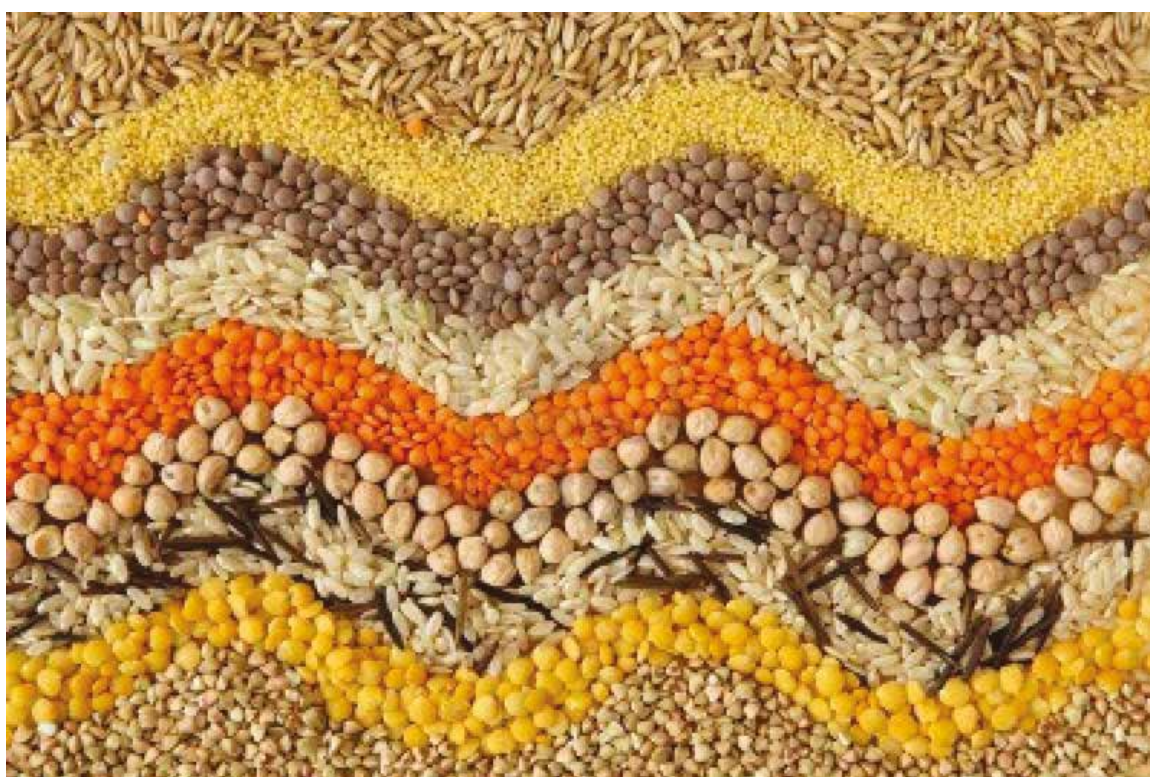


# POST-HARVESTING PROCESSING



# POST-HARVESTING PROCESSING



## 1.-Total post-harvest cereal system

### General information

Each type of cereal requires a specific post-harvest treatment, however, there are certain general principles that apply to most of them.

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 cereals includes cleaning, grading, hulling, milling, pounding, grinding, tempering, parboiling, soaking, drying, sieving.

Secondary processing of cereals (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 cereals includes the following processes: fermentation, baking, puffing, flaking, frying and extrusion.

**Puffing.** Puffed grains are often used as breakfast cereals or as snack food. During puffing, grains are exposed to a very high steam pressure which causes the grain to burst open. The puffed grains can be further processed by toasting, coating or mixing with other ingredients.

**Flaking.** 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. They are then pressed or rolled into flakes which are dried. The flakes are eaten crisp and should have a moisture content of below 7%.

**Fermentation.** Doughs made from cereal flour can be fermented to make a range of products.

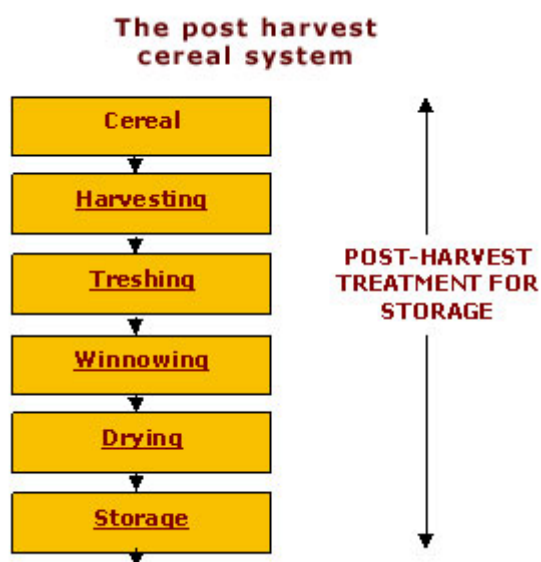
**Baking.** Doughs and batters made from cereal flours are baked to produce a range of goods.

**Extrusion.** Extrusion involves heating and forcing food (usually a dough) through a small hole to make strands or other shapes. The extruded shapes then undergo further processing such as frying, boiling or drying. Extruded products include pastas, noodles, snack foods and breakfast cereals.

Projects and small businesses may involve only one or several of the activities in the total chain, from the growing of crops through to the production of edible products. Some small businesses are set up to clean and package wholegrains. These businesses can be successful as there is very little need for equipment. However, as with all businesses, there must be a clear demand for the product.

## 2.- The post-harvest cereal system

### 2.1.- Post-harvest treatment for storage



#### A.1-Harvesting

There is an optimum time for harvesting cereals, depending on the maturity of the crop and the climatic conditions. This has a significant effect on the quality of the grain during storage.

Harvesting often begins before the grain is ripe and continues until mould and insect damage are prevalent. Grain not fully ripened contains a higher proportion of moisture and will deteriorate more quickly than mature grains because the enzyme systems are still active.

If the grain remains in the field after maturing, it may spoil through wetting caused by morning dew and rain showers. There is also an increased risk of insect damage.

Cereals are traditionally harvested manually. There are three main types of harvesting equipment for the small scale producer: manual, animal powered and engine powered.

A range of mechanised harvesting equipment suitable for the small-scale farmer has been developed. Some of it is more efficient and cost effective than others.

Harvested crops are left in the field for a few days to dry before further processing.

### **A.2.-Threshing**

Threshing is the removal of grains from the rest of the plant. It involves three different operations: Separating the grain from the panicle; sorting the grain from the straw; winnowing the chaff from the grain.

Separation of the grain from the panicle is the most energy-demanding of the three processes. It is the first process to have been mechanised. Sorting the grain from the straw is relatively easy, but is difficult to mechanise. Winnowing is relatively easy, both by hand and by machine.

Most manual threshing methods use an implement to separate the grain from the ears and straw. The simplest method is a stick or hinged flail that is used to beat the crop while it is spread on the floor.

A range of engine powered threshers are available.

### **A.3.-Winnowing**

Winnowing is the separation of the grains from the chaff or straw. It is traditionally carried out by lifting and tossing the threshed material so that the lighter chaff and straw get blown to one side while the heavier seeds fall down vertically.

Hand-held winnowing baskets are used to shake the seeds to separate out the dirt and chaff. They are very effective, but slow.

There is a range of winnowing machines that use a fan to create artificial wind. This speeds up the winnowing process.

Some of these contains sieves and screens that grade the grains as well.

### **A.4.-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.

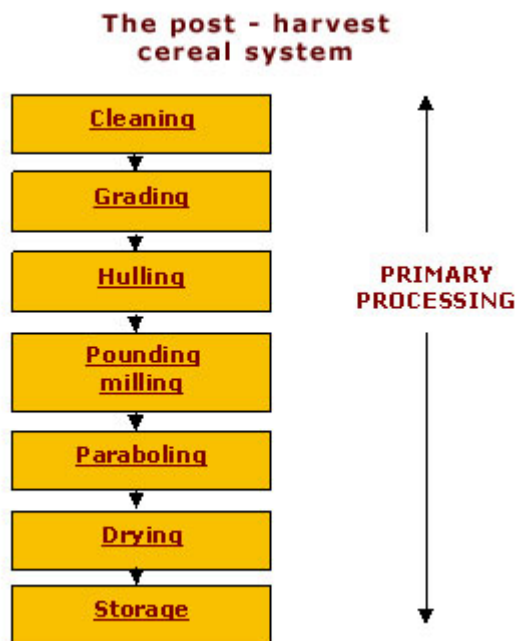
Cereal grains should be dried to 10-15% moisture before storage.

### A.5.-Storage

Dried grains are stored in bulk until required for processing.

The grains should be inspected regularly for signs of spoilage and the moisture content tested. If the grain has picked up moisture it should be re-dried. Grains are often protected with insecticides and must be stored in rodent-proof containers.

### 2.2.- Primary processing



### B.1.-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.



### B.2.-Hulling

Several grains have an unpalatable husk or shell that needs to be removed by a decorticator. A range of specialised machines are available for this task. A range of small rice hullers (both manual and powered) is available.



Less rice is broken during hulling if the rice is parboiled first. Rice polishers are available for removing the rice bran after hulling.

### **B.3.-Pounding/Milling**

Three main types of grain mill are available: Plate mill; Hammer mill; Roller mill.

The choice of mill depends on the raw material and the scale of production. Hammer mills are almost universally used throughout the developing world. Plate mills are widely available in West Africa.

Roller mills are not used at the small scale because of their high cost and maintenance requirements.

The plate mill is usually limited to about 7kW and is derived from the stone mill or quern.

Two chilled iron plates are mounted on a horizontal axis so that one of the plates rotates and the grain is ground between them.

The pressure between the two plates governs the fineness of the product and is adjusted by a hand screw.

There are manual versions of the plate mill available, though they are arduous and hard work to use.

Small-scale hammer mills range in size from 2kW to 20kW. They consist of a circular chamber in which beaters whirl at a high speed.

The milled grain is filtered out through a perforated plate that runs around the edge of the mill chamber.

The size of the holes in the perforated plate determines the fineness of grinding of the particles.

Most grains can be ground in a hammer mill.

Grain for human food is ground to a 1mm particle size while animal food is ground to a 3mm particle size.

Hammer mills cannot be used for wet milling. Roller mills crush the grains rather than milling them into smaller particles. Roller mills are usually used for animal food. It is important to ensure that the grains have the optimum moisture content before milling. If the grain is too dry and hard, it is difficult to break down and requires more energy to convert it into flour. If the grain is too moist, the material sticks to the mill. The optimum moisture content varies between cereal types and with the particular mill being used. Dry grain can be conditioned by soaking in water. Moist grain can be dried before grinding. Different cereal grains have different milling and grinding requirements. See the individual grains for more details.

### **B.4.-Paraboiling**

Parboiling rice is an optional step, but one that improves the quality of hulling as it results in fewer broken grains. About 50% of all rice grown is parboiled.

Parboiling involves soaking and heating the rice which pre-cooks the grains, loosens the hull, sterilises and preserves the rice. At the village level, parboiling is carried out in large pans over an open fire. Rice parboilers, that improve the efficiency of cooking, are available.



### **B.5.-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.

### **B.6.-Storage- SECONDARY PROCESSING**

Dried grains are stored in bulk until required for processing.

The grains should be inspected regularly for signs of spoilage and the moisture content tested. If the grain has picked up moisture it should be re-dried. Grains are often protected with insecticides and must be stored in rodent-proof containers.

<b>Baking</b>	<b>Frying</b>
<b>Blending</b>	<b>Extrusion</b>
<b>Fermentation</b>	<b>Roasting</b>

### **3.- Raw materials:**

The quality of raw materials has an influence over the quality of the products. High quality raw materials should be used.

Small-scale bakers do not normally have facilities for flour analysis and rely on information supplied by the miller or wholesaler. There are a few simple tests that they can carry out which give useful information about the flour quality.

### 3.1.-Flour

Flour can be milled from a variety of cereals. The type available in each country or region may depend upon the types of cereal grown, although wheat flour tends to be available in most places.

#### Wheat flour

Wheat flour contains proteins known as glutes. These are capable of forming a strong elastic network within the dough, which is very useful when making leavened bread.

The protein network traps the gas that is given off by the yeast during fermentation. This causes the dough to increase in volume and produces a bread with a light texture.

If flours that are low in gluten are used to make leavened bread, the gas escapes and the bread is flat and heavy.

Wheat flour is available in different grades according to the degree it is extracted from the whole wheat grain. Flours of different extraction rates include the following:

- Wholemeal flour - 100% extraction
- Wheatmeal flour - 90-95% extraction
- Straight run flour - 70-72% extraction
- Patents - 20-40% extraction

#### Non-wheat flours

There are a variety of non-wheat flours available that can be mixed with wheat flour to make bread.

**Cassava flour** is a fine white powdery flour that has a shelf life of up to one year. It is widely used as a staple food and for the production of a range of fried and baked goods including bread, cakes and biscuits.

**Cereal flours**, especially from maize and sorghum, which are both staple crops, are used to make breads and snackfoods. Sorghum is mainly used to make bread or porridge. Maize is used to make tortillas, snacks and for the production of cornflour and thickeners.

**Soy/composite flour** is a fine creamy flour that is combined with maize flour or other cereal flours to increase the protein content and balance the amino acid composition of the composite flours. In this form it is used as a breakfast porridge and as a weaning food.

#### - Different types of wheat flour -

Different types of wheat flour are available in each country. Wholemeal flour is used for the production of brown bread, rolls and other high fibre products.

Atta is a wheat flour that is suitable for making chappatis. It is also available as a wheatmeal flour.

Special bakers flour (bread making flour) is a strong flour that is used for bread, rolls and pastry. Bakers flour should contain a good quality gluten so that it can produce a light bread.



Biscuit flour. This is a special blend of flour that is made for mechanical biscuit plants.

Self raising flour. This flour is a soft flour that is fortified with a chemical aerating additive similar to baking powder. It is used for making chemically aerated breads such as soda bread. Soft flour is used for cake making.

### 3.2.-Raw materials: Maize

Maize (*Zea mays* ssp. *mays*) is a cereal grain that was domesticated in Mesoamerica. It is called corn in the United States, Canada, and Australia, but in other countries that term may refer to other cereal grains. It is called mealies in southern Africa. Hybrid maize is preferred by farmers over conventional varieties for its high grain yield, due to heterosis ("hybrid vigour"). Maize is one of the first crops for which genetically modified varieties make up a significant proportion of the total harvesting.

Because it is cold-intolerant, in the temperate zones maize must be planted in the spring. Its root system is generally shallow, so the plant is dependent on soil moisture. As a C4 plant (a plant that uses C4 photosynthesis), maize is considered a substantially water-efficient crop, but it can be sensitive to drought, mainly at the time of silk emergence, when the flowers are ready for pollination. In the United States, a good harvest was traditionally predicted if the corn was "knee-high by the Fourth of July", although modern hybrids generally exceed this growth rate.

Maize used for silage is harvested while the plant is green and the fruit immature. Sweet corn is harvested in the "milk stage", after pollination but before starch had formed. Field corn is left in the field very late, in order to thoroughly dry the grain. The importance of sufficient soil moisture is shown in many parts of Africa, where periodic drought regularly causes famine by causing maize crop failure.

#### Cultivars of maize

Scientific classification	
Kingdom:	<b>Plantae</b>
Division:	<b>Magnoliophyta</b>
Class:	<b>Liliopsida</b>
Order:	<b>Poales</b>
Family:	<b>Poaceae</b>
Genus:	<b><i>Zea</i></b>
Species:	<i>Z. mays</i>
Binomial name	
<i>Zea mays</i>	

#### 4.- Proximate composition of cereal grains (FAO, 1999)

Cereal	Crude protein	Crude fat	Ash	Crude fibre	Available carbohydrate
Brown ri	7,3	2,2	1,4	0,8	64,3
Sorghum	8,3	3,9	2,6	4,1	62,9
Rye	8,7	1,5	1,8	2,2	7108
Oats	9,3	5,9	2,3	2,3	62,9
Maize	9,8	4,9	1,4	2,0	63,6
Wheat	10,6	1,9	1,4	1,0	69,7
Barley	11,0	3,4	1,9	3,7	55,8
Pearl mil	11,5	4,7	1,5	1,5	63,4

#### 5.- Maize

Maize can either be wet or dry milled. In dry milling, maize is ground between stones or by using a hand-powered plate mill or at a larger scale, using a hammer mill or powered plate mill.

In wet milling, the grain is soaked and allowed to ferment slightly to improve the flavour before milling with a hand or pwered plate mill.

Maize is sometimes soaked in alkaline water to facilitate removal of the bran before it is milled. If the maize meal is not used whole, it is transferred to a flat basket and shaken so that the bran is separated from the floury endosperm.

The flour is sometimes ground again to make a finer product. The bran is often used to feed chickens.

Maize has a relatively high fat content and tends to go rancid quickly. Ground maize meal therefore has a short shelf life.

#### 6.-Paddy rice

In some countries paddy is parboiled before the husk is removed. Parboiling is the partial cooking of the rice to gelatinise the starch, which makes the grain tougher. There is also a slight change in flavour which some people prefer.

The toughening process makes the seed more resistant to insect attack and to shattering during husking. It also helps to prevent absorption of moisture from the air during storage. The parboiling process involves three stages:

- soaking or steeping of the paddy in cold or hot water to increase its moisture content
- steaming to gelatinise the starch in the kernel
- drying.

The rice should be dried carefully after parboiling to minimise losses. Husking paddy, which is sometimes referred to as de-husking or milling is the process of removing the outer husk.

Husked paddy is referred to as brown rice, whereas de-husked (or polished) rice is white rice. Brown rice is nutritionally superior to white rice as it contains some of the bran which contains protein and vitamin B1 (thiamine).

## **7.- Millet**

The outer layers of some varieties of sorghum seed (usually the red seed varieties) contain tannins that are slightly toxic, have a bitter taste and inhibit the digestion of proteins. For this reason, sorghum is generally hulled before grinding into a flour.

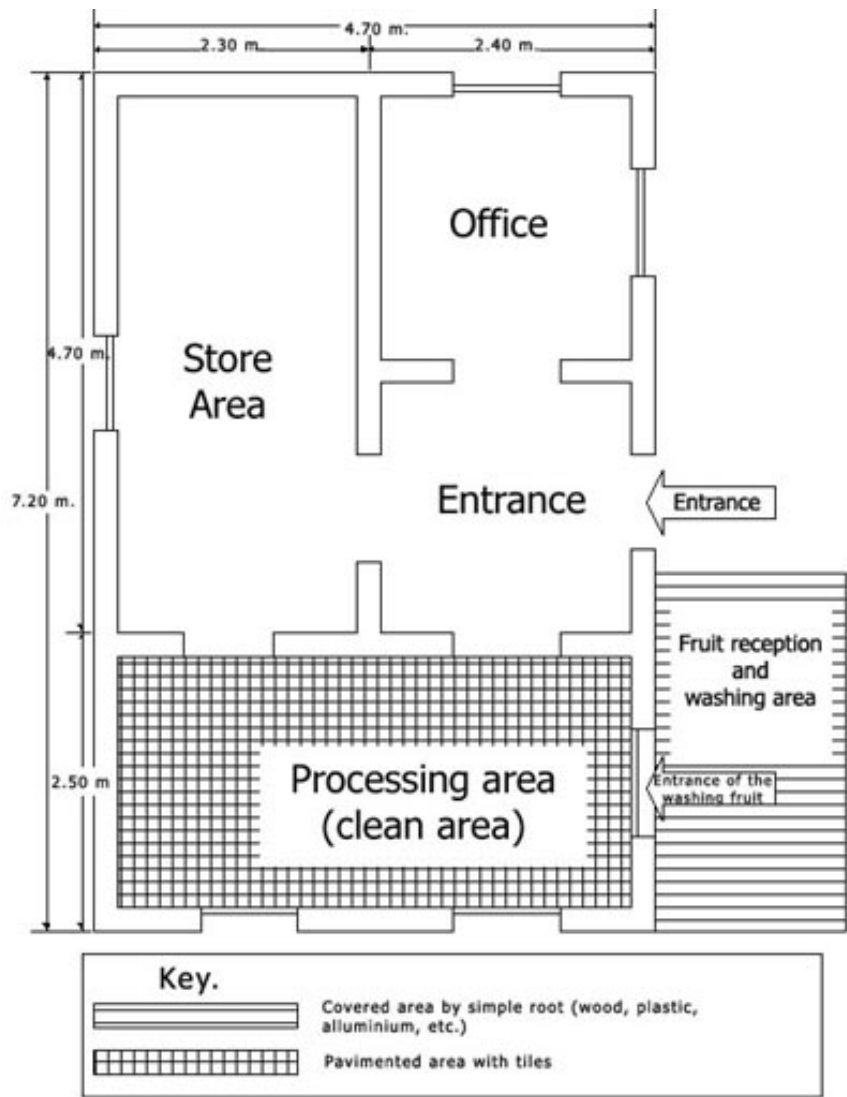
Traditionally sorghum and millet is ground by hand using querns or hand plate mills.

The seed is winnowed to remove foreign matter, then put into a large mortar and wetted. It is then pounded to strip the bran or shell from the grain, followed by winnowing to get rid of the bran. Pounding and winnowing are repeated several times to get a good quality milled seed.

The milled seed is washed to remove any small pieces of bran and soaked in water for 24 hours to condition or temper it. The grain is dried to the correct moisture content then re-ground using a pestle and mortar.

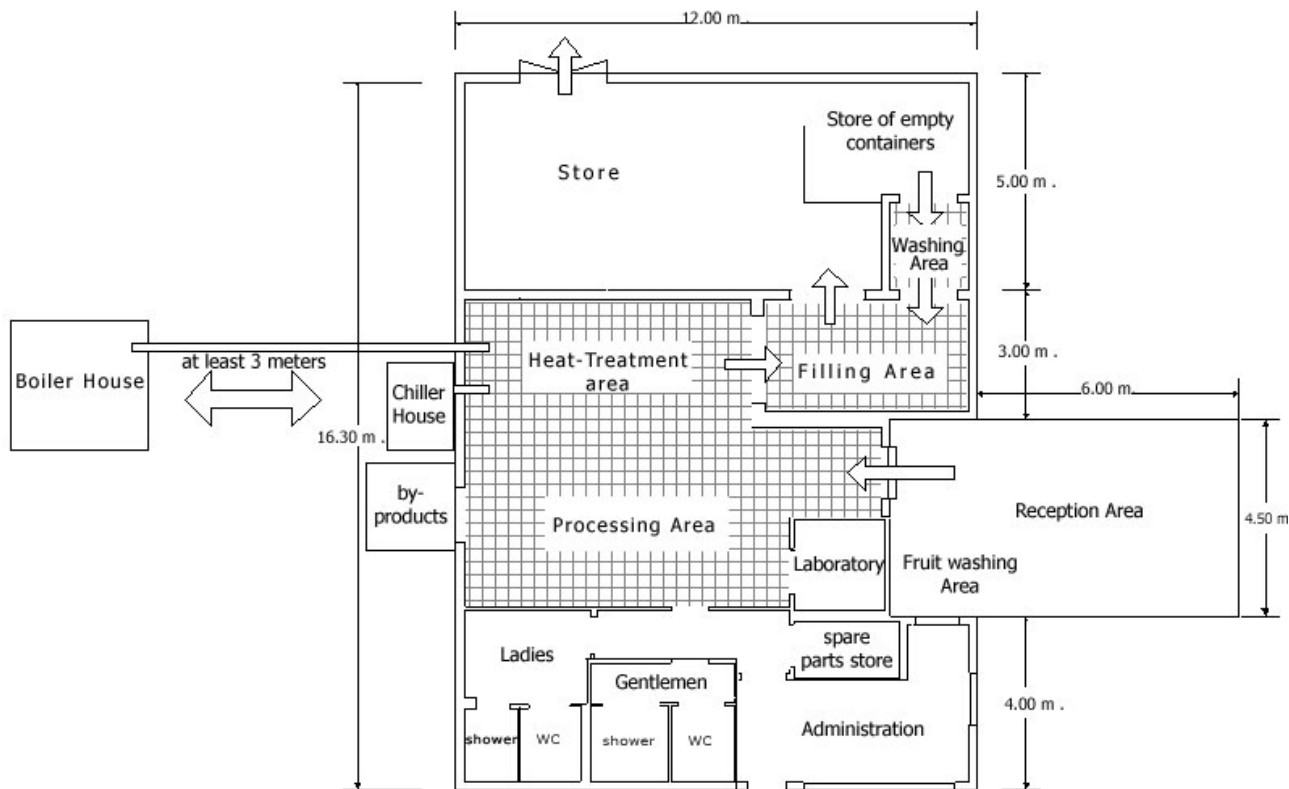
PROCESSING UNIT

SMALL SCALE - Scan in layout of bakery from Bathie



**B.- MEDIUM SCALE**

**Scan in layout of bakery from Bathie**



## Operation: Cleaning and grading -

Prices Codes	Cost (\$US)
1	0-170
2	171-850

### ° Suppliers of cleaning and grading equipment

Equipment category	Scale	Name of the equipment	Technical description	Price code	Ref.	Images
Cleaners	S-M	Seed Cleaners/Graders TA Range	A range of electric powered cleaners that are suitable for processing grains and pulses into high quality seed.		11	
	M-L	Seed Cleaners/Graders TAE Range	These grain cleaners are suitable for installations in which control of dust is a premium requirement. The machines are totally enclosed to minimise the emission of dust. Electrically powered.		11	
	S-M	Hand Operated Grain Cleaner	This machine is used for cleaning and grading of grains. It is manually operated and separates impurities like stubble, chaff and dirt from the grain. There are 3 extra sieves to make it suitable for a variety of cereals and pulses. Throughput 150kg/hour.		11	
	S-M	Pedal-cum-Power Operated Grain Cleaner	This machine can be operated manually or by electric motor. It removes stubbles, dirt and broken or small size grain to deliver clean graded grain. Throughput 200-400kg/hour.		11	
	M-L	Rice Polishing Machine RS 40	Moisture content of rice grains is increased by a humidifier before feeding between milling rollers for skinning and polishing. Rice bran is removed by centrifugal fans. Percentage of broken rice grains is less than 2%, produces export quality rice. Good design, easy and safe to operate. Automatic control on input and output. Throughput 4 tonnes per hour.	4	11	
	M-L	Rice whitener VSW 40	Removes bran by creating friction between rice grains and emery/grinding net (1st stage) then between rice grains and blade/grinding net (2nd stage). Rice bran is removed by a centrifugal fan. Rice with high humidity (15-19%) can be used. There is a low percentage of broken rice grains after 2 stages of whitening: 6-12%. Throughput 3-4 tonnes per hour.	4	11	
	M-L	Screen Air Separator	This machine is most suited as a precleaner before the storage of seeds. Variable speed drive ensures accurate quality separations at high capacity. Totally enclosed aspiration system with cyclone provides dust-free working in the plant. Throughput 100-2000kg/hour.	3	11	
	M-L	Sab-Pre Cleaner and UB Fine Cleaner	This machine is used for fine cleaning and grading.		11	



	M-L	Grain Cleaning Machine	An electric powered machine for cleaning milled rice. Throughput 500kg/hour.	3	11	
	M-L	Grain Cleaner	Grain cleaning machine.		11	
	M-L	Grain - Seed - Flour Cleaner and Grader	An electric powered machine used for cleaning and grading various types of cereals. Throughput 500kg/hour.		11	
Graders	M-L	Mechanised Grader	Used for separating food groups such as peanuts and dhal etc. into different sizes where grading by size is required. Throughput 0.5-3.0 tonnes/hour. Electric powered.	3	11	
	M-L	Clean - O - Grader	Used to finely grind a range of cereals. Control of air allows suction of lighter impurities/seeds as desired. Pre and post aspiration system with collection chamber and cyclone ensures dust free working in the plant. Throughput 100-2000kg/hour. Electric or battery powered versions available.	3	11	
	M-L	Gyro Screen	Used for optimum continuous screening at maximum efficiency and feed rate. Throughput 125-500kg/hour. Either diesel or electric powered.	3	11	
	S-M	Screener	Screening machine and density separator for grains.		11	
	S-M	Grain - Flour Separator	Power operated (electric) equipment for separation of milled wheat into various fractions which are collected at different outlets. Suitable for small scale processing units. Throughput 80-120kg/hour.	3	11	
	S-M	Precision Air Classifier	This machine is used for 3 functions - to separate hulls mixed with unhulled seeds; to recover oil bearing kernels from the hulls; and to separate light materials from heavy materials. Throughput 150-2000kg/hour. Electric or diesel powered.	2,3	11	
	M-L	Gravity Separator	This machine grades the seeds on a gravity basis into heavies, mediums and lights so that the best quality seeds can be made available for export. Throughput 500kg/hour. Electric or diesel powered.	3	11	
	S-M	TSR 150 Sorter	This machine can be used at different stages in rice processing: to separate long and short paddy grains; to eliminate large (lumps of earth etc.) or small (sand, seeds etc.) foreign matter; to remove white rice fragments; or to separate broken and whole grains. Throughput 150-2000kg/hour.		11	
	M-L	Gravity Separator	Pressure/vacuum gravity separators. Throughput 100-2000kg/hour. Electric or battery powered.	3	11	
	S-M	Screen Separators	Circular motion screener is widely used for removal of oversized and undersized material. Throughput 100-2000kg/hour. Electric or battery powered.	3	11	



	M-L	Vibro-Separators	Products include cleaners, graders, destoners, screens and separators.		11	
	S-M	Hi-Cap Gravity Separator	For separating dry bulk particles that are similar in size and shape but different in weight.		11	
	S-M	Paddy Separator	For separating paddy grains. Throughput 750kg/hour. Electric powered.	2	11	

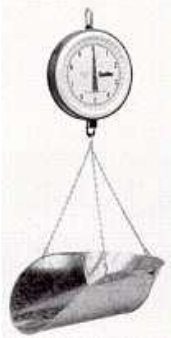




## B- Suppliers of cleaning and grading equipment


Acufil Machines	India
Central Institute of Agricultural Engineering	India
Forsberg Agritech India PVT Ltd	India
Goldin (India) Equipment (PVT) Limited	India
John Fowler India Limited	India
Premium Engineers PVT Ltd	India
Rajan Universal Exports Manufacturers PVT Limited	India
Kundasala Engineers	Sri Lanka
Kongsonglee Kanchang	Thailand
Sai Gon Industrial Corporation (SINCO)	Vietnam
Gauthier	France
Marot	France
Alvan Blanch	UK

## C- Operation: Quality control -


### °Suppliers for testing and quality control

Equipment category	Scale	Name of Equipment	Technical Description	Price code	Reference	Image
Temperature control	S-M	thermometer general purpose	Made of stainless steel (0-150 C), this thermometer comprises a mercury-filled, toughened bulb, with an anti-roll cap. Seven versions are available, differing in temperature range and graduation. Length: 30.5cm.	1	2	
Weight control	S-M	add and wegh scale	This measures the weight of foods. The add-and-weigh facility allows the continuous weighing of ingredients to be carried out in the same bowl. Measurements are carried out in 25g increments. Capacity: 3kg.	1	2	

	S-M	hanging scale	These heavy duty, hanging scales have an adjustable tare. Capacity: 30kg x 100g.	1	2	
	M	portable platform scale	These scales weigh bulky/large materials such as sacks of flour. The equipment includes a cast iron box, steel knife edges, and a platform-on-wheels. Weight of scales: 250kg. Dimensions: 40.6 x 63.7cm.	3	2	
	S-M	electronic scale	These scales weigh in 1g increments. Any type of bowl or solid food can be placed onto the scales directly. There is also an add-and-weigh feature, and an automatic cut-off. Capacity: 4kg. Dimensions: 15 x 16 x 3cm.	1	2	
Volume control	S-M	mixer jugs	This jug can be used as either a measuring jug or a mixing bowl. It is fabricated from heat-resistant polypropylene and can withstand boiling water. The jug is graduated in pints, fluid ounces and millilitres with an overall capacity of 2 litres. Smaller jugs (0.57 and 1.1 litres (1 or 2 pints)) are also available.	1	2	
	S-M	pyrex measuring cylinders	This measuring cylinder has a capacity of 10-250ml.	1	2	
pH control	S-M	battery operated pH meter	This portable pH meter has a range of pH 2-12, with 0.1 pH accuracy.	1	2	

	S-M	pH meter digital	This is a self-contained and portable instrument designed for accurate pH reading. The meter has an LED display for easy reading. Range: pH 0-14. Accuracy: pH +/- 0.01 unit, mV +/- 0.1% of full scale. Temperature compensation: 0-100°C. Power supply: 230V.	1	2	
	S-M	Waterproof pocket pH meter	This easy to use, hand held pH meter is completely water proof and can be completely immersed in water. It has an easy-to read LCD and a positive push-button ON/OFF switch. The display indicates when a stable pH value has been reached, ensuring that only accurate readings are taken. Calibration is automatic and can be performed easily, even by non-technical operators. The meter has an auto-switch-off feature (after 10 minutes) that prolongs the life of the batteries and gives up to 300 hours of use.	1	29	
	S-M	GroCheck Meter pH, EC and TDS	This combination model measures pH, EC (conductivity) and TDS (for measuring fertiliser application). It is an easy-to-use, hand held meter that is battery operated (total battery life is about 150 hours). It is supplied complete with probe, pH 7 buffer, 1.41 EC and 1500ppm calibration solutions, a 9V battery and instruction manual.	1	29	
	S-M	Combo Waterproof pH/EC/TDS tester	This battery-operated waterproof tester is designed for high accuracy pH, EC/TDS and temperature measurements. Calibration and temperature compensation is automatic.	1	29	

	S-M	Fisher Accumet (AP71) pH meters	A range of pH meters is available from Fisher Scientific. Easy to use, hand-held models come with a range of specifications and in various prices.	1,2	29	
Brine control	S-M	Brine meter	This meter can be used to measure the percentage of salt in a solution.	1	2	
	S-M	Fisherbrand salt water/brine unit	This hand held equipment is a two scale unit that measures specific gravity and the concentration of salt in water (parts per thousand (ppt)). It has automatic temperature compensation. The meter measures salinity from 0-100ppt.	1	29	
Testing equipment	M	samplers for milk	These are ladles which are dipped into milk to obtain a sample for testing.	1	2	
Refractometers	S-M	Fisherbrand Refractometers	These refractometers are handheld, easy to use and accurate, with a focusing eye piece. Nine models are available, that cover a range of applications and measurement scales. Some models have automatic temperature compensation (ATC) between 10 and 30C. The Brix scale is used to measure the sugar concentration in solutions such as fruit juice, wine and soft drinks. Different sizes are available as follows: 0-18 Brix; 0-32 Brix; 28-62 Brix; 45-82 Brix; 58-90 Brix.	1	29	
	S-M	Pocket Refractometer	Comes with leather carrying case.	1	29	
	S-M	Sugar Refractometer	This measures sugar content. The following size ranges are available: 0-45% and 40-85%.	1	29	

Water treatment	S-M	sodastream filterstream on line water filter unit	<p>This high specification water filter removes the chlorine taste, organic particles and herbicides from water. Easy installation, no plumbing skills are needed. Continuous supply of purer water from an extra tap fitted on the sink. Up to 2000 litres from one cartridge, recommended replacement interval is 6 months.</p>	1	22	
	M	UV water disinfection unit	<p>This is used to treat water by destroying bacteria using ultra-violet light. It uses a single phase, 220V 50Hz power supply, or alternatively it can be battery-operated. Water flow is at 750 litres per hour.</p>	1	2	