145. PROFILE ON PRODUCTION OF SUGAR FROM CANE

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I. SUMMARY

This profile envisages the establishment of a plant for the production of sugar from sugar cane with a capacity of 47,250 tonnes per annum.

The present demand for the proposed product is estimated at 409,054 tonnes per annum. The demand is expected to reach at 832,553 tonnes by the year 2017.

The plant will create employment opportunities for 279 persons.

The total investment requirement is estimated at Birr 321.41 million, out of which Birr 200 million is required for plant and machinery.

The project is financially viable with an internal rate of return (IRR) of 37% and a net present value (NPV) of Birr 413.87 million discounted at 8.5%.

II. PRODUCT DESCRIPTION AND APPLICATION

Sugar, or sucrose, is a carbohydrate that occurs naturally in every fruit and vegetable in the plant kingdom. It is the major product of photosynthesis, the process by which plants transform the sugar energy into food. Sugar occurs in greatest quantities in sugar cane and sugar beets from which it is separated for commercial use.

The industrial practice in Ethiopia is the production of sugar from sugar cane. The product is mainly used for direct consumption, but also is used to prepare other types of foods such as, biscuits, confectioneries, breweries ,soft drinks, etc.

III. MARKET STUDY AND PLANT CAPACITY

A. MARKET STUDY

1. PAST SUPPLY AND PRESENT DEMAND

Sugar is consumed by households as well as different industries such as confectioneries, food processing and beverage industries, institution like colleges and universities, military, hotels, restaurants and bars. Due to its wide application in different sectors the demand for sugar is very huge in the domestic as well as international markets.

Ethiopia has been meeting most of its sugar requirement through local production. However, due to the shortages created in the past few years nearly 20% of sugar requirement is met through import. The historical domestic production and consumption/sales data of sugar is shown in Table 3.1

Table 3.1

DOMESTIC PRODUCTION AND SALES OF SUGAR (TON)

Year	Production	Consumption/Sales	Per Cent Sold
1996/92	172,217	145,357	84.4
1997/98	172,571	184,528	106,9
1998/99	234,987	198,164	84.3
1999/00	250,869	246,364	98.2
2000/01	251,349	245,498	97.7
2001/02	248,152	203,246	81.9
2002/03	268,008	283,300	105.7
2003/04	198,762	276,400	139.1
2004/05	274,836	273,777	99.6
Total	**2,071,751**	**2,056,634**	**99.4**

Source:- *CSA, Statistical Abstract of Ethiopa,2006.*

The historical production and consumption (sales) data reveals that the highest production, i.e. 274,836 tons, was registered in 2004/05 while the highest consumption (sales) of 283,300 tons was registered in 2001/02. During the entire period of nine years, production has averaged 230,195 ton while sales has averaged 228,515 tons. This indicates that the factories were holding 1,680 tons (1%) as a sock for strategic reasons.

The nine years data also indicates that production and consumption of sugar has been rising. During 1996/97 and 1997/98 production and consumption on the average was about 172.4 thousand tons and 165 thousand tons respectively. During 1998/99-2001/02, the yearly average production was about 246 thousand tons while the consumption/sales was around 223 thousand tons, respectively.

Production and consumption of sugar in the past three recent years has increased substantially compared to the previous years as a result of increased capacity utilization of the new Fincha Sugar Factory. Production and consumption during 2004/05 has been registered 274,836 and 273,777 tons.

In addition to the domestic production, sugar is supplied from import. Import of sugar for the past 10 years is presented in Table 3.2.

Table 3.2

IMPORT OF SUGAR (CANE OR BEET SUGAR) IN TON

Year	Quantity	Value(Birr)
1997	1,403	2,797,773
1998	1,925	5,255,238
1999	1,995	5,098,249
2000	2,770	7,062,891
2001	4,724	13,060,176
2002	825	2,570,990
2003	5,971	17,755,870
2004	53,771	133,657,497
2005	37,758	112,262,173
2006	52,407	212,711,375

As could be seen from Table 3.2, import of sugar in the recent three years has increased substantially to fill some part of the unsatisfied demand. During the period 1997-2002 the yearly average leved of import was about 2,273 tons. During 2003-imported sugar amounted 5,971 tons which is more than double of the previous years average. Import of sugar has sharply increased during 2004-2006. The yearly average import during these years was about 48 thousand tons. During year 2006 alone Ethiopia has imported 52,407 tons of sugar with an expenditure of about Birr 213 million. This indicates that Ethiopia needs more sugar factories to satisfy the existing demand.

To estimate the current demand for sugar the following methodology is adopted.

- The imported and domestically supplied sugar in the year 2006 has been added and found to be 327,243 tons (274,836 tons from local and 52,407 tons from import)
- According to opinions gathered from knowledgeable people in the area, the current supply of sugar (from import and domestic production) is much lower than the economy requires. Due to shortage of sugar a number of candy factories are closed or working at a very low capacity. Other sectors of the economy as well as households are also forced to buy sugar at higher price. Moreover, controband sugar is especially rampant in the eastern part of the country. Hence, it is estimated that the current supply is satisfying about 80% of the demand. For this reason year 2006 supply has been raised by 20%.
- By raising year 2006 supply, which is 327,243 tons, the current demand is estimated at 409,054 tons ($\underline{327{,}243 \text{ X } 100}$). 80.

2. Projected Demand

The increase in sugar consumption is mainly a function of four demand determining variables:- Population, income, consumption habit and the growth of the industrial & service sector, mainly hotels & restaurants as well as the food and beverage industries. The total population growth rate in Ethiopia is 2.9% per annum while that of the urban population growth rate is 4% per annum. More and more of the rural population is also

expected to consume sugar as a result of higher income and change in consumption habit. During the recent past years GDP at constant prices has been growing by more than 8%.

Hence, in order to estimate the probable level of domestic demand, present demand is assumed to increase by a slightly higher rate than the urban population growth rate and lower than GDP growth rate i.e. 6%. On the other hand sugar has an export market if the necessary marketing strategies are in place. According to data obtained from Customs Authority there were years where Ethiopia has been exporting sugar to Djibouti, Portugal, Kenya and the Middle East. For instance, during 2000 and 2002 the exhorted quantity has been 64,653 tons and 95,645 tons. Taking the past experience 100,000 tons of sugar can be exported annually to the world market.

The demand projected on the basis of the above assumptions is shown in Table 3.3.

Table 3.3

PROJECTED DEMAND FOR SUGAR (TON)

Year	For Domestic market	For Export	Total Demand	Domestic Production	Supply Gap
2008	433,597	100,000	533,597	274,836	258,761
2009	459,613	100,000	559,613	274,836	284,777
2010	487,190	100,000	587,190	274,836	312,354
2011	516,421	100,000	616,421	274,836	341,585
2012	547,406	100,000	647,406	274,836	372,570
2013	580,251	100,000	680,251	274,836	405,415
2014	615,066	100,000	715,066	274,836	440,230
2015	651,970	100,000	751,970	274,836	477,134
2016	691,088	100,000	791,088	274,836	516,252
2017	732,553	100,000	832,553	274,836	557,717

The unsatisfied domestic demand for sugar will increase from 158,761 tons in the year 2008 to 272,570 tons and 457,717 tons by the year 2012 and 2017 respectively. When export is considered the total unsatisfied demand will increase from 258,761 tons in the year 2000 to 372,570 tons and 557,717 tons by the year 2012 and 2017 respectively. This indicates the existence of a wide market, which would allow establishing a number of medium to large-scale sugar factories.

3. Pricing and Distribution

The current ex-factory price of sugar in Ethiopia is around Birr 4,500 per ton. This price is adopted for sales revenue projection. Regarding distribution, the existing factories rely on two methods:-

- Whole sale based on open tender, and
- quota sales (for industries, the army etc)

These methods, with some adaptation can be used by the envisaged plant to distribute its products.

B. PLANT CAPACITY AND OPERATION PROGRAMME

1. Plant Capacity

The market study reveals that there is high demand for sugar both in local and international market. So, the factors for determining capacity are availability of raw material and minimum economies of scale for the sugar plant.

The minimum economic of scale for plantation white sugar production from sugar cane is 47,250 tons per annum. It is assumed that the envisaged plant will partially cover local market demand and will venture into export market for the remaining part of production.

2. Production Programme

The sugar plant will be set into operation for 270 days per year, working in three shifts (8 hours each) per day. Production will start at 75% of full capacity during the first year and then rise to 85% and full capacity (100%) in the second and third year of operation, respectively.

IV. MATERIALS AND INPUTS

A. RAW MATERIALS

The main raw material is sugar cane which requires a temperature range of (32-38) ^{0} C, and a minimum rainfall during the growing season. A short dry season is needed before harvesting to maximize sucrose accumulation.

SNNPRS is believed to have suitable soil and weather conditions for growing sugar cane. Establishment of sugar industry needs to be integrated with the development of sugar cane farming. In this profile it is assumed that out-growers handle sugar cane supply.

Table 4.1 indicates the annual raw material requirement at full capacity operation of the plant and the cost estimates.

Table 4.1

ANNUAL RAW MATERIALS REQUIREMENT AND COST

AT FULL CAPACITY PRODUCTION

Sr. No.	Description	Qty.	Cost ('000 Birr)		
			FC	LC	TC
1	Sugar Cane	675,000 MT	-	51,975	51,975
2	Industrial & laboratory Chemicals	-	1000	200	1200
3	Materials and Supplies	-	2500	1000	3500
4	Packing Materials (pp bags 50 kg)	1,410,000	-	3,144.3	3,144.3
TOTAL			**3,500**	**56,319**	**59,819**

As shown in the table above, the annual cost of raw materials for producing 30,000 tones of white sugar is estimated at about Birr 59.819 million.

B. UTILITIES

Electrical Power: The envisage sugar plant basically utilizes its own electrical power generated within the plant at the power generation station. This is done by producing steam in the steam generating plant, utilizing the by-product from sugar cane (bagasse) as a main fuel and furnace oil as an auxiliary fuel. The generated steam is let to the power steam turbines and generators to produce the required electrical power. During operation, there are times when no electrical power available from the power generation station (Black -out or during factory start up).During this time and when the sugar plant is not operational(Annual maintenance time), other sources of electrical power (Diesel generator or EPCO grid) is utilized.

For this purpose a total of 4000 kWh electrical power is required from EPCO grid and 20 m^3 of diesel oil is required for diesel generator.

The annual expenditure on utilities is estimated at Birr 8,167,294. The total amount of utilities required and their cost is shown in Table 4.2

Table 4.2

ANNUAL REQUIREMENTS OF UTILITIES

Sr. No.	Utilities	UOM	Annual Consumption	Unit Cost	Estimated Cost (Birr 'OOO)		
					F.C	L.C	T.C
1	Electricity	Kwh	4000	0.4736	-	1.894	1.894
2	Water	M^3	700,000	10	-	7000	7000
3	Diesel oil	M^3	20	4.17	-	83.4	83.4
4	Furnace oil	M^3	200	5.41	-	1082	1082
	Grand Total				**-**	**8167.294**	**8167.294**

V. TECHNOLOGY AND ENGINEERING

A. TECHNOLOGY

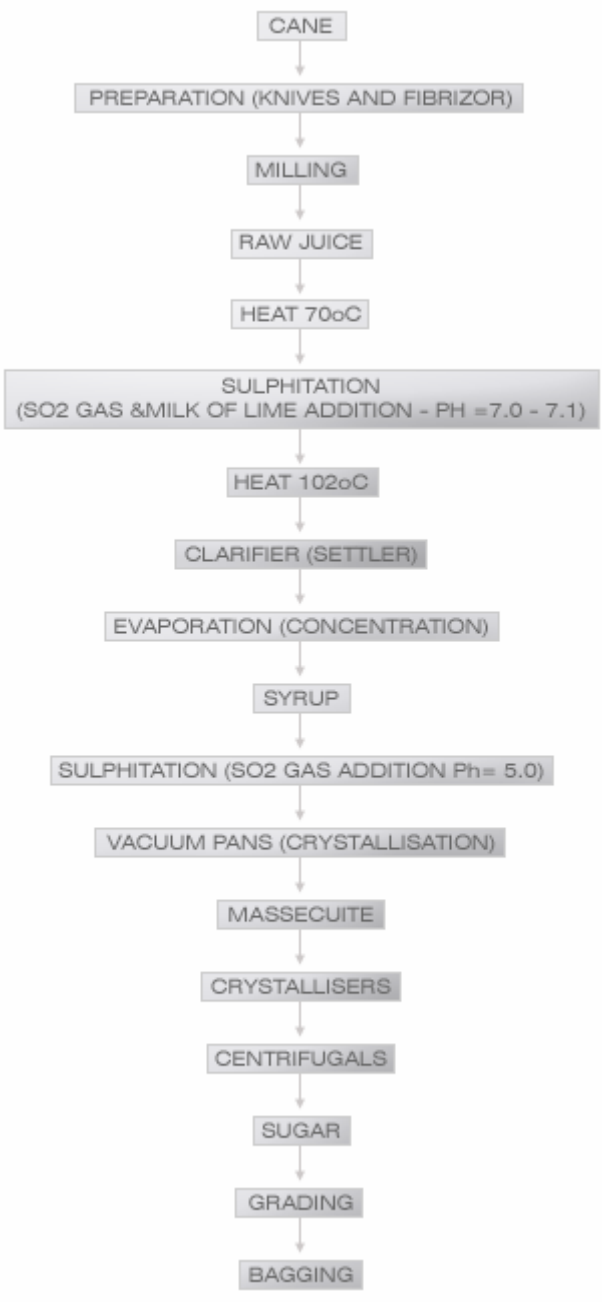
1. Process Description

Approximately 10% of sugar cane can be processed into commercial sugar. Sugar cane consists of 70% of water, 14% of fiber, and 13.3% of saccharose (about 10 to 15% sucrose) and 2.7% of soluble impurities.

The envisaged plant follows the standard double sulphitation process of clarification and 3 1/2 massecuite boiling scheme for production of direct plantation white sugar in accordance with the following process flow diagram:

Fig.4.1

PROCESS FLOW DIAGRAM OF PLANTATION WHITE SUGAR PRODUCTION



The main process description of the envisaged plant is as follows:

Harvesting:

Mature sugar canes are gathered manually and mechanically. Hand cutting is the most common method, but some locations use mechanical harvesters. Canes are cut at ground level, the leaves are removed and the top is trimmed by cutting off the last mature joint. Cane is then tied in bundles and transported to a sugar factory. After cutting, cane deteriorates rapidly, so the sugar cane cannot be stored for later processing without excessive deterioration of the sucrose content.

Cane handling, Cleaning and preparation:

The cane stalks are unloaded from tractors/trucks to the cane table and thoroughly washed (depending on local condition) and let to pass to sets of rotating knives and fibrizers/shredder. The sets of Rotating knives cut the cane into pieces, and fibrizers or shredders rapture the cell of the sugar cane and then transferred to the mills by conveyers for juice extraction process.

Milling (Juice extraction):

The shredded sugarcane travels on a conveyer belt through a series of heavy-duty rollers, which extract juice the prepared cane. During juice extraction, hot water is sprayed onto the sugarcane to dissolve any remaining hard sugar. The prepared cane residue (bagasse) that remains at the last mill with a moisture of 49-51% passes to the steam generating plant as a main fuel and the raw (mixed juice) is pumped to the boiling house for further weighing clarification, heating, evaporation and crystallization process.

Clarification:

Carbon dioxide and lime juice are added to the liquid sugar and heated to around 95 degrees Celsius. As the carbon dioxide travels through the liquid, it forms calcium carbonate, which precipitates non-sugar debris (fats, gums and wax) from the juice. This precipitate, called "mud," is then separated from the juice by vacuum rotary filters. The juice is then sulphited to remove any remaining impurities.

Evaporation and heating:

The factory can clean up the juice quite easily with slaked lime (a relative of chalk), which settles out a lot of the dirt so that it can be sent back to the fields. Once this is done, the juice is thickened up into syrup by boiling off the water using steam in a process called evaporation. Sometimes the syrup is cleaned up again but more often it just goes on to the crystal-making step without any more cleaning. The evaporation is undertaken in order to improve the energy efficiency of the factory. The syrup is then heated and sulphited to get the required temperature and pH before passing to vacuum pans for further evaporation and crystallization.

Crystallization:

The syrup is placed into a very large pan for boiling, the last stage. In the pan even more water is boiled off until conditions are right for sugar crystals to grow. You may have done something like this at school but probably not with sugar because it is difficult to get the crystals to grow well. In the factory the workers usually have to throw in some sugar dust to initiate crystal formation. Once the crystals have grown mixture of crystal and mother liquor (massacuiet) is formed.

Centrifuging:

The resulting mixture of crystals and mother liquor is spun in centrifuges to separate the two, rather like washing is spin-dried.

Drying:

The crystals are then given a final dry with hot air before being stored ready for dispatch.

Grading and Bagging:

The dried sugar then passes through a set of graders (sieves) to get the required crystal sizes before bagging of the final product.

Effluent treatment

The Effluent (waste water) from sugar factory contains organic materials, which will have to be contained and treated prior to disposal to the environment. The objective of treatment of such effluent is to reduce the biological and chemical oxygen demands to allowable levels. This can be achieved by carrying out primary clarification, aeration, fuel clarification and sludge drying. The sludge so obtained can be used as organic fertilizer.

2. Source of Technology

The address of machinery supplier is given below:-

National Heavy Engineering Pvt . ltd
Pune Bombay Road

Phone 91-2114-222261
Fax: 91-2114-222762
E-mail: Sales export@nhecl.com
info@nhecl.com

B. ENGINEERING

1. Machinery And Equipment

Machinery and equipment required for the production of sugar are presented in Table 5.1. The total cost of plant machinery and equipment is estimated at about Birr 200 million, out of which Birr 150 million is required in foreign currency. Due to the nature of the technology the machinery and equipment are supplied as a package and turn-key project.

Table 5.1

LIST OF MACHINERY AND EQUIPMENT

Sr. No.	Plant/Station Description
1	Cane weighment
2	Cane unloading
3	Cane preparation
4	Juice extraction plant
5	Juice treatment section
6	Clarification and filtration
7	SO_2 and Milk of lime preparation station
8	Juice heating and evaporation
9	Graining and crystallizes
10	Centrifugal machines (Batch & Continuous)
11	Sugar handling and bagging
12	Vapor Condensing plant
13	Steam Generation and distribution plant
14	Power Generation and distribution plant
15	Power evacuation system
16	Bagasse handling system
17	Automation
18	Fabrication workshop
19	Laboratory
20	Plant water system
21	Fire fighting system
22	Piping, insulation and cladding, Chutes, gutters and structures
23	Sugar Store
24	Molasses Store
25	Heating, Ventilation, and Air conditioning
26	Auxiliary Equipment and Various tanks
27	Effluent treatment plant

2. Land, Building and Civil Works

The total land requirement is 50,000 square meters. This includes space required by plant, administration building, auxiliary facilities, etc, and open space for waste treatment plant, open storage for can sugar, molasses storage area, and other utilities. The space requirement by the plant is estimated at 24,000 square meters the cost of land at a lease rate of Birr 1 per m^2 for 95 years is about Birr 50,000. The total cost estimate of building and civil works at unit cost of Birr 2800 per m^2 is about Birr 84.0 million. Therefore, the total cost estimate of land, building and civil works is about Birr 84,050,000.

3. Proposed Location

The plant can be located in area where sugar cane can be grown. The area requires a temperature between 32^oc – 38^oc, and a minimum rainfall of (1000 – 1500) mm during the growing season or near the major rivers.

According to the resource potential study of the region, the raw material is identified in Woredas like Sodo Zuria ,Damot gal, Daramallo . Based on the availability of raw material infrastructure, utility and market out let Sodo town of Sodo Zuria woreda is selected and recommended to be the location of the envisaged plant.

VI. MANPOWER AND TRAINING REQUIREMENT

A. MANPOWER REQUIREMENT

The envisaged sugar plant requires production manpower specialized in the areas of chemical (process) engineering, mechanical and electrical engineering, chemists, production operators, mechanics and electricians. The manpower requirement of the project is 279 persons. The details of manpower required for accomplishing plant production and administrative functions are presented in Table 6.1.

Table 6.1

MANPOWER REQUIREMENT AND ANNUAL LABOUR COST

Sr. No.	Description	Qty.	Monthly Salary (Birr)	Annual Salary (Birr)
1	Plant Manager	1	4,500	54000
2	Executive Secretary	1	1,200	14400
3	Legal service head	1	3600	43200
4	Planning and programming service hear		3600	43200
5	Quality Control Service Head	1	3,600	43200
6	Audit service head	1	3600	43200
7	Telephone operator	1	850	10200
8	Administration Department	1	3,500	42000
9	Finance Department	1	3,500	42000
10	Technical Department	1	3900	46800
11	Production Department	1	3900	46800
12	Workshop head	1	3900	46800
13	Secretary	4	3,200	38400
14	Chemical Engineer	3	6,000	7200
15	Mechanical Engineer	3	6,000	7200
16	Electrical Engineer	2	6,000	7200
17	Chemists	3	5700	68400
18	Administrative Personnel	1	1800	21600
19	Sales Head	1	1500	18000
20	Purchase Head	1	1500	18000
21	Market Research and Promotion Division Head	1	2500	30000
22	Medical director	1	2800	33600

Sr. No.	Description	Qty.	Monthly Salary (Birr)	Annual Salary (Birr)
23	Nurse	9	13500	162000
24	Pharmacy keeper	2	1900	22800
25	Cleaners	6	1800	21600
26	Clerks	5	4500	54000
27	Production Operators	60	72,000	864000
28	Technologist	2	2000	24000
29	Lab Technician	10	9000	108000
30	Mechanics fitters	30	28500	342000
31	Welders	9	8100	97200
32	Helper to welder	9	4950	59400
33	Grease man	4	2400	28800
34	Power plant operators	27	6300	75600
35	Semi-Skilled Laborers	70	35000	420000
36	Unskilled Laborers	90	27000	324000
37	Messengers	4	1200	14400
38	Drivers	4	2000	24000
39	Guards	36	18000	216000
Sub-Total			**-**	**3,583,200**
Benefits (25% of Sub-Total benefits (25% Of Sub-Total)			-	895800
Total		**279**	**-**	**4,479,000**

B. TRAINING REQUIREMENT

Trainings is required for production operators, engineers, chemists and technicians. Three months training needs to be planned and executed overseas in the country of technology supplier. The total cost of training is estimated at about Birr 800,000 out of which Birr 500,000 is required in foreign currency.

VII. FINANCIAL ANALYSIS

The financial analysis of the cane sugar project is based on the data presented in the previous chapters and the following assumptions:-

Construction period	1 year
Source of finance	30 % equity
	70 % loan
Tax holidays	5 years
Bank interest	8%
Discount cash flow	8.5%
Accounts receivable	30 days
Raw material local	30 days
Raw material, import	90 days
Work in progress	2 days
Finished products	30 days
Cash in hand	5 days
Accounts payable	30 days

A. TOTAL INITIAL INVESTMENT COST

The total investment cost of the project including working capital is estimated at Birr 321.42 million, of which 53 per cent will be required in foreign currency.

The major breakdown of the total initial investment cost is shown in Table 7.1.

Table 7.1

INITIAL INVESTMENT COST

Sr. No.	Cost Items	Total Cost ('000 Birr)
1	Land lease value	4,750.0
2	Building and Civil Work	84,000.0
3	Plant Machinery and Equipment	200,000.0
4	Office Furniture and Equipment	250.0
5	Vehicle	750.0
6	Pre-production Expenditure*	18,659.8
7	Working Capital	13,016.6
	Total Investment cost	**321,426.4**
	Foreign Share	53

** N.B Pre-production expenditure includes interest during construction (Birr 17.66 million) training (Birr 800 thousand) and Birr 200 thousand costs of registration, licensing and formation of the company including legal fees, commissioning expenses, etc.*

B. PRODUCTION COST

The annual production cost at full operation capacity is estimated at Birr 111.44 million (see Table 7.2). The material and utility cost accounts for 61 per cent, while repair and maintenance take 0.45 per cent of the production cost.

Table 7.2

ANNUAL PRODUCTION COST AT FULL CAPACITY ('000 BIRR)

Items	Cost	%
Raw Material and Inputs	59,819.00	53.67
Utilities	8167.29	7.33
Maintenance and repair	500	0.45
Labour direct	2149.92	1.93
Factory overheads	716.64	0.64
Administration Costs	1433.28	1.29
Total Operating Costs	72,786.13	65.31
Depreciation	24575	22.05
Cost of Finance	14088.84	12.64
Total Production Cost	**111,449.97**	**100**

C. FINANCIAL EVALUATION

1. Profitability

According to the projected income statement, the project will start generating profit in the first year of operation. Important ratios such as profit to total sales, net profit to equity (Return on equity) and net profit plus interest on total investment (return on total investment) show an increasing trend during the life-time of the project.

The income statement and the other indicators of profitability show that the project is viable.

2. Break-even Analysis

The break-even point of the project including cost of finance when it starts to operate at full capacity (year 3) is estimated by using income statement projection.

$$BE = \frac{\text{Fixed Cost}}{\text{Sales} - \text{Variable Cost}} = 34\ \%$$

3. Pay Back Period

The investment cost and income statement projection are used to project the pay-back period. The project's initial investment will be fully recovered within 3 years.

4. Internal Rate of Return and Net Present Value

Based on the cash flow statement, the calculated IRR of the project is 37 % and the net present value at 8.5% discount rate is Birr 413.87 million.

D. ECONOMIC BENEFITS

The project can create employment for 297 persons. In addition to supply of the domestic needs, the project will generate Birr 227.78 million in terms of tax revenue.