

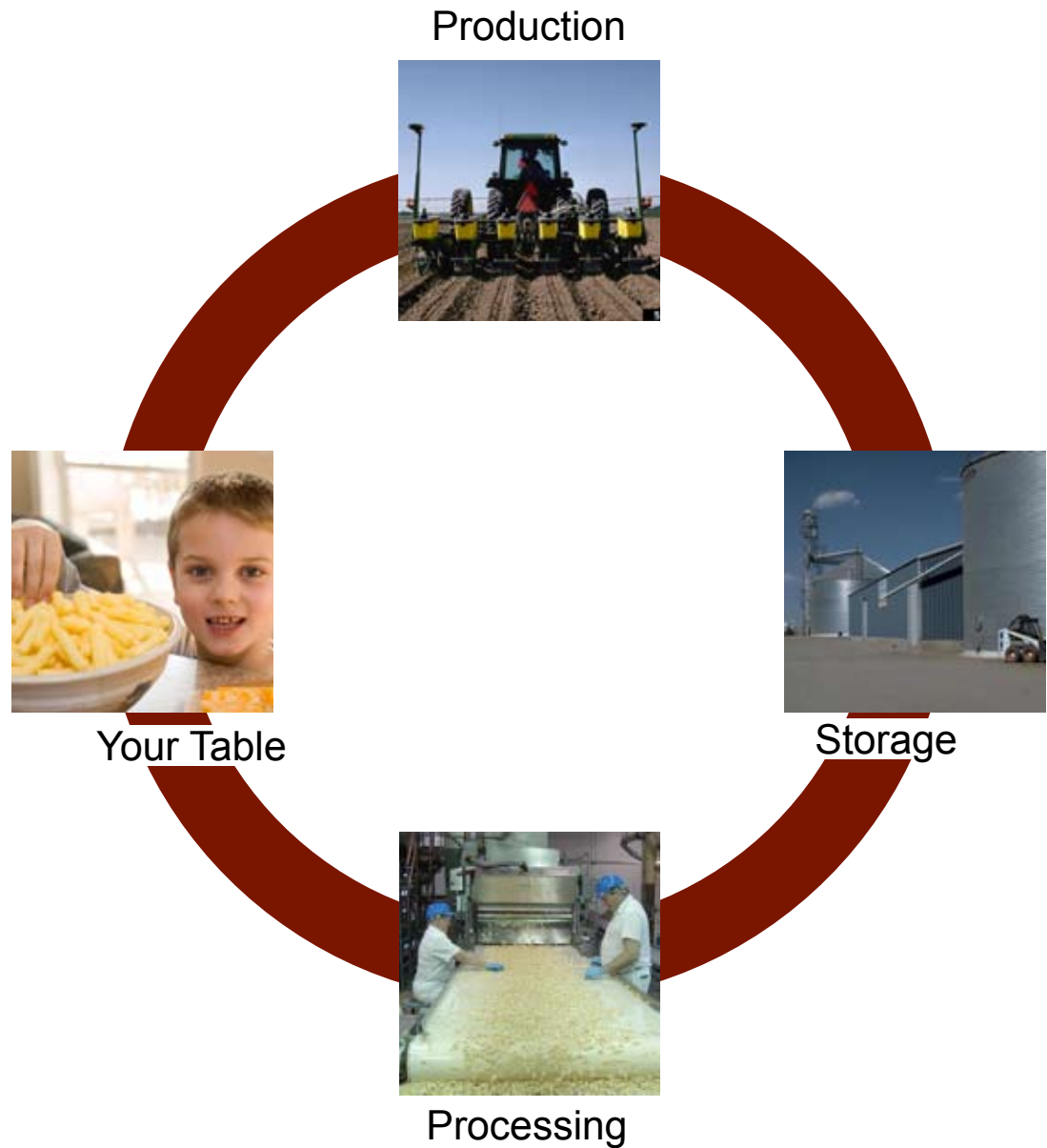
# Farm to Fork

Dr. Clifford Hall  
Clifford.Hall@NDSU.edu

Dr. Hall is an Associate Professor of Food Sciences at North Dakota State University, Fargo, North Dakota, and a Member of the Bean Institute Editorial Board.



“Farm to fork” is a model that encompasses the flow of food from the time the seed is planted until the finished product reaches the consumer’s plate. Understanding that what happens on the farm can influence the product consumed allows for the production of higher quality and safer food.



Beans belong to the family of plants called legumes. A legume is a plant that produces seeds in a pod (fruit) and may have the ability to fix atmospheric nitrogen. The physical shape of the seed helps distinguish beans from peas and lentils. Usually, beans are kidney-shaped or oval, peas are round and lentils are flat disks. Most dry beans grown in this country belong to the species *Phaseolus vulgaris*, or common bean.

The term “dry beans” includes varieties of beans other than green beans, string beans and soybeans. Dry beans are available uncooked in sealed bags or pre-cooked in cans. The type or variety of bean grown is dependent on how the bean will be consumed. The beans below represent a hand full of the beans grown worldwide.

## Cultivar



Light Red Kidney Beans



Pinto Beans



Black Beans



Navy Beans



Small Red Beans



## Bean Production: Planting

Agronomics is the science and economics of crop production and land management. Today's bean producers are business people and stewards of the land. America is by far the world leader in quality bean production. That's because the equipment used for harvesting is the most modern and technically advanced in the world. Each year, U.S. farmers plant from 1.5 to 1.8 million acres of dry beans. Beans can be planted in May and take about 12-14 weeks to grow to full height. Under ideal condition the soil should reach a temperature of 65 °F.

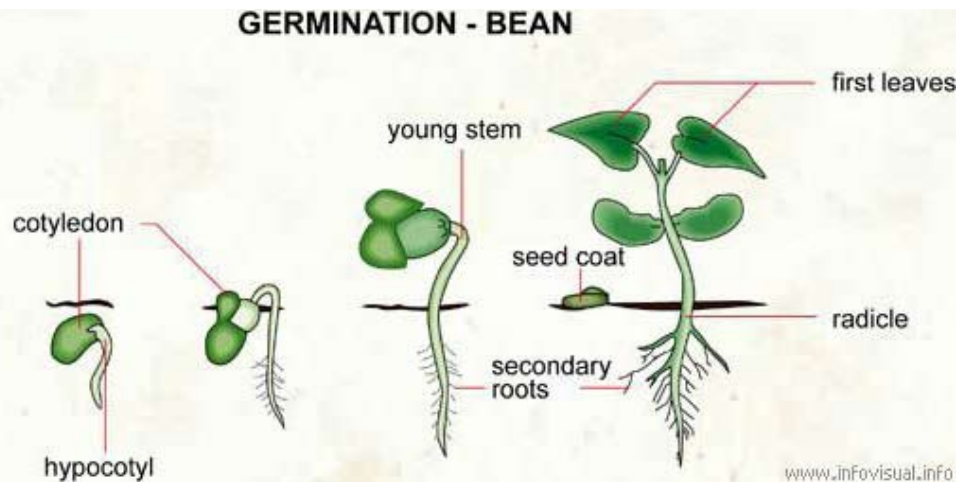


Photo by Howard F. Schwartz, Colorado State University, Bugwood.org

## Bean Production: Germination

Once the beans have been covered with soil during the planting step, the dry bean picks up moisture from the soil. Once the seed has absorbed enough water it begins to soften and eventually germinates. As long as the soil remains above 65 °F, beans will germinate quickly. Germination usually occurs around 12-15 days after planting.

See [http://www.playfullearning.com/Playful\\_Learning/Blog/Entries/2008/7/11\\_Bean\\_Seeds.html](http://www.playfullearning.com/Playful_Learning/Blog/Entries/2008/7/11_Bean_Seeds.html) for video of germination.



## Bean Production: Growth and Flowering

Once the plant has germinated and emerged from the soil, it enters the second stage of life where it grows to a height of 12 to 18 inches. At these heights, most beans are considered mature and begin to develop small flowers that vary in color depending on the bean variety. All this activity occurs 4-6 weeks after germination.



Small Bean



Developing Flowers



Flowering Bean

## Bean Production: Pod Development and Maturation

After flowering, insects such as bees fertilize the flowers. Eventually the flowers give way to pods, within which the small beans begin to take shape. During the next several weeks the beans within the pods continue to increase in size. The pods generally hold anywhere from 1 to 6 seeds. The warm summer days ripen the beans inside the pods. One or two weeks before harvest, the plants change color from green to golden yellow, signaling they are ready for harvest.



Bean in Pods



Mature Beans



Dry Beans

Top and right photos by Howard F. Schwartz,  
Colorado State University, Bugwood.org



## Bean Production: Harvesting

After the leaves have turned yellow and dropped from the plant, only the stems and dry pod remain. Harvesting begins at this stage in August and can last until October in the United States. The harvesting results in the removal of the pod from the bean. The dry, free flowing beans are then transferred from the combine into a truck which then transports the beans to storage bin on the farm or at a bean elevator.



Cutting of Beans



Harvest of Beans

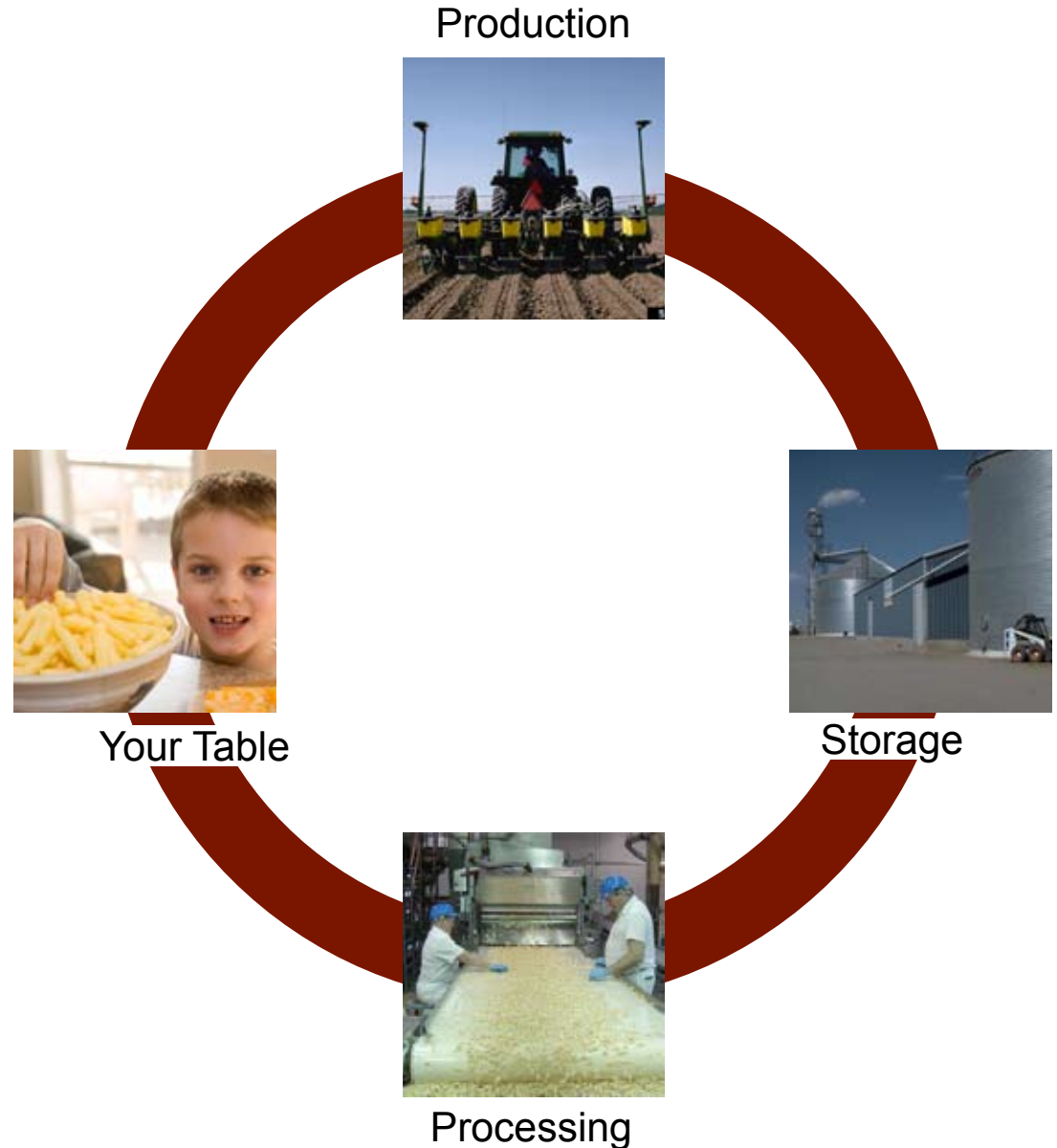


Transfer of Beans to Truck



## Introduction

The processing segment of the farm to fork model begins when the beans are removed from the bean elevator and shipped to a processing facility. At the factory, beans are cleaned and then processed into ingredient or consumer products. Products such as packaged dry beans, canned bean products and bean flours all result from processing.



Beans received from farmers are those that have come from the combine and have been transported to a bean elevator. As a result, beans will have an average of 4-8% foreign material, broken beans and beans of varying color depending on the season. The bean elevator will then condition the bean in preparation for further processing or packaging.

Dry packaged beans are beans that have been re-conditioned and then packed into containers, which are usually plastic bags for the retail market. These beans are then used by consumers where they are soaked and then cooked or added to recipes.

Processed beans are bean products that have been created from dried beans. Processed beans imply that an additional step beyond conditioning has been completed on the beans resulting in products such as canned beans, baked beans, bean pastes, puffed snacks, texturized analogs and cereal products. In addition, refried beans, rehydrated beans and bean flours can be made from the further conditioned dry beans.

## Cleaning



## Conditioning

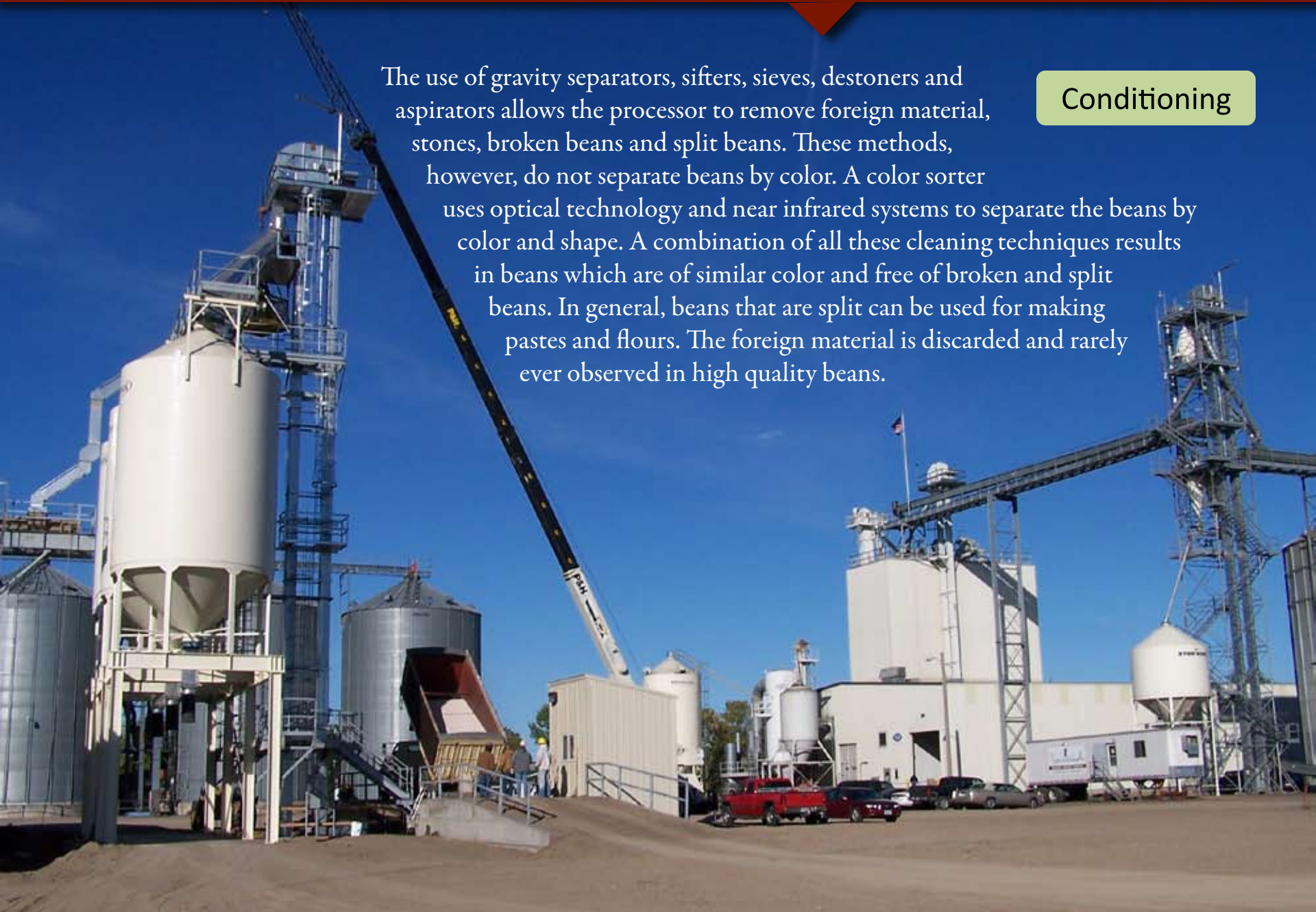


Conditioning is designed to remove foreign material, broken beans, stones, and off-colored beans. Uniformity in the beans aid in further processing and allows for the beans to soak up water and cook uniformly. Cleaning is conducted using a variety of methods that include gravity separators, sifters, sieves, aspirators, destoners and color sorters.



## Conditioning

The use of gravity separators, sifters, sieves, destoners and aspirators allows the processor to remove foreign material, stones, broken beans and split beans. These methods, however, do not separate beans by color. A color sorter uses optical technology and near infrared systems to separate the beans by color and shape. A combination of all these cleaning techniques results in beans which are of similar color and free of broken and split beans. In general, beans that are split can be used for making pastes and flours. The foreign material is discarded and rarely ever observed in high quality beans.



Conditioned beans are first inspected prior to entering the bean processing plant. Once approved, they are then washed in the case of a cooked bean product, blanched, placed in cans and then brine (i.e. salt solution) or other sauce, such as chili. The cans are sealed and then placed in a retort for canning using high temperature and pressure. The finished products are shelf stable canned beans with or without sauces. Some canned products require that the bean be cooked and ground into a paste. The paste would be placed in cans, sealed and then thermally processed with a retort. Refried beans and bean paste are just two of the products that would be processed in this manner.



Inspection of beans



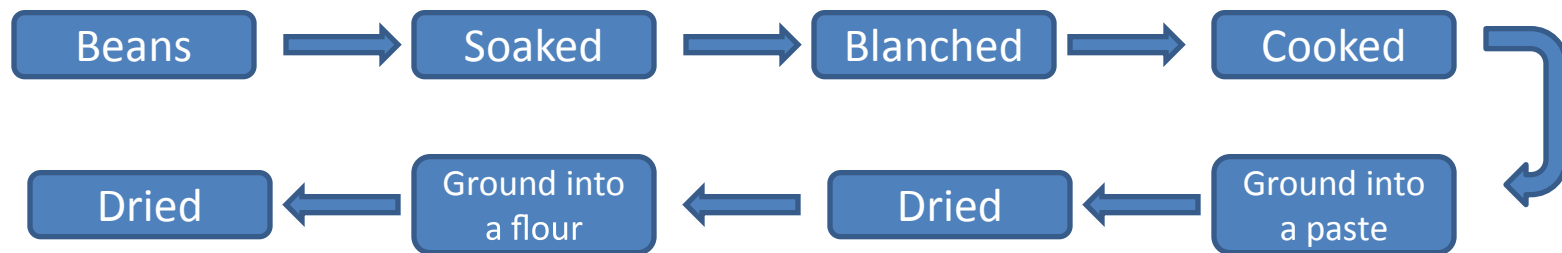
Blanching of beans

Filling cans with beans  
and chili sauce

Place in a retort  
for canning.

Processed  
Products

Bean flours can be prepared using several methods. The flow chart below demonstrates that during the process a heating step is necessary to inactivate enzymes that might later affect quality. There are two basic approaches used to make bean flour. One is the pre-cook method whereby the beans are blanched and dried prior to being made into a flour. An alternative method is to grind the beans into a flour and then apply a heat treatment. In this case, the bean flour is not a precooked flour. Raw bean flours are seldom used by the industry as the bean flour can undergo off-flavor formation during storage in 3-4 months. Bean flour can be processed into breakfast and snack food products, as well as a texturing ingredient in tortilla chips, baked products and pasta.



Preparation of bean flours using a pre-cook method.



Preparation of bean flours using a grinding step prior to heating.



Processed  
Products

Bean flour is used in extrusion applications. Extrusion processing of bean flour occurs under high pressure and temperature. This combination allows bean flour to be puffed into different shapes. The process begins when the bean flour and water mix and move down the barrels in the extruder. The bean flour hydrates into a paste-like consistency while continuing through the extruder. The paste like material is plasticized and discharged in the die. The die is partly responsible for the shape. A pressure build up inside the extruder occurs as the material moves through. This pressure is released when the product moves through the die. The pressure drop causes the bean flour-water mix to puff. As a result, the product takes on the appearance of a puff cereal or snack product.



Bean Flour

An example of an Extruder  
needed to make puff productProduct coming out  
of the extruder