**FOOD PROCESSING AND PRESERVATION OF CEREALS**

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 also known as Preservation. 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.

**FOOD PROCESSING OF CEREALS**

**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.

**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.

**Hulling**: Several grains have an unpalatable husk or shell that needs to be removed by a decorticator. A range of specialized 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.

**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.

**Parboiling:** 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, sterilizes and preserves the rice. At the village level, parboiling is carried out in large pans over an open fire.

**SECONDARY PROCESSING**

Secondary processing of cereals (or 'adding value' to cereals) is the utilization of the primary products (whole grains, flakes or flour) to make more interesting products and add variety to the diet. 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. The quality of raw materials has an influence over the quality of the products.

**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. High quality raw materials should be used. Small-scale bakers do not normally have facilities for

**Wheat flour:** Wheat flour contains proteins known as glutens. 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: Whole meal flour - 100% extraction Wheat meal 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 snack foods. Sorghum is mainly used to make bread or porridge. Maize is used to make tortillas, snacks and for the production of corn flour 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 Whole meal flour is used for the production of brown bread, rolls and other high fiber products. Atta is a wheat flour that is suitable for making chapattis. It is also available as a wheat meal flour. Special bakers’ flour (bread making flour) is a strong flour that is used for bread, rolls and pastry. Baker’s 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.

**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 flavor before milling with a hand or powered 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.

**Paddy rice:** In some countries paddy is parboiled before the husk is removed. Parboiling is the partial cooking of the rice to gelatinize the starch, which makes the grain tougher. There is also a slight change in flavor 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 gelatinize the starch in the kernel

- drying.

The rice should be dried carefully after parboiling to minimize 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).

**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 reground using a pestle and mortar.

**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:** Dough made from cereal flour can be fermented to make a range of products. Baking. Dough 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.

**FOOD PRSERVATION OF CEREALS:**

**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 mechanized 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.

**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 mechanized. Sorting the grain from the straw is relatively easy, but is difficult to mechanize. 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.

**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.

**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, and gas or burning biomass. Cereal grains should be dried to 10-15% moisture before storage.

**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.

**REFERENCES**

 [www.fao.org](http://www.fao.org)

**CONCLUSIONS**

Proper processing and preservation machineries and structures should be put in place especially for the farmers in rural areas, so they can properly utilize the full potential of cereal crops.

Maintenance of the existing structures and machineries should be properly monitored

Government and local private investors should heavily fund this sector because it is a highly profitable venture.