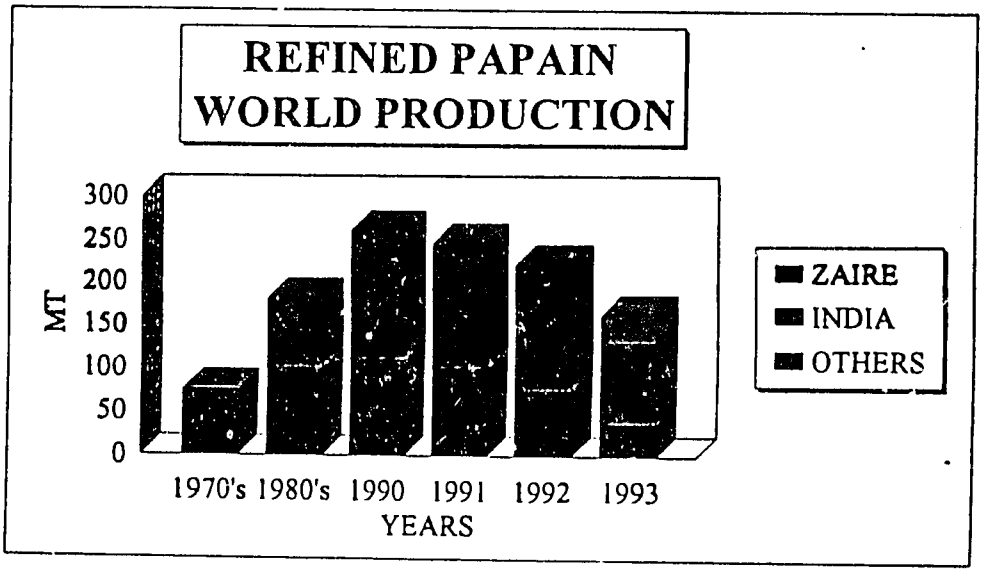
maintaining processing facilities without regular latex supplies has forced some processors to close down their refining operations.

The major producers of refined papain in India are presently:

- **Jain Plastics, PVT Ltd.**, India, a family owned company, established in 1979. Their principal activity is plastic pipe manufacture. They currently produce approximately 60 tonnes of refined papain per year.

- **Enzo-Chem Laboratories PVT Ltd.**, India, established in 1980 by the Warma family. They currently produce approximately 30 tonnes of refined papain per year.

There are as well several minor processors of refined papain in India producing approximately A0 tonnes per annum for domestic and export markets.



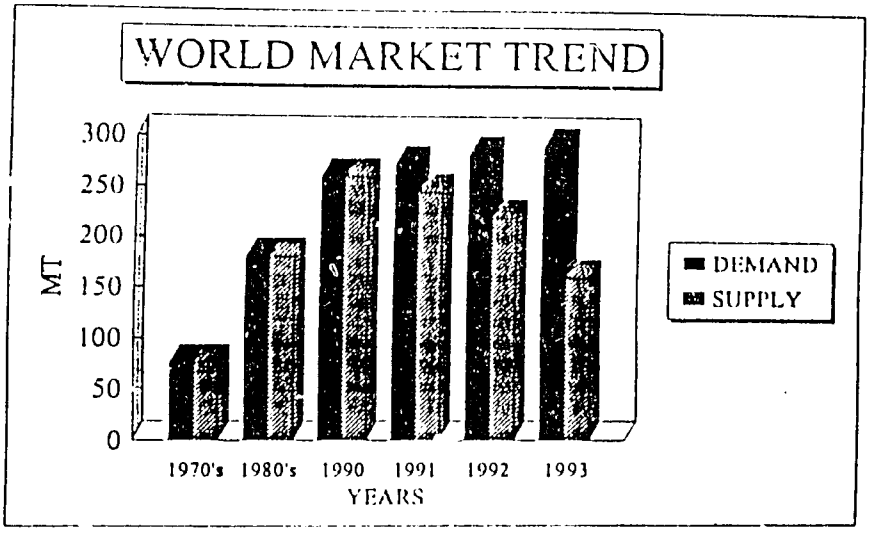
2.2.3 Others

Reco Industries Limited, Uganda, owned by Mr. Rwabwogo, has a small processing facility with an installed capacity of up to 25 tonnes of refined papain per year. Located near the Zaire border, they are entirely dependent on Zaire for latex supply and as a result have experienced erratic production levels; 1993 output is estimated at 15 tonnes.

In Japan, Kirin Brewery, were producing small quantities of refined papain for their own use. However, due to high production costs, their plant was closed down in 1985 and they now import their refined papain requirements.

2.3 SUPPLY/DEMAND FORECAST

The declining production in Zaire and India has created a world market shortage of refined papain:



Processors in India have tried to increase their production by importing crude papain from Sri Lanka for refining; their current production is approximately two to three tonnes per annum. This has proved to be expensive and of inferior quality as the initial drying of papaya latex to obtain crude papain results in loss of activity.

China is also presently trying to exploit the market shortage of refined papain and are producing small quantities of a semi refined product of an inferior quality which has had minimal acceptance in the market.

2.4 HISTORIC AND PROJECTED CONSUMPTION TRENDS

2.4.1 Introduction

Papain is one of the best known examples of an enzyme derived from a tropical fruit. During the last twenty years the industrial use of enzymes has rapidly expanded. In some sectors of industry the use of enzymes is still in its infancy. The reasons behind the success of enzymes can be summed up in four words; efficiency, precision, convenience and cost effectiveness.

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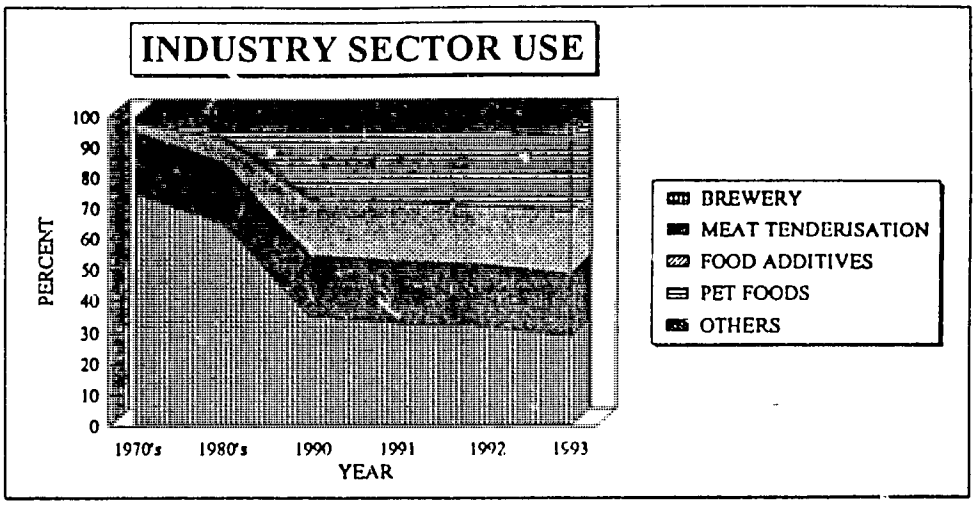


2.4.2 Brewing

During the 1970's refined papain consumption was dominated by the brewing industry which represented up to approximately 75 per cent of world market demand. This usage substantially declined due to:

- the invention of alternative methods to chill proof beer without the use of additives;
- a change in distribution methods, has reduced the necessity for prolonged storage of beer, in which papain was used as a quality preservative.

However, information obtained from the brewing industry indicates that the use of refined papain as a chill proofer and a quality preservative will remain at its current level for the foreseeable future.

2.4.3 Pet Foods

In the early 1980's a substantial market emerged for refined papain in the pet food industry which has developed to a current level of approximately 25 per cent of the world market demand for refined papain.

Papain is used in pet foods on an increasing scale due to:

- its ability to lower the viscosity of meat slurries facilitating handling and transport in a processing plant;
- the enzymatic hydrolysis of meat by papain produces peptides and amino acids that creates a savory flavour attractive to pets.

2.4.4 Meat Tenderisation

The use of refined papain in the meat tenderisation industry has maintained a consistent share of approximately 20 per cent of world market demand. The industry is dominated by the U.S. which has the highest per capita meat consumption in the world and where pre-slaughter and post-slaughter injection of liquified refined papain is widely used.

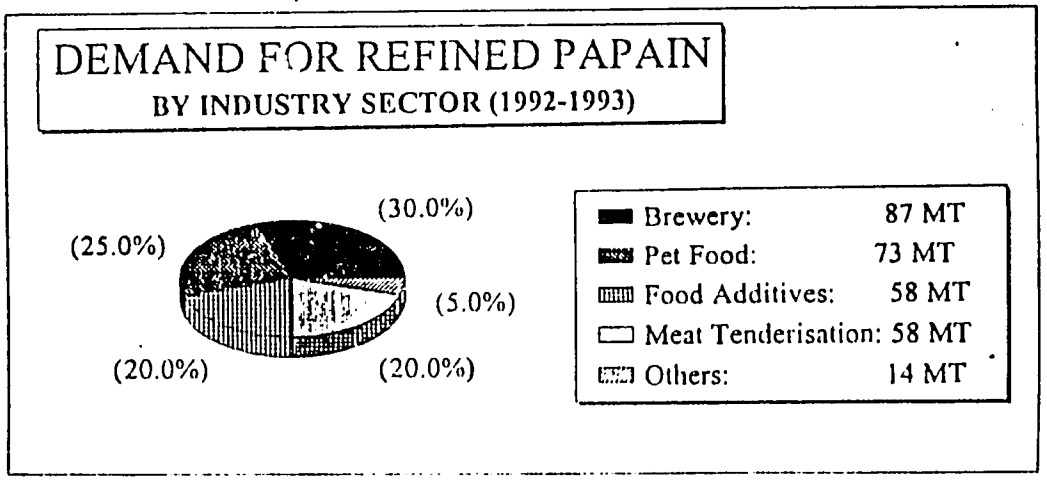
2.4.5 Food Additives

There has been a substantial increase in the use of food additives due to the rapid growth in consumption of processed and convenience foods.

The most important uses of refined papain in food additives are:

- production of yeast extracts,
- production of hydrolysed proteins.

2.4.6 Others



Due to the versatility of the papain enzyme there are several minor uses referred to in section 2.1 and new sources of use that are continually being evaluated.

2.4.7 Industry Outlook

Due to the present unreliability of supplies, manufacturers within the food industry are having to substitute refined papain with less efficient enzyme combinations.

It should be noted that papain can be produced synthetically. However due to its complex nature it has not been considered to be an economically viable proposition

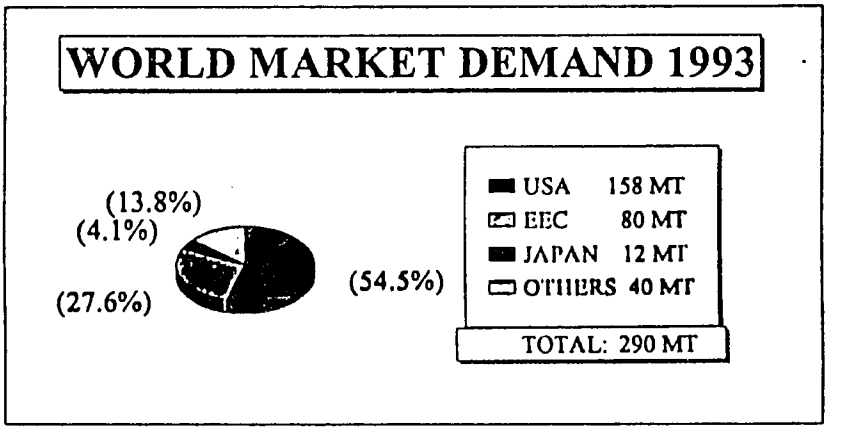
The preference for the use of refined papain over other enzymes is principally due to:

- its natural product source,
- its ability to retain activity at high temperatures,
- its ability to retain activity across a wide pH range.

Interviews conducted with manufacturers of enzyme preparations indicated that there will be a return to the use of refined papain once the current imbalance in the supply and demand situation is alleviated.

2.5 THE MARKET

The principal markets for refined papain are the USA, EEC (in particular UK, France, Belgium, Germany and The Netherlands) and Japan. Other markets for refined papain include Australia, Canada and South America which currently represent approximately 40 MT per annum.



The importers/distributors of refined papain and manufacturers of papain enzyme preparations interviewed for this market report, (Annex I) currently represent approximately 70 per cent (170 MT) of the market demand for refined papain in the USA, EEC and Japan.

2.5.1 Projected Market Share

Based on industry estimates, the projected potential average annual growth rate for refined papain consumption is 2.5 per cent per annum.

The following shows Papinex Limited projected market share based on a two year replanting schedule (Annex III).

	1995	1996	1997	1998	1999
Projected World Market Demand MT	304	312	320	328	336
Projected Sales Papinex Ltd MT	8*	44	37	41	44
% Market Share	2.6%	14%	12%	13%	13%

* six months sales

	2000	2001	2002	2003	2004
Projected World Market Demand MT	344	353	362	371	380
Projected Sales Papinex Ltd MT	36	49	35	47	37
% Market Share	10%	14%	10%	13%	10%

2.6 MARKETING AND SALES

The end users of refined papain purchase their requirements from importers and distributors, who also act as stockists, or enzyme manufacturers/processors who convert refined papain powder into standard liquid preparations to suit customer requirements.

This system provides the end user with the advantage of not having to carry large inventories and avoids the problems of verifying quality, delays in delivery and overseas payments. Most purchasing by the end user is on an open account basis, with prices fixed on a one year contract.

Manufacturers of refined papain in India sell directly to importers/distributors/enzyme manufacturers as they have no overseas representatives. Enra S.A., Zaire have their own marketing company Enzymase International in Belgium. Sales are normally made on a cash against documents basis as most of the customers are long established in the refined papain industry.

Imports of refined purified are normally airfreighted due to its low volume and high value.

It is recommended that Papinex Limited appoint sales agents for the principal markets, with agency agreements established on a performance basis. Sales agents should maintain regular stock levels to ensure spot deliveries to clients. In addition the sales agent should provide information on changing market conditions and price fluctuations.

It is proposed that a marketing budget be established to enable the company to develop in conjunction with their agents the following:

- contact with the importers, distributors and manufacturers of enzyme preparations in the principal export markets;
- product sampling to potential buyers;
- provide for independent testing of the refined papain to establish the quality of the product.

However, due to the current world market shortage of refined papain, it is anticipated that minimal market promotion will be required.

Papinex Limited will have the unique advantage of an integrated cultivation and processing facility without having to rely on outgrowers for latex supply. This should result in the highest quality standard of finished product and ensure market acceptability at a premium price.

2.7 IMPORT REGULATIONS/TARIFFS

In the European Community, refined papain is imported duty free under the Lomé Convention, whereby preferential tariff agreements have been established with African, Caribbean and Pacific (ACP) countries.

In the USA and Japan refined papain is imported duty free from all sources, except India, which is subject to six per cent import duty in the USA. This tariff was recently imposed as a retaliatory measure for India's refusal to sign an "Intellectual and Patent Rights" agreement and is unlikely to be removed in the near future.

The customs classification for refined papain is 'Enzymes and Prepared Enzymes (excluding rennet and concentrates)' and the tariff no. is 350790000.

2.8 QUALITY STANDARDS

The quality of refined papain is based on its activity as an enzyme which is expressed in tyrosine units or N.F. units. This is defined as the quantity of papain required to break down a specified quantity of protein.

The most common quality standard for refined papain is 800 tryosine units or 48,000 N.F. units per mg.

The only published standard specification for refined papain is in the Food Chemical Codex of the USA (1st edition); the assay method cited is used universally (Annex IV).

In the EEC refined papain is listed in the Einex directory (European Index) which classifies all substances used in the manufacture of foods and pharmaceuticals.

2.9 PRICING AND TRENDS

Average Refined Papain prices FOB Zaire/India (US$/kg)

1989	1990	1991	1992	1993*
38.00	40.00	42.00	52.00	81.00

* six months

The above prices of refined papain are based on the most commonly used activity level of 800 tyrosine units or 48,000 N.F. units per mg.

Up to 1991, the price of refined papain remained relatively stable with minor increases reflecting a rise in processing costs and air freight charges.

The inflated prices of 1992 and 1993 are a direct result of the ongoing world market shortage of refined papain caused by the situation in Zaire and the production decline in India.

2.10 Market Forecast

It is ancitipated that the current inflated price levels will stabilise at approximately US$55-60 per kg over the next 18 months, due to a concerted effort by producers in India to increase their output.

3 TECHNICAL STUDY FOR REFINED PAPAIN

3 TECHNICAL STUDY FOR REFINED PAPAIN

3.1 PAPAYA PLANTATION AND CULTIVATION

3.1.1 Background

The papaya (Carica Papaya L.), although native to Central America is now grown in most tropical regions up to an altitude of 1,000 m. The main producers are Mexico, Brazil, Peru and Venezuela in South America; Sri Lanka, India, Taiwan, Thailand and Philippines in Asia and Uganda, Kenya, Tanzania, Ghana and Zaire in Africa.

Papaya is a soft wooded tree that grows to a height of up to 10 m and has palm like leaves. It is generally dioecious but occasionally bi-sexual varieties are found. The fragrant flowers are pale yellow and fruits are borne on leaf axles on the trunk, starting at a height of approximately 1 m from the ground.

3.1.2 Climate

Papaya thrives under hot sunny humid conditions and also under dry conditions, given adequate irrigation. High sunlight radiation is required to produce superior quality fruit and maximum latex yields. Low temperature and frost are harmful, cold nights effect fruit quality and also extends the period to maturity.

The Gambia lies between latitudes 13° 12' 15'N and 13° 32' 56'N on the western coast of Africa. The climate is sub-tropical with a long dry season from November to May and the rainy season from June to October. The average total rainfall is 817 mm per annum and is generally confined to nights. The dry season is marked by a cool dry period from November to March, coinciding with the movement of the north-east trade winds (harmattan), and a shorter dry period from mid-March to June. Mean temperatures vary between 15°C - 31°C minimum during the cool season and between 28°C - 40°C during the hot season. Relative humidity ranges are between 22 per cent and 96 per cent and the average sunshine hours are approximately seven - eight hours per day (Annex V).

There is no history in The Gambia of adverse climatic conditions such as storms, high winds, hurricanes etc. which could damage the papaya crop.

The overall climatic pattern is ideally suited for the cultivation of papaya, with all the required climatic parameters available for healthy and vigorous growth.

3.1.3 Soil

Papaya grows in most soils except heavy clays. Good drainage is essential as the papaya root system is easily damaged if the soil becomes saturated with water. The papaya plant is fast growing and must have a continuous supply of plant food and moisture to ensure satisfactory growth.

The soil at the proposed site is sandy loam with good drainage characteristics. It is slightly acidic, which is beneficial for papaya cultivation. The soil analysis reports (Annex VI) show

a deficiency in organic matter and potash which will be rectified by the addition of fertilisers to improve the available phosphorous and nitrogen content. These improvements will also change the soil structure and increase its capability to retain water and discourage leeching.

A fairly high level of nematode infestation was also noted in the soil, which can easily be eradicated using a suitable nematicide in conjunction with locally available neem cake. With the preventive measures and treatments detailed in section 4.1.17, nematodes are not considered a risk to papaya cultivation.

3.1.4 Drainage Topography

The proposed site lies on slightly sloping land that provides for good irrigation. It drains gently from the south east and north east sectors of the site into the nearby swampy bolong. Its southern border runs parallel to one of the main drainage channels of the town of Brikama. It should be ensured that no effluent seepage, from any composting operations, or other factory disposals are allowed to drain into the nearby bolong, nor be allowed to contaminate the spring water.

3.1.5 Site Location

The area of the proposed site is 209 ha, located in the western division administrative area which borders the Greater Banjul Area (GBA); it lies close to the estuary of the River Gambia. These regions are the traditional rice producing and horticultural development areas.

The site lies about 5 kms from the town of Brikama which has a population of 35,000. Brikama is located on the Banjul/Basse highway approximately 35 kms from the city of Banjul and 12 kms from the international airport.

Access to the site is off the Brikama/Basse by-pass, on an unpaved road. It is surrounded by a number of villages on the northern sector and market garden plots in the eastern sector (Annex VII).

3.1.6 Water

Adjacent to the proposed site, the village market gardening area of Kembjeng is renowned for its natural springs. The site lies on an underground water path, giving the property a unique quality in the region as a location for adequate underground water for irrigation. Based on information obtained from other geological surveys conducted in the region and discussions with hydro geologists and drillers working in the area, it was concluded that the potential exists to exploit adequate ground water to meet the requirements of the project. However, it is recommended that a detailed geophysical survey of the site is conducted including electrical sounding, profiling, drilling of a test borehole to establish the potential for maximum extraction of groundwater.

It should be noted that the drilling log of the existing bore hole dug at the proposed site shows the static water level at 10 m depth.

3.1.7 Cultivar Selection

The papaya has numerous sub species and papaya grown in one country is sometimes conspicuously different from fruit grown elsewhere. Some of the varieties are named; Washington, Honey Dew, Peradeniya, Solo, Sunrise Solo, Selection No. 1, Blue Stem Panama Red, Fairchild, and commercially bred varieties from India named CO's one - six.

Only the female plant produces fruit, from which latex can be extracted for papain production. An extensive evaluation of the different varieties of papaya concluded that three varieties of papaya should be cultivated in The Gambia to obtain the required balance between yields and availability of sufficient female plants to optimise refined papain production:

- a selection from the local Gambian variety,
- CO5 variety from India,
- a bi-sexual variety from Taiwan.

The CO5 variety from India which is uni-sexual has the highest latex yield. The variety from Taiwan, although lower yielding is bi-sexual and will ensure sufficient numbers of female plants. There are two or three lower yielding mixed varieties in The Gambia from which a medium sized variety with dark green ribbed fruits has been selected. This variety has the advantage of being long established in The Gambia, well adapted to the local environment and has acquired an immunity to most local disease. It is therefore recommended that one third of the total area is planted with each variety.

3.1.8 Land Clearance

The land is currently planted with 30,000 lime trees most of which are over 15 years old. It is proposed that the entire area be cleared by a local sub-contractor. The cleared area will be divided into square blocks of 10 ha with access on all sides.

3.1.9 Irrigation and Bore Holes

A papaya tree requires an average of 12 litres of water per day, and a regular supply of nutrients to maintain healthy growth. It is therefore recommended that a drip irrigation system be installed to facilitate economic distribution of water and nutrients directly to the root system (Annex VIII). For 200 ha under cultivation at the proposed site, it is recommended that 12 bore holes be installed.

Information on the availability of water in the area of the proposed site was obtained from the Director of Water Resources in Banjul. There is an abundant supply of water at an approximate depth of 10 m, resulting from accumulated rainfall in the wet season. It will therefore not be necessary to obtain additional water supplies from The Gambia river.

The peak water requirement per day for 200 ha under cultivation is 4,800,000 litres. Based on 12 boreholes producing 400,000 litres each per day, one hole will be required to pump for 11 hours per day at a rate of 36,000 litres per hour.

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The factory water requirements are:

Process	15,000 litres per day
Washing and cleaning	10,000 litres per day

Additional pumping required for the factory water would be approximately one hour per day.

3.1.10 Pit Digging and Manuring

It is recommended that pits of 2.5' x 2.5' x 2.5' be dug at a spacing of 7'x 7'. As the soil is poor in organic matter, the pits should be filled with compost, bone meal etc. The pits are then allowed to weather and must be irrigated for a few weeks prior to planting. As the soil is sandy loam, pit digging can be executed manually. Due to the fairly high level of nematode infestation in the soil, the back filled soil and compost should be treated with suitable nematicides, fungicides and insecticides to provide an acceptable sterile environment for healthy development of the transplanted seedlings.

As availability of organic manure/compost in The Gambia is limited, it will be necessary to initially import bone meal, peat, neem cake etc. The total start up quantity required will be approximately 3,000 tonnes. In subsequent years, the farm will self generate most of its compost requirements which will be supplemented by procurement of animal manure, neem cake and seeds in The Gambia.

The annual cost for the procurement of organic compost is estimated at US$35,000, initially broken down as follows:

- US$20,000 for local procurement of groundnut cake, cattle manure, sewage waste and small quantities of neem seeds (compost preparation is included in labour costs);
- US$15,000 for imported concentrates of bone and blood meal, fish waste and neem cake.

The quantities of imported concentrates will reduce as local neem collection is increased as detailed in section 4.1.17

3.1.11 Cultivation of Seedlings for Transplanting

Approximately 8,000 seedlings are required to plant 1 ha with four seedlings in each pit. The nursery should be started approximately two months prior to transplanting. The seeds are raised in nursery bags with drainage holes which are filled with soft loose top soil mixed with compost. This mixture must be treated with nematicides, insecticides and fungicides to prevent any carry over of plant disease to the field. The seedlings should be raised under cover and hand watered regularly. Seeds will germinate within 15 to 20 days and transplanting can be carried out after about two months when the seedlings grow to a height of between 6"-9".

3.1.12 Transplanting

Four seedlings should be planted in each pit. To prevent mutilation of the roots, a large part of the moist soil containing the entire root system should be lifted and transplanted into the pit. The seedlings should be held erect in the hole with the root collar about ½" below the ground surface. A papaya seedling has a long tapering, thick fleshy white tap root, the upper part of which has the largest number of fibrous roots that forms the future root system of the papaya plant. It is essential that all fibrous roots are preserved intact during transplanting as rough handling of the seedlings can lead to stunted growth and other abnormalities. The seedling must be thoroughly irrigated immediately after transplanting and daily thereafter.

3.1.13 Thinning

As only the female plant can be used for latex collection and there are no means to determine the sex of the plant before it flowers, four plants are grown in each pit. Flowering takes place about four – five months after planting when the sex can be determined. Male flowers are borne on long drooping flower stalks in great numbers and the female flowers are borne on short branched stalks in the leaf axils.

For the C05 and The Gambian varieties, the first trees in each pit which show female flowers will be preserved and the rest destroyed. About one month later the strongest of the remaining females is preserved and the others are removed leaving one female in each pit. About 25 male plants, which function as pollenisers, are retained for every 1,000 female plants, suitably spaced in the plantation.

3.1.14 Weed Control

The soil surrounding the plant base is likely to have weed growth which must be continuously removed.

3.1.15 Fertilisation

As vigorous growth of papaya must be induced for an abundant latex supply, it is recommended that the organic manure be supplemented with nutrients, in particular nitrogen. The drip irrigation system will facilitate the delivery of micro doses of chemical fertilisers and trace elements direct to the root system. The quantities of nutrients required should be formulated based on detailed soil analysis of different sectors of the site after clearance. Approximately 200 tonnes of imported complex fertiliser will be required per annum.

3.1.16 Replanting Schedule

Based on observations of climatic and soil conditions in The Gambia, it has been determined that the commercially viable tapping life of the papaya tree is approximately 15 months, after which replanting should commence. The nursery raised seedlings should be transplanted equi-distant from the existing plants. The older plants can be retained for 30 – 45 days after fresh transplanting, before removal, as they will provide shade for the seedlings. Replanting can take place continuously every 24-26 months provided that sufficient soil nutrients are

available. With rotation planting, it is essential to remove all old trees even though the tapping life of some trees may not be exhausted.

3.1.17 Papaya Pests and Diseases

Occasionally the spider mite is found on papaya which attacks the leaves and fruits. Spider mites can be easily controlled by regular spraying of acaricides on a preventive basis while the plant is still young. Other possible diseases are fungal types the most common being collar rot, root rot, fruit rot, and mildews which attack the leaf, fruit and root. There are many effective fungicides available to alleviate fungal attack. The most difficult disease to control is the leaf curl virus and the mosaic virus. Observations in The Gambia show no evidence of these viruses being present.

For control of nematodes, neem cake, neem oil and crushed neem seeds and leaves are recommended as they will also provide nutrients and mulch to the plant. This should be used as an adjunct to chemical plant control measures for which carbofuran is recommended for effective eradication of nematodes. Neem is plentiful in The Gambia but as no harvesting is presently conducted, it is recommended that a collection system be implemented. The estimated cost of local purchases of neem seeds is between 100 - 150 dalasis per tonne. Additional costs of transport and neem seed crushing (to generate neem cake for compost and neem oil for use as an insecticide), are negligible and are included in labour and transport overheads. The estimated annual cost of neem cake and oil, when total requirements can be procured locally, is US$8,000.

The initial start up quantities of pesticides/fungicides required will be approximately 500 tonnes. Utilisation should be on a preventive and as required basis.

In The Gambia, where there has been no widespread use of pesticides/fungicides plant protection control measures will be enhanced as immunity levels are low.

3.2 LATEX RECOVERY

Latex collection should be carried out in the early hours of the morning which is the period of greatest latex flow. Only the oldest fruits (lowest on the trunk) should be tapped while they are still entirely green and have reached about 75 per cent of their maturity. If younger fruits higher on the trunk are tapped at the same time as the old fruits, growth will be retarded and they will ripen prematurely. Further, the whole tree will be greatly weakened by the excessive loss of fluid.

3.2.1 Tapping Method

The area to be tapped should be divided into three sections and one section tapped per day, returning to the first section on the fourth day, thus giving the tree sufficient time to recover its productivity.

Tapping consists of making tow to three incisions not more than 1.5-2 mm deep running laterally down the fruit using a stainless steel razor blade embedded in the end of a stick. Deep incisions do not heal and frequently the fruit rots. A greater number of incisions on a

fruit will result in a lesser quantity of latex being collected as much of the latex remains as droplets on the fruit. The latex flows into a collection tray which consists of a polyethylene sheet clamped to the tree.

The latex flows for about 60-70 seconds after which it will coagulate on the fruit. The coagulated material is scrapped off by hand and collected in buckets. The latex which has dripped onto the tray and coagulated, is also collected in buckets before the tray is refitted to an adjacent tree. It is estimated that 50 trays will be required per tapping hectare and that approximately 70-80 trees can per tapped per hour per tapping team (tapper and latex collector).

3.2.2 Latex Collection and Handling

During latex collection, large extraneous matter such as flowers, leaves and insects are removed from the tray. After collection in buckets, preservatives are added to the latex to ensure the retention of maximum activity. The material is then transferred to 55 litre stainless steel air tight drums for transport to the factory.

3.2.3 Estimated Latex Yield

Three to four months after the rainy season, is the period of maximum latex yield, with the minimum yield during the dry season. However, the proposed drip irrigation system will help to reduce this imbalance of latex yields.

For a plantation of 200 ha the optimum average latex yield per annum, (based on 2,000 trees per hectare producing 1.25 kg of latex per tree) is approximately 500 tonnes. When processed, this converts into approximately 50 tonnes of refined papain.

3.3 FIELD TRANSPORT

It is recommended that trucks, tractors and trailers be provided to convey all plantation personnel to their respective work sites and for transport of agricultural inputs and fresh latex supplies. The tractors should be fitted with spraying attachments for pest control operations.

3.4 TECHNICAL DESCRIPTION OF PROCESS

3.4.1 Reception/Inspection

The latex, when delivered in the 55 litre stainless steel drums is in the form of a crumbly gel. It should be inspected, weighed (according to area and tapping team) and spread on stainless steel tables. Extraneous matter such as dirt and insects are manually extracted before the material passes through a coarse filtration to remove the smaller foreign matter.

3.4.2 Liquification

The gelled latex is agitated at high speed with a shear stirrer in a vessel with baffles to prevent the addition of air into the liquid through the vortex formation. The material being thixotropic will change in consistency and become a milk like liquid.

3.4.3 Refrigerated Storage

The liquid is pumped into insulated, refrigerated and sealed buffer tanks of 2,500 litres each, which should be located on a platform with the outlet nozzles 4' from ground level. These tanks are fitted with a slow speed anchor type stirrer to keep the additives in suspension. The temperature is lowered to between 2°–5°C using chilled water circulation, supplied from an ice bank system of 5 tonne capacity, to prevent deterioration of the product and filter aids are added to facilitate fast filtration.

3.4.4 Filtration

The liquid papaya latex contains the active soluble enzyme along with other insolubles consisting of gums, pectins, starches, sugars etc. For product refining, the insoluble fraction must be separated from the soluble.

A series filtration is performed starting with a nutche filter to remove the coarser particles and most of the gums. The filtrate is then pumped to a tank equipped with a stirrer. Additional filter aids are added and a fine filtration is performed through a plate and frame filter press to remove all insoluble, suspended and visible matter. Finally, the clear filtrate, containing enzyme, is pumped to a buffer tank and sterile filtered using horizontal filters through filter pads.

The residual cake from the nutche filtration and plate and franie filtration is collected, mixed with water and centrifuged in a slow speed centrifuge to recover the residual soluble, active enzyme in the cake. The filtrate from the residual cake is added to the filtrate from the nutche filter and passed through the plate and frame filter.

3.4.5 Concentration

The thin filtered sterile liquid containing between 8–10 per cent soluble solids should be concentrated to between 40–45 per cent solids prior to drying. There are two possible methods of concentration :

- low temperature vacuum evaporation,
- ultra filtration using hollow fibre or membrane filters.

Considering the level of available skills, maintenance facilities and technological development in The Gambia, the low temperature vacuum evaporation system is recommended. Vacuum evaporation is a long established procedure requiring equipment with very few moving parts that is easy to operate and maintain. The vacuum evaporator has higher energy consumption which is compensated by its reliability, sturdiness and higher concentration outputs.

Ultra filtration is a relatively new procedure, the equipment being highly sensitive, sophisticated and easily damaged. The equipment is not repairable at site and whole modules need to be replaced. The recovery of product and concentration is lower than by vacuum evaporation.

The recommended system consists of a single stage forced circulation evaporator, operating at 500 kg per hour evaporation rate, with vacuum supplied by a steam ejector and barometric condenser operating at 15 torr. The thin stabilised liquid is pumped into the evaporator by vacuum and heated in a calandria by steam. The heated liquid boils at a low temperature, below 25°C, and passes into the flash tank where part of the liquid is returned to the calandria. The vapour is removed by the vacuum line to the ejector and condensed in a barometric condenser. The thin liquid is concentrated by this method from 8–10 per cent solids to 40–45 per cent solids after which the thick syrupy liquid is extracted through an extraction pump.

The total steam requirements for the evaporation process are:

- 600 kg/hr for evaporation,
- 70 kg/hr for steam ejector.

3.4.6 Drying

Many methods have been used for drying papain, however, the two most commonly used are low temperature vacuum drying and spray drying.

Low Temperature Vacuum Drying

The principle behind vacuum drying is that thermally unstable products can be dried at low temperatures without causing much degradation. Liquids boil at lower temperatures as the degree of vacuum is increased. As low drying temperatures are required for producing high activity papain, a steam ejector vacuum system capable of 2 torr with 40 kg moisture evaporation/hr is recommended where the drying temperature will be approximately 5°C.

The vacuum dryer consists of a reinforced chamber with hollow shelves through which hot water can be circulated. The water is heated by steam in a shell and tube heat exchanger and hot water is circulated using a centrifugal pump. Vacuum of 2 torr is created by a three stage steam ejector system. The thick concentrated enzyme is spread onto teflon coated stainless steel trays placed onto the hollow shelves and vacuum is created in the chamber. The product is heated by addition of steam to the water circulating through the shelves. The temperature is monitored by temperature probes inserted in the product and will initially be around 5°C. The drying process takes between 6–8 hours, including loading/unloading, with temperatures not exceeding 10°C. After drying, the trays are removed and the product scraped off and pulverised to the required mesh in a stainless steel pin mill, before it is sieved and packed.

Four vacuum dryers are recommended, with 60 trays of 0.25 m^2 each on 10 shelves of 1.5 m^2 each, totalling 15 m^2 per dryer. Each tray will produce 900–1,000 g of finished product per drying cycle which equates to an installed capacity of approximately 700 kg of finished product per day.

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The total steam requirements for the vacuum drying process are:

- 50 kg per hour for heating,
- 180 kg per hour peak load for the ejector.

Spray Drying

The principle of spray drying is to convert the liquid into very fine droplets and allow it to drop through a counter current of hot air. The liquid is atomised either through high pressure nozzles or through high speed centrifugal disc atomises. The drying temperatures, although very high do not usually damage the product as contact time is very short. The powder is collected in a cyclone separator and the fines in a wet scrubber.

The entire operation of a spray drying plant is automatically controlled through a central control panel which also houses the motor control centre.

Due to the technical sophistication of the spray drying method and the lack of maintenance facilities in The Gambia, it is not recommended that this system be used.

3.4.7 Boiler

The recommended boiler to be installed is an oil fired, three pass smoke tube type, with a capacity of 2,000 kg/hr and with pressure at 5 kg/cm². In addition to the evaporator and vacuum dryers steam requirements (detailed in sections 4.4.5 and 4.4.6), the generation of hot water for cleaning down purposes requires 50 kg steam/hr.

3.4.8 Cold Storage

Two types of cold room facilities will be required; one operating at −15°C for storage of surplus latex and concentrated material which would be necessary in the event of a plant breakdown/temporary closure. Refrigerated storage of finished product at 5°C is also required. It is recommended that a cold storage room of 20' x 10' be installed with two temperature zones and having a total capacity of 5 tonnes.

3.5 QUALITY CONTROL

A quality control laboratory will be required for constant analysis of:

- samples of latex received at the factory to establish activity and total soluble solids;
- samples of the residual cake from the centrifuge to ensure that maximum activity has been recovered;
- samples of the concentrated material from the evaporator to verify activity, solubility and total soluble solids;

- samples from each drying batch after grinding to ensure that the highest quality standard of product has been achieved prior to shipment.

3.6 INSTALLED CAPACITY

The plant will be designed to handle 500,000 kg of fresh latex per annum, averaging 2,500 kg per working day. However supplies will peak during the three months immediately after the rains. Based on 200 ha cultivated, latex yields could be as high as 6,000 kg per day for a short period. The recommended plant specifications have taken this into consideration.

It is recommended that after two years of production, outgrowing is developed to compensate for the fluctuations in production due to the fixed replanting schedules. Outgrower planting schedules should be dove tailed into the project in order to maximise production capacity utilisation for refined papain.

3.7 PACKING AND SHIPMENT

To preserve activity, refined papain must be stored at low temperatures in airtight containers. 30 litre fibre or plastic drums with polyethylene linings and a nett content of 20 kg are recommended. The air in the inner liner should be evacuated before closing. The product containing 4–5 per cent moisture stored at 1°–5° C has a shelf life of approximately one year.

As a high value product, refined papain is normally air freighted. There are frequent passenger air services from The Gambia to UK, Belgium and Switzerland. In addition, the British based freight company Redcoat which is established in Banjul, is introducing an exclusive air cargo service from The Gambia to Europe.

3.8 SAFETY STANDARDS

Papain, being a proteolytic enzyme, requires careful handling and certain precautions need to be observed. Direct contact with papain both in latex and powder forms can cause minor irritation of the skin under certain conditions. All personnel handling latex will be provided with gloves and packing area staff will be provided with protective uniforms and masks to avoid inhalation of the dusty fines.

3.9 INFRASTRUCTURE

The region of the proposed site location is the major population centre of the country. It provides all necessary infrastructure required including good road networks, excellent telecommunication facilities, and is within close proximity of the international airport and port of Banjul. Although municipal electricity and water supplies are available in the area, the plantation complex will generate its own energy and water requirements to ensure reliable and cost effective supplies.

3.10 ENVIRONMENTAL IMPACT

The cultivation of papaya under the proposed controlled conditions will have a positive effect on the immediate environment. The recommended pest control measures are environmentally

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acceptable and the quantities of insecticides used will have no contaminating effect. The manufacture of papain, which is primarily a mechanical separation operation, does not require the use of solvents, chemicals or any other toxic or environmentally hazardous substances or processes. The waste from the process are diatomaceous earth and cellulose filter pads both of which are environmentally beneficial and degradable.

The plantation waste consisting of fruit, stem and leaves etc is estimated at 22,000–25,000 tonnes per year. Approximately 4,000–6,000 tonnes of fruit could be used for the manufacture of papaya puree/juice and the remaining waste should be used for composting. Weight loss after composting will be approximately 70 per cent, and this should generate between 5,000 – 6,000 tons of suitable compost for the plantation. The cost of waste removal and transfer to the compost pits is included in labour and transportation overheads.

4 FINANCIAL PROJECTIONS

4. FINANCIAL PROJECTIONS (US$)

4.1 SALES AND PRODUCTION

SALES	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10
SALES REFINED PAPAIN (KG)	8,000	44,000	37,000	41,000	44,000	36,000	49,000	35,000	47,000	37,000
SALES PRICE EX FACTORY (KG)	50	50	50	50	50	50	50	50	50	50
TOTAL SALES INCOME	400,000	2,200,000	1,850,000	2,050,000	2,200,000	1,800,000	2,450,000	1,750,000	2,350,000	1,850,000

PRODUCTION	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10
PRODUCTION REFINED PAPAIN (KG)	8,000	45,000	37,000	41,000	44,000	36,000	49,000	35,000	47,000	37,000
STOCK AT YEAR END (KG)	0	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
TOTAL VALUE STOCK AT YEAR END	0	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000

4.2 PROJECTED CASH FLOW

	YEAR 0	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10
INFLOWS											
PROFIT BEFORE TAX	0	(110,250)	511,582	342,608	564,595	741,502	459,378	1,242,635	667,619	1,208,892	746,575
ADD DEPRECIATION	0	87,619	350,475	350,475	350,475	350,475	313,625	158,075	143,638	143,325	154,842
FUNDS GENERATED FROM OPERATIONS	0	(22,532)	862,057	693,083	915,070	1,091,977	773,004	1,400,710	811,257	1,352,217	901,417
SHARE CAPITAL	1,000,000	0	0	0	0	0	0	0	0	0	0
LOAN DRAWDOWN	1,500,000	1,000,000	0	0	0	0	0	0	0	0	0
INCREASE IN ACCRUED LIABILITIES		16,238	15,170	(3,280)	1,640	1,230	(3,280)	5,330	(5,740)	4,920	(4,100)
TOTAL INFLOW	2,500,000	993,607	877,227	689,804	916,710	1,093,207	769,724	1,406,040	805,517	1,357,137	897,317
OUTFLOWS											
PURCHASE OF FIXED ASSETS	1,369,882	1,000,000									
PRE-START UP EXPENSES	737,000										
PRE-OPERATING FINANCIAL COSTS	300,000										
INCREASE IN STOCKS OF FINISHED PRODUCT		0	50,000	0	0	0	0	0	0	0	0
INCREASE IN DEBTORS		66,667	116,667	(29,167)	16,667	12,500	(33,333)	54,167	(58,333)	50,000	(41,667)
INVETMENTS IN PLANT & EQUIPMENT		0	0	0	0	100,000	0	0	150,000	180,000	150,000
LOAN REPAYMENT		0	416,667	416,667	416,667	416,667	416,667	416,667	0	0	0
DIVIDENDS		0	300,000	300,000	450,000	550,000	200,000	475,000	425,000	675,000	475,000
TOTAL OUTFLOWS	2,406,882	1,066,667	883,334	687,500	883,333	1,079,167	583,333	945,833	516,667	905,000	583,333
NET CASH	93,118	(73,060)	(6,106)	2,304	33,377	14,040	186,390	460,207	288,850	452,137	313,984
CASH B/FWD	93,118	20,058	13,952	16,256	49,632	63,673	250,063	710,270	999,121	1,451,258	1,765,241

4.3 PROJECTED PROFIT & LOSS ACCOUNT

	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10
REVENUE										
SALES INCOME	400,000	2,200,000	1,850,000	2,050,000	2,200,000	1,800,000	2,450,000	1,750,000	2,350,000	1,850,000
TOTAL	400,000	2,200,000	1,850,000	2,050,000	2,200,000	1,800,000	2,450,000	1,750,000	2,350,000	1,850,000
OPERATING EXPENSES										
FACTORY COSTS	0	0	50,000	0	0	0	0	0	0	0
PLANTATION COSTS	300,000	0	0	0	0	0	0	0	0	0
OVERHEAD COSTS	1,369,882	1,000,000	0	0	0	0	0	0	0	0
PERSONNEL/LABOUR	737,000	0	0	0	0	0	0	0	0	0
TOTAL	2,406,882	1,000,000	50,000	0	0	0	0	0	0	0
GROSS OPERATING PROFIT	(2,006,882)	1,212,057	1,800,000	2,050,000	2,200,000	1,800,000	2,450,000	1,750,000	2,350,000	1,850,000
DEPRECIATION	87,619	350,475	350,475	350,475	350,475	313,625	158,075	143,638	143,325	154,842
INTEREST ON LONG TERM DEBT	0	0	416,667	416,667	416,667	416,667	416,667	416,667	0	0
NETT PROFIT	(2,094,501)	511,582	1,032,858	1,282,858	1,432,858	1,069,708	1,875,258	1,189,695	2,206,675	1,695,158
CORPORATION TAX	0	0	0	0	0	374,398	656,340	416,393	772,336	593,305
DIVIDENDS	0	300,000	300,000	450,000	550,000	200,000	475,000	425,000	675,000	475 000
RETAINED EARNINGS	(110,250)	211,582	42,608	114,595	191,502	259,378	767,635	242,619	533,892	271,575

4.4 PROJECTED BALANCE SHEET

	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10
ASSETS										
FIXED ASSETS										
LAND	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000
BORE HOLES	295,000	275,000	255,000	235,000	215,000	195,000	175,000	155,000	135,000	165,000
DRIP IRRIGATION	297,834	277,642	257,450	237,258	217,065	196,873	176,681	156,489	136,297	166,105
FACTORY BUILDING	198,000	190,000	182,000	174,000	166,000	158,000	150,000	142,000	184,000	174,000
EXPATRIATE HOUSING	247,500	237,500	227,500	217,500	207,500	197,500	187,500	177,500	182,500	171,900
PLANTATION EQUIPMENT	149,467	139,333	129,200	119,067	108,933	98,800	88,667	128,533	115,967	101,600
PRODUCTION EQUIPMENT	737,500	687,500	637,500	587,500	537,500	487,500	437,500	487,500	530,833	467,500
VEHICLES - PLANTATION	96,250	81,250	66,250	51,250	111,250	85,000	58,750	41,250	30,000	43,750
VEHICLES	48,125	40,625	33,125	25,625	43,125	31,875	20,625	13,750	10,000	31,250
OFFICE FURNITURE & EQUIPMENT	14,438	12,188	9,938	7,688	5,438	3,188	938	0	15,000	12,750
TOTAL	2,334,113	2,191,038	2,047,962	1,904,887	1,861,811	1,703,736	1,545,660	1,552,022	1,588,697	1,583,855
INTANGIBLE ASSETS										
PRE-OPERATING COSTS	700,150	552,750	405,350	257,950	110,550	0	0	0	0	0
PRE-OPERATING FINANCIAL COSTS	285,000	225,000	165,000	105,000	45,000	0	0	0	0	0
TOTAL INTANGIBLE ASSETS	985,150	777,750	570,350	362,950	155,550	0	0	0	0	0
CURRENT ASSETS										
STOCKS - FINISHED PRODUCT	0	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000
DEBTORS	66,667	183,333	154,167	170,833	183,333	150,000	204,167	145,833	195,833	154,167
CASH IN BANK	20,058	13,952	16,256	49,632	63,673	250,063	710,270	999,121	1,451,258	1,765,241
TOTAL CURRENT ASSETS	86,725	247,285	220,423	270,465	297,006	450,063	964,437	1,194,954	1,697,091	1,969,408
TOTAL ASSETS	3,405,988	3,216,073	2,838,735	2,538,302	2,314,367	2,153,799	2,510,097	2,746,976	3,285,788	3,553,263
LIABILITIES										
SHARE CAPITAL	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000
RETAINED EARNINGS	(110,250)	101,331	143,939	258,534	450,036	709,414	1,477,649	1,719,668	2,253,559	2,525,134
TOTAL	889,750	1,101,331	1,143,939	1,258,534	1,450,036	1,709,414	2,477,649	2,719,668	3,253,559	2,525,134
CURRENT LIABILITIES										
ACCRUED LIABILITIES	16,238	31,408	28,128	29,768	30,998	27,718	33,048	27,308	32,228	28,128
TERM FINANCING	416,667	416,667	416,667	416,667	416,667	416,667	0	0	0	0
TOTAL CURRENT LIABILITIES	432,905	448,075	444,795	446,435	447,665	444,385	33,048	27,308	32,228	28,128
LONG TERM LIABILITIES										
TERM FINANCING	2,083,333	1,666,667	1,250,000	833,333	416,667	0	0	0	0	0
TOTAL LONG TERM LIABILITIES	2,083,333	1,666,667	1,250,000	833,333	416,667	0	0	0	0	0
TOTAL LIABILITIES	3,405,988	3,216,073	2,838,734	2,538,303	2,314,367	2,153,799	2,510,097	2,746,976	3,285,788	3,553,263

4.5.3. PERSONNEL COSTS

PLANTATION PERSONNEL	NUMBER	ANNUAL SALARY	SOCIAL BENEFITS (10%)	SUB TOTAL	TOTAL
EXPATRIATE (INCLUDING LOCAL ALLOWANCES)					
PLANTATION MANAGER	1	18,667	0	18,667	18,667
ASSISTANT PLANTATION MANAGER	1	14,333	0	14,333	14,333
LOCAL					
SUPERVISORS	19	3,333	333	3,667	69,667
PLANTATION LABOUR (PERMANENT)	138	500	50	550	75,900
TAPPERS (PART TIME CASUAL LABOUR)	340	278	28	306	103,889
TOTAL	499	37,111	411	37,522	282,456
FACTORY PERSONNEL					
EXPATRIATE (INCLUDING LOCAL ALLOWANCES)					
PRODUCTION MANAGER	1	18,667	0	18,667	18,667
ASSISTANT PRODUCTION MANAGER/LAB. SUPERVISOR	1	14,333	0	14,333	14,333
LOCAL					
SUPERVISOR	3	913	91	1,004	3,011
BOILER OPERATOR	2	4,000	400	4,400	8,800
ELECTRICAL/MECHANICAL ENGINEER	1	4,000	400	4,400	4,400
WORKSHOP MANAGER	1	4,000	400	4,400	4,400
SKILLED LABOUR	6	4,000	400	4,400	26,400
SEMI- SKILLED LABOUR	5	2,000	200	2,200	11,000
UNSKILLED LABOUR	3	500	50	550	1,650
TOTAL	23	52,413	1,941	54,354	92,661
MANAGEMENT AND ADMINISTRATIVE PERSONNEL					
EXPATRIATE					
MANAGING DIRECTOR	1	42,000	0	42,000	42,000
LOCAL					
SECRETARY	2	3,200	320	3,520	7,040
SECRETARY/RECEPTIONIST	1	2,400	240	2,640	2,640
FINANCIAL CONTROLLER	1	6,667	667	7,333	7,333
INVENTORY CLERK	1	2,400	240	2,640	2,640
PERSONNEL MANAGER	1	5,333	533	5,867	5,867
ASSISTANT PERSONNEL MANAGER	1	4,000	400	4,400	4,400
PURCHASE/EXPORT MANAGER	1	2,400	240	2,640	2,640
DRIVER/MESSENGER	1	1,333	133	1,467	1,467
SECURITY GUARD	6	667	67	733	4,400
TOTAL	16	70,400	2,840	73,240	80,427
TOTAL PERSONNEL	538	159,924	5,192	165,116	455,543

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4.5.4 ASSET SCHEDULES

INVESTMENTS		RATE	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10
LAND	250,000									
BORE HOLES	300,000	6.6%								50,000
DRIP IRRIGATION	302,882	6.6%								50,000
EXPATRIATE HOUSING	200,000	4%							50,000	
FACTORY BUILDING	250,000	4%							15,000	
PLANTATION EQUIPMENT	152,000	6.6%						50,000		
PRODUCTION EQUIPMENT	750,000	6.6%						100,000	100,000	
VEHICLES - PLANTATION	100,000	15%			75,000					25,000
VEHICLES	50,000	15%			25,000					25,000
OFFICE FURNITURE & EQUIPMENT	15,000	15%							15,000	
TOTAL INVESTMENTS	2,369,882									
PRE-OPERATING EXPENSES	737,000	20%								
TOTAL	3,106,882									
PRE-OPERATING FINANCIAL COSTS	300,000	20%								

DEPRECIATION	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10
BORE HOLES	5,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000
DRIP IRRIGATION	5,048	20,192	20,192	20,192	20,192	20,192	20,192	20,192	20,192	20,192
EXPATRIATE HOUSING	2,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	10,000
FACTORY BUILDING	2,500	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
PLANTATION EQUIPMENT	2,533	10,133	10,133	10,133	10,133	10,133	10,133	10,133	13,467	13,467
PRODUCTION EQUIPMENT	12,500	50,000	50,000	50,000	50,000	50,000	50,000	50,000	56,667	63,333
VEHICLES - PLANTATION	3,750	15,000	15,000	15,000	15,000	26,250	17,500	17,500	11,250	11,250
VEHICLES	1,875	7,500	7,500	7,500	7,500	11,250	11,250	6,875	3,750	3,750
OFFICE FURNITURE & EQUIPMENT	563	2,250	2,250	2,250	2,250	2,250	2,250	938	0	2,250
PRE-OPERATING COSTS	36,850	147,400	147,400	147,400	147,400	110,550	0	0	0	0
PRE-OPERATING FINANCIAL COSTS	15,000	60,000	60,000	60,000	60,000	45,000	0	0	0	0
TOTAL	87,619	350,475	350,475	350,475	350,475	313,625	155,075	141,638	143,325	154,842

BOOK VALUES	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10
BORE HOLES	295,000	275,000	255,000	235,000	215,000	195,000	175,000	155,000	135,000	165,000
DRIP IRRIGATION	297,834	277,642	257,450	237,258	217,065	196,873	176,681	156,489	136,297	166,105
EXPATRIATE HOUSING	198,000	190,000	182,000	174,000	166,000	158,000	150,000	142,000	184,000	174,000
FACTORY BUILDING	247,500	237,500	227,500	217,500	207,500	197,500	187,500	177,500	182,500	171,900
PLANTATION EQUIPMENT	149,467	139,333	129,200	119,067	108,933	98,800	88,667	128,533	115,067	101,600
PRODUCTION EQUIPMENT	737,500	687,500	637,500	587,500	537,500	487,500	437,500	487,500	530,833	467,500
VEHICLES - PLANTATION	96,250	81,250	66,250	51,250	111,250	85,000	58,750	41,250	30,000	43,750
VEHICLES	48,125	40,625	33,125	25,625	43,125	31,875	20,625	13,750	10,000	31,250
OFFICE FURNITURE & EQUIPMENT	14,438	12,188	9,938	7,688	5,438	3,188	938	0	15,000	12,750
PRE-OPERATING COSTS	700,150	552,750	405,350	257,950	110,550	0	0	0	0	0
PRE-OPERATING FINANCIAL COSTS	285,000	225,000	165,000	105,000	45,000	0	0	0	0	0
TOTAL	3,069,263	2,718,788	2,368,312	2,017,837	1,767,361	1,453,736	1,295,669	1,302,022	1,338,697	1,333,555

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4.5.5 OVERHEAD COSTS - ADMINISTRATION (PER ANNUM)

VEHICLES	6,000
OFFICE SUPPLIES	2,000
TRANSPORT: AIR/LOCAL	30,000
LEGAL/AUDIT	7,000
MARKETING	10,000
TEL/FAX/TLX	12,000
INSURANCE	25,000
TOTAL	92,000

4.5.6 ANALYSIS OF PRE-OPERATING COSTS (18 MONTHS)

LAND CLEARANCE/ACCESS ROADS	100,000
SEEDS/PLASTIC BAGS	15,000
FERTILIZER	60,000
PESTICIDES	40,000
ORGANIC COMPOST	70,000
SPARE PARTS AND MAINTENANCE	25,000
LABOUR	250,000
OVERHEAD COSTS	125,000
PROJECT FINANCING/LEGAL	50,000
COMPANY FORMATION	2,000
TOTAL	737,000
WORKING CAPITAL	393,118
TOTAL PROJECT COST	3,500,000

4.5.7 FINANCIAL AND INVENTORY ASSUMPTIONS

TOTAL PROJECT COST	3,500,000
FINANCED BY:	
EQUITY	1,000,000
LONG TERM LOANS	2,500,000

	PRE-OPERATIONAL*		PRODUCTION&SALES							
	12 MTHS	6 MTHS	YEAR 1**	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8
LOAN DRAW DOWN	1,500,000									
REPAYMENTS			0	250,000	250,000	250,000	250,000	250,000	250,000	0
INTEREST AT 10%			300,000	150,000	125,000	100,000	75,000	50,000	25,000	0
LOAN DRAW DOWN		1,000,000								
REPAYMENTS			0	166,667	166,667	166,667	166,667	166,667	166,667	0
INTEREST AT 10%			0	200,000	83,333	66,667	50,000	33,333	16,667	0

* PRE-OPERATIONAL PERIOD IS 18 MONTHS
** PRODUCTION AND SALES YEAR 1 ASSUMES 3 MONTHS TRIAL PRODUCTION, 3 MONTHS SALES AND 3 MONTHS DEPRECIATION

DEBTORS: 1 MONTH SALES
ACCRUED LIABILITIES: 1 MONTH OVERHEAD/PLANTATION/PRODUCTION COSTS

CORPORATE TAXES: ASUMES THAT THE COMPANY WILL BE GRANTED THE INVESTMENT INCENTIVES UNDER THE GAMBIA DEVELOPMENT ACT OF 1988

CASH IN BANK: ASSUMES NO INTEREST ON DEPOSITS

4.5.8 FINANCIAL RATIOS

Projected Internal Rate of Return: 13%

Projected Shareholders return on investment: 27%

ANNEX I

SOURCES AND REFERENCES

U.S.A.

Client	Location	Contact
Ask Ingredients	New Jersey	Mr. Rohit Kripalani
Ampak Co.	New York	Mr. Amarish
Botanical Int. Inc.	California	Mr. David Solomon
CAL India Foods Int.	California	Mr. Vick Rathi
Chart Corporation	New Jersey	Ms. Claudia Blum
Enzyme Development Corp.	New York	Mr. Jack Haim
Marcor Development Corp.	New Jersey	Mr. Hans Eugster
Meer Corporation	New York	Mr. Pat Lepore
National Stabilsers Inc.	California	Mr. Bob Burger
Penta Manufacturing Co.	New Jersey	Mr. Eposito
J. Siebel & Sons	Chicago	Mr. George Sheppard
Spectrum Chem. Mfg Corp.	New Jersey	Mr. Mark Hurd
Weinstein Chemicals Inc.	California	Ms. Aileen Watanabe

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E.E.C.

Client	Location	Contact
Biocon	Ireland	Mr. Michael Woulfe
Biocatalyst	Wales	Prof. Tony Godfrey
Rhone Poulenc Chemicals	England	Mr. Tom Delaney
Murphy & Sons	England	Mr. Stephen Haile
Eurotrading Produce Ltd	England	Mr. Alistair Todd
Direct Tea Supplies	England	Mr. Brian Judd
Enzymase Int. S.A.	Belgium	Mr. Rene Benbassat
Kleginger	Belgium	Mr. R. Peeters
New Biolux	Belgium	Mr. Danny Tas
Rapidase-Wallerstein	France	Mr. R de Coker
Ste. de Prod. Chem. Ind	France	Mr. Lochon
Schmitt Jourdan	France	Mr. Schmitt
Franco-Chim	France	Mr. Patoux
Schluter & Co.,	Switzerland	Mr. John Schluter
Otto Brandes	Germany	Dr. Lucken
Heinrich Ambrosius	Germany	Mr. J Ambrosius
Gist Brocades	The Netherlands	Mr. Anton Mayer

JAPAN

Mitsui & Co	UK Rep. Office	Mr. Nishida
Mitsubishi Corporation	UK Rep. Office	Mr. R. Alexander
C. Itoh	UK Rep. Office	MR. G. Daniels
Toshoku	UK Rep. Office	Mr. Kama

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ANNEX I

SOURCES AND REFERENCES

A. Publications

Tropical Products Institute: The Market Potential for Papain (UK)

Economic Botany: The Production of Papain (UK)

Agricultural University, Wageningen, The Netherlands: Food Enzymes Prospects and Limitations

Patent Specification: Method for Processing Papaya Latex, and Product Obtained

Tropical Science: A Review – Production and Utilisation of Papain

Food Chemicals Codex (US)

Process Biochemistry: Refined Papain

Enzymase International S.A. – Company Literature for Refined Papain

Hwang & Ivy University of Illinois, Chicago – Review of Papain

B. Government Agencies

National Research Institute (UK)

Central Food Technological Research Institute, Mysore, India

Eurostat (EEC)

U.S. Dept. of Agriculture

U.S. Department of Commerce

Japan Export Trade Organisation (JETRO)

H.M. Customs & Excises

U.S. Customs Services

C. Trade Associations/Industry Sources

1) Brewing

The Brewers Society (UK)
United States Brewers Association
The Breweries Association of Japan

2) Pet Foods

The Pet Food Manufacturers Association (UK)
Pet Care Europe (Division of Mars International Inc.)
The Pet Food Institute, USA

3) Meat Tenderisation

The Meat and Livestock Commission (UK)
The American Meat Institute (USA)
Swift & Co. (USA)

4) Food Additives

Distillers Company (Yeast) Limited, UK
Kraft (US) (Yeast Extract Products)
Institute of Food and Technology (US)
Ministry of Agriculture, Fisheries & Food, National Food Survey (UK)

D. Processors

Jain Plastics, India Mr. R.B. Jain

Enzochem Laboratories PVT, India : Mr. Warma

Enzymase International S.A., Belgium: Mr Rene Benbassat

Reco Industries, Uganda: Mr. Rwabwogo

E. Importers/Distributers/Manufacturers of Papain Enzyme Preparations

The following list of importers/distributors and manufacturers of papain enzyme preparations were contacted by fax (sample questionnaire attached) and/or telephone. In the case of Japan, where all imports of refined papain are made through the major trading companies, marketing information was obtained through the assistance of their UK representative offices.

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To:

Date:

Attn:

We are currently undertaking a feasibility study for establishing a papaya cultivation and refined papain processing plant to be located in West Africa.

In order to assist our research we would be grateful if you could fill in the questionnaire below and return to the above fax number.

What are your annual requirements for refined papain

What price are you currently paying per kg C&F for refined papain

From what source/country of origin are you obtaining refined papain

Would you be interested in obtaining refined papain from a new supplier source.

Other comments:

Thank you for your assistance and we shall advise you as and when the plant becomes operational.

C.F. Street

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F. MEETINGS CONDUCTED IN THE GAMBIA BY Mr. P. JOHN

1. Water Analysis

Director of Water Resources Dept., - Mr. S. Johnson
Banjul

2. Soil Analysis

Manager of Soil Chemistry Laboratory - Mr. Sheriff Njie
Dept. of Agriculture, Banjul

3. Pests & Diseases

Director of Agriculture Pest Management Unit - Mr. Bakary Trawally
Dept. of Agricultural Services, Yundum

Technical Advisor - Dr. Sharma
Dept. of Agriculture, Banjul

4. Bore Holes

George Stowe & Co. Ltd, representative in The Gambia - Mr. D.W. Clarke

5. Construction

Taf Construction Ltd.
General Manager - Mr. Mustapha Njie

6. Accountant

Mr. Augustus F. Prom

7. General

Radvill Farms
Managing Director - Rohit Shah
Farm Manager - Mr. Axel Pedersen

Former engineer of Citro Products Ltd., - Mr. Reynold Carol

Agricultural Consultant - Mr. Pa Gaye

ANNEX II

PROFILES OF CONSULTANTS

ANNEX II

PROFILES OF CONSULTANTS

Mr. C.F. Street
Nationality: British
Date of Birth: 23rd October, 1939

1986 – Present: Arinor Limited – Managing Director

Specialist responsibilities include trading and marketing, in Europe and the U.S., of a diverse range of natural products with special emphasis on enzymes in particular papain, bromelin and ficin; spices (ginger, chilies, tumeric) and spice extracts; black pepper oleoresin, ginger oleoresin, chili oleoresin; essential oils from spices and other natural materials. He was responsible for the feasibility studies for a liquid and powdered papain product for the food industry, which was successfully introduced into the U.K. market and a pre-feasibility study for establishing a papaya plantation for the production of purified papain powder in Nigeria. He has also advised on papaya latex collection in Sri Lanka for an existing plantation.

1976 – 1986: Biddle Sawyer & Co. Ltd – Technical and Marketing Director, Natural Products Division

Responsibilities included; the marketing of papain and other enzymes, spices, essential oils, herbs, gums ,waxes to the food, chemical, perfumery and allied industries in Europe and the U.S.; management of a small research and quality control laboratory; market research and development of new product areas; pilot plant studies and laboratory studies for the formulation of new products. In particular, he was responsible for long range financial planning and preparation of the annual budgets for his division.

1972 – 1976: Brooke Bond Liebig Commodities Ltd – Director of Marketing and New Product Development

Responsible for; market research projects involving the sale of food ingredients to outside industries; liaison with research and technical development departments in the group; budget and costing reviews for the company's new products development.

1964 – 1972: Glaxo Laboratories Ltd. – Technical and Research Manager

Responsible for studies on the spray-drying of milk based foods, including product development form pilot plant through to full production and pilot plant studies on other methods of dehydrating foods, including drum drying, fluid-bed drying and freeze-drying. He developed a new method of spray-drying milk to achieve a semi-instant product.

Mr. Street obtained his B.Sc. (Honours) in Nutrition and M.Sc. in General Biochemistry from the University of London.

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Mr. Philip John
Nationality: Indian
Date of Birth: 12th July, 1947

1985 – Present: Technical Consultant

Specialist consultant in all aspects of establishing manufacturing units in the field of enzymes based processes, oleoresins, essential oils in India. The assignments have involved providing a complete technical evaluation of the plant required, equipment specifications, design and sourcing, recommended processes and methodology and technical assistance for project implementation.

Major Clients of successful installations in India include:

Encee Aromatics Pvt. Ltd. – Purified papain processing plant

Indo Nissin Foods Ltd. – Food enzymes research, including papain

Accelerated Freeze Drying Co. Ltd. – recommended improvements to existing papain processing plant and advised on spray drying techniques

Dhamayanthi Oleo Exports – Ginger, chili and tumeric oleoresin and essential oil plant

Geekay Agro Valley – papaya cultivation plantation for the production of crude papain

Chemmannur Extracts Pvt. Ltd. – Ginger, chili and tumeric oleoresin and essential oil plant

G.K. Industries – Ginger and chili oleoresin and essential oil plant

Amalgam Foods Ltd. – Sea food extracts plant for the extraction of flavour components using enzyme technology

He has also developed improved processes for the extraction of spice oleoresins and essential oils, with particular emphasis on ginger and chili, for Brooke Bond, India.

1979 – 1985

Founded Tropical Enzymes Pvt. Ltd., for the manufacture of purified papain powder. Successfully imported and implemented the technical know-how from Belgium for the manufacture of fully refined papain and exported the product to Australia, Belgium and U.K.

1970 – 1979 Shaw Wallace & Co. Ltd, India

Joined Shaw Wallace & Co., as a management trainee and in 1973 established their export division for the marketing of adhesive products and other chemicals. He was posted to London in 1975 as General Manager of Shaw Wallace Overseas Ltd. Activities included sales of all Shaw Wallace products into Europe and the U.S. and responsibility for all import requirements of the operations in India. He identified new areas of opportunity for high value agricultural processed products, particularly in spices, and researched and advised on extraction techniques for implementation in the parent company.

Mr. John obtained his engineering degree from the University of Madras, and Marketing qualification from the Institute of Marketing, London.

ANNEX III

PRODUCTION AND REPLANTING CHART

PRODUCTION AND REPLANTING CHART

	MONTHS												
	1	2	3	4	5	6	7	8	9	10	11	12	TOTAL PROD (KGS)
YEAR 1 (6 MONTHS)													
PAPAIN YIELD (KGS)							417	832	1,250	1,667	2,083	2,500	8,750
NO. HCTS. PLANTED							20	40	60	80	100	120	
YEAR 2													
PAPAIN YIELD (KGS)	2,917	3,333	3,750	4,167	4,167	4,167	4,167	4,167	4,167	3,750	3,333	2,917	45,002
NO. HCTS. PLANTED	140	160	180	200	200	200	200	200	200	180	160	140	
YEAR 3													
PAPAIN YIELD (KGS)	2,500	2,083	1,667	2,083	2,500	2,917	3,333	3,750	4,167	4,167	4,167	4,167	37,501
NO. HCTS. PLANTED	120	100	80	100	120	140	160	180	200	200	200	200	
YEAR 4													
PAPAIN YIELD (KGS)	4,167	4,167	4,167	4,167	4,167	4,167	3,750	3,333	2,917	2,500	2,083	1,667	41,252
NO. HCTS. PLANTED	200	200	200	200	200	200	180	160	140	120	100	80	
YEAR 5													
PAPAIN YIELD (KGS)	2,083	2,500	2,917	3,333	3,750	4,167	4,167	4,167	4,167	4,167	4,167	4,167	43,752
NO. HCTS. PLANTED	100	120	140	160	180	200	200	200	200	200	200	200	
YEAR 6													
PAPAIN YIELD (KGS)	4,167	4,167	4,167	3,750	3,333	2,917	2,500	2,083	1,667	2,083	2,500	2,917	36,251
NO. HCTS. PLANTED	200	200	200	180	160	140	120	100	80	100	120	140	
YEAR 7													
PAPAIN YIELD (KGS)	3,333	3,750	4,167	4,167	4,167	4,167	4,167	4,167	4,167	4,167	4,167	4,167	48,753
NO. HCTS. PLANTED	160	180	200	200	200	200	200	200	200	200	200	200	
YEAR 8				2,500									
PAPAIN YIELD (KGS)	3,750	3,333	2,917	120	2,083	1,667	2,083	2,500	2,917	3,333	3,750	4,167	35,000
NO. HCTS. PLANTED	180	160	140		100	80	100	120	140	160	180	200	
YEAR 9				4,167									
PAPAIN YIELD (KGS)	4,167	4,167	4,167	200	4,167	4,167	4,167	4,167	4,167	3,750	3,333	2,917	47,503
NO. HCTS. PLANTED	200	200	200		200	200	200	200	200	180	160	140	
YEAR 10				2,083									
PAPAIN YIELD (KGS)	2,500	2,083	1,667	100	2,500	2,917	3,333	3,750	4,167	4,167	4,167	4,167	37,501
NO. HCTS. PLANTED	120	100	80		120	140	160	180	200	200	200	200	

NOTES TO PRODUCTION AND REPLANTING CHART

Production of refined papain is based on the followng assumptions:

No. of trees planted per hectare: 2,000
Average latex yield per tree: 1.25 kg per annum

Latex after processin yields 10 per cent refined papain

Replanting cycle is based on the following assumptions:

No. of ha planted per month: 20

Tee cultivation period until first latex yield: nine months

Average duration of latex yeild: 15 months

Replanting cycle: 24 months

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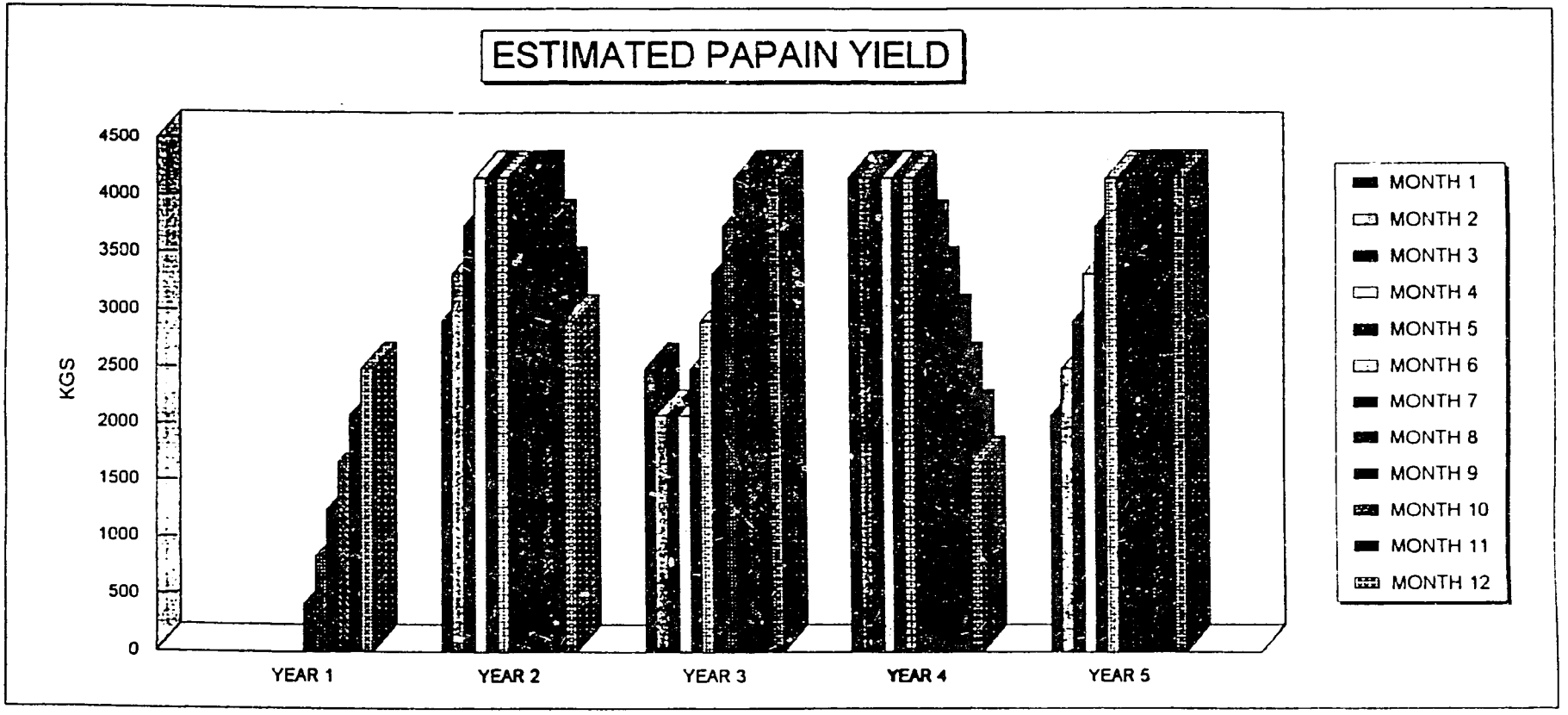
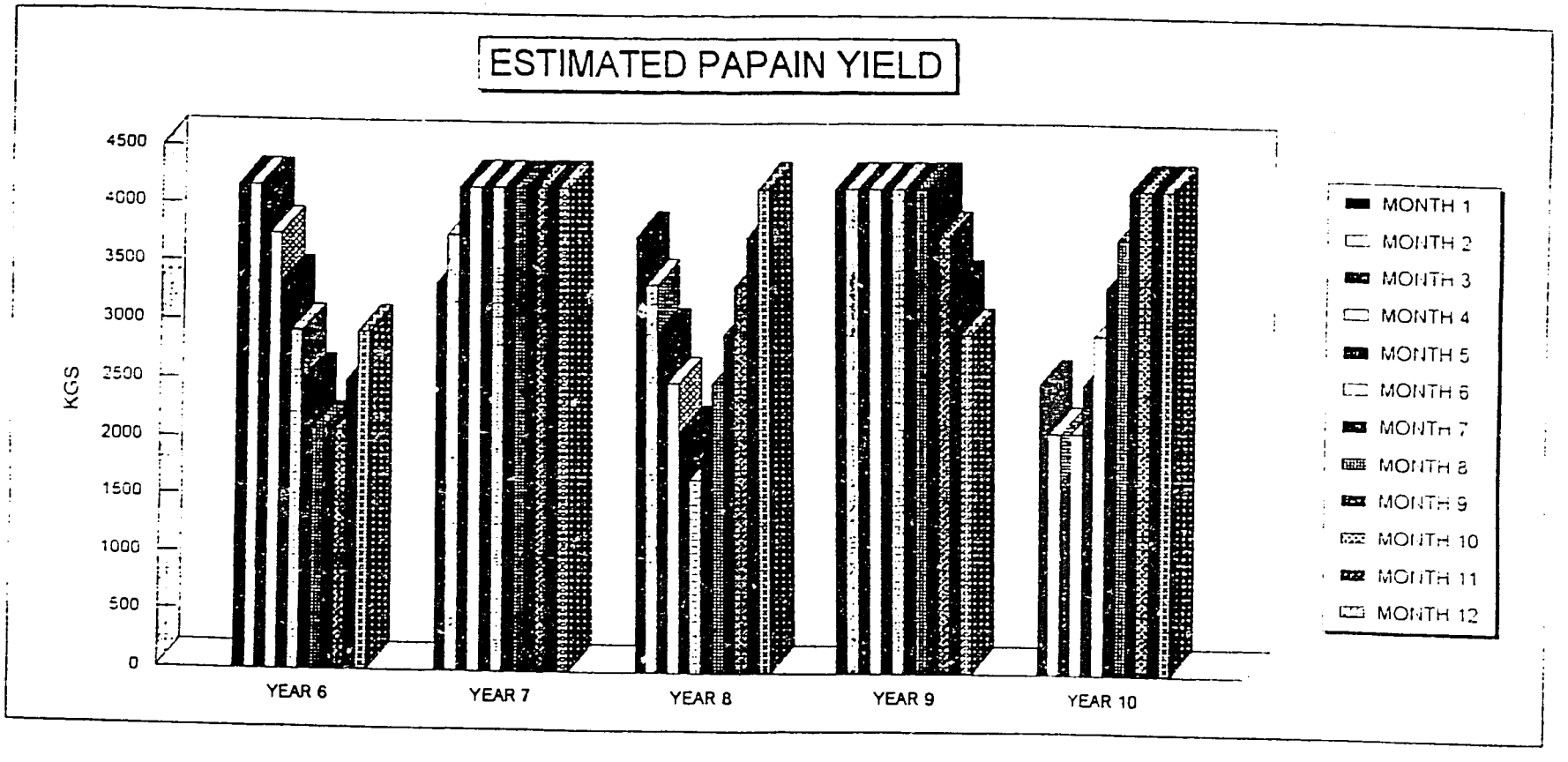

ESTIMATED PAPAIN YIELD
KGS
4500
4000
3500
3000
2500
2000
1500
1000
500
0
YEAR 1
YEAR 2
YEAR 3
YEAR 4
YEAR 5
MONTH 1
MONTH 2
MONTH 3
MONTH 4
MONTH 5
MONTH 6
MONTH 7
MONTH 8
MONTH 9
MONTH 10
MONTH 11
MONTH 12


ESTIMATED PAPAIN YIELD
KGS
4500
4000
3500
3000
2500
2000
1500
1000
500
0
YEAR 6
YEAR 7
YEAR 8
YEAR 9
YEAR 10
MONTH 1
MONTH 2
MONTH 3
MONTH 4
MONTH 5
MONTH 6
MONTH 7
MONTH 8
MONTH 9
MONTH 10
MONTH 11
MONTH 12

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ANNEX IV

SPECIFICATIONS AND STANDARDS

ANNEX IV

SPECIFICATIONS AND STANDARDS

Assay: Not less than 6000 N.F. units of papain activity per mg. (Note: One N.F. Unit of papain activity is the activity which releases the equivalent of 1 mg of tyrosine from a specificed casein substrate under the conditions of the Assay, using the enzyme concentration which liberates 40 mg of tyrosine per ml of Standard Solution)

Loss on drying: not more than 7 per cent

pH of a 1 in 50 solution: between 4.8 and 6.2

Limits of Impurities:

Arsenic (as As): not more than 3 parts per million 0.0003 per cent)

Heavy metals (as Pb): Not more than 10 parts per million (0.0001 per cent)

ANNEX V

METEROLOGICAL CHARTS

ANNEX V

METEROLOGICAL CHARTS

Rainfall (mm) for Gambia, averages over the priod 1982–1991

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	NR
Yundum Airpor	0	0	0	0	0	51	214	312	191	49	1	1	817	9

Rainfall (mm) for Yundum Airport

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1982	0	0	0	0	2	26	261	312	141	106	0	0	848
1983	0	0	0	0	0	19	115	193	88	9	0	0	424
1984	0	0	0	0	0	187	132	185	123	34	5	0	666
1985	0	0	0	0	0	19	380	313	198	34	0	5	949
1986	0	0	0	0	0	34	47	406	215	66	0	0	768
1987	0	0	1	0	0	44	135	292	231	98	0	0	801
1988	0	0	0	0	1	22	383	547	215	55	0	0	1222
1989	0	0	0	0	0	157	242	347	340	48	0	0	1135
1990	0				0	2	265	330	213	14			824*
1991	0	0	0	0	0	0	178	192	152	23	0	0	544
A76	0	0*	0*	0*	0	51	214	312	191	49	1*	1*	817*

Rainfall (mm) for Gambia, Averages over the period 1951–1990

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	NR
Yundum Airpor	1	1	0	0	4	67	250	391	282	81	6	1	1101	36

Source: Department of Water Resources, Banjul

Yundum Relative Humidity % 41-Year Normal (1950-90)			
Month	Mean Max	Mean Min	Mean
Jan	82	22	57
Feb	83	22	53
Mar	86	25	57
Apr	86	31	64
May	90	42	71
Jun	92	53	76
Jul	94	65	83
Aug	96	67	87
Sept	96	51	87
Oct	95	58	83
Nov	94	40	73
Dec	88	27	59

Source: Department of Water Resources, Banjul

Sunshine Duration (hours) for Yundum Airport

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1984	6.8	..	8.4	9.1	..	4.6	6.1	7.2	..	7.4	8.2	5.8	7.1*
1985	6.0	9.3	5.8	7.9	8.6	5.9	5.0	5.1	6.2	7.5	8.8	6.3	6.7*
1986	7.7	10.3	9.1	..	7.4	6.8	6.3	5.2	5.7	7.9	..	..	7.3*
1987	7.6	..	9.2	6.5	..	6.4	6.8	5.9	..	..	8.0	7.9	7.4*
1988	7.0	6.4	..	8.7	..	6.1	..	4.7	..	8.0	8.4	8.0	7.4*
1989	..	..	7.6	8.5	9.5	..	..	5.4	7.6	..	7.5	..	6.4*
1990						7.7		..		7.0	..		8.0*
Avg	7.0*	8.7*	8.0*	8.1*	8.5*	6.3*	6.1*	5.6*	6.5*	7.7*	8.2*	7.0*	..

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ANNEX VI

SOIL ANALYSIS

ANNEX VI

SOIL ANALYSIS

Yundum Soils Laboratory – Soil Analysis Results
Tray 4

Tray	Box	Sample Identification	Soil pH Water 1:2	Soil pH .01 CaC12 1:2	EC mmhos/cm 1:2	Bray-1 Avl.P ppm	Nh40AC Exch K ppm	Nh40Ac Exch Na ppm	Nh40Ac Exch Ca ppm
78	9 Philip John,	Citro Field-Brikama. Site 1	5.0	4.3	0.28	3.6	26	99	247
78	10 Philip John,	Citro Field-Brikama. Site 2	6.8	6.7	0.15	11.0	21	40	307
78	11 Philip John,	Citro Field-Brikama. Site 3	6.5	5.7	0.05	5.8	10	40	262
78	12 Philip John,	Citro Field-Brikama. Site 4	5.7	4.6	0.02	3.0	15	60	210
78	13 Philip John,	Citro Field-Brikama. Site 5	6.0	5.0	0.05	4.8	27	46	272
78	14 Philip John,	Citro Field-Brikama. Site 6	6.2	5.7	0.04	9.2	10	35	345
78	15 Philip John,	Citro Field-Brikama. Site 7	6.1	5.3	0.04	26.0	14	26	162
78	16 Philip John,	Citro Field-Brikama. Site 8	6.0	5.4	0.05	5.0	16	43	399
78	17 Philip John,	Citro Field-Brikama. Site 9	5.7	4.7	0.02	5.0	17	40	347
78	18 Philip John,	Citro Field-Brikama. Site 10	5.4	4.4	0.04	9.5	17	35	120

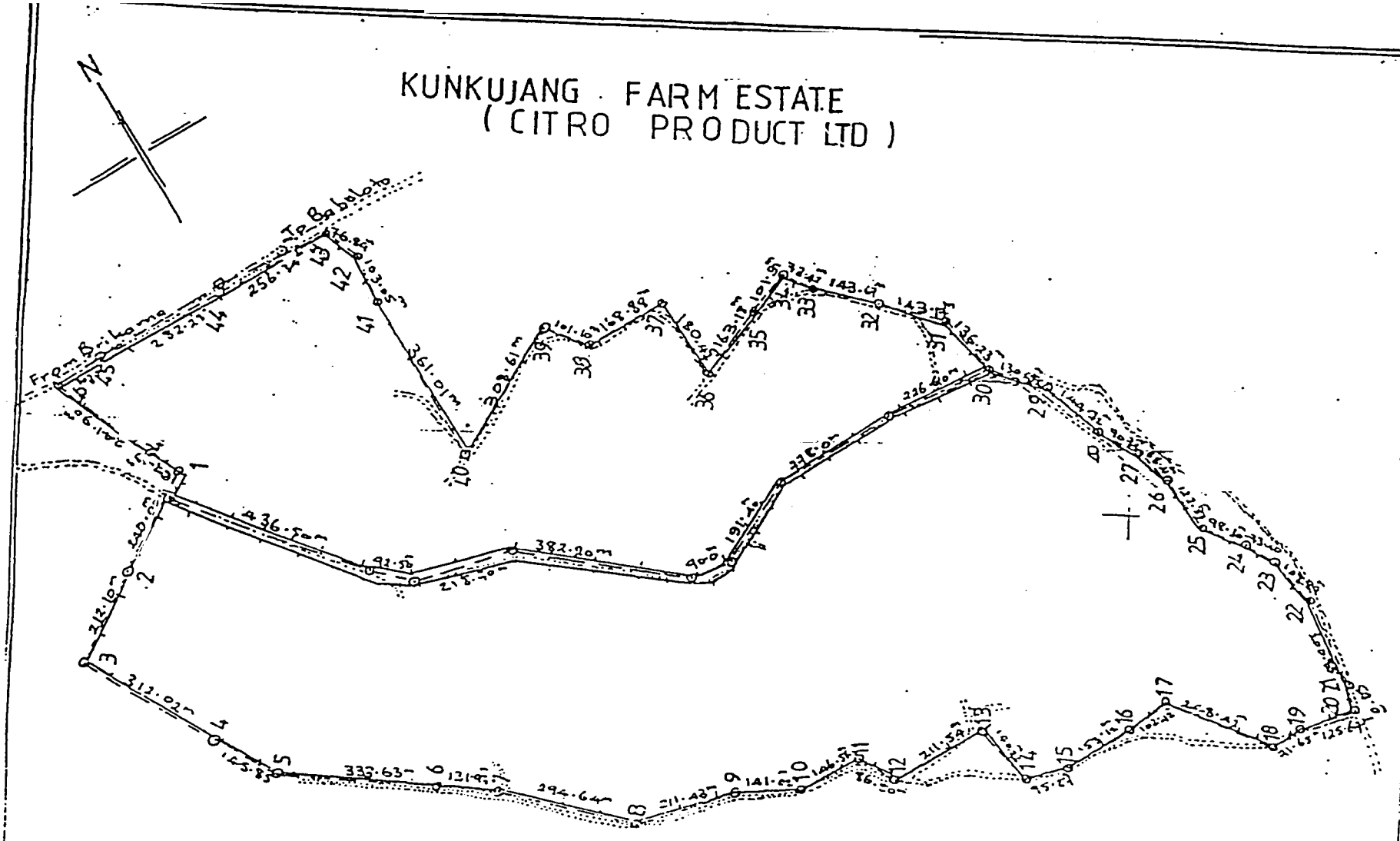
Yundum Soils Laboratory – Soil Analysis Results
Tray 4

Tray	Box	Sample Identification	LOI 360C	% Sand	% Clay	% Silt	% N
78	9 Philip John,	Citro Field-Brikama. Site 1	1.85	53.7	18.3	28.0	1.3
78	10 Philip John,	Citro Field-Brikama. Site 2	1.17	71.7	22.3	6.0	1.3
78	11 Philip John,	Citro Field-Brikama. Site 3	1.23	55.7	12.3	32.0	2.3
78	12 Philip John,	Citro Field-Brikama. Site 4	1.49	61.7	14.3	24.0	0.8
78	13 Philip John,	Citro Field-Brikama. Site 5	1.43	61.7	10.3	28.0	0.8
78	14 Philip John,	Citro Field-Brikama. Site 6	0.92	75.7	12.3	12.0	1.3
78	15 Philip John,	Citro Field-Brikama. Site 7	0.79	71.7	12.3	16.0	0.8
78	16 Philip John,	Citro Field-Brikama. Site 8	1.34	61.7	12.3	26.0	1.5
78	17 Philip John,	Citro Field-Brikama. Site 9	1.33	61.7	16.3	22.0	0.8
78	18 Philip John,	Citro Field-Brikama. Site 10	0.62	79.7	8.0	8.0	0.8

ANNEX VII

KUNKUJANG FARM ESTATE

KUNKUJANG FARM ESTATE
(CITRO PRODUCT LTD)



TRAVERSE ROUTE - - - - -
BP POINT θ

MT ROAD ==========

SCALE 1:10000

SURVEYOR
15/5/91
LANG CONSULTANTS

ANNEX VIII

IRRIGATION METHODS

ANNEX VIII
IRRIGATION METHODS

Introduction

Conventional methods of irrigation such as furrow irrigation, border irrigation and basin irrigation do not effectively control the water application rate and can cause water logging, build up of salinity etc. In addition, appreciable amounts of irrigation water may be lost due to percolation beyond the root zone. The concept of drip irrigation, developed in the seventies in Israel, has overcome many of these problems.

The drip irrigation system ensures the delivery of sufficient water and nutrients directly to the root system according to the plants need. It makes efficient use of limited water resources and optimum use of other inputs such as nutrients.

Drip System Requirements

A drip irrigation system consists of the following:

Water supply pump
Filters, fertilizer mixing tank
Control system
Pressure regulators
Monitor valve/water meter
Header lines
Laterals
Drippers

Advantages of Drip Irrigation System

1. Water Saving

By applying water directly to the root zone, water saving ranges from 30 per cent to 70 per cent depending upon the area covered by the plants. This is due to:

a) only the required surface soil is dampened
b) less water is lost through wind evaporation
c) water is distributed evenly through the root zone
d) no water is lost below the root zone (percolation loss)
e) no water is utilised by weeds

Water loss under various irrigation methods:

	Normal Climate	Hot Climate
Surface Irrigation	30–45%	35–50%
Gate Pipe Irrigation	15–20%	20–25%
Sprinkler Irrigation	6–9%	10–20%
Drip Irrigation	1–2%	2–3%

2. Labour Saving

a) the drip system eliminates the need for labour intensive construction of borders, channels etc. associated with conventional irrigation techniques
b) constant optimal oxygen/moisture relation eliminates scraping and tilling
c) there is no conflict between irrigation, spraying and harvesting
d) soil needs no furrow renewals, and is not eroded
e) weeding is minimised

Trials for papaya, conducted by Jain Irrigation Systems, India, determined a 75 per cent increase in yield and 68 per cent saving in water by drip irrigation when compared to conventional irrigation methods.

3. Non-interference with Cultivation Procedures

Most cultivation procedures may be carried out during the drip irrigation process as only the immediate areas around the plant are dampened. This is beneficial to an inter-spaced rotation planting system where new pits can be dig in dry soil areas.

4. Reduced Weed Growth

Weed seed germination and subsequent growth depends upon adequate soil moisture. Since only the root zone receives moisture under a drip irrigation system, widespread weed growth is inhibited.

5. Fertilizer and Micro-elements

A reduction of between 30-60 per cent can be achieved on fertilizer/chemical usage due to:

a) fertilizers and micro nutrients are applied directly to the root zone
b) no chemical sediment remains on soil, leaves etc.
c) there is no run off or leaching of nutrients/chemicals

6. Yield and Plant Growth

Increased yield and plant growth is due to:

a) optimum soil moisture
b) frequent and slow fertilisation, including micro nutrients
c) maintenance of ideal moisture/oxygen ratio
d) increase in the growth of soil micro-organisms
e) higher soil temperature, less energy spent on evaporation
f) conservation of soil fertility

Additional advantages of the drip irrigation system are:

a) it is not susceptible to wind
b) it works at a very low pressure
c) land levelling is not required
d) it helps retain the soil structure for improved respiration
e) increased water holding capacity
f) no pollution is caused due to: runoff of fertilizer to the ground water
g) less herbicide requirements
h) less disease as stems and leaves are not dampened

Unlike sprinkler or flood irrigation systems, a drip irrigation system allows usage of poor quality water. With continuous water application, the root zone does not dry out and the salt concentration moves away from the root zone. Accumulated salt is therefore leached to the edge of the dampened soil area. Drip irrigation removes the highest salt concentration away from the plant root zone, and as a much smaller quantity of water is applied to the soil, the total salt content is lower.

ANNEX XI

PLANT AND EQUIPMENT SPECIFICATIONS

ANNEX IX

PROJECT IMPLEMENTATION SCHEDULE

MONTHS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
LAND CLEARANCE																		
BORE HOLE INSTALLATION																		
FENCING/INTERNAL ACCESS																		
CONSTRUCTION OF HOUSING COMPLEX																		
NURSERY PREPARATION																		
INSTALLATION OF DRIP IRRIGATION																		
PIT DIGGING																		
RAISE NURSERY SEEDLINGS (CONTINUOUS)																		
TRANSPLANT SEEDLINGS																		
ORDER EQUIPMENT																		
INSTALLATION OF DRIP IRRIGATION SYSTEM																		
CONSTRUCTION OF FACTORY																		
PIT DIGGING																		
TRANSPLANTING OF NURSERY SEEDLINGS																		
INSTALL/COMMISSION EQUIPMENT																		
FIRST LATEX YIELDS TRIAL PRODUCTION																		
TAPPING OF 1ST 20 HCTS																		

ANNEX X

TRAINING SCHEDULE

ANNEX X

TRAINING SCHEDULE

MONTHS	5	6	7	8	9	15	16	17
NURSERY LABOUR								
PIT DIGGING LABOUR								
TRANSPLANTING LABOUR								
FACTORY SUPERVISORS/OPERATORS								
LABORATORY TECHNICIANS								
TAPPING LABOUR								

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ANNEX IX

PROJECT IMPLEMENTATION SCHEDULE

ANNEX XI

PLANT AND EQUIPMENT SPECIFICATIONS

PROCESSING PLANT

DESCRIPTION	EST. COST US$	MANUFACTURER
12 STAINLESS STEEL TANKS WITH EMULSIFIERS & STIRRERS 9 TANKS X 300 LITRES X 800 MM X 600 MM 3 TANKS X 500 LITRES X 1100 MM X 600 MM	25,850	VIJAYA INC.
5 STAINLESS STEEL INSPECTION TABLES 7.75' X 3.75' WITH STAINLESS STEEL PIPE LEGS	1,500	VIJAYA INC.
100 STAINLESS STEEL 55 LITRE DRUMS	10,800	VIJAYA INC.
VACUUM EVAPORATOR @ 500 KGS PER HOUR	42,000	VIJAYA INC.
4 VACUUM SHELF DRYERS EACH WITH MOISTURE REMOVAL CAPACITY OF 40 KGS/HR	180,000	VIJAYA INC.
PLANETARY MIXER - 100 LITRES	3,250	VIJAYA INC.
DOUBLE CONE BLENDER - 300 KGS	2,850	VIJAYA INC.
DE-MINERALISING UNIT - 500 LITRES/HR OUTPUT WITH 8 HRS REGENERATION	2,500	VIJAYA INC.
DE-COLOURISING UNIT - 6" DIAMETER COLUMN WITH 4 DISTRIBUTORS	400	VIJAYA INC.
STAINLESS STEEL STERILISER - 1000 MM X 1000 MM	6,000	VIJAYA INC.
HOT WATER STAINLESS STEEL JACKETED TANK - 350 LITRES	1,000	VIJAYA INC.
5 STAINLESS STEEL CENTRIFUGES - 32" DIA. BASKET TYPE WITH 5MM HOLES. MOTOR OF 5 HP/1440 RPM	64,700	ENGINEERING DESIGN SYSTEMS
2 FILTER PRESSES PLATE AND FRAME TYPE CONTAINING 20 X 24" PLATES MADE OF STAINLESS STEEL 304 AND, 20 FRAMES EACH 30 MM THICK	51,700	ARGUS INDUSTRIES
4 SPARKLER FILTERS	16,500	ARGUS INDUSTRIES
VARIOUS PUMPS	10,900	ARGUS INDUSTRIES
AIR FILTRATION SYSTEM WITH FORCED VENTILATION SYSTEM WITH CENTRIFUGAL FANS TO PROVIDE 20 AIR CHANGES	38,700	INDUSTRIAL HYGENIC INC.
3 WEIGHING SCALES	1,930	AVERY INDIA
PULVERISER - PIN MILL TYPE	6,350	BATLIBOI & CO.
WORKSHOP EQUIPMENT	9,720	VARIOUS SUPPLIERS
LABORATORY EQUIPMENT	43,350	VARIOUS SUPPLIERS
BOILER - OIL FIRED TYPE WITH CAPACITY 2,000 KG/HR WITH PRESSURE AT 5 KG/CM2	52,000	THERMAX LTD
REFRIGERATION EQUIPMENT 1. ICE BANK SYSTEM FOR CHILLED WATER SUPPLY - 5 TONNE CAPACITY 2. REFRIGERATED ROOM FREEZER/CHILLER AREAS SIZE 20' X 10' - 5 TONNE CAPACITY	30,000	YETI REFRIGERATION
NUTCHE FILTER WITH CAPACITY OF 400 LTIRES FILTRATE AND 200 LTIRES CAKE	13,000	ARGUS INDUSTRIES
PIPING/ELECTRICALS/ACCESSORIES	48,000	VARIOUS SUPPLIERS
INSTALLATION	22,000	
FREIGHT/INSURANCE	40,000	
CONTINGENCY	25,000	
TOTAL	750,000	

Note: The above quotations have been obtained from various equipment suppliers in India

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NOTES TO PROJECT IMPLEMENTATION SCHEDULE

At start up of plantation operations the following essential inputs should be ordered:

Drip irrigation system (delivery approximately four months)

Compost, bone meal, pesticides, fungicides, nematicides, seeds plastic bags, farm vehicles etc. (delivery approximately three months)

Throughout the project implementation phase, continuous personnel training will be undertaken for all plantation and factory operations as required.

Vehicles	Est. Cost US$
4 Tractors/Trailers	65,000
3 Pick-Up Trucks	35,000
3 Four Wheel	50,000
Total	150,000

Plantation Equipment	Est.Cost US$
2 Generators (250 KVA)	50,000
5 Generators (75 KVA)	45,000
Spraying Equipment	5,000
Fencing	10,000
Tapping Equipment	15,000
Tools and Equipment	15,000
Spare Parts	12,000
Total	152,000

ANNEX XII

ANALYSIS OF CONVERSION FROM FRESH LATEX TO REFINED PAPAIN

ANNEX XII

ANALYSIS OF CONVERSION FROM FRESH LATEX TO REFINED PAPAIN

Estimated maximum yield of latex: 6,000 kg per day

6,000 kg latex at 10 per cent solids, contains approximately 5,400 kg water and 600 kg solids.

At 40 per cent concentration, latex will contain 900 kg water and 600 kg solids.

Water to be removed is therefore 5,400 – 900 = 4,500 kg water per 24 hours.

Evaporator has capacity of 500 kg per hr

Therefore 4,500 kg could be evaporated in nine hours (4500/500)

To dry the 900 + 600 = 1,500 kg resulting concentrate to say six per cent moisture, there is a need to reduce this weight to 636 kg dried latex. Therefore a further 864 kg water is removed in the four dryers.

Time taken to remove 864 kg by 4 x 40 kg per hr dryers is therefore 5.4 hours