

Utilization of Legumes in the Tropics

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Abstract

In order to address protein malnutrition and food security issues in developing countries, there is need to emphasize the utilization of legumes as a low-cost dietary vegetable protein source. This exactly what this paper is all about.

Legumes can be introduced into human diet in various forms. These include cooked beans, Bean soup, Bean cake and pudding, Soymilk, Soy cheese, Dawadawa, Vegetable oils, Boiled and roasted groundnut, Peanut butter, African Locust Bean, etc. The proteins of legumes are adequate in essential amino acid and they are also good sources of different minerals such as calcium and phosphorus.

It is hereby recommended that there is need to explore the processing of underutilized legumes, there is need for value addition through proper packaging, there is need for improved appropriate processing facilities, and there is need for improved product quality and safety, it is also recommended that Improved nutritional quality can be achieved by combining legumes with cereals Processing and Utilization.

Introduction

Legumes belong to the family *Leguminosae*. They are the next important food crop after cereals. They are sources of low-cost dietary vegetable proteins and minerals when compared with animal products such as meat, fish and egg. Indigenous legumes therefore are an important source of affordable alternative protein to poor resource people in many tropical countries especially in Africa and Asia where they are predominantly consumed. In the developing countries, research attention is being paid to better utilization of legumes in addressing protein malnutrition and food security issues. Legumes can be classified as:

1. Pulses or grain legumes which are various peas and seeds that are low in fat content
2. Oilseeds such as soybean and groundnut
3. Forage leguminous crops such as *Mucuna pruriens*, *Psopocarpur tetragonolobus* (winged bean).
4. Swollen root or tuberous root consumed as vegetable or fresh salad such as

Pachyrrhisus erosus, *P. tuberosus* so called as Yam bean. Yam bean in Indonesia is widely planted by farmers for cash crop with better income. The other species such as *Flemingia grahamiana*, *F. procumbent*, *Psoralea esculenta* and *Pueraria lobata* are still under-utilized. The highlight of this chapter is on the pulses and the leguminous oilseeds. Different types of legumes grown are consumed in different tropical regions in the world. Legume growing areas in Tropical Africa include Nigeria, Senegal, Togo, Cameroun and Cote d'Ivoire and in Tropical Asia include Indonesia and India. Some legumes are commonly used as commercial food crops such as cowpea in West Africa while some are lesser known, neglected or underutilized outside their indigenous areas. Table 1 shows some of the Legumes grown in the tropics.

Underutilization can be due to the hard- to cook phenomenon in legumes and lack of information on potential food uses. Pigeon pea, African yam bean, lima bean and bambara groundnut are neglected or underutilized crops in many parts of tropical Africa

The term "tropics" refers to the continuously warm and frost free zone of the world that lies approximately between the Tropic of Cancer (or latitude 23.5° north of the equator) and the Tropic of Capricorn (or latitude 23.5° south of the equator) (Juo et al., 2003). This area of the planet is inhabited by millions of people who rely on sustainable agriculture to feed themselves, their fellow countrymen, and provide a means of profit.

NUTRITIONAL, HEALTH AND ECONOMIC IMPORTANCE OF LEGUMES

Legumes are rich in protein and their chemical composition varies depending on variety, species and region. The protein content of legumes is twice or triples that of cereals depending on the type of the legume. The protein of legumes though adequate in essential amino acid lysine is however deficient in sulphur containing amino acids methionine and cystine. Legumes, however, form good supplements for cereals which are lacking in essential amino acid lysine. Improved nutritional quality can therefore be achieved by combining legumes with cereals Processing and Utilization of Legumes in the Tropics

Most legumes are low sources of fat with the exception of soybean and groundnut. Legumes are also good sources of different minerals such as calcium and phosphorus. The bioavailability of these minerals can be

improved through processing. Legumes contain anti-nutritional factors such as lectins, saponin, haemagglutinin, protease inhibitor, oxalate, goitrogen, phytates, trypsin inhibitor and tannin. These compounds reduce protein digestibility and availability. Some anti-nutritional factors in legumes have been reported to have health benefits. Tannin, a polyphenolic compound is reported to possess antioxidative activity. Raw legumes have higher content of anti-nutritional factors but can be eliminated or reduced by processing. Legumes are also good sources of carbohydrates, minerals, dietary fibres and water soluble vitamins which are important in human health. Dietary fibre consists of indigestible polymers which are made up of cellulose, hemicellulose, pectin and lignin. They provide bulk in natural food and are resistant to hydrolysis by enzymes in the alimentary tract. Dietary fibre is important in aiding absorption of water from the digestive track. It also has health benefits such as lowering of blood pressure and serum cholesterol, protection against cardiovascular diseases, diabetes, obesity and colon cancer. Legumes also have complex sugars such as raffinose and stachyose which are responsible for flatulence. Legumes are important both in human and animal nutrition especially in tropical Africa where they are more consumed. Legumes are processed into various semi- finished and finished products. Retail legume products serve as a means of economic empowerment for individuals which also help to boost the national economy of some countries. Legumes Protein Fat Carbohydrate Fibre Ash

TABLE 1, COMMON LEGUMES THAT GROW IN THE TROPICS

Common names	Botanical names	Areas available/consumed
Cowpea	<i>Vigna unguiculata</i>	Asia, Tropical Africa, West Indies
Blackeyed pea	<i>Vigna sinensis</i>	Asia, Africa, West, Indies
Soybean	<i>Glycine max</i>	America, Asia, Africa
Groundnut	<i>Arachis hypogaea</i>	Tropical Africa, Central and South, America
Pigeon pea	<i>Cajanus cajan</i>	West Africa, East Africa, Pakistan, Middle East, Asia
Lentils	<i>Lens esculenta</i> , <i>Lens culnaris</i>	Central America, India, North Africa, West Asia
Mung bean	<i>Phaseolus aureus</i>	East Asia, East Africa
African yam bean	<i>Stenostylis stenocarpa</i>	West and East Africa
Lima bean	<i>Phaseolus lunatus</i>	Central America, Africa, Tropical Africa
Faba bean	<i>Vicia faba</i>	Africa
Kidney bean	<i>Phaseolus vulgaris</i>	East Africa, Latin America
Chickpea	<i>Cicer arietinum</i>	India, Pakistan
Lathyrus pea	<i>Lathyrus sativus</i>	
Bambarra groundnut	<i>Vigna subterranea</i>	Tropical Africa
Jack bean	<i>Canvalia ensiformis</i>	
Winged bean	<i>Psophacarpus tetragonolobus</i>	Tropical Asia, South East Asia

(Ihekoronye A.I. and Ngoddy P.O. 1985)

SHORT DISCURSION ON VARIETY OF LEGUMES

▪ BEANS

The most common varieties of legumes are beans. These include adzuki beans, black beans, soybeans, anasazi beans, fava beans, garbanzo beans (chickpeas), kidney beans and lima beans. These foods are high in protein and carbohydrates but low in fat. For example, 1 cup of cooked adzuki beans contains 17.3 grams of protein, 57 grams of carbohydrates, 294 calories and only 0.2 grams of fat. In comparison, 1 cup of cooked chickpeas contains 14.5 grams of protein, 45 grams of carbohydrates, 269 calories and 4.3 grams of fat. Because of their assortment of flavors and textures, a mixture of lightly-seasoned, cooked-then-cooled beans makes a flavorful, nutritious and filling salad.

▪ NUTS

Some legumes are inappropriately called "nuts." The most common example is the peanut, with other examples including soy nuts and carob nuts. Similar to other nuts, these legumes contain high concentrations of protein, fat and carbohydrates. For example, 1 cup of dry-roasted soy nuts contains

68.1 grams of protein, 37.2 grams of fat, 56.3 grams of carbohydrates and 776 calories. One cup of dry-roasted peanuts is much lower in protein and higher in fat, with 34.6 grams of protein, 31.4 grams of carbohydrates, 854 calories and 72.5 grams of fat. When eating soy or peanuts, choose dry-roasted and unsalted varieties to avoid the high fat and sodium content of oil-roasted, salted nuts.

▪ PEAS

A number of legumes are labeled as peas, including green peas, snow peas, snap peas, split peas and black-eyed peas. Similar to beans, peas contain high concentrations of carbohydrates and protein but little fat. For example, 1 cup of boiled green peas contains 8.6 grams of protein, 25 grams of carbohydrates, 134 calories and 0.4 gram of fat. Split peas contain higher concentrations of protein and carbohydrates but a similar amount of fat. One cup of boiled split peas contains 16.4 grams of protein, 41.4 grams of carbohydrates, 231 calories and only 0.8 grams of fat. As most varieties have a naturally sweet flavor, peas are great as a side-dish, snack, and addition to a stir-fry or topping on a salad.

▪ LENTILS

Legumes that are classified as nuts, beans and peas are approximately spherical in shape. With their flat, round shape, lentils differ from this general pattern. Whether yellow, orange, green, brown or black, the nutritional profile of lentils does not change with their color. However, sprouted lentils differ from non-sprouted lentils in their nutritional content. One cup of uncooked sprouted lentils contains 6.9 grams of protein, 17.1 grams of carbohydrates, 82 calories and 0.4 gram of fat. As they are much denser, non-sprouted lentils provide larger amounts of these nutrients. One cup of uncooked, non-sprouted lentils contains 49.5 grams of protein, 115.4 grams of carbohydrates, 2 grams of fat and 678 calories. Although the non-sprouted variety is more common in cooked dishes, both varieties can serve as the basis for Indian dal curries.

HOUSEHOLD UTILIZATION OF SOME TROPICAL LEGUMES

✓ COWPEA

- **COOKED BEANS:** This can be in the form of cooked whole beans or cooked dehulled beans. Whole beans take longer period of time to cook than dehulled beans. Whole beans are boiled for about 45 to 60 minutes on the cooking stove or gas cooker depending on the hardness of the hull at household level. It is eaten whole or mashed. It used in or may be eaten alone or in combination with other food products like bread, *gari*, boiled yam with vegetable soup or fish meat sauce. Cooked dehulled beans reduce flatulence and is an excellent meal for both children and adults. The whole cooked bean can also be made into bean porridge by adding other ingredients such as palm oil, salt, pepper, onion and spices. Cooked beans prepared for income generating purpose are usually cooked with firewood which imparts a characteristic flavour. This, however, has its occupational hazards to processors. Long term effect of wood smoke in contact with eyes has its health and cost implications. Modern cooking methods also involve the use of locally fabricated cooking gas equipment at the commercial level.
- **BEAN SOUP:** In this food preparation, beans are washed, soaked, dehulled, boiled, mashed and sieved. The sieved beans is then cooked with palm oil along with other ingredients such as pepper, spices and seasoning with or without fresh or dried fish to taste to produce *gbegiri*. It is eaten with reconstituted yam flour product *amala*.
- **BEAN CAKE AND PUDDING:** beans are washed, soaked, dehulled and milled into paste. In making the bean cake, the paste is mixed to a fluffy texture by trapping in air. Other ingredient such as onion and pepper are milled with the dehulled beans and the paste is fried with oil. Among the Yorubas of Nigeria , this product is called *akara* while the steamed pudding is called *moinmoin*. The pudding however is mixed with other ingredients that include vegetable oil. Traditionally, the mixture is packaged in leaves and steamed. Steaming of the pudding however today may be done in stainless steel

cups. Some local processors use polyethylene bags in steaming the paste. Use of polyethylene bag is however being discouraged due to leaching of the chemicals in the package into the product which may lead to future health complications. Bean cakes and pudding are excellent diets that are usually consumed with fermented maize gruel *ogi*, *bread*, *gari*, *eko*, or *just on its own*. Bean cake and pudding are usually consumed as a breakfast meal, but they can also be consumed during lunch and supper too. They are considered as light meals.

✓ **SOYBEAN**

This has been known as an excellent source of protein, fat and minerals especially calcium. Soybean also has its unique characteristics in that it can be processed into a number or variety of products. Many economically challenged families in Nigeria utilize soybean processing as a means of income generation for household as well as ensure food security.

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- **SOYMILK:** This is a popular soybean product rich in protein, fat and minerals. It is usually processed by soaking soybean in water, followed by milling, sieving, boiling and adding ingredients such as sugar and desired flavours to taste. A common hindrance or limitation to soymilk consumption is the beany flavour. However, research efforts have been conducted to reduce the beany flavour and obtain a better tasting and acceptable product.

Soy-corn milk is another product from a blend of fresh sweet corn and soymilk to improve the nutritional quality of soymilk.

- **SOY CHEESE:** This in the Orient is called *tofu*. In Nigeria, the local name is *soya-wara* or *soywarankasi*. It is a highly digestible product that is good for people suffering from lactose intolerance. Locally, it is processed by first preparing soymilk and further precipitating the milk with a coagulant. Different cheap locally sourced coagulants have been used in soy cheese processing. This includes the enzyme based *Calotropis procera* leave water extract or acidic based lime juice, lemon juice, fermented maize water liquor (32, 28). Fermented maize water liquor is the most common type. Some local processors also use alum. Calcium salts are not usually used due to the cost implication.

- **TEMPEH:** This is a soy product that originated from Indonesia. It is made from whole soybean seeds which are soaked, dehulled and partly cooked. Spores of *Rhizopus oligosporus*, used as a fermenting culture is mixed with the seeds. The seeds are spread thinly on a tray and allowed to ferment for 24 to 36 hours at 30°C. Good *tempeh* is characterized by proper knitting together to have a firm texture. This can be cut, soaked in brine or salty sauce and then fried. *Tempeh* has also been processed from other types of beans or mixture with whole grains. Figure 1 shows the pod of climbing beans, the mature seeds and the processed beans made into *tempeh*.

Common climbing beans from young pod to matured seeds which can be used as vegetable, old seeds may be processed into *tempeh* mixed or supplemented with soybean.

- **SOY YOGHURT:** Yoghurt is a fermented milk product produced from mixed culture of *Lactobacillus bulgaricus* and *Streptococcus thermophilus*. Soy yoghurt is processed from soybean which is quite cheaper than yoghurt from milk. It is a good source of protein and minerals.
- **SOY SAUCE:** This is a condiment common in East and South East Asia. It is processed by fermenting soybean seeds with two molds of *Aspergillus oryzae* and *Aspergillus sojae* in the presence of salt and water. The fermentation process yields a product called *Moromi* which is pressed to obtain a liquid called soy sauce. Soy sauce is also called *Miso* which may also be prepared from rice or barley.

✓ **GROUNDNUT**

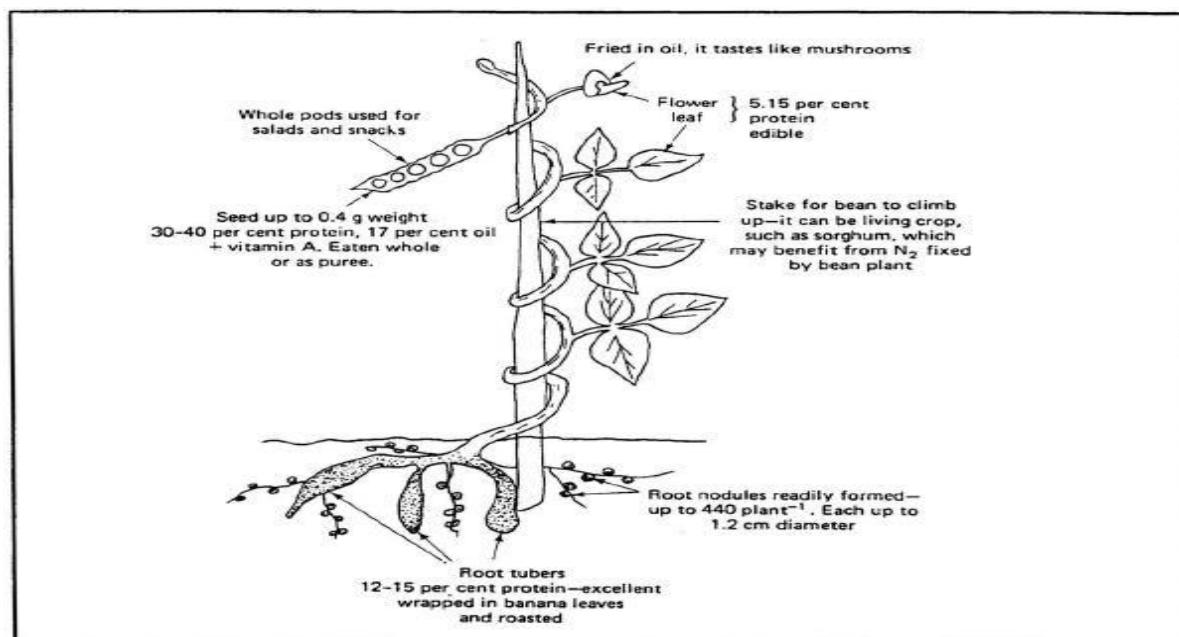
- **BOILED AND ROASTED GROUNDNUT:** In some West African countries, groundnuts are cooked with the pods to get the cooked/ boiled groundnuts while shelled or unshelled groundnuts are usually roasted. The shelled groundnut can be roasted in the presence or absence of salt. This can be consumed directly. Roasted groundnuts can also be grounded into powder and used in the preparation of sauce or as ingredients in other food dishes.

- **PEANUT BUTTER:** This is usually used as sandwich spread. Groundnuts also called peanuts are dry roasted and ground into a smooth paste. Stabilizers in form of partial or complete hydrogenated vegetable oil, sweetener, spices, emulsifier and salt are also added.
- ✓ **FAVA BEANS**
- **ROASTED FAVA BEANS:** fava beans are cleaned, roasted at about 200°C for 20 minutes, cooled and packaged. The roasted beans can be consumed directly as snack or used as raw ingredient in gruel preparation
- **CHICKPEA**
This can be processed into split legume called *kikk* in Ethiopia. This is used in producing a traditional sauce. This can be used in eating with local staples like *injera*, a cereal based product.
- ✓ **AFRICAN LOCUST BEAN**
- **DAWADAWA:** Fermented African locust bean is called dawadawa or Iru . Dawadawa is generally processed from fermented oilseed called African locust bean (2, 27). This product is a traditional Nigerian condiment. The seeds are cooked, dehulled, spread thinly in containers usually calabash lined with leaves and fermented for 24-36 hours. African locust bean seeds are very hard to cook. Traditionally they are cooked overnight over firewood. Dawadawa has characteristic ammoniacal smell with its unique flavour in dishes. Dawadawa is used as natural seasonings in preparing soups, stews and traditional delicacies. Dawadawa has been processed also from other legumes such as soybean, bambara groundnuts and pigeon pea seeds.
- ❖ **INDUSTRIAL PRODUCTS FROM LEGUMES**
- ❖ **FLOURS**
Legumes are multi-purpose crops. At the household, cottage and large scale level, flours have been processed from different types of legumes. This has added to household convenience. Due to changing trends in consumer demands for more convenient products. Research studies have been geared towards developing innovative products from legumes. Many people working outside of their homes desire foods that can be easily prepared. Cowpea, soybean, pigeon and African yam bean seeds have been processed into flours. The common unit operations involved in flour production includes washing, soaking, dehulling, drying, milling, sieving and packaging. Flours have been developed into different household recipes such cake, cookies, kokoro with comparable sensory attributes with products from freshly prepared legumes. Composite flours have also been developed from cereals and tuber crops mixed with legume flours. In Africa, cowpea is the most popular legume. Cowpea flour is usually rehydrated and utilized in formulations as desired.
- ❖ **VEGETABLE OILS**
Vegetable oils are usually produced from soybean and groundnut more at the industrial level than at the household level. These oils contribute to gross domestic products and foreign exchange earnings in vegetable oil producing countries. Groundnut has about 42-48% oil content and soybean has about 18-21% which is extracted locally by means of mechanical presses. Refining of expressed oil in Nigeria is still rudimentary. Cake from the expressed seeds is used as animal feed and that of groundnut is fried to produce *kulikuli* a snack commonly eaten by children. Cake from melon seeds are used in producing *robo* a fried snack.
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- ❖ **LEGUME PROTEIN ISOLATES**
These are concentrates which have versatile functionalities. Soy protein isolate is a common isolate. It has high protein content of about 90%. It is made of defatted soy meal by removing most of the fats and the carbohydrates. Soy protein isolate is usually combined with other food ingredients such as minerals, vitamins and flavours in preparation of soy protein shake powder. Protein isolates have also been developed from a variety of legumes such as pinto and navy beans.
- ❖ **LIMITING FACTORS TO HOUSEHOLD UTILIZATION OF LEGUMES**
The hard-to-cook phenomenon due to the hard test of some of the legume has led to long cooking times and utilization of more fuel during preparation. This led to under-utilization of legumes. The presences of anti-nutritional factors such as phytates which affect digestion and cause flatulence have also limited consumption of legumes by people. Research studies have shown that removal of the outer testa will reduce some of these effects. Dehulling process can be laborious and time consuming for hard

testa seeds especially for cottage or large processing. Research efforts should however be geared towards improving the utilization of legumes to achieve improved nutritional status.

Uses of the thousands of known legume species, less than 20 are planted extensively today. Those in common use include peanuts (groundnuts), soybeans, peas, lentils, pigeon peas, chickpeas, mungbeans, kidney beans (also known as common or dry beans), cowpeas, alfalfa (lucerne), clovers (*Trifolium* spp.), and vetches. They represent all three subfamilies of the Leguminosae. The Papilionoideae, with a worldwide distribution, are the largest subfamily. They are mostly herbs and include the most important species for human food.

The Mimosoideae and Caesalpinoideae are mostly woody trees and shrubs. Many are valuable for lumber, fuelwood, tannins, and animal fodder.



OTHER USES

Many species in the Mimosoideae and Caesalpinoideae subfamilies provide valuable timber, dyes, tannins, resins, gums, insecticides, medicines, and fibers. Many provide green manure for crops, such as *Sesbania rostrata* in rice cropping systems and *Gliricidia sepium* and *Leucaena leucocephala* in alley cropping. Many tree legumes have been identified as useful multipurpose species, and these are being introduced through agroforestry, soil restoration, and erosion control programs in many countries.

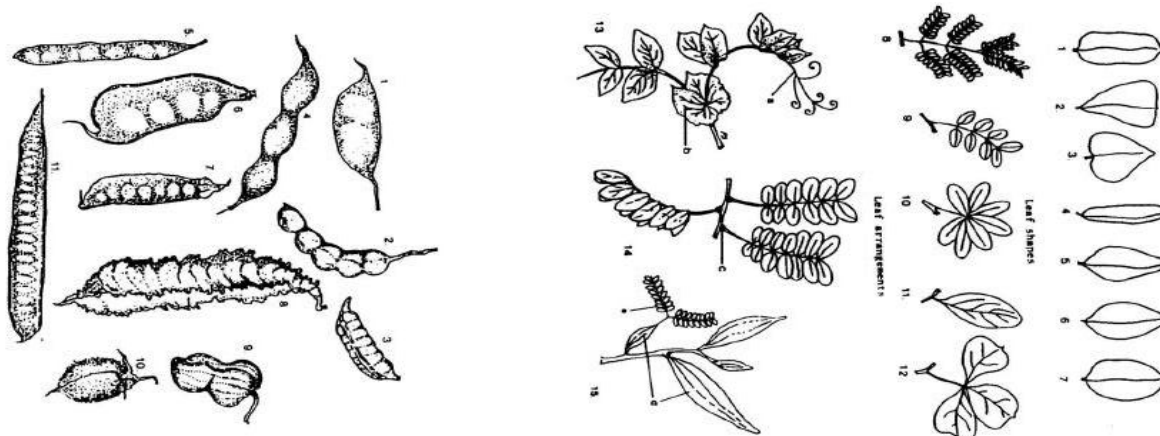
PLANTS IN THE LEGUMINOSE FAMILY

Plants in the Leguminose family have characteristic leaves and pods that help identify them as legumes. The leaves are usually alternate and compound

All legumes have similar fruits, called 'pods'. Within the

Leguminosae, particular subfamilies and species can only be distinguished reliably by an examination of their flowers. For accurate identification of legume species in the field, consult a botanist or send a specimen to the national arboretum in the country where you work.

SOME EXAMPLES OF LEGUMES ARE:



CONCLUSION

Legume seeds (also called pulses or grain legumes) are second only to cereals as a source of human and animal food. When legumes and cereals are eaten together, they provide complete protein nutrition. Nutritionally, legume seeds are two to three times richer in protein than cereal grains. Some legumes, such as soybeans and peanuts, are also rich in oil. Kidney beans and other legumes are a major source of food in Latin America, while lentils, pigeon peas, and chickpeas are important in South Asia. In the Middle East and North Africa, faba beans, lentils, and chickpeas are particularly important. Common food products made from legumes include tofu, peanut butter, and soymilk.

Animal Feed as standards of human nutrition improve in all countries, there is a corresponding increase in demand for animal products such as milk, butter, eggs, and meat. This demand can only be met by using animal feeds with high protein content. Among the grain legumes, soybeans are the most extensively used in animal feed.

Forage legumes are commonly provided to animals in grass-legume mixtures. In the temperate regions, clovers, medics, trefoils, and vetches are important. In tropical and subtropical pastures, *Stylosanthes*, *Pueraria*, *Lablab*, *Desmodium*, and other tropical pasture crops are important sources of livestock fodder.

RECOMMENDATIONS

It is hereby recommended that there is need to explore the processing of underutilized legumes, there is need for value addition through proper packaging, there is need for improved appropriate processing facilities, and there is need for improved product quality and safety, it is also recommended that Improved nutritional quality can be achieved by combining legumes with cereals Processing and Utilization.

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