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Sub-Topic-	**Definition and Meaning of Pulses** **Classification of pulses** **Importance** **Pulses and Nutrition** **Reasons for poor yield of pulses** **Factors limiting pulse crop production:** **Anti - nutritional and toxic factors**

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Pulses Crops

Definition of Pulse:

The word **'Legume'** comes from Latin word 'Legere' meaning 'to gather' and indicated that the seeds are collected by hand instead of being threshed from the plant as in cereal grains. The term 'legume' refers to the plants whose fruit is enclosed in a pod which contains the seeds. The legume pod is a one - celled seed container formed by two sealed parts called valves. Legume pods always split along the seam which connects the two valves. This characteristic is called dehiscent, from the Latin word meaning to gape or burst open. Some pods are winged or indehiscent (meaning the pods do not split open at maturity). The legume fruit (pod) develops from a simple carpel and usually dehisces (opens along a seam) on two sides. Examples of crops that bear legume fruits include alfalfa, clover, peas, beans, lupins and peanuts. A peanut is not a nut in the botanical sense but it is an indehiscent legume. The green pods of legume crops that are used for culinary purposes are known as "legume vegetables' namely; cowpea, cluster bean, garden pea, french bean, pigeon pea, bengal gram, faba bean and lablab bean. The whole plant of legume crops used a s green fodder namely: cowpea (Lobia), cluster bean (Guar), clovers (Senji), alfalfa (lucerne) are called 'Fodder legumes'. Legume crops used for oil extraction namely; soybean and groundnut are called oil seeds legumes' and cluster bean (Guar) for extraction of gum. The grain legumes are leguminous species with edible seeds which includes the pulse grains and high protein leguminous oilseeds such as soybean and peanut.

The term Pulse is derived from the Latin 'puls' meaning thick soup or potage. The word 'Pulse' is defined as the split cotyledons of dry legume seed. The word 'pulse' has been used from biblical times to describe legumes that bear edible. dry seeds that are directly consumed by man. Pulses are dry seeds of leguminous plants which are distinguished from leguminous oil seeds by their low fat content. Pulses are used only after de - husking and splitting. Strictly, the definition applies to pigeonpea, lathyrus, chickpea, greengram, blackgram and lentil. Pulses are known for their high protein and essential amino acids but with low fat content. Pulses can be consumed as whole or split, ground in to flours or separated into fractions such as protein, fiber and starch. Pulse is boiled in water, softened, macerated and used as soup. Presently all legumes are used as dried, fried or boiled, powdered or macerated into soup. Grain legumes belong to the family Fabaceae (alternatively Leguminosae). Leguminous plants that produce edible parts are generally referred to as 'food legumes'. Most of the pulse crops assigned to kharif season (rainy season) thrive in uplands as rainfed crops - source of moisture from rain water. The rabi season (post - rainy season) pulses largely grow on conserved moisture with supplemental irrigation competing with highly remunerative oil seeds as well as cereals crops. Summer pulses are grown with supplemental irrigation. All rabi pulses have a chromosome number of 2n = 14 except chickpea which has 16 whereas kharif pulses possess 2n = 22 except horse gram and field bean which have 24. FAO recognizes 11 primary pulses globally which are as follows:

- **Dry beans** (Phaseolus spp. Now in Vigna spp)
    - Kidney bean, haricot bean, pinto bean, navy bean (Phaseolus vulgaris)
    - Lima bean, butter bean (Phaseolus lunatus)
    - Azuki bean , adzuki bean (Vigna angularis)
    - Mung bean, golden gram, green gram (Vigna radiata)
    - Black gram, urd (Vigna mungo) Scarlet runner bean (Phaseolus coccineus) Ricebean (Vigna umbellata)
    - Moth bean (Viena acontifolia)
    - Tepary bean (Phaseolus acutifolius
- **Dry broad beans (Vicia faba)**
    - Horse bean (Vicia faba var. Equina)
    - Broad bean (Vicia faba var. Major)
    - Tic bean (Vicia faba var. Minor)
- **Dry peas (Pisum spp.)**
    - Garden pea (Pisum sativum var. hortense)
    - Field pea (Pisum sativum var. arvense)
- **Bengal gram,** garbanzo (Cicer arietinum)
- **Dry cowpea,** black - eyed pea, blackeye bean (Vigna unguiculata)
- **Pigeon pea**, Arhar / Tur, cajan pea, congo bean, gandules (Cajanus cajan)
- **Lentil** (Lens culinaris)
- **Bambara groundnut**, earth pea (Vigna subterranea (L.) Verde)
- **Vetch**, common vetch (Vicia sativa)
- **Lupins** (Lupinus spp.)
- **Minor pulses**, including:
    - Lablab, hyacinth bean (Lablab purpureus)
    - Jack bean (Canavalia ensiformis), sword bean (Canavalia gladiata)
    - Winged bean (Psophocarpus teragonolobus)
    - Velvet bean, cowitch (Mucuna pruriens var. utilis)
    - Yam bean (Pachyrrizus erosus).

Classification of pulses based on area of production in India:

- Major pulses: Bengal gram (Chana); Pigeon pea (Arhar); Green gram (Moong bean); Black gram (Urd bean); and Lentil (Masur).
- Minor pulses: Kidney bean (Moth bean); Field pea (Matar), Horse gram (Kulthi); Cow pea (Lobia); French bean (Rajmash); Grass pea (Lathyrus / Khesari); Lablab bean (Sem); and Faba bean (Baqla).

Classification of pulses based on growth features:

- Dwarf or bush varieties (which do not require climbing support and mature early)
- Climbing varieties (which take long duration to mature and require support)

Importance:

Pulses form an important source of human food next to their cereals. In India, people are mostly vegetarian, depending largely on cereals and pulses as their staple food. Pulses provide the main source of dietary proteins and calories. India is the largest pulses producing country and consumer in the World. The significant producer and exporter of pulses to India are Canada, Myanmar, Australia, Tanzania, France and USA. Canada alone accounts for 35% of global pulse trade. India is the major pulse growing country of the world accounting roughly for one third of the total world area under pulses and one fourth of the world production pulse. In the tropics, cereals on an average account for about 68% of total plant protein consumption; legume seed accounts 18.5%, tubers, nuts, fruit and vegetables accounts 13.5%. Grain legumes are synergistic with cereals, roots and tubers in the farming systems. They intensify cropping systems by utilizing under - exploited system niches as rotation, double- and inter-crops.

Grain legumes also diversify farming systems, making them more fourth of the world production pulse. In vegetables accounts 13.5% nutrient - efficient, resilient and sustainable. Legumes also break pest, disease and weed cycles of other crops, and extend soil - protective land cover.

Legumes have ability to fix atmospheric nitrogen through a symbiotic relationship with certain bacteria known as rhizobia which are found in root nodules of these plants. Legumes convert atmospheric nitrogen into nitrogenous compounds useful to plants. Root nodules containing the bacteria Rhizobium fix free nitrogen for the plants and in return, the legumes then supply the bacteria with valuable carbon produced by photosynthesis. Legume nitrogen fixation starts with the formation of a nodule. The rhizobia bacteria in the soil invade the root and multiply within its cortex cells. The plant supplies all the necessary nutrients and energy nodules are visible with the naked eye. In the field, small nodules can be seen 2 to 3 weeks after planting, depending on legume species and germination conditions. When nodules are young, they are usually white or gray inside. As nodules grow in size, they gradually turn pink or reddish in color, indicating nitrogen fixation has started. The pink or red color is caused by leghemoglobin (similar to hemoglobin in blood) that controls oxygen flow to the bacteria. If white, gray, or green nodules predominate, little nitrogen fixation is occurring as a result of an inefficient rhizobia strain, poor plant nutrition, pod filling, or other plant stress. Pink or red nodules should predominate on a legume in the middle of the growing season. The legume fixes the atmospheric nitrogen for their own needs and for soil enrichment, thereby reducing the requirement of fertilizer nitrogen in crop production. The quantity of nitrogen fixed for different legume crops are furnished in Table.

Quantity of nitrogen fixed by legume crops

Crops	Quantity of nitrogen fixed (kg/ha)
Pigeon pea	41-91
Green Gram	61
Cow Pea	65-80
Cluster bean	130
Soybeen	65
Chick pea	103
Ground nut	24
Pea	50-75
Lintil	35-75

Nitrogen harvest index values (seed nitrogen / total plant nitrogen) for cowpea, soybean, groundnut and chickpea is 0.61, 0.75, 0.80 and 0.73 respectively the nitrogen economy of pulse or legume crops. Pulse crops have deep penetrating tap root system that helps to utilize the limited available soil moisture more efficiently than many other crops including cereals that contribute substantially to the loosening up of the soil. Pulses such as redgram, horsegram, mothbean, lathyrus and lentil are drought tolerant.

Pigeon pea, chickpea, black gram, green gram and horse gram have a seed coat accounting for 12-15% of the total weight of the grain where as it is in the range of 8-11% for lentils, French bean, kidney bean , pea, soybean and cowpea. On an average, pulses (including soybean) contain 11% seed coat, 2% embryo and 87% cotyledons. The embryo has two parts known as hypocotyl and plumule.

Legumes are the cheapest option for improving human nutrition. The seeds of legumes are higher in protein than any other food crop and are close to animal meat in quality. Pulses are often called 'poor man's meat' because of inexpensive source of high - quality protein. In general, pulses contain 20 to 30% protein, 60% carbohydrates, 1.0 to

2.5% fat and are fairly good sources of thiamine, nicotinic acid, calcium and iron. The cotyledon contains about 90% of protein and minerals of the whole seed. The pulse proteins are rich in lysine and show deficiency of tryptophan and sulphur containing amino acids like methionine and systine, a reverse situation exists in the cereals proteins. Seed coat accounted for 32 to 50% of calcium of the whole seed.

The protein provided by cereals and pulse mixture is equivalent to skimmed milk in terms of its biological value. Pulses help to eradicate protein malnutrition, especially among children and nursing mothers. Pulses mixed with cereals in 3: 7 proportions enhance the overall nutritive value of proteins. Although grain legumes are considered primarily as sources of protein, they also provide energy particularly those with high oil content. The average energy supply of cowpea, pigeon pea, soybean and groundnut is 13.9, 14.8, 18.0 and 22.9 MJ kg ha ", compared with an average of 15 MJ kg ha 'for cereals in tropics. The major form of phosphorus fraction in pulses is phytin phosphorus, which accounts for 40 to 50% of total phosphorus. Pulses are a good source of vitamins. There will be a loss of 20 to 35% during cooking and a further loss of 10 to 15% during storage. Germination and cooking improve protein digestibility. 'Kabuli' type of bengalgram has higher protein content than 'Desi' type. Black gram is superior in its nutritive value among the pulse crops. The digestibility coefficient, biological value and protein efficiency ratio varied from 60 to 90%, 45 to 78% and 0.7 to 1.1% respectively. Blackgram and redgram are deficient in methionine, trytophan, threomine and lysine. The presence of saponins, glycosides, tanins, alkaloids with phytin in hemicellulose substance inhibit the action of digestive enzyme Trypsin in different pulses adversely affect the pulses digestibility. Many legumes contain gums for thickeners such as gum arabic, guar gum and tragacanth gum. Germinated seeds of pulses contained increased amounts of carotene, ascorbic acid, pantothenic, biotin, nicotinic acid, thiamine, riboflavin and vitamin B12.

Pulses and Nutrition

Pulses are part of a healthy, balanced diet and have been shown to have an important role in preventing illnesses such as cancer, diabetes and heart disease.

Pulses are a low fat source of protein, with a high fibre content and low glycemic index.

Pulses are very high in fibre, containing both soluble and insoluble fibres. Soluble fibre helps to decrease blood cholesterol levels and control blood sugar levels, and insoluble fibre helps with digestion and regularity.

Pulses provide important amounts of vitamins and mineral. Some of the key minerals in pulses include: iron, potassium, magnesium and zinc. Pulses are also particularly abundant in B vitamins; including folate, thiamin and niacin.

Pulses typically contain about twice the amount of protein found in whole grain cereals like wheat, oats, barley and rice, and in most developing countries constitute the main source of protein for most populations.

In addition to contributing to a healthy, balanced diet, pulses nutritional qualities make them particularly helpful in the fight against some non-communicable diseases.

The World Health Organization estimates that up to 80% of heart disease, stroke, and type 2 diabetes and over a third of cancers could be prevented by eliminating risk factors, such as unhealthy diets and promoting better eating habits, of which pulses are an essential component.

Pulses can help lower blood cholesterol and attenuate blood glucose, which is a key factors in against diabetes and cardiovascular disease. Eating pulses as a replacement to some animal protein also helps limit the intake of saturated fats and increases the intake of fibres.

Pulses have also been shown to be helpful in the prevention of certain cancers, because of their fibre content but also because of their mineral and amino-acid contents, in particular folate.

Pulses are included in all 'food baskets' and dietary guidelines. The World Food Programme (WFP) for instance includes 60 grams of pulses in its typical food basket, alongside cereals, oils and sugar and salt.

Encouraging awareness of the nutritional value of pulses can help consumers adopt healthier diets. In developing countries, where the trend in dietary choices tends to go towards more animal based protein and cereals, retaining pulses is an important way to ensure diets remain balanced and to avoid the increase in non-communicable disease often associated with diet transitions and rising incomes.

Several studies have shown that legumes are been associated with long-lived food cultures such as the Japanese (soy, tofu, natto, miso), the Swedes (brown beans, peas), and the Mediterranean people (lentils, chickpeas, white beans) and that they could be an important dietary factor in improving longevity.

Reasons for poor yield of pulses:

Grain legumes have either originated or being cultivated on marginal lands. Pulses have their deep root systems, nodulation and nitrogen fixation capacity. These hardly enjoyed the inputs of irrigation and fertilization. Growth habit of grain legumes like Phaseolus, Vigna and Pisum are prostrate / spreading / twining which near maturity pods becomes very close to or on to the ground. This type of growth creates a tight leaf canopy that does not allow air exchange and is inefficient in utilizing sunlight growth and development are suppressed or delayed due to self shading. Vicia, Cicer and Cajanus have crect growth habit with different degrees of branching and herbaceous woody stems. Most of them have indeterminate growth habit except a few improved varieties. The plants continue to grow vegetatively even after the start of reproductive development. Here the competition for available metabolites occurs between pod / seed development and vegetative growth. Consequently many flowers and pods abscise / abort for lack of nutrition and the potential yield is diminished. There may be 30 to 50% flower shedding. The already formed pods do not develop to their full potential. Uneven maturity occurs in indeterminate cultivars that makes difficult in harvest, lower the quality of produce and necessitates several pickings of pods. Rising of plant population in indeterminate crop varieties restricts branching and helps in shattering the flowering and fruiting periods. All the grain legumes have a high rate of photorespiration, typical of C3 plants. Selection for lower rates of photorespiration should be carried out. The C4 and CAM (Crassulacian Acid Metabolism plants) are not found in the grain legumes.

Pulses, which are part of staple diet of Indians is gradually vanishing from the plates. India is the largest consumer of pulses but a fourth of its demand of pulses is met through import which is a big worry. Recently, pulses have become a matter of concern among policymakers, especially members of the Opposition have pointed to the exceptionally high cost of certain pulses which is an indication of high food inflation. In result of this, a committee on pulses has been set up by the government, headed by Chief Economic Advisor Arvind Subramanian, to look after the country's pulse production, trade and distribution. After demonetization has set in, there has been a gradual fall in the price of the pulse crops. While at one side the consumers are relishing their meals, on the other side farmers are severely hit by this. Moreover, the unsustainable and inefficient agricultural cycle is also holding back India in the growth and development of its agricultural sector. And the more alarming issue is, losing of precious foreign exchange by India while importing pulses. The major problems related to productivity of pulses and cereals are technological setbacks as well as the lack of a managerial setup to supervise the current scenario. There is a severe lack of a mechanism for the procurement and marketing of pulses, which becomes a major obstacle in the propagation of pulses. Therefore, despite of the fact that India is the largest producer of pulses in the world it is the largest importer as well, since the domestic production has not kept pace with demand. The production of pulse will be incentivised if the government assures that it will procure pulses vis-à-vis rice and wheat through the Food Corporation of India and other State agencies.

- Agro-climatic condition- Indian agriculture is largely dependent on rainfall for its agricultural production, and especially the pulse crops are only grown in the rain-fed areas. However, the harsh truth is that the agro – climatic condition in India is comparatively less suitable for pulses, which hampers the cultivation of pulses across the country and around the year.
- Indian pulses are not much yielding genetically and are also vulnerable to pests which are a major hindrances to adoption of pulses by farmers. Being rain-fed, pulses often experience drought at critical growth stages. Therefore, lack of drought and disease resistant varieties of pulse seeds is alarming.
- Lack of information about the production technologies is a big gap leading to low productivity. It is the need of the hour that agricultural sector hires a quality personnel, who must be trained and equipped with exceptional knowledge and latest practices. Moreover, poor availability of agricultural inputs such as seeds, bio-pesticides and micronutrients is another big barrier.
- There is creation of arrangement of irrigation in the Gangetic plain to cultivate cereals and cash crops and hence, pulses are left to less productive regions.

What is being done and what should be done?

One of the key findings made by the committee under Chief Economic Advisor that if farmer are to be encouraged growing more pulses, they must get sufficient profit from the production. The minimum support price given by the government was not sufficient to procure pulses especially tur dal and hence it ended leaving increase in prices of pulses. Also, the state and central governments both are shifting to impose various price controls or price levels on pulses as a result of concerns about rising prices. Controlling prices of pulses can be disadvantageous to the entire agricultural sector –and will effectively demean demand and supply dynamics and move away from free-market principles. The fluctuation of prices due to supply and demand provides incentives for farmers and importers to continue operations. Price controls cannot be imposed merely on seasonal profits and it will just provide disincentives to farmers and importers who depend on the revenue they earn from high demand will lower their effort which will affect not only the production, and supply of pulses but will also leave a negative impact on the consumers in the long run.

If the government is serious about solving this problem, the least they can do is provide for free access to the market to the farmers to give them a fair field to play upon figuratively. The restrictions on the functioning market must be removed. To start with, the government must abolish restrictions on the export of the pulses produced by our farmers especially when the MSP cannot be guaranteed. These limitations on the export are anti-farmer in nature. The government must also impose import duties on the import of pulses for a period till farmers complete their harvests. Further, a mechanism must be developed by the government which would help farmers getting signals of the market price in advance. This would reduce risk from decisions of planting as well as give an idea to the farmers of future prices. Also, private agencies must be hired by the government to stockpile a buffer stock which will save farmers from crashing of prices.

Factors limiting pulse crop production:

- **Ecological factors:** 92% of area under pulse cultivation is rainfed. More than 50% of area under pulses is sown in post rainy (rabi) season, largely on limited moisture. Pulses are sensitive to excess moisture, water logging, acidity, salinity and alkalinity. Frost and low temperature during the night cause heavy damages to rabi pulses particularly to chickpea whereas continuous rain invites more pest and diseases both in kharif and rabi pulses.
- **Lack of proper agronomic management:** Pulse crops can utilize the limited soil moisture and nutrients. Pulses are grown with poor management practices such as inadequate seed rate, non availability of rhizobium culture, improper sowing time, defective method of sowing and uneven distribution of seeds due to broadcasting.
- **Varietal features:** Non availability of seeds of improved varieties, indeterminate growth. No response to good management, flower and pod drop due to limitation of nutrients, hormonal imbalance, low or high temperatures, etc.
- Socio - economic factors: Pulses have subsidiary status as catch crops or intererops. Hence, limited resource is allocated for pulses production. There is a low economic return from pulse crop. Pulses are not remunerative as the high yielding cereals, potato, sugarcane. cotton and tobacco. Pulses lack price policy in parity with cereals.

Anti - nutritional and toxic factors: Legumes / pulses contain anti - nutritional and toxic substances such as phytohnomagglutinins, protease inhibitors, iectins, goitrogens, phytates, saponins, favism factors, lathyrism actors, amylase inhibitors, tannins. polyphenolic compounds, aflatoxins, amines, cyanogenic glycosides, pyrimidine glycosides, protease inhibitors, oestrogens, antivitamins, alatulence factors, non protein amino acids, quinolividine alkaloids, allergens and lyxinoalanino. Lathyrism is a paralytic disease affecting the lower limbs. The disease has been associated with consumption of kesari dhal (Lathyrus sarivus) is usually noticed in poor families who regularly eat considerable quantity of the dhal. However, lathyrism develops only when the consumption of dhal is high (300 g daily) and the diet does not contain sufficient quantities of cereals and is used for long time (six months or more). The toxic substance of Lathyrus sativus responsible for lathyrism has been identified as selenium. Favism is a disease characterized by haemolytic anaemia which affects certain individuals following the ingestion of fresh or cooked broad beans (Vicia faba). The anti-nutritional factors elimination can be achieved either by selection of plant genotype with low levels of such factors or through post-harvest processing (germination, soaking, heating, boiling, leaching, fermentation, extraction etc.). Panching and roasting of pulse seeds improved nutritive value of proteins and biological value.

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