MINISTRY OF FOOD PROCESSING INDUSTRIES
GOVERNMENT OF INDIA

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PM Formalisation of
Micro Food Processing Enterprises Scheme

DETAILED PROJECT REPORT FOR PROCESSING OF SORGHUM FLAKES

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Project At a Glance		
1	Name of the Project	Sorghum flakes
2	Name of the entrepreneur/FPO/SHG/Cooperative	
3	Nature of proposed project	Proprietorship/Company/ Partnership
4	Registered office	
5	Project site/location	
6	Names of Partner (if partnership)	
7	No of shareholders (if company/FPC)	
8	Technical advisor	
9	Marketing advisor/partners	
10	Proposed project capacity	150 MT/annum (55, 65, 75,90 & 100% capacity utilization in the 2nd, 3rd, 4th ,5th & 6th years' onwards respectively
11	Raw materials	Sorghum Grain
12	Major product outputs	Sorghum flakes
13	Total project cost (Lakhs)	22.27
	Land development, building & civil construction	5.18
	Machinery and equipment	5.92
	Utilities (Power & water facilities)	0.8
	Miscellaneous fixed assets	0.9
	Pre-operative expenses	0.90
	Contingencies	1.20
	Working capital margin	7.37
14	Working capital Management (In Lakhs)	
	Second Year	22.12
	Third Year	26.14
	Fourth Year	35.65
15	Means of Finance	
	Subsidy grant by MoFPI (max 10 lakhs)	9.91
	Promoter's contribution (min 20%)	5.56
	Term loan (45%)	6.79
16	Debt-equity ratio	1.22 : 1
17	Profit after Depreciation, Interest & Tax	
	2nd year	48.79
	3rd year	59.21
	4th year	69.63
18	Average DSCR	2.16
	Benefit Cost Ratio	1.95
	Term Loan Payment	7 Years with 1 year grace period
	Pay Back Period for investment	2 Years

Note: All the data/contents of this DPR are taken from the available information on IIFPT site.

1 GENERAL OVERVIEW OF SORGHUM PRODUCTION, CLUSTERS, POST-HARVEST MANAGEMENT AND VALUE ADDITION IN INDIA

1.1 INTRODUCTION

Sorghum is a genus of about 25 species of flowering plants in the grass family Poaceae. Some of these species have grown as cereals for human consumption and some in pastures for animals. One species, *Sorghum bicolor*, was originally domesticated in Africa and has since spread throughout the globe. Seventeen of the 25 species are native to Australia, with the range of some extending to Africa, Asia, Mesoamerica, and certain islands in the Indian and Pacific Oceans. One species is grown for grain, while many others are used as fodder plants, either cultivated in warm climates worldwide or naturalized in pasture lands *Sorghum* is in the subfamily Panicoideae and the tribe Andropogoneae (the tribe of big bluestem and sugarcane).

Sorghum, (Sorghum bicolor), also called great millet, Indian millet, milo, durra, or shallu, cereal grain plant of the grass family (Poaceae) and its edible starchy seeds. The plant likely originated in Africa, where it is a major food crop. It is the fifth major staple cereal after wheat, rice, maize and barley. It is cultivated worldwide in warmer climates and is an important food crop in semiarid tropical areas of Africa, Asia and Central America. In India sorghum is known as jowar, cholam, or Jonna. Different varieties of sorghum range in colour from white and pale yellow to deep red, purple and brown. Sorghum is especially valued in hot and arid regions for its resistance to drought and heat. It is tolerant to drought because of its root system. It performs better than maize during drought and occupies areas unsuitable for maize in stress-prone semiarid areas. It is tolerant of salinity and to some extent to waterlogging for a short period. It is sensitive to frost and to sustain flooding. In recent years, there has been a shift in sorghum production from the drier western production areas to the wetter eastern

areas. This change in production area has resulted in the identification and development of cultivars, which are more tolerant to lower temperatures.

Over half a billion people rely on sorghum as a dietary mainstay and, given its diversity of uses, as an important source of income. The grain is used mainly for food, prepared in the form of flat breads and porridges of different kinds. Other uses of Sorghum are: Cereal and Flour: Sorghum has been used for human food for thousands of years in Africa and parts of Asia. Sorghum flour is a popular substitute for wheat flour for those who are unable to tolerate gluten. It can be used for baked goods, snack foods and noodles Livestock Feed: Its feed value is similar to corn. More countries such as Colombia/Peru and China are changing the compound feed ration to include more sorghum in the formula. Syrup: A variety of sorghum known as sweet sorghum is grown in the south-eastern and gulf states for the manufacture of syrup. Sorghum syrup is similar to molasses and can be substituted for sugar, honey or corn syrup in cooking or poured over pancakes, biscuits or waffles. Alcoholic Beverages: In Africa, sorghum is used to make a traditional beer known as opaque beer. In the U.S., Anheuser-Busch produces a type of sorghum beer, called Red bridge, which is marketed to those who suffer from wheat allergy. Industry/Ethanol: Sorghum is increasingly used for the production of ethanol, second only to corn. Percentage of Sorghum usage for ethanol depends on prices. It can be used for many different types of ethanol production including starch based, sugar-based and cellulosic ethanol production. Sorghum and corn are interchangeable in the grain-based ethanol market. A bushel of grain sorghum produces as much ethanol as a bushel of corn.

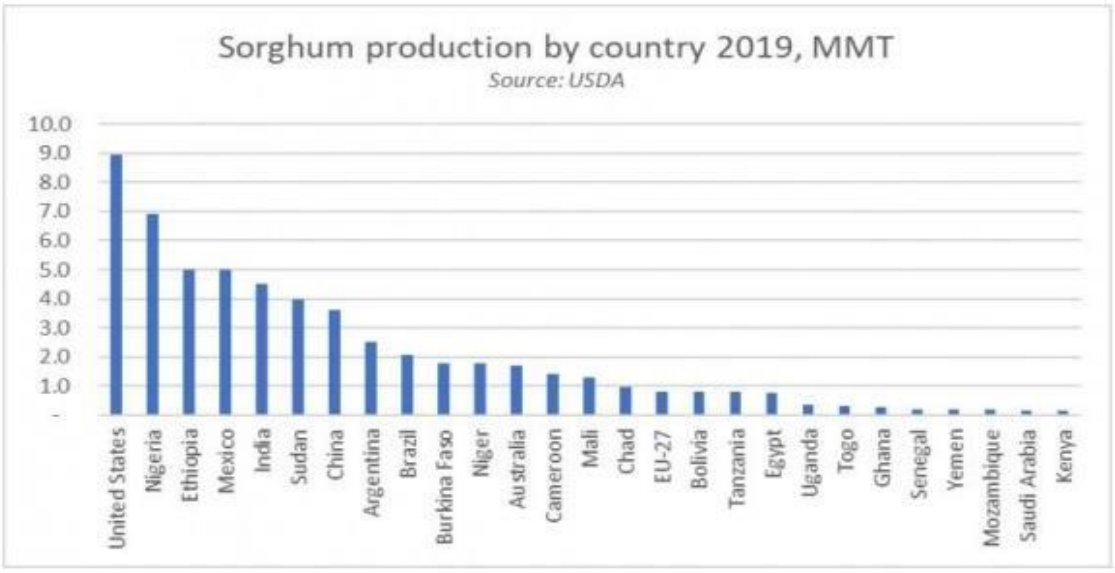
1.2 ORIGIN, DISTRIBUTION AND PRODUCTION OF SORGHUM

Sorghum is an ancient cereal grain belonging to the grass family *Poaceae.* It's small, round, and usually white or yellow — though some varieties are red, brown, black, or purple.

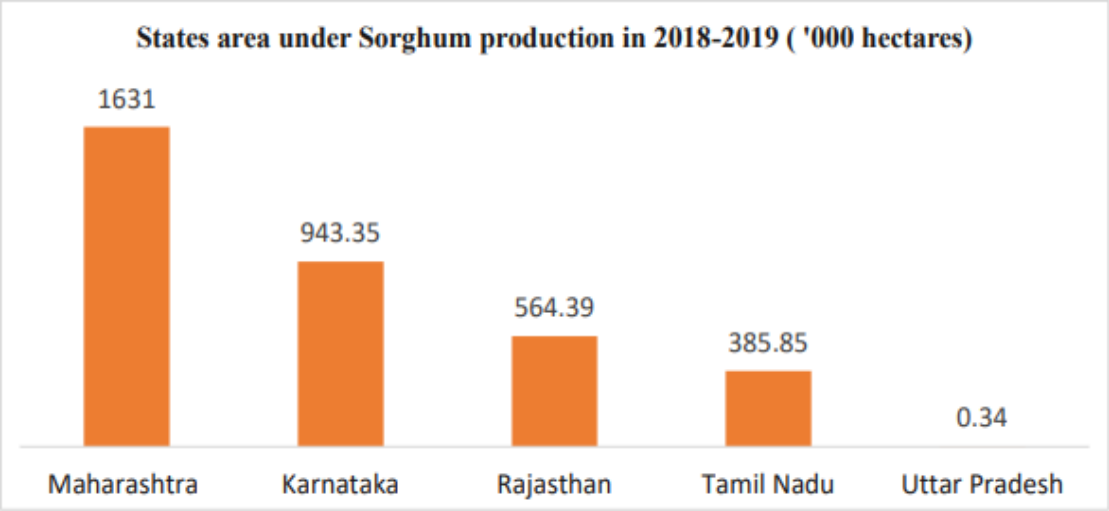
World Scenario: by area, more than 90% of the world's sorghum can be found in developing countries, mainly in Africa and Asia.

There are many species of sorghum, the most popular being *Sorghum bicolor*, which is native to Africa. Other popular species are native to Australia, India, and other Southeast Asian countries. Although sorghum is less known in the Western world, it's the fifth most produced cereal crop in the world, with an annual production of around 57.6 million tons. Farmers favor this crop due to its tolerance to drought, heat, and various soil conditions. In North America, sorghum is commonly used in animal feed and ethanol fuel production. That said, interest in using it for human food is increasing, thanks to its impressive nutritional profile.

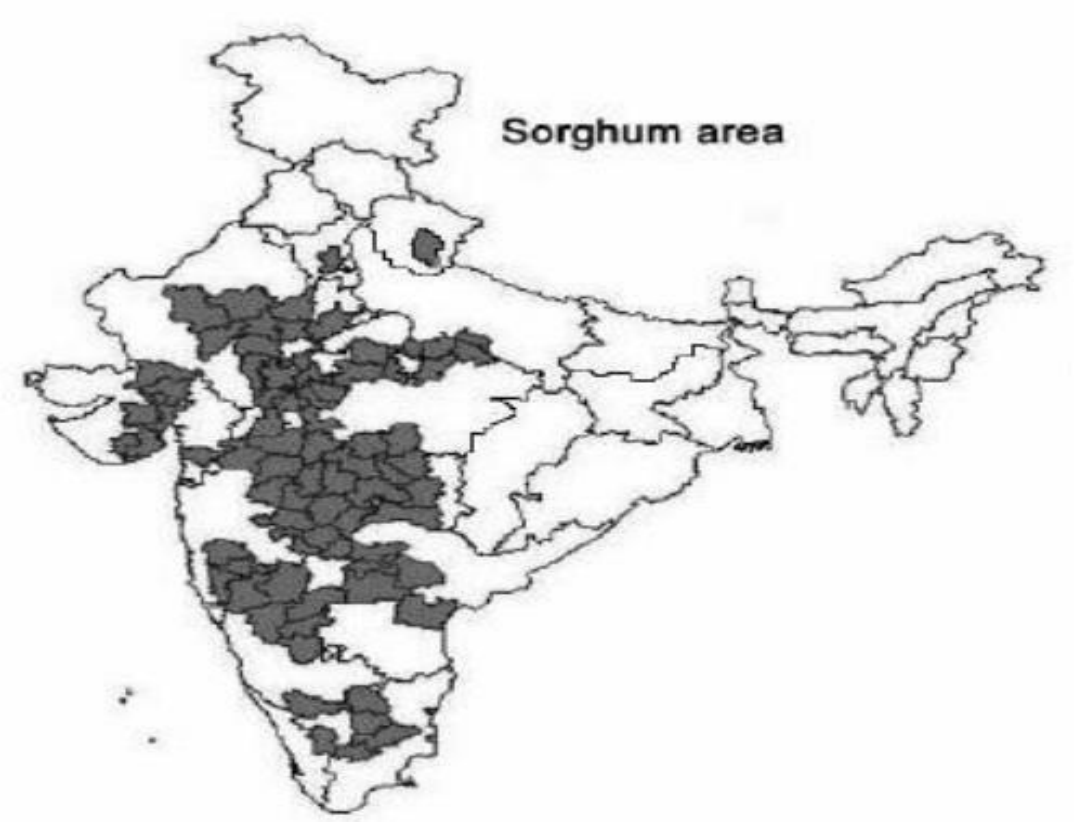
By production, the USA currently leads with an annual output of around 9 million metric tonnes, followed by Nigeria (6.9MMT), Ethiopia (5.0MMT) and Mexico (5.0MMT), India (4.5MMT), and China (3.6MMT). Production by country is likely to change as farmers hit hardest by climate change and a reduction in rainfall look to replace maize with drought-resistant sorghum.



Indian Scenario Total sorghum production in India was 3.475 MMT in 2019 (Source: Directorate of Economics and Statistics, Department of Agriculture, Cooperation and Farmers Welfare.)



States above contributed 95% of country's total area and production under sorghum.



Export from India

Market Year	Exports	Unit of Measure	Growth Rate
2018	51	1000 MT	-59.20 %
2019	31	1000 MT	-39.22 %
2020	50	1000 MT	61.29 %

Top 5 countries which imports Sorghum from India are Saudi Arabia, UAE, Philippines, Kuwait and Japan which is worth USD 3.5 million in 2020.

In its whole form, this grain can be cooked like quinoa or rice, milled into flour, or popped like popcorn. It's also converted into syrup that's used to sweeten many processed foods.

1.3 VARIETIES

Varieties of sorghum growing in India are:

Sl No.	Variety	*Av. yield (kg/ha)	Duration (days)	Suitable Areas
1	CSV 1	3000-5000	95-100	All kharif sorghum growing areas of MH, GJ, KA and AP.

2	CSV 2	3000-3500	105-110	Kharif tracts of MH, MP and adjoining areas of RJ, Bundelkhand (UP) and North Telangana
3	CSV 3	3500-4000	105-110	All kharif growing areas of country
4	CSV 4	3000-3500	105-110	All kharif sorghum growing areas
5	CSV 5	3000-3500	110-120	KA,TN and MH
6	CSV 6	3200-3500	115-120	Assured rainfall areas of vidharbha and west MH regions,MP, Kota region of RJ, Bundelkhand (UP), South GJ, Adilabad (AP) and TN
7	CSV 9	3200-3500	110-115	All kharif sorghum growing areas in India
8	CSV 10	3000-3500	110-115	MH, KA, AP and RJ
9	CSV 11	3250	110-115	All kharif growing areas in India
10	CSV 13	3525	110-120	All kharif growing areas of the country
11	CSV 15	3621	110-112	All kharif growing areas of the country
12	CSV 17	2500	97	Low rainfall and drought prone sorghum regions of the country

13	CSV 20	3100	109	All India

* Yield Kg/ha (Dry)

***KA**:KARNATAKA, **TN**:TAMILNADU, **AP**:ANDHRA PRADESH, **RJ**:RAJASTHAN, **GJ**:GUJARAT, **UP**:UTTAR PRADESH, **MH**:MAHARASHTRA, **MP**:MADHYA PRADESH

1.4 HEALTH BENEFITS AND NUTRITIONAL INFORMATION

Nutritional value:

Sorghum is an underrated, nutrient-rich cereal grain. Half a cup of uncooked sorghum (96 grams) provides:

Calories: 316

Protein: 10 grams

Fat: 3 grams

Carbohydrates: 69 grams

Fiber: 6 grams

Vitamin B1 (thiamine): 26% of the Daily Value (DV)

Vitamin B2 (riboflavin): 7% of the DV

Vitamin B5 (pantothenic acid): 7% of the DV

Vitamin B6: 25% of the DV

Copper: 30%of the DV

Iron: 18% of the DV

Magnesium: 37% of the DV

Phosphorus: 22% of the DV

Potassium: 7% of the DV

Zinc: 14% of the DV

- Sorghum is rich in a variety of nutrients, including B vitamins, which play an essential role in metabolism, neural development, and skin and hair health.

- It's also a rich source of magnesium, a mineral that's important for bone formation, heart health, and over 600 biochemical reactions in your body, such as energy production and protein metabolism.

- In addition, sorghum is high in antioxidants like flavonoids, phenolic acids, and tannins. Eating a diet rich in these antioxidants can lower oxidative stress and inflammation in your body.

- Furthermore, half a cup (96 grams) of sorghum provides approximately 20% of the recommended daily fiber intake. A diet rich in fiber promotes gut health, stabilizes your blood sugar levels, and aids weight management.

- Finally, this grain is a great source of protein. In fact, it provides as much protein as quinoa, a cereal grain renowned for its high protein content.

CONSTITUENTS AND HEALTH BENEFITS OF SORGHUM

Sorghum also has many potential health benefits. Eating oranges may lower your risk of heart disease, cancer, and kidney stones.

Health benefits:

Anti-Inflammatory Effects

Sorghum is known to be rich in phenolic compounds, many of which act as antioxidants. It has also been shown to be good at reducing some forms of inflammation due to its antioxidant properties

Anti- Cancer Effects

Several of the phenolic compounds in sorghum have been linked to anti-cancer effects. The tannins in sorghum, which contribute to the grain's pigmentation, may inhibit an enzyme linked to the development of breast cancer. Another set of phenolic compounds found in sorghum, known as 3- deoxy-anthocyanidins, have been shown to have a destructive effect on some human cancer cells.

Weight Loss

The starches in sorghum are difficult for the human body to digest, compared to other grains. As a result, sorghum is an excellent addition to any meal, helping you feel full without contributing too many calories to your diet.

Safe for Celiac Disease

Sorghum and its by-products, including sorghum flour, have been determined to be a safe alternative grain for those with Celiac's disease.

Controls Blood Sugar Levels

Sorghum, a complex carbohydrate, is digested slowly, prompting a more gradual rise in blood sugar. Therefore, it is a great choice for people with diabetes.

Good for Bone Health

Because it contains high levels of magnesium, Sorghum helps maintain calcium levels in the body (magnesium increases calcium absorption)

Digestive System

The high dietary fiber content in Sorghum also helps improve digestion. The fiber is a bulking agent that helps stool pass smoothly through the digestive tract. The whole grain helps improve digestive health and is useful in treating conditions like diarrhoea, bloating, stomach ache and constipation.

Improves Heart Health

Sorghum is rich in dietary fiber. The abundance of fiber in it helps lower LDL (or bad cholesterol) levels in the body, thus reducing the risk of heart attack. The cholesterol lowering properties of Sorghum also reduce the chances of hindered blood flow, arteriosclerosis and plaque formation.

Nutrition credentials of wholegrain sorghum:

- Rich in carbohydrates (mainly starch).
- Moderate protein content, but low in lysine.
- Low in fat, most of which is unsaturated.
- A good source of dietary fiber.
- High in potassium and low in sodium.
- Gluten free.
- Contains B-group vitamins such as thiamine, riboflavin, niacin, vitamin B6 (pyridoxine), folate and pantothenic acid.

- Contains vitamin E.

- Contains iron, zinc, magnesium, phosphorus and selenium (depending on the soil content of selenium).

- Contains small amounts of copper, manganese and calcium.

- Contains phytochemicals including lignans, phenolic acids, phytic acid, plant sterols and saponins.

1.5 CULTIVATION, BEARING & POST HARVEST MANAGEMENT:-

Sorghum (*Sorghum bicolor*), also called great millet, Indian millet, milo, durra, orshallu, cereal grain plant of the grass family (*Poaceae*) and its edible starchy seeds. The plant likely originated in Africa, where it is a major food crop, and has numerous varieties, including grain sorghums, used for food; grass sorghums, grown for hay and fodder; and broomcorn, used in making brooms and brushes. In India sorghum is known as jowar, *cholam*, or *jonna*, in West Africa as Guinea corn, and in China as kaoliang. Sorghum is especially valued in hot and arid regions for its resistance to drought and heat.

Sorghum is a strong grass and usually grows to a height of 0.6 to 2.4 metres (2 to 8 feet), sometimes reaching as high as 4.6 metres (15 feet). Stalks and leaves are coated with a white wax, and the pith, or central portion, of the stalks of certain varieties is juicy and sweet. The leaves are about 5 cm (2 inches) broad and 76 cm (2.5 feet) long. The tiny flowers are produced in panicles that range from loose to dense; each flower cluster bears 800–3,000 kernels. The seeds vary widely among different types in colour, shape, and size, but they are smaller than those of wheat.

Sorghum is of a lower feed quality than corn (maize). It is high in carbohydrates, with 10 percent protein and 3.4 percent fat, and contains calcium and small amounts of iron, vitamin B_1, and niacin. For human consumption, the gluten-free grain is

usually ground into a meal that is made into porridge, flatbreads, and cakes. The characteristic strong flavour can be reduced by processing. The grain is also used in making edible oil, starch, dextrose (a sugar), paste, and alcoholic beverages. The stalks are used as fodder and building materials. Sweet sorghums, or sorgos, are grown mainly in the United States and southern Africa for forage and for syrup manufacture and are sometimes used in the production of ethyl alcohol for biofuel.

Cultivation and Bearing:-

Sorghum *[Sorghum bicolour*] is an indigenous crop to Africa, and though commercial needs and uses may change over time, sorghum will remain a basic staple food for many rural communities. The latter is especially true in the more drought prone areas of South Africa where this hardy crop provides better household food security than maize.

Sorghum is mainly cultivated in drier areas, especially on shallow and heavy clay soils. The production of sorghum in South Africa varies from 100 000 tonnes (130 00 ha) to 180 000 tonnes (150 000 ha) per annum. The Free State and Mpumalanga provinces are the largest contributors to the area planted to sorghum and sorghum production.

In recent years, there has been a shift in sorghum production from the drier western production areas to the wetter eastern areas. This change in production area has resulted in the identification and development of cultivars, which are more tolerant to lower temperatures.

The optimum growth requirements of sorghum plants, in order to exploit its inherit yield potential, are a deep well-drained fertile soil, a medium to good and fairly stable rainfall pattern during the growing season, temperate to warm weather (20 to 30 ºC) and a frost-free period of approximately 120 to 140 days.

Sorghum is mainly grown on low potential, shallow soils with high clay content, which usually are not suitable for the production of maize. Sorghum usually grows poorly on sandy

soils, except where a heavy textured sub-soil is present. Sorghum is more tolerant of alkaline salts than other grain crops and can therefore be successfully cultivated on soils with a pH (KCl) between 5.5 and 8.5. Sorghum can better tolerate short periods of water logging compared with maize. Soils with a clay percentage of between 10 % and 30 % are optimal for sorghum production.

The climatic requirements for the production of sorghum are divided into temperature, day length and water needs.

Sorghum is a warm-weather crop, which requires high temperatures for good germination and growth. The minimum temperature for germination varies from 7 to 10 ºC. At a temperature of 15 ºC, 80 % of seed germinate within 10 to 12 days. The best time to plant is when there is sufficient water in the soil and the soil temperature is 15 ºC or higher at a depth of 10 cm. Temperature plays an important role in growth and development after germination. A temperature of 27 to 30 ºC is required for optimum growth and development. The temperature can, however be as low as 21 ºC, without a dramatic effect on growth and yield. Exceptionally high temperatures cause a decrease in yield. Flower initiation and the development of flower primordia are delayed with increased day and night temperatures.

Plants with four to six mature leaves that are exposed to a cold treatment (temperatures less than 18 ºC) will form lateral shoots.

However, in plants with or beyond the eight-leaf stage, apical dominance will prevent the formation of lateral shoots. Temperatures below freezing are detrimental to sorghum and may kill the plant. At an age of one to three weeks, plants may recover if exposed to a temperature of 5 ºC below the freezing point, but at 7 ºC below freezing, plants are killed. Plants older than three weeks are less tolerant to low temperatures and may be killed at 0 ºC.

Sorghum is produced in South Africa on a wide range of soils, and under fluctuating rainfall conditions of approximately 400 mm in the drier western parts to about 800 mm in the wetter eastern parts.

The high yielding varieties mature in about 100-120 days duration after which they are harvested. Generally two methods of harvesting i.e. either stalk-cut or cutting of earheads by sickles are employed. However, in foreign countries sorghum harvesters are used. In case of stock cut method the plants are cut from near the ground level, the stalks are tied into bundles of convenient removed from plants, while in later case the earheads, after their removal from the standing crop, are piled up on the threshing floor and after few days they are threshed. Threshing of earheds is done either by beating them with sticks or by trampling them under bullock's feet. Later method is quicker and is practiced by majority of farmers who use to grow the crop on larger scale.

1.6 PROCESSING & VALUE ADDITION:-

Sorghum *(Sorghum bicolor L. Moench*) is an important drought resistant cereal crop and fifth largest produced cereal in the world after wheat, rice, barley and maize. Sorghum is valued because of its ability to produce in tropical and arid regions of the world, where it is difficult to grow any other cereal, and also, because of its relatively short growing season requirement, thus its suitability for double cropping and crop rotation systems. Around 10 to 30% of the produced grains gets wasted or damaged. Sorghum acts as a principal source of energy, protein, vitamins and minerals for millions of the poorest people living in drought regions, who cultivate sorghum for consumption at home and in certain cases for feeding their cattle. It is consumed as whole grain or processed into flour, from which traditional meals are prepared.

Additionally, sorghum contains iron, zinc, manganese and copper. Also, its protein structure helps to ensure the quality of various foods: snacks, porridges, flour, and also feed concentrate. Furthermore, it is gluten free and so is consumed by diabetics, and it is a substitute for wheat flour

Cereal flakes are popular breakfast products and at present they are mostly made from corn. By suitable processing it might be feasible to produce flakes

from sorghum. Ready to eat products like flakes are very popular, being crisp and friable in texture. Cereal flakes are one of the most popular types of ready to eat cereals. The relatively smaller size and quick hydration of sorghum make them most suitable for the production of flakes

Sorghum is versatile and easy to add to a number of recipes.

- Replace rice or quinoa. It can be cooked as whole grain and with pearled sorghum similarly to how rice and quinoa is cooked.
- Milled flour. It has a neutral flavor and light color. Sorghum is naturally gluten-free, making it a good option for someone avoiding gluten. Gluten is a group of proteins found in certain grains that gives food products a stretchy quality and structure.
- Popped. The grains are heated in a pan to pop like popcorn. Seasonings are added for extra flavor.
- Flaked. Similarly, to other cereal grains like oats, flaked sorghum is delicious as a cereal and in baked products, such as granola bars and cookies.
- Syrup. Sorghum syrup is commonly added to processed foods as a natural sweetener or an alternative to molasses

Flakes are a convenient food product often used as snacks. Flaking of cereals such as corn and rice to a larger extent whereas wheat, barley, oats and millets also to some extent is practiced worldwide for preparation of snacks and breakfast cereals. Flakes are generally precooked and require minimum preparation to consume as snacks and thus are classified as convenience foods and are suitable for consumption by all age groups. Conventionally, rice flakes are prepared by toasting paddy or rough rice. Cereal flakes are popular breakfast products and at present they are mostly made from corn. By suitable processing it might be feasible to produce flakes from millets. Ready to eat products like flakes are very popular, being crisp and friable in texture. The relatively

smaller size and quick hydration of millets make them most suitable for the production of flakes.

At present there are three kinds of cereal flakes: (i) conventional flakes, (ii) flakes prepared using a roller flaker and (iii) RTE breakfast cereals (Lu and Walker, 1988). The first category of flakes is largely confined to rice, the second category includes flakes from almost all cereals, including oats and barley, whereas the third category of flakes is produced mainly from maize. Currently, sorghum flake products are limited, but it is possible to prepare all three types of flakes from sorghum. Sorghum flakes, similar to those of rice, have been successfully produced on a semi-industrial scale from a roller flaker (Fast et al., 1990).

Sorghum Flakes Savouries

Sorghum flakes are powerhouse of nutrition and a gluten free grain. It is easy on tummy and is good for babies and toddlers too. Sorghum flakes can be made into simple and easy dishes. It can be enjoyed in the form of Upma as it is quite easy and nutritious delicacy for early morning breakfast or along with tea. Sorghum Poha is indeed another healthy breakfast snack preferred in India. Other ways in which Sorghum flakes can be utilised is along with milk or curd.

Cereals undergo a number of processing stages between harvest and consumption. This chain of processes is often referred to as the total post-harvest system. The post-harvest system can be split into three distinct areas. The first is the preparation of harvested grain for storage. The second, which is referred to as primary processing, involves further treatment of the grain to clean it, remove the husk or reduce the size. The products from primary processing are still not consumable. The third stage (secondary processing) transforms the grains into edible products. Primary processing involves several different processes, designed to clean, sort and remove the inedible fractions from the grains. Primary processing of sorghum includes cleaning, grading, hulling, milling, pounding, grinding, tempering, parboiling, soaking, drying, sieving. Secondary processing of sorghum (or 'adding value' to cereals) is the utilisation of the primary products (whole

grains, flakes or flour) to make more interesting products and add variety to the diet. Secondary processing of sorghum includes the following processes: fermentation, baking, puffing, flaking, frying and extrusion.

2. MODEL SORGHUM FLAKES PROCESSING UNDER FME SCHEME

2.1 LOCATION OF THE PROPOSED PROJECT AND LAND

The entrepreneur must provide description of the proposed location, site of the project, distance from the targeted local and distant markets; and the reasons/advantages thereof i.e. in terms of raw materials availability, market accessibility, logistics support, basic infrastructure availability etc. The major sorghum producing states are Maharashtra, Karnataka, Madhya Pradesh, Tamil Nadu, Andhra Pradesh, Rajasthan, Uttar Pradesh, Gujarat and Others.

2.2 INSTALLED CAPACITY OF THE SORGHUM FLAKES PROCESSING UNIT

The maximum installed capacity of the Sorghum flakes manufacturing unit in the present model project is proposed as 150 tonns/annum or 500 kg/day Sorghum flakes. The unit is assumed to operate 300 days/annum @ 8-10 hrs/day the 1styear is assumed to be construction/expansion period of the project; and in the 2nd year 55 percent capacity, 3rd year 65 percent capacity, 4th year 75 percent capacity, 5th year 90 percent capacity & 6th year onwards 100 percent capacity utilization is assumed in this model project.

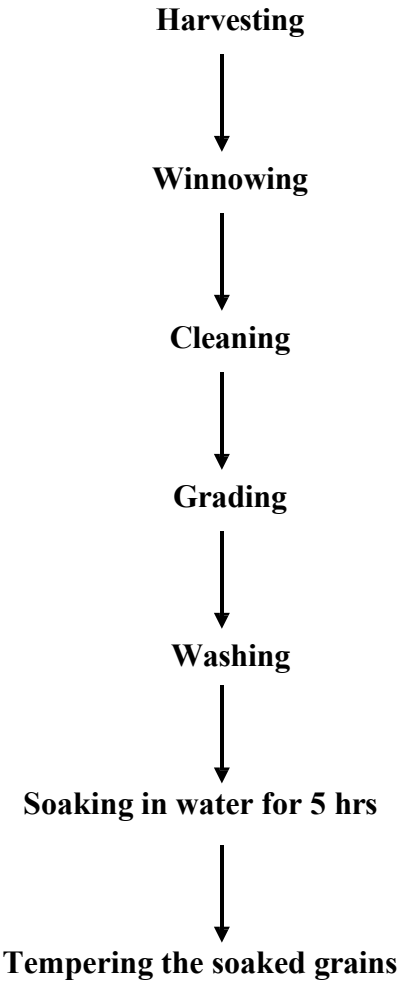
2.3 RAW MATERIAL REQUIREMENTS FOR THE UNIT

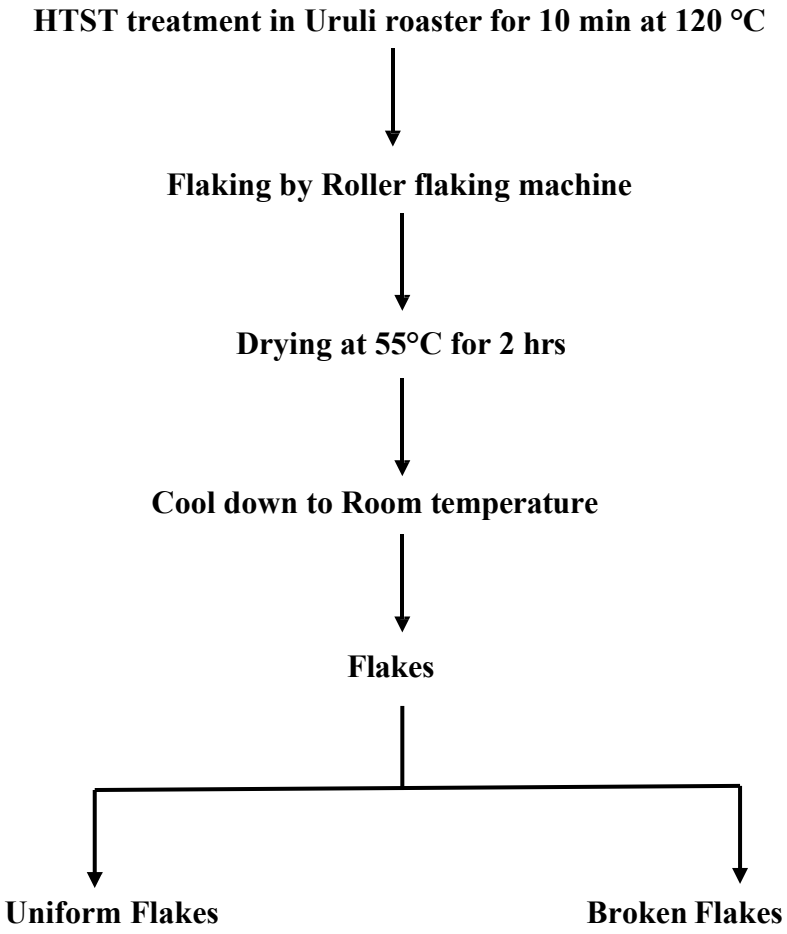
A sustainable food processing unit must ensure maximum capacity utilization and thus requires an operation of minimum 280-300 days per year to get reasonable profit.

Therefore, ensuring uninterrupted raw materials supply requires maintenance of adequate raw material inventory. The processor must have linkage with producer organizations preferably FPCs through legal contract to get adequate quantity and quality of raw materials which otherwise get spoiled. In the Sorghum flakes manufacturing project, the unit requires 467.5 kg/day, 552.5 kg/day, 637.5 kg/day, 765 Kg/day & 850 kg/day Sorghum grains at 55, 65, 75, 90 & 100 percent capacity utilization, respectively.

2.4 MANUFACTURING PROCESS OF THE SORGHUM FLAKES

Flow chart for sorghum flakes:





PRIMARY PROCESSING OF SORGHUM

Cleaning and Grading

Before further processing, grains are cleaned and graded according to size. Winnowing machines can be used to separate out the chaff, soil and dirt. Some machines have integral sieves that combine cleaning with grading.

Parboiling

It involves steeping the soaked sorghum in hot water and steaming at steam pressure of 1.5 kg/ cm 2 for 10 minutes. Degree of parboiling depends on the water content of the steeped

grain. Then drying is done to reduce the moisture content. This process allows the vitamins and minerals present in the hulls and bran coat to be carried into the endosperm.

Milling

The cleaned grain is conditioned, by addition of water, to soften the endosperm, and milled by the conventional roller mills to separate the endosperm, germ and bran from each other. Another milling process for sorghum is 'pearling' or decortications. In this case cleaned grains are wetted by spraying water for 12-15 min. and immediately milled in rice huller, to remove a major part of the coarse fibre, with minimum degree of cracking of the grain. A maximum of 12 per cent polishing can be carried out. This type of milling can give products rich in protein (up to 27 per cent), and which are also high in fat and give a high yield of ash, but are low in fibre. These products are used in the preparation of food products of high protein content.

Drying

Prior to storage or further processing, cereal grains need to be dried. The most cost-effective method is to spread out in the sun to dry. In humid climates it may be necessary to use an artificial dryer. Simple grain dryers can be made from a large rectangular box or tray with a perforated base. The grain is spread over the base of the box and hot air is blown up through a lower chamber by a fan. The fan can be powered by diesel or electricity and the heat supplied by kerosene, electricity, gas or burning biomass. Cereal grains should be dried to 10-15% moisture before storage.

SECONDARY PROCESSING (FLAKING) OF SORGHUM

Soaking

At the cottage level, soaking of grain is done in metal drums or cement tanks for about 5 hours, after which the water is drained. Too much soaking can make sorghum grains soggy.

Softening

Flaked cereals are partially cooked and can be used as quick-cooking or ready to eat foods. The grains are softened by partially cooking in steam or pressure cooking for 15 min. Subjecting hydrated sorghum to high temperature short time treatment in grain roster (till starch content of the sorghum get gelatinised without rupturing the overall integrity of the sorghum but causing slight swelling) or cooked due to hydrothermal effect and the sorghum grain are rendered malleable.

Pre-Drying

The cooked grains are allowed to cool for 1 hour at 70 degree Celsius in cabinet dryer, stabilizing the moisture content of each grain.

Flaking

Flattening the cooked sorghum in edge runner machine by repeated pressing between side wall of rotating machine till the sorghum flatten to the desired degree of thinness. After completion of flaking, the flaked sorghum is scooped out and collected in wide-mouthed, shallow trays. Flakes prepared from the edge-runner are short, broad, almost circular and white in colour comparable to rice flakes.

Roasting

The still soft and flexible Sorghum flakes are dried in the roaster machine with heat. This is where the flakes get their typical “crunch” through the formation of blisters.

Sieving and Grading

The flaked sorghum is sieved in a sieve shaker in order to separate small, broken, powdered material and lumps. The graded flaked sorghum is collected in heaps and turned from time to time until cool. It requires drying in order to avoid any moisture before packing which may reduce its shelf life.

2.5 MARKET DEMAND AND SUPPLY FOR SORGHUM FLAKES

Sorghum is beneficial for farmers because it is able to provide molasses, as sorghum seeds have higher sugar content. They also help farmers because the lower leaves of sorghum do not dry when the plant matures. Sorghum seeds can grow in very poor soils where maize, rice and other cereals cannot grow. Sorghum plantations are increasing at a rapid rate because it is a versatile plant which can withstand drought, soil toxicities, a wide range of temperatures, and high altitudes. Substantial demand from pet food industries and other customers is producing exceptional marketing opportunities for the sorghum seed market. Sorghum seed is also used for ethanol production.

The driving factor for the global sorghum seed market is a result of increase in sorghum seed in daily diet. Sorghum seed is used as biofuel and it has several advantages when used in alcoholic beverages. Globally, countries are investing a lot of money for the development of sorghum seed market to utilize barren lands where water availability is scarce. Similarly, high return on seed sales motivates the private sector to invest in sorghum seeds. Furthermore, rising demand for sorghum seeds in the Chinese market has transformed the demand scenario for the sorghum market, due to a huge difference between the import prices versus the local price. This factor creates an opportunity for farmers to invest in this field. Moreover, this factor motivates a country to increase its import business. Thus, demand for sorghum seed is increasing continuously and it is expected that this trend will continue in future. However, increased competition from substitutes coupled with changes in customer preferences is hampering the market growth.

1. Sorghum and millets are primarily consumed in form as unleavened pancakes and also in the form of thick porridge but seldom processed, especially for production of convenient high value food products. Hence, with advent of this process where in sorghum and millets are converted to flakes may offer cheaper alternative to rice flakes of good quality which are nutritious.

2. Sorghum flakes are circular or oval in shape and offer better nutrition benefits than traditional rice flakes owing to higher proportion of minerals, vitamins and antioxidants and also dietary fibre. The slow releasing carbohydrates in sorghum will help in minimising the incidence of lifestyle diseases such as diabetes, obesity, etc.

3. The technology offers snacking and breakfast cereals preparation option thereby the demand for sorghum will be enhanced due to convenience attached to the technology in question, in long run it would help to strengthen the demand for sorghum crop cultivation and aids the poor dry land farmers in the country.

4. The process is simple and does not require sophisticated equipments and machinery. The flakes following this process could be prepared manufactured at cottage scale industry making use of conventional grain cleaning units, soaking tanks, grain roaster and the edge runner machine.

5. The process can be applied to any kind of clean sorghum and millet grains irrespective of agro-climatic condition of harvest, variety, shape and size of the grains. Even grain with poor economic strata could also be processed to prepare flakes.

6. The flakes could be used in conventional manner similar to rice flakes or could be processed further to prepare value added sweet and savoury products.

2.6 MARKETING STRATEGY FOR SORGHUM FLAKES

The increasing urbanization and income offers huge scope for marketing of grain based products. Urban organized platforms such as departmental stores, malls, super markets can be attractive platforms to sell well packaged and branded sorghum products.

2.7 DETAILED PROJECT ASSUMPTIONS

This model DPR for Sorghum flakes unit is basically prepared as a template based on certain assumptions that may vary with capacity, location, raw materials availability etc. An entrepreneur can use this model DPR format and modify as per requirement and suitability. The assumptions made in preparation of this particular DPR are given in This DPR assumes expansion of existing grain processing unit by adding new flakes processing line. Therefore, land and civil infrastructures are assumed as already available with the entrepreneurs.

- Herewith in this DPR, we have considered the assumptions as listed below in the tables of different costs, which may vary as per region, seasons and machinery designs and supplier.
    1. Sorghum cost considered @ Rs.40/-per kg.
    2. 1 kg Sorghum will produce 60% recovery.
    3. 1 Batch size is approximately 500 kg.
    4. No. of hours per day are approximately 8-10 hours.
    5. Batch yield is 95%.

Detailed Project Assumptions		
Parameter	Assumption	
Capacity of the Sorghum flakes Unit	150	MT/annum
Utilization of capacity	1st Year Implementation, 55% in second, 65% in third, 75% in fourth year, 90% in fifth & onwards	
Working days per year	300	days
Working hours per day	10	hours
Interest on term and working capital loan	12%	
Repayment period	Seven year with one year grace period is considered.	

Average prices of raw material	40	
Average sale prices per Kg	180	Rs/kg
Pulp extraction	60	
SORGHUM FLAKES	1 kg Sorghum flakes from 1.7 kg Sorghum grain	

2.8 FIXED CAPITAL INVESTMENT

2.8.1 MACHINERY AND EQUIPMENT

Sr No.	Equipment	Capacity	Quantity	Price (Rs. In Lacs)
1	Winnowing machine	1	Suitable	0.6
2	Size screen	5	Suitable	0.15
3	Washing tank	1	500 liter	0.4
4	Soaking drum	6	200 liter	0.09
5	Uruli Roaster	1	80 Kg/Batch	0.4
6	Roller flaking machine	1	Suitable	1.3
7	Mesh trays	10	Suitable	0.6
8	Wood fire Hot air oven	1	Suitable	0.8
9	Induction sealer	1	Suitable	0.3
10	Shrink tunnel	1	Suitable	0.35
11	Cont. sealing machine	1	Suitable	0.25
12	Batch coding machine	1	Suitable	0.12
13	Weighing balance	1	Suitable	0.06

14	Accessories	1	Suitable	0.5
			Total	5.92

2.8.2 OTHER COSTS:-

Utilities and Fittings:-

Utilities and Fittings	
1.Water	Rs. 0.8Lacs total
2.Power	

Other Fixed Assests:

Other Fixed Assets	
1. Furniture & Fixtures	Rs. 0.9 lac total
2. Plastic tray capacity	
3. Electrical fittings	

Pre-operative expenses

Pre-operative Expenses	
Legal expenses, Start-up expenses, Establishment cost, consultancy fees, trials and others.	0.9 LAC
Total preoperative expenses	0.9 LAC

Contingency cost to be added as approx.1.2 Lac.

So total startup cost at own land & Premise may be somewhat similar to 22.27 lacs. This is according to survey done at X location India. This may vary on location, situation and design change over.

2.9 WORKING CAPITAL REQUIREMENTS

Particulars	Period	Year 2 (55%)	Year 3 (65%)	Year 4 (75%)
Raw material stock	7 days	2.51	2.96	4.04
Work in progress	15 days	5.01	5.92	8.07
Packing material	15 days	0.90	1.06	1.45
Finished goods' stock	15 days	6.72	7.94	10.83
Receivables	30 days	13.45	15.89	21.67
Working expenses	30 days	0.91	1.07	1.46
Total current assets		29.49	34.85	47.53
Trade creditors		0.00	0.00	0.00
Working capital gap		29.49	34.85	47.53
Margin money (25%)		7.37	8.71	11.88
Bank finance		22.12	26.14	35.65

2.10 TOTAL PROJECT COST AND MEANS OF FINANCES

Particulars	Amount in Lakhs
i. Land and building (20 x 32 x 12 ft - LxBxH)	5.18
ii. Plant and machinery	5.92
iii. Utilities & Fittings	0.8
iv. Other Fixed assets	0.9
v. Pre-operative expenses	0.90
vi. Contingencies	1.20
vii. Working capital margin	7.37
Total project cost (i to vii)	22.27

Means Of finance	
i. Subsidy	9.91
ii. Promoters Contribution	5.57
iii. Term Loan (@10%)	6.79

2.11 MANPOWER REQUIREMENTS

Total Monthly Salary (Rs.)	No	Wages	Total Monthly	Total Annualy
Supervisor (can be the owner)	1	18000	18000	216000
Technician	1	14000	14000	168000
Helper	1	5500	5500	66000
Semi-skilled	2	7600	15200	182400
Sales man	1	8000	8000	96000
			60700	728400

2.12 EXPENDITURE, REVENUE AND PROFITABILITY ANALYSIS

	Particulars	1st Year	2nd Year	3rd Year	4th Year	5th year	6th year
A	Total Installed Capacity (MT)	255 MT Sorghum grains/Annum	82.5	97.5	112.5	135	150
	Capacity utilization (%)	Under Const.	55%	65%	75%	90%	100%
B	**Expenditure (Rs. in Lakh)**	0					
	Sorghum grains (Av. Price @ Rs. 40/Kg)	0.00	56.10	66.30	76.50	91.80	102.00
	Packaging materials	0.00	9.90	11.70	13.50	16.20	18.00
	Utilities (Electricity, Fuel)	0.00	0.65	0.77	0.89	1.07	1.19
	Salaries (1st yr only manager's salary)	2.16	7.28	7.28	7.28	7.28	7.28
	Repair & maintenance	0.00	0.70	0.80	0.90	0.90	0.90
	Insurance	0.30	0.30	0.30	0.30	0.30	0.30
	Miscellaneous expenses	0.50	2.30	2.30	2.30	2.30	2.30
	Total Expenditure	**2.96**	**77.24**	**89.46**	**101.68**	**119.86**	**131.97**
C	**Total Sales Revenue (Rs. in Lakh)**	**0.00**	**148.50**	**175.50**	**202.50**	**243.00**	**270.00**
	Sale of Sorghum flakes (Av. Sale Price @ Rs.180/kg)	0.00	148.50	175.50	202.50	243.00	270.00
D	**PBDIT (Total exp.-Total sales rev.) (Rs. in Lakh)/Cash Inflows**	**-2.96**	**71.26**	**86.04**	**100.82**	**123.14**	**138.03**
	Depreciation on civil works @ 5% per annum	0.26	0.25	0.23	0.22	0.21	0.20
	Depreciation on machinery @ 10% per annum	0.59	0.53	0.48	0.43	0.39	0.35
	Depreciation on other fixed assets @ 15% per annum	0.12	0.10	0.09	0.07	0.06	0.05
	Interest on term loan @ 12%	0.71	0.68	0.65	0.62	0.59	0.56
	Interest on working capital @ 12%	0.00	2.65	3.14	4.28	4.28	4.28
E	Profit after depreciation and Interest (Rs. in Lakh)	**-4.64**	**69.70**	**84.59**	**99.47**	**121.89**	**136.87**

F	Tax (assumed 30%) (Rs. in Lakh)	**0.00**	**20.91**	**25.38**	**29.84**	**36.57**	**41.06**
G	Profit after depreciation, Interest & Tax (Rs. in Lakh)	**-4.64**	**48.79**	**59.21**	**69.63**	**85.32**	**95.81**
H	Surplus available for repayment (PBDIT-Interest on working capital-Tax) (Rs. in Lakh)	0.71	0.68	0.65	0.62	0.59	0.56
I	Coverage available (Rs. in Lakh)	0.71	0.68	0.65	0.62	0.59	0.56
J	Total Debt Outgo (Rs. in Lakh)	0.24	0.26	0.29	0.32	0.35	0.39
K	Debt Service Coverage Ratio (DSCR)	3.00	2.62	2.28	1.97	1.69	1.44
	Average DSCR	2.16					
L	Cash accruals (PBDIT- Interest-Tax) (Rs. in Lakh)	-3.67	49.67	60.01	70.36	85.99	96.41
M	Payback Period	2.5 Years					
	(on Rs. 22.27 Lakhs initial investment)						

2.13 REPAYMENT SCHEDULE

Year	Beginning	PMT	Interest	Principal	Ending Balance
1	679,322.87	94,235.11	70,649.58	23,585.53	655,737.34
2	655,737.34	94,235.11	68,196.68	26,038.43	629,698.91
3	629,698.91	94,235.11	65,488.69	28,746.43	600,952.48
4	600,952.48	94,235.11	62,499.06	31,736.06	569,216.42
5	569,216.42	94,235.11	59,198.51	35,036.61	534,179.82
6	534,179.82	94,235.11	55,554.70	38,680.41	495,499.40
7	495,499.40	94,235.11	51,531.94	42,703.18	452,796.23
8	452,796.23	94,235.11	47,090.81	47,144.31	405,651.92
9	405,651.92	94,235.11	42,187.80	52,047.31	353,604.61

10	353,604.61	94,235.11	36,774.88	57,460.23	296,144.38
11	296,144.38	94,235.11	30,799.02	63,436.10	232,708.28
12	232,708.28	94,235.11	24,201.66	70,033.45	162,674.82
13	162,674.82	94,235.11	16,918.18	77,316.93	85,357.89
14	85,357.89	94,235.11	8,877.22	85,357.89	-
		1,319,291.59	639,968.72	679,322.87	(679,322.87)

2.14 ASSET'S DEPRECIATION

Assets' Depreciation (Down Value Method)							Amounts in Lakhs	
Particulars	1st Year	2nd year	3 rd year	4th year	5th year	6th year	7th year	8th year
Civil works	5.18	4.92	4.67	4.44	4.22	4.01	3.81	3.62
Depreciation	0.26	0.25	0.23	0.22	0.21	0.20	0.19	0.18
Depreciated value	4.92	4.67	4.44	4.22	4.01	3.81	3.62	3.44
Plant & Machinery	5.92	5.33	4.80	4.32	3.88	3.50	3.15	2.83
Depreciation	0.59	0.53	0.48	0.43	0.39	0.35	0.31	0.28
Depreciated value	5.33	4.80	4.32	3.88	3.50	3.15	2.83	2.55
Other Fixed Assets	0.80	0.68	0.58	0.49	0.42	0.35	0.30	0.26
Depreciation	0.12	0.10	0.09	0.07	0.06	0.05	0.05	0.04

Depreciated value	0.68	0.58	0.49	0.42	0.35	0.30	0.26	0.22
All Assets	11.90	10.93	10.05	9.25	8.52	7.86	7.26	6.71
Depreciation	0.97	0.88	0.80	0.73	0.66	0.60	0.55	0.50
Depreciated value	10.93	10.05	9.25	8.52	7.86	7.26	6.71	6.20

2.15 FINANCIAL ASSESSMENT OF THE PROJECT

Benefit Cost Ratio (BCR) and Net Present Worth (NPW)

Particulars	1st Year	2nd year	3 rd year	4th year	5th year	6th year	7th year	8th year	
Capital cost (Rs. in Lakh)	22.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Recurring cost (Rs. in Lakh)	2.96	77.24	89.46	101.68	119.86	131.97	131.97	131.97	
Total cost (Rs. in Lakh)	25.23	77.24	89.46	101.68	119.86	131.97	131.97	131.97	809.38
Benefit (Rs. in Lakh)	0.00	148.50	175.50	202.50	243.00	270.00	270.00	270.00	
Total Depreciated value of all assets (Rs. in Lakh)								6.20	
Total benefits (Rs. in Lakh)	0.00	148.50	175.50	202.50	243.00	270.00	270.00	276.20	1585.70
Benefit-Cost Ratio (BCR): (Highly Profitable project)	**1.959**								
Net Present Worth (NPW):	776.32								

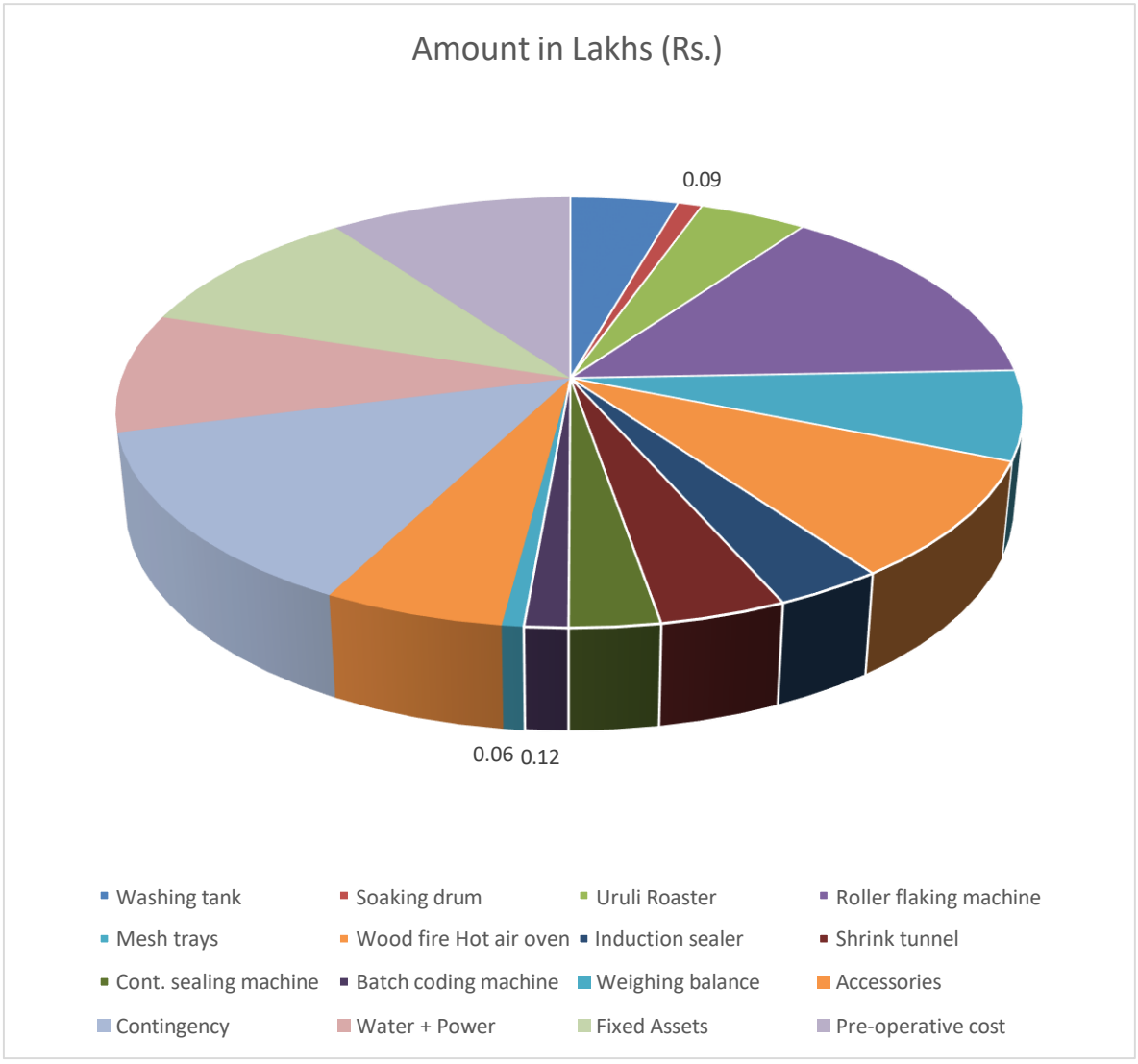
2.16 BREAK EVEN ANALYSIS

Break even analysis indicates costs-volume profit relations in the short run. This is the level at which, the firm is in no loss no profit situation.

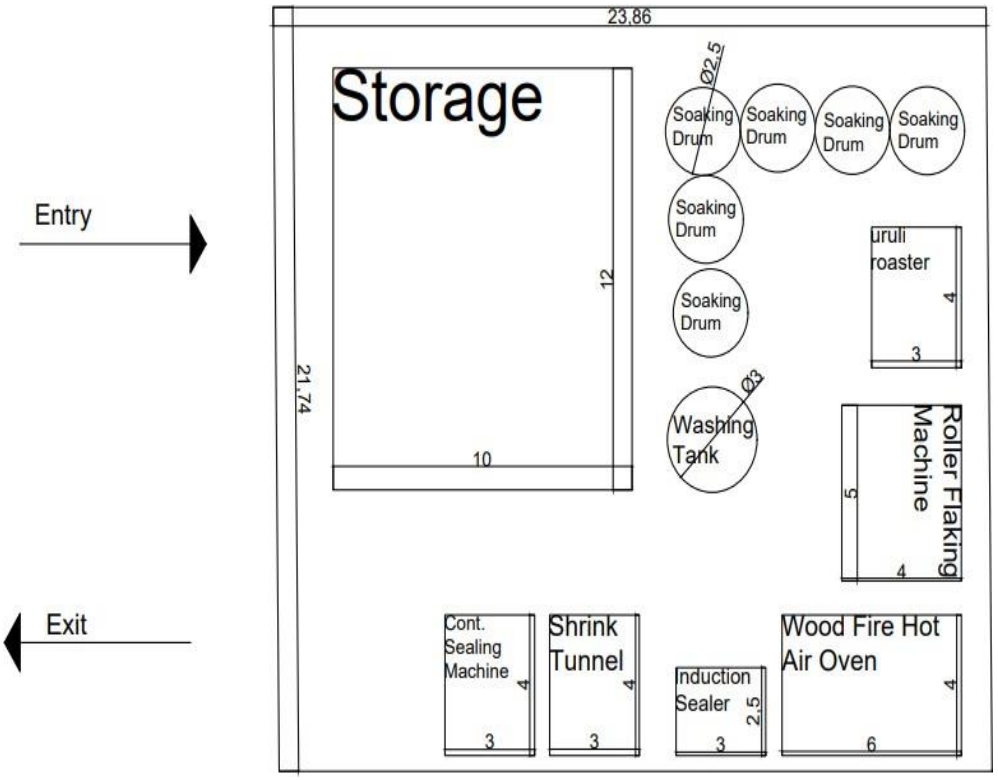
Particulars	**1st Year**	**2nd year**	**3 rd year**	**4th year**	**5th year**	**6th year**	**7th year**	**8th year**
Capacity utilization (%)	Under Const.	55%	65%	75%	90%	100%	100%	100%
Production MT/Annum		82.5	97.5	112.5	135	150	150	150
Fixed Cost (Rs. in Lakh)								
Permanent staff salaries	7.284	7.284	7.284	7.284	7.284	7.284	7.284	7.284
Depreciation on building @ 5% per annum	0.26	0.25	0.23	0.22	0.21	0.20	0.19	0.18
Depreciation on machinery @ 10% per annum	0.59	0.53	0.48	0.43	0.39	0.35	0.31	0.28
Depreciation on other fixed assets @ 15% per annum	0.12	0.10	0.09	0.07	0.06	0.05	0.05	0.04
Interest on term loan	0.71	0.68	0.65	0.62	0.59	0.56	0.52	0.47
Insurance	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Total Fixed Cost (Rs. in Lakh)	**9.26**	**9.14**	**9.03**	**8.93**	**8.83**	**8.74**	**8.64**	**8.55**
Sales Revenue (Rs. in Lakh)	**0**	**148.5**	**175.5**	**202.5**	**243**	**270**	**270**	**270**
Variable Cost (Rs. in Lakh)								
Sorghum Grains (Av. Price @ Rs.40/Kg)	0.00	56.10	66.30	76.50	91.80	102.00	102.00	102.00
Packaging materials	0.00	9.90	11.70	13.50	16.20	18.00	18.00	18.00
Casual staff salaries	0.00	5.78	5.78	5.78	5.78	5.78	5.78	5.78
Utilities (Electricity, Fuel)	0.00	0.65	0.77	0.89	1.07	1.19	1.19	1.19
Repair & maintenance	0.00	0.70	0.80	0.90	0.90	0.90	0.90	0.90
Miscellaneous expenses	0.50	2.00	2.00	2.00	2.00	2.00	2.00	2.00

Interest on working capital @ 12%	0.00	2.65	3.14	4.28	4.28	4.28	4.28	4.28
Total Variable Cost (Rs. in Lakh)	**0.50**	**77.79**	**90.49**	**103.85**	**122.03**	**134.15**	**134.15**	**134.15**
Break Even Point (BEP)								
as % of sale	-	12.00	10.00	8.00	8.00	7.00	7.00	6.00
Break Even Point (BEP) in terms of sales value (Rs. in Lakhs)	-	17.82	17.55	16.20	19.44	18.90	18.90	16.20

2.17 PIE CHART FOR BETTER UNDERSTANDING OF EXPENSES OF EACH HEAD:



2.18 TYPICAL SORGHUM FLAKES MANUFACTURING UNIT LAYOUT



2.19 MACHINERY SUPPLIERS

There are many machinery suppliers available within India for Grains based beverage processing machineries and equipment. Some of the suppliers are:

1. Bajaj Process pack Limited, Noida, India 0
2. Shriyan Enterprises. Mumbai, India

3. LIMITATIONS OF MODEL DPR & GUIDELINES FOR ENTREPRENEURS

3.1 LIMITATIONS OF THE DPR

i. This DPR has provided only the basic standard components and methodology to be adopted by an entrepreneur while submitting a proposal under the Formalization of Micro Food Processing Enterprises Scheme of MoFPI.

ii. This DPR is made to provide general methodological structure not for specific entrepreneur/crops/location. Therefore, information on the entrepreneur, forms and structure (proprietorship/partnership/cooperative/ FPC/joint stock company) of business, background of proposed project, location, raw material base/contract sourcing, entrepreneur's own SWOT analysis, market research, rationale of the project for specific location, community advantage/benefit, employment generation etc are not given in detail.

iii. The present DPR is based on certain assumptions on cost, prices, interest, capacity utilization, output recovery rate and so on. However, these assumptions in reality may vary across places, markets and situations; thus the resultant calculations will also change accordingly.

3.2 GUIDELINES FOR THE ENTREPRENEURS

i. The success of any prospective food processing project depends on how closer the assumptions made in the initial stage are with the reality of the targeted market/place/situation. Therefore, the entrepreneurs must do its homework as realistic as possible on the assumed parameters.

ii. This model DPR must be made more comprehensive by the entrepreneur by including information on the entrepreneur, forms and structure (proprietorship/partnership/cooperative/ FPC/joint stock company) of entrepreneur's business, project location, raw material costing base/contract sourcing, detailed market research, comprehensive dehydrated product mix based on demand, rationale of the project for specific location, community

advantage/benefit from the project, employment generation, production/availability of the raw materials/crops in the targeted area/clusters and many more relevant aspects for acceptance and approval of the competent authority.

iii. The entrepreneur must be efficient in managing the strategic, financial, operational, material and marketing aspects of a business. In spite of the assumed parameter being closely realistic, a project may become unsustainable if the entrepreneur does not possess the required efficiency in managing different aspects of the business and respond effectively in changing situations.

iv. The machineries should be purchased after thorough market research and satisfactory demonstration.

v. The entrepreneur must ensure uninterrupted quality raw materials' supply and maintain optimum inventory levels for smooth operations management.

vi. The entrepreneur must possess a strategic look to steer the business in upward trajectory.

vii. The entrepreneur must maintain optimum (not more or less) inventory, current assets. Selecting optimum source of finance, not too high debt-equity ratio, proper capital budgeting and judicious utilization of surplus profit for expansion is must.

viii. The entrepreneur must explore prospective markets through extensive research, find innovative marketing strategy, and maintain quality, adjust product mix to demand.

ix. The entrepreneur must provide required documents on land, financial transaction, balance sheet, further project analysis as required by the competent authority for approval.

x. The entrepreneur must be hopeful and remain positive in attitude while all situations.

Contact Us

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