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Feeling the pulse of pulses: Focus on health issues for educating masses: A Review

[1] Anahat Kang, [2] Harrajdeep Kaur, [*3] JS Kang, [4] Harmeet Singh, [5] Gurbir Singh

[1] GTB College of Nursing, Ludhiana, Punjab, India
[2] Lecturer Botany, Ludhiana, Punjab, India
[3] Senior Agronomist and Incharge RCT section, Dept. of Agronomy, PAU Ludhiana, Punjab, India
[4] Professor, Dept. of Agronomy, PAU, Ludhiana, Punjab, India
[5] Research Associate, SIU, IL. USA

Abstract
Pulses are good source of proteins for the majority vegetarian Indians and in combination with cereals supply all essential amino acids. Pulses are rich in dietary fibre, which helps in decreasing blood cholesterol levels and controls sugar levels in blood, the key factors in the fight against cardiovascular diseases and diabetes. They are also a good source of Vitamin B complex including folic acid, several minerals and a number of non-nutritional beneficial organic molecules and thus important in human nutrition and health. Indian are lacking in knowledge about beneficial effects of pulses and legumes and need to be educated.

Keywords: legumes, protein, essential amino acids, dietary fibre, vitamins, coronary, obesity

Introduction

Pulses are a major source of proteins, essential amino acids, fibre, vitamins, minerals and a number of non-nutritional biomolecules. Pulses contain 22–24 percent protein, which is almost twice the content of protein in wheat and three times than that in rice. Some vitamins, especially folate and some other constituents help fight cancers of different kinds and also could affect carcinogenesis in numerous specific cancers [1]. List of complete green legumes with world production and regions of consumptions, energy, protein, carbohydrates and fat is as given in Table 1 and Table 2 [2, 3]. With low in energy density but good source of digestible protein, the pulses are slowly digested, which allows some of the slightest glycemic index (GI) among carbohydrate containing foods. Hypocholesterolemic response, mitigation of diabetes and weight control are important positive health responses of pulses. Providing required nutritional and health benefits the pulses can also impact and reduce several diseases such as colon cancer and cardio-vascular diseases. In developing countries, pulses are regular part of diet, consumed by both vegetarian and non-vegetarian segments of population [4]. Over 60 percent of total utilization of pulses is for human consumption. The lower income nation have more consumption of pulses. The share of food use in total utilization of pulses in the developing countries is over 75 percent, compared with 25 percent in the developed countries. Pulses are of particular importance for food security in low income countries because it contribute about 10 percent of the daily protein intake and 5 percent of energy intake. Pulses have significant amount of nutrients like calcium, iron and lysine. Pulses are locally adapted and can be cultivated by growers for their own family and as well as for sale. The nutritional properties of pulses are reported to impart physiologically beneficial effects in humans which have been investigated extensively. India has the largest area under pulses and is the largest producer of pulses in the world but since it is also the largest consumer of pulses, it has to import pulses from other countries to meet its demand. The per capita availability of pulses in India has been drastically reduced during the last 55 years, from 65.5g/person/day in 1960 to less than 30 g/person/day in 2015, mainly due to increase in population and these are just the averages; people below poverty line (BPL) are getting much less. In comparison with developed nations the recommended dietary allowance (RDA) for proteins is 56 g/day for 19-70-year-old men and 40 g/day for 19-70-year-old women. In many countries these crops are bread and butter of farming peoples and is solely due to the enthusiasm of poor farmers. Despite having superior nutritional quality over the cereals and being well adapted under local conditions, the cropped area under pulse crops and their productivity in India have been slowing down. The prices of pulses are beyond the purchasing power of people below poverty line (BPL) and forces them to procure these from public distribution system (PDS) shops at a subsidized price. Most below poverty line people have to rely more and more on cereals for their protein and carbohydrate needs.

Table 1: World Production Scenario of Pulses and their Utilization

Grain legumes	Latin name	World production metric tons x 10^{-3}	Region of consumption
Pulses		3819	
Dry beans (*Phaseolus* spp.		1162	
Kidney bean, haricot bean, pinto bean, navy bean	*Phaseolus vulgaris*		World-wide
Lima bean, butter bean	*Vigna lunatus*		Americas, Africa
Adzuki bean	*Vigna angularis*		Asia, especially Japan
Mung bean, golden gram, green gram	*Vigna radiata*		

Black gram, urd	*Vigna mungo*		Asia
Scarlet runner bean	*Phaseolus coccineus*		
Rice bean	*Vigna umbellata*		
Moth bean	*Vigna acontifolia*		
Tepary bean	*Phaseolus acutifolius*		
Dry broad beans (*Vicia faba*):		255	
Horse bean	*Vicia faba*		Temperate regions
Broad bean	*Vicia faba*		Temperate regions
Field bean	*Vicia faba*		
Dry peas (*Pisum spp.*):		892	
Garden pea	*Pisum sativum* var. *sativum*		
Protein pea	*Pisum sativum* var. *arvense*		
Chickpea	*Cicer arietinum*	478	Asian and Middle East
Dry cowpea,	*Vigna unguiculata* ssp.	350	Africa, Asia, South
	Dekindtiana		America
Pigeon pea,	*Cajanus cajan*	103	Asia, Africa
Lentil	*Lens culinaris*	199	World-wide
Bambara groundnut, earth pea	*Vigna subterranea*		
Vetch, common vetch	*Vicia sativa*	99	
Lupins	*Lupinus spp.*	45	
Minor pulses			
Lablab, hyacinth bean	*Lablab purpureus*		
Jack bean, sword bean	*Canavalia ensiformis,*		
Winged bean	*Psophocarpus teragonolobus*		
Velvet bean, cowitch	*Mucuna pruriens* var. *utilis*		

Table 2: Protein, Carbohydrates and Fat in Pulses (per 100 g edible part)

Pulse (Dal)	Energy (K cal)	Protein	Carbohydrates (g)	Fat (g)
Chickpea	360	17.1	60.9	5.3
Blackgram	347	24	59.6	1.4
Cowpea	323	24.1	54.5	1.0
Beans	347	24.9	60.1	0.8
Green gram	334	24	56.7	1.3
Lentil	343	25.1	59	0.7
Horsegram	330	23.6	56.5	1.1
Peas (green)	93	7.2	15.9	0.1
Peas (dry)	315	19.7	56.5	1.1
Rajmash	346	22.9	60.6	1.3
Red gram Arhar	335	22.3	57.6	1.7
Soybean		43.2	20.9	19.5

Minerals and Vitamins

The recommended daily intake for adults is 12–15 mg [5] and legumes supply adequate protein vitamins and minerals [6]. Mineral contents of legumes indicate that beans and lentils have the highest iron (110 and 122 µg g^{-1}, respectively), and zinc contents (44 and 48 µg g^{-1}, respectively). The levels of minerals in legumes generally range between 1.5–5.0 µg Cu g^{-1}, 0.05–0.60 µg Cr g^{-1}, 18.8–82.4 µg Fe g^{-1}, 32.6–70.2 µg Zn g^{-1}, 2.7–45.8 µg Al g^{-1}, 0.02–0.35 µg Ni g^{-1}, 0.32–0.70 µg Pb g^{-1} and not detectable–0.018 µg Cd g^{-1}. The Iron (Fe) contents is generally high in legumes and beans have the highest content. The determination of minerals and elements in foodstuffs is an important part of nutritional analyses. Copper, chromium, iron, and zinc (Table 2, 3, 5) are essential micronutrients for human health found in legumes and play an important role in human metabolism. Therefore interest in these elements is increasing together with reports of correlation between trace element and oxidative diseases [6]. For Iron metabolism, Copper is required and can be found in many enzymes in pulses The content of Fe and other minerals is generally high in legumes with beans having the highest mineral content. Iron levels in pulses boost iron in women.. Although it is non-heme iron but when taken with vitamin C, can absorb iron better to produce red blood cells and ATP (adenosine triphosphate) and iron transports oxygen throughout the body for energy production and metabolism. People who are deficient in iron may develop anemia or ADHD. When the Fe amount supplied does not satisfy the requirement, Fe deficiency ensues. The recommended daily intake in adults is 10–15 mg Fe [5].

Table 3: Copper, iron and zinc content (µg g^{-1}) in legumes.

Sample	Origin	Copper	Iron	Zinc
Beans	Spain	-	62.0	35.0
	Germany	0.14	0.83	0.18
	India	9-22	108-150	50-109
	UK	3.2±0.7	68±1.6	44±1.2
	UK	10.9	42.0	50.5
	Italy	-	57.9±2.0	32.9±4.0
	--	2.1-2.4	22.5-33.7	10.1-11.6
Broad beans	Spain	-	55.0	31.0
	UK	9.1±0.7	110±3.2	58±2.7
Chickpeas	Spain	-	-	33.5±3.6
	Spain	-	68.0	10.0
	Spain	3.51	72.0	8.0
Lentils	Spain	-	-	45.1±14.2

	Spain	2.5	70.0	55.0
	Spain	-	82.0	37.0
	France	-	80.0	-
	UK	9.1±0.7	122±4.1	48±1.0
	UK	10.2	111.0	39.0
Green peas	Spain	19.0	7.0	
	Spain	1.75	19.0	7.0
	Italy	-	57.9±2.0	32.9±4.0
	-	2.1-2.4	22.5-33.7	10.1-11.6
Broad beans	Spain	-	55.0	31.0
	UK	9.1±0.7	110±3.2	58±2.7
Chickpeas	Spain	-	-	33.5±3.6
	Spain	-	68.0	10.0
	Spain	3.51	72.0	8.0
Lentils	Spain	-	-	45.1±14.2
	Spain	-	82.0	37.0
	Spain	2.5	70.0	55.0
	Spain	-	82.0	37.0
	France	-	80.0	-
	UK	10.2	111.0	39.0

Modified from Cabrera *et al*. (2003).

Table 4: Mineral content (µg g^{-1} of the edible portion) of legumes.

Legume	Copper	Chromium	Iron	Zinc	Nickel	Lead	Cadmium
Lentil	2.5	0.31	71	56.5	0.24	0.51	0.009
Bean							
Haricot bean	2.8	0.15	62.5	39.7	0.15	0.62	0.0005
Kidney bean	3	0.17	64.4	46.9	0.17	0.69	0.007
Broad bean	4.3	0.28	80	41.2	0.17	0.4	0.012
Chickpea	3.5	0.12	68.8	39.2	0.26	0.48	0.01
Green peas							
Fresh	1.7	0.08	20.2	38.9	0.05	0.37	ND
Canned	1.8	0.09	24.6	58.8	0.07	0.45	0.015

Adapted from Cabrera *et al*. (2003) ND=Not detectable

Table 5: Vitamin composition (mg 1000 g^{-1} dry weight) in *Phaseolus vulgaris*

	Raw	Cooked
Thiamin	0.81-1.32	0.64-1.06
Riboflavin	0.112-0.411	0.086-0.246
Niacin	0.85-3.21	0.59-1.96
Vitamin B_6	0.299-0.659	0.200-0.515
Folic acid	0.148-0.676	0.088-0.521

Adapted from Augustin *et al*. (1981)

Zinc enzymes affects metabolism including synthesis or degradation of carbohydrate, lipid and protein (deoxyribonucleic and ribonucleic acid synthesis and role in stabilizing plasma membranes) [7]. Zinc is involved in protection against oxidative processes by acting as co enzymes. The net delivery of Zn to an organism is a function of the total amount of this element in foods and its bioavailability. Selenium (Se) is an essential micronutrient in human nutrition and lacking this would mean turning down important regulatory and protective mechanisms but large populations in parts of the world are severely Se deficient [8]. The Se might compromises the health of developing children and their ability to combat the effects of heavy metals in the human diet [9]. Lentils has 425–673 µg /kg^{-1} of Se depending on various characteristics and growing conditions. The variation of vitamins content in nine commercial Phaseolus vulgaris classes were evaluated by workers [10, 11]. The raw bean samples contained 0.99 mg of thiamin, 0.20 mg riboflavin, 1.99 mg niacin, 0.49 mg vitamin B12, 0.30 mg folic acid, but only 70–75% of water-soluble vitamins were retained in cooked seeds. Legumes are very good sources of folates which are not readily available due to complex binding with bio-molecules. Beans are excellent source of folate at 400– 600 mcg representing 95% of daily requirements. Pulses are rich in Folate, also known as folic acid or vitamin B-9. It supports nervous system health, helps in energy metabolism and synthesis of DNA, RNA and red blood cells. Pregnant women who consume pulses daily may lessen the risk of their child born with birth defect. Higher folate intake has been inversely associated with the risk of colon cancer [12]. Current folic acid requirement is set at 140 µg 100 g^{-1} grains, while clinicians recommend 400 µg day^{-1} for women of childbearing age. Composition of thiamine, riboflavin, niacin, pyridoxamine, pyridoxal and pyridoxine. Lentils var., variabilis (Table 4, 5) [13]. Most plant-derived foods contain low to moderate levels of vitamin E activity. However, owing to the abundance of plant-derived foods in our diets, they provide a significant and consistent source of vitamin E [14]. Tocopherol content is higher in seeds and legumes than cereals. Peas contain greater amounts of a than b + c-tocopherols (10.4 and 5.7 mg 100 g–1, respectively) and chickpeas contain similar levels of a- and b + c-tocopherols 6.9 and 5.5 mg 100 g–1, respectively.

Pulses role in Obesity and cardiovascular diseases

Raised body mass index (BMI) is a major risk factor for non-communicable diseases such as: cardiovascular diseases (mainly heart disease and stroke), which were the leading cause of death, diabetes, musculoskeletal disorders (especially osteoarthritis – a highly disabling degenerative disease of the joints), some cancers (including endometrial, breast, ovarian, prostate, liver, gallbladder, kidney, and colon). The risk for these non-communicable diseases increases, with increases in BMI. Childhood obesity is associated with a higher chance of obesity, premature death and disability in adulthood. But in addition to increased future risks, obese children experience breathing difficulties, increased risk of fractures, hypertension, early markers of cardiovascular disease, insulin resistance and psychological effects. Overweight or obesity is the key feature of the metabolic problem and prevention of excessive weight gain is a health priority everywhere. Diet comprising of whole-grain foods, like cereals and legumes (Table 6, 7), will help in controlling against obesity, but it has been expressed that refined-grain intake may directly contribute to even deteriorating obesity [16]. In the United Kingdom, study on women's diet were concluded from seven clusters of food consumption, Women with these food consumption patterns had significantly lower average BMI values (high bran, whole meal, and pulses), low diversity vegetarians (high whole meal bread and pulses), and high diversity vegetarians [17] (high whole meal bread, cereals, pasta and rice, and pulses). From another study in the UK, it identified four diet patterns and found the one with high intakes of rice, pasta, and pulses was negatively correlated with waist-to-hip (WHR) ratio [18]. One a trial from Mexico which compared a low- and a high-GI diet, providing 63 g vs. 55 g, respectively, of carbohydrate from cereals and legumes. The low-GI diet (high in whole-grain bread and beans and with less white bread and rice) resulted in improved glycemic control and greater weight loss [19]. Consumption of legumes has been (Table 6) linked with low risk of and cardio-vascular disease (CVD) and coronary heart disease (CHD); With regular legume in diet at least four times or more in a week compared with less than once a week, was related with 22% lower risk of CHD, and 11% lower risk of CVD [20, 21, 22]. In legume based meal, significant beneficial effects were observed on glucose, insulin, and homocysteine concentrations and lipid peroxidation in patients of coronary artery disease (CAD) and substantially reduced the risk factors for CAD and diabetes [23].

Table 6: Relative risk of coronary heart disease and cardiovascular disease according to frequency of legume intake in 9632 NHEFS participants

Variable	Frequency of legume intake per week				
	Less than once (n = 3885)	Once (n= 2128)	2-3 times (n=2226)	≥ 4 times (n = 1393)	P value for trend
Person-years	63,046	36,015	37,283	23,255	--
Coronary heart disease					
No. events RR (95% Ci)	812	355	401	234	--
Age, race, sex, and energy adjusted	1.00	0.90 (0.79-1.02)	0.93(0.83-1.03)	0.82(0.72-0.94)	.02
Multivariate model 1[b]	1.00	0.91(0.79-1.04)	0.91(0.81-1.01)	0.79(0.68-0.90)	.002
Multivariate model 2[c]	1.00	0.93(0.81-1.07)	0.90(0.81-1.01)	0.79(0.69-0.91)	.003
Cardiovascular disease					
No. events RR (95% Ci)	1593	758	818	511	...
Age, race, sex, and energy adjusted	1.00	0.95(0.87-1.03)	0.94(0.86-1.01)	0.91(0.82-1.01)	.07
Multivariate model 1[b]	1.00	0.96(0.87-1.06)	0.94(0.87-1.02)	0.89(0.80-0.98)	.02
Multivariate model 2[c]	1.00	0.99(0.90-1.08)	0.95(0.88-1.03)	0.91(0.82-1.01)	.06

Adapted from From Bazzano *et al*. (2001)

[a] NHEF - indicates First National Health and Nutrition Examination Survey Epidemiologic Follow-up Study ; RR, relative risk: and CI, confidence interval.

[b] Stratified by birth cohort and adjusted for age, sex, race, history of diabetes, recreational physical activity, level of education, regular alcohol consumption, current cigarette smoking, and total energy intake; n = 9178

[c] Additionally adjusted for total serum cholesterol level, systolic blood pressure, body mass index, saturated fat intake, frequency of meat and poultry intake, and frequency of fruit and vegetable intake; n = 9078.

Table 7: Pulses and their main potential positive and beneficial effects

	Involved metabolism	Beneficial effect
Legumes (including some pulses)	Cardiovascular	22% lower risk of coronary heart disease, and an 11% lower risk of cardiovascular disease
	Cardiovascular and diabetes	Modulation of glucose, insulin, and homocysteine concentrations and lipid peroxidation in coronary artery disease patients
Azuki bean juice	Hypertriglyceridemia	Decreased triglyceride concentrations by inhibited pancreatic lipase activity
Legumes	Type II diabetes mellitus	Risk reduction to develop T2DM in the order of 20-30%
Mung bean	Glucose and lipid metabolism	Modify glucose and lipid metabolism favourably in rats
Legumes	Endometrial cancer	Low risk of endometrial cancer
	Breast cancer	Low breast cancer risk
	Colon cancer	Low risk of colorectal adenoma
Legumes and cereals	Obesity	Low average body mass index (BMI) and low risk of obesity
Pulses	Obesity	Low waist-to-hip (WHR) ratio

Whole grains, beans, and legumes	Obesity	Low body mass index and waist circumference (WC)
Whole grains, bread and beans	Glycaemia and obesity	Glycemic control and weight loss
Chickpeas	Skin and ear inflammation	Low risk of skin diseases and inflammation of the ear
		Tonic, appetizer, stimulant and aphrodisiac, anthelmintic properties
	Hypertriglyceridemia	Reductions in serum total and low-density lipoprotein cholesterols
Common bean	Colon cancer	Inhibition of aberrant foci crypt development in rat colon

In one of ths studies, from Nurses' Health observed that vitamin B6 and folate from diet and supplements, could protect against coronary heart disease (CHD). A higher intake of folate (0.8 mg folic acid) would reduce the risk of ischaemic (heart problems caused by narrowed heart arteries) heart disease by 16% and stroke by 24 per cent [24]. Total cholesterol levels can be brought down by Consuming beans according to new research from the Agricultural Research Service of the U.S. Department of Agriculture.

In an clinical trial Volunteers between the ages of 18 and 55 participated, with half being healthy and the other half was prone to risk for cardiovascular disease (because having symptoms that lead to metabolic syndrome). For 3 months half of the group was on diet with cooked pinto beans every day along with their regular diet. The other half was given a replacement serving of chicken soup. After 3 months it was concluded that participants who were on pinto beans had their cholesterol under control and was lowered [25].

These findings agree with earlier studies that have found beans to have cholesterol lowering properties. Therefore, healthy adults consuming dried, cooked pinto beans daily (130 g, 12 weeks) can reduce their TC, LDL (important CVD risk factor) and HDL levels.

The studies carried out on (Table 4) relative risk of coronary heart and cardiovascular diseases made conclusion about decreasing rates of coronary heart and cardiovascular diseases with more intake of legume among the participants [26]. In other hand, it was reported that whole-grain consumption is associated with a reduced risk of non cardiovascular, non cancer death attributed to inflammatory diseases in the Iowa women's health study [27]. In a study it was indicated that the nutrition of pregnant women is decisive in the course of gestation and the health of both mother and child, and recommended 7–8 portions of cereals and legumes per day.

Pulses role in Diabetes and other Diseases

Chickpeas are the largest grown legume crop in Pakistan [28] and various varieties of chickpeas are popularly consumed as a source of dietary protein. They are used as tonic, appetizer, stimulant and aphrodisiac, and they also have anthelmintic properties. Seeds of chickpea is beneficial for blood and had cured inflammation of the ear and some skin diseases [29].

Adult women and men were immensely benefitted from dietary supplementation of chickpea by lowering total serum and low density lipoprotein. Another study that can be associated with reducing effects of disease by intake of legumes is childhood acute lymphoblastic leukemia (ALL), a type of cancer in which the bone marrow makes too many immature lymphocytes (a type of white blood cell) and affect red blood cells, white blood cells, and platelets. Increased consumption of fruits and perhaps vegetables (including pulses) reduces the risk of ALL [31]. It was concluded from results that the incidence of ALL among young children could be reduced by maternal obedience during pregnancy to the generally accepted principles concerning a vigorous diet throughout life. Shozuto, a Chinese medicine, composed mainly of azuki beans (Azuki beans, *Phaseolus angularis* WIGHT, have long been widely cultivated and consumed in confectionary and other traditional dishes) which has been recognized to have antidotal, diuretic, and laxative effects and is thus used to treat constipation, nephritis, beriberi, and insufficient postpartum lactation [32]. Extracts of the beans have an inhibitory effect on malonaldehyde formation, and thereby exert antioxidant activity and has been used to prevent damage associated with the stress of aging. People who consume 3 or more servings of whole-grain foods per day are less likely to build up type II diabetes mellitus (T2DM) than consumers who are taking less serving. Population having low serving per week have more risk to this disorder (with a 20–30% more risk). It is generally accepted due to recent research conclusion and suggest that whole-grain foods might save from harm against the development of diabetes as well as being useful in the management of people who have already developed type II diabetes mellitus (T2DM) [33]. Epidemiological studies robustly support the proposal that high intakes of whole-grain foods guard against the development of T2DM. The role of legumes (Table 7) in the anticipation of diabetes is not very clear because of the moderately low intake of legumes foods from the populations put under study.

However, legumes share qualities with whole grains of prospective gain to glycaemic control including slow release carbohydrate and a high fibre content. A significant boost in dietary intake of legumes for more quickly digested carbohydrate be expected to improve glycaemic control and thus trim down incident of diabetes [34]. Mung bean (*Vigna radiata*) is an tremendous source of protein, minerals and vitamins and its essential amino acid profile comparable to that of other legumes like; soybean and kidney bean but latest investigations revealed that mung bean in take can trigger small increase in blood glycemic index in persons making it an pretty good option for diabetic patients [35].

Mung bean (*Vigna radiata*) has a tremendous source of protein, minerals and vitamins and its essential amino acid profile comparable to that of other legumes like; soybean and kidney bean but latest investigations revealed that mung bean in take can trigger small increase in blood glycemic index in persons making it an pretty good option for diabetic patients [35]. It is also well recognized fact that some certain proteins in mung bean have properties of acting like both antifungal and antibacterial activity. In one study it was reported that adherence to vegetables and legumes were inversely associated with the risk of type 2 diabetes in a large Chinese population [36]. Because of aldose reductase inhibitory, it was found that some components are directly associated with prevention and/or treatment of T2DM [37]. The functions (e.g., anti atherosclerotic, antihypertensive, antilipemic, antithrombotic, lipase, lipid peroxidation, lipoxygenase and platelet aggregation inhibitory activities) of other vegetable and legume components are also associated with ameliorating T2DM. A recent case control study found an inverse

relationship between vegetables (dark green/dark yellow) and legumes with endometrial cancer risk [38]. These findings are consistent with other epidemiological studies linking reduced risk for hormone related cancers with dark green/dark yellow vegetables consumption. In a large potential study, reduced breast cancer risk was associated with higher intake of legumes [39]. Also, a diet rich in whole grains (including legumes), fruits and vegetables may trim down the chances of colon cancer in women [40]. Other studies revealed that consumption of legumes such as dried beans, split peas or lentils was negatively linked with menace of colorectal adenoma. Vegetables (dark green/dark yellow) also contain high concentration of carotenoids, folates, vitamin C and riboflavin. Carotenoids and vitamin C may inhibit endometrial carcinogenesis via antioxidant effects, while folate influences DNA stability via its important role in the synthesis of nucleotides and DNA methylation. Folate also could affect carcinogenesis in numerous specific cancers [41].

4. Enhancing Consumption of Pulses and Conclusion

Pattern of food consumption has undergone substantial change due to various factors like swell in income, urbanization, change in consumer taste and preferences, responsiveness about safe and healthy food, etc. It is very apparent from the fact that the dietary plan has shifted away from cereals and pulses toward vegetables, processed food and food items of animal origin. As a result, the composition of diet and nutrition intake has changed noticeably and hence therefore, the utilization of pulses has come down due to different reasons like poor accessibility, high prices and availability of cheaper alternatives of animal origin. Intake of protein has come down primarily due to decline in the dietary plan of less consumption of pulses, which are major source of quality protein compared to other food items. No doubt, though the change in consumption towards horticultural crops and food items of animal origin has no doubt contributed towards higher intake of calories. The health workers serious concern regarding reduction in consumption of pulses for predominantly vegetarian society and country like India although making progress in agricultural production is still grappling to feed more population with weather extremities and stagnant production and also due to high price and fluctuation in supply of pulses. Once known as poor man's rich food is now only with the bowl of the rich man. Though, the production of pulses has registered an impressive growth in the recent decade but it is not in pace with the increase in the population. Moreover, pulses could act as a low cost replacement during towering prices of vegetables and food items of animal origin. In some countries including India, the agricultural marketing system is such that middle man makes lofty profit than producer and deliberately ultimately raise prices and produce goes out of reach of poor man.

Protein malnutrition / undernourishment is a worldwide observable fact happening in every nation around the world. Deficiencies of vitamin A, iron, and zinc affect over one-half of the world's population which could have come from pulses. Biofortification is the development of protein/micronutrient-dense staple crops using the best traditional breeding practices, modern biotechnology and to some extent by appropriate agro-technologies. This approach has multiple advantages. It capitalizes on the regular daily intake of a consistent and large amount of food staples by all family members. Biofortification is the process of increasing the natural content of nutrients in edible part of crop plants. The supply of minerals to the developing grain originates from two sources: first as a result of direct uptake from the soil and second from the remobilization of stored minerals in leaves as they senesce during the stage of grain filling. Concentration of Zn and Fe in grain may increase with an increase in Zn or Fe fertilizer additions at critical growth stages. The process of mineral-enrichment takes place well above the sufficiency level of a nutrient with-in the crop plant. Although simple and inexpensive, the application of fertilizers containing essential mineral micronutrients is complicated by several factors. Therefore, this strategy has been successful in only limited cases and in particular geographical locations. Iodine and selenium are mobile in soil and in plants, thus biofortification with iodine and selenium fertilizers has been particularly successful. Because Zn is also mobile in the soil applications of ZnSO4 can also increase yield and Zn concentrations in legumes. In contrast, Fe has a low mobility in soil becauseFeSO4 is rapidly bound by soil particles and converted therefore, Fe fertilizers have not been successful in biofortification efforts. Furthermore, large quantities of metals applied to soils can be deleterious to plant growth and other soil organisms and may affect health of humans if concentration is very high. More research on biofortification is needed in pulses to supply particular element by this method in areas where deficient is reported. Moreover, once in place, the biofortified plant system is highly sustainable. After the one-time venture to develop seeds that reinforce themselves, recurrent costs are low, and germplasm can be shared internationally which makes it cost-effective across time and distance.

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