

Pulse of life

2016 – INTERNATIONAL YEAR OF PULSES



Navdanya

Pulse of Life

The Rich Biodiversity of Edible Legumes

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Acknowledgment

Our journey into the World of edible legumes has been an immensely informative and fascinating one thanks to the work of many predecessors. We would like to express our deep gratitude to all those-authors, researchers and websites- who enabled us to compile this offering.



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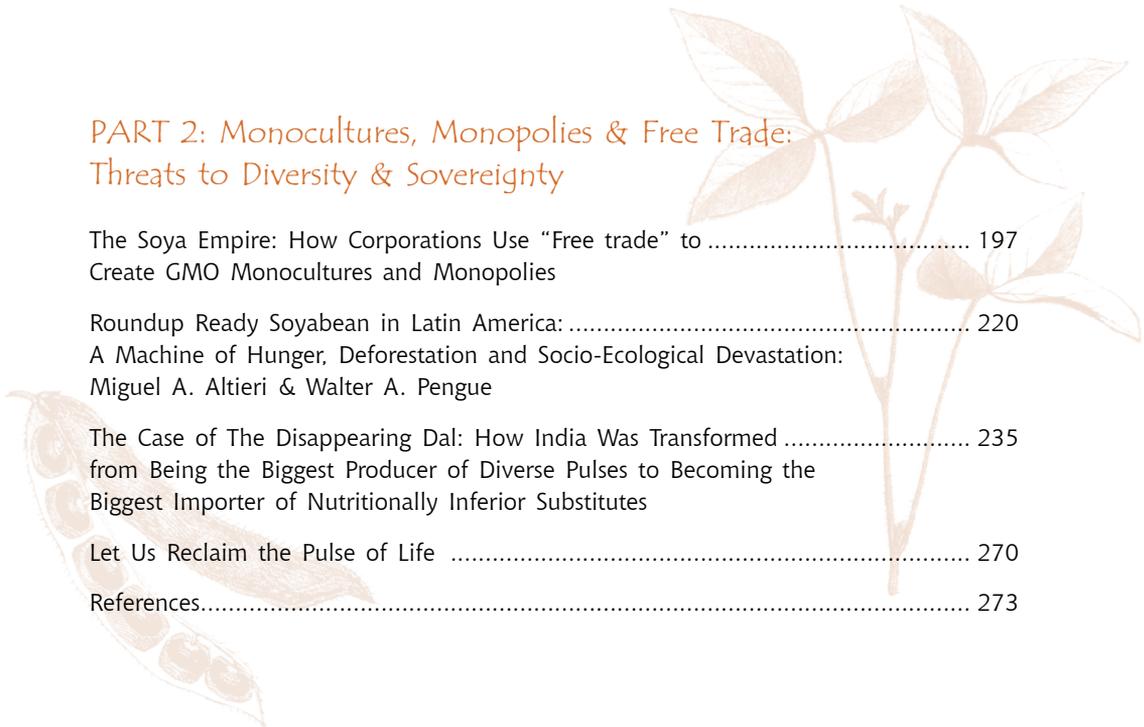




Illustration: Kaia Singh

Introduction

Pulses for healthy soils, healthy people, healthy planet

Pulses and edible legumes are truly the pulse of life for the soil, for people and the planet.

In our farms they give life to the soil by providing nitrogen. This is how ancient cultures enriched their soils. Farming did not begin with the Green Revolution and synthetic nitrogen fertilisers. Whether it is the diversity based systems of India- *Navdanya*, where 9 crops are planted together, *Baranaja*, where 12 crops are planted together, or the three sisters planted by the first nations in North America, or the ancient *Milpa* system of Mexico, beans and pulses were vital to indigenous agro-ecological systems.

As Sir Albert Howard, known as the father of modern agriculture, writes in *The Agriculture Testament*, comparing agriculture in the West with Agriculture in India:

“Mixed crops are the rule. In this respect the cultivators of the Orient have followed Nature’s method as seen in the primeval forest. Mixed cropping is perhaps most universal when the cereal crop is the main constituent. Crops like millets, wheat, barley, and maize are mixed with an appropriate subsidiary pulse, sometimes a species that ripens much later than the cereal. The pigeon pea (*Cajanus indicus*), perhaps the most important leguminous crop of the Gangetic alluvium, is grown either with millets or with maize.....

Leguminous plants are common. Although it was not until 1888, after a protracted controversy lasting thirty years, that Western science finally accepted as proved the important role played by pulse crops in enriching the soil, centuries of experience had taught the peasants of the east the same lesson.”

Sir Albert Howard. *An Agricultural Testament*. pg 13

The displacement of biodiversity, by monocultures, had a direct impact on the decline of pulse production, and with it a depletion of soil fertility. Mixed cropping was impossible with the chemical intensive Green Revolution. With the change from mixed cropping to monocultures, less pulses were planted, reducing production and, without legumes, leaving nitrogen levels in the soil depleted.

Similarly vegetable protein from pulses was also at the heart of a balanced, nutritious diet for humans. The Benevolent Bean is central to the Mediterranean diet. India's food culture is based on “*dal roti*” and “*dal chawal*”. *Urad, moong, masoor, chana, rajma, tur, lobia, gahat* have been our staples since ancient times. While they bring us health and nutrition, they also bring health to our soils by fixing nitrogen naturally, and thus make us free of chemical fertilisers. That is why we always grew dals as mixtures with cereals.

India was the largest producer of pulses in the world. Today we are the biggest importers. And since the rest of the world does not grow the diversity of pulses we grow, what is being imported cannot replace the diversity necessary for the Indian diet.

Pulses: The nonviolent alternative to provide nitrogen to soils

My book *Soil not Oil* highlights how industrial agriculture is a fossil fuel based system, and contributes more than 40% of the green house gases that are contributing to climate change.

Nitrogen oxide released by synthetic fertilisers is a Green House Gas which has 300 times more impact than carbon dioxide in destabilizing the climate. Nitrogen oxides also react with water in the atmosphere to form acid rain.

Synthetic nitrogen fertilisers are based on fossil fuels and use the same process that also made explosives and ammunitions for Hitler during World War II. Synthetic nitrogen fertilizer were promoted in agriculture after World War II when large stocks of leftover ammonium nitrate munitions were marketed for agricultural use. The energy intensive Haber Bosch process uses natural gas to artificially fix nitrogen from the air at high temperature and produce ammonia. Ammonia is the feedstock for all synthetic nitrogen fertilisers as well as for explosives.

One kg of nitrogen fertilizer requires the energy equivalent of 2 litres of diesel. Energy used during fertilizer manufacture was equivalent to 191 billion litres of diesel in 2000 and is projected to rise to 277 billion in 2030. This is a major contributor to climate change, yet largely ignored.

The dominant narrative is that synthetic fertilisers feed us and without them people will starve. They produce “bread from air” it has been said.

This is false for 2 reasons. Firstly, nature and humans have evolved many nonviolent, effective, sustainable ways to provide nitrogen to soil and plants. Secondly, use of synthetic fertilisers are non sustainable because they destroy soil ecology, pollute water systems, and are a major contributor to climate change. Because they do not build soil fertility but instead undermine it, over time there is a decline in the fertiliser response.

(Soil Health by P D Sharma, ICAR)

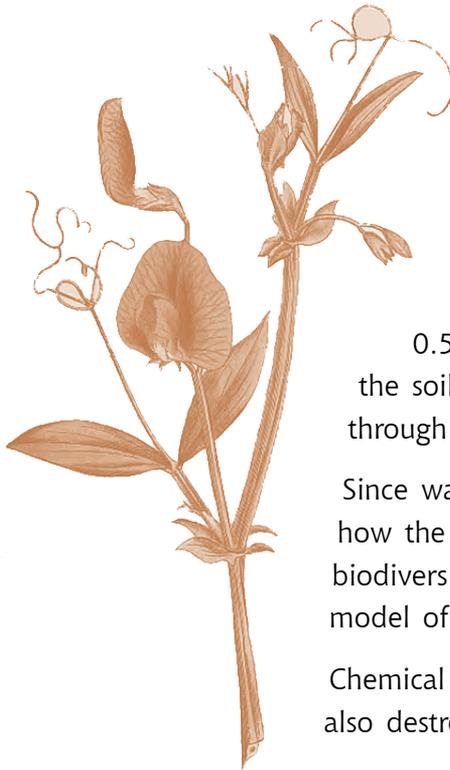
Take the miraculous pulse legumes, our dals. They fix nitrogen from the air without fossil fuels and without violent processes. They have small nodules in their roots which absorb nitrogen from the atmosphere. The bacteria (rhizobia)

in the nodules convert the atmospheric nitrogen into ammonia, and then into organic compounds by the plant to be used for growth.

Intercropping or rotating pulses with cereals has been an ancient practice in India. We also used green manures which are nitrogen fixing.

Besides the rhizobium, we have the amazing earthworm. Earthworm castings contain five times more nitrogen than soil without earthworms.

Returning organic matter to the soil builds up soil nitrogen. A recent study we are undertaking shows that organic farming has increased nitrogen content of soil between 44-144%, depending on the crops.



Not only does organic farming avoid the emissions that come from industrial agriculture, organic farming transforms carbon in the air through photosynthesis and builds it up in the soil, thus contributing to higher soil fertility, higher food production, and a sustainable, low cost technology for addressing climate change.

Mixed cropping and organic farming reduce evaporation, conserve water and transform the soil into a water reservoir.

0.5% increase in organic matter can increase the water held in the soil by 80,000 litres per hectare, thus reducing water requirement through irrigation.

Since war expertise does not provide expertise about how plants work, how the soil works, how ecological processes work, the potential of biodiversity and organic farming was totally ignored by the militarized model of industrial agriculture.

Chemical fertilisers do not merely contribute to climate change: they are also destroying our water and oceans.

As I reported in my book, *The Violence of the Green Revolution*, agriculture based on chemical fertilisers requires ten times more water to produce the same amount of food. This is largely because chemical fertilisers destroy the living organisms in the soil which increase the water holding capacity of soil. And just as farms without pulses need external inputs of nitrogen fertilisers, soils without organic matter need external inputs of water through irrigation. This intensive irrigation is destroying our rivers and groundwater through over-exploitation. In the Green Revolution areas of Punjab, Haryana, and Rajasthan, groundwater beneath the northern Indian states has decreased by more than 88 million acre-feet during the past decade. That's nearly eight times the amount held in Lake Mead, the largest reservoir in the United States.

Source: <http://svs.gsfc.nasa.gov/vis/a010000/a010700/a010764/>

Besides contributing to climate change and creating water scarcity, agriculture systems based on external inputs of synthetic nitrogen fertilisers has other ecologically destructive impacts, undermining food security. Plants take up very small amounts of the synthetic nitrogen. The rest runs off, polluting ground water and water bodies. Nitrate pollution of drinking water can cause serious health problems including the potentially fatal blue-baby syndrome.

Source: http://www.who.int/water_sanitation_health/diseases/methaemoglobin/en/

The excess nitrogen that runs off into waterways, creates massive "algal blooms" of nitrate-fed algae which starve water of oxygen, suffocating fish and other aquatic life and creating huge "dead zones" in lakes and oceans. The number of identified oceanic dead zones has grown from 10 in the 1960s to 60 in 1995 to 405 in 2008. The Mississippi River fertilises a dead zone in the Gulf of Mexico measuring 6,474 square miles, the annual Gulf of Mexico "dead zone" covers an area roughly the size of Connecticut and Rhode Island combined.

Source: <http://www.weather.com/science/environment/news/2015-dead-zone-gulf-of-mexico>

Growing pulses organically as mixtures avoids all the above negative impacts while contributing positively to our health and the health of the planet

Threats to diversity of pulses

Across the world there are new threats to the diversity of our pulses and edible legumes. There are three steps through which pulses have declined in Indian agriculture and in the diet of most Indians.

The first cause for erosion of pulses is colonialism. When the Europeans, specially the British, colonized the world, they had no idea of the role of vegetable proteins in the human diet. So when you read the English names of the indigenous pulses of India, they are all referred to as animal feed. *Tur* or *Arhar* becomes pigeon pea, *gahat* becomes horse gram, *chana* becomes chickpea, *lobia* becomes cowpea. The devaluation of pulses in Agriculture and the diet was thus a part of colonialism.

The next step of displacement of pulses from our farms, our plates took place with the Green Revolution.

Our dal diversity was destroyed by the Green Revolution Monocultures based on chemical rice and wheat. We have produced more rice and wheat, but our pulses have disappeared from the monoculture fields. Between 1960-61 and 2010-2011 acreage under wheat has gone up from 29.58% to 44.5%, rice from 4.79% to 25%. Meantime area under pulses has dropped from 19% to 0.21%, oilseeds 3.9% to 0.71%, millets from 11.26% to 0.21%. When measured in terms of nutrition per acre and health per acre, Punjab is actually producing less food and nutrition as a result of the Green Revolution.

The Green Revolution is largely based on finding use for the war industry in the post war era. And war chemicals became agricultural inputs. Plants were adapted

to chemical agriculture. And with external inputs, monocultures of wheat, rice, maize were promoted. Pulses disappeared from Green Revolution fields.

The third threat comes from the model of “Free Trade” and Globalisation which has enabled global corporations to take over food and agriculture, from the seed and our farms, to our kitchens and plates.

Free Trade agreements include introduction of patents and intellectual property rights to seed, and the removal of trade barriers in the form of tariffs and quantitative restrictions which protected domestic production. Since patents were originally introduced through GMOs, free trade has meant the expansion of GM soya monocultures and the emergence of monopolies.

Monocultures of GM Bt cotton and soya are displacing our pulses; 11.6 million hectares of Bt-Cotton were planted in India in 2014. If pulses had been planted on half this land, we would have had an additional 4 million tonnes of pulses available. In 2014, 12.12 million hectares were planted with soya instead of growing the 10 million tonnes of pulses we could have grown. Why are we growing soya for export and importing the pulses we eat?

With the artificially created pulse scarcity, pulses have become unaffordable for many Indians. This artificially created scarcity is being used by the Government to import pulses from corporations like Cargill - which has established a pulses desk in Delhi to focus on peas from Canada, and also exports soya from India, turning a profit both ways.

The removal of quantitative restrictions and the scarcity created by the neglect of production of pulses and plant proteins have also encouraged subsidized duty free imports of inferior pulses, which are further displacing indigenous cultivation of pulse diversity. Free Trade has transformed India from being the biggest producer of a diversity of pulses into the biggest importer



And since the rest of the world does not grow the diversity of pulses we grow, what is being imported cannot replace the diversity necessary for the Indian diet. Large quantities of 'yellow pea' from US and Canada are imported at the cost of billions of dollars. In 2012 the Comptroller and Auditor General (CAG) had audited the pulse imports and had questioned the repeated import of 'yellow pea' stating. "The MoCA and F&PD decided in 2008 that the agencies need not go for further contracts of yellow peas, but the Union Cabinet in 2009 decided to allow the agencies to import these. The agencies continued to import even when they had huge unsold stocks, resulting in a loss of Rs. 897.37 crore, 75 per cent of the total loss of Rs. 1,201.32 crore".

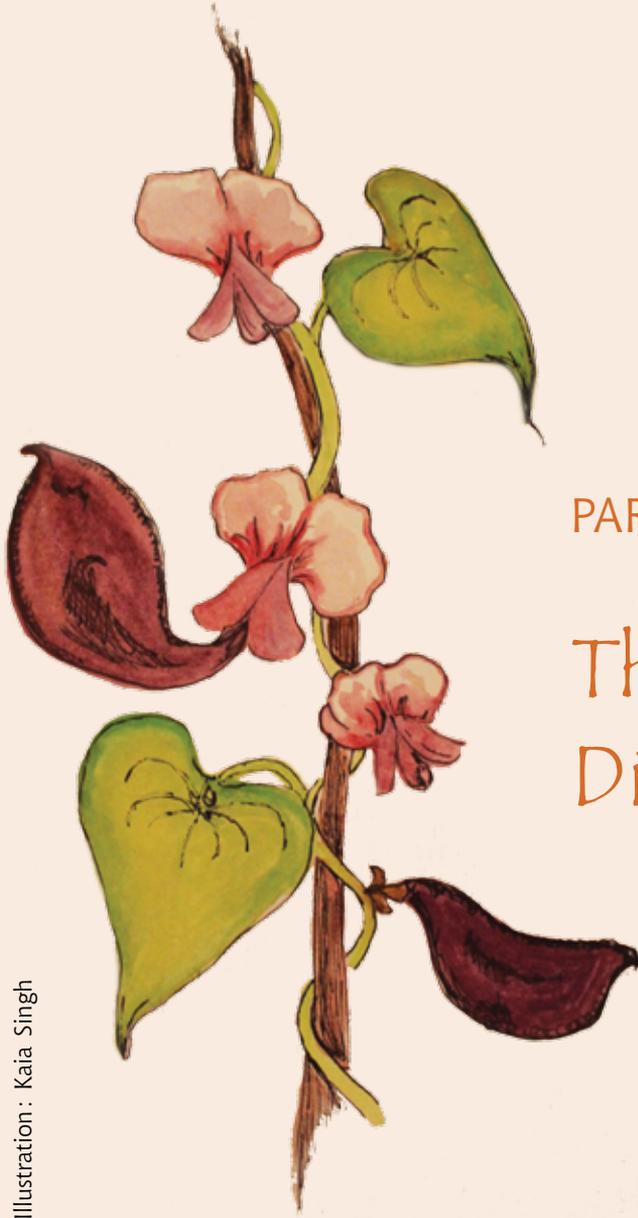
But the loss is not only to the exchequer. Import of yellow pea translates into importing nutritional deficiency for people and the soil, and decline in soil health. In 2015-16 India plans to import more than 5 million tonnes of yellow pea from Canada and US. Yellow pea has only 7.5% protein compared to indigenous pulses having 20-30%. Importing 5 million tonnes of yellow pea instead of growing our own pulses is thus importing a deficiency for Indians, of 1 million tonnes of protein. Not growing 5 million tonnes is depriving our soils of more than 1 billion kg of nitrogen.

Source: <https://www.fatsecret.com/calories-nutrition/generic/green-or-yellow-split-peas-dry-cooked?portionid=51928&portionamount=100.000>

2016 is the International Year of Pulses. It provides an opportunity to remember how important the diversity of our pulses are to the health of the soil and our health. We need to rejuvenate the pulse of life on our farms and our *thalis*.

Rejuvenating the Pulse of life has become an imperative for food sovereignty, the health of our soils and health of people, for the conservation of the rich biodiversity of our edible legume crops, and the cultural diversity of our foods.

Illustration : Kaia Singh



PART 1

The Bio-Cultural Diversity of Pulses

The World of Pulses & Edible Legumes

Overview

The Year of Pulses is a good opportunity to renew or get acquainted with this important element of our food platter which is slowly but surely receding from our memory in spite of its seminal potential to increase food and nutrition security in times of climate change. This is therefore a time for us to remember not only the forgotten diversity of pulses but also that of the other edible legumes which are in fact disappearing even faster from our consciousness and hence from our diets.

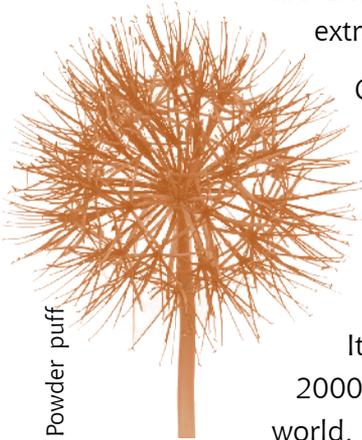
A pulse is a plant belonging to the legume family that comprises all plants growing and maturing in a dehiscent pod containing one or several seeds and splitting along the seams on two sides. Some legumes can have an indehiscent pod, as for example the peanut. They are divided into three categories, beans, lentils and peas as per their shape: beans are kidney-shaped, lentils are convex, like a lens while peas are spherical. All legumes named peas do not however belong to the pea family, *Pisum sativum*. The FAO uses the term “pulses” for crops harvested for dry seeds. This definition therefore excludes green beans, such as French beans and green peas such as the garden pea and mange tout, solely used when they

are green and therefore considered as vegetables. However, as every thing in life, contours cannot be sharply demarcated for some beans and peas such as lima beans and pigeon peas are eaten both fresh and dried.

In India, which has an age-old food culture of vegetarianism, pulses, known as dal, play an important role in providing a healthy and balanced diet. A diversity of pulses are/were eaten, though today city people very often refer to the “yellow dal” and the “black dal”, reducing the various legumes to a single colour. In fact many of them, such as *tur*, the pigeon pea, *urad*, the black gram, *mung*, the green gram, *lablab*, known as *val papadi*, *kulath*, aka *gahath*, the horse gram, *moth* and *navrangi*, as also Bengal gram, *chana*, have their centre of origin or domestication in India. Quaint stories are associated with some (see cultural section) while others form part of festive foods (see culinary section). The most commonly eaten dals are processed in a variety of ways: split, with coat removed, for the traditional dal preparations, accompanying rice or *rotis*, flat breads; fermented and ground with rice for *dosai*, pancakes and *idlis*, steamed cakes, to name but some.

Also not included in the pulses category, yet playing a seminal ecological role are crops used exclusively for soil cover such as clover or legumes used for oil extraction such as soy and peanut.

Given the sterling role legumes, in all their forms, play as food, green manure, fodder, cover plants, a deeper exploration of this plant family cannot be ignored. Known as the *Fabaceae* or *Leguminosae* family, it is subdivided into three sub family: a) *papilionoideae* (ex: lupines and most edible pulse legumes), b) *caesalpinioideae* (ex: *Tamarindus indica*, *Senna*, c) *mimosoideae* (ex: *Calliandra haematocephala*, the powder puff). It is the 3rd largest family of flowering plants, counting between 18,000-20000 described species and includes herbs, shrubs, trees and vines, across the world, including tropical rain forests.



Legumes, from the French “légume”, which in turn comes from the Latin “legere”, meaning to gather, are of high antiquity. Their cultivation probably goes back to the Bronze Age or even 8000 years ago as per archeological evidence. In *The Archeo-botany of Indian pulses: Identification, Processing and Evidence for cultivation*, D.A. Fuller and E.L. Harvey (2006) tell us that pigeon pea has been found in two Neolithic sites in Odisha: Gopalpur and Golbai-Sassan, dating between 3,400 & 3,000 years ago, as well as in South India, in Sangera-Kallu and Tuljapur Garhi - dating back to 3,400 years ago.

Lentils are mentioned in the Bible and ancient Indian classical texts. There is also evidence that legumes were known in Ancient Egypt where beans were a symbol of life. Then again, already as far back as 300 BC, the Greek botanist Theophrastus talks about how legumes reinvigorate the soil and could therefore be used as manure. In fact, according to Ladock (2010), they were actually used to enrich the poor soil of the Mediterranean region. In their essay/article, Kimberly B. Flint and Hamilton say that Marcus Porcius Cato (234 BC - 149 BC) acknowledges the importance of legumes on a well functioning farm, recommending the addition of at least “one Lupine vat (labrum lupinarium) as part of the requisite equipment for olive groves and vineyards.” The authors go on to say: “That a successful legume harvest was considered important can be demonstrated by Cato’s recommendation that farmers offer incense and wine to Ceres, Janug and Jupiter before the harvesting of beans.” If fava beans, lentils and peas were known in the Old World since many centuries, remains having been found in ruins of Troy and Pompeii, it is only in the 16th & 17th centuries, post the Columbian era, that other beans as well as peanut, which were known since ancient times in what we still call the New World, travelled to Europe.

This high antiquity points to the importance of legumes for the health of our bodies as well as the health of soil. In *Changing Roles for Legumes in Mediterranean Agriculture: Developments from an Australian Perspective*, J.G. Hokinson, G.W. O'Hara, S.J. Carr say: "Legumes have been used since antiquity as a primary nitrogen source across a range of agricultural and social settings. The cool season pulses: *Cicer arietinum* (chickpea), *Lens culinaris* Medik (lentil), *Pisum sativum* L. (field pea) and *Vicia faba* L. (faba bean) have for millennia provided the major protein component in human diets in West Asia, North Africa, the Indian sub-continent and parts of Central and South America."

Generally speaking, legumes are rich in complex carbohydrates and dietary fiber; fibers are known to assist intestinal transit and since they absorb water in the stomach, they reduce hunger and create a feeling of satiety or what we call *tripti* in India, thereby favouring weight loss. Legumes also have a low fat content and are a good source of vitamins and minerals, in particular B group vitamins as well as potassium and magnesium, iron, calcium, selenium (an antioxidant which helps combat skin aging) and zinc, a mineral which supports wound healing, protein synthesis, reproductive health, nerve function and brain development. However, since legumes generally fall short of two of the nine essential amino acids the body needs but cannot make, they must be consumed in association with some cereals such as rice, wheat or corn, to complete the full range. Combined with cereals, legumes are a good source of proteins; in fact it is necessary to add legumes with other sources of proteins to complete the required protein length. This fact was well known by the culinary wisdom of various food cultures. For example, in India, *dal chaawal* (rice and dal) or *dal roti* (dal and flat bread) have been our customary diet for times immemorial; in East Africa it is rice and peanut that are combined. Similarly, in Mexico, maize are complemented by beans and in North Africa, the famous couscous dish combines semolina with chickpea.





A word of caution here regarding the consumption of soy beans would not be de trop: though it contains the full range of amino acids, its consumption is very problematic and therefore this legume should be eaten only in its fermented forms (see *Glycine*).

Given their remarkable nutritional profile beans, peas and lentils are actually a storehouse of health benefits. To quote Rebacca Wood, in *the new whole foods encyclopaedia* (p:30-31): “Beans and legumes strengthen the kidneys and adrenal glands and therefore promote physical growth and development. As does the protein in meat, bean protein builds body mass; **but unlike meat, beans don’t add cholesterol, saturated fat, or toxic nitrogen byproducts.**” And an added feather in the cap for legumes is the fact that for the same amount of protein that meat can give, they need less acreage. Yet, the irony is that post 1914 there has been a decrease in legume intake while that of meat has substantially increased. Similarly, as Vandana Shiva states in the introduction, in India due to various distortions, the acreage under dal has also decreased, leading to unhealthy substitutions such as i-dal.

It is therefore a very opportune initiative to have the Year of Pulses. In a feature on pulses, carried in www.fao.org/news/story/en/item/343558/icode/, as part of the Year of Pulses promotion, the organisation states:

“Low in fat and rich in nutrients and soluble fibre, pulses are also excellent for managing cholesterol and digestive health; their high iron and zinc content make them a potent food for combating anaemia in women and children. They are a key ingredient in healthy diets to address obesity and to prevent and manage chronic diseases such as diabetes, coronary conditions and cancer.”

Depending on its colour, a bean benefits a particular organ: green ones, such as *mung*, are good for the liver; red ones, like adzuki and kidney beans, act upon the heart; yellow ones, think chickpeas and Bengal gram, are beneficial for

the spleen and pancreas; the white beans which include lima and navy beans energise the lungs and the colon; the black beans are particularly supportive of the kidneys (Wood,p.31).

Beans contain the phytochemical diosgenin, said to inhibit cancer cells from multiplying. They also act upon the levels of serum cholesterol thereby offering some protection to the heart.

Beans and other legumes have a low glycemic index, their sugars being absorbed slowly, making them a diabetic friendly food.

Most members of the *Fabaceae* family, i.e. legumes, are a good source of isoflavones, which help in the prevention of post menopausal cancer and heart disease.

On the flip side, some concerns have been raised regarding the digestibility of legumes, their tendency to cause flatulence as well as some anti-nutrients they contain, some less, some more as in the case of soya. Let us look at some of these elements, their actions and ways to deactivate them:



- i) Lectins, present in legumes, interfere with nutrient absorption; they are, however, normally deactivated by soaking, sprouting, cooking, fermentation or heating (A.Pusztai,1991, cited by Tumwebaze Joel in *Anti-nutrients in Legumes and their Removal*);
- ii) Phytates/phytic acids: phytates bind minerals such as copper, iron, magnesium, calcium and zinc. However germination and fermentation help in substantially decreasing this anti-nutrient; soaking and cooking too remove 50 to 80% of the phytate contained in legumes (Deshpande, 2002, cited by Tumwebaze Joel in above cited article). Since soya beans are particularly high in phytic acid, in their case, deactivation is lesser except when fermented (see *Glycine*).

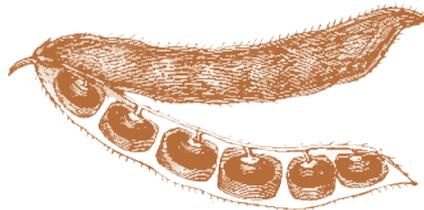
- iii) Trypsin inhibitors: these inhibit the action of the enzyme trypsin which together with chymotrypsin (protease) break down protein for absorption by the body. Again, traditional methods of cooking mitigate their action.
- iv) Raffinose oligosaccharides: their activity in the digestive system causes flatulence, dyspepsia and constipation or diarrhea.
- v) Polyphenols, as for example, tannins: they interfere with protein digestibility and are found mostly in the seed coat. This is taken care of in India very easily thanks to the Indian way of processing dal by splitting the seeds and removing the coats. Moreover, the dehulled dal are eaten more regularly than the whole, *sabut* ones, reserved for occasions.

Actually, some of the anti-nutrients such as polyphenols, also have a beneficial action and eating of legumes has been a very ancient tradition, which has led to the evolution of cooking practices ensuring pulses are prepared in beneficial ways while minimising the unpleasant side effects. Indian cuisines, across regions, resort to the utilisation of spices such as asafoetida, cumin seeds, pepper as well as ginger, ingredients that help digestion and prevent gas formation. Traditionally, all food cultures using beans and other pulses always soak them, sometimes for several hours or overnight, throwing the soaking water more than once in some cases. This method not only softens the pulse but also leaches out the indigestible elements leading to gas formation. Soaking also activates enzymes that break down complex carbohydrates into simpler and more digestible starches. Again, this process eliminates the phytic acid of the beans making their minerals more bioavailable. Some people add baking soda to soften beans, a process which destroys B vitamins. We have already talked about how in India various legumes are processed as dal whereby the seeds are split and the outer coats are sometimes removed (we have *chhilka wali dal* and *bagair chhilka wali dal*), the digestibility is thus further increased.

As per Ayurveda, legumes are astringent in taste and in the case of mung beans, which are highly detoxifying, they tone up the digestive system. This apart, legumes in general help to consolidate the seven types of *dhatu*s (body tissues) and more so the muscle tissue.

Our next section will present brief descriptions of pulses and other legumes. Before this, some points need to be clarified. There could be confusion arising from the fact that all erstwhile Asian *Phaseolus* species have now been reclassified as *Vigna*: for example mung which is now *Vigna radiata* was earlier *Phaseolus aureus*, a classification which may not have been corrected in publications predating the change. For good measure, *urad* is classified as *Vigna mungo* which again could lead to confusion. Then, the same appellations are used for different species, as they refer to a utilisation: both *Fava* beans and Jack beans are sometimes called horse beans and we have the Indian *kulath* which is horse gram in English. Similarly, both Jicama (*Pachyrhizus erosus*) and African yam bean (*Sphenostylis stenocarpa*) are called yam bean. We also have the situation where legumes of the same colour as for example black soy, black gram and black pea are confused for each other.

We hope that as we individually approach major pulses and other legumes consumed in India and across the world, as well as some little known and underutilized ones their multiple facets will be revealed so as to enable a better comprehension of these most nurturing gifts of Mother Earth.

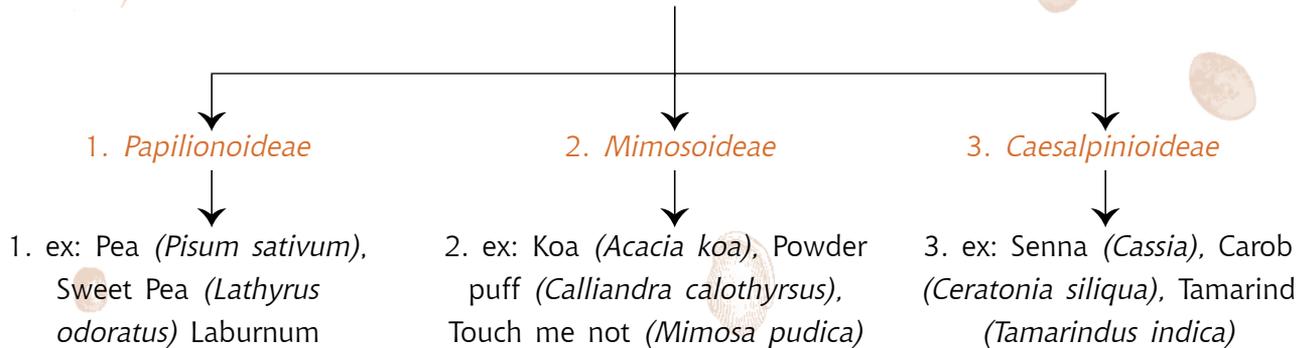




The Legume Family

Third largest plant family on Earth

Leguminosae/Fabaceae



Mimosoideae:

80 genera and 3,200 species. Mostly tropical and warm temperate regions of Asia and America (*Mimosa*, *Acacia*).

Caesalpinioideae:

170 genera and 2,000 species, cosmopolitan (*Caesalpinia*, *Senna*, *Bauhinia*, *Amherstia*).

Papilionoideae (Faboideae):

470 genera and 14,000 species, cosmopolitan (*Astragalus*, *Lupinus*).

Legumes: 700 genera; more than 1800 species; a simple dry fruit in a pod containing several seeds and splitting along the seams on two sides

Papilionoideae is the largest family of legumes comprising 2/3rds of the legume family; most edible crops belong to this group.

Legumes can be trees, shrubs or herbaceous plants, which can be annuals, biennials or perennials. These can be either erect / upright or vines, climbing trees, poles, walls etc. and thus known as pole or garden beans; they can have runners and grow prostrate on the ground. All wild beans species and some domesticated ones have runners.

Most Prominently Cultivated Pulses

Pigeon Pea

Cajun cajanus

Names: (Eng:) Pigeon pea; (Hindi) arhar; (Guj:) tuvar, tur; (Tamil) togari; (Kannada) thovari; (Tel:) kandalu; (Malayalam) tuvara; (Beng:) urur, orol; (Fr:) pois d'angole; (Port:) guandu; (Spa:) gendul.

Antiquity and origin

Pigeon Pea, which is not really a pea, originated in India where it has been growing for millennia as archeo-botanical evidence attests. In India, remains of pigeon pea have been found at Bhokardan in Maharashtra, dating to the 2nd and 3rd centuries A.D. This apart, archeological remains have also been discovered at two Neolithic sites in Odisha at Gopalpur and Golbai Sassan, dating to 3,400 and 3,000 years ago. Sites of archeological evidence, going back 3,400 years ago, also exist in South India at Sangana Kallu and Tuljapur Garhi (Fuller, D.Q & Harvey E.L.: 2006).

It reached Africa in 2000 B.C. or earlier, where a centre of diversity developed in East Africa. Since the Europeans discovered it there, pigeon pea was named Congo pea. From there, with the conquests and as a result of the slave trade, pigeon pea reached the Americas. It is now grown all over the tropical and subtropical regions of the world, with the largest production coming from just six countries: India, Myanmar, Malawi, Uganda, Tanzania and Nepal.

The centre of origin of pigeon pea is disputed, with some scientists placing it in Africa and others in the Indian sub-continent. However, in



the light of the very high diversity (probably the highest) of wild species as well as domesticated ones in India and also given its wide spread culinary use across India, in 1951, Vavilov placed the centre of origin of pigeon pea in India. The scientist Vander Maeson too placed the centre of origin of this legume in Eastern India where, in the state of Odisha, the closest wild relatives, (*Cajanus cajanifolia*) are to be found in the deciduous woodlands.

Etymology & nomenclature

The botanical name *Cajanus cajan* is probably from the Malay cachang which in turn must have been corrupted from the Telegu kandi.

Source: *Lifting the Level of Awareness on Pigeon pea - A Global Perspective* -by M.G. Mula & K.B. Saxena (eprints icrisat ac.in)

The name pigeon pea comes probably from Barbados where the seeds of the plant were used to feed pigeons. The Indian names *arhar* in North India and *tur* in South India could be from *Adhaki* or *Adhuki* (in Sanskrit) and *Tovorai* or *Tuvari*, meaning astringent in Sanskrit, respectively. The Portuguese *guandu* and the Spanish *gandul* may probably have come from the Telegu *kandulu*. According to M.G. Mula & K.B. Saxena, though Vander Maeson (1986) recorded 350 names for pigeon pea, they have recorded 792 vernacular names in 140 countries.



Cultivation

Pigeon pea is cultivated during the monsoons, under rainfed conditions, between 600-1400 mm. Since it is deep rooted it can seek moisture from the deeper layers of the soil. Being drought resistant, it is considered to be an important crop for small- scale farmers of the semi-arid zones; **it is felt that the high levels of protein and B vitamins of the legume can provide nutrition security to subsistence level farmers.**

Currently, as per Masood Ali & Shiv Kumar (*Pulses*, p: 15, 2005), pigeon pea is the 4th most important pulse crop in the world. It is, globally, grown on about 4.05 million ha, with a production level of 3.10 million tonnes of grains and an average yield of 764 kg per ha.

Morphology

Cajanus cajan is an erect shrub up to 4 metres tall, with roots that extend up to 2 metres into the soil. Its main stem is erect, ribbed and the plant has many secondary branches.

The leaves are alternate along the stems and are composed of three leaflets, positioned alternately along the stem. The petiole (the stalk which connects the leaf to the stem) is 1-8 cm long and grooved above. The leaflets are elliptical to lance-shaped and are 2.5-13.5 cm long to 1-5.5 cm wide. The leaflets are green above and a silvery grey-green beneath and are covered on their lower surfaces in small yellow glands.

The stalked flowers are arranged along an unbranched axis (a raceme). The racemes are axillary. The flowers are yellow and are papilionaceous, typical of species belonging to the *Leguminosae* subfamily *Papilionoideae*, and resemble, for example, the pea flower. Each flower has 10 stamens, 9 of which are fused into a partial tube, with the tenth stamen free. The ovary is positioned above the sepals, petals and stamens. The style is curved.

The fruit is a straight or sickle-shaped pod 2-13 cm long x 0.5-1.5 cm wide containing up to 9 seeds. The seeds are 4-9 mm x 3-8 mm and can be white, brown, purplish, black or mottled.

Acknowledgment: <http://www.kew.org/science-conservation/plants-fungi/cajanus-cajan-pigeon-pea>

Uses

Pigeon pea has multiple uses:

For humans:

In India, pigeon pea is eaten both as a pulse, in the form of dal, for which there are many recipes (see recipe section), prepared from the split seeds and as a vegetable with the fresh young pods being used in various regional cuisines. In South India, it is put in *sambhar*, a soupy preparation.

Ethiopian cuisine uses the pods as well as the young shoots and leaves.

Given its excellent nutritional profile, pigeon pea is a highly recommended food to include in one's diet.

According to Ayurveda, since Charaka (700 BC) the blood purifying property of pigeon pea has been recognised. It is also deemed to be improving complexion.

Some traditional healthcare systems use the leaves to treat various illnesses such as diarrhea, gonorrhoea, measles, burns, gums, headache, etc.; roots are used for cough and toothache.



Other uses:

As animal feed

Pigeon pea is also used for animal feed in the form of the dehulled material left after dal has been processed. The seeds and seed pods are also used as forage, especially for increasing milk in livestock and meat in poultry (Duke 1981).

As green manure

Being a legume, pigeon pea has excellent nitrogen fixing properties, providing up to 90 kg of nitrogen per hectare (Adu - Gyarrifi, 2007).

The leaves of the plant are good for mulching.

Miscellaneous

- The stems and branches of the pigeon pea plant have multiple uses: they can be used as fuel, for fencing, as thatch and for basketry.
- The plant is also used in some places as a host for silkworm and for lac producing insects.

17 *cajanus* species in india
13 wild species in australia
1 in Africa

Source: *Indian Pulses Through the Millennia* by Y.L Nene in http://asianagrihistory.org/articles/Indian_pulses.pdf
<http://www.kew.org/science-conservation/plants-fungi/cajanus-cajan-pigeon-pea>

Chickpea/Bengal gram

Cicer arietinum

Names: (Hindi) chana, kabuli chana, chhola; (Kannada) kadale; (Tamil:) kadalai; (Tel:) sacagala; (Malayalam) kadula; (Beng:) but; (Urdu:) but; (Eng:) chickpea, garbanzo, garbanzo bean, Bengal gram, Egyptian pea, (Fr:) pois chiche; (Arabic:) hummus, hamezi.

Origin & antiquity

Chickpea is probably one of the earliest cultivated legumes, as evidenced by the carbonized remains of chickpea from Cajoni in Turkey (Van Zeist, 1972) as well as from Tell Abu Hureyra in Syria (Hillman, 1975).

Vavilov (1926, 1949) places the centre of origin in South West Asia and the Mediterranean region whereas Ladinsky (1975) places it in South Eastern Turkey.

Etymology & nomenclature

The etymology of chickpea goes to the French chiche from Latin *cicer*; as for the term garbanzo, it is directly taken from modern Spanish though in the 17th century the term garvance existed in American English, as an alteration of the old Spanish word arvanço.

Morphology

A slender, erect annual growing up to 100 cm tall, with simple or branched stems.

Extensive root system. Roots bearing nodules containing nitrogen-fixing bacteria (including *Mesorhizobium ciceri* and *M. mediterraneum*).

Divided into 5–7 pairs of leaflets. Leaflets up to 16 mm long and 14 mm wide with toothed margins and weak, spreading, glandular hairs. Triangular stipules (leaf-like appendages) are borne at the leaf base.

Typical pea flowers, up to 12 mm long, borne singly, with white or lilac to violet petals.

A small, inflated and rounded pod, up to 3 cm long and 1.5 cm wide, with glandular hairs.

Roughly spherical, with smooth or rough surface, up to 14 mm in diameter. Variable in colour, usually creamy-whitish when dried. One or two seeds per pod.

Many cultivars of chickpea have been described. There are two main groups in cultivation:

- *Desi* (microsperma) cultivars – producing small, angular seeds with rough, yellow-brown coats. The *desi* forms predominate in the Indian subcontinent, Ethiopia, Mexico and Iran. They are often used for split peas (dal) or flour after the hulls are removed.
- *Kabuli* (macrosperma) cultivars - producing relatively large, plump seeds with a smooth, cream-coloured coat. The *kabuli* forms predominate in Afghanistan through western Asia to North Africa and in southern Europe and America (excluding Mexico). They are usually sold whole.

Cultivation

Chickpea thrives in a sunny site in a cool, dry climate on well-drained soils. It is generally grown on heavy black or red soils with a pH of 5.5–8.6. Frost, hailstones and excessive rain can damage the crop. Some cultivars can tolerate temperatures as low as -9.5°C in the early stages or under snow cover.

Acknowledgment: www.kew.org/scienceconservation/plants-fungi/cicer-arietimum-chickpea.

There are three main kinds of chickpea:

- i) The 'desi' type, which is called *kala chana* in Hindi/Urdu and Bengal gram in English; it has small, darker seeds than the whiter, bigger *kabuli chana*. It is grown in India, the Indian subcontinent, Ethiopia, Mexico and Iran. It is probably the earliest variety since it resembles seeds found both on archeological sites and the wild plant ancestor, *Cicer reticulatum*. Its fibre content is higher than the other varieties.

Within this there is also a “*Bambai*” variety, dark but larger than the “*desi*”.

- ii) We then have the Kabuli variety, which is larger and much lighter in colour. This variety grows mostly in the Mediterranean region, Southern Europe, Northern Africa, South America as well as the Indian subcontinent. The name kabuli comes from the fact that it reached India via Kabul in the 18th century.
- iii) The third variety, *ceci neri*, is larger and darker than the desi and only grown in Apulla, in South Eastern Italy.

This unusual legume, which has only one pea per pod, comes in a diversity of colours: red, white, brown and black.

Source: Clovegarden



As far as cultivation is concerned, it is grown in tropical semi arid eco-zones during the cool season. In India it is a rabi crop, grown after the rainy season. Given its long tap roots which can penetrate deep into the subsoil to access water, it is quite drought tolerant and therefore suitable for dry land or low irrigation farming. Since it does not tolerate excessive moisture, it should be grown on well drained soil.

Important chickpea growing countries include India, Pakistan, Ethiopia, Burma and Turkey. According to ICRISAT, quoting data from FAOSTAT database (www.faostat.org), between 1994 and 2005 the global acreage under chickpea was 10,7 million hectares. The ICRISAT analysis showed that between 1994-2006, “the overall growth area, production and productivity was almost stagnant ranging between 9 to 12 million hectares 7 to 9 million tonnes and 713 to 802 tonnes per hectare.”

(Data from ICRISAT Nairobi: Menale Kassie, Bekele Shiferaw, Solomon Asfaw, Tsedeke Abate, Geoffrey Muricho, Setotew Ferede, Million Eshete, Kebebew Assefa, www.icrisat.org/tropicallegumes/pdfs/current-Situation.pdf.)

Depending on the cultural practices and the seeds used, the yield of chickpea per hectare can vary between 1.3 t per hectare to 2.09 t per hectare as per data given in the ejournal of ICRISAT by authors A. Ramakrishna, S.P. Wani, Ch. Srinivasa Rao and U. Srinivas Reddy. (This study is entitled *Increased Chickpea Yield and Economic Benefits by Improved Crop Production Technology in Rainfed Areas of Kurnool District of Andhra Pradesh, India*). Others such as Guriqbal Singh, Harbhajan Singh Sekhon & Jaspinder Singh Kolar in *Pulses* have also indicated the potential yield of 5 t/ ha in sub tropical regions and 3 t/ ha with irrigation in tropical regions.



Uses

For human consumption

The use of chickpea for human consumption goes back to 8000 B.C. since the time of the *Rigveda*. Already then, *sattoo* (see recipe section), an extremely nourishing and nurturing food, made from grinding roasted chickpea, barley or wheat into flour was commonly used for sustenance. It would be mixed with milk or water and cane jaggery. *Sattoo* continues to be a prized food in Bihar, for rich and poor alike. Its cooling property continues to quench thirst during the scorching summer months. Susruta (between 1200-1600 BC), considered to be the “founding father of surgery” and to whom the treatise on surgery, the *Sushruta Samhita* is attributed, talks about the various ways in which chickpea was consumed: the leaves as a vegetable, the green seeds as well as the dry whole seeds and flour made from the dry seeds. Today also in India we still consume chickpea in these various forms.



Though in the USA it is mostly known as an offering at salad bars, traditional communities around the world have evolved many delectable recipes to include this superfood in their diets. Think falafel, the mid-eastern chickpea patty, *besan chila*, the Indian pancake, the eponymous Arabic humus, *guasanas* from Mexico, the Algerian shepherds' warming *chakhchoukha*, now popular in many parts of Algeria; the Tuscan chickpea soup. Surprisingly, China too has a couple of nourishing chickpea recipes from the Zhejiang region that may go back 250 years, according to Carolyn Philips who blogs at Madame Huang's kitchen about authentic Chinese cuisine.

Various culinary uses exist for chickpea, be they traditional or modern. For example, given the rising trend of veganism, some chefs have experienced with good results replacing eggs with chickpea-derived liquid, *aqua faba*, for preparing mousse and meringue.

Health benefits

This cornucopia of dishes is a measure of the popularity of chickpea, which is one of the healthiest foods available to us.

Traditional Indian systems of medicine and Ayurveda hold the chickpea, more specifically Bengal gram, in high regard. Already in 700 B.C. Charaka mentions that chickpea "*soopah*" is very nourishing and helps one to recover from spleen and liver disorders (Vidyalankar, 1984 cited by Y.L Nene).

The malic and oxalic acid exudates from chickpea leaves have therapeutic values, helping in digestion and acting as a coolant. They are sometimes crystallized and used as vinegar.

Ayurveda considers the *desi* chickpea, as opposed to the *kabuli* one which blocks the channels of the body, to be *agneya*, which means it not only boosts the metabolism but clears *ama*, i.e. toxins. Its outer coat is replete with antioxidants.

Two-thirds of chickpea's fiber content is insoluble, a trait that helps digestion and colon health. The insoluble fibers also create a feeling of satiety, which promotes weight loss.

Its low glycemic index (gi) makes chickpea, specially the *desi* variety, a diabetic friendly food: $\frac{3}{4}$ cup provides 25 gms of carb with a gi of 3.

It is replete with the goodness of all legumes: protein, vitamins and minerals (see boxes) and supports the spleen-pancreas meridian, stomach and heart.



1 cup of cooked chickpeas contains

Calories	269
Carbohydrate	45gm
Proteins	15gm
Dietary fiber	13gm
Fats	4gm
Cholesterol	0gm

1 cup of raw chickpeas provides

Potassium	50%
Vitamin A	2%
Sodium	21%
Vitamin C	13%
Iron	69%
Sodium	2%
Vitamin B ₆	55%
Magnesium	57%

in terms of daily need

Additionally, chickpeas contain vitamin K, folate, phosphorus, zinc, copper, manganese, choline and selenium.

Besides being an excellent vegan and gluten-free source of protein and fiber, chickpeas also contain exceptional levels of iron, vitamin B₆ and magnesium.

Given the excellence of its nutritional content and diversity of usage, chickpea became an imperial choice (see culture section).

Source: <http://www.medicalnewstoday.com/articles/280244.php?page=2>

Miscellaneous uses

- The milled seeds, husks and green or dried stems as well as leaves of chickpea are used for stock feed,
- Starch from the seeds is used for textile sizing giving a light finish to silk, wool and cotton cloth (Duke, 1981 cited in <https://hort.purdue.edu/newcrop/cropfact/sheets/chickpea.html>).

Lentils

Lens culinaris Medik aka as Lens esculenta

Names: (Eng:) lentils; (Fr:) lentilles, lentillons; (Port:) lentilla; (Swahili) medenga; (Hindi/Urdu) masur.

Antiquity and origin

The deep antiquity of lentils is attested by architectural remains from Greece, which go back to 11,000 B.C. However they do not clearly demonstrate whether the seeds were of wild or domesticated origins. The first clear evidence of lentils as a cultivated crop, according to Christopher Cumo (in *Foods that Changed History*) comes from the remains of Jarmo, In Iraq, "where farmers grew the legumes as early as 7000 BCE." There is general agreement that lentils have been around as a staple in Europe, the Middle East and India since 8000 years.

This apart, there are references in the *Book of Genesis* as to the existence of lentils and the high regard it was held in, as the story of Jacob and Esau illustrates (see story in cultural section).

Lentils are said to have originated in the Near East (Zohary, 1972) and spread to the Nile, Central Europe and the Indian subcontinent, reaching the Mediterranean basin by the end of the Bronze Age (www.inspection.gc.ca). The Spanish may have taken lentils to South and Central America and then before World War - II it was introduced to USA, reaching Canada in 1969 (www.inspection.gc.ca). Two centers of diversity exist for *Lens culinaris, spp.orientalis*: south eastern Turkey and north western Syria being one; and southern Syria and northern Jordan being the other (*Lentil: An Ancient Crops for Modern Times*; Ed; by Shyam S. Yadav, David H McNell, Phillip C Stevenson).



Etymology and Culture

The names lentil, lentille, lentilha: etc: are very clearly derived from lens for obvious reasons related to the shape of the seeds. The Hindi/Urdu word, *masur* is also related to the shape, coming from the Sanskrit *masura*, meaning pillow. Lentils resonate with cultural significance and have a rich history: they are the first pulse crop mentioned in the Bible and are known to be part of the diet of ancient Greeks, Romans and Jews. They played a particularly valuable role as nourishment for the poor. In Egypt they had a deity, Horus, dedicated to them.

Morphology

Lens culinaris is an erect, pale green annual herb up to 75 cm tall. Its main stem is square in cross-section, and from it many branches extend.

The pinnately compound leaves are arranged alternately along the stem. Each leaf consists of 5-16 leaflets which are inserted along the leaf's central axis (the rachis).

The stalked flowers are arranged along an unbranched axis. The racemes are about 7-flowered and axillary. The flowers are pale blue, white or pink and are papilionaceous, typical of species belonging to the *Leguminosae* subfamily *Papilionoideae*, and resemble, for example, the pea flower. Each flower has 10 stamens 9 of which are fused into a partial tube, with the tenth stamen free. The ovary is positioned above the sepals, petals and stamens. The style is inflexed and its inner surface is bearded.

The fruit is a 6-20 mm long x 3-12 mm wide pod containing up to 3 seeds. The seeds are lens-shaped, 2-9 mm long x 2-3 mm wide and can be grey, green, brownish green, pale red speckled with black or pure black in colour.

Acknowledgment: <http://www.kew.org/science-conservation/plants-fungi/lens-culinaris-lentil>

Cultivation and production

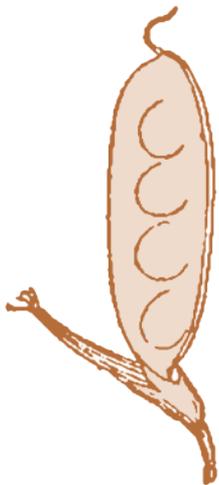
Lentils like sandy or clayey soils and grow in warm temperature and tropical zones. They are grown as a summer crop in temperate countries with cold winters and a winter crop in sub tropical areas where the farmers prefer to cultivate them at higher elevations. The temperatures they grow in vary from 6°-27°C; they do not like humid or hot tropical conditions, nor for that matter do they like frost and intense cold. An annual rainfall below 750mm works well for *masur*. They come in a range of colours going from orange, green, brown and black, which are called Beluga lentils given their resemblance to caviar.

Production wise, lentils are the 5th most important legume grains in the world. According to FAOSTAT, in the year 2013 the world production of lentils reached 4, 975, 621 metric tons, with the main production centers being Canada, India and Turkey. India produces about a quarter of the world production, which it consumes locally.

Uses

For human consumption

Lentils are an important component of the diet of several countries: in Iran, where it is consumed in the form of a stew poured over rice, it is a prized food item; in Ethiopia they are consumed in various forms: as a stew called *kok* or *kit wot*; as paste from flowers, called *azifa* and *elbet*; as split seeds just boiled and salted, *nufro*. It is also one of the first food Ethiopian mothers feed their babies. In India, it is made into a *pulao*, a nutritionally perfect dish, combining the protein of lentils with that of rice (see recipe section); it is however commonly eaten as a dal. In many European countries, lentils are prepared as a salad. Nowadays enterprising chefs have also used this ingredient to prepare shepherd's pie or burger patties, definitely an ecological choice given the low carbon



footprint of this version as compared to the meat one, specially the rain forest eating McDonald's one. Apart from dry seeds, which are also processed as flour for cakes and breads, fresh pods are eaten as vegetables.

The popularity of lentils as a food comes as no surprise given its high quotient on taste as well as health; one of the easiest legumes for the stomach to digest, it is also packed with all the goodness of its ilk; vitamins, proteins, minerals. Here is a look at what one cup of lentils (198gm) offers:

For only 230 calories, one cup of *Lens culinaris* offers 18 gm of protein; 1 gm of fat; 40 gm of carbohydrate (which includes 16 gm of fiber and 4 gm of sugar); 90% of our daily requirement of folate, 37% that of iron, 49% that of manganese, 51% that of phosphorus, 22% that of thiamin; 21% that of potassium and 21% that of B₆, 28 % that of B₁ (www.whfoods, for % of daily requirement) you also get vitamin A, riboflavin, niacin, pantothenic acid, magnesium, zinc, copper and selenium. **It is considered by many as possibly the highest-ranking legume, (without controversy) for protein; since it does not contain sulphur, it produces very little gas.**

As per Rebecca Wood, lentils are mildly diuretic, good for the heart and the circulatory system while also increasing kidney health. Being low on glycemic index, they control blood sugar; they help to control cholesterol and lower blood pressure.

In India, they are used as a poultice for sores as well as for retexturing the skin, in the form of a paste to which milk has been added. As per Ayurveda, they have blood purifying property and are highly nutritious.



Miscellaneous uses:

Animal feed: seeds and by products

Lentils are considered good feed for animals, specially poultry. Husks, bran and dry leafy stems are used as fodder, specially in the Middle East and North Africa.

- Other uses include as green manure and as fuel from straw.

Here is a list of lentil diversity taken from Clovegarden:

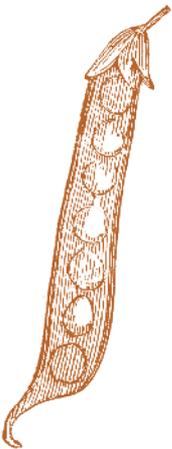
- Black lentils also called Beluga lentils
- Brown lentils also called Brewer lentils, US Regular, Green lentils, Continental lentils
- Egyptian lentils
- Masur
- Pardina lentils
- Puy lentils (French Green lentils; Verte du Puy)
- Red lentils
- Tarahumara Pinks

Pea

Pisum sativum

Names: (Eng:) garden pea, English pea, green pea, field pea; (Hindi) matar; (Guj:) vatana.

According to archeological evidence from neolithic Syria, Turkey and Jordan, peas date back to 7,000 yrs. They would have reached Europe already in the Bronze Age and Egypt by 4800-4400 B.C. In India, the earliest reference to the legume goes back to the dictionary *Amarcosa* (C.200 B.C.) by Amarsimha who uses the Sanskrit name *khandika* or *harenu*. Varahamihira (6th Century A.D.) and Bhavaprakash also mention the legume (16th Century A.D.).



According to A. Pratap and J. Kumar, though the wild progenitor or early history are unknown, Vavilov (1949) recognized Ethiopia, the Mediterranean and Central Asian regions as the possible centre of origin.

The taxonomy of pea is highly complex and even debatable, as per Feedipedia. We reproduce here what the site has to share on this matter:

Morphology

Pea taxonomy is complex and debatable. In particular, there is no authoritative and definitive way to classify *arvense* (field) and *hortense* (garden) peas. They used to be considered as separate species (*Pisum arvense*, *Pisum hortense*) but they are now seen as separate varieties or subspecies of *Pisum sativum* (*Pisum sativum* var. *arvense*, *Pisum sativum* var. *hortense*, *Pisum sativum* subsp. *hortense*) or as separate varieties of the subspecies *Pisum sativum* subsp. *sativum* (*Pisum sativum* subsp. *sativum* var. *arvense*, *Pisum sativum* subsp. *sativum* var. *sativum*) (Martin-Sanz et al., 2011; USDA, 2011).

Acknowledgement: <http://www.feedipedia.org/node/7047>

As if this were not complex enough, the term pea is also used to describe other legumes, which have a round, spherical shape: chickpea, pigeon pea, cowpea as also sweet pea (*Lathyrus* spp: grown only as ornamentals).

As far as *Pisum sativum* is concerned, the plant can be both low growing or vining and flowers can be of different colours (white, pink, purple), as per tannin content. The white flowered peas have less tannin content. Many varieties of *Pisum sativum* exist, some are winter plants, others grow in spring, some are leafy, others leafless; seeds too come in a diversity of colours: green, yellow, pale green, brown, mottled, even black. One must be careful not to mix up the yellow and black variety with toxic vetches from the *Lathyrus* spp. Similarly, they can be thin or thick hulled, smooth or wrinkled and of varying shapes and sizes. (Source: Feedipedia).

Garden peas are harvested green, to be eaten as a vegetable, whole (ex: mange-tout) or just green seeds (garden peas); they are normally of the hortense type.

Field peas are harvested ripe and belong to the arvense type. They can be eaten whole, split (as the Indian *mattar dal*) or ground into flour. They can also be used as feed. It must be specified that “protein peas” are field peas, developed from the hortense type.

Apart from these, there are peas such as the Austrian winter pea that are grown essentially for forage purposes.

As far as their cultivation goes, peas can grow in different environments, on a wide range of soils, which must be well drained, at heights ranging from 1800 to 3000 m. They thrive in cooler climates having a temperature ranging from 7°C to 24°C and an annual rainfall in the range of 800-1000 mm.

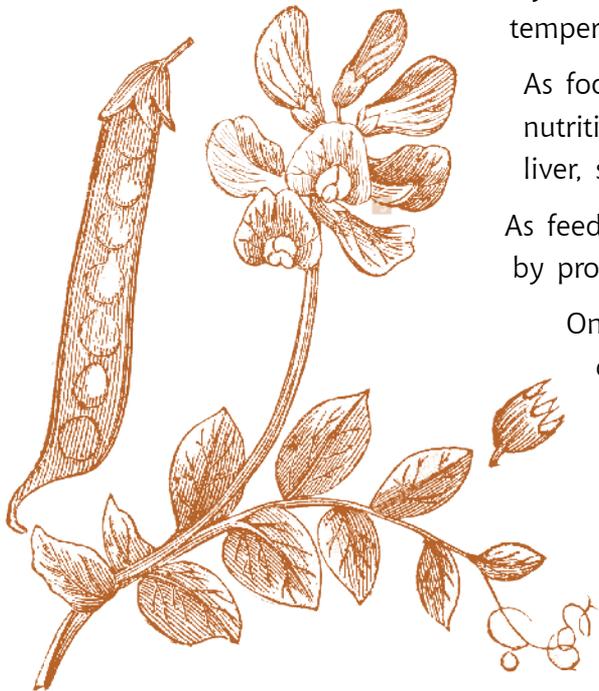
They do not perform well in drought situations or at higher temperatures.

As food, peas are very nourishing since they have the legume nutritional profile. They are also said to be beneficial to the liver, stomach, spleen and pancreas (Rebecca Wood).

As feed, they make an important contribution; seeds, hay and by products can all be used.

On the field, too, they are beneficial in rotations with cereals as they break the cereal disease cycles. They help the weed controlling process and improve soil fertility (Chittaranjan, 2007, in Feedipedia <http://www.feedipedia.org/node/264>).

List of various pea varieties (Source: Clovegarden http://www.clovegarden.com/ingred/bp_legumev.html).





- Green peas: (English peas, garden peas) earlier a popular home garden plant, today they have become a commercially grown one. Enjoyed in numerous dishes across the world: in Indian curries, as soups, as salads etc.
- *Kala vatana*: black peas from India; not very common; specially eaten in the Maharashtrian regions of India; not to be confused with black eyed pea or black bean. They are more dark brown, mottled than black. Several recipes exist. (Not to be confused with *Lathyrus niger*).
- Maple peas: black peas from England; also called Carlin peas or Brown Badgers and sometimes pigeon peas (not to be mistaken with *Cajanus cajan*). Mostly eaten in the Lancashire County of England, during fairs; sometimes served in cups with a little vinegar. Found from October to November. A minor crop in Canada. (Not to be confused with *Lathyrus niger*).
- Marrowfat peas: olive green peas, a little larger than green peas. Cooked as a lumpy paste called “mushy peas” in Northern England; served with fish and chips or in cups with mint sauce at fairs. Grown in a minor way in Canada.
- Snap peas: (sugar snap; *Pisum macrocarpon*). Eaten pods and all; these are thick and round, different from the snow peas. Eaten raw or stir-fried.
- Snow peas: (sugar pea, mange-tout; also *macrocarpon* variety): eaten with pods; harvested when pods are flat and seeds immature. Used mostly in stir-fries.
- Yellow peas: (Canada peas; *Pisum sativum* cultivars: Century, Lenca, Miranda, Paloma). Lighter in colour than green field pea; grown more in northern climates; Traditionally used in Scandinavian & French Canadian pea soups. For the latter whole peas and not split ones to be used. Not to be confused with the toxic *Lathyrus aphaca*, a non edible vetch.

Canadian yellow peas have been imported in large quantities by India, leading to a non-savoury situation, in all aspects (see chapter on Disappearing Dal).

Sources: <http://www.feedipedia.org/node/264>

http://www.clovegarden.com/ingred/bp_legumev.html

Biology and Breeding of Food Legumes ed: by Aditya Pratap and Jitendra Kumar

Peanut

Arachis hypogaea

Names: (Eng:) groundnut; (Hindi) mung-phali; (Por:) amendoim;
(German:) erdnuss.

The peanut, which is actually a legume, may have its centre of origin in Paraguay or Bolivia. It has been cultivated since antiquity, by the Aztecs and the Mayas. From South America, it travelled to Africa, Europe, Asia and North America. It is said that in the 1900s, botanist George Washington Carver mechanized the cultivation of peanut and developed hundreds of ways of using it in food. This led to peanut becoming an important crop in the USA (Rebecca Wood).



The plant has trailing stems that can grow up to 0.5 m long. An unusual feature about it is that after pollination, the flower elongates and forces the pod into the ground, from where the name groundnut comes. In fact it is called a nut because though other legumes store starch, the peanut stores fat, like nuts. The oil content in peanut can be up to 50%. Unlike most legumes the pod of peanut does not split open easily.

It is widely cultivated around the world both by small farmers and as a cash crop given the various ways in which it is processed. According to FAOSTAT (2011), nearly 23.95 million ha worldwide is under groundnut cultivation, yielding 36.45 million tons, with China, India, Nigeria, USA and Myanmar being the major growers.

Though peanut is a very nutritious food source, there are some health concerns around it: it is one of the ten most common



food allergens; people who have a delicate liver and those who suffer from cancer, gout or candida are advised not to consume peanut. In fact, Ayurveda does not recommend it for any body type.

In spite of these reservations, peanut has several therapeutic values: it can help lactating mothers increase milk; it promotes heart health and is a good source of vitamin E, niacin, folate, protein and manganese.

There are multiple ways of consuming peanuts: boiled, roasted or fried as a snack; in the form of the ubiquitous peanut butter; used as a base for various sauces (Indian, Malay...); as brittles, called *chikki* in India and the list can go on and on. Peanuts cannot be eaten raw.

Since peanut is a cash crop, there are a few precautions one must take while purchasing it: given that it is heavily treated with chemicals, it is advisable to buy organic peanut; since peanut oxidizes easily, it is better to buy the unshelled form.

The Phaseoli

According to P Gepts (www.plantsciences.ucdavis.edu/gepls/a/749.pdf), the Phaseolus genus, on the whole, has 50 wild species, distributed only in the Americas and there are 5 domesticated species which are, in decreasing order, Phaseolus vulgaris, the common bean; P. lunatus L., the lima bean; P. coccineus L., the runner bean; P. acutifolius A. Gray, the tepary bean and P. polyanthus Greenmann, the year bean. The minor Phaseoli also feature here as they should be promoted.

The Common Bean

Phaseolus vulgaris

Cultivars within this denomination: red kidney bean, Jacob's cattle bean, anasazi bean, black turtle bean, bolita bean, pinquito (pink bean), pinto, navy (white

bean, Boston bean, pea bean, haricot blanc), cannellini beans (white kidney beans), cranberry beans, flor de mayo, great northern beans, string or snap beans or green beans (yellow, green purple in colour), manteca beans (prim bean); Peruvian bean (peruano bean, canaria bean, mayocoba bean, azufrado bean); red beans, romano bean (Italian flat bean), nuna (popping beans);

Phaseolus vulgaris is the botanical name of a diversity of cultivars of the common bean, as listed above. (list consolidated from *Clovegarden & the new whole food encyclopedia*).

It counts many domestication sites ranging from the Middle to the Andean South America (Harlan and de Wet, 1971; Gepts et al., 1986). According to archeological evidence from South America, the domestication of *P. vulgaris* goes back to 6,500-5,000 B.C. (Kaplan et al., 1973; Evans 1976) and probably earlier, since according to Kaplan the earliest domesticated types, discovered in deposits in Guitarreno Cave in Peru, go back to 7680-10,000 B.C. (*Pulses* p:125).



There are three main types of common bean: bushy, semi-pole and pole types. They can be annuals or perennial, requiring warm to cool temperatures and dry to wet conditions (P. Gepts).

The average yield can be 700 kg/ha though, in some countries, it could go up to 2000-3000 kg/ha.

Morphology

The common bean (*Phaseolus vulgaris* L.) is a major grain legume consumed worldwide for its edible seeds and pods. It is a highly polymorphic warm-season, herbaceous annual. There are 2 plant types: erect herbaceous bushes, up to 20-60 cm high; and twining, climbing vines up to 2-5 m long (Ecocrop, 2013; Smoliak et al., 1990). It has a taproot with many adventitious roots (Ecocrop, 2013). The stems of bushy types are rather slender, pubescent and many-branched. In twinning types, the stems are prostrate for most of their length and rise toward the end (Ecocrop, 2013). The leaves, borne on long green petioles, are green or purple in colour and trifoliolate. Leaflets are 6-15 cm long and 3-11 cm broad. The inflorescences are axillary or terminal, 15-35 cm long racemes. The flowers are arranged in pairs or solitary along the rachis, white to purple and typically papilionaceous (Ecocrop, 2013; Wortmann, 2006). Once pollinated, each flower gives rise to one pod. Pods are slender, green, yellow, black or purple in colour, sometimes striped. They can be cylindrical or flat, straight or curved, 1-1.5 cm wide and up to 20 cm in length (Wortmann, 2006). The pods may contain 4 to 12 seeds. The seeds are 0.5-2 cm long, kidney-shaped and highly variable in colour depending on the variety: white, red, green, tan, purple, gray or black.

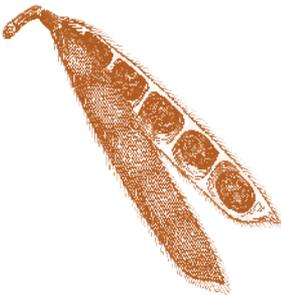
Acknowledgment: <http://www.feedipedia.org/node/266>

Common beans are an important source of proteins, minerals (iron and zinc) and vitamins for many human populations (Beebe et al., 2000). Immature pods are eaten fresh and can be easily preserved by freezing, canning or dehydrating. Mature pods and seeds are dried. Beans are eaten boiled, baked, fried, or ground into flour. Crop residues, such as dried pods and stems (straw) and processing by-products (discarded pods, pod extremities), can be used as fodder (Wortmann, 2006; CNC, 2004).

The common bean counts as the most important food legume worldwide and is consumed in the form of dry seeds, seeds, green pods and for some cultivars leaves as well.

Brief sketches of individual *Phaseolus vulgaris* cultivar:

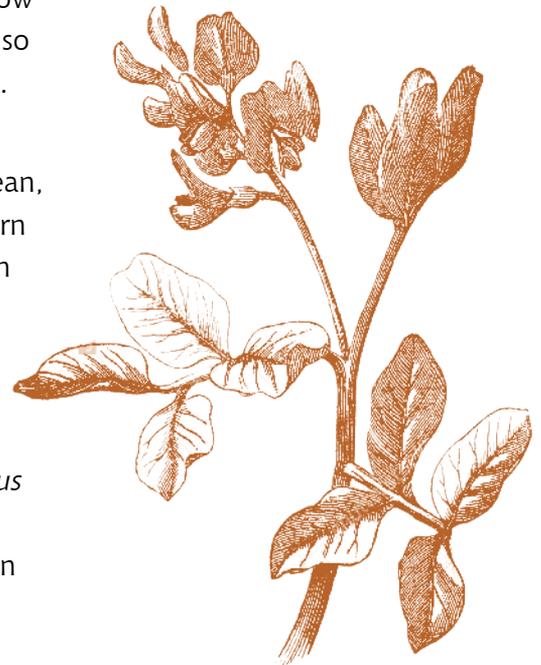
- Anasazi bean: mottled, maroon and white; sweet in taste; compared to other beans, easier to digest; containing 75% less of flatulence-causing trisaccharides than pinto; (Rebecca Wood).
- Black turtle bean: native to Mexico; can replace pinto in any dish but will leave black colour; sweet, spicy & robust taste; could be confused with black soy but where black soy has a shiny appearance, the turtle bean is dull. Good for soups and refried (Rebecca Wood).
- Bolita bean: predominantly pink but ranges from buff to yellow; irregular in size and shape; is most probably an heirloom variety with high adaptability. Richer and sweeter in flavor than pinto (Rebecca Wood).
- Cannellini beans (white kidney beans): Italian in origin; white, with creamy texture; earthy taste; longer and lumpier than navy beans. (Rebecca Wood). A highly popular bean in Italy; a recipe of Tuscan origin features in our recipe section.
- Cranberry beans: same size and shape as pinto; beige with pinkish red blotches when uncooked; turns uniform beige when cooked (Rebecca Wood).
- Flageolet: medium sized and kidney-shaped; pale green in colour. Primarily cultivated in France and Italy; normally harvested and dried before it reaches maturity; delicate and creamy flavour (Rebecca Wood).
- Flor de mayo: a native of Mexico; high taste and texture quotient, variable in colour: mottled purple, tan or light brown; (www.clovegarden.com).
- Great northern beans: a medium size white bean, resembling navy bean; used in baked beans or pork and bean dishes; (Rebecca Wood).



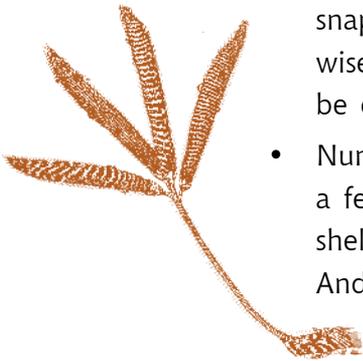
- Green bean: comprising the following varieties: filet bean, French bean, haricot vert, snap bean, string bean, wax bean; the pod of green beans is normally green but there are varieties which are purple or yellow (wax bean); heirloom varieties which have a fibrous string along the length of the pod seam are called string beans; modern cultivars are stringless; can grow on bushes or twine on poles.

Green beans have multiple health benefits: they tone the spleen-pancreas meridian and kidneys; they are diuretic and diabetic-friendly. From an Ayurveda perspective, they are tridoshic. They provide vitamins A, B-complex as well as calcium & potassium (Rebecca Wood).

- Manteca beans (prim bean): Manteca dry beans have been growing in Chile for a long time; they are reputed to be less gaseous; Dr Colin Leakey of U.K. is said to have developed a hybrid variety which can grow outside Chilean eco zones so they are now available in U.K. The regular ones are also available in California (www.clovegarden.com).
- Navy: (white bean, Boston bean, pea bean, haricot blanc): smaller than great northern bean but similar in flavour; can be eaten as a green vegetable when immature (Rebecca Wood). Clove Garden site lists pea bean under navy bean but pea bean can also be red-brown. Pea bean is sometimes listed as *Phaseolus aegypticus* but as per Wikipedia there is horticultural consensus about placing it in *P. vulgaris*.



- Pink bean: (also known as pinto): an heirloom bean from Mexico; sweet and meaty taste; similar size as navy bean (Rebecca Wood).
- Pinto: the famous bean for tacos; a family of kidney bean; colour is buff to pink; according to Rebecca Wood since its hybridization for high yield, heirloom varieties of this bean are less preferred. Highest production after soya in USA. (Rebecca Wood).
- Jacob's cattle bean: (Dalmatian bean, trout bean): has a creamy white background with one large purple blotch and numerous purple speckles. A New England heirloom variety; excellent flavour; kidney shape; similar to ansazi bean (Rebecca Wood).
- Peruvian bean (peruano bean, canaria bean, mayocoba bean, azufrado bean): a medium size white bean with a yellow greenish cast; smooth, shiny and plump seed; very creamy texture; (www.clovegarden.com).
- Red kidney bean (Mexican bean, Spanish Tolosana): name from its kidney-like shape, full-bodied flavor; creamy texture.
- Red beans: this refers to any of the various red varieties of the common bean and includes kidney bean, Honduran red bean and Salvadoran red bean including Indian *chori* bean.
- Romano bean: (Italian flat bean): Romano beans are often sold as green snap beans in North America; yellow & purple varieties also exist, flavour wise it is somewhat different from round and flat string beans; should not be overcooked. (www.clovegarden.com).
- Nuna or popping beans: are so called because they pop when heated for a few minutes in a hot skillet or air popper; bright in colour; have a hard shell; taste like roasted peanuts but are soft. Limited availability outside Andes. (Rebecca Wood).



Nutritional Analysis* of Selected Dry Beans Compared with a Reference Diet

Serving Size = ½ cup

	Calories	Total Fat	Saturated Fat	Trans Fat	Cholesterol	Sodium	Total Carbohydrate	Fiber	Protein	Iron	Folate
	(kca/)	(g)	(g)	(g)	(mg)	(mg)	(g)	(g)	(g)	(mg)	(mcg DFE)
Reference Diet (Food Label)	2000	Less than 65	Less than 20	Minimize in diet	Less than 300	Less than 2,400	300	25	50	18	400**
Pinto	122	0.5	0.1	0	0	1	22.4	7.7	7.7	1.8	147
Navy	127	0.5	0.09	0	0	0	23.7	9.6	7.5	2.2	127
Black	114	0.5	0.12	0	0	1	20.4	7.5	7.6	1.8	128
Great Northern	104	0.4	0.1	0	0	2	18.7	6.2	7.3	1.9	90
Cranberry	120	0.4	0.1	0	0	1	21.6	8.8	8.3	1.8	183
Pink	126	0.4	0.1	0	0	2	23.6	4.5	7.7	1.9	142
Red Kidney	112	0.4	0.08	0	0	2	20.2	6.5	7.7	2.6	115

Sources: U.S. Department of Agriculture, Agricultural Research Service, National Nutrient Database for Standard Reference and U.S. Food and Drug Administration.

*All nutrient values per ½ cup, cooked, boiled, without added salt

**400 mcg DFE (dietary folate equivalents) per day is recommended dietary allowance (RDA) for adult men/women (not pregnant or lactating)

Tepary bean

Phaseolus acutifolius A. Gray

Names: (Eng:) tepary bean, Texas bean; (other languages) yori nui, yorimuni, pawi, pavi, escomite; called tepary bean in Hindi as well.

Origin & antiquity

Archeological evidence attests to the high antiquity of Tepary bean in the South West of USA where it must have come from Mexico about 1200 years ago, as

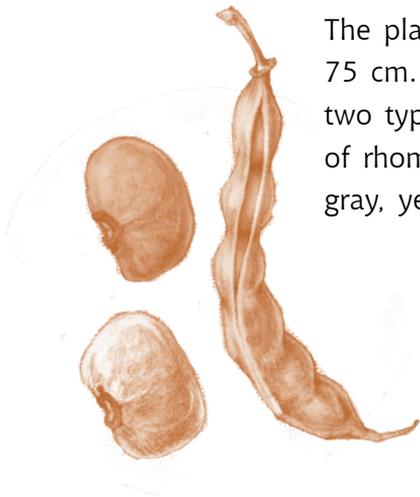
well as in Puebla where its cultivation goes back to 5,000 yrs. (Source: Bean www.purdue.edu, Debouck). The centre of domestication of this legume is not known though it is deemed a native of S. Western USA & Mexico. Two wild varieties exist: (var: acutifolius and var: tenuifolins).

The name Tepary is said to come from the phrase *t'pawi* which means it's a bean in the Tohono O'odham language. Other names such as yorimuni & yori mui would indicate a "non-Indian" origin according to Feiger and Moser (cited in Wikipedia).

This legume is a drought resistant legume, growing in the desert and semi-desert regions, from Arizona to Costa Rica. It is also cultivated in African countries, India, Asia and Australia. It requires less than 400 mm annual rainfall to grow, though during germination a lot of moisture is needed. It is sensitive to flooding and water logging. The crop matures within 75-85 days depending both on cultivars/varieties and location. One can obtain seed yields of 500-800 kg/ha without irrigation and 900-1700 kg/ha with irrigation (Jansen, 1989). It is normally grown in association with maize, on the borders of fields, in some areas. It is also grown as a catch crop requiring very little weeding. Soil wise it grows on well- drained sandy or muddy soils or sometimes organic ones.

The plants exist in both bushy and semi-vining forms, with heights averaging at 75 cm. Pods are about 8 cm long and contain between 5-6 seeds. Seeds are of two types: small, round seeds which are either white or black and larger ones, of rhomboid shape, which come in a range of colours; white, greenish white, gray, yellow, mahogany, black, violet speckled, brown.

Paradoxically on one hand there are some factors which led to the marginalisation of this plant while on the other hand, peasant communities have preserved it because it is a low maintenance crop, requiring little water and resistant to diseases, while maturing early (Debouck).



Uses

For human consumption

The dried seed is consumed for its high protein level, sweet and nutty flavour and creamy texture. It cooks faster than many other beans and has a taste quite of its own.

As feed

Leaves, stems and green pods are used for livestock. *Tepary bean* has a potential for increased cultivation given its high culinary quotient and undemanding requirements.

Runner bean

Phaseolus coccineus

Names: (Eng:) Runner bean, scarlet runner bean, pole beans, Oregon lima bean; (Nahuatl) ayocoti; (Spanish) ayocote; (Clovegarden); (Hindi) sem.

P. Coccineus, the scarlet runner bean, is of high antiquity. Archeologically it has been found only in Mexico (Durango) and Puebla. Its wild species occur only in Tamaulipas (Debouck, cited in hortpurdue.com). Growing for centuries in the highlands of Mesoamerica, it was cultivated extensively by the Anahuac people. However, changes in maize cultivation (introduction of softer varieties, use of fertilisers etc.)

have now marginalised the crop in eastern Guatemala and Costa Rica. Further marginalisation is due to market forces favouring crops like vetch, broad bean, cabbage, garlic & onion.



The legume must have reached southern Columbia and Europe (where it is also known as haricot d'Espagne), in the 17th century, before reaching elsewhere in the world (ex: Ethiopian highlands).

Acknowledgment: hort.purdue.edu/newcrop/1472

Uses

Human consumption

Though very often scarlet runner bean is cultivated as an ornamental plant, especially in North America, it was/is consumed as food. Its popularity has decreased in Latin America, compared to pre-Columbian times for various reasons as stated above but the many coloured seeds as well as the flowers and edible roots are eaten. The roots in fact have medicinal value. The green pod too is used as vegetable in many parts of the world. Very often it is grown in vegetable gardens. *The little known runner bean is an underutilised plant.*

Lima bean

Phaseolus lunatus (earlier referred to as *P. limensis*)

Names: large seeded variety: (Eng:) Madagascar bean, fordhook bean, grandma's bean, haba bean, Chad bean, pallar bean, Java bean.

Small seeded variety: (Eng:) sieva bean, butter bean, baby lima, Dixie speckled butter bean; (Hindi) rangooni val, val.

(Source: *the new whole foods encyclopedia* Rebecca Wood, www.clovegarden.com).

According to the site Ch08 of FAO, there exists two main genetic stocks for *P. lunatus*, coming from two separate wild forms. There are two seed sizes: the larger one and the smaller one. According to archeological findings in Ancash, Peru, the large-seed variety was the first to be cultivated about 8,000 years ago and appeared 5000 years ago on the coast of Peru, where they were culturally and nutritionally



important for the Mochican and Nazca people. The small-seeded variety originated in the Mesoamerica region and date back only 1,200 yrs. (Source: Ch08).

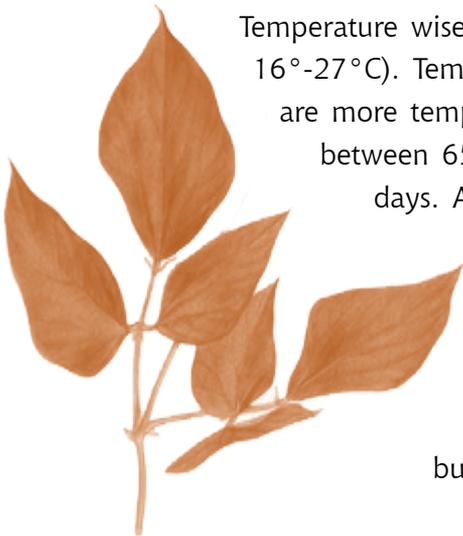
The wild forms of *P. lunatus*, both small and large types, are to be found only in the Americas though today the cultivated forms are present in all tropical regions of the world and even in Italy.

The various names of Lima beans reflect the diversity of its provenance and sometimes refer to its taste. The term Lima beans actually points to its centre of origin, believed to be Peru.

This bean comes in a range of colours going from cream and white to tan to purple-tan, mottled, green, brown and black. The pod is flat, oblong and slightly curved (about 3 ins in length) and contains in general 2-4 flat kidney shaped seeds. Plants can be both annual or perennial, bushy, erect type or twining, pole type. The erect ones grow up to 1 metre long while the twining ones can attain 4 metres. Their leaves are trifoliolate and compound, with oval leaflets. The flowers are white to yellow, growing in clusters of racemes, which are loose and unbranched (source: eol.org).

Temperature wise, lima beans require a long, warm growing season (between 16°-27°C). Temperatures below 13°C slow the growth. The large seeded ones are more temperature sensitive than small ones. The bush varieties grow between 65-100 days whereas the large seeded ones require 200-270 days. As far as rainfall is concerned, they thrive best in humid and sub-humid tropics with an annual fall ranging between 900-1500 mm. It could also grow with only 500 mm with top up irrigation, especially during flowering and pod setting stages. (Tony Winch).

Soil wise the plants like a well aerated and well drained soil but can do well in soils that are too acidic for the beans.



Uses

For human consumption

Lima beans have been used as food since 5000 BC (N. Haq in *Biology & Breeding of Food Legumes*). Leaves, pods and green seeds are used as vegetable and the matured, dried seeds are used in various ways: soups, curries, stews...; flour made from the seeds is used to prepare noodles.

Medicinal use

Both leaves and seeds of the plant have therapeutic value. According to Rebecca Wood, lima beans are beneficial to the liver and lungs. It is anti-acidic. From the Ayurveda perspective, they reduce *pitta* and *kapha*.

Other uses

Lima bean plant can be used as cattle fodder as well as for green manure and as a cover crop.

Year bean

Phaseolus polyanthus Greenmann

Names: (Eng:) Year bean; (Fr:) haricot cache, cache.

The *Phaseolus polyanthus* Greenmann is not a very well known legume of the Meso-America and Northern Andes region (Mexico, Guatemala, Venezuela, Columbia, Ecuador and Peru, Debouck et al., 1990; Schmit, 1992), where it grows in the humid tropical highlands. It is also found in the highlands of East Africa (Debouck: personal comment). It has been of late marginalised because of the change in agricultural practices of growing maize, with which it is intercropped frequently as also with gourds and *Phaseolus coccineus*, the runner bean. Other factors of marginalisation are the plantations of coffee and livestock rearing. Moreover, the distribution area of the wild form in Central-Western Guatemala, the only site of occurrence, is being threatened both by urbanisation

and agriculture as primary forests where it grows are being cut down to set up coffee plantations. It therefore becomes urgent, as the site from which this information is sourced points out, to complete the collection of germplasm, (Source: <https://hort.purdue.edu/newcrop/1492/beans.html>).

No recordings of this legume exist archeologically, which could be due to the fact that the conditions under which it grows are not conducive to its preservation. However, it is felt that this legume must be ancient. This *Phaseolus* species is the least evolved of all *Phaseoli*. There are some natural hybrids with *P. coccineus* in Putomayo, Columbia and *P. vulgaris* in Tolima, Columbia. This leads to the existence of a variety of colours in the seeds, which though normally of an orange hue, are also found in reddish brown, black or creamy white. This last colour, according to hort.purdue.edu, offers an interesting potential of development, as a competition to the *caballeros* (*P. vulgaris*) having white large and round seeds but which do not grow in humid areas as *P. polyanthus* Greenmann does. This legume grows up to 800-2,600 m under cool and humid climate. Flowering takes 2-5 months and it can have two flowering and fruiting seasons under high rainfall in Columbia and Venezuela. It requires deep, organic soils that are humid and well drained and can tolerate shade moderately.

Morphology

Only pluriannual forms of *P. polyanthus* are known, which can live from two to four years. In drier parts (for example, western Cajamarca, Peru); it tends to behave as an annual. It is easily distinguished from the other species by its epigeal germination; fibrous, fasciculate roots; inflorescences with 6 to 16 fruit-bearing stems; primary bracts and long, narrow bracteoles (giving the pseudoraceme the appearance of a spike); white or lilac flowers (purplish pink in the wild form); and terminal stigma. Its seed (70 to 100 g per 100 seeds for cultivated varieties and 16 to 25 g for wild forms) has a wide, elliptical hilum and the parahilum is frequently broken.

Acknowledgment: <https://hort.purdue.edu/newcrop/1492/beans.html>.

As far as human consumption goes, it is eaten more in the green form though dry beans are also consumed as soups, stews or even a sweet dish in Amazon. It is said that dry *P. polyanthus* Greenmann has a higher content of sulfur-containing amino-acids than *P. vulgaris* (Schmit, 1992; Baudoin & Maquet, 1999, cited in www.academia.edu: *Regeneration of fertile plants from callus in P. polyanthus* Greenmann).

The *Vicia* genus and vetches

The Vicia genus contains approximately 160 species with V.faba being a major pulse and some vetches being used for human consumption in a minor way. Vetches are extensively used as cover crops, forage, hay, silage, erosion control and green manure. The genus is distributed across Europe, the Americas, Asia & Africa. Both prominent and minor Vicia crops are featured here to form one cluster (source: kew.org).



Most vetches belong to the *Vicia* genus though some of them are not part of the this genus as for example *Lathyrus sativus*, *L. cicera* (chickling vetch/pea), *L. latifolius* (bitter vetch) and *Astragalus diffusus* (milk vetch). Some vetches produce edible seeds and pods, most famously *Vicia faba*. Vetches are also used as forage and green manures as they are great soil restorers, like most legumes. They also have the capacity to attract beneficial insects and can be used as ground cover as well.

Vicia sativa, the common vetch, features in the FAO list of eleven important pulse crops. It is also known as tare, the vesce and the garden vetch in English. As per Feedipedia, there are many synonyms for it, a list of which follows:

Names: (Eng:) vetch, tare, the vesce, garden vetch; (Fr:) vesce commune, vesce cultivée; (Spanish) veza, alverja común; (Por:) ervilhaca; (Dutch:) voederwikke; (Gr:) Futterwicke, Saatwicke; (Italian) veccia comune.

Source: www.feedipedia.org/node/239

Other *Vicia* species which are used as feed are: the hairy vetch (*Vicia villosa*), purple vetch (*Vicia benghalensis*), narbon vetch (*Vicia narbonensis*) and broad bean (*Vicia faba*).

Vicia sativa, which originated in southern Europe, is now widely cultivated in the Mediterranean basin, West and Central Asia, China, Eastern Asia, India and the U.S.A. It can grow on a large variety of soils (sandy, loamy, clayey), preferably well drained. In the early stages it is not drought tolerant and grows in areas having an annual rainfall of 310 mm to 1630 mm.

Morphology

The common vetch (*Vicia sativa* L.) is an annual scrambling and climbing legume. It has a slender highly branched taproot that can go down to 1-1.5 m deep. Its stems are thin, angled, procumbent and branched, reaching up to 2 m. The leaves are compound with 3-8 pairs of opposite leaflets and 2-3 terminal tendrils that help climbing. The leaflets are elliptic or oblong, 1.5-3.5 cm long, 5-15 mm wide. Stems and leaves are mainly glabrous. The flowers, borne on leaf axils, are blue to purple, sometimes white, mostly paired, sometimes unique. Pods are cylindrical, 3.5-8 cm long and erect; with 4-12 round, but flattened, black to brownish seeds (FAO, 2010; UC SAREP, 2006; Sattell et al., 1998).

Vicia sativa provides palatable forage (fresh, hay and silage) and grain to livestock. Due to the presence of antinutritional factors, seeds may be used only in small amounts in the diets of monogastric species (including humans). Common vetch also provides a valuable cover crop and green manure (Sattell et al., 1998).

Acknowledgment: <http://www.feedipedia.org/node/239>

Fava bean

Vicia faba

Names: broad bean, horse bean; tic bean, fava bean, field bean, bell bean.

According to A. Pratap and J. Kumar, there are divergent views about the origin & domestication of faba bean, with earlier studies postulating the Near East as the centre of origin (Cubero 1973, 1974) from where, through various possible routes, it could have travelled to Spain and Europe, along the North African coast, to Ethiopia along the Nile, to India via Mesopotamia; while later studies suggest Central Asia (Ladinsky, 1975) or south-eastern Europe and south-western Asia (Muratova, 1931; Maxted, 1995).

Vicia faba comes in three different sizes:

- *Vicia faba* minor (small), called tick bean and field bean;
- *V. faba* equine (medium), called horse bean;
- *V. faba* major (large), called broad beans. There is also a special variety, very important in Egypt called ful beans (*Vicia faba/Faba sativa*), used to make its prized dish, *ful medames*.

Small seeds occur importantly in northern Europe whereas the medium ones grow in the Middle East as well as North Africa and the broad ones in Southern Europe and areas of China (source: *Biology and Breeding of Food Legumes* ed: by Aditya Pratap and Jitendra Kumar). In India, fava bean is cultivated in a small way.

Vicia faba grows well in cooler temperatures and can withstand harsh winter conditions. It can grow in various soil types: clayey soils, soils with high salinity, thriving in rich, loamy, well-drained soils.



Morphology

Vicia faba is an erect, robust annual herb growing up to 2 metres tall. It has a stout, square stem, which is hollow and has additional basal branches. The plant has a well-developed taproot with strong lateral roots.

The leaves are arranged alternately along the stem; each leaf is paripinnate (terminating in a leaflet pair), composed of 2-6 leaflets. Faba bean has conspicuous stipules (appendages at the base of the leaf) which are toothed at the margins and vary widely in shape. The leaflets are ovate to elliptical and are up to 10 x 4 cm in size.

The stalked flowers are arranged on a raceme, ie an unbranched axis. The racemes are short, 1-6 flowered and axillary. The flowers are fragrant, the petals white, the outermost petal (the standard) marked with a central, basal, dark brown or black blotch, and are papilionaceous resembling, the pea flower. Each flower has 10 stamens, nine of which are fused into a partial tube, with the tenth stamen free. The ovary is positioned above the sepals, petals and stamens. The style is approximately 3mm long and is abruptly upturned, with a tuft of hairs near the stigma.

The fruit is a narrowly oblong, cylindrical to a laterally flattened pod up to 30 cm long containing up to 6 seeds. The seeds are 1-3 cm in diameter and are ovoid to oblong in shape and compressed. The colours of the seeds range from brown to reddish or green.

Acknowledgment: <http://www.kew.org/science-conservation/plants-fungi/vicia-faba-faba-bean>

Vicia faba is not crossable with any other *Vicia* species (Lawes, 1980 cited by K B Wangari in *Pulses*, ed. by Guriqbal Singh, Harbhajan Singh Sekhon, Jaspinder Singh Kolar).

Vicia faba has multiple uses: as food for human consumption, as feed for livestock, as an agricultural input in the fields (green manure, crop rotation etc.). Its use to prepare biofuels in Sweden has also been reported.

Fava beans pose certain concerns in their use as food and feed: the presence of anti-nutritional elements in the legume such as tannins which reduce protein utilization and the glycosides vicine and convicine, which can cause favism in humans lacking the enzyme glucose-6-phosphate dehydrogenase. Various methods to deactivate/mitigate the anti-nutrients in legumes exist (see story of Pythagoras in cultural section)

As far as feed is concerned, according to Feedipedia, the small seed variety of *Vicia faba* is lower in tannins and vicine and convicine; they are, therefore, preferred as feed.

Fava is among one of the most ancient cultivated food plant in the world. The earliest relics of the legume were found in Jericho, dating back to 6250 B.C. (Hopf (1969) cited by H.B. Wanjari in *Pulses*). In various parts of Europe, relics going back to the Iron Age have also been found (Rebecca Wood). Fava beans were the mainstay in Europe in pre-Columbian times. They are an important component of the cuisines of Mediterranean and North African regions. The dish *shiro wot*, in Ethiopia, falafel in several Mid-eastern countries and *ful medames* in Egypt, all use fava bean as the main ingredient.

Fava beans have an earthy flavour and are usually peeled before use, especially the mature ones.

Despite the concern of favism, this legume offers some medicinal uses too. Rebecca Wood states that it tones up the spleen-pancreas and kidney meridians; moreover it improves blood circulation. J.M. Rabey et al., have reported on the positive effects of consumption of fava in patients affected by Parkinson's disease.

Regarding its other uses, as feed for animals, fava is preferred over soy. It offers good quality silage. In Egypt and Sudan fava straw is a preferred cash crop (source: <http://www.feedipedia.org/node/4926>).

On the fields too, fava bean has a very beneficial effect. It works very well as a green manure, especially for maize and vegetables. In a crop rotation system with wheat, it is said to have improved the protein content of wheat not only by fixing nitrogen but also by controlling some diseases such as crown rot and nematodes. (Source: <http://www.feedipedia.org/node/4926>).

So do yourself, your animals and your fields a fava!

Vigna

There are approximately 104 species listed under Vigna with some being major pulses, vegetable, fodder and green manure crops. Asian Phaseoli have been reclassified as Vigna. The Vigna genus has a pan-tropical distribution. Both major and underutilised Vigna species feature in this cluster.

Adzuki Bean

Vigna angularis

Names: (Eng:) adzuki bean, azuki, aduki; (Guj:) chori.

Adzuki bean probably originated in the Far East but is now grown throughout East Asia, India, the U.S.A., South America, Angola, Zaire and New Zealand. It can grow both in temperate as well as sub-temperate climates.

This annual plant grows erect and/or as a bush; it is normally 30-90 cm tall. The flowers, which are bright yellow, grow in a cluster of 6-12. It has cylindrical pods that are 6-12 cm long and contain 4-12 seeds. The temperature range for its growth is 15-30°C; as far as rainfall is concerned, it can grow under 500-17,000 mm of precipitation. Soil wise too, it can grow on various soil types: from light to heavy clay; however it does not perform well on highly acidic soils (source: N. Haq, *Biology & Breeding of Food Legumes*).



Though young beans are eaten as vegetables, it is mostly prized for the seeds, especially in Japan where it is considered to be the “king of beans”. In Japanese and East Asian cuisines, the beans are mostly prepared sweetened in various desserts. In India, Gujrat, where it is known as *chori*, it is used as a dal type curry.

The seeds are said to have medicinal properties: according to Rebecca Wood, the adzuki beans purify the kidneys and have diuretic properties. This effect is reinforced if the beans are cooked with sweet rice or if the liquid from cooked beans are drunk 20 minutes before a meal. The beans also reduce *vata*, *pitta* and especially *kapha*.

Adzuki is used as forage and as green manure too in China and Japan.

The adzuki bean is a short duration crop which is often grown with rice bean in mixed cropping.

According to N. Haq inter cropping with cereal crops can make adzuki more attractive economically. It is currently underutilised.

Black gram

Vigna mungo

Names: (Eng:) black gram; (Hindi); urd, urad, (Tamil) ulunthu; (Telegu) uddinabele; (Gujarati) adad; (Oriya) biridali; (Bengali) mashkalaidal; (Nepali) maash; (Fr:) haricot urad ou soja noir; (not to be confused with *Glycine soya*)

Antiquity & origin

The centre of origin of black gram is indisputably India, where it was domesticated from its wild form, *Vigna mungo var. silvestris* (Lukoki, Maréchal & Otul). Its centre of diversity is also India. Many authors have referred to

the high antiquity of this pulse. According to some archaeological evidence, *urad* bean may have already been in use around 1660-1440 BC (Mittre, 1974 in *Biology & Breeding of Food Legumes*). In *Essays in Indian History: Towards a Marxist Perception*, the historian Irfan Habib mentions that “two pulses, gram and *khesari*, also appear along with black gram” in the Indus Basin, around 2000 BC. In *Indian Pulses through the Millennia*, Y.L Nene reports that black gram, known as *mash* in Sanskrit, has been mentioned in the *Brahadaranyaka*, dating to 5500 BC as well as the *Mahabharata* around 2000 BC.

Etymology & nomenclature

The botanical appellation of black gram, *Vigna mungo*, is viewed as slightly problematic since it can be confused with mung beans (*Vigna radiata*) which it resembles to the extent of appearing as a variant of a single species. (Verdcourt, 1970 in *Biology & Breeding of Food Legumes*), a confusion dispelled by Watt & Marechal (1977) (*Biology & Breeding of Food Legumes*).

Cultivation

Black gram is a warm weather crop, growing in areas receiving an annual rainfall ranging from 600-1000 mm. It often forms part of a mixed cropping system with cereals, especially rice so as to conserve soil nutrients and use leftover moisture. It grows well in water retentive soils but not saline or alkaline ones. It is normally cultivated during the rabi or late rabi season in India, which is the largest world producer and consumer of this legume, with a 1.5-1.9 million tons annual production on 3.5 million hectares.



Morphology

Black gram (*Vigna mungo L.*) belongs to the *Fabaceae* or *Leguminosae* family. It has a tap root system. Stem is slightly ridged, covered with brown hairs and much branched from the base. Leaves are large, trifoliolate and hairy with purplish tinge. The leaflets are 5-10 cm long and ovate. Inflorescence consists of a cluster of 5-6 flowers at the top. Pods are long and cylindrical and 4-6 cm long. Each pod contains 4-10 seeds which are black or dark brown.

Source: <http://uasr.agropedias.in/content/botanical-description-black-gram>

Culinary uses

Urad or black gram, is consumed both whole and split, with skin removed. In these forms, it is sometimes called black & white lentils but should not be confused with *Lens culinaris*, the actual black lentil. Whole, it is well sought after to prepare the now globally famous *dal makhni* (see recipe section).

The split version, without the outer coating, is used to prepare several North & South Indian delicacies such as the ubiquitous, pro-biotic steamed rice cake and pancake, *idli-dosa*, the fritter *vada*, *papadums* and the sweet, *imarti*.

The preparation of these traditional dishes ensures minimum flatulence, a side-effect of bean consumption, as the soaking water for the dal is changed a few times and as the batter for *idli*, *dosa* and *imarti* are fermented.

As all legumes, being a storehouse of proteins, minerals and vitamins while being low in fat, this legume has many therapeutic uses in Ayurveda. It is considered to be anti-inflammatory and pacifying of the *vata dosha*. It strengthens the nervous system, helps digestive disorders specially constipation, piles and colic and stimulates the liver as well as the immune system.

Black gram also has some traditional cosmetic uses: a pack made from its flour is considered good for the hair which is strengthened and made lustrous; the pack also promotes a good skin texture.

Black gram is also used to feed cattle and horses.

Bambara Groundnut

Vigna subterranean (L.) Verdc

Names: (Eng:) Bambara groundnut, earth pea, jugo bean; (Fr:) voandzou, pois de terre, pois bambara; (Por:) mancara de Bijagó, jinguba de Cabambe; (Swahili) njugu mawe

According to FAO, the legume Bambara groundnut is mostly grown by subsistence farmers of sub-Saharan Africa. It offers many advantages to these farmers as it can grow in poor quality soils, even in drought conditions, yielding a crop even when other legumes fail. It is suitable for intercropping with maize, millet, sorghum. Its centre of origin is probably north eastern Nigeria and northern Cameroun, where wild species are still found. It is cultivated throughout tropical Africa as well as in some regions of Americas, Asia and Australia (Kew).

Morphology

Vigna subterranea is a leafy, annual, creeping legume with glabrous (hairless) leaves supported by a petiole 5-30 cm long. Each leaf is composed of three leaflets and can be up to 11 cm long.

Yellow flowers are clustered 1-3 on a raceme. They are papilionaceous, typical of species belonging to the subfamily *Papilionoideae*. The peduncle is up to 3 cm long, hairy and after flowering it expands and bends downwards so that the fruits develop underground.

The ovary, which develops into the seed pod, contains 1-4 ovules. Once mature the seeds, which can be of various colours, are almost spherical and are 8-15 mm in diameter. Bambara groundnut has a deep taproot surrounded by lateral roots bearing nitrogen-fixing nodules.

Acknowledgment: <http://www.kew.org/science-conservation/plants-fungi/vigna-subterranea-bambara-groundnut>).

It is considered to be a “complete food” since the seeds contain around 63% carbohydrates, 19% protein and 6.5% fat. It is eaten in various ways: boiled, roasted or fried, as a snack, ground into flour for making porridge and dumplings; fermented into products similar to tempeh. Milk can also be made from the seeds. It has medicinal uses in Senegal where leaves are used as poultice for wounds and abscesses; leaf sap are applied to eyes to treat epilepsy; pounded seeds are mixed with water to treat cataracts (source: <http://www.kew.org/science-conservation/plants-fungi/vigna-subterranea-bambara-groundnut>).

Bambara groundnut leaves, which are rich in nitrogen and potassium, are also used as fodder for pigs and poultry.

In the fields, they improve soil quality and make a good rotation crop.

Though Bambara groundnut offers nutrition security, given its high nutritional value and ability to grow in poor soils, with very little water demands, it is highly underutilized (source: underutilized.org/science-conservation/plants-fungi/vigna-subterranea-bambara-groundnut).

Cowpea

Vigna unguiculata

Names: (Eng:) cowpea, china bean, black-eyed bean, crowder pea; (Kannada) asande; (Tamil) karamani; (Telugu) alasandalu; (Malayalam) vanpayaru; (Beng:) barbati; (Punjabi) rawan,souta

Also included under the same nomenclature is the sub-species yard long bean.

Antiquity & origin

Though Vavilov placed India as a centre of origin for cowpea, with Africa and China being a secondary centre of diversity, archeological evidence from

West Africa, dating its existence to 3000 B.C. would suggest Africa as the centre of origin. This is further supported by the presence of the maximum diversity of cowpea in Ethiopia. In fact, the belief is that by 3000 B.C cowpea cultivation was thriving in Central Africa. Moreover, wild forms are present throughout tropical Africa and Madagascar but not in Asia.

The crop would have reached India by 15 B.C. and then travelled to China and South East Asia. It was probably introduced to Europe in 300 B.C. via Egypt, reaching U.S.A. in the 16th century during the slave trade period (Singh, 1991, cited by K.B. Wanjari in *Pulses*).

Cowpea was probably first domesticated in the Zambezi region and West Africa (Ng & Maréchal, 1985) with centres of diversity in South and South East Asia (Steele & Mehra, 1980).

Etymology & nomenclature

The fairly extensive nomenclature for cowpea reflects the diversity of the species: southern crowder pea, field pea, pink-eye, purple hull, black eye, creamers, pwa (from pois).

In Sanskrit cowpea is called *rajmash* (which should not be confused with *rajmah*, the Hindi for kidney bean a *phaseolus* variety). Jain literature mentions the legume as *chavala* whereas the *Ain-i-Akbari* (1590 AD) refers to it by its Persian name *lohbia*, which is a term used even today in India. (Y.L Nene)



Morphology

Cowpea (*Vigna unguiculata* (L.) Walp.) is one of the most popular grain legumes in Africa as well as in some regions of America and Asia. The main subspecies is *Vigna unguiculata* (L.) Walp. subsp. *unguiculata* (L.) Walp. Cowpea is often called “black-eyed pea” due to its black- or brown-ringed hylum. Cowpea is called the “hungry-season crop” because it is the first crop to be harvested before the cereal crops (Gomez, 2004). Its fresh or dried seeds, pods and leaves are commonly used as human food. Since they are highly valuable as food, cowpeas are only occasionally used to feed livestock but the hay and silage can be an important fodder. Cowpea has great flexibility in use: farmers can choose to harvest them for grains or to harvest forage for their livestock, depending on economical or climatological constraints (Gomez, 2004). Dual-purpose varieties have been developed in order to provide both grain and fodder while suiting the different cropping systems encountered in Africa (Tarawali et al., 1997). Cowpea by-products such as cowpea seed waste and cowpea hulls (which result from the dehulling of the seeds for food) have been used to replace conventional feedstuffs in some developing countries (Ikechukwu, 2000).

Acknowledgment: <http://www.feedipedia.org/node/232>

Cultivation and distribution

Cowpeas can be erect, semi-erect, trailing or climbing. Varieties grown in India are better suited to rainfed conditions in arid and semi-arid regions. The crop is an important food legume in the semi arid tropical regions of Asia, Africa, southern Europe as well as Central and South America.

Being shade tolerant, cowpea is intercropped with maize, millet, sorghum, sugarcane and cotton. Often it is either a companion or a relay crop.

Temperature wise, cowpea does not tolerate frost. It germinates rapidly at 65°F or above but growth is delayed with too much watering, leading to a lowering of soil temperature.

Being resilient, cowpea grows well in various soils but thrives on well drained sandy loamy or sandy soils.

Uses

Human consumption

Cowpea is normally used in many forms: in Africa, the young tender leaves are eaten as spinach; the immature pods are cooked like snap peas, mixed with other ingredients. When green, the seeds are boiled and eaten as vegetable. In India, dry seeds are consumed as dal or in curries. Black-eyed pea is a classic New Year's Day dish in southern U.S.A.

Health benefits

In her book *the new whole foods encyclopedia*, Rebecca Wood states that the sweet tasting black-eyed pea tones the spleen-pancreas and stomach meridian. It has a diuretic effect while also relieving conditions such as leucorrhea.

The sub-species of *Vigna unguiculata*, the yard-long bean, is also known by a variety of names: asparagus bean, Chinese long bean, cow bean, dou gok, long bean. This bean is only eaten in the green form.

Miscellaneous

As feed for livestock

Cowpea is often the only source of high quality hay in several parts of the world. It is used both as seed or green for fodder. Vines and leaves are both used as feed; husks obtained after threshing also serve the same purpose.

As an agricultural input

Cowpea is excellent for green manuring, fixing nitrogen and controlling erosion. End note from [www.mother of a hubbard.com](http://www.motherofahubbard.com)

“Black-eyed peas are just one of many types of cowpea. There are pink-eyed, brown-eyed and green-eyed cowpeas, as well as those without an ‘eye’. There are cream peas that produce a beautiful light broth when cooked, rather than the dark ‘pot liquor’ of most varieties. There are dainty lady cowpeas, and blocky crowder cowpeas, so called because they completely fill the pods and crowd each other into cowpea cubes. There are beautifully speckled whippoorwill cowpeas, and multicolor calico cowpeas.”

Green gram

Vigna radiata (moved from *Phaseolus aureus*)

Names: (Eng:) green gram, mung bean; also see below under etymology.

The mung bean is a native of the Indian subcontinent (de Candolle, 1884; Vavilov, 1926) and India is considered as the first region of domestication, given the wide diversity which exists both in the cultivated and wild forms. Noted centres of diversity of the wild type in India are located in Himachal Pradesh and Western Ghats (Chandel, 1981) with a secondary centre in Bihar. A wide range of diversity of progenitors of *mung* (*V. radiata*, var. *sublobata*) exists as weeds in cultivated as well as wastelands in India. The subtropical wetlands of northern and eastern Australia (Lawn and Cottell, 1988) are also home to the wild weedy variety. The *sublobata* variety is also to be found in the Indian Ocean region, extending to the eastern coast of Africa and in Madagascar, where it is called *V. peirrieriana* (R, Viguiet, *Pulses*).



Antiquity

As many pulses in India, green gram too is of high antiquity. A few archeological sites have been found with carbonised grains of both mung & urad beans according to which their use would go back to 1660 to 1440 BC

(Vishnu Mittre 1974 in *Pulses*) or even to 2200-1000 B.C. as per Kajale (1977). Other sites from where charred grains of mung beans have been found include Chalcolithic Navdatoli (1500-1000 BC) and Neolithic Chairand in Bihar (1800 BC to AD 200); Kajale (1977) reports the presence of charred wild types in Daimabad, Ahmednagar District, Maharashtra. (*Biology & Breeding of Food Legumes*)

Etymology & nomenclature

The word mung comes from the Tamil *munku* or *mungu* and the Sanskrit *mudga* which led to the Hindi *mung*, sometimes pronounced *moog*.

In English mungbean is also known as green gram. In French, it is known sometimes as soja vert (green soja), which is a confusing and error-prone appellation since it does not belong to the *Glycine* family at all. Another confusing name in French is haricot mungo, which could lead to a confusion with *Vigna mungo*, black gram. The preferred French name should be ambérique verte.

Many other languages use words such as *monggo* (East Timor), *munggus* (Cebuano) or *mung eta* (Sinhalese), all of which go back to the word mung.

Cultivation

Mung bean, a warm season plant with deep roots, has the ability to adapt to inferior soils and drought conditions, which makes it a hardy plant. In India, while it is normally cultivated during the warm and wet kharif season in the North, it is grown during the mild winter season in the South. It is sensitive to water logging. A wide diversity of cultivated as well as weedy wild types of *mung* exists in India which is the largest producer in the world. China and Thailand too are important producers.

Morphology

The mung bean (*Vigna radiata* (L.) R. Wilczek) is a legume cultivated for its edible seeds and sprouts across Asia. There are 3 subgroups of *Vigna radiata*: one is cultivated (*Vigna radiata* subsp. *radiata*), and two are wild (*Vigna radiata* subsp. *sublobata* and *Vigna radiata* subsp. *glabra*). The mung bean plant is an annual, erect or semi-erect, reaching a height of 0.15-1.25 m (FAO, 2012; Lambrides et al., 2006; Mogotsi, 2006). It is slightly hairy with a well-developed root system. Wild types tend to be prostrate while cultivated types are more erect (Lambrides et al., 2006). The stems are many-branched, sometimes twining at the tips (Mogotsi, 2006). The leaves are alternate, trifoliate with elliptical to ovate leaflets, 5-18 cm long x 3-15 cm broad. The flowers (4-30) are papilionaceous, pale yellow or greenish in colour. The pods are long, cylindrical, hairy and pending. They contain 7 to 20 small, ellipsoid or cube-shaped seeds. The seeds are variable in colour: they are usually green, but can also be yellow, olive, brown, purplish brown or black, mottled and/or ridged. Seed colours and presence or absence of a rough layer are used to distinguish different types of mung bean (Lambrides et al., 2006; Mogotsi, 2006). Cultivated types are generally green or golden and can be shiny or dull depending on the presence of a texture layer (Lambrides et al., 2006). Golden gram, which has yellow seeds, low seed yield and pods that shatter at maturity, is often grown for forage or green manure. Green gram has bright green seeds, is more prolific and ripens more uniformly, with a lower tendency for pods to shatter. In India, two other types of mung beans exist, one with black seeds and one with brown seeds (Mogotsi, 2006). The mung bean resembles the black gram (*Vigna mungo* (L.)) with two main differences: the corolla of *Vigna mungo* is bright yellow while that of *Vigna radiata* is pale yellow; mung bean pods are pendulous whereas they are erect in black gram. Mung bean is slightly less hairy than black gram. Mung bean is sown on lighter soils than black gram (Göhl, 1982).

Acknowledgment: <http://www.feedipedia.org/node/235>

Uses

For human beings

Mung bean or green gram is an important food throughout Asia: India, its country of origin, China, the Philippines, Vietnam, Pakistan, Bangladesh, Korea, Japan amongst others. It is eaten in a multitude of forms: as dal in South Asia; as a fried snack or pancake in India; as soup in many South East countries; sprouted, possibly globally. Sweet preparations are also made whether in India or China and Indonesia.

Processed either split, with or without the outer covering, or made into paste, flour or cellophane noodles (from mungbean starch only), mung bean is a very versatile ingredient.

Health benefits

In China, mung bean is considered highly detoxifying and used extensively during summer for clearing body heat and toxin build-up as well as to balance organs.

As per Ayurveda too green gram is cooling in property; it is a tridoshic food, which means it balances all three Ayurvedic *doshas*; *kapha*, *pitta* and *vata*. Moreover, since it is astringent in taste and contains, like all legumes, a good amount of fiber, it helps in purging mucus from bowels, removing toxins and parasites from the gut.

Compared to other legumes, mung bean is considered more easily digestible.

As far back as the 6th century B.C., Buddha is said to have recommended green gram soup to his disciples; travelers such as Ibn Batuta (1325-1354 A.D.), Tavernier (1640-1667 A.D.) and Abdur Razzak (1443) have mentioned that for the preparation of *khichdi* green gram is the preferred ingredient (Y.L. Nene).

Apart for eating, green gram flour and its leaves are said to be excellent as a soap, leaving the skin smooth and soft.

Animal fodder

Mung bean can provide fodder in the form of hay, straw & silage (Megolsi, 2006 in Feedipedia). It can be grazed six weeks after planting and two grazings are usually obtained (FAO 2012 in Feedipedia).

Miscellaneous

Green gram is a good green manure whilst also being a cover crop. It provides important amount of biomass and is effective for nitrogen fixing.

Moth bean

Vigna aconitifolia

Names: (Eng:) dew bean, dew gram, mothbean; (Indian appellations) moth, mat, matki.



Antiquity and origin

Not much is known about the antiquity of moth bean; however, it is mentioned in *History of Agriculture in India, upto C.1200 A.D* by Vinod Chandra Srivastava, as being grown already in the Neolithic Level. According to Srivastava, together with other crops, it must have been cultivated from the first millennium BC. The first mention of moth bean goes back to the *Taitriya Brahmana*, a commentary on *Yajurveda* (c. 7000 BC).

Moth bean is definitely considered to be a native of India and Pakistan, where it is grown for food, forage and as a cover crop. Sri Lanka and Pakistan are considered centres of diversity by Maréchal et al. (1978).

In India about 1.5 million hectares are devoted to moth bean. This legume is also grown in USA, Australia, Thailand and other parts of Asia. However, though it is found in Sudan, Somalia and other tropical countries of Africa, it is not a very important crop in that continent.

Up till now, the first wild variety is not known.

To quote R.N. Adsule from *Food and Feed from Legumes and Oilseeds*:

“Moth bean is a short, semi-erect hairy annual bushy plant, with prostrate creeping habit. Flowers are bright yellow in colour. Pods are linear, brown in colour, with a short curved beak; they contain 4-10 seeds which are small, rectangular and have a mottled seed coat (Janoria et al.,1984).”

The seeds are said to contain very high levels of protein, ranging between 22-24%. Given its widespread tap root system, it is able to source water from deeper layers of the soil. Moreover, since it has low-lying leaf-covering on the surface, it helps retain the moisture of the soil. This hot weather plant is considered to be drought resistant and, given its root formation, it is able to combat soil erosion. It can grow on a wide range of soil types but does not tolerate water logging, growing best on well-drained soil and demanding very little irrigation. However, the matted branch formation of the plant makes it difficult to use machines during the harvesting season and so sickles are used for the purposes of harvesting.

Given the hardy nature of this plant as well as the high level of protein content of the seeds, the National Academy of Sciences has identified it as a food source to develop in the future.

Uses

For human consumption

In India, *moth dal* is more often eaten as a dal but in regional cuisines, especially in Maharashtra, it is prepared in diverse ways: as *usal*, a curry like preparation or as *misal* (see recipe section), a snack eaten with *pav*, an Indian version of bread or as *amti*, a soup. In Rajasthan where there is a large production of this bean, it is used as one of the pulses of the *panchmel* or *panchratna* dal. Fresh pods are eaten as vegetables.

Seeds are also ground into flour for making flat breads and *papads*.

Moth bean also has therapeutic values and is used in diets for treating fever while coats are said to have narcotic properties.

Other uses

As forage, manure and green cover.

Moth bean which is very hardy and adaptable to harsh eco-zones, provides a wonderful green cover to soil in dry and arid regions, keeping the soil moisture locked in. It is also a very good manure and helps nitrogen fixation.

In India, the empty pods and residue left after the processing of dal are used as animal feed.

An unusual use for moth bean has recently surfaced according to some beauty sites (www.beautynewsnyc.com). The extract of this legume has apparently similar properties to retinol, a beauty additive which is problematic to use but which renews collagen and refines skin texture. The extract from moth being biological does not cause the side effects of chemical retinol.

The cultural chapter carries a story related to the bean.

Rice Bean

Vigna Umbellata (formerly Phaseolus calcarathus)

Names: (Hindi) naurangi; (Eng.) rice bean.

Antiquity and origin

Not much is known about the antiquity of rice bean. As per Vavilov (1926) its primary centre of origin is India, (excluding north-west region). However in *The Origins of Chinese Civilization*, David N Keightley suggests that rice bean originated in South China; N.Haq places it in Indo-China (in *Biological Breeding of Food legumes*). Today, as per Hooker (1879), cited in *Pulses*, rice bean is to be found in both wild and cultivated forms throughout the tropical zone of the Indian subcontinent, stretching from the Himalayas to Sri Lanka, as well as other countries of Asia. It is also present in a smaller way in Mauritius, West Indies, East Africa, Australia and USA (Baldev, 88).

As far as cultivation goes, the resilient rice bean is often grown on marginal and exhausted soil or where other crops do not grow too well. It adapts itself to high temperatures but performs best within 18°30°C, with an annual rainfall of 700-1730 mm. It is also tolerant of water logging. As per Haq, the “growth, maturity and yield of rice bean vary depending on cultivar, climatic conditions and type of sowing.” If in Angola it is ready within 60 days, in eastern India and Bangladesh it takes 130 days. Seed yield ranges between 600 to 2100 kg/ha while green fodder yield can be between 20,000 to 22,000 kg/ha. An amazing fact about this crop is its ability to be free of pests and diseases. It is normally intercropped.

Nutrition wise, as most legumes, it has an excellent profile with 16-25% protein, a good amount of calcium and the presence of many important vitamins, including thiamine, niacin and riboflavin, it is also a good source of iron and phosphorous.

In the Garhwal Himalaya the rice bean is known as *naurangi* because they come in nine colours; in other regions the seeds are often monochromatic.

In Indian regional cuisines, rice bean is used both as a vegetable and a pulse; leaves and pods are used for curries and dried seeds are made into dal; they are also steamed, to be used as a snack.

Rice bean has been used as animal fodder and has a sizable contribution to make agriculturally. Grown on marginal and exhausted soil, it fixes nitrogen and replenishes nutrients. It has been used to increase the fertility of paddy fields, which probably accounts for its name as rice bean. It acts as a very effective cover crop.

Morphology

Vigna umbellata is a short-lived perennial legume usually grown as an annual. It has a very variable habit: it can be erect, semi-erect or twining. It is 30-100 cm in height, up to 200 cm (Ecoport, 2014). It has an extensive root system with a taproot that can go as deep as 100-150 cm. The stems are branched, finely haired. The leaves are trifoliolate with 6-9 cm long leaflets. The flowers, borne on 5-10 cm long axillary racemes, are papilionaceous and bright yellow. The fruits are cylindrical, 7.5-12.5 cm long pods that contain 6-10 oblong, 6-8 mm seeds with a concave hilum. Rice bean seeds are very variable in colour, from greenish-yellow to black through yellow, brown. Yellow-brownish types are reported to be more nutritious. The red type gives its common name to the grain in several languages, like in Chinese (Ecoport, 2014).

Acknowledgment: www.feedifedia.org/node/234

Rice bean is one of the legumes which scientists have identified as a legume to be promoted for its remarkable performance. This little known crop, excellent on the plate and in the field, could become a legume of the future given its resilience.

Soya Bean

Glycine max

According to Kew's website, the genus *Glycine* has 19 species. The name *Glycine* actually comes from the Greek *glycys*, which means sweet; it basically referred to the sweet smelling and tasting roots and leaves of a species no longer in *Glycine* but in *Apios*, a fact which points to the highly complicated taxonomic history of this genus.

Today the best known species of this genus is *Glycine max*, the soya bean, the wild ancestor of which is *Glycine soja*. Though FAO has classified this bean under oilseeds, soy or soya bean is so widely used as food, in various forms, in spite of the controversies that surround its consumption in non fermented forms, that it becomes important to familiarise oneself with this legume.

Soya most probably originated in China, and was domesticated some time around the 11th century B.C., during the Chou dynasty (Ho, cited by William Shurtleiff and Akiko Aoyagi in *The Soybean Plant: Botany, Nomenclature, Taxonomy, Domestication, and Dissemination*). The pictograph of this bean, ie the character shu, emphasising the nodules of the roots, caused by rhizobium, (while those of other grains counted as sacred depict seed and stem) seems to indicate its importance more as an agricultural input than as food; it is only, a few centuries later, after the discovery of fermentation techniques that it was used for human consumption in the form of *tempeh*, *natto*, *miso* and *shogu* (source: Sally Fallon and Mary Enig, Ph.D. in *Concerns Regarding Soybeans* www.fda.gov). And therein lies the crux of the matter regarding the appropriateness of soya and its products as food. This matter becomes all the more controversial in view of the genetic modification of the legume.



Since soya bean contains high levels of anti-nutrients, higher than other legumes, its consumption as food should be limited to its fermented forms, as fermentation deactivates the growth depressing trypsin inhibitors and hemagglutinin. As far as tofu and bean curd are concerned, opinions are divided, with some nutritionists claiming that they should be avoided and others saying that since the level of enzyme inhibitors is reduced, being concentrated in the soaking liquid, they could be eaten.

Regarding phytates, present in higher quantity in soybean than any other grains or legumes, even prolonged slow cooking, a process which normally reduces phytates considerably in other legumes, is not effective in the case of soy.

Given all these reservations, to benefit of the goodness of soy, it is best to consume its fermented forms.

To be absolutely avoided because of their lack of nutritional quality, not to say harmful effects, are various highly processed soy foods such as:

- soy meat analog, also called textured vegetable protein(TVP), made from highly refined soy isolate which is a chemically processed by-product of the meal left once soya bean has been pressed for oil;
- soya flakes and flour, from which the trypsin inhibitor and other anti-nutrients have not been removed;
- soya oil, which is in fact considered toxic in traditional Chinese medicine and is difficult to digest.

Fermented soya products that are beneficial:

- Miso: a fermented paste made from soybean, *koji* inoculant, salt and rice or barley. Comes in a range of flavours from meaty and complex to subtle and sweet. Can be added to soups or used as seasoning for sauces. It is anti carcinogenic while also mitigating the effects of radiation, smoking,

air pollution and other environmental toxins. For full benefits, use darker coloured miso (Rebecca Wood).

- Natto: a strong flavoured, fermented food, full of enzymes, bacteria and fungi. Is an acquired taste, used as a condiment for rice or other grains or stirred into soups and noodles. It is a potent digestive aid, regulates blood sugar and is also an excellent source of protein (Rebecca Wood).
- Tempeh: a traditional Indonesian fermented food, made from soybean and some other beans. Has a bolder flavour than tofu and can be used for preparing vegetarian burgers, kebabs, etc: (not to be confused with harmful meat analogs). Health benefits include energy- building and B₁₂ content (Rebecca Wood).

Apart from fermented soy products, mentioned above, the black soya bean, growing in India, in the Himalayan regions, where they would have reached from China, as well as in some parts of Central India, and the green soya bean are both suitable for human consumption as they are more easily digestible. The green one is eaten, cooked in the pod, while still immature; the black one requires 10-12 hours of soaking and 3-4 hours of cooking.

Source: William Shurtleiff & Akiko Aoyagi in *The Soybean Plant: Botany, Nomenclature, Taxonomy, Domestication, and Dissemination*.

Rebecca Wood: *the new whole foods encyclopaedia*

Concerns Regarding Soybeans www.fda.gov

Minor Legumes (brief thumbnails)

Acacia

Also known as thorn trees, wattle in Australia, *khangkhut* in Manipur (N.E. India), *cha-om* in Thailand. A wide ranging genus, counting 1350 species, of which 1000 are found in Australia. Grows as shrubs or small trees; flowers come in various shades: cream, pale yellow to gold, with one variety having purple and another red flowers. Has many uses: for wood, as an ornamental, for flavouring (American soft drinks, candies & gums as well as Thai omelets & fritters); also used for culinary purposes in Manipur. In Mexico, beans called guajes/huajes, used as food (raw, cooked, toasted). Gum arabic is obtained from *Acacia Senegal* and in India, *katha* used in *paan*, betel preparation, is obtained from *Acacia catechu*, which also has medicinal properties as per Ayurveda.

African Yam bean

Sphenostylis stenocarpa

Names: (Eng:) African yam bean, yam-pea; (Fr:) pois tubéreux africain, haricot igname, pomme de terre du Mossi; (Ghana) kutreku, kulege, akitereku, apetreku; (Nigeria) girigiri, kutonoso, roya, efik, nsama, ibibio; (Malawi) cinkhoma, nkhoma; (Ibo) okpo dudu; (Obudu) bitei; (Togo:) sesonge, gundosollo, sumpelegu, tschangilu; (Yoruba) sese, sheshe; (Congo) giliabande, pempo, mpempe.

The origins of the African yam bean could be Ethiopia (NRI, 1987) or West and Central Africa (Potter & Doyle 1992). Its wild and cultivated forms are spread out across tropical Africa: south of Zimbabwe, West Africa, Central Africa and

East Africa. It grows on deep, loose sandy or loamy soils, with good drainage; it can also grow on acidic soil, at a height of up to 1800m and in a diversity of eco-zones ranging from savannah to rainforest. Rainfall wise, results are better with 800-1400 mm, with at least 1000 mm during growing stage (source: <http://www.feedipedia.org/node/704> & *Biology and Breeding of Food Legumes* ed: by Aditya Pratap and Jitendra Kumar).

Morphology

The African yam bean (*Sphenostylis stenocarpa* (Hochst. ex A. Rich.) Harms) is a perennial climbing bush, 1-3 m high, generally grown as an annual. Its leaves are trifoliolate with oval leaflets (2.7 to 13 cm long and 0.2 to 5.5 cm broad). *Sphenostylis stenocarpa* is cultivated for its edible tubers, which look like elongated sweet potatoes, and for its seeds, which are contained in hard and tough, 20-30 cm long pods. It is mainly used as food but can be used to feed animals.

Acknowledgment: <http://www.feedipedia.org/node/704>

African yam bean, like other legumes, is a good source of proteins, minerals such as phosphorus, iron and potassium whilst also containing anti-nutrients.

The African yam bean is an underutilized plant. Akande (2010) reports that currently mostly older farmers grow it (Saka et al. 2004). It is eaten in various ways: the tubers are eaten like potatoes with yam, maize or rice. It can replace cowpea in many preparations. Seeds are seasoned, wrapped in plantain leaf, boiled and eaten. Beans require long soaking and cooking time, which is a deterrent, except in times of scarcity. Flour made from seeds is mixed with cassava for soups.

Apart from being used as food, the African yam bean is also used as feed for livestock and as green manure for soil restoration (Saka et al 2004).

In traditional farming, it is intercropped with cassava, maize and okra. It makes for a good ground cover and is excellent for nitrogen fixation.

In his presentation, Akande felt there was a need for germplasm collection as currently only the older generations of farmers were growing the African yam bean in Nigeria.

Source: *Biology and Breeding of Food Legumes* ed: by Aditya Pratap and Jitendra Kumar
Article of S.R. Akande, titled *Germplasm characterization of African Yam Bean (sphenostylis stenocarpa) from South West Nigeria* (from PGR Newsletter, issue N°154, p.25 to 29).

Agati

1. *Sesbania grandiflora*: (Eng:) white flowers; also called vegetable hummingbird; (Hindi) gaach-munga; (Malayalam) akatti; (Sanskrit) agasti; (Sinhalese) kathmurunga; (Bhasa-Indonesia) bungaturi; (Thai) dok khae.
2. *Sesbania bispinosa*: (Eng:) yellow flowers; (Hindi) danchi or dunchi; (Thai) doc sano.

Flowers of both varieties are eaten in various ways: fried, in omelets, in curries, steamed with fish sauce; in India and Sri Lanka, young pods and leaves are also eaten. Leaves and flowers have medicinal properties: as a tonic, a diuretic, a laxative; for headaches and vision amongst others.

Geocarpa Groundnut

Macrotyloma geocarpum

Names: (Eng:) Kersting's groundnut, Hausa groundnut, geocarpa groundnut, ground bean; (Fr:) lentille de terre, fève de kandale. (source: www.prota4u.org/protav8.asp?g.....)

The origin of Geocarpa groundnut is not known but could be northern Togo or Central Benin. It is cultivated in the West African savannah zone, from Nigeria

to Cameroun. It can also be found in Mauritius, Fiji and Tanzania. It is in many ways similar to Bambara groundnut, growing underground and is an underutilized plant, looked down upon since it is mostly grown by women on small farms. **This legume too grows in very hardy conditions and grows where other crops may fail.** Its nutritional value is quite high. Its taste is also good. Yet it is a disappearing species for many reasons: low yield, small grain size, labour intensive crop, non-acceptability socially, despite its cultural importance in West Africa, particularly Togo, (a possible reason of its survival). (Source: PGR News letter, Issue N° 152, p:45-40; authors: B.J. Amujoyeqbe, I.O. Obisesan, A.O. Ajayi, F.A. Aderanti).

Hog peanut

Amphicarpaea bracteata

Names: (Eng:) hog peanut, ground bean.

The hog peanut is a perennial vine, native to eastern North America. It grows up to 1.5 m and is suitable for sandy, loamy and clayey soils. Two types of seeds are produced, those in pods from flowers near the ground, which get buried, giving a single seed, high in taste and used very much like peanuts except that they can be eaten raw too; then, there are seeds from pods from higher flowers, that do not go underground; these seeds must be cooked before usage. Roots of this plant are also edible.

(Source: http://www.clovegarden.com/ingred/bp_legumev.html & pfaf.org.)

Horse gram

Macrotyloma uniflorum

Names: (Eng:) horse gram, Madras gram; (Hindi) kulath, gahath.

Antiquity and origin

The horse gram is deemed to be a native of the Indian subcontinent, with Indian plains and hills of the south considered as areas of domestication (K.R. Krishna in *Agroecosystems of South India: Nutrientdynamics, Ecology and Productivity*). According to Y.L Nene, citing Mehra (op. cit.), archeological evidence shows that horse gram was used as food since circa 2000 B.C.

The plant is also mentioned as *kathakula*, its original Sanskrit name in the *Brahadaranyaka* (c. 5500 B.C). K.T. Achaya (1998) indicates that an ancient Ayurveda text refers to horse gram as *kulatha*, as do Buddhist and Jain literature. Susruta, a physician existing before the Christian era, talks of *vanyakulatha*, (*kulatha of the forest*) which would point to a wild species. There are also several other evidences which attest to its antiquity, as for example evidence from Neolithic dwellings in South India (Bolvin et al., 2007).

Etymology and nomenclature

The English name horse gram clearly comes from its usage as feed for cattle, especially horses. Botanically, it was known as *Dolichos biflorus* until 1954, though today the accepted nomenclature is *Macrotyloma uniflorus*; a fact that can lead to confusion, according to many, is that it is still sometimes called *Dolichos biflorus*.



Production, cultivation and distribution

From its area of distribution, in South India, during Neolithic times, horse gram spread to the western and northern parts of India as well, being grown in India from Uttarakhand hills to Gujrat, Bengal and the South. Some Asian countries comprising China, Bhutan, Sri Lanka and others also grow horse gram. In Africa, it is cultivated in countries of the east and north-east of the continent. A small area of production is to be found in Queensland, Australia.

Generally, horse gram grows on all kinds of soil, except very alkaline ones. This drought resistant plant cannot tolerate water logging. It is used as a preparatory crop on new land, where it is grown two or three times before the main food grain is sown. It is also **sown on land that could not be prepared for lack of time**. In the Himalayan foothills, horse gram forms part of *baranaja* (twelve crops) fields. Though it grows best on a wide range of soils (black cotton soils, deep red loam soils, clay loam paddy soils), it has the amazing property of also growing in poor soils. It requires low to moderate annual rainfall (500-700mm) and temperatures ranging from 20°-34°C. (Source: agrifarming.in)

Morphology

It is a twining annual or perennial plant which has a dense growth. Its leaves are trifoliolate and it has yellow flowers with a violet blot on the standard. Pods are 6-8 cm long and 4-8mm wide and contain 6-7 seeds (Source: <http://www.feedipedia.org/node/628>).

Uses

Human consumption

The history of the human consumption of *kulath* goes back to at least c. 1500-800 B.C as per K.T. Achaya, renowned historian of Indian foods. During this period, known as the *Sutra* period, *yusa*, a soup made from *kulath* was

consumed on a regular basis and, in Achaya's opinion, it would have been the precursor of what we call *rasam* today. He also mentions that *vadas* prepared from this pulse are referred to in the *Vamuka Samuchaya* (1520 A.D).

Modern day India too has several recipes for *kulath* aka *gahath*. In the Garwal Himalayas, a dal is prepared from it; it is sometimes used as a stuffing in flat breads. In Maharashtra a snack called *usal* made from *kulath* is relished by many. In the Konkan area a curry with sprouted horse gram, potatoes and onions is prepared.

Several health benefits are attributed to horse gram in traditional medicine in India. As per Ayurveda, it has warming properties and must be consumed during the winter months. It reduces the *medha dhatu*, ie body fat, improves sperm count and regulates the menstrual cycle to name but a few of its therapeutic uses. One of the main health benefits it is known for is the dissolving of kidney stones.

Other uses

As animal feed

Given its high nutritional profile, horse gram is used as a cattle feed in many forms: seeds and by-products, forage, green fodder.

Ice cream bean

Inga edulis, I.feuilleei

These trees of the legume family, native to Central and South America, yield beans with a sweet, pulpy flesh, reminding of vanilla ice cream. (Other legumes with pulpy flesh: carob, tamarind, mesquite-*Prosopis glandulosa*-, honey locust-*Gladiata triacanthos*).

Jack bean

Canavalia ensiformis (L) DC.

Names: (Eng:) Jack bean, Chickasaw lima bean, Brazilian broad bean, coffee bean, ensiform bean, horse bean, mole bean, Go-Ta-Ki, overlook bean, Pearson bean, Watanka; (Hindi) *jack sem* (source: Purdue).

For a little known and used bean, *Canavalia ensiformis* has an extensive nomenclature which is both confusing, as it refers to other plants (ex: horse bean which is actually *Vicia fabia* equine) and illustrative as it refers to its unknown use (ex: coffee bean since it is sometimes used as a coffee substitute (Purdue)). Moreover members of the genus *Canavalia* are often called jack-beans. According to D.F. Austin (cited in Wikipedia), the name of the genus comes from a “Malabar” word, *Kavavali*, i.e. forest-climber.

The Jack bean is deemed to be a native of West Indies, Central America and as per Feedipedia also tropical Africa. It is now cultivated in many parts of the world (USDA 2009).

The legume is used both for human and animal consumption; however since it contains HCN and other toxins, it requires a long cooking time for detoxification (N. Haq in *Biology & Breeding of Food Legumes*). Traditionally, for the same purpose, the seeds are boiled for a long time and the water drained. Though Jack bean contains the rich nutrient profile of legumes, it is specially prized as the source of *concanavali* A, a lectin used for biotechnology application and immunology, as well as a source of purified urease enzyme used for scientific research.

Apart from the seeds, the flat, sword-like pods, young leaves and flowers are also eaten. However, since, on the whole, seeds and green parts are not high on taste, the plant is primarily grown to serve as forage and to serve a useful agronomic role since it can serve as living mulch which can control weeds and pathogens

(J.A. Caamal-Maldonado et al., 2001) Jack bean can also control erosion while improving the soil. It is intercropped with sugarcane, coffee, tobacco, rubber and sisal; it also functions as a cover crop for cocoa, coconut & pineapple

The plant thrives in humid tropical lowlands but is also found growing at altitudes of up to 1800m. It requires a rainfall ranging from 800-2000 mm but given its deep roots, it can also sustain dry periods.

Morphology

Jack bean (*Canavalia ensiformis* (L.) DC.) is a climbing perennial legume commonly cultivated as an annual. It grows up to 2 m high with 8-20 cm long trifoliate leaves and a strong root system. Flowers are pink, mauve or white with a red base. Pods are up to 36 cm long and contain 1-2 cm long, ellipsoid seeds. Pods and seeds are edible and used for food, the young pods being cooked as a vegetable. The whole plant, the pods and seeds are also used to feed animals

Acknowledgment: <http://www.feedipedia.org/node/327>

Kudzu

Genus *Pueraria*, with several species, (*P. lobata*, *P. montana*, *P. edulis*, amongst others).

A fast growing bean, originating in the eastern- south-eastern belt of Asia as well as some Pacific islands. Brought to U.S.A, from Japan, to control soil erosion but declared invasive later. Kudzu, however, has many uses: leaves are eaten as greens, root tubers are also edible as are flowers; “Japanese arrowroot” is made from the powder of tubers. Flowers provide nectar to bees, butterflies and pollinating insects. Animals graze on leave and ethanol can be made from the plant. Currently underutilised.

Lathyrus

The *Lathyrus* genus is primarily a flowering plant species, of which the sweet pea (*Lathyrus odoratus*) is the most notable. Also known as vetchlings, the genus counts 160 species, most of which are not fit for consumption since they are quite toxic; some members though are cultivated as food, the grass pea, *Lathyrus sativus* being the most important economically. Others include the red pea (*L. cicera*), the Cyprus Vetch (*L. ochrus*), the Spanish vetchling (*L. clymenum*) and the tuberous pea (*L. tuberosus*), so called because it is for the starchy edible tuber that it is grown.



Given that the seeds of the *Lathyrus* species are toxic, as they contain a neurotoxin, the consumption of edible ones should be moderate as otherwise they could cause lathyrism, a condition leading to paralysis.

A list of the edible varieties is given below, with a brief description:

- *Lathyrus sativus*: the grass pea, chuckling vetch, Indian pea/vetch, *khesari* or *lateri* (Hindi), *lakh* (Marathi). This annual legume is grown both for human food and fodder. Its ability to tolerate both aridity and flooding makes it a preferred crop for poor, arid zones. Originating in the Balkan Peninsula, during the early Neolithic period, today it is cultivated and naturalized in many parts of South, Central and Eastern Europe, the Mediterranean basin, Iraq, Afghanistan, Bangladesh, India, Pakistan, Nepal and Ethiopia. **In fact in South Asia and Ethiopia, given its hardiness, grass pea is sometimes the only available food.**

Cultivation habits

Season of growth: spring in temperate areas and winter in subtropical areas.

Height: can be cultivated from sea level to 1200 m (India), 1700-2700 m (Ethiopia).

Temperature: an average of 10°-25°C.

Annual rainfall: 400-650 mm.

Soil requirements: wide range, including poor and heavy soils.

Grass pea tolerates water logging and water scarcity as well as alkaline and saline conditions (Yadav et al., 2006).

Human consumption: as soups (Georgia) and as dal, (South Asia). Often used as a cheap adulterant for pigeon pea, Bengal gram or *besan* (chickpea flour).

As feed: straw is used for fodder: silage can be made and at early stage of growth animals graze on it.

Tuberous pea, tuberous vetchling

Lathyrus tuberosus

This native of wet regions of Europe and Western Asia has been cultivated since the 17th Century for its tubers, which are both tasty and nutritious. However yields are not very high (Clovegarden).

Heath pea

Lathyrus linifolius

This native of Europe and parts of Asia has an interesting history. Its tubers are/ were the edible parts and up till the 18th century, when potato arrived, heath pea was cultivated for its tubers, which were dried and kept. These were notable for their appetite suppressing effect which, it is said, could last for days, making them a preferred food in times of food scarcity. It is for this aspect that it evokes interest today.

Pink vetchling

Lathyrus roseus

Not much information is available on this species. According to Clovegarden, it is a native of Caucasus, particularly Georgia and it would seem that young seed pods are consumed.

Spanish vetchling

Lathyrus clymenum

The seeds of this native of the Mediterranean region, more specifically Santorini and neighboring islands, are notably used to prepare the Greek dish *fava santorinis*. Recently the plant has acquired a Protection of Designation of Origin rating from the European Union, since it grows best in the volcanic soil of this region.

Sea pea, beach pea, circumpolar pea, sea vetchling

Lathyrus japonicus

This species is a native of temperate coastal areas of Asia, Europe, North and South America. It has a variant known as *Lathyrus maritimus* which typically grows in sandy or stony coastal habitats. The seeds have an ability to withstand floating in seawater. Pods of this species can be eaten but with caution as, like other members of this genus, they contain neurotoxins. The leaves of the plant are, however, useful in traditional Chinese medicine.

Source: Feedipedia, Wikipedia, Clovegarden

Lupines

The genus *Lupinus* comprises flowering plants of the *Fabaceae* family. It owes its name, which comes from the Latin *lupus* for wolf, to the erroneous belief that it devoured nutrients from the soil; but, quite on the contrary, like other legumes, plants of this genus actually enhance soil fertility by fixing nitrogen.

They number possibly more than 200 species. The major centers of diversity of lupines are in South America and Western North America, with secondary centres in the Mediterranean and African regions.

Most of the plants of the genus are herbaceous perennials, with some being annuals; there are also shrubs which can grow up to 3m tall and one species, *Lupinus jaimehintoniana* in Oaxaca, Mexico, being a tree.

The genus *Lupinus* was first divided by Watson (1873) into three subgenera: *platycarpus*, *lupinus* and *lupinellus*, on the basis of habitat and number of ovules. Asclerson and Graebrer subsequently revised this division in 1907 on the basis of a more global study. Currently it has again been divided by Kurlovich and Stankevich (2002) into the subgenera *platycarpus* and *lupinus*: *platycarpus* regroups about 270 varieties which are both perennial and annual, from the Americas, mostly southwestern U.S.A. and the Andes in South America whereas *lupinus* regroups 11 species from Africa and the Mediterranean region. *Lupinus* also grows in Australia.

Lupines are toxic plants, some more than the others and therefore have to be detoxified before use for human consumption. Various traditional methods exist since they have been used as food for millennia. The less toxic varieties are called sweet lupines. **They also have an important ecological role since they are the food of larvae of several butterflies.**

The following are the most commonly eaten varieties:

Lupini beans

Lupinus albus (white lupines)/*Lupinus lutieus*, yellow lupines

The Romans propagated the cultivation of lupines throughout their empire; they are commonly found in Spain, Portugal, Italy, Greece and Brazil; they also exist in Syria, Lebanon, Palestine, Jordan, Israel and Turkey. They are primarily eaten as a snack, processed with salt and citric acid and kept in jars. They require days of soaking in salted water, with several changes to remove the bitter toxins.



Tarwi or Pearl lupine

Lupinus mutabilis

It is also called tarhui, chocho, altramuz, Andean lupine, South American lupine, Peruvian field lupine. It was domesticated in the New World and played/plays an important role in the Andean region, where it has been conserved for several millennia. Unfortunately after the Spanish conquest, which impacted food practices in the region, it was marginalized. Today it is getting back its prominence.

Though it is highly toxic as it contains bitter alkaloids, it can be detoxified through soaking and several changes of water, across 5-6 days.

It is prepared in many ways: stews, salads, soups. It is also pressed for oil.

Tarwi seeds are being used as an animal feed, preferred over soy, groundnut cake and fishmeal.

Lupinex, a bitter compound, is being extracted from it to be used as a bio-pesticide (Kahnt and Hijazi, 2008).

Blue lupines

Lupinus angustifolus

This European species is now widely cultivated in South West Australia. It is used both as food and feed. As food it is being processed in similar ways to soya beans. They are also eaten sprouted. They are deemed to be potentially a very good source of protein for processed foods.

Wild lupine

Lupinus perennis

This lupine, also known as blue lupine, sundial lupine or perennial lupine, has medicinal uses. Ecologically also it is important as various insects such as beetles, butterflies and moths feed on them. Unfortunately many factors have led to a drastic decrease of the plant, which in turn has endangered the kerner blue butterfly.

Source: *Biology and Breeding of Food Legumes*, ed: by Aditya Pratap and Jitendra Kumar Wikipedia
www.clovegarden.com, Beans, Peas and Lentils.

Sataw

Parkia speciosa

Known as twisted cluster bean, stink bean, sator/ sataw (Thai), nejire-fusamame (Jap.) zaungtah (Miso); belongs to the *Parkia* genus (*P.speciosa*) where with other species (*P.javanica*, *P.singularis*) the tree yields beans, the plump, green seeds of which are edible, though foul smelling. In India, *Parka* species grow wild in the North- East, specially Manipur, where they are used to prepare the delicacy Eromba or Yongchak singju. They are cooked in combination with shrimps, meat, chilies and garlic, a combination which ensures good absorption of the nutrients in beans. A North-eastern recipe of stink beans features in our recipe section.

Sword bean

Canavalia gladiola

Names: (English) sword bean, horse bean;
(Hindi) badi sem; (Sanskrit) mahasimbi

Sword bean, which belongs to the *Canavalia* genus, together with jack bean, is very close to it and sometimes confused with it. It is a perennial plant, often cultivated as an annual (Ekanayake et al., 2000).



Morphology

Sword bean is a perennial legume mainly cultivated as an annual (Ekanayake et al., 2000). Sword bean has a vigorous climbing or trailing habit and can be up to 10 m long. Some cultivars may also be semi-erect. Sword bean has a deep root system. Its stems are woody. The leaves are alternate, large, trifoliolate. Sword bean leaflets are oval-shaped, 7.5–20 cm long × 5–14 cm broad, shortly pubescent on both faces. The inflorescence is a large axillary raceme (7 to 12 cm long) bearing several flowers. The flowers are papilionaceous, inverted, white to pink in colour. The fruits are long (20-40 -60) cm), straight, rough-surfaced and consist of slightly compressed dehiscent pods containing 8 to 16 seeds. The seed are 2-3.5 cm -1.5-2 cm, oblong-ellipsoid in shape, very variable in colour. They range from red, red-brown to white or black. The hilum is as long as the seed, dark brown in colour.

Acknowledgment: <http://www.feedipedia.org/node/326>

The plant, like others in its genus, is considered a neglected one, and is not cultivated commercially. It is, however, used in many African and Asian regions for human consumption: interiors and central parts of South India, Sri Lanka, China, Korea, Japan and Madagascar. In fact in Tanzania the expression being happy in Swahili translates as “eating sword bean” (Bosch 2004). Both seeds and pods are edible and nutritious; mature seeds contain anti-nutritional substance and must therefore be used carefully: dehulled, soaked in salted water and even fermented. Consumption of large quantities is not recommended (Duke, 1981, in Feedipedia).

Sword bean has therapeutic values in traditional medical systems. In Ayurveda, it is considered as balancing *kapha* and *pitta doshas*; it is recommended in case of vomiting, lumbago, and asthma amongst many other discomforts.

The plant also has other uses; as fodder: foliage for animals, seeds, in moderate quantities for cattle and chicken; as an ornamental and cover crop, believed to have snake repelling properties.

Velvet bean

Mucina pruriens

Names: (English) velvet bean, Bengal velvet bean, Florida velvet bean, Mauritius velvet bean, Yokohama velvet bean, Cowage, cowitch, lacura bean, Lyon bean; (Hindi) kiwanch or kooch; (Sanskrit) atmagupta or kapikachu; (Nigeria) Devil Beans; (Angola & Mozambique) feijao maluco (mad bean) (source: Wikipedia).

The Velvet bean is a native of Asia and Africa; it is now cultivated widely across the world as the nomenclature reflects. It is either annual or perennial, existing in both bushy and climbing forms, the latter being more common.

Morphology

The plant is an annual climbing shrub with long vines that can reach over 15 m in length. When the plant is young, it is almost completely covered with fuzzy hairs, but when older, it is almost completely free of hairs. The leaves are tripinnate, ovate, reverse ovate, rhombus-shaped or widely ovate. The sides of the leaves are often heavily grooved and the tips are pointy. In young *M.pruriens* plants, both sides of the leaves have hairs. The stems of the leaflets are two to three millimeters long.

The flower heads take the form of axially arrayed panicles. They are 15 to 32 cm long and have two or three, or many flowers. The accompanying leaves are about 12.5 mm long, the flower stand axes are from 2.5 to 5 mm. The bell is 7.5 to 9 mm long and silky. The sepals are longer or of the same length as the shuttles. The crown is purplish or white. The flag is 1.5 mm long. The wings are 2.5 to 3.8 cm long.

In the fruit ripening stage, a 4 to 13 cm-long, 1 to 2 cm-wide, unwinged, leguminous fruit develops. There is a ridge along the length of the fruit. The husk is very hairy and carries up to seven seeds. The seeds are flattened uniform ellipsoids, 1 to 1.9 cm long, 0.8 to 1.3 cm wide and 4 to 6.5 cm thick. The hilum, the base of the funiculus (connection between placenta and plant seeds) is surrounded by a significant arillus (fleshy seed shell).

Acknowledgment: https://en.wikipedia.org/wiki/Mucuna_pruriens

Uses

The main uses of the crop are for food, forage and cover. It also has valuable pharmaceutical properties.

As far as human consumption goes, velvet bean is eaten both as vegetable (immature pods and leaves) and as seeds, after boiling to remove toxins. The seeds are also prepared as a bean cake or fermented into *tempe* in Indonesia. The beans are also used as a coffee substitute (like Jack bean) called nescafe.

Traditional Indian systems of medicine (Unani, Ayurveda) use velvet bean to treat various conditions. In pharmacology, the L-DOPA, which it contains, has been researched for its use in treating Parkinson's disease. Velvet bean also contains small amounts of serotonin, 5-HTP, nicotine, dimethyltryptamine, bufotenine and 5-MeO-DMT.

As far as animal consumption is concerned, the whole plant comes into use: for grazing after pods' maturity; as forage, when pods are still young (90-120 days after sowing). Yields of green fodder may be up to 20-35 t/ha (Ecocrop, 2011, cited in www.feedpedia.org).

Velvet bean is a good cover crop and an effective green manure. It grows very fast and does not need much soil preparation. As a legume it improves soil fertility through nitrogen fixation; **it protects the soil from heavy rains during the wet season, serves as thick mulch when cut, protecting the soil from erosion and weed germination. In intercropping systems, velvet bean is advantageous to the companion crops, protecting them from pests and weeds** (source: Feedipedia).

As far as new developments are concerned, according to N. Haq (in *Biology & Breeding of Food Legumes*), the use of the seed as a source of high-viscosity starch (as a thickening agent in food processing and as an adhesive in the paper making and textile sectors) has been researched and proven to give good results.

Winged Bean

Psophocarpus tetragonolobus (L.)

Names: (Eng:) winged bean, Goa bean, princess bean, Mauritius bean, asparagus pea, four-angled bean, winged pea (source: Clovegarden).

The origin of the winged bean is thought to be Mauritius or Madagascar and today it is distributed throughout the Asia and Pacific regions, the Caribbean islands and Africa. It was discovered in the early eighties in the U.S.A. where it was hailed as “a supermarket on a stalk” since almost all parts of the plant, from the root tubers, to the pods, the leaves, the flowers and the seeds, are edible. All parts are rich in protein, vitamins and minerals as legumes are. The seeds have received particular attention since they are deemed to be like soybeans. In fact winged beans are substituted for soy in tofu, tempeh or even milk. Flavour wise it is pleasanter than soy and has an almost meaty texture. It is also less flatulence inducing. The seeds can also be pressed for oil. However winged bean seeds too have trypsin inhibitors and hemagglutinins which inhibit digestion; they therefore require about 2-3 hours of cooking to destroy these.

A great diversity of cultivars/varieties is to be found and several of them exhibit differences at various levels. *P. tetragonolobus* can grow in poor clayey or sandy soils because of its nitrogen capturing ability.

Morphology

The winged bean plant grows as a vine with climbing stems and leaves, 3–4 m in height. It is an herbaceous perennial, but can be grown as an annual. It is generally taller and notably larger than the Common bean. The bean pod is typically 15–22 cm (6–9 in) long and has four wings with frilly edges running lengthwise. The skin is waxy and the flesh partially translucent in the young pods. When the pod is fully ripe, it turns an ash-brown color and splits open to release the seeds. The large flower is a pale blue. The beans themselves are similar to soybeans in both use and nutritional content (being 29.8% to 39% protein).

There is abundant variation in the appearance of winged bean. The shape of its leaves ranges from ovate, deltoid, ovate-lanceolate, lanceolate and long lanceolate. The leaves of winged bean also vary in colour appearing as different shades of green.

Stem colour is commonly green, but can vary from shades of green to shades of purple.

Pod shape is most commonly rectangular, but can also appear flat. Pod colour may also vary from shades of cream, green, pink or purple. The exterior surface of the pod also varies in texture. Pods can appear smooth or rough depending on genotype. Seed shape is often round, but oval and rectangular seeds are also found. Seed colour changes based on environmental factors and storage conditions. Seeds may appear white, cream, brown or dark tan in appearance. The shape of winged bean tuberous roots also show variation.

Given its high nodulating ability, winged bean is suitable as a cover crop. It could also be used as animal or fish feed (Wikipedia).

Acknowledgment https://en.wikipedia.org/wiki/Winged_bean

In spite of so much going for it, it is surprising that the winged bean is still not so widely used.

Yam bean

Pachyrhizus erosus

Names: (Eng:) yam bean, jicama, Chinese potato, Sa kot, Mexican yam bean, Mexican turnip; (Hindi) shankhalu.

P. Erosus is a Central American root vegetable actually belonging to the bean family. Native to Mexico, jicama, from Nahuatl, xicamati, travelled all the way to Philippines, where it is called *singkama* and other Asian countries including China and India where it is known as *shankhalu* and *kesaur*. The genus *Pachyrhizus*, to which jicama belongs, is commonly called yam bean. Three species are cultivated: *P. erosus* (Mexico & Central America), *P. tuberosus* (tropical lowlands along the Andes) and *P. ahipa* (sub tropical east Andean valleys in Bolivia & Argentina) (source: www.fao.org). *P. erosus* has two cultivated form: *jicama de agua* and *jicama de leche*, reflecting their composition since the elongated root of de leche has a milky juice. Leaves, seeds and pods are not eaten as they are toxic. The root of the *P. ahipa* species is also eaten; however it is a shrub and not a vine like *P. erosus*. It is not well known outside the Andes and West Indies where it also grows (source: Clovegarden).

The *P. tuberosus* is an annual vine; its roots as well as its leaves, pods and beans are eaten (source: Clovegarden).

There are many ways to eat this tuber but it is best eaten in raw preparations as the flavour diminishes on cooking.

Nutrition wise jicama, also known as *shankhalu* in Bengal, is very good, being high in dietary fiber and containing the pre-biotic oligofructose inulin. It also provides potassium and vitamin C and is low in sodium.

Health wise, according to Rebecca Wood, it is an excellent dieter's food, as it is composed of 86-90% of water. It balances *pitta* and *kapha*. To be used moderately in *vata* conditions.

Legumes used as Vegetables, Health Foods, Flavouring & Beverages

Some vegetable legumes feature under the pulses section as they are also used as pulses. (examples *P. vulgaris* plants such as french beans & *P. sativum*, peas)

Vegetables

Cluster beans

Cyamopsis tetragonoloba

Names: (Hindi) Guar, guwar phalli

Guar bean, also called cluster beans, because of the way it grows, has never been found in the wild so that its origin is not known. It has been domesticated since centuries in India and Pakistan and today India is its biggest producer.

The beans are eaten green, as a vegetable in many regions of India; they also yield the guar gum, about 7 times more thickening than corn starch. The gum has many uses in the food industry but shot to fame when it was used as a component to the “fracking” mix used for extracting oil. This caused a commercial turbulence with prices first soaring and then crashing.

Khejri

Prosopis cineraria

The Khejri is a flowering tree of the arid West Asian regions and the Indian sub-continent. It is also found in the Gulf countries such as Bahrain & UAE. It is in fact the state tree of Rajasthan and Telangana in India, the national tree of the

United Arab Emirates and known as the Tree of Life in Bahrain where a large, approximately 400 year old, tree is growing in a desert with no obvious sources of water. Apart from its usage as a fuel source, fodder and green manure, in Rajasthan the Khejri pods known as *sangri* are made into its signature dish, *ker-sangri*. Its ecological importance is underlined in a story featuring in the section *Bouillons de culture*.

Flavouring

Carob

Ceratonia siliqua

Names: St. John's bread, locust bean

Carob is also known as St. John's Bread because, according to the Bible, when he was in the wilderness, St. John sustained himself on "locusts" which referred actually to the carob pods.

Originating in the eastern Mediterranean region, the carob tree has today spread to various parts of the world: Greece, Italy, Morocco, Spain, Majorca and Portugal, southern California and Mexico (where it was introduced by Spanish missionaries), amongst others. It is said that in the Mediterranean region, in times of food scarcity, peasants survived on the pods.

The carob pods have been used and are used in multiple ways: the pods, which are quite sweet, are simply chewed; they are roasted and ground into a powder which is often used as a cocoa substitute in various preparations, from milk shake to pancakes, breads and candy bars. A syrup of thick consistency is made from coarsely ground pods. The seeds also yield a gum which is like that of tragacanth, a mid-eastern tree legume; it is used as a stabilizer and thickener in bakery goods,

sauces, ice-cream etc. After gum has been extracted, the pod residue is processed into starch and a sugar free flour, rich in protein, suitable for diabetics.

Roasted seeds have also been used as a coffee substitute.

Pods are also used as feed for various animals, excluding chickens. However, since they contain tannins, which inhibit growth, they must be used in moderation, especially in the case of children.

Health wise, carob has a good nutritional profile, rich in vitamins and minerals. It contains less fat than chocolate, no caffeine or oxalic acid and it is naturally sweet.

Source: www.hort.purdue

www.clovegarden.com

Rebecca Wood: *the new whole foods encyclopaedia*

Carob beans were ground into milk to prepare a pudding in ancient Egypt.

Fenugreek

Trigonella foenum-graecum

This legume belongs actually to the spice box. Its rhomboid, yellow seeds are highly prized in various Indian cuisines as are its dried leaves, specially the ones from the region of Qasoor, in Pakistan, since they impart a rich, warm flavour to sauces. Green leaves are also used to flavour pilafs and flat breads.

Fenugreek has various health benefits as it tones up the liver and the kidney. It promotes digestion and regulates blood sugar. It reduces cholesterol, increases milk flow, is beneficial to those suffering from gout, anemia and debility.

It has many cosmetic uses in India where it is used, as a paste, to promote hair growth.

Senna

Caesalpinioideae

Several Senna species were formerly placed under the genus Cassia. The genus Senna includes herbs, shrubs and trees. Not all, but some Senna species are

used for human consumption: Cassia gum, used as a thickener, comes from *S. obtusifolia*. The leaves and flowers of *Senna siamea* are used in Thai cuisine. Many Senna species have medicinal uses. *Senna* seeds are used with psyllium fiber (isabgol) to regulate bowel movements.

Tamarind

Tamarindus indica

The genus *Tamarindus* has only this one species. It is a tree which may have originated in Africa but is widely grown in India so much so that it was believed to be a native of it, as the botanical and the fruit's names suggest. Tamarind comes from the Arabic *tamarhind*, Indian date. Indeed, today India is the largest producer of tamarind.

The tree grows wild in several African countries and is prevalent throughout the tropics.

Tamarind pulp has many culinary and medicinal uses: it is used as a souring and flavouring agent in many Asian countries, including India; the not so secret anymore ingredient in Worcester sauce is none other than tamarind; both in South Asia and Mexico it is used to prepare a cooling drink because of its refrigerant property; it is also laxative and carminative; all these properties make it a much in demand ingredient in pharmacopoeia. It aids digestion, even that of elephants, so it is believed! Leaves, bark and flowers, all have therapeutic values.

Twigs and pulp are even used for tanning and dying. Leaves are sometimes used as feed.

Beverages

Rooibos (bush tea, red bush tea)

Aspalathus linearis

A popular tea in South Africa and neighbouring countries; has no caffeine and can be left to brew for a long time without turning bitter. Rich in antioxidants.

Since the Rooibos plant is endemic to a small region of the Western Cape province of South Africa and attempts to grow it outside this area have failed scientists feel that climate change may threaten the survival of the plant. (Source: Wikipedia)

US trademark controversy

In 1994, Burke International registered the name “Rooibos” with the US Patent and Trademark Office, thus establishing a monopoly on the name in the United States at a time when it was virtually unknown there. When the plant later entered more widespread use, Burke demanded that companies either pay fees for use of the name, or cease its use. In 2005, the American Herbal Products Association and a number of import companies succeeded in defeating the trademark through petitions and lawsuits; after losing one of the cases, Burke surrendered the name to the public domain.

Legal protection of the name rooibos

The South African Department of Trade and Industry issued final rules on 6 September 2013 that protect and restrict the use of the names “rooibos”, “red bush”, “rooibostee”, “rooibos tea”, “rooitee” and “rooibosch” in that country, so that the name cannot be used for things not derived from the *Aspalathus linearis* plant. It also provides guidance and restrictions for how products which include Rooibos, and in what measures, should use the name “rooibos” in their branding.

Acknowledgment: <https://en.wikipedia.org/wiki/Rooibos>

Licorice

Glycyrrhiza glabra (other varieties include *G. lepidola*, *G. uralensis*, *G. echinata*)

Names: (Arabic) erk-soos; (Tel:) athimadhuram; (Kannada) jyeshthamadhu; (Tamil) athimadhuram; (Malayalam) irattimadhuram; (Sanskrit) yastimadhu; (Hindi) mulethi; (Sinhalese) Vel Mee; (Guj:) jethimadh; (Marathi) jyeshthamadh.

Licorice comes from the sweet roots of *G. glabra*, a herbaceous, perennial legume plant, native to southern Europe, India and parts of Asia. The extract from roots is used for flavouring, specially candies and tobacco. It has several therapeutic uses in traditional medicine systems: it is anti-inflammatory and anti-depressant; effective as a cure for asthma, colds, flu, chronic fatigue, emphysema, heart burn amongst others. It is said, however, that excess licorice can be harmful to the liver or cause high blood pressure, an unlikely eventuality, given the amount of licorice one would have to ingest.

Little known legumes

Rudimentary sketches of uncommon, region specific legumes; The list is taken from Clovegarden and included here as a reminder that using indigenous food increases food security.

Aila (Tahitian chestnut)

Inocarpus fagifer/edulis

A tree which grows in the tropical regions of south west Pacific and south east Asian countries. Traditionally used by Polynesians and Melanesians. Seeds are toxic when raw but edible when cooked.

Baru

Dipteryx alata

A tree only found in the Cerrado region of Brazil and Chiquitano region of eastern Bolivia. The pulp of the fruit is sweet and made into jams, jellies and liquor. Seed kernels are rich in flavour and used roasted, made into pesto and even breads or cakes. Oil is also extracted from them.

Butterfly Pea (blue pea, Cordofan pea, bunga telang, in Malay)

Clitoria ternatea

A native of Asia, now growing in Africa, Australia and the Americas. Young pods are edible. Flowers yield a blue colouring agent. Roots have medicinal properties.

Elephant Ear tree (Guanacaste, caro caro)

Enterolobium cyclocarpum

A stately, flowering tree, which is the national tree of Costa Rica. Native to the tropical regions of Americas: from central Mexico to northern Brazil to Venezuela. Has a large canopy and bears pods similar to an elephant's ear. Green seeds are harvested and eaten boiled in Mexico.

Guaje (white leadtree, white popinac; *huaxim*, *huaxcuahuitl*; *phakatin*, in Mayan, Nahuatl and Thai, respectively)

Leucaena leucocephala

A fast growing shrub, native to the Mayan region: from southern Mexico to Central America. Flowers are white. Young beans can be eaten. Useful as animal fodder and for green manuring.

Gum Arabic tree: (white Acacia, *Senegalia senegal*; red Acacia, *Vachelia seyal*)

The trees are native to the semi desert regions of sub-saharan Africa, Oman, Pakistan and the west coast of India. Though pods are eaten locally, the trees are better known for gum arabic, used as a food stabiliser.

Jatoba (Brazilian cherry, South American/West Indian locust, stinking toe etc:)

Hymenaea sp.

A tree that can grow up to 100 feet high and has a huge canopy. Widespread in the Caribbean region as well as central/south America. Popular in North America for timber. In South America the pulp of the fruit, which has a high nutrition quotient, has many uses: eaten raw, used in powder form for bakery goods, soups, stews, fermented drinks. A smelly legume but locally accepted. Same sub family as tamarind.

Jering: (dogfruit, jengko in Indonesia, jering in Malay, luk neang in Thailand, Da nyin thee in Myanmar)

Archidendron pauciflorum

Tree bearing pods, native of South East Asia. Not pleasant smelling yet a popular food in Indonesia, Malaysia, Myanmar and Thailand.

Kalahari White Bauhinia

Bauhinia petersania

A native of sub-saharan Africa. Seeds highly appreciated in Botswana as nuts or ground for coffee.

Monkey pod (Manilla tamarind, Madras thorn, ebony black bead, camachili in Philippine)

Pithecellobium dulce

A native of the Pacific coast of tropical Mexico, Central and South America. Yields curled pods containing black seeds surrounded by edible sweet white pulp; seeds also edible and yield oil.

Marama or Morama bean (gemsbok bean, tamani berry)

Tylosema esculentum

A long living perennial plant, native to arid regions of South Africa, producing edible pods and tubers of high nutritional value. Beans normally roasted. Plant with a high potential.

Nam nam

Cynometra cauliflora

A tree with many branches, bearing flowers directly from the trunk; fruits have a hard shell; their flesh is edible though sour when unripe. Used for chutneys,

sambal and sauces. Possibly a native of Malaysia but also occurring in Sri Lanka and western and southern India.

Prairie turnip (breadroot, pomme blanche, tipsin)

Psoralea esculenta

A native of North America; grows from tuberous roots; takes 2-4 years to develop mature roots and so cultivation was not too prevalent; however roots are very nutritious with high level of protein and vitamin C; eaten raw, cooked or ground into flour for making bread.

Sathon

Millettia utilis; Millettia leucantha

Trees found in northern Thailand, Laos and Myanmar. Used in Thailand for making a popular sauce; was used for medicinal purposes earlier.

Velvet tamarind (pebble tamarind, *gal siyambala*, *yee, luk yee*: in Thai; *keranji* in Malay; *yoryi* in Ghana; *tsamian biri, icheku, awin* in Nigeria)

Dialium indum

The tree yields a fruit like tamarind except sweeter; two varieties exist, a smaller one with a dry, powdery pulp and a larger one, dry but with a sticky pulp; normally sold as snack on the streets.

Water mimosa (sensitive neptunia)

Neptunia oleracea

Grows near streams or floating in still water; origin not known; could be southern Mexico or northern South America; cultivated as a vegetable in Southeast Asia; young leaves, tender pods and shoots eaten raw or used in curries.

Yeheb Bush

Cordeauxia edulis

Sole species of *Cordeauxia* genus. The bush considered important for Somali nomads; once very prevalent in Somalia and parts of southeast Ethiopia but today due to over-grazing, war and drought it is much reduced. Attempts are on to reinstate. Seeds are a little toxic but eaten roasted or boiled; water in which they were boiled used as beverage sometimes; leaves too are used for tea. Needs to be protected.

Did You Know?



Liana entada is the longest pod going up to 5 feet, also called monkey ladder or “escalera de mono” in Costa Rica.

Coffee, vanilla and cocoa are not legumes even though they are called beans. Vanilla is from the orchid family, cocoa is from the hibiscus family & the pod of the cocoa is actually a berry whereas coffee is from the *Rubiaceae* family and is the pit of a fruit.

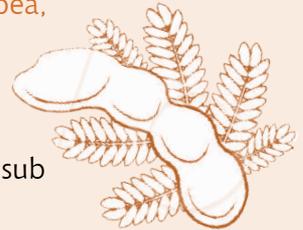
Four of the most distinguished Roman families were named after beans:

Fabius from fava bean, Lentilus from lentil, Piso from pisum, the pea,

Cicero from *Cicer arietinum*, the chickpea.

The spice fenugreek is actually a legume

Tamarind is a legume which belongs to the Caesalpinioideae, a sub family of the *Leguminosae* family.



Bio-plastic can be made using pea starch or soya starch. Henry Ford made a car using bio-plastic from soya for its body. It is said that by 1935 he was using one bushel of soya for every car manufactured (source: ncsoy.org).



Vigna mungo is actually not mungbean but uradbean; mungbean is *Vigna radiata*

Peanut is not a nut but a bean



These days vegans are using aquafaba, brine of chickpea and other beans, to replace eggs in various desserts such as mousse, ice-cream, pavlova, meringue.

Illustration : Kaia Singh



Bouillons de Culture

Cultural Aspects of Legumes

With 700 genera and more than 18000 species, how could the *Leguminosae* family, also known as *Fabaceae* not be intricately woven into the web of our life? From herbs to shrubs to trees, they play an important role in our diverse cultural ethos around the world, whether as signature, festive dishes or emblematic reminders of history or linked to our beliefs. They are, as the French say, *incontournables* in our lives.

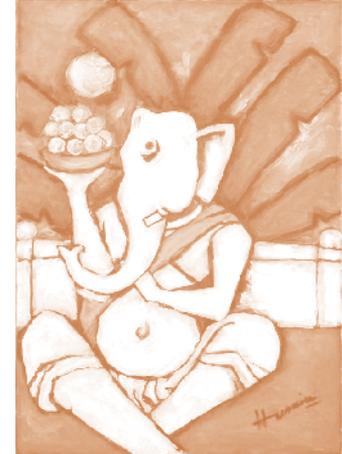
Stories abound around them. They evoke emotions such as comfort and nourishment, so much so that Esau preferred a bowl of lentil soup to his elder's birthright. They teach us resilience and generosity, thriving in hardy conditions while contributing to the health of the soil. They bring an element of beauty in our lives, through the wide array of stunning flowers they produce, amongst which we can count the powder puff, sweet peas and lupines.

In food cultures too, since the hoary past, across continents, beans, peas and lentils have been part of the human diet and their nurturing factor acknowledged. Be it in India, where the *Vedas* recommended *soopah*, a chickpea soup, to restore strength or in various meat eating countries where they were called "the poor man's meat" because of their protein content.

If we look at food cultures at a global level, we see that many signature dishes have evolved around legumes, specifically pulses. From the cassoulet in France to the Hoppin' John, almost de rigueur for New Year's feast in southern U.S.A, to the *chhole-bhature*, *rajmah-chawal* in India to *frejon* (a coconut milk based black bean pudding), eaten in some African countries, during Good Friday, when meat is prohibited, to the Mexican refried beans, the list is unending.

Let us now journey to India and look at some pulses based preparations, traditionally offered as *prasaad* to the Divine or made during a particular festival.

To start on a favourable note, the elephant-headed Ganesha, son of Shiva and Parvati, lord of Auspicious Beginnings, remover of obstacles, scribe of the *Mahabharata*, to name but a few of his attributes, is always propitiated with an offering of *laddus*, a sweet using *besan*, chickpea flour. During *Ganesha Chaturthi*, a festival in his honour, in Maharashtra, *kaala vatana*, a black pea specific to the region, is cooked.



On *Sankranti*, when the sun transits into the zodiacal sign Capricorn and heralds the start of spring, *khichadi*, a dish combining rice and a pulse (either split *mung* or *urad*), the perfect nutritional blend, is a must to ring in good luck. In the south of India, on the same occasion, *pongal*, using rice, mung dal and jaggery is made.

During *Navratra*, the nine nights when the Devi fights the demon, on the eighth day, at the course of the ceremony called *kanjak*, young girls are honoured and offered a dish of *kaala chana*, Bengal gram.

If some festivals are anchored in traditional or religious belief, others have sprung up in response to a modern situation. We shall now explore some of them, both in India and worldwide.

Festivals and fairs are fun and celebratory ways of perpetuating the memory of a plant, an ingredient or a speciality. Apart from already existing festivals, given that many beans/legumes, some specific to a region, are under threat of disappearing in a monoculture driven world, quite a few new ones have sprung up around them.

Here is a brief look at some:

- In France, two such festivals have been instituted not so long ago. We have one for the *haricot tarbais*, an heirloom variety of white bean which almost disappeared but was fortunately revived by a group of 64 farmers who together produce 130 tonnes. The festival is held on the first week of September. The other one is dedicated, since 2005, to the *haricot de Soissons*, also a white bean variety, used in various ways including in what some restaurateurs call “le soissonnais”, in reference to the cassoulet. One of the several legends linked to it features below. Both the tarbais and the Soissons bean have a red label and are registered under the “Protected Geographical Region” of the EU, as does the bean “la Mogette” from the Vendée region.
- Bengaluru has a festival dedicated to the lablab bean, also known as the hyacinth bean. It is called the *Avarekai Mela* and is held in the first week of January. Many dishes, both sweet and savoury, are on offer during the event.
- In many parts of Gujrat, on and around the 14th of January, kite festivals are organised to celebrate *Sankranti*. During these, food plays an important role and specially on offer is the signature dish of the state, *oondhyo*, in which the star ingredient is *papadi val*, a local lablab bean variety (see recipe section).
- Around the world, several harvest festivals are held during which bean/legume delicacies feature in some form or the other: if in South India, during *Onam* it is *olan*, a stew made with white pumpkin and red gram, in Hong Kong, China, or Viet Nam, during the mid-autumn festival, it is the red bean moon cake. Then, during *Baisakhi*, yet another Indian harvest festival, celebrated mostly in Punjab, apart from *sarson ka saag & makki ki roti*, *pindi chana* and *chhole bhature*, both using *Cicer arietinum*, regale everyone (see recipe section).
- In Nigeria, it is the African honey bean, a black-eyed pea variety, which is a festive dish during the Festival of Nations.



- In South America, beans have been playing a very important role since Mayan and Aztec times. According to *The Oxford Companion to American Food and Drink* (by Andrew F. Smith), indigenous people of what is called Latin America, such as the Hopi, Papajos and Iriquois, grew several types of beans and “even worshipped them in ceremonial bean dances or festivals.” Today also various types of legumes continue to play an important role in the lives of people of this region.

Legumes and beliefs, rituals and practices

In India, black gram, called *urad* and chickpea, called *chana*, play an important role in many rituals:

- Being a prized dal, whole urad bean is one of the offerings in ancestral worship performed during the *shraadh* period, dedicated to honouring the departed souls of our loved ones.
- To counter negativity, people put 14 beans of *urad* in oil, offer this to the deity Hanuman and then see the reflection of their face in the oil.
- Prior to the marriage ceremony, during a ritual called *haldi*, the groom and the bride to be are smeared with a paste of *besan*, chickpea flour, mixed with turmeric. This combination is cosmetically very effective as *besan* softens the skin and turmeric heals blemishes. A similar paste is smeared on the scalp of infants after their *mundan* ceremony when their baby hair is removed to allow for the growth of a thick mane.
- In the Jewish mourning tradition, lentils and boiled eggs are partaken by the mourners as the round shape of these food items symbolises the life cycle.
- In Italy and Hungary, eating lentils on New Year’s eve symbolises the hope of a prosperous year.
- In ancient Greece and Rome dried beans were used as ballots: white meant acceptance and black rejection.

- In the *Dictionary of Jamaican English* it is said that *Canavalia ensiformis* is called the overlook bean since it was believed to have a protective or “overlooking” influence on provision grounds.
- In some Christian countries, twelve beans are put in an egg during Easter to represent the twelve apostles.
- *Macrotyloma geocarpum* or Kersting’s groundnut, as this legume is also called, plays an important role in West African culture, especially in Togo. In fact this may have contributed to its conservation. Kaybé and Mauba people use these seed during funeral ceremonies. In many areas, they are exclusively intended for male members, in particular the headmen and voodoo priests. In Ghana, the Sisala people only feed these seeds to children who have lost their mothers during their funeral ceremony.
(source: www. prota4u.org)

Emblematic legume trees

- The Cockspur Coral Tree (*Erythrina crista-galli*), is the national flower of Argentina and Uruguay
- The Elephant Ear Tree (*Enterolobium cyclocarpum*) is the national tree of Costa Rica, by Executive Order of 31 August 1959.
- The Brazilwood Tree (*Caesalpinia echinata*) has been the national tree of Brazil since 1978
- The Golden Wattle, *Acacia pycnantha* is Australia’s national flower.
- The Hong Kong Orchid tree, *Bauhinia blakeana*, is the national flower of Hong Kong.
- The Khejri tree *Prosopis cineraria* is the sacred tree of the Bishnois as well as the state tree of Rajasthan and Telengana. It is also the national tree of U.A.E.
- *Sesbania bispinosa* is the provincial flower of Phra Nakhon Si Ayutthaya Province, Thailand.

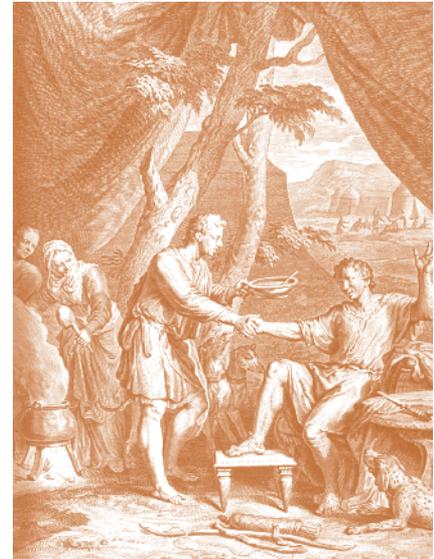
Stories: historical, apocryphal, fictional, biblical

Biblical

“And Jacob sold pottage: and Esau came from the field, and he was faint: And Esau said to Jacob, Feed me, I pray thee, with that same red pottage; for I am faint: therefore was his name called Edom. And Jacob said, Sell me this day thy birthright. And Esau said, Behold, I am at the point to die: and what profit shall this birthright do to me? And Jacob said, Swear to me this day; and he swore unto him: and he sold his birthright unto Jacob. Then Jacob gave Esau bread and pottage of lentiles; and he did eat and drink, and rose up, and went his way: thus Esau gave up his birthright.”

Genesis 25:29-34

Cited in: <http://christianity.stackexchange.com/questions/35731/why-did-esau-despise-his-birthright>



From the Book of Daniel in the Bible

The Old Testament carries the story of Daniel and his three friends. Taken captive to Babylon for training, Daniel and his friends were offered the rich food and drinks served at the king's table. Daniel demurred, proposing a 10-day experiment wherein he and his friends would eat the simple food known as pulse, and drink only water. Pulse is a traditional dish of cooked edible seeds, usually leguminous, such as lentils, chickpeas, and, perhaps, foods grown from those seeds. This plant-based diet was successful as Daniel and his friends were later found to look better and test wiser than those eating the king's fare. Daniel was wise beyond his years.

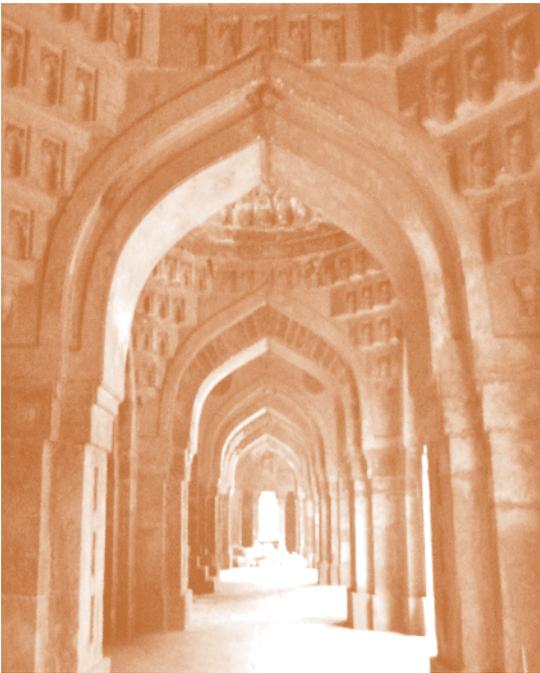
Cited in: <http://www.wordofwisdomliving.com/home/the-benevolent-bean.html>

Historical

Pythagoras & Fava Bean

Pythagoras, a Greek philosopher of the fifth century B.C, discovered the numerical relationships of musical tones and is considered the Father of Mathematics. He is also remembered for founding a religious brotherhood prohibiting eating of beans since they clouded thinking. The reason could be because he may have suffered from favism, a congenital adverse reaction to fava beans. Ironically it is believed that he met his death at the edge of a bean field, since he didn't step into it when being pursued by the people of Crotona.

Source: the new whole foods encyclopedia and The Benevolent Bean



Glimpse of Masjid Moth's architecture

Apocryphal / Historical

A charming story is associated with the humble moth bean; in fact two versions of the story exist. In one version, while strolling to visit a mosque, not too far away from the present Moth ki Masjid, Sultan Sikander Lodi bent down to pick up a seed, dropped by a bird. The seed happened to be a moth bean one. The king offered it to his Wazir of whom he was very fond. The gesture of his king so touched his Wazir, Miyan Bhaiya, that he told himself the seed must be put into the service of God. Taking it from the Sultan, he there and then decided to plant it in his garden. Over the years and multiple replanting that one seed grew exponentially to give him a rich enough harvest, enabling him to build a mosque. He invited his king to lay the foundation of the place

of worship which epitomises the best there is in the architectural style of the time. The mosque was naturally called Moth ki Masjid, the Mosque from moth bean. In the other version of the story, the seed was given in jest by the Sultan. However, not to be disrespectful towards his monarch, the Wazir honoured the gift by planting the seed. When the *masjid* was built from the revenue of the harvest, the Wazir invited his king to offer prayers there. An impressed Lodi named the mosque Moth ki Masjid.

Apocryphal or historical, the story emphasises the power of a single seed, the symbol of eternal renewability.

A sister story

Many stories revolve around the “haricot de Soissons”: one is very similar to that of the moth story. In 1728, a Spanish diplomat is said to have given a big fat white bean to the gardener Jacquot of the abbey of Saint Léger de Soissons, whom he had befriended when he came for a conference on Gibraltar. Jacquot multiplied the bean which became a particularity of Soissons. The Soissons bean is very big and it is supposed to be *P. coccineus* and not *P. vulgaris*; today this variety has a red label.

Chana, the Imperial Choice

Legend has it that when, imprisoned by Aurangzeb, Shah Jahan was asked to choose just one food item for the rest of his life, he opted for the versatile *chana*. This legume could be pounded into flour or *besan*, split into dal, cooked as a curry or even transformed into kebabs and its leaves could be made into *saag*. This choice was judicious not only from the culinary perspective but also from the health benefits angle.



Khejri

The Original Chipko: Before Rachel Carson

Dr. Vandana Shiva

My biological life and ecological journey started in the forests of the Himalaya. My involvement in the contemporary ecology movement began with “Chipko”, a non-violent peaceful response to the large-scale deforestation that was taking place. Chipko means “to hug”, “to embrace”. Women

declared that they would hug the trees, and the loggers would have to kill them before they killed the trees. In the 1970’s, peasant women from my region in the Garhwal Himalaya came out in defense of the forests. Logging had led to landslides and floods, and scarcity of water, fodder and fuel. Since women provide these basic needs, the scarcity meant longer walks for collecting water and firewood, and a heavier burden. Women knew that the real value of forests was not the timber from a dead tree, but the springs and streams, food for their cattle and fuel for their hearth. The folk songs of that period said –

“These beautiful oaks and rhododendrons,
They give us cool water
Don’t cut these trees
We have to keep them alive”

But the Chipko of the 1970’s was not India’s first Chipko. In an earlier Chipko in 1730, 363 people sacrificed their lives to protect their sacred *Khejri* tree (*Prosopis cineraria*). The *Khejri* stands as a sentinel in the desert landscape of Rajasthan.

The tree is vital to sustainability in the desert ecosystem. It is a source of fuel, firewood and organic fertilizer. Its fruit *Saangri* is rich in protein and is used for pickles and vegetables. The shade of the *Khejri* conserves moisture in the soil, and offers protection from the scorching sun to humans and animals.

The *Khejri* was declared a sacred tree by Jambhoji, a saint, who founded the *Bishnoi* religion. *Bishnoi* means 29, and the religion is based on 29 rules of compassion and conservation. Air Commodore Bishnoi, a family friend from Dehradun, and a supporter of the Chipko movement, has documented the first Chipko of the eighteenth century in his book “Conservation as Creed”.

In 1484 – 1485, Rajasthan experienced a severe famine. Jambhoji gave immediate relief by having seeds brought from Sindh (now in Pakistan). But he also used the crisis to establish the 29 rules for long term ecological security. Among these rules were compassion towards all living beings and not cutting green trees. In a discourse to one of his disciples, Nathaji, Jambhoji said –

Do no fell a green tree,
This is a charter for everyone,
Be always ready to save (trees)
This is the duty of everyone.

Udhonji Nain, a poet saint who accompanied Jambhoji, put the 29 tenets to verse–

“karaen roonkh pritipal,
Khejra raakhet rachen”

(All trees should be protected with care, and the Khejra should be tended with love)

Over two centuries, people were living according to these tenets, creating flourishing groves of trees and protecting wildlife in the Rajasthan desert. One such Bishnoi village was Khejarli, situated 20 km south of Jodhpur.

When the king's palace was being built, a court official, Girdhar Das, was given the responsibility for procuring firewood for burning the limestone for making lime. They arrived at the house of Amrita Devi, who was home with her three young daughters Asu Bai, Ratni Bai and Bhagni Bai. Amrita Devi had a giant Khejri growing at her door step. When the king's men started to cut the tree, she tried to stop them, saying the cutting of green trees was against her religion. She said she would rather sacrifice her life, than sacrifice the tree. Saying –

“sar ssathey roonkh rahey to bhi saasto jaan”

She offered her head, and the axemen who had come to cut trees cut off her head. Her daughters followed. They too were beheaded. The news spread like wildfire, and Bishnois of 84 villages gathered in Khejrli to join the stream of volunteers to protect the trees. 363 people sacrificed their lives, and the sacred Khejri trees were saved.

When the king of Jodhpur heard about this sacrifice, he immediately issued a royal decree making all cutting of green trees and hunting of animals within the revenue boundaries of Bishnoi villages a crime.

Even today, the Bishnois take people to court for killing their sacred species – the Khejri, the black buck, and the great Indian bustard. Famous film stars from Bollywood have had to face the court of compassion for killing wildlife.

The Indigo revolt

Indigo (a *Fabaceae* plant) planting in Bengal dated back to 1777. Louis Bonard was probably the first indigo planter. With expansion of British power in the Nawabate of Bengal, indigo planting became more and more commercially profitable due to the demand for blue dye in Europe. It was introduced in large parts of Burdwan, Bankura, Birbhum, Murshidabad, etc. The indigo planters left no stones unturned to make money. They mercilessly pursued the peasants to plant indigo instead of food crops. They provided loans, called dadon at a very

high interest. Once a farmer took such loans he remained in debt for the whole of his life before passing it to his successors. The price paid by the planters was meagre, only 2.5% of the market price. The farmers could make no profit growing indigo. The farmers were totally unprotected from the brutal indigo planters, who resorted to mortgages or destruction of their property if they were unwilling to obey them. Government rules favoured the planters. By an act in 1833, the planters were granted a free hand in oppression. Even the zamindars, money lenders and other influential persons sided with the planters. Out of the severe oppression unleashed on them the farmers resorted to revolt.

The Bengali middle class supported the peasants whole-heartedly. Harish Chandra Mukherjee thoroughly described the plight of the poor peasants in his newspaper *The Hindu Patriot*. However the articles were overshadowed by Dinabandhu Mitra, who gave an accurate account of the situation in his play *Neel darpan*. The play created a huge controversy.

The revolt started from Nadia where Bishnucharan Biswas and Digambar Biswas first led the rebellion against the planters. It spread rapidly in Murshidabad, Birbhum, Burdwan, Pabna, Khulna, Narail, etc. Some indigo planters were given a public trial and executed. The indigo depots were burned down. Many planters fled to avoid being caught. The zamindars were also targets of the rebellious peasants.

The revolt was ruthlessly suppressed. Large forces of police and military, backed by the British Government and the zamindars, mercilessly slaughtered a number of peasants. In spite of this, the revolt was fairly popular, involving almost the whole of Bengal. The Biswas brothers of Nadia, Kader Molla of Pabna, Rafique Mondal of Malda were popular leaders. Even some of the zamindars supported the revolt, the most important of whom was Ramratan Mullick of Narail.

Acknowledgment: Wikipedia

A Fairy Tale

Princess and the Pea

Once upon a time there was a prince who wanted to marry a princess; but she would have to be a real princess. He travelled all over the world to find one, but nowhere could he get what he wanted. There were princesses enough, but it was difficult to find out whether they were real ones. There was always something about them that was not as it should be. So he came home again and was sad, for he would have liked very much to have a real princess.

One evening a terrible storm came on; there was thunder and lightning, and the rain poured down in torrents. Suddenly a knocking was heard at the city gate, and the old king went to open it.

It was a princess standing out there in front of the gate. But, good gracious! what a sight the rain and the wind had made her look. The water ran down from her hair and clothes; it ran down into the toes of her shoes and out again at the heels. And yet she said that she was a real princess.

Well, we'll soon find that out, thought the old queen. But she said nothing, went into the bed-room, took all the bedding off the bedstead, and laid a pea on the bottom; then she took twenty mattresses and laid them on the pea, and then twenty eider-down beds on top of the mattresses.

On this the princess had to lie all night. In the morning she was asked how she had slept.

"Oh, very badly!" said she. "I have scarcely closed my eyes all night. Heaven only knows what was in the bed, but I was lying on something hard, so that I am black and blue all over my body. It's horrible!"

Now they knew that she was a real princess because she had felt the pea right through the twenty mattresses and the twenty eider-down beds.

Nobody but a real princess could be as sensitive as that.

So the prince took her for his wife, for now he knew that he had a real princess; and the pea was put in the museum, where it may still be seen, if no one has stolen it.

Acknowledgment: <http://www.eastoftheweb.com/short-stories/UBooks/PriPea.shtml>

Whats Cooking?

Beans, Peas & Lentils

Arhar / Tuvar Dal (Pigeon Pea)

Chholar Dal
Rasam
Sambar

Kabuli Chana (Chickpea)

Pindi Chhole
Vagharia

Desi / Kala Chana (Bengal Gram)

Chatpatey channe
Kala chana rasedar

Chana Dal (Bengal Gram Split)

Masala vada
Bengal gram kheer (madgane)
Chana dal and ghia – sukha
Pithore (besan)
Gatte ki sabzi (besan)
Jholi (besan)

Black Lentils (sabut masur)/ Red Lentils (lal masur) Black Gram (urad)

Masur pulav
Dhansak
Red lentil dal

Urad sabut / Urad Dhuli (Black Gram)

Dal makhani
Rice black gram poda pitha
Khatta dhokla
Sepu badi
Dahi bhalle
Garhwali chainsoo
Safed urad ki dum dal (dry)

Moong sabut/Moong Dhuli (Green Gram)

Green gram dal kheer
Bhaja moong dal
Moong and buckwheat

Khichdi
Amiri khaman
Dal palak soup
Sprouts and peanuts
Moong besan chila
Sweet pongal

Naurangi Dal (Rice Bean)

Naurangi dal

Rajma (Kidney Bean/ Common Bean)

Rajma salad
Rajma madrah
Punjabi rajma

Kulath Dal / Gehat (Horse Gram)

Alan manga jholi
Badil
Phaanu
Kulath saar

Matki - Moth Dal

Matki usal

Matki farasbee bhaji

Missal pav

Lobia (Cowpea)

Black eyed beans curry

Bhatt Dal (Black Soya)

Ras

Bhatt ki churdhani

Thathawani

Legume Vegetables

Undhyo

Gawar phalli (cluster beans)

French beans Talasani

Peas

Peapods sabzi

Legumes used Around the World

Pinto bean thanksgiving recipe

Baked bean

Moroccan chickpea soup
(vegetarian soup)

Mexican red bean

Stinky bean akhuni chutney

Lentil salad

Hummus

Tuscan bean soup



Chholar Dal

INGREDIENTS

250 grams	tuvar dal / arhar dal / yellow split pigeon peas
3	tej patta / bay leaves
3	whole red chillies
2 tbsp	mustard oil
1 ½ tsp	jeera / whole cumin seeds
½ tsp	ginger paste
½ tsp	ground chilli
1 tsp	jeera / fresh ground cumin
1 tsp	dhania / fresh coriander
400 ml	water
3 tsp	sugar
1 tbsp	ghee
2 tsp	ground garam masala
½	a coconut
	Salt to taste

Rasam

Ingredients

2 tbsp	tuvar dal / arhar dal / yellow split pigeon peas
1 small	tomato
1 ½ tsp	imli / tamarind soaked in ¼ cup water
2-3 tsp	rasam powder
a pinch	hing / asafetida
a pinch	haldi / turmeric powder
	salt to taste
For the tempering:	
1 tsp	oil
¼ tsp	rai / sarsoon / mustard seeds
5-6	kadi patta / curry leaves

METHOD

Weigh out the yellow split peas and cook them in the pressure cooker with double the amount of water and bay leaves and red chillies. Leave the cooker on high flame for 15-20 minutes. Take half the coconut and pry out the flesh from inside the shell.

Once peeled the coconut should be chopped into tiny pieces and fried in the pre-heated mustard oil, until the pieces start to turn pink.

Add whole cumin seeds, fry for a couple of minutes. Then add ginger paste, ground chilli, fresh ground cumin and coriander and salt to taste.

Fry the mixture for 2-3 minutes and then pour in the dal.

Stir all the contents, adding water when necessary until all the grains of the dal are mashed.

Add the sugar.

Just before removing the dal from the fire add ghee and garam masala.

Method

Combine the arhar dal with 1 cup of water and pressure cook for 2 to 3 whistles or until the dal is cooked.

Add the chopped tomato and tamarind water to the cooked dal and simmer for 2 to 3 minutes.

Add the rasam powder, asafetida, turmeric powder and salt with 3 cups of water and simmer for 8 to 10 minutes.

For the tempering, heat the oil in a pan and add the mustard seeds and curry leaves.

When the seeds crackle, add the tempering to the prepared rasam and simmer for another 4 to 5 minutes. Serve hot, garnished with the coriander.

Sambar

Ingredients

Ingredients A

- ½ bitter gourd (Pavakkai)
- 1 brinjal / Egg Plant / aubergines
- 1 drum stick
- 4 bhindi / okra / ladies finger
- 4 red Chillies Split Into 2

Ingredients B

- 1 cup sambar dal / masoor dal / red gram dal
- 1 sprig kadi patta / curry leaves
- ½ tsp turmeric powder
- 1 cup water

Ingredients C

- Golf ball size imli / tamarind
- 1 sprig curry leaves
- ¼ tsp asafetida powder
- 1 tsp red chilli powder
- ¼ tsp grated jaggery / cane sugar
- 2 tbsp coconut oil
- salt to taste
- 1 cup water

Ingredients 'D'

- ¼ tsp urad dal / white gram dal
- 2 tbsp dried dhania / coriander seeds
- ¼ tsp methi / fenugreek
- 4 dried chilli
- ½ tsp coconut oil

Ingredients 'E'

- 2 tsp coconut oil
- 2 dried chillies split into two
- 1 tsp rai / sarsoon / mustard

Ingredients 'F'

- a few dhania / coriander leaves

Method

Clean the vegetables and slice into long pieces. Wash the dal. Boil 3 cups of water and cook dal in it. Add turmeric powder and curry leaves into the dal. Keep it aside. Fry the ingredients in ½ tsp coconut oil. Grind it to a smooth paste and keep aside. Mash the tamarind in 1 cup water and strain. Boil the tamarind water with red chilli powder, salt, curry leaves, asafetida and jaggery. When it boils, add 2 tbsp of coconut oil. Add the vegetables except the okra to it. Cook till done and add the prepared dal into it. Bring to a boil and add the okra and the ground masala. Remove from fire after boiling. Season with rai and dried chillies. Sprinkle the sambar with chopped coriander leaves.



Pindi Chhole

Ingredients

To pressure cook

- 1 cup kabuli chana / bengal gram
- 2 tbsp chana dal / chickpea / split bengal gram
- 2 badi elaichi / big cardamoms
- 1" stick dalchini / cinnamon
- 2 tsp tea leaves tied in a muslin cloth
- ¼ tsp soda

Masala

- 2 onions chopped finely
- 1 ½ tsp anardana / pomegranate seeds powder
- 1 big tomato chopped finely
- 1" piece ginger chopped finely
- 1 green chilli chopped finely
- ½ tsp garam masala
- 1 tsp dhania / coriander powder
- 1 tsp chana masala
- salt & red chilli powder to taste

Vagharia

Ingredients

- 1 cup kabuli chana / bengal gram
- 6 black kokum
- 1 tbsp. dhania / coriander leaves finely chopped
- 1 stalk kadi patta / curry leaves
- 1 tbsp. besan / gram flour
- 1 tbsp. chilli powder
- ¼ tsp. haldi / turmeric powder
- 2-3 pinches hing / asafetida
- 1 tbsp. jaggery / cane sugar grated
- ½ tsp. rai / sarsoon / mustard seeds
- 2 cups water
- salt to taste

Method

Soak chana dal & kabuli chana overnight or for 6-8 hours in a pressure cooker.

Next morning, discard water. Wash the chana with fresh water and add elaichi, dalchini, tea leaves, soda, and enough water to cover the chana nicely.

Pressure cook all the ingredients together to give one whistle. After the first whistle, keep on low flame for about 20-25 minutes. Keep aside.

Heat the oil.

Add onions. Sauté till transparent. Add anardana powder. Cook stirring till onions turn dark brown.

Add chopped tomatoes, ginger & green chilli. Stir fry for 3-4 minutes.

Add dhania powder, chilli powder & garam masala.

Mash and stir fry tomatoes till they turn brownish in colour and the oil separates.

Strain chana, reserving the liquid.

Remove tea bag from the boiled chana and add the chana to the onion-tomato masala. Mix well. Add salt.

Stir fry gently for 5-7 minutes. Add chana masala and salt. Add the chana liquid. Cook for 15-20 minutes on medium heat till the liquid dries up a little.

Method

Soak and pressure cook chana, wash and drain.

Add one and half cups water.

Soak kokum in ¼ cup water for 5 minutes, keep aside.

Dissolve flour in ¼ cup water, keep aside.

Heat the oil in a large pan. Add rai seeds and allow spluttering. Add curry leaves, hing, kokum and water.

Add all other masala and jaggery. Stir fry for a minute.

Add chana with water, bring to a boil. Add besan; cook stirring, till boil is resumed. Simmer and cook till gravy is fairly thick. Add salt, stir and garnish with chopped coriander. Serve hot with steamed rice or parathas.

Chatpatey Chana

Ingredients

1 cup	kala chana / black chana
½" piece	ginger
1 tbsp	jeera / cumin
1 tsp	kala namak / rock salt
¼ cup	pudina / mint
½ cup	coriander, chopped
1 tbsp	amchur / mango powder
1 tbsp	chat masala
2	green chillies
½ tsp	chili powder
1 tbsp	oil
½ tsp	haldi / turmeric powder
½ tbsp	rai / sarsoon / mustard seeds

Kala Chana

Ingredients

250 grams	kala chana / black chana
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To grind

1	onion
4-5 flakes	garlic
½" piece	ginger
2-3 sticks	dalchini / cinnamon
3-4	lavang / cloves
2	star anise
2	elaichi / brown cardamom
1	/ green/white cardamom

To season

¼ tsp	haldi / turmeric powder
1 tsp	red chilly powder
	salt to taste

Method

Soak chana overnight and next day boil it with little salt in it.

See to it that they are quite soft to eat.

Grind together, coriander leaves, cumin seeds, pudina, ginger, green chillies, kala namak.

In pan heat oil and temper it with rai, hing and haldi.

To that add ground paste and fry for a minute or so.

Then add the remaining seasoning to it and boiled chana.

Add salt to taste and fry for couple of minutes.

Do not add water, and garnish it with freshly grated coconut, chopped coriander, onion rings and lemon wedges.

Method

Soak the kala chana overnight.

Boil it either in a cooker or a microwave cooker.

Grind the onion, ginger and the garlic flakes coarsely, do not make it a paste, keep mix aside.

Next take all the other spices and grind them together into a fine powder.

Heat oil in a pan or a kadai and add the ground spices and fry for a few minutes, add the turmeric and the chilly powder too.

Now add the onion, ginger and garlic mix and keep frying until you get a pleasant aroma.

Finally add the boiled kala chana and cover it with a lid.

Allow it to boil for a few minutes.

Kala Chana - Rasedar

Ingredients

200 grams	kabuli chana / bengal gram (soaked overnight)
1 litre	water
¼ tsp	soda bicarbonate
1	tej patta / bay leaf
2	elaichi / black cardamoms
1	small dalchini / cinnamon stick
¾ tsp	haldi / turmeric powder
	salt to taste

Curry gravy

2-3 tbsp	oil
1 tsp	jeera / cumin seeds
2	onions (peeled and quartered)
3	garlic cloves
1" piece	ginger
2 tsp	dhania / coriander powder
¼ tsp	chilli powder
200 grams	tomatoes (chopped)
1/4 tsp	garam masala
	a handful of chopped dhania / coriander leaves.
	a large pinch of hing / asafetida (optional)

Method

Wash and soak gram in water with the soda, overnight.

Place gram, water, turmeric, salt, bay leaf, cardamom and cinnamon in a pressure cooker. Close the lid and bring to boil, until you hear hissing sound. Turn heat down to medium and cook for 20-30 minutes. Cool and check that they are soft when pressed. If not, cook for another 10 minutes.

Meanwhile, grind onion, ginger and garlic to a paste or chop/grate very finely.

Heat the oil in a pan.

Add jeera and hing. As soon as seeds splutter, add onion, ginger, garlic paste and stir fry until nicely browned.

Add dhania powder, chilli and stir for a few seconds. Now add tomatoes and stir fry until oil separates from the paste.

Add to the gram mix in the pressure cooker. Add more water if needed

Pressure cook for 5 minutes. Allow to cool.

Open pressure cooker only when cool. Add garam masala and half the coriander leaves.

Garnish with rest of coriander leaves and serve hot.



Masala Vada

Ingredients

1 cup	chana dal / split Bengal gram
1/2 cup	onion finely chopped
1/2 cup	coriander finely chopped
1/2 cup	shepi / shepu / dill leaves, finely chopped
1/2 cup	pudina / mint leaves, chopped
3-4	green chillies, finely chopped
1/2 tsp	jeera / cumin seeds
	oil to deep fry

Method

Wash and soak dal for 3-4 hours.
Keep 2 tbsp. dal aside, coarsely grind the rest.
Mix all other ingredients, including whole dal.
Add 2-3 tbsp. hot oil to the mixture.
Make flattened balls of the mixture with moist palm.
Heat oil,
Carefully put the flattened rounds in the hot oil.
Fry first one side then the other till golden brown.
Serve hot with green chutney, tamarind chutney, or ketchup

Bengal Gram Kheer (Madgane)

Ingredients

1/2 cup	chana dal / split Bengal gram
1 cup	jaggery / cane sugar grated
10	elaichi / cardamoms (powdered)
2 cups	coconut milk (extract of 1 large coconut)
1/2 cup	cashew nut pieces
1/2 cup	rice flour or roasted wheat semolina

Method

Cook the chana dal and cashew pieces in 3 cups water.
When cooked, add jaggery and 2 cups water and cook well again.
Add the rice flour paste or fried semolina paste and stir well to avoid lumps.
Add coconut milk and cardamom powder.

Chana Dal & Ghia – Sukha

Ingredients

500 grams	chana dal / split Bengal gram
1	small ghia / kaddu / bottle gourd
1	onion
1 tsp	garam masala
2	tej patta / bay leaves
2 tsp	turmeric powder
1 tsp	red chili powder
2	lavang / cloves

Method

Cut the ghia into large pieces and keep aside.
Boil dal with turmeric powder and salt till done.
Heat oil and add tej patta and then onions.
Fry onions till they appear transparent and then add the cut ghia and salt as per taste
Let it cook; when done, add (1 tsp) garam masala and (1 tsp) red chili powder.
Mix dal and ghia and temper with 1 tbsp ghee, 1 tej patta and 2 cloves.

Pithore

Ingredients

For the pithore

1 ¼ cups	besan / chickpea flour / gram flour
2 tbsp	ginger-garlic paste
1 tsp	red chilli powder
½ tsp	haldi / turmeric powder
2	green chillies (chopped)
1½ cups	water
¾ cup	

For dry pithore

3 tbsp	oil
1 tsp	rai / sarsoon / mustard seeds
	juice of 1 lemon

For pithore with gravy

2 ½ cups	dahi / curds / yogurt
½ cup	oil
3	lavang / cloves
2	black elaichi / cardamoms
2	dalchini / cinnamon sticks (small)
2	onions (finely chopped)
	a few sprigs green dhanian / coriander (chopped)
4 tsp	ginger-garlic paste
1" piece	ginger (chopped)
1 tsp	red chilli powder
½ tsp	haldi / turmeric powder
2 tbsp	dhanian / coriander powder
½ cup	dahi / curds / yogurt
1 cup	water
	salt to taste

Method

For the pithore, mix together the gram flour, yoghurt, ginger, garlic paste, red chilli powder, turmeric powder, salt, green coriander, ginger and green chillies.

Add water and mix well.

Heat the oil in a wok.

Gradually pour the above mixture into the wok.

Cook till the mixture leaves the sides of the wok.

Spread the mixture uniformly in a greased tray.

Let it set for 1-2 hours.

Cut with a knife into 1" cubes or diamond shapes.

For dry pithore.

Heat the oil in a wok.

Add the rai seeds; when they crackle, add the pithore pieces.

Stir gently for a minute.

Remove from the flame and arrange in a dish.

Sprinkle the juice of a lemon on top, garnish with green coriander and serve as a snack.

For pithore with gravy

Heat the oil in a wok.

Add the cloves, black cardamoms and cinnamon sticks.

Sauté over medium heat for a few seconds.

Add the onions and cook till they are golden brown in colour.

Mix the ginger-garlic paste, red chilli powder, turmeric powder, salt and coriander powder with the yoghurt.

Add this to the wok

Cook till the oil separates.

Add the pithore pieces and the water.

Bring to a boil and then simmer for 5 minutes.

Serve hot.

Gatte Ka Saag

(Steamed Gram Flour Dumplings In Spicy Gravy)

Ingredients

1¼ cup	besan / chickpea flour / gram flour
2 cups	dahi / curds / yoghurt, sour
2 tsp	red chilli powder
1 tsp	haldi / turmeric powder
1 cup	oil
3 tsp	jeera / cumin seeds
1 cup	water
1 tbsp	dhania / coriander powder
	salt to taste
	water to boil



Method

Make soft dough with the gram flour, ½ cup yoghurt, salt, 3 tbsp oil, ¼ tsp red chilli powder and 1 tsp turmeric powder.

Apply a little oil on the hands and roll out 1" x 6" long cylindrical rolls of the dough.

Bring the water to a boil and slide in the rolls.

Cook for 5-7 minutes or till they become firm.

Drain the water and put the rolls aside to cool for 15 minutes.

Cut into ¾" – long pieces.

Heat the remaining oil;

Add the jeera seeds and let them crackle.

Add the gram flour pieces and stir-fry for 1-2 minutes.

Put the remaining dahi in a bowl, add the leftover spices and mix well. Add this mixture to the pieces, stir and cook for 2-3 minutes.

Add salt to taste.

Add water and bring to a boil.

Simmer for 5-7 minutes.

If the gravy is very thick, add a little more water and boil till the oil separates.

Serve hot.

Jholi

Ingredients

1 cup	besan / chickpea flour / gram flour
3 cups	dahi / curd / yogurt
½ cup	oil or ghee
4-5	garlic cloves
1 tsp	jeera / cumin seeds
4-5	red chillies, whole
½ tsp	dry dhania / coriander powder
½ tsp	haldi / turmeric powder
½ tsp	red chillies powder
3 cups	water
	salt to taste
	a pinch hing / asafetida
	chopped spinach or fenugreek leaves (optional)



Method

Jholi can be made of besan or rice flour.

Mix besan, 1/4 tsp turmeric powder and 1/2 tsp salt.

Make it into a thick paste by gradually adding water, and continuously folding it with a spatula

Now mix the paste with curd and water.

Churn the mixture well.

Take a pan or kadai and heat the oil.

Add garlic cloves in the hot oil.

When the garlic turns light brown, add red chillies and hing.

Immediately pour the curd mix into the frying pan.

Add turmeric powder, dry coriander powder, red chillies powder and salt.

Cook till the gravy starts thickening and the raw smell of besan is gone.

Let the jholi cook for about 10-15 minutes.

If you are using rice flour then cook it for few minutes more.

Add more water to keep the consistency thin.

Before taking it off from heat, add handful of chopped spinach leaves or chopped spring onion leaves.

Cook for few more minutes till the leaves are tender.

Garnish with a tablespoon full of ghee, coriander leaves and green chillies (slit apart into two pieces) and serve with steamed rice.

Masoor Pulav

Ingredients

1 cup	basmati rice
½ cup	whole masoor dal / red lentil
2	onions (cut lengthwise)
2	tomatoes (chopped finely)
1½ tsp	ginger, garlic and green chilly paste
1½ cups	cubed mixed vegetables (beans, carrots, green peas etc)
1 tbsp	garam masala
3 tbsp	oil
1 tsp	jeera / cumin
	salt to taste

Dhansak

Ingredients

¼ cup	tuvar dal / arhar al / yellow split pigeon peas
¼ cup	moong dal / green moong dal
¼ cup	urad dal / white gram dal
¼ cup	masur dal / red lentil
¾ cup	green pepper diced
½ cup	broccoli
½ cup	baigan / eggplant / aubergines
½ cup	carrots
½ cup	celery
½ cup	tomatoes
½ cup	onions
1 tbsp	ginger-garlic paste
1 tbsp	green chillies
1 tbsp	garam masala
¼ tsp	jeera / cumin seeds
1 tbsp	oil
½ tsp	ghee (optional)
	dhania / coriander leaves
	salt to taste

Method

Soak the masur for 3 hours. Precook the masur till done. Wash and soak the rice for about 1/2 an hour. Put 3 tbsp of oil in a thick kadai or wok, add jeera, fry for a second. Add onions and fry till pink. Add ginger garlic chilly paste and fry for a second. Add all the mixed vegetables and fry for a minute. Add 1 3/4 cup of water and let it come to a boil, add salt to taste. Add the rice, precook masur and biryani pulav masala too. Stir lightly and let the rice get cooked on low flame till all the water evaporates.

Note: if after all the water has evaporated and rice appears dry and under cooked you can sprinkle water and cook on low flame. Masoor pulav is ready.

Method

Wash all the dals together. Add 2 to 2 1/2 cups of water. Add broccoli, carrots, celery and cook in the pressure cooker. Heat oil; add cumin seeds, green chillies, onion and fry until onion becomes golden brown. Add ginger-garlic paste and fry for some more time. Add tomatoes, green pepper, and eggplant. Cover the vessel. Add some salt. Stir occasionally. Cook the vegetables. Then add cooked dal. Add some water, garam masala, coriander leaves, some salt if needed. Stir until boiling. Add ghee for great taste.

Red Lentil Dal

Ingredients

1 cup	masoor dal / split red lentils soaked for 30 min
¼ tsp	methi / fenugreek seeds
1	small tomato (finely chopped)
1 flake	garlic (crushed)
1 stalk	curry leaves
1 tbsp	dhania / coriander (finely chopped)
2	green chillies (halved)
1 tsp	red chili powder
¼ tsp	haldi / turmeric powder
¼ tsp	dhania / coriander powder
¼ tsp	garam masala powder
¼ tsp	jeera / cumin powder
¼ tsp	jeera / cumin & rai / sarsoon / mustard seeds
2-3	pinches hing / asafetida powder
2 tbsp	ghee or oil
	Juice of ½ a lemon
	Salt to taste

Method

Boil 1 litre water in a deep vessel. Add washed, drained, dal and methi seeds. Cover and simmer for one hour, or till dal is mushy. Or pressure cook for 3-4 whistles, till soft. Heat ghee in a pan; add mustard seeds, hing, allow spluttering. Add garlic, curry leaves, tomatoes. Add all dry masala powders, salt, and 2 tbsp of water. Stir and cook for a few seconds. Add cooked dal, stir and bring to a boil. Cover and simmer for 2-3 minutes. Take off fire, add lemon juice. Stir well, add coriander leaves. Serve hot with steamed or jeera rice.

Dal Makhani

Ingredients

100 grams	whole urad
25 grams	rajma / kidney beans
1 tsp	jeera / cumin seeds
1 tbsp	chopped garlic
1 tbsp	chopped ginger
1 tsp	garam masala powder
½ cup	fresh malai / cream
1 tbsp	red chili powder
50 grams	butter
½ cup	chopped tomato
1 cup	chopped onion
1 tbsp	oil
	salt to taste

Method

Pick, wash and soak black urad and rajma overnight in 5 cups of water. Cook the soaked dal and rajma in 5 cups of water with salt, red chili powder and chopped ginger till dal and rajma are cooked / soft. Heat the oil and butter in a thick bottomed pan. Add cumin seeds, let it crackle. Add chopped onions and cook till golden brown in colour. Add chopped ginger, garlic and chopped tomatoes. Sauté till tomatoes are well mashed and fat starts to leave the masala. Add boiled dal and rajma to this. Add garam masala powder and simmer on very slow flame for 15 minutes; add fresh cream and let it simmer for 5 minutes. Serve hot with naan or paratha.

Safed Urad ki Dum Daal (dry)

Ingredients

250 gms	urad dal
3	red chillies whole
1 tbsp	ginger chopped
	ghee
	salt to taste
	mint for garnishing

Method

Soak dal in clean water for 30 minutes and drain. Put a cooking vessel on fire and add ghee; break the whole red chillies into the pot. Add soaked dal, chopped ginger and salt.

Add enough water so that the dal cooks fully and is intact. It should not become soggy or very soft.

Temper with fried brown onions. Distribute the leftover ghee all over the dish.

Garnish with fresh chopped mint.

Serve with roti or parantha.

Rice Black Gram Poda Pitha

Ingredients

250 grams	rice
250 grams	whole urad
½	a fresh coconut
150 grams	sugar
150 grams	desi ghee / clarified butter

Method

Wash the rice and black gram dal under running water and soak in water for about 5 hours separately. Remove extra water from both.

Grind the soaked black gram dal into paste and keep it aside

Grind half of the soaked rice into coarse powder and mix it with the black gram paste. Add little water and salt.

This paste should resemble an idli mixture.

Keep the mixture overnight for fermentation.

Before cooking, add the coconut pieces and sugar.

Pour half of the ghee into a deep pan or kadai and heat.

Pour the mixture into the pan and cover with metal lid.

Let this simmer at low temperature for ½ an hour.

Keep stirring; pour the rest of the oil and simmer for another 15 minutes. Place the poda pitha on a plate and cut into pieces.



Khatta Dhokla

Ingredients

3 cups	rice
1 cup	urad dal / split black lentil
½ cup	sour dahi / curds / yogurt
2 tbsp	green chilli – ginger paste
¾ tsp	soda bi-carb
¼ tsp	hing / asafetida
1 tbsp	kali miri / black pepper, coarsely ground
3 tbsp	oil
	salt to taste

Sepu Badi

Ingredients

500 Grams	urad dal / split black lentil (soaked overnight and ground coarsely)
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For Masala

1 ½ tbsp	jeera / cumin seeds
1 ½ tbsp	dhania / coriander seeds
2-3	brown elaichi / cardamom
2	green elaichi / cardamom
1-2	whole red chillies
2-3	lavang / cloves
1 inch	dalchini / cinnamon
	pinch of hing / asafetida
	salt to taste

For Gravy

½ kg	palak / spinach (cut fine)
½ tsp	haldi / turmeric powder
1 glass	water
	salt to taste
	oil

For Garnish julienne of dry dates

Method

Alternatively, soak the rice and urad dal overnight in plenty of water and grind in a mixer the next day. Add the sour curds and hot water and make into a thick paste.

Allow to ferment for at least 6 to 7 hours.

Add the soda bi-carb, oil, asafetida, green chilli-ginger paste and salt and mix well.

Apply a little oil to a metal thali (flat metal plate with low rim). Pour enough batter so as to fill half the height of the thali.

This should ordinarily be about ½ cup for a small thali. Sprinkle a little ground pepper on top.

Steam for 10 minutes.

Repeat with the rest of the batter.

Cut into pieces and serve with oil and green chutney.

Method

Grind the soaked dal to a rough consistency.

Mix all the ingredients listed under masala.

Add the masala mixture to dal.

Take a huge oval-shaped lump of this mixture and drop it in boiling water.

Let it boil on high flame for 5 minutes till it automatically starts surfacing.

Drain water and cool cooked portion before cutting it into pieces.

Deep fry these cut pieces or badis and keep aside.

Heat the oil. Add spinach and the remaining masala, turmeric, salt and water.

Cook till the water evaporates.

At this stage you may add coriander and garam masala to spice up the dish.

Steam for six to seven minutes.

Dahi Bhalle

Ingredients

250 grams	urad dal / split black lentil
1	onion chopped finely
1" piece	ginger (chopped)
1 small bunch	green dhania / coriander (chopped)
2	green chillies
½ tsp	jeera / cumin seed
½ tsp	salt
¼ tsp	soda-bi-carb
750 grams	dahi / curds / yogurt
15-20	raisins
	water to soak dal
	oil for frying

Method

Wash and soak dal for 3 hours in enough water to cover the dal.

Drain water and grind, add chopped onion, ginger, coriander, chillies, salt, cumin seed and soda.

Heat the oil.

With moistened hands, make bhalla of 2" disc with dal batter.

Deep fry each bhalla till light brown. Drain oil, keep aside. Soak it in hot water for ten minutes.

Press out water lightly. Beat curds; add salt and 1/2 tsp. jeera. Soak the raisins in water for ten minutes.

Add to the curd. Lay bhallas in a flat dish, pour curds on it, garnish with red chilli powder, chopped coriander, and powdered cumin seeds.

Serve with tamarind chutney and the beaten curd.

Garhwali Chainsoo

Ingredients

1 cup	whole urad
½ cup	oil
4-5 cloves	garlic
1 tsp	jeera / cumin seeds
4	kali miri / black pepper corns
4-5	red chillies, whole
½ tsp	dry dhania / coriander powder
¼ tsp	haldi / turmeric powder
½ tsp	red chillies powder
3 cups	water
½ tsp	garam masala
	a pinch hing / asafetida
	salt to taste

Method

Place an iron frying pan (kadai) on a moderate flame.

Put sabut urad (black gram) in it and roast it without oil for about 3 to 5 minutes or till the pleasant aroma of roasted seeds is released.

Do not over cook it. Take off the flame.

Grind the roasted seeds into a coarse powder.

Heat oil in the kadai and add garlic cloves, when the garlic turns light brown, add cumin seeds, red chillies, black pepper, and hing. Immediately add the ground dal and fry it for 1-2 minute or so. Add turmeric powder, dry coriander powder, red chillies powder, salt and water. Bring it to boil.

Cover and cook till the dal becomes very soft.

Simmer for 20-30 minutes. Before taking it off the heat, sprinkle garam masala over chainsoo. Garnish with pure ghee and chopped coriander leaves. Serve with hot steamed rice.

Green Gram Dal Kheer

Ingredients

2 cups	moong dal / green gram dal
1	coconut (grated, ground, milk extracted)
1 tbsp	ghee / clarified butter
1 1/2 cups	jaggery / cane sugar
6 cups	water
	elaichi / cardamom powder

Method

Roast the dal in ghee.
Add 6 cups water and cook.
When well-cooked, add jaggery.
Cook for ten more minutes, add coconut milk and cardamom powder, and remove from heat.

Bhaja Moong Dal (Broiled Green Gram)

Ingredients

200 grams	split moong dal / split green gram
1 tbsp	oil
2 tsp	aniseed
3	lavang / cloves
3	green chillies slit
1 tsp	sugar
	Salt to taste

Method

Broil the split green gram on a griddle (tava) till golden brown.
Boil 2 cups of water and cook the split green gram till done. Heat the oil in a small pan; add aniseed, cloves and green chillies. Sauté just for a few seconds and then add to the split green gram. Add the sugar and salt, stir well and serve immediately.

Moong and Buckwheat Khichdi

Ingredients

1/2 cup	yellow moong dal / split yellow gram
1 1/2 cups	kuttu / kutti no daro / buckwheat
2	kali miri / peppercorns
1 to 2	lavang / cloves
1/ tsp	jeera / cumin seeds
1/4 tsp	hing / asafetida
1/4 tsp	haldi turmeric powder
1 tsp	oil
	salt to taste

Method

Clean and wash the moong dal and buckwheat together. Drain and keep aside.
Heat the oil in a pressure cooker and add the peppercorns, cloves and cumin seeds.
When the cumin seeds crackle, add the asafetida, followed by the moong dal and buckwheat and sauté for 2 to 3 minutes.
Add the turmeric powder, salt and around 4 cups of water and pressure cook for 2 to 3 whistles. Serve hot.

Amiri Khaman

Ingredients

For khaman

1 cup chana dal / split Bengal gram
Salt to taste.

For topping

1/4 cup imli / tamarind chutney
2 tbsp green chutney
1 cup fine bland shev
2 onions chopped finely
2 tbsp dhania / coriander leaves finely chopped
1 tsp crushed jeera / cumin seeds
salt to taste

Dal Palak Soup

Ingredients

200 grams palak / spinach leaves
1 tbsp moong dal / green gram
1 tbsp butter
1 tbsp maida / refined wheat flour
1/2 tea cup milk
salt & pepper to taste

Sprouts and Peanuts Salad

Ingredients

50 grams sprouted moong / green gram
50 grams sprouted chana / chickpea / bengal gram
50 grams peanuts
1 lemon
1/4 tsp kali miri / black pepper powder
salt to taste

Method

For khaman

Wash and soak the dal for 4 to 5 hours
Grind the soaked dal in mixer till fine. Keep the batter fairly thick. Add salt, mix well; pour into a pressure cooker container. Cover with lid, pressure cook for 2 whistles. Cool. Crumble the khaman
The result should be like bread crumbs.

To serve

Spread some khaman crumbs on a serving plate.
On this sprinkle the chutneys.
Sprinkle salt, cumin, shev, onions and coriander.
Serve immediately.

Method

Thoroughly wash the dal and spinach separately and remove the thick stems of the spinach. Cook them in a pressure cooker until they are well cooked. Blend the spinach and dal to a smooth puree in a blender.
Heat pan and put the butter in it Add the flour and cook a little. Add the milk, puree, salt and pepper
Cook for 4-5 minutes, stirring once in 2 minutes.

Method

Roast the peanuts and remove skin.
Mix the sprouted moong, chana and peanuts
Add black pepper, salt and lemon juice to the mixture and mix well
If required garnish with chopped coriander and serve.

Moong Besan Chila

Ingredients

1 cup	green moong dal / split green gram
4	green chillies
2 tbsp	fresh dahi / curds / yogurt
1 tbsp	besan / chickpea flour / gram flour
½ tsp	baking powder
	a pinch hing / asafetida
	salt to taste
	oil for cooking

For the stuffing

4	potatoes boiled
1 tsp	jeera / cumin seeds
1	onion chopped
4	green chillies
1 tbsp	dhania / coriander chopped
½ tsp	chilli powder
1 tsp	amchur / mango powder
1 tbsp	ghee
	salt to taste

Sweet Pongal

Ingredients

2 cups	rice
¾ cup	split moong dal / green gram dal
1-3 cups	milk
3 cups	jaggery / cane sugar
½ grated	fresh coconut
50 grams	cashew nuts
50 grams	raisins
7-8	elaichi / cardamom
½ cup	ghee

Method

For The Stuffing

Mash the potatoes coarsely or cut into very small pieces. Heat the ghee in a vessel, add the cumin seeds and onion and fry for at least 3 minutes.

Add the green chillies and fry again for 1 minute.

Add the potatoes, coriander, chilli, powder and salt. Mix well and cook for 1 minute.

Cool the mixture.

For the chilas

Soak the dal overnight or for at least 3 to 4 hours.

Grind the soaked dal with the green chillies and curd.

Add the besan, asafetida, baking powder and salt and mix well. Heat a non-stick tava and spread a little of the moong dal mixture

Spread a little stuffing on each round and smear a little oil on the sides. Cook on both sides.

Repeat with the remaining mixture and stuffing.

Method

Wash and rinse the rice and green gram separately.

Lightly fry the green gram dal. In a large vessel, boil the milk and water and add the rice and green gram dal.

Cook till all the liquid has been absorbed and it looks soft and pulpy. Add the jaggery and cook over a slow fire stirring it often to prevent sticking to the bottom

4 tsp of ghee could be added to prevent this.

It should be kept on the fire till the jaggery mixes well with rice and the pongal becomes sticky in consistency.

Fry the cashew nuts, raisins and coconut gratings in a little ghee.

Add the cardamom powder to fried ingredients, fry a little more, and then mix into the pongal.

Add the remaining ghee in liquid form to the pongal. Remove from fire and serve.

Naurangi Dal

Ingredients

1 cup	naurangi dal / rice bean
500 ml	water
1	onion, medium
¼ cup	oil
1"piece	ginger, crushed
5	garlic cloves
2	green chillies chopped
2 tbsp	green coriander, chopped
½ tsp	haldi / turmeric powder
1 tsp	garam masala
1	tomato medium
1 tsp	red chilli powder
1 tsp	dhania / coriander powder
1 tsp	salt

Method

Wash dal in water until water runs clear, then leave to soak in cold water for about an hour. Drain dal and keep aside. Heat the oil in a saucepan. Add the chopped onions, ginger and garlic. Stirring frequently, fry for a few minutes until the mixture turns to a pale golden colour. Add 3-4 tbsp of water if the mixture sticks to the bottom of the pan. Add chilli powder, turmeric, salt and coriander powder and about 5 tbsp of water to prevent the spices from burning. Stirring frequently, fry the mixture for about 5 minutes to a golden colour. Add the tomatoes. Still stirring frequently, fry the onion mixture for about 10 minutes until the tomatoes are reduced to a pulp. Add a little water, if necessary, to prevent the mixture from sticking to the bottom of the pan. Keep frying until the oil begins to separate. Add the drained dal and water. Mix well, reduce the heat, cover and allow to cook for about 30 minutes or until dal is tender and all the moisture has dried up. Add garam masala, coriander leaves and green chillies. Serve with naan, or roti.

Rajma Salad

Ingredients

¼ cup	rajma / kidney beans soaked overnight
1 tsp	lemon juice
¼ cup	cucumber finely chopped
1 tsp	roasted jeera / cumin powder
¼ cup	tomato chopped
	salt to taste

Method

Drain out the water from the soaked rajma. Add fresh water and salt and pressure cook the rajma until soft but not mushy. Drain and cool completely. In a bowl, combine with the cucumber, tomato, lemon juice, cumin powder and salt and mix well. Serve immediately.



Rajma Madrah

Ingredients

1 cup	rajma / red kidney beans soaked overnight
2 cups	dahi / curds / yogurt
1 tbsp	besan / chickpea flour / gram flour
½ cup	ghee / clarified butter
1 tsp	red chilli powder
½ tsp	haldi / turmeric powder
½ tsp	methi / fenugreek seeds (roasted and powdered)
1 tsp	whole garam masala (mixed spices)
1	tej patta / bay leaf
½ cup	cashew nuts and almonds (chopped)
¼ cup	raisins
¼ cup	dry coconut (finely sliced)
	salt

Method

Cook beans with salt till done.
Beat curd and gram flour together.
Heat clarified butter.
Add bay leaf and splutter garam masala.
Add curd mixture and cook till it starts browning.
Add rajma and continue to cook for a few minutes.
Add chilli powder, turmeric, fenugreek and cook for a while on low flame.
Add dry fruits, coconut and serve hot.

Punjabi Rajma

Ingredients

1 cup	rajma / kidney beans
1	onion
1	tomato
1	green chilli
4-5	garlic cloves
1" piece	ginger
1 tsp	red chilli powder
½ tsp	haldi / turmeric powder
½ tsp	dhania / coriander powder
1 tsp	garam masala powder
3 tbsp	vegetable oil
	salt to taste
	dhania / coriander leaves for garnishing

Method

Soak rajma in water overnight.
Pressure cook the rajma until tender.
Cut onion, tomato and green chilli.
Grind them in the mixer along with ginger and garlic to make a paste. Heat the oil in a pan.
Add the paste and fry on medium heat until golden brown (the oil starts separating from the mixture).
Add red chilli powder, turmeric powder, coriander powder, garam masala and salt. Mix well.
Fry for 2-3 minutes. Add enough water to make thick gravy.
Bring the gravy to boil.
Add cooked rajma along with the water in which it was cooked.
Stir well and cook over medium heat for 5-7 minutes.
Garnish with chopped green coriander leaves and serve hot.

Alan Manga Jholi

Ingredients

300 grams	kulath / horsegram
1 tsp	haldi / turmeric powder
50 grams	rice paste
1 tsp	dhania / coriander powder
1 tsp	red chilli powder
20 grams	ginger
	a pinch hing/ asafetida
4-5	garlic cloves
½ tsp	jeera / cumin seeds

Badil

Ingredients

1 cup	kulath / horse gram
2 cups	mix of tuvar / arhar, moong, and chana dals
½ cup	oil or ghee
10	garlic cloves
1" piece	ginger
1 tsp	ajwain / carom seeds
3-4	green chillies
1 tsp	jeera / cumin seeds
4	kali miri / black peppercorns
1.27 cm	dalchini / cinnamon
4	lavang / cloves
½ tsp	dry dhania / coriander powder
½ tsp	haldi / turmeric powder
½ tsp	red chilli powder
2 cups	water
	salt to taste
	a pinch hing / asafetida

Method

Chop ginger and garlic.

Boil dal and add ginger, garlic, turmeric, coriander, half of the chilli powder and salt.

When done, add rice paste and cook for some time.

Temper with cumin seeds, hing, and rest of the chilli powder.

Method

Put the frying pan on a moderate flame.

Pour one-teaspoon oil.

When the oil gets hot temper it with hing and

ajwain. To this hot oil mixture add two cups

water and salt to taste. When the water starts

boiling add the mixture of all the pulses (dals).

Cover with a lid and cook for about 10 minutes

on a moderate flame. Add some water if required

Crush and grind the cooked pulses with a ladle.

Continue doing this till the pulses do not stick to

the ladle. Now apply some oil in a thali / plate

with raised edges and pour the cooked pulses in

it. Spread uniformly, and allow it to cool.

On cooling and solidifying cut it into small cakes

called badil. Shallow fry these badils.

Serve on a plate with sweet & sour chutney and

garnish with coriander leaves and grated coconut.

Phaanu

Ingredients

1 cup	kulath / horse gram
½ cup	oil
4-5	garlic cloves
1/2" piece	ginger
3-4	green chillies
1 tsp	jeera / cumin seeds
½ tsp	dry dhania / coriander powder
¼ tsp	haldi / turmeric powder
3 cups	water
a pinch	hing / asafoetida
	salt to taste

Method

Soak kulath in water overnight. In the morning wash and rub the dal in running water so that it is free of seed covering (chilka). Then, grind it into a dry thick paste in a mixer or on a silbatta along with green chillies, garlic and ginger. Place a tawa on a moderate flame. Put some oil and make thick pancakes with the dal paste. Use only half of the paste for making the cakes. Mix water with the remaining paste making it a pouring consistency. Heat oil in a pan and add hing. Now add the kulath paste, turmeric powder, dry coriander powder and salt. Cover and cook for about 10 minutes on slow fire. Add the cakes to the gravy and continue simmering for another ten minutes. The gravy should be of a pouring consistency. If thick add some water and heat till it boils. Garnish with pure ghee and chopped coriander leaves. Serve with steamed rice.

Kulita Saar

Ingredients

1 cup	Kulath / Horsegram
½ cup	grated coconut
1 tsp	dhania / coriander seeds
2	green chillies
4 to 5	red chillies
1	onion
9 to 10	garlic flakes
2" piece	imli / tamarind or 1 tsp pulp
	oil
	salt

Method

Cook the kulath in a pressure cooker. Heat the oil. Fry the coriander seeds. Grind with coconut, red chillies, tamarind. Grind cooked kulath with the ground masala. Add water to make it a little watery. Add chopped onion & bring it to boil. Add green chillies and salt. Cook for about 15-20 minutes. Heat the oil for seasoning. Add garlic to the oil and cook till the garlic turns a light brown. Add this to Saar.

Matki Usal

Ingredients

1 cup	moth/matki beans soaked overnight
2	onions medium sized, chopped
1 tsp	red chilli powder
1 tsp	rai / sarsoon / mustard seeds
1 tsp	jeera / cumin seeds roasted and powdered
4 flakes	garlic chopped
4	green chillies chopped
1 tsp	goda masala or garam masala powder.
½ tsp	haldi / turmeric powder
2	tomatoes medium sized, chopped
1 tsp	jaggery / cane sugar grated
1 sprig	kadi patta / curry leaves optional
2 tbsp	oil
	salt to taste
	coconut shavings (optional)
	finely chopped dhania / coriander leaves to garnish.

Matki Farasbee Bhaji

Ingredients

2 cups	chopped green beans
1½ cup	sprouted matki/moth
1 tbsp	goda masala
1 tsp	chilli powder
2-3 tbsp	crushed jaggery / cane sugar
3 tbsp	fresh/frozen grated coconut (optional)
¾ cup	hot water
1 tsp	oil
½ tsp	rai / sarsoon / mustard seeds
	chopped dhania / coriander leaves (optional)
	a pinch hing / asafoetida
	a pinch haldi / turmeric powder
	salt to taste

Method

Heat the oil, drop in the mustard seeds and let them splutter.

Add the chopped green chillies, garlic and curry leaves (optional).

Stir fry for a few seconds.

Now add the chopped onions and sauté on medium heat for 5 minutes or till the onions are lightly browned.

Add the jeera, haldi and red chilli powders.

Add the hot spice mix, jaggery, salt, tomatoes and fry till oil separates.

Add the drained moth beans / matki.

Mix well and add water just enough to cover this mixture.

Bring to a boil. Cover and cook on medium / low heat for 20 minutes or till the moth beans are fully cooked.

Garnish with coconut shavings (optional) and finely chopped coriander leaves.

Method

Heat the oil in a pan.

Add mustard seeds and let them splutter.

Then add the hing.

Add the chopped beans, sprouts and haldi powder. Sprinkle some water on them.

Cover with a lid and steam them till they are cooked yet have a slight crunch.

Now add the hot water and all the other ingredients.

Simmer very gently for 3-4 minutes.

Garnish with some more chopped coriander leaves or grated coconut.

Missal Pav

Ingredients

1 cup	moong / green gram sprouts
1 cup	matki / moth sprouts
2 tbsps	oil
½ tsp	rai / sarsoon / mustard seeds
	a few kadi patta / curry leaves
2	onions (finely chopped)
2	green chillies (slit)
1 tsp	garlic paste
1 tsp	ginger paste
½ tsp	haldi / turmeric powder
1 ½ tsp	red chilli powder
½ tsp	dhania / coriander powder
½ tsp	jeera / cumin powder
1 tsp	garam masala powder
2 tbsps	fresh dhania / coriander leaves (finely chopped)
½ cup	shev
	a pinch hing / asafoetida
	salt to taste
	lemon juice as required
	lemon slices as required
8	pavs (bread)

Method

Mix sprouts in a colander and wash under running water for a minute. Drain and keep aside. Heat oil in a pan; add hing, rai seeds, kadi patta and half the onions. Sauté for a minute and add green chillies. Add garlic paste and ginger paste. Stir well and sprinkle a little water. Add haldi powder, red chilli powder, dhania powder, jeera powder and mix well. Add the sprouts. Add salt to taste and three cups of water. Bring to a boil. Add garam masala powder and coriander leaves, keeping aside some for garnish.

Cover and cook for ten to twelve minutes.

To serve: pour a ladleful of cooked sprouts in a deep bowl. Sprinkle generously with shev.

Sprinkle remaining onion, coriander leaves and freshly squeezed lemon juice. Serve with lemon slices and pav.

Black Eyed Beans Curry

Ingredients

2 cups	lobia / black eyed beans
1 ½ tsp	dhania / coriander powder
¾ tsp	jeera / cumin powder
½ tsp	haldi / turmeric powder
2 tbsps	oil
1	onion small size, chopped
2	garlic cloves chopped
¾" piece	ginger chopped
½ tsp	jeera / cumin seeds
1	tomato medium sized, chopped
	salt to taste

Method

Soak the beans overnight in water.

Next day, drain beans, cover with fresh water and bring to boil. Add salt, dhania, jeera and haldi. Simmer until beans are just tender, about 30 to 45 minutes. Heat the oil in deep saucepan.

Add onion, garlic, ginger and jeera.

Fry for 10 minutes and add tomato.

Cook for another 5 minutes and add the lobia / black eyed beans and cooking liquid.

Continue to simmer, uncovered, until lobia are soft but not completely dissolved.

Mixture should be soupy.

Ras

Ingredients

½ cup	black bhatt / black soy beans
¼ cup	rajma / kidney beans
¼ cup	lobia / black eyed beans
¼ cup	kala chana / bengal gram
¼ cup	kabuli chana / chickpea
¼ cup	whole urad / black gram
½ cup	kulath / horse gram
1 tsp	dhania / coriander powder
1 tsp	jeera / cumin powder
½ tsp	red chilli powder
½ tsp	garam masala
2 tbsps	ghee
4-5	whole red chillies
	salt to taste

Method

Soak all the dals overnight and next day boil them in plenty of water till soft.

Mash the dals well and strain the ras i.e. the stock. Mash and strain the remaining pulp again till the water runs clear. Put the stock on heat and keep boiling till it starts to thicken. While boiling add the haldi, dhania powder, jeera powder, red chilli powder, garam masala and salt to the ras.

When ras is gravy like consistency, take off from heat. Temper by heating the ghee, and adding whole red chillies, pinch of hing, jeera.

Allow to crackle and pour over ras. Serve with lots of ghee and rice.

Bhatt Ki Churdhani

Ingredients

1 cup	black bhatt / black soy beans
1	onion
½ tsp	jeera / cumin seeds
1 tsp	dhania / coriander powder
1 tsp	jeera / cumin powder
½ tsp	chilli powder
2 tbsps	oil
4-5 cups	water
	rice paste or plain flour
	salt to taste

Method

Soak bhatt overnight. Heat the oil in a kadai.

Add jeera, chopped onion and the soaked bhatt together and fry till the onions start getting brown.

Now add 1-2 tsp of plain flour and fry again for few minutes. Put haldi, dhania, jeera powder and chilli powder. Fry for few more seconds.

Add 4 cups of water and cook on high flames.

Cover and simmer for 30-40 minutes or till bhatt is soft and the curry is thick.

The colour of churdhani should be dark greenish black. It is served with hot steamed rice.

Thathawani

Ingredients

2 cups	black bhatt / black soy bean
1 cup	kala chana / bengal gram
½ cup	kulath / horse gram
½ cup	urad / black gram
½ cup	rajma, whole / kidney beans
8-10	garlic cloves
1	onion
1"piece	ginger
1 tsp	jeera / cumin seeds
4	kali miri / black peppercorns
1.27 cm	piece dalchini / cinnamon
7	lavang / clove
5	elaichi / cardamoms
4-5	red chillies, whole
1 tsp	dhania / coriander powder
1 tsp	khus-khus / poppy seeds, rice thickener
1 tbsp	rice powder
	salt to taste
1 cup	water
2 tbsp	ghee
½ tsp	shah jeera
½ cup	dhania / coriander leaves

Method

Wash the dals and soak them in water for about two hours. When the seeds have become well soaked, boil them with water in an iron utensil. Cook for about one and a half to two hours. The longer the dals are cooked the tastier the broth becomes. Alternately the dals can be cooked in a pressure cooker for 30 to 45 minutes.

Drain the dals and keep the liquid broth aside. Grind all the green and dry masala into a uniform paste with a little water. Mix rice powder, salt and water to make the rice thickener.

Add the masala paste to the rice thickener. Put an iron frying pan on a moderate flame. Pour the liquid broth and masala paste with the rice thickener. Cook for about ten minutes to get thathawani. Take a wok, pour the ghee and allow it to get hot. Put shah jeera in the hot ghee. Add the seasoning to the thathawani.

Garnish with ghee and coriander leaves if desired.



Undhyo

Ingredients

1 cup	baby potatoes, peeled
1	raw banana cut into 25 mm. (1") cubes
3 to 4	baigan / eggplant / aubergines small black variety
1 1/4 cups	surti vaal papdi / fresh lablab, stringed and cut into halves
3/4 cup	kand / purple yam, peeled and cut into cubes
1/4 cup	suran / yam, peeled and chopped
1/4 cup	fresh tuvar / arhar / pigeon pea / dana
2 tbsp	oil
1/2 tsp	ajwain / carom seeds
1/4 tsp	hing / asafetida
	salt to taste

Coriander-coconut masala

1 cup	freshly grated coconut
1/2 cup	dhania / coriander leaves finely chopped
1/3 cup	green garlic finely chopped
1 tbsp	dhaniya - jeera powder / coriander-cumin powder
2 tsp	ginger-green chilli paste
1 1/2 tsp	chilli powder
1 tbsp	sugar
1 tbsp	lemon juice
	salt to taste

Methi moothiyas

3 cups	methi / fenugreek leaves
	salt to taste
1/2 cup	gehun ka atta / whole wheat flour
1/2 cup	besan / chickpea flour / gram flour
3 tsp	ginger-green chilli paste
2 1/2 tsp	sugar
1/2 tsp	haldi / turmeric powder
1 tsp	chilli powder
3 tbsp	oil
	oil for deep frying

Garnish

3 tbsp	dhania / coriander leaves finely chopped
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Method

For the methi moothiyas

Combine the fenugreek leaves and a little salt in a bowl and mix well. Allow to stand for 5 to 7 minutes and squeeze out all the liquid from the fenugreek leaves.

Add all the remaining ingredients and knead into a soft dough, adding water only if required.

Divide the dough into 20 equal portions and shape each portion roughly into a round by rolling it between your palms and fingers.

Heat the oil deep fry the moothiyas a few at a time on a medium flame till they turn golden brown in colour.

Drain on an absorbent paper and keep aside.

Make a criss-cross slit on each baby potato, banana piece and brinjal taking care not to separate the segments.

Stuff the vegetables evenly using 1/2 of the coriander-coconut masala mixture and keep aside. Combine the fresh surti papdi, kand, suran, touvar dana and the remaining masala mixture in a bowl, mix well and keep aside to marinate for 8 to 10 minutes.

Heat the oil in a pressure cooker, add the ajwain and hing sauté on a medium flame for a few seconds. Add the stuffed baby potatoes and brinjal, all the marinated vegetables, salt and 2 cups of hot water, mix gently and pressure cook on a high flame for 2 whistles. Allow the steam to escape before opening the lid.

Transfer the cooked vegetables into a big non-stick pan, add the stuffed bananas and methi muthias, toss gently and cook on a slow flame till the bananas are tender, while stirring occasionally. Serve hot garnished with coriander.

Gawar phalli (cluster beans)

Ingredients

250 grams	gawar phalli / cluster beans
1 tbsp	oil
1 pinch	hing / asafetida
1/4 tsp	roasted jeera / cumin powder
1/4 tsp	haldi / turmeric powder
1 tsp	dhania / coriander powder
1/4 tsp	red chilli powder
2-3	green chilli, finely chopped
	salt to taste
1/4 tsp	amchur / dry mango powder
1 tbsp	dhania / coriander leaves finely chopped

Method

Thoroughly wash the gawar, and remove the edges and strings from it. Cut the beans into 2 inch pieces each. Heat oil in a pan; Add hing, jeera and fry them till the jeera becomes brown in colour. Add haldi powder, dhania powder, green chilli, red chilli and mix well. Add salt and cluster beans stir it for 2-3 minutes. Add 1 table spoon water, cover and simmer 10 minutes. Cook till the beans are tender. Add amchur powder in and simmer for 3-4 minutes on a medium flame. Garnish with dhania leaves before serving.

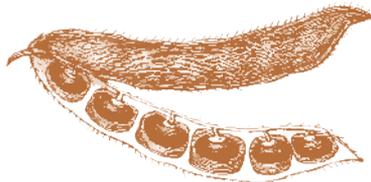
French beans - Talasani

Ingredients

1/4 kg	French beans, ends cut and stringed
2-3	whole red chillies roughly cut
5-6	whole garlic cloves peels kept, crushed slightly
2 tsp	oil
	salt to taste

Method

Snap the beans into one inch pieces. In a kadai add oil and saute the garlic cloves in it till they start turning brown. Add the chillies and saute for a minute. Add the beans and salt to taste. Sprinkle a few tbsps of water. Cover with a lid and cook for 5-10 minutes or till the beans are cooked. Serve with rice and dal.



Peas

Ingredients

3	medium to large tomatoes, chopped
10 to 12	cashews/kaju
1 cup	matar / peas
½ inch	ginger
1 to 2	green chillies
2 tbsp	fresh curd/dahi / yogurt, beaten
2 tbsp	milk
	a pinch hing / asafoetida
½ tsp	haldi / turmeric powder
½ to ¾ tsp	lal mirch powder / red chili powder
1 tsp	jeera / cumin powder
1 tsp	dhania powder / coriander powder
½ tsp	garam masala powder
½ tsp	kasuri methi / dry fenugreek leaves, crushed
1 cup	water
3 tbsp	oil
	salt to taste
	whole garam masala
1 bay	tej patta / bay leaf
2	lavang / cloves
2	chotti elachi / cardamoms
1 inch	dalchini / cinnamon
1 or 2 single	strands of javitri / mace (optional)

Method

First soak kaju in warm water for 20 to 30 minutes; while the kaju are soaking, steam the fresh peas till they are cooked.

In a mortar-pestle crush to a paste the ginger and green chillies. Drain the cashews and blend them with the chopped tomatoes without adding any water, grind to a fine and smooth paste. Keep aside. Heat oil in a pan. Add the garam masala.

Saute till the spices give off a fragrant aroma.

Add ginger and green chili paste and a generous pinch of hing. Stir and saute till the raw aroma of ginger and green chillies go away. Add the tomato-cashew paste. Cover and cook for a few minutes

Keep stirring till it thickens and you see oil specks on top and oil releasing from the sides.

Add the haldi, red chili powder, jeera powder, dhania powder and the garam masala powder. Stir and saute for a minute. Lower the flame and add beaten curd. Keep stirring so that the curd does not curdle.

Add 1 cup water. Now add the cooked green peas. season with salt. Add the milk.

Bring the peas masala curry to a simmer on a low to medium flame. Lastly add crushed kasuri methi.

Garnish with coriander leaves before serving



Peapods sabzi

Ingredients

1 cup	matar ke chhilke (peel of pea pods), chopped small
1 cup	boiled potato, peeled and cubed in small size
1 tsp	jeera / cumin seeds
	A pinch hing / asafetida
	salt to taste
½ tsp	red chili powder
1 tsp	haldi / turmeric powder
½ tsp	amchur / dry mango powder
1	green chilli, finely chopped
½ tsp	garam masala (optional)
1 tbsp	cooking oil

Pinto Bean Thanksgiving Recipe

Ingredients

1/2 Kilo	red beans or pintos beans
	1 bay leaf
2 tbsp	extra virgin olive oil
1	yellow or red onion, chopped
	salt to taste
2 to 4	garlic cloves (to taste), minced
¼ cup	tomato paste
2 tbsp	honey
2	chipotles in adobo, seeded and minced (chipotles are dried, smoked jalapeños. Adobo is a tangy, slightly sweet red sauce)
2 large	sweet potatoes peeled and cut in large dices.

Method

Peel the pea pods and separate the two halves of each pod. Now fold and press each half of the pea pod in such a way that outer fleshy side of the pod remains outside. Remove the inner tough membrane of pod, by sliding it down slowly along the length of the pod from inside. Separate all the peels and then chop them in small pieces. Keep them aside for later use. Heat the oil in a pan and add hing and jeera seeds. Add chopped peels of pea pods. Let it cook for few minutes on a medium flame. Add cubed potatoes to this and mix. Add haldi, red chili powder, chopped green chillies and salt. Cook covered on low heat till the vegetable is just tender. Add in amchoor powder and garam masala powder. Remove and serve hot with chapati

Method

Pick the beans for stones and then soak overnight in water. Place the beans and soaking water in an ovenproof casserole. Add bay leaf and bring to a gentle boil over medium heat. Reduce heat to low, cover and simmer 1 hour. Check beans at regular intervals to make sure they are submerged, and add water as necessary. Meanwhile, heat oven to 300 degrees. Heat 1 tablespoon of the oil in a heavy skillet and add onion. Cook, stirring often, until tender, about 5 minutes. Add a generous pinch of salt and the garlic and cook, stirring, until garlic is fragrant, 30 seconds to a minute. Stir onion and garlic into beans, along with salt to taste, tomato paste, honey, and chipotles, and stir together. Add sweet potatoes and bring back to a simmer, drizzle with remaining olive oil, and place in oven. Bake 1 to 1 1/2 hours, until beans are thoroughly soft and sweet potatoes are beginning to fall apart, checking and stirring from time to time to make sure that beans are submerged. Either add liquid or push them down into the simmering broth if necessary. Remove from heat and serve hot.

Baked Bean

Ingredients

250 grams	pinto or white beans, soaked overnight in water
1 can	“no salt added” tomato sauce
2 1/2 tbsp	soy sauce or gluten-free soy sauce
1 3/4 cup	water or vegetable broth
2 tbsp	apple cider vinegar
2 tsp	minced garlic
1 tbsp	molasses (blackstrap or regular)
1/8 tsp	pure stevia extract, or 4 tbsp brown sugar or coconut sugar
1/2 tsp	salt
1 tbsp	jeera / cumin powder
1 1/4 tsp	chili powder
1/2 tsp	onion powder

Method

Drain and rinse the beans.

Lightly grease a heavy bottomed pot, then add all ingredients. Cover with the lid, and cook on high 7 hours or until beans are soft.

Turning off the heat, but keeping the lid closed, let sit 1 hour.

Serve immediately, or transfer to a container and refrigerate for up to 4 days.

If reheating, add a little water (up to 1/2 cup for the entire recipe) and stir, then heat. Yields about 3 1/2 cups.

Moroccan Chickpea Soup (Vegetarian Soup)

Ingredients

1 tbsp	olive oil
1 medium	onion, chopped
2	celery sticks, chopped
2 tsp	ground jeera / cumin
600ml	hot vegetable stock
400g	can chopped plum tomatoes with garlic
400g	can chickpeas, rinsed and drained
100g	frozen broad beans
	zest and juice 1/2 lemon
	large handful coriander or parsley
	flatbread, to serve

Method

Heat the oil in a large saucepan, then fry the onion and celery gently for 10 mins until softened, stirring frequently. Tip in the cumin and fry for another min.

Turn up the heat, then add the stock, tomatoes and chickpeas, plus a good grind of black pepper. Simmer for 8 mins. Throw in broad beans and lemon juice, cook for a further 2 mins. Season to taste, then top with a sprinkling of lemon zest and chopped herbs. Serve with flatbread

Mexican Red Bean

Ingredients

1/2 kilo	dried red beans or Pinto beans
2 cups	water
2 cups	hot water
1 large	onion, coarsely chopped
1 can	diced tomatoes
2	garlic cloves, minced
1 teaspoon	crushed red pepper flakes
2 teaspoons	salt

Method

Sort beans and wash under running water. Place beans in a large pan and bring to a boil. Boil for 10 minutes, drain. Place the precooked beans in a crock pot adding water and remaining ingredients. Cover and cook on high for 1 to 2 hours; turn down to low and continue to cook for 8 hours. During cooking add additional hot water if needed.

Stinky Bean / Axoni Recipe

Ingredients

1	tomato diced
3	garlic cloves diced
100 grams	dried stinky beans
1 tbsp	any cooking oil
	a pinch of paprika
	salt to taste

Method

Soak the dried stinky beans in boiling hot water and leave it for 10 minutes. Heat oil in a pan and add the diced tomatoes. Add salt and stir till the tomatoes are cooked. Add garlic and the soaked stinky beans. Simmer for 10 minutes. Add freshly ground paprika before serving.



Bean & Pulses Salad

Ingredients

1/4 cup	boiled rajma / kidney beans
1/2 cup	boiled kabuli chana / white chickpeas
1/2 cup	boiled vaal / field beans/ butter beans
2	spring Onions, finely chopped
1	tomato, cubed
1/4 cup	cooking cheese cubes or cheese, cut into 1/2" cubes
1 cup	iceberg lettuce, torn into pieces

For the dressing

1 1/2 tbsp	tomato ketchup
3 tbsp	olive oil
1 tsp	dried oregano
	salt and freshly ground pepper to taste

Hummus

Ingredients

Please note	1 cup = 250 ml
1 1/2 cup	chickpeas, soaked in water for 8-9 hours and then cooked till soft
1/2 cup	olive oil. Add more if required
2-3	garlic cloves
1 tbsp	lemon juice
1/2 tsp	red chili powder or cayenne pepper
1/2 tsp	black pepper powder
1 tsp	jeera / cumin powder
1/2 cup	white til / sesame roasted and powdered or 1/2 cup tahini
	a few sprigs Parsley or coriander / cilantro
	salt as required

Method

Combine all the ingredients except the dressing in a salad bowl.
Toss well.
Chill for at least 2 to 3 hours.
Just before serving, add the dressing in the salad.
Serve immediately.

Method

Roast the sesame seeds and then powder these finely.
In a blender grind the cooked chickpeas, with all the spices, parsley, salt and garlic.
Add the powdered sesame seeds, lemon juice and olive oil.
Blend to a smooth paste.
Serve the hummus with warm pita bread garnished with a few sprigs of parsley.

Tuscan Bean Soup

Ingredients

2 cups	dried cannellini beans, soaked overnight
2 medium	carrots, roughly chopped
1 stalk	celery, roughly chopped
1/2	yellow onion, roughly chopped
3/4 cup	extra-virgin olive oil
4 cloves	garlic (3 minced, 1 halved)
250 grams	squash, such as lal bhopla / butternut, peeled and cut into 1/2" cubes (about 2 cups)
4 large	kale leaves, preferably lacinato or cavalo nero, stemmed and chopped
1 medium	waxy-style potato, peeled and cut into 1/2" cubes
	salt and freshly ground black pepper, to taste
1/2 tsp.	crushed fennel seeds
8 thick slices	country-style bread

Method

Drain beans and transfer to a large saucepan along with half the carrots, the celery, the onions, and 5 cups water. Bring to a boil and reduce heat to low; simmer, covered, until beans are tender, 40–45 minutes. Set 3/4 cup beans aside.

Transfer the remaining beans and their cooking liquid to a blender and purée. Set puréed beans aside. Heat 2 tbsp. oil in a large pot over medium heat. Add minced garlic and cook, stirring often, until soft, about 3 minutes. Add reserved bean purée, along with the remaining carrots, the squash, kale, potato, and 1 cup water. Season with salt and pepper, bring to a boil, and reduce heat to medium-low.

Cook, covered, until the vegetables are tender, about 20 minutes. Stir in the crushed fennel seeds and reserved whole beans. Meanwhile, toast the bread and rub it with the cut end of the halved garlic clove. Drizzle each toast with 1 tbsp. oil.

To serve, place 1 to 2 pieces toasted bread in the bottom of soup bowls and ladle soup over the top. Drizzle soup with remaining oil



Pulses in Organic Farming and Food Systems

Pulses improve soil health through biological nitrogen fixation as they improve human health through providing much needed protein. Mixed farming based on integrating pulses into the cropping system is thus an ecological and sustainable alternative to chemical fertilizers, which pollute soil, water and air.

Mixed and intercropping

Mixed cropping refers to growing two or more crops simultaneously with either distinct row arrangements or no row arrangements on the same piece of land. The different crops/species are either mixed in an organized manner, or sown with a fixed pattern or spacing and plant populations, or, in an unorganized manner, where species are unevenly distributed. Mixed cropping varies considerably from one area to another and even differs among farmers within a single location. The common feature is that each system tends to reflect the farmer's needs, resources, economic considerations and convenience, marketing feasibility and labour availability (Aiyer 1949). Traditional crop mixtures consisted of a cereal crop, a pulse crop and an oilseed crop in different proportions and the mixture was generally broadcast. More than 50% area of the rainfed crops in Asia, Africa and Latin America are grown under mixed/intercropping systems. In India, the most common mixtures are wheat + chickpea, barley + chickpea, linseed + chickpea and pigeon pea + chickpea and pigeon pea + sorghum.

Scientifically, intercropping is defined as growing two or more dissimilar crops simultaneously on the same piece of land, base crop necessarily in distinct row arrangement. The recommended optimum plant population of the base crop is suitably combined with appropriate additional plant density of the component

crop. In fact, intercropping is the space and time dependent form of multiple cropping. In terms of land use, growing of crops by intercropping is regarded as more productive than growing them separately particularly under rainfed conditions. However, the major limitation of pulse based intercropping occurs where the component crops have different requirements.

Table 1: Important pulse-based cropping systems in different agro climatic zones of India

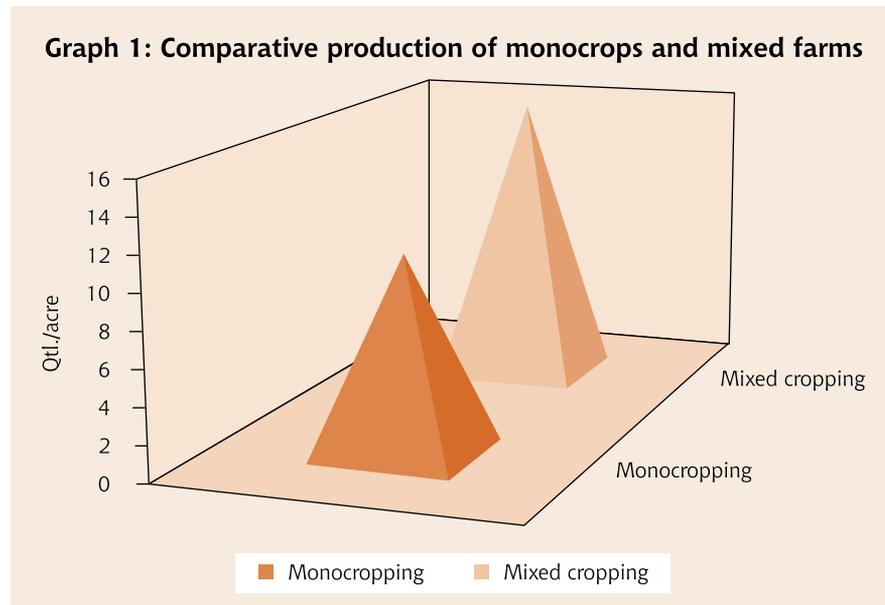
Zone	States represented	Annual rainfall range (mm)	Cropping systems
Western Himalayan Region	Jammu and Kashmir, Himachal Pradesh, Uttar Pradesh	1650-2000	Rice-chickpea/ fieldpea; Maize-chickpea/fieldpea;Ragi-chickpea/ lentil/ fieldpea; Maize/urad bean/ mung bean – wheat; Pigeon pea, wheat, mung bean/urad bean – mustard, common bean-potato
Eastern Himalayan Region	Assam, West Bengal, Manipur, Meghalaya, Nagaland, Arunachal Pradesh	1940-3530	Summer rice-Urad bean/mung bean, Maize-pigeonpea/ horse gram, Maize-chickpea/lentil/fieldpea, Jute-Urad bean-chickpea/lentil
Lower Gangetic Plains Region	West Bengal	1300-1600	Maize-chickpea/lentil/field pea, Rice-chickpea/lentil/field pea, Rice-chickpea + mustard/lentil
Middle Gangetic Plains Region	Uttar Pradesh, Bihar	1200-1470	Maize-wheat-summer mung bean/ urad bean, Rice-potato-summer mung bean/ urad bean, rice-chickpea + mustard, sugarcane + mung bean/urad bean-chickpea, Pigeonpea – wheat
Upper Gangetic Plains Region	Uttar Pradesh	720 – 980	Rice-wheat/potato-summer mung bean, Maize-wheat/potato-summer mung bean, Mung bean/Urads bean-wheat, Sorghum (fodder)-chickpea, Pearl millet (grain/fodder) – chickpea Rice-chickpea/lentil
Trans Gangetic Plains Region	Punjab, Haryana	360-890	Maize-potato-summer mung bean/urad bean, Rice/Maize-wheat-summer mung bean/urad bean, Maize-early potato-late potato-summer mung bean/urad bean, Rice-chickpea/ lentil, Sorghum (fodder)-chickpea/lentil/field pea, Cotton-chickpea, Pigeon pea- wheat/barley/lentil, Rice-toria-summer mung bean/Urads bean, Maize-toria-summer mung bean/urad bean

Eastern Plateau and Hills Region	Madhya Pradesh, Maharashtra, Orissa, West Bengal	1270 – 1430	Early rice-urad bean, Rice-rice-cowpea, Jute –maize-cowpea, Jute-urad bean
Central Plateau and Hills Region	Madhya Pradesh, Rajasthan, Uttar Pradesh	490 – 1570	Sorghum (grain/fodder) – Chickpea, Fallow-chickpea, Sorghum + pigeon pea – fallow, Pearl Millet + pigeon pea – fallow, Rice/maize – chickpea/lentil/field pea, Moth bean/mung bean/urad bean-wheat, Pearl millet-chickpea, Pearl Millet + moth bean-chickpea/lentil, Soybean + pigeon pea-fallow/chickpea, Urad bean-mustard/linseed
Western Plateau and Hills Region	Maharashtra, Madhya Pradesh, Rajasthan	600 – 1040	Urad bean-rabi sorghum, Sorghum-potato-mung bean, Cotton + urad bean/mung bean-fallow, Sorghum-wheat-cow pea/mung bean, Cotton/sorghum-chickpea, Soybean-chickpea, Soybean + pigeon pea-fallow, Mung bean/Urads bean-safflower
Southern Plateau and Hills Region	Andhra Pradesh, Tamil Nadu, Karnataka	680 – 1000	Maize-sorghum + pigeon pea, Sorghum-chickpea, Pearl Millet-horse gram, Mung bean/urad bean-safflower, Rice-mung bean/urad bean/cow pea, Mung bean-sorghum/safflower, Mung bean-pigeon pea, Rice + rice – mung bean/urad bean/cow pea
East Coast Plains and Hills Region	Orissa, Andhra Pradesh, Tamil Nadu, Pondicherry	780 – 1290	Rice-mung bean/urad bean, Sorghum-mung bean/urad bean, Tapoica + mung bean/urad bean Rice-rice-mung bean/urad bean, Rice-maize/cow pea Maize-horse gram/pigeon pea/chickpea
West Cost Plains and Hills Region	Tamil Nadu, Karnataka, Kerala, Goa, Maharashtra	2230 – 3640	Rice-urad bean/cow pea/chickpea, Sugarcane + urad bean
Gujarat Plains and Hills Region	Gujarat	340 – 1790	Urad bean-safflower/niger, Cowpea-safflower, Mung bean-tobacco, Pearl millet/sorghum + pigeon pea-chickpea
Western Dry Region	Rajasthan	400	Rice/cotton-chickpea, Pearl millet/sorghum-chickpea + mustard
Island Region	Andaman and Nicobar, Lakshadweep Islands	1500-3090	Rice-maize/rice-urad bean

The use of mixtures reduces the feasibility of mechanization, pesticide application and harvesting. Nevertheless, mixed intercropping should often be regarded as a highly adapted practice rather than an out-of-date one. In semi arid regions, wheat and chickpea in mixtures ensure reasonable harvests with more cereals, if rains are above average, and more pulses, if little rain falls. Roots of pulses penetrate deeper than those of cereals; in combination, they can exploit the soil more effectively for water and nutrients. Wheat – chickpea, sorghum – pigeon pea are just some of the best-known crop mixtures.

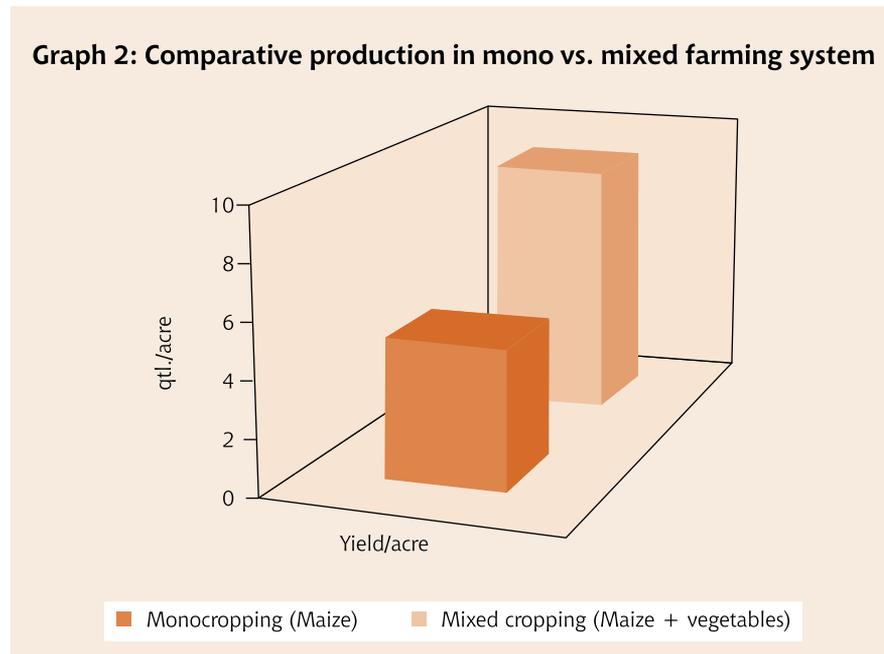
Green manure species have special use. Small seeded legume species or pulse cultivars are preferable, as their seed harvests compete less with food grains.

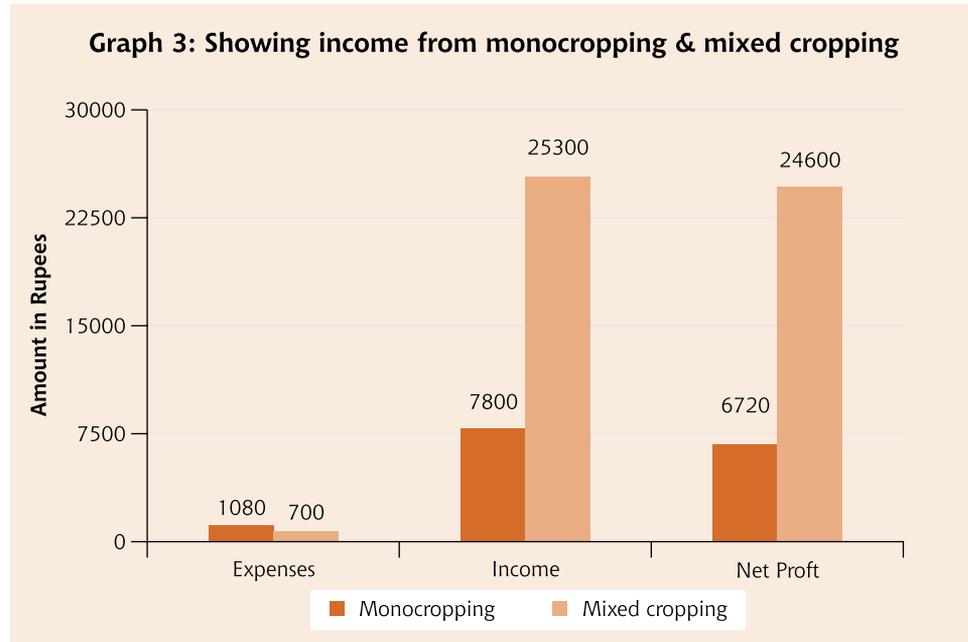
Cost benefit analysis based on survey



Contrary to the myth of industrial agriculture, organic and biodiverse systems of agriculture produce more food and higher incomes than industrial monocultures. We conducted a survey to collect data on different practices involved in agriculture. The results showed that the farmers doing mixed cropping were getting more benefit as compared to mono cropping. Here is the graphical representation of the income earned by the farmers from mono cropping and mixed cropping respectively.

Comparative productivity status of the farming systems surveyed





The graph reveals that productivity under monocropping in terms of financial return is less than 50% as compared to mixed farming systems. Also, a wide range of crops under mixed farming are seen to have a wider insurance against crop failure than in the case of monocrops.

The mixed farming systems are practiced and understood by the farmers as a multidimensional concept that covers both natural resources (soil, water and soil microorganisms) as well as livelihood aspects of the farming communities. Sustainability under a mixed farming system is best defined as the wealth of economies that include the component of soil fertility, soil and water conservation and high microbial population that can be considered as the ecological capital for agriculture.

Integrating pulses into farming systems produces high value food and clean water and clean air

As pulses disappear from the fields, nitrogen fixation will disappear forcing the usage of nitrogen fertilizers, which is known for its extremely negative impact, since it leaches into water systems. Nitrate in water supplies has become one of the major environmental issues because of its implications on human health. Nitrate accumulation in water systems originating from fertilizers has been reported from many parts of the world.

In India as well as in other developing countries, conventional agriculture is characterized by the use of high doses of chemical fertilizers, pesticides, herbicides, etc. With the advent of high yielding varieties and fertilizer-centred technologies, the Indian Government offered these inputs at a subsidized rate. This has led to increased consumption of fertilizers and consequently resulted in fertilizer related environmental hazard like nitrate pollution of ground water, increased emission of gaseous nitrogen and metal toxicity (Katyal, 1989). In the recent years the pollution of the environment with man-made organic compounds has become a major problem. Many of these compounds introduced into nature are termed as xenobiotics (xenos meaning foreign in Greek), and the indigenous micro flora and fauna do not easily degrade a large number of them.

As pulses have been displaced from farming systems, consumption of chemical fertilizers has increased tremendously in recent years. Nitrogen, phosphorous and potassium are the primary fertilizer nutrients, which are widely used in our country. In the past 50 years, the use of N-fertilizers has increased tremendously from 58,700 tonnes in 1951-52 to 11, 592,700 tonnes in 1999-2000. Even in the two decades between 1980-2000, the consumption of Nitrogen has increased three folds (Sharma and Bhatnager, 2002). Nitrate is currently recognized as the most serious agricultural chemical pollutant (Alfoldi, 1983).

Punjab and Haryana are the states consuming more than 100 kg/ha of N fertilizers which is the major reason for highest nitrate pollution of well waters (Agrawal et al., 1999) of the two states. However nitrate pollution level above the WHO permissible limits was also reported from Gujarat, Maharashtra, and Ganjam districts of Orissa (Handa, 1986). According to Durgaprasad (2000), there are 773 nitrate-affected villages in Gujarat. The earlier studies showed an increase in shallow well waters from 0.04-6.15 in 1975 to 0.31 mg NO₃-N/L in 1988 (Singh et al., 1995). A survey in Delhi reported a range of 26-150 mg NO₃-N/L in shallow well water, which is very high constituting a warning (CGWA, 1998).

Nitrogen is applied to the soil as urea (which is readily hydrolyzed to ammonium), ammonium nitrate or a combination of ammonium and nitrate. About 40-60 percent of applied nitrogen is lost by volatilisation, run off, denitrification and leaching. The nitrate that is leached causes a lot of visible and invisible hazardous effects. Tripathi (1990) reported that effluents discharged from a chemical fertilizer factory in India affected the physiochemical properties of soil, its mineral composition and germination of wheat. In their study, the concentration of Na was 40 times higher in the effluent than in the nearby well water.

Many studies reported the heavy pollution of groundwater with nitrate in rural areas, especially those producing vegetables, fruits, tea and livestock. It is clear that the heavy application of fertilizers is the cause of nitrate pollution of underground water. According to Singh and Sekhon (1979), nitrate is highly stable and can percolate slowly towards deep aquifers for years. Even if all fertilizer applications were suspended immediately in areas where deep aquifers are beginning to show nitrate pollution, the inputs of past years would still slowly percolate toward the aquifers, and nitrate input to the ground water would continue for many years.

High nitrate concentration in drinking water has drawn a lot of attention due to its harmful biological effects on health. It has been reported that indigestion of water containing higher nitrate concentrations causes methemoglobinemia (i.e. infant cyanosis or blue-baby syndrome) ((Sharma and Bhatnager, 2002). It also affects the blood in such a way as to reduce its oxygen carrying capacity (OECD, 1988). The functioning of the central nervous system and cardiovascular system may also be affected adversely by nitrate rich water (Agrawal et al., 1999). The World Health Organization has recommended the permissible limit of 10 mg/l nitrate nitrogen (NO₃-N) or equivalent to 45 mg/L of NO₃, which is also accepted by Indian Council of Medical Research.

A wide range of contaminants can reach the river and marine water either via groundwater or through drainage ditches. A part of the water received through precipitation becomes surface runoff and is lost from the land through rivers and streams. Surface water receives agricultural chemicals by runoff from field applications and from the dumping of excess chemical fertilizers (Afford and Ferguson, 1982). There are numerous hydro geological settings where there is a significant hydraulic connection between a stream or river and an underlying aquifer. Thus, nitrates, which were initially lost through leaching to ground water can contribute to the nitrate pollution of surface water such as streams, rivers, lakes and sea.

Nitrates, which are highly soluble and easily transported in runoff, also contribute to eutrophication (Oglesby, 1971). Since, 1970 the increasing levels of nitrates entering the rivers in our country were largely responsible for eutrophication occurring in running waters. Normally, blue green algae are very important in the river ecosystem, photosynthesizing sunlight energy and liberating oxygen into the water. The changes in water quality caused by eutrophication can be a major cause of stress to fishes due to the high pH release of highly toxic gaseous ammonia and depletion of oxygen.

Farmers generally apply too much fertilizer to their crops and this excess, particularly the nitrates, can be easily leached into lakes, streams and ground water. Nitrate is the main form of N in ground waters, river system and marine water. Several authors (Hill, 1982; Pacheco and Cabrera, 1997; Steinich et al., 1998; Daskalaki et al., 1998; Antonakos and Lambrakis, 2000) have related ground water nitrates to different sources. The main sources are chemical fertilizers applied to the agricultural fields. The problem of nitrate pollution in groundwater has become severe in India.

Source: J Hazard Mater. 2009 Nov 15;171(1-3):189-99. doi: 10.1016/j.jhazmat.2009.05.111. Epub 2009 Jun 6.

A study on nitrate contamination in the groundwater of some rural areas of Rajasthan, India, showed that a total of 64 groundwater samples from 21 different villages/sub-villages of district Sri Ganganagar, India were collected and analyzed for nitrate (as NO_3^-), sulphate (as SO_4^{2-}) and few other parameters. NO_3^- level in groundwater was 7.10-82.0 mg l⁻¹ for individual samples. But average NO_3^- for total samples was 60.6 +/-33.6 (SD) mg l⁻¹, which indicates the non-suitability of groundwater for drinking purposes, if BIS permissible limit (22.6 mg l⁻¹) is considered as reference level. SO_4^{2-} ranged from 28.6 to 660.3 mg l⁻¹ in this area.

Source: <http://www.ncbi.nlm.nih.gov/pubmed/19545944>

Table 2: List of districts showing localized occurrence of nitrate (>45 mg/litre) in ground water in different states of India

S.N.	State	Parts of Districts having Nitrate > 45 mg/litre
1	Andhra Pradesh	Adilabad, Anantpur, Chittoor, Cuddapah, East Godavari, Guntur, Hyderabad, Karimnagar, Khammam, Krishna, Kurnool, Mahbubnagar, Medak, Nalgonda, Nellore, Nizamabad, Prakasam, Ranga Reddy, Srikakulam, Visakhapatnam, Vizianagaram, Warangal, West Godavari
2	Bihar	Aurangabad, Banka, Bhagalpur, Bhojpur, Kaimur(Bhabua), Patna, Rohtas, Saran, Siwan
3	Chattisgarh	Bastar, Bilaspur, Dantewada, Dhamtari, Jashpur, Kanker, Kawardha, Korba, Mahasamund, Raigarh, Raipur, Rajnandgaon
4	Delhi	Central Delhi, New Delhi, North Delhi, North West Delhi, South Delhi, South West Delhi, West Delhi
5	Goa	North Goa
6	Gujarat	Ahmadabad, Amreli, Anand, Banaskantha, Bharuch, Bhavnagar, Dohad, Jamnagar, Junagadh, Kachchh, Kheda, Mehsana, Narmada, Navsari, Panchmahals, Patan, Porbandar, Rajkot, Sabarkantha, Surat, Surendranagar, Vadodara,
7	Haryana	Ambala, Bhiwani, Faridabad, Fatehabad, Gurgaon, Hissar, Jhajjar, Jind, Kaithal, Karnal, Kurukshetra, Mahendragarh, Panchkula, Panipat, Rewari, Rohtak, Sirsa, Sonapat, Yamuna Nagar
8	Himachal Pradesh	Una
9	Jammu & Kashmir	Jammu, Kathua
10	Jharkhand	Chatra, Garhwa, Godda, Gumla, Lohardaga, Pakaur, Palamu, Paschimi Singhbhum, Purbi Singhbhum, Ranchi, Sahibganj
11	Karnataka	Bagalkot, Bangalore, Belgaum, Bellary, Bidar, Bijapur, Chikmagalur, Chitradurga, Davangere, Dharwad, Gadag, Gulburga, Hassan, Haveri, Kodagu, Kolar, Koppal, Mandya, Mysore, Raichur, Shimoga, Udupi, Uttara Kannada
12		
	Kerala	Alappuzha, Idukki, Kollam, Kottayam, Kozhikode, Malappuram, Palakkad, Pathanamthitta, Thiruvananthapuram, Thrissur, Wayanad

13	Maharashtra	Ahmednagar, Akola, Amravati, Auragabad, Beed, Bhandara, Buldana, Chandrapur, Dhule, Gadchiroli, Gondia, Hingoli, Jalgaon, Jalna, Kohlapur, Latur, Nagpur, Nanded, Nandurbar, Nashik, Osmanabad, Parbhani, Pune, Sangli, Satara, Solapur, Wardha, Washim, Yavatma
14	Madhya Pradesh	Anuppur, Ashok Nagar, Balaghat, Barwani, Betul, Bhind, Bhopal, Burhanpur, Chhatarpur, Chhindwara, Damoh, Datia, Dewas, Dhar, Gwalior, Harda, Hoshangabad, Indore, Jabalpur, Jhabua, Katni, Khandwa, Khargaon, Mandla, Mandsaur, Morena, Narsimhapur, Neemuch, Panna, Raisen, Rajgarh, Ratlam, Rewa, Sagar, Satna, Sehore, Seoni, Shahdol, Shajapur, Sheopur, Shivpuri, Sidhi, Tikamgarh, Ujjain, Umariya, Vidisha
15	Orissa	Angul, Balasore, Bargarh, Bhadrak, Bolangir, Boudh, Cuttack, Deogarh, Dhenkanal, Gajapati, Ganjam, J.Singhpur, Jajpur, Jharsuguda, Kalahandi, Kendrapara, Keonjhar, Khurda, Koraput, Malkangiri, Mayurbhanj, Nawapada, Nayagarh, Phulbani, Puri, Sambalpur, Sundergarh, Sonapur
16	Punjab	Amritsar, Bathinda, Faridkot, Fatehgarh Sahib, Firozpur, Gurdaspur, Hoshiarpur, Jalandhar, Kapurthala, Ludhiana, Mansa, Moga, Muktsar, Nawan Shahr, Patiala, Rupnagar, Sangrur
17	Rajasthan	Ajmer, Alwar, Banaswara, Baran, Barmer, Bundi, Bharatpur, Bhilwara, Bikaner, Chittaurgarh, Churu, Dausa, Dhaulpur, Dungarpur, Ganganagar, Hanumangarh, Jaipur, Jaisalmer, Jalor, Jhalawar, Jhunjhunun, Jodhpur, Karauli, Kota, Nagaur, Pali, Partapur, Rajsamand, Sirohi, Sikar, Sawai Madhopur, Tonk, Udaipur
18	Tamil Nadu	Chennai, Coimbatore, Cuddalore, Dharmapuri, Dindigul, Erode, Kancheepuram, Kanyakumari, Karur, Madurai, Namakkal, Nilgiris, Perambalur, Pudukkottai, Ramanathapuram, Salem, Sivaganga, Theni, Thiruvannamalai, Thanjavur, Tirunelveli, Thiruvallur, Trichi, Tuticorin, Vellore, Villupuram, Virudhunagar
19	Uttar Pradesh	Agra, Aligarh, Allahabad, Ambedkar Nagar, Auraiya, Badaun, Baghpat, Balrampur, Banda, Barabanki, Bareilly, Basti, Bijnor, Bulandshahr, Chitrakoot, Etah, Etawa, Fatehpur, Firozabad, GB Nagar, Ghaziabad, Ghazipur, Hamirpur, Hardoi, Jaunpur, Jhansi, Kannauj, Kanpur Dehat, Lakhimpur, Mahoba, Mathura, Meerut, Moradabad, Muzaffarnagar, Raebareilly, Rampur, Sant Ravidas Nagar, Shahjahanpur, Sitapur, Sonbhadra, Sultanpur, Unnao
20	Uttarakhand	Dehradun, Haridwar, Udham Singhpur
21	West Bengal	Bankura, Bardhaman

Source: Jain, S. K. and Sharma, V. Contamination of Ground Water, CGWB, ministry of water resources. 2008, Government of India, Faridabad.

Chemical fertilizers add nitrate directly to the groundwater. Since the plants cannot often utilize all the nitrogen applied to the fields, some of them are left in the soil and it can leach into groundwater (Stone et al., 1998). Since nitrate is highly water-soluble and is not held by soil particles, or not chemically fixed in the soil, it easily moves with water through the soil, porous rock and sand layers to underground water supplies. The more the amount of nitrogen fertilizers applied, the higher the amount of nitrate leach to the groundwater. Nitrogen fertilizers have been applied in very high amounts to field crops since the 1950's in many countries to enhance their growth and productivity. According to reports (Shirmohammadi et al., 1998, Lawrence et al., 1988, Glanville et al., 1998), amounts went dramatically up, particularly with the introduction of new high yielding crop varieties. Nitrate is therefore a widespread contaminant of ground and surface water worldwide.

A number of studies have shown correlations between nitrogen fertilizer use and polluted groundwater (Singh and Sekhon, 1978/1979; Zaporozec, 1983; McWilliams, 1984). When the amount of nitrogen in fertilizer applied exceeds the uptake by plants, the excess may leach into groundwater through soil. This leaching takes place usually as water-soluble nitrate and contaminates the shallow wells that are the main drinking water source in dense agricultural areas. This problem becomes severe in rural areas where the people residing are entirely dependent on the drinking water from shallow dug wells.

Nitrogen applied through fertilizers is converted to plant available nitrogen by bacteria living in the soil. Nitrate-nitrogen not taken up by crops or immobilized by bacteria into soil organic matter can leach out of the root zone and end up in ground water and also get converted to atmospheric gases by denitrification which contribute to climate change.

In view of all these findings, integrating nitrogen fixing pulses into agriculture does not merely provide nutrition, it also avoids water pollution and contributes to clean drinking water. Pulses also contribute to clean air. Nitrogen fertilizers are a major source of nitrogen oxide, which is two hundred times more potent, as a greenhouse gas, than carbon dioxide. Pulses intercropped in farming help reduce the impact of climate change by reducing nitrogen dioxide emissions. They are a food of the future.

Source: Hemant W. Khandare /Int.J.ChemTech Res.2013,5(4) [http://www.sphinxesai.com/2013/VOL5_NO.4_APRIL/PDFS_VOL5_NO.4/CT=72\(1921-1926\)AJ13.pdf](http://www.sphinxesai.com/2013/VOL5_NO.4_APRIL/PDFS_VOL5_NO.4/CT=72(1921-1926)AJ13.pdf)

Table 3: Estimates of the proportion of plant N derived from N₂ fixation and total nitrogen fixed by different pulse crops

Crop	N fix (%)	N – Fixed (kg ha ⁻¹)	References
Chickpea	0-86	0-141	Peoples et al. (1995); Heritage et al. (1995-1998); Aslam et al. (1997); unkovich et al. (1997); Schwenke et al. (1998); Marcellos et al. (1998)
Common Bean	0-73	0-165	Jensen and Casetellanos (1994); Peoples et al. (1995); Castellanos et al. (1996)
Cowpea	32-89	9-201	George et al. (1995), Peoples et al. (1995)
Faba Bean	19-92	15-330	Peoples et al.(1995); Unkovich et al.(1997); Shwenke et al (1998)
Field pea	20-95	16-245	Evans et al.(1989); Jensen and Castellanos (1994); Peoples et al. (1995)
Lentil	39-100	10-192	Peoples et al.(1995); Shah et al. (1997)
Lupin	29-97	26-288	Evans et al.(1989); Unkovich et al.(1997)
Mung bean	15-77	9-137	Chapman and Myers (1987); George et al. (1995); Peoples et al. (1995)
Pigeon pea	10-81	7-235	Peoples et al.(1995); Ladha et al.(1996)
Urad Bean	37-98	21-140	Peoples et al.(1995)

Source: *Pulses*, ed. by Guriqbal Singh, Harbajan Singh Sekhon, Jaspinder Singh Kolar, Agrotech Publishing Academy, Udaipur, 2005.

Pulse crops fix atmospheric nitrogen in their root nodules in association with rhizobium/ biadyrrhizobium species. Mixtures in fact can increase the fixation of nitrogen.

Table 4: Nitrogen balance in soil after the harvest of pulses

Crop	N Balance (kg ha ⁻¹)
Chickpea	-47 to +46
-67 to +61	
-63 to -77	
-41 to +56	
Cowpea	-5 to +26
Faba Bean	-12 to +94
Field Pea	-32 to +96
-32 to +96	
Lupin	-41 to +135
-41 to +141	
Mung Bean	-19 to +10
Pigeon Pea	-20 to -49
+70	

Source: *Pulses* ed. by Guriqbal Singh, Harbajan Singh Sekhon, Jaspinder Singh Kolar, Agrotech Publishing Academy, Udaipur, 2005.

Besides providing nitrogen to the soil, pulses also provide potassium and phosphorus. The availability of phosphorus and potassium is higher in soils after pulse based cropping systems than after non-pulse based cropping systems (G.P. Srivastava and V.C. Srivastava, *Nitrogen Economy and Productivity of Wheat (Triticum artivium) Succeeding Grain Legumes*, in Indian Journal of Agricultural Sciences, 63,p694-698, 1993).

Pulses also add significant amounts of organic residue to the soil in the form of root bioneers and leaf litter. Microbial activity in the soil also increases by intercropping pulses. Pulses thus contribute to productivity of other crops. Chemical fertilizers and herbicides have an adverse effect on nodulation and nitrogen fixation of pulses.

Monocultures of the Green Revolution, focusing excessively on rice and wheat, have driven pulses out of our farms, and also out of the diet of the poor. Per capita availability of pulses has declined from 69 gram in 1961 to 36 gram in 2000 leading to severe protein calorie malnutrition. A minimum of 50 gram of pulses per capita per day is necessary for a healthy diet.

Table 5: Contribution of Pulses in supply of food nutrients in India, Asia and World (FAO 2001)

Nutrition supply through pulses	World	Asia	India
Pulse capita –1 year –1 (Kg)	5.90	5.60	12.80
Calorie capita –1 day –1 (number)	55.90	52.50	122.20
Protein capita –1 day –1 (gram)	3.50	3.20	7.20
Fat capita –1 day –1 (gram)	0.40	0.40	1.10

Source: *Pulses* ed. by Guriqbal Singh, Harbajan Singh Sekhon, Jaspinder Singh Kolar, Agrotech Publishing Academy, Udaipur, 2005.

Since pulses have been so significant to India’s agriculture, diet and cuisine, India is the most significant producer of pulses with 25% of the global production. Pulse production is now concentrated only in states where Green Revolution agriculture did not destroy the mixed farming based on intercropping of pulses to create monocultures of rice and wheat. These include Madhya Pradesh, Uttar Pradesh, Maharashtra, Rajasthan, Karnataka, Andhra Pradesh and the Himalayan States. While India’s production is declining, U.S., Canada and

Australia are expanding their pulse production to export to India, especially under the free trade regime of WTO. During 1999-2000, India imported 3,50,000 tonnes of pulses.

A more sustainable alternative is to move from chemical intensive monocultures of cereals to diversified mixed farming systems integrating pulses and oilseeds. These systems also produce more food and higher incomes for farmers.

In Navdanya's organic farm, we grow 12 crops, 9 crops, 7 crops, and 5 crops in mixtures. Biodiverse systems produce more food and higher incomes than monocultures (see table 6). Monocultures produce more control not more food. They facilitate corporate control over agriculture by making farmers dependent on monopoly markets and high cost and extended inputs. They create profits for corporations, which sell costly inputs and buy cheap commodities through contract farming. For farmers they translate into a negative economy of high costs and low returns, which leads to debt, suicides and landlessness.

The average production and total amount of *Baranaja* (12 crops), *Navdanya* (9 crops), *Saptrishi* (7 crops) and *Punhranga* (5 crops) v/s Monocropping growing at Navdanya Farm is shown on Table 6.

Table 6: Year: 2004-2005

S.N.	Name of the Crops	Average production / ha. (Kg.)	Average Rate/ Kg	Total Amount Rs.
NAVDANYA				
1	Till / Sesame	400.00	30.00	12000.00
2	Safed chemi	720.00	25.00	18000.00
3	Mandua / Finger Millet	1120.00	10.00	11200.00
4	Dholiyia dal	640.00	20.00	12800.00
5	Safed Bhatt / White Soya	760.00	15.00	11400.00
6	Lobia / Blackeyed Pea	800.00	20.00	16000.00
7	Jhongora / Barnyard Millet	520.00	15.00	7800.00
8	Maize	560.00	8.00	4480.00
9	Gahet / Horsegram	480.00	25.00	12000.00
		6000.00		1,05680.00
MONOCULTURE				
1	Mandua / Finger Millet	3600.00	10.00	36000.00
SAPTRISHI				
1	Urd	600.00	20.00	12000.00
2	Moong	520.00	25.00	13000.00
3	Mandua / Finger Millet	560.00	10.00	5600.00
4	Safed Bhatt / White Soya	680.00	15.00	10200.00
5	Dohyalya Dal	560.00	20.00	11200.00
6	Maize	680.00	8.00	5440.00
7	Lobia Dal / Blackeyed Pea	600.00	20.00	12000.00
	Total	4200.00		69440.00
MONOCULTURE				
1	Urd	2400.00	20.00	48000.00

BARANAJA			
Bajra / Pearl Millet	440.00	8.00	3520.00
Maize	1280.00	8.00	10240.00
Safed Chemi	600.00	25.00	15000.00
Aongal	360.00	20.00	7200.00
Mandua / Finger Millet	600.00	10.00	6000.00
Jhangora / Barnyard Millet	440.00	15.00	6600.00
Urd	600.00	20.00	12000.00
Navrangi / Rice Bean	680.00	20.00	13600.00
Koni No.1	280.00	10.00	2800.00
Lobia / Blackeyed Bean	600.00	20.00	12000.00
Till / Sesame	400.00	30.00	12000.00
Koni No.2	340.00	10.00	3400.00
	6620		1,04360
MONOCULTURE			
Maize	5400	8.00	43,200

Source: Navdanya field work

Processing of pulses

Generally, in India pulses are consumed after being converted into dal – the dehusked split pulse. Removal of the seed coat improves appearance, taste and palatability. It also improves cooking quality and digestibility. Conversion of pulses to dal is the third largest food processing industry in the country after rice and wheat milling industries. It is estimated that about 75% of the pulses produced in the country are very ancient crops. About 30% of the production of pulses is retained by the farmers and is processed in the rural sector using traditional techniques.

There were about 7000 dal mills working in various parts of the country processing different pulses throughout the year. However, with the advent of organized large scale milling systems, most of these small-scale processors have been thrown out of their profession and livelihood. The global agribusinesses are now taking over food processing by making the fresh, locally produced food appear backward and promote stale food wrapped in plastic appear “modern and healthy”. Industrial processing and packaging is destroying the livelihood of small farmers to earn large-scale profits.

Dehulling method

Dehulling of pulses is an age-old practice in India. In earlier days, hand pounding was common, which was later replaced by stone *chakkis*. Several traditional methods are used (Kurien and Parpia 1968), that can be broadly classified into two categories; (i) the wet method that involves water soaking, sun drying, and dehulling, and (ii) the dry method that involves oil/water application, sun drying, and dehulling.

Traditional pulse processing technologies

The dehulling technology of pulses involves two basic steps, viz. loosening of the husk (either by wet or dry method), followed by its removal, and splitting into cotyledons by suitable machinery.

For small scale dehulling, the basic unit is a *chakki* comprising two grinding stones. The treatments given before dehulling in a *chakki* vary from region to region (Singh and Jambunathan 1981). For example, in the Indian states of Maharashtra, Uttar Pradesh and Madhya Pradesh, soaking pigeon pea in water for 2-14 hr is a common practice. In some other states, villagers prefer to treat the material with oil before dehulling. In some households, pigeon pea is first split using a *chakki*, then treated with oil/water, and finally hand pounded to

remove the seed coat. Another procedure, followed in Uttar Pradesh is heating the pigeon pea on an iron pan, with or without sand, before grinding.

Domestic processing of pulses

The domestic process involves conditioning and milling. Mixing water or oil followed by drying does the conditioning. The purpose is to loosen the husk for easy separation during milling. The milling involves dehusking, splitting and polishing. Complete splitting is achieved in 2- 3 passes. The left out dehusked and unsplit grains are reconditioned and refeed to the milling machines. The husk is separated and dal is polished either by addition of water or oil.

Nutritional importance of pulses

Pulses are excellent sources of protein (20-40%), carbohydrates (50-60%), which include fibre, starch, sugars and unavailable carbohydrates, fat (2-3%), minerals (2-4%), i.e. calcium, magnesium, zinc, iron, potassium and phosphorus and B-Vitamins like thiamine and niacin. Table 9 shows the nutritional value of different pulses and legumes.

Pulses supply 340 Kcal g dry seed, which is almost similar to calorie value of cereals. Pulses give nearly double the amount of protein as compared to cereals. The nutritive value of dietary proteins is governed by protein profile, i.e. the pattern and the quantity of essential amino acids present in it. The globulins and albumins are the predominant proteins in pulses.

Pulses contain 55 to 60% starch, soluble sugars and fibre and besides the unavailable carbohydrates. The whole grains of pulses are especially rich in fibre as compared to dehusked split dal. Pulses also contain high amount of polyunsaturated fatty acids, thus along with cereals, they meet the requirements of essential amino acids for an adult.

The legumes are also rich in minerals like calcium, magnesium, zinc, iron, potassium and phosphorus.

Pulses have a high protein content, the value is about twice that in cereal and several times that in root tuber (FAO, 1968), so they can help to improve the protein intake of meals in which cereals and root tubers in combination with pulses are eaten (Kushwah et al., 2002). Pulse when eaten with cereals, can also help to increase the protein quality of the meal. In man, protein helps in the repair of body tissue, synthesis of enzymes and hormones and also in the supply of energy. In children, the consumption of pulses should be encouraged, particularly where animal protein is scarce and expensive, as this would help to furnish the child with the necessary amino acids required for growth. (*Journal of Applied Sciences and Environmental Management*, Vol. 9, No. 3, pp 99-104)

Vitamins present in appreciable quantities in pulses are thiamin, riboflavin, pyridoxine and folic acid; vitamin E and K are also found in pulses. The B-vitamins act as co-enzymes in biological processes. Vitamin E is known to play a role as an antioxidant inhibiting the oxidation of vitamin A in the GIT and of polyunsaturates in the tissues. It is also believed to maintain the stability of cell membranes (Davies and Stewart, 1987). Vitamin K functions primarily in the liver where it is necessary for the formation of blood clotting factors.

Quality improvement of pulses

(a) Cooking

Pulses take considerably longer time for cooking than any other vegetable products. The cooking processes soften the hard seed by improving the plasticity of the cell wall, thus, facilitating cell expansion and reduction of intercellular bond. Cell cementing material pectin is altered during cooking so that the cells of the pulses separate with comparative ease.

Studies reported by Raghunath and Belavady (1979a) have shown that cooking loss of riboflavin varies from 13 to 35 per cent in the four pulses (table 7). On the other hand cooking losses of vitamin B6 in these pulses were relatively low (13 per cent) and constant.

Table 7: Cooking losses of riboflavin and total B6 content of dhals

Dhals	Riboflavin		Total B6	
	mg per 100 g	Cooking loss (%)	mg per 100 g	Cooking loss (%)
Chick-pea	0.23	35.0	0.38	15.2
Pigeon-pea	0.25	17.8	0.32	13.2
Green gram	0.24	14.8	0.31	12.9
Black gram	0.25	13.2	0.24	12.8

(b) Soaking

Many pulses, particularly whole grains, have hard outer covering and need soaking prior to cooking. During soaking water enters through the hilum and seeps inside and causes the seed coat to wrinkle. These wrinkles are eliminated when cotyledons swell completely. Soaking makes the pulse seed tender and hastens the cooking process. In urad bean dal, the per cent loss of phytic acid was 25-30 on soaking, 35-40 in ordinary cooking of soaked seeds, 6-9 on ordinary cooking of unsoaked seeds (Dulhan et al. 1989; Kataria et al., 1989) found that soaking for 18 hr removed 30% phytic acid in mung bean and extent of removal was still higher when the period of soaking was raised. Khokhar and Chauhan (1986) found that the losses in the phytic acid content of moth bean were 46-50% on soaking.

Overnight soaking results in 25-50% loss of tannins. When seeds are soaked in water, some leakage of water-soluble nutrients from the pulses into water also

occurs. The process is greatly enhanced in the presence of broken and split seed coats.

(c) Sprouting

Whole grains of pulses are soaked overnight and water is drained away and seeds are tied in a cotton cloth for sprouting. Water is sprinkled twice or thrice a day, and in a day or two germination takes place. Moisture and warmth are essential for germination. Mung bean can be germinated in the shortest time.

During sprouting, dormant enzymes get activated and digestibility and availability of nutrients is improved. Starches and proteins are converted to simpler substances. As germination proceeds, the ratio of essential to non-essential amino acids changes, providing more of essential amino acids.

The content of B group vitamins like riboflavin, niacin, folic acid, choline and biotin increases significantly on germination of whole grain of pulses. Ascorbic acid is synthesized during germination. The increase in ascorbic acid is around 7 to 20 mg per 100 g of seed. Ascorbic acid content is maximal after about 30 hrs of germination.

During sprouting minerals like calcium, zinc and iron are released from bounded form. Giri et al. (1981) found that the available iron increased with progressive stages of germination, possibly due to the release of iron from the protein bound combinations. It was found that mung bean had the highest percentage of increase of absolute available iron of 731%, followed by field pea (656) and horse gram (431). The least increase was in cowpea (2), followed by chickpea (19).

Recent studies have shown that the most commonly consumed pulses, namely chickpea, pigeon pea, green gram and black gram, contain a significant amount of tannin that is mostly present in the seed coat. In overnight soaking 25-50 per cent of this tannin is lost, probably through leaching (table 8). In 24 to 48-hour

germination, there is an additional loss of 10 to 25 per cent (Udayasekhara Rao and Deosthale, unpublished).

Table 8: Effect of soaking, germination, and cooking: Percentage loss of polyphenols of four Indian pulses

	Tannin (mg/100 g)	Percentage loss of tannin on:			
		Soaking	Germination	Cooking	
		24 hours	24-28 hours	Raw	Germinated
Chick-pea	179 + 21	50	3-8	70	75
Pigeon-pea	996 + 93	50	3-10	60	75
Green gram	612 + 53	25	20-25	70	76
Black gram	861 + 92	25	10-25	70	77

(d) Fermentation

Fermentation process increases the digestibility, palatability and nutritive value. There was a significant improvement in B Vitamins and ascorbic acid. Toxic substances can be eliminated by this process and it also improves the availability of essential amino acids and thus, the nutritional quality of protein is improved. On fermentation, the loss of phytates in various pulses increased to 50% (Ramakrishnan 1979).

Table 9: Nutritional values of pulses and legumes (per 100 gms. of edible sources)

Name	Moisture (g)	Protein (g)	Fat (g)	Minerals (g)	Fibre (g)	Carbohydrates (g)	Energy (Kcal)	Calcium (mg)	Phosphorus (mg)	Iron (mg)
Bengal Gram (whole)	9.8	17.1	5.3	3.0	3.9	60.9	360	202	312	4.6
Bengal Gram (Dal)	9.9	20.8	5.6	2.7	1.2	59.8	372	56	331	5.3
Black Gram (Dal)	10.9	24.0	1.4	3.2	0.9	59.6	347	154	385	3.8
Cow pea	13.4	24.1	1.0	3.2	3.8	54.5	323	77	414	8.6
Green Gram (Moong) Whole	10.4	24.0	1.3	3.5	4.1	56.7	334	124	326	4.4
Green Gram (Moong) Dal	10.1	24.5	1.2	3.5	0.8	59.9	348	75	405	3.9
Horse Gram (Kulath)	11.8	22.0	0.5	3.2	5.3	57.2	321	287	311	6.77
Lentil (Masoor)	12.4	25.1	0.7	2.1	0.7	59.0	343	69	293	7.58
Moth Beans	10.8	23.6	1.1	3.5	4.5	56.5	330	202	230	9.5
Peas (dry)	16.0	19.7	1.1	2.2	4.5	56.5	315	75	298	7.05
Rajmah	12.0	22.9	1.3	3.2	4.8	60.6	346	260	410	5.1
Red Gram (Arhar) Dal	13.4	22.3	1.7	3.5	1.5	57.6	335	73	304	2.7

Source: Nutritive values of Indian Foods, 2002.

Uses of Legumes in Agroecology

Dr. Ashok Panigrahi

Legumes are members of the large family *Leguminosae*, syn. *Fabaceae*, composed of dicotyledonous herbs, shrubs, and trees bearing fruits that are legumes or pods, developing nodules on the roots that contain nitrogen-fixing bacteria, and including important proteinous food and forage plants. However, all legumes are not edible; legume trees like *Laburnum* and the woody climbing vine *Wisteria* are poisonous but ornamental.

Legumes are nitrogen fixers

Most cultivated legumes (with exception to only the members of the Genus *Styphnolobium*) such as alfalfa, clover, grams, peas, beans, lentils, soybeans, and peanuts etc. contain symbiotic bacteria called rhizobia within their root nodules. These bacteria have the ability of fixing nitrogen (N) from atmospheric and molecular sources into ammonia (NH₃). Ammonia is then converted to nitrate (NO₃⁻) and nitrite (NO₂⁻) in the soil with the help of another set of bacteria, Nitrobacter. This arrangement means that the root nodules are sources of nitrogen for legumes, making them relatively rich in plant proteins. All proteins are made up of nitrogenous compounds called amino acids. Nitrogen is, therefore, a necessary ingredient in the production of proteins. Hence, legumes are known as nitrogen fixers and are among the best sources of plant protein. Numerous legumes farmed for a variety of purposes include a wide variety of leguminous plants such as *Pisum*, *Lens*, *Phaseolus*, *Cymopsis*, *Sesbania* and *Gliricidia* species. Some legume species are farmed for timber production worldwide, including numerous *Acacia* species and *Castanospermum australe*.

Legumes as source of soil nitrogen

Following the harvest, when legume plants die in the fields, all of their remaining nitrogen get incorporated into amino acids, packed inside the remaining plant tissues which then get released back into the soil under soil incorporation. In the soil, these amino acids are converted to nitrate (NO_3^-) through bacterial action, making soil-nitrogen available to other plants, thereby serving as fertilizer for future crops. As a matter of fact, all plants need this vital primary plant nutrient for their own growth and without which they will either not grow or die out early.

The amount of nitrogen fixed by a legume depends on the legume variety, the environment of the legume-bacteria association in root nodules, general soil fertility and existing climatic conditions. Legumes used for the purpose of enhancing soil fertility may be annual or perennial. However, compared to the annual legumes, perennial legumes have higher levels of nitrogen fixation ability. A portion of this fixed nitrogen is removed as hay and does not remain in the soil. But what is left as root exudates, decaying roots and above ground stubble is significant to maintain soil health and fertility. *Sesbania* sp. is the best legume for all cereal crops, especially rice.

Growing a legume crop to be soil incorporated is an old agricultural practice that is again gaining popularity in the event of popularization of organic farming practices. It is used for a variety of purposes such as a soil building practice that adds organic residues, conserves and recycles plant nutrients and protects the soil from erosion. It is a viable alternative to conventional summer fallowing and can reduce or eliminate dependence on artificial nitrogen fertilizers.

Early settler-cultivators of Canada seldom used legumes in rotation because the newly cultivated grassland soils were generally fertile. However, the land's nitrogen status became depleted after years of cropping cereals with no addition

of fertilizer. Growing legumes like sweet clover as green manures or as forage crops became an important practice for maintaining soil productivity.

Legume in crop rotation and intercropping

The use of legumes in crop rotations has increased in recent days. Many farmers have resorted to legume cultivations with the intention to reduce external input costs and replace the same with internal inputs that effectively reduce the dependence on commercially produced chemical fertilizers. In many cases, farmers have stopped using artificial chemical fertilisers altogether. The incorporated legume residues are a biological source of nitrogen with carbon that reduces the amount of chemical fertilizer required for the following crop.

In organic farming practices, crop rotation involving legumes is common. By alternating between legumes and nonlegumes and sometimes using legumes as intercrop in a field of nonlegumes, the field is made to receive sufficient amount of nitrogenous compounds in soil to benefit the nonleguminous crop nutritionally. According to an old practice, even visible today in Odisha, legumes like *Cajanus* were cultivated along with major kharif crop of cereals like rice.

Legumes as green manure

Legumes are generally referred to as 'green manure' crops. Soil productivity is an important concern for farmers. Green manuring is gaining popularity as a method that successfully improves soil fertility and hence, its productivity. Green manuring means growing preferably a legume that will be worked into the soil later. The addition of organic material improves soil health. At the same time, the nutrients used up in promoting plant growth are conserved and returned back to the soil to enhance its fertility when plant residues are worked into the soil. Almost any crop can be used for green manuring, but legumes are preferred because of their ability to fix nitrogen from the air. Green manuring

with legumes (peas, beans, grams, clovers, lentils, etc.) is called 'legume green manuring' and is more beneficial than nonleguminous plants manuring.

Multiple field studies have shown that between 10 and 20 per cent of the total annual legume- nitrogen added to the soil through green manure is used by the first subsequent cereal crop. An additional 64 per cent of the legume nitrogen can be found in the top 1 meter (± 4 ft) of soil even a year after green manuring. This nitrogen becomes available as the plant residues continue to decompose within the soil. A cereal crop requires on an average 15-20 kg. / acre of nitrogen for optimum growth. The cereal crop can obtain 5-8 kg. /acre of nitrogen from the ploughed-down legume crop if the legume residue contains 25-30 kg. /acre of nitrogen. Assuming an additional 7-10 kg. /acre of mineral nitrogen is released from the soil reserves, then the cereal crop will require only about ± 5 kg. /acre of nitrogen that can be met from a variety of other sources such as vermicompost. However, high nitrogen availability in soil is not translated into crop yield but a healthy and suitable balance between nitrogen, phosphorus and potash, the three primary essential plant nutrients in soil. Ideal vermicompost with green manure and fresh cow urine application is the solution to achieve optimum crop yield. Legume green manuring is, therefore, an essential management tool worth implementing without much fuss.

Green manures also function like cover crops. It helps protect the soil from wind or water erosion between normal cropping periods. Growing legumes gives a producer several advantages besides only green manuring. The crop can be a source of high quality feed in years of hay shortage, or it can be grown for seed and serve as a cash crop such as grams, garden pea and *sesbania*.

Soil incorporation of legumes and other crop residues

Incorporating crop residues to the soil by and large helps maintain soil organic matter. The increase in soil organic matter increases plant nutrient availability

and improves the physical qualities of soil such as water infiltration, moisture storage or holding capacity, aggregate stability, and resistance to erosion. It has been estimated that a good humus rich organic soil holds 70% or more water when the soil where chemical fertilisers are repeatedly applied holds only 18% or less water. Soil organic matter decomposes slowly irrespective of whether a crop is growing or not. Decomposition of organic matter releases significant amounts of plant nutrients and it never interferes with plant growth negatively.

The intense summer tillage during fallowing physically disrupts the soil and increases aeration, which accelerates the process of solar and moisture penetration thereby helping decomposition of crop residues and other soil organic matter. A substantial portion of the released nutrients remains in the soil and is used by the crop following the fallow. When organic matter levels are relatively high, conventional summer fallowing can be used to supply nutrients to a crop. This decreases the need for chemical fertilizers in the long-term.

Legume plant residues are broken down into plant nutrient components by heterotrophic bacteria that consume organic matter. Warmth and moisture contribute to this process, similar to creating compost fertilizer. The plant matter releases large amounts of carbon dioxide and humic acids that react with insoluble soil minerals to release beneficial nutrients. For example, green manure can be applied to soils that are high in calcium minerals to generate higher phosphate content in the soil, which in turn acts as a fertilizer.

The ratio of carbon to nitrogen in soil and a plant is a crucial factor to consider, since it will impact the nutrient content of the soil and may starve a crop of nitrogen, if the incorrect plants are used to make green manure. The ratio of carbon to nitrogen will differ from species to species, and depending upon the age of the plant. The ratio is referred to as C: N. The value of N is always one, whereas the value of carbon or carbohydrates is expressed in a value of about

10 to 90. The C: N ratio should ideally be less than 30:1 in the soil in order to prevent the manure bacteria from depleting existing nitrogen in the soil. *Rhizobia* are soil organisms that interact with green manure to trap atmospheric nitrogen in the soil. Legumes, such as grams, beans, alfalfa, clover and lentils, have root nodules rich in *rhizobia*, making them the preferred source of green manure material.

Importance of cropping

Cropping is essential for nutrient recycling in farm soil. The lack of a crop to recycle nutrients back into the soil after the fallow may cause significant losses of some nutrients, such as nitrogen. In the crop-fallow system, common to many parts of the world, nitrogen removed from the soil has far exceeded that returned in crop residues or fertilizers. Reports indicate that prairie soils, which originally had the potential to release up to 50-55 kg/acre/yr. of mineral nitrogen, today may actually deliver as little as 4 kg/acre/yr. This decreasing supply of plant available nitrogen results in poor crop growth and the need for greater additions of artificial nitrogen fertilizers to obtain adequate crop yields.

Legumes as soil cover preventing soil erosion

Conventional summer fallow is used to increase moisture levels in the soil and reduce weed populations. It, however, leaves the soil susceptible to erosion. Legume green manuring acts as soil cover, adds more crop residues and more nitrogen to the soil, provides protection from erosion and helps to improve soil carbon-nitrogen levels. Thus, a legume green manure can be considered as a better alternative to fallow system that has a soil-building cover crop on the land for a part of the year.

Legumes like all plants use water while growing. In comparison to conventional summer fallow, legume green manuring may reduce the amount of moisture

availability for the subsequent crop. However, annual legumes have been shown to use only one-half to two-thirds the water used by a normal crop of spring wheat. In more moist areas where recropping is common (e.g., Black and Gray soils) this moisture reduction is usually not critical. Even in the drier areas such as Brown and Dark Brown soil zones, green manuring will not adversely affect yields if average rainfall occurs. This is shown in the achieved research results of Scott, Saskatchewan on a Dark Brown soil. However, under severe drought conditions, water loss due to growing legumes can perhaps depress the subsequent crop yields compared to conventional fallowing.

Managing legume green manure

Perennial, biennial and annual legumes have all been successfully used as green manures. The choice of legume depends on soil type and climate, especially levels of precipitation. In regions with adequate precipitation, under-seeding of a perennial legume to be green manured in the second or even third year is a common practice. In drier regions, annual legumes grown for six to seven weeks before soil incorporation at full bloom do not excessively deplete soil moisture reserves for the subsequent crop.

Perennials and biennials legumes used for green manuring include *Gliricidia*, clovers and alfalfa etc. Annual legumes presently used for green manure include field peas, flat peas (sweet pea family), grams and lentils etc.

Selection of a legume suitable for green manuring

A legume used for green manure should meet the following basic requirements:

- i. Ability to provide adequate ground cover to protect against soil erosion.
- ii. A high rate of nitrogen fixation and good biomass production.
- iii. High water-use efficiency when used in drier regions. The legume should

use as little water as possible while still producing substantial quantities of top-growth as *Sesbania*.

- iv. Compete well with weeds, especially the broadleaved varieties.

Advantages of a legume green manure

There are many advantages to using a legume green manure crop in rotation, which include:

- i. **N-fixation**: the actual amount of atmospheric N that is fixed and becomes available to subsequent crops depends on environmental conditions, soil fertility (other than nitrogen) and overall crop health. As a rule, soil N levels greater than 14 kg. /ac. can delay or reduce N fixation.
- ii. **Pest and disease control**: legume green manures provide a break in cereal and oilseed crop rotations to help minimize pest and disease pressures.
- iii. **Erosion control**: fallow operations, especially intensive summer tillage, can leave the soil exposed to wind and water erosion. Legume green manure crops provide cover, and promote soil retention by helping to build soil structure.
- iv. **Later seeding**: green manure crops are not grown to full maturity, and later seeding dates will not affect N-fixation negatively unless soil moisture becomes too low. In areas where soil moisture is limiting, or where limited soil moisture storage may become an issue, legume green manure crops should be seeded early, and terminated before the end of June, to allow time for soil moisture recharge.
- v. **Increased soil aggregation**: legume crops help build soil structure over time, which increases aeration, water infiltration and root growth, and helps decrease the risk of soil erosion.

The disadvantages of a legume green manure

There are also disadvantages to using legume green manure crops, which include:

- i. **Moisture use:** where moisture is limiting, green manure crops can utilize moisture that may otherwise be conserved during fallow. If moisture is not limiting, moisture uptake by green manure crops is less than moisture uptake in crops grown to maturity.
- ii. **Establishment costs:** a marketable crop is not achieved during the period of green manure crop. Legume seeds come with a cost that may be additional if not saved.
- iii. **Rotation limitations:** a green manure crop is invariably another legume in the crop rotation. To minimize pest and disease problems, the use of other legume crops for grain production may need to be restricted.

Illustration: Kaia Singh



PART 2

Monocultures,
Monopolies &
Free Trade:
Threats to Diversity
& Sovereignty

The Soya Empire: How Corporations Use "Free Trade" to Create GMO Monocultures and Monopolies

Across the world, in different climates and cultures, a diversity of pulses and edible legumes have sustained communities over centuries. Pulses have been the main source of vegetable protein for Indians. Multiple varieties have been evolved and grown in India over millennia, each with its own health benefits, all benefitting the soil by fixing nitrogen.

The diversity of pulses in our food and farming systems have disappeared in the past half-century causing a nutritional degradation of our diets and our soils. Instead of diversity we now have a corporate controlled global GMO soya empire, with Monsanto controlling the seeds, and the agribusiness cartel including Cargill and ADM controlling processing and trade.

These corporations have driven the industrialisation of production systems and promotion of the Monoculture model of external input based agriculture called the 'Green Revolution' - a mere re-branding and market creation exercise for chemicals of the World Wars, to keep the chemical companies in business in peace time. The Green Revolution increased monoculture acreage of wheat - which was bred for and dependent on costly chemical inputs - displacing the pulse based mixtures typical of indigenous farming systems.

The introduction of GMOs in agriculture is also called the second Green Revolution. The spread of GM soya has been made possible through the deregulation of commerce through the globalisation of trade and distribution systems through the corporate controlled model of “free trade” shaped by the rules and agreements of WTO in the period 1995-2015. The Trade Related Intellectual Property Rights Agreement of WTO (TRIPS) was written by Monsanto, which became - with the help of the laws it wrote promoting its own seed monopoly - the world’s largest seed corporation (*Peddling Life Sciences or Death Sciences: Monsanto the Gene Giant* by RFSTE/Navdanya/Polaris Institute).

The Agreement on Agriculture was shaped by Cargill, the world’s largest grain trading corporation, whose Vice President was delegated to head the US negotiating team on Agriculture. Cargill is the largest private company in the world. Although Cargill is US based, its main commodity trading operation is run out of Switzerland for tax evasion (*Cargill and the Corporate Hijack of Agriculture* Navdanya 2007). Besides being a major player in the trading, processing and transporting of the most important agricultural commodities, fertiliser and meats, it is one of the world’s largest hedge funds.

The objective of the TRIPS agreement was the collection of royalties from patented GMOs. For Cargill, GM soya presented a vertically integrated supply of vegetable protein, hexane-extracted soya oil and animal feed. Each toxic step of the soya economy profiting Monsanto or Cargill. Which is exactly how, through the imposition of costly, chemical intensive GM soya seeds by Monsanto and the stealthy inclusion of soya in everything from McDonald’s burger buns to Lays crisps, profits were vertically integrated into the corporate industrial food system.



It's no wonder GM soya - corporate industrial agriculture's 'magic bean' - has spread so rapidly across the world since the 1990's, helped along the way by laws written by the corporations themselves.

The objective of the agreement on agriculture was market capture by dismantling import restrictions and dumping subsidised commodities on the Third World. The case by the US against India in the WTO, on Quantitative Restrictions, opened the flood gates for forced imports of soya oil and pulses, destroying self reliance and food sovereignty. (*Yoked to Death* RFSTE, 2001, *Mirage of Market Access* RFSTE, 2003, *Roti Kapda aur Makan* RFSTE, 2006, *Why is Every 4th Indian Hungry* Navdanya 2009). The expansion of industrial agriculture and globalised distribution create a global market based on a few commodities, destroying the biodiversity of economies, including local and national food systems, which support the biodiversity of our crops and foods.

And contrary to the claim of "free trade" propagandists, prices of staples like pulses have gone up in the Third World, and cartelisation of the big traders as well as price manipulation by them has increased. Diversity of local crops produced by small farmers has been replaced by a few commodities traded globally by big traders which are inferior in nutrition and quality than the diversity they violently displace. For the poor, "free trade" translates into less food, worse food, with less nutrition, all at a higher cost. This is a recipe for hunger and malnutrition.

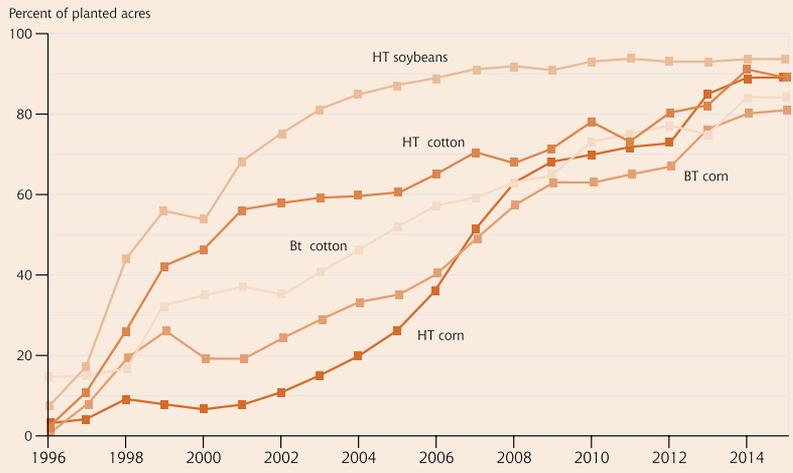
Both pulses and oilseeds were first destroyed by the monocultures of rice, wheat and corn promoted by the Green Revolution. Now both pulses and oilseeds diversity are being displaced in every society by expansion of monocultures of GM soya, and dumping of GM soya oil and GMO products. Eighty-five percent of the GM soya goes for animal feed, Monsanto seed, Monsanto chemicals, Cargill oil, Cargill MSG, Cargill feed, Cargill meat and are destroying the planet and our health, calling it a "Commodities Boom" while farmers - the producers of food - go hungry.

The global soya monoculture

Alongside the coming into force in 1995, Monsanto received approval for GM RoundUp Ready Soya in 1994 in the U.S., in Canada in 1995, in Japan and in Argentina in 1996, in Uruguay in 1997 and in Mexico and Brazil in 1998. Once the approval, and more importantly, TRIPS in the WTO were in place, Monsanto looked to corner the Soy market. In *The Dark Side of Soy*, Mary Vance writes, “These days the industry has discovered ways to use every part of the bean for profit. Soy oil has become the base for most vegetable oils; soy lecithin, the waste product left over after the soybean is processed, is used as an emulsifier; soy flour appears in baked and packaged goods; different forms of processed soy protein are added to everything from animal feed to muscle-building protein powders.” RoundUp Ready Soy is in virtually every processed food and cannot be avoided even if nutrition labels are diligently checked because the Corporate food industry has been mislabeling products long before the GMO debate.

The Soya lobby backed by Big Ag and Big Food has managed to change standards and laws to allow cheaply available soya products and all by-products - some extremely toxic - into the food system. In an example of Big Ag lobbying SANA asked the Food Safety and Inspection Service to “accurately label” frozen pizza by *removing* the requirement to mention percent compositions. SANA stated in a docket dated January 2nd, 2002, [Our] “members agree that pizza products should be appropriately named, but we do not support the descriptive labelling system proposed by FSIS. *Listing the names of the pizza ingredients in the product name as proposed would be awkward and cumbersome.*” ...“Requiring percent labeling in the product name could also result in a competition between companies to present the highest percent meat or poultry, thus running counter to USDA’s goal of encouraging development of pizzas with lower saturated fat and cholesterol content.”

Graph 1: Adoption of genetically engineered crops in the United State, 1996-2015



Data for each crop category include varieties with both HT and Bt (stacked) traits. Sources: USDA, Economic Research Service using data from Fernandez-Cornejo and McBride (2002) for the years 1996-99 and USDA, National Agricultural Statistics Service, *June Agricultural Survey* for the years 2000-15.

The growth in soya production has occurred through large scale contract based farming. Mechanisation and aerial spraying of herbicides has undermined local economies, alienating farm workers who have been left out of the “Soya boom”. To profit from this projected demand from the industrial food complex, the Big Six seed companies have 20 GM varieties of soya approved in the US, all of which are Herbicide Resistant (HT).

Table 1:

Applicant	Phenotype	Date Effective
Monsanto	Lepidopteran-Resistant SoybeanMON 87751	10/17/14
Dow	2, 4-D, Herbicide and Glufosinate Tolerant	9/22/14
Dow	2,4-D and Glufosinate Tolerant	9/22/14
Bayer/Syngenta	HPPD and Glufosinate Tolerant	7/18/14
Dow	Insect Resistant	4/17/14
BASF	Imidazolinone Tolerant	3/18/14
Monsanto	Increased Yield	11/7/13
Bayer and M.S. Technologies	Herbicide and Isoxaflutole TolerantFG72	8/21/13
Monsanto	Stearidonic Acid Produced	7/13/12

Monsanto	Improved Fatty Acid Profile	12/16/11
Monsanto	Insect Resistant	10/12/11
Pioneer	High Oleic Acid	6/8/10
Pioneer	Herbicide & Acetolactate Synthase Tolerant	7/24/08
Monsanto	Herbicide Tolerant	7/23/07
AgrEvo	Phosphinothricin Tolerant	11/23/98
AgrEvo	Phosphinothricin Tolerant	6/8/98
Du Pont	High Oleic Acid Oil	5/7/97
AgrEvo	Glufosinate Tolerant	7/31/96
Monsanto	Herbicide Tolerant	5/18/94
Monsanto	Dicamba Tolerant	

With marketing materials ready, the Soyfood Association of North America - funded generously by Archer Daniels Midland Company (ADM) - waited, in October 1999 for the FDA to declare: “25 grams of soy protein a day, as part of a diet low in saturated fat and cholesterol, may reduce the risk of heart disease. Products that contain at least 6.25 grams of soy protein per serving, and are low in fat, saturated fat, and cholesterol will be eligible to carry the claim.”

“FDA has just given the American public another reason to eat soyfoods, one of the fastest growing segments of the soy industry,” said the President of the Soyfoods Association of North America (SANA). A Tulane University study said that other kinds of beans are actually twice as good at fighting heart disease than soyabean, but it was only the soyabean that had been patented so soya was marketed as a heart healthy food. The benefits of soyabean for the industrial food system include the availability of cheap raw material that can be included in any processed food and the inclusion of cheap soya allows the processed foods to be marketed as ‘healthy’ owing to the FDA’s false recommendations. Products like

Prolia, from Cargill are mixed into meat products so that less meat - much more costly than soya protein - is included in industrial meat products.

Cargill states about Prolia: Even with chicken's delicate flavor, taste tests have concluded that patties with 10% Prolia™ defatted soy flour were indistinguishable from all-chicken patties – and half the participants preferred them.

Adding 10% Prolia allows Cargill to sell meat products as “heart healthy”. Demand for soya soared because consumers were misled into thinking they were eating healthier. The FDA's position has since been questioned by the FDA itself.

“The FDA may determine that a re-evaluation of the health claims may be needed when new scientific evidence does not support the current claim,” said Kimberly Rawlings, FDA Spokesperson, in an interview in 2006. For the Industrial food cartel, the market was ready.

Since 1997, GM soya has dramatically increased in US, Brazil and Argentina- 3 countries accounting for 80% of global soya production. In the US, acreage for Herbicide Tolerant Soybean jumped from 17% in 1997 to 68% in 2001, and 94% in 2014-15. Compared to other GMO crops, soybean saw a much more rapid

adoption rate because of the market created by the FDA.

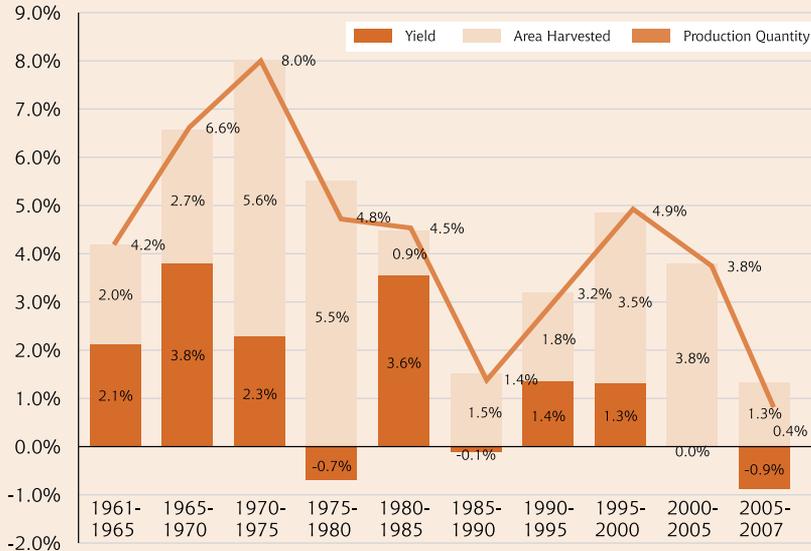
A closer look at global soya production shows that the increased production of soya is due to an increase in area harvested. Herbicide Tolerance has no effect, wherever yield has not actually increased with a switch to GM soya.

Graph 2: Global production of soybean (Million Metric Tonnes)



Source: USDA

Graph 3



A research paper titled *World Soybean Production: Area Harvested, Yield, and Long-Term Projections* by Tadayoshi Masuda and Peter D. Goldsmith, of the University of Illinois found:

“After 1990s, however, the contribution of yield growth to production growth declined. The compound annual growth rates of world average soybean yield were 1.4 % in 1990-95 and 1.3% in 1995-2000, then 0.0% in

2000-05 and -0.9% in 2005-07 (Graph 6). The world soybean production growth rates during the above four periods (3.2%, 4.9%, 3.8% and 0.4%) are supported by the area harvested growth rates (1.8%, 3.5%, 3.8%, and 1.3%).”

With lower yields and higher demand from the industrial food complex, more and more land is required by the Soya machine, leading to large scale deforestation and displacement of entire communities in order to accommodate the greed - or “value chain” - of Monsanto, Cargill, ADM and the rest of the Industrial food Cartel.

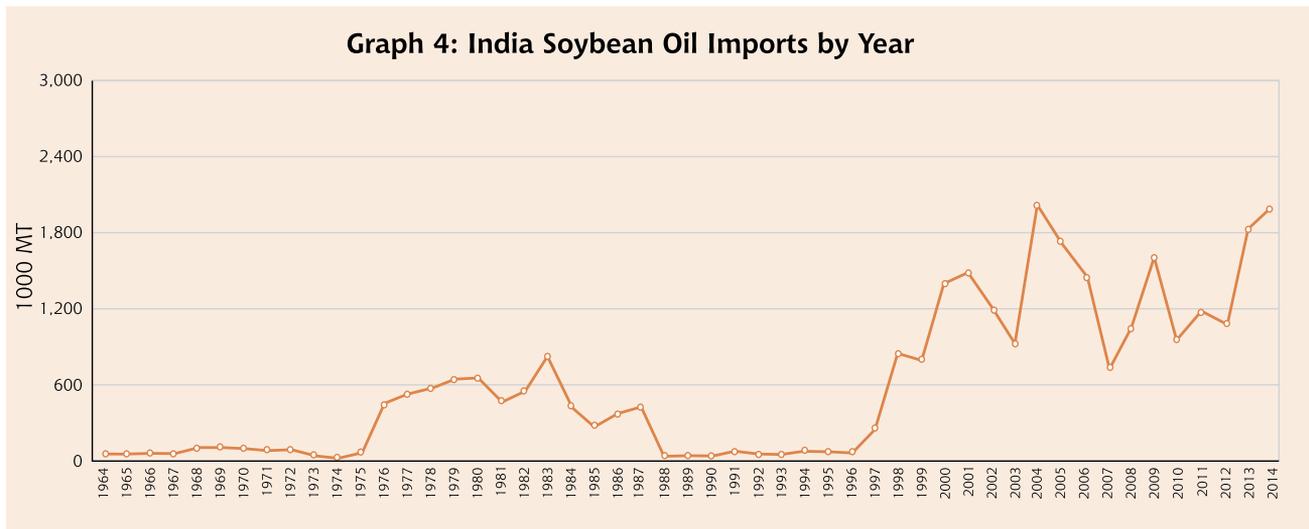
In Argentina, where all cultivated soya is Monsanto HT Soya, besides the loss of livelihoods, the rampant and unchecked use of Glyphosate has created a health epidemic of tragic proportions.

How India was made dependent on soya and pulse imports

Since the mid 1990's, India, which was the biggest producer of pulses and oilseeds has been transformed into the biggest importer of pulses and oilseeds.

Since nowhere else in the world are the rich diversity of pulses and oilseeds grown, the richness, nutrition and diversity of the diet is getting degraded.

GM soya oil is being imported to India in ever larger quantities.



“After near self-sufficiency in edible oils until the mid-1990s, Indian imports of such oils increased rapidly to make the country the world’s largest importer of edible oils. With domestic production of edible oils, an essential item of mass consumption, falling short of effective demand, edible oil imports were liberalized in April 1994 when import of edible vegetable palmolein was placed under Open General License (OGL) with 65 per cent import duty. With this liberalization and the demand-supply gap, a substantial part of the domestic consumption started to be met through imports. Imports and the associated

international prices, in turn, have direct impact on domestic production and prices of oilseeds and oils, and hence on the livelihood of the farmers. “

Source: <http://finmin.nic.in/reports/ReportRationalEC.pdf>

Soybean meals are usually extracted with hexane, a solvent that is extremely flammable and non-biorenewable, poses health risks and is regulated as a hazardous air pollutant (O’Quinn et al., 1997).

Source: <http://www.feedipedia.org/node/674>

Spread of soya in India - displacing pulses

Although soya has been cultivated in India for the last millennium, it is not a staple and has been grown sustainably on small farms. Current soya cultivation, as a raw material for the industrial food system, is a completely new phenomenon. With an uncertain future in South America, Monsanto, Cargill and Archer Daniel Midland (ADM) are looking elsewhere to take over land and ensure the global soya engine keeps chugging. In an unprecedented arrangement, the Government of Maharashtra has entered into a Public Private Partnership for Integrated Agriculture Development Programme (PPPIAD), an agriculture project, with ADM - a shipping company. ADM and Monsanto have managed to increase soya acreage from 7,000 ha in 2001 to 3.80 lakh hectares in year 2014-15 (Kharif season) using the “well-defined institutional mechanism” created by the government - without having to invest or work for it - maximising profits riding on tax payer rupees.

Source: <http://www.ficci.com/spdocument/20539/SOYBEAN-Report.pdf>

In its report on the project, ADM states “Labor consists 30% of the total cost of Soybean cultivation for a one acre land. Mechanization is a logical choice when the country is looking for ways of managing agriculture labor concerns. Introduction of new farm implements in Soybean cultivation which led to end to end mechanized solutions led to net saving of 30% in Soybean cultivation,

25% increase in yield and saving of Rs 640 per acre in cost of seed. Two FPOs (Farmer Producer Organizations) formed for establishing custom hiring centres for Soybean cultivation were very efficient. There is need to promote soybean variety fit for mechanical harvesting.”

For ADM, 30% of the total cost of soya production being labour, money going to the local economy for work done, is unnecessary. ADM would much rather save the 30%, while creating a market for companies like John Deere and Monsanto to sell expensive equipment to farmers who are currently barely getting by. Monsanto’s Bt cotton has already pushed the farmers of Maharashtra into a debt trap from which the only escape has been suicide. 300,000 farmers have committed suicide since the WTO allowed Monsanto to charge exorbitant royalties for its seeds - without which farmers who have not saved their seeds cannot farm. Together with the Bt-Cotton growing regions, the current push for growing soya by international corporations encompasses most of central India, leaving the soils of the region and the farmers vulnerable.

Monsanto’s Bt cotton has been responsible for farmer suicides since its illegal introduction in 1999, especially in Maharashtra. Farmers looking to switch from growing the failed Bt-Cotton have jumped out of the pan and into the fire of the predatory industrial soya economy. Soya does not have a market without industrial processes like hexane extraction. Neither does it (or any by-products) have any non-industrial application, hence no non-industrial market. For the Indian soya farmer, there is one buyer - ADM. The farmer has to buy seeds from corporations at a price determined by them and sell the harvest to ADM, at a price determined by ADM. In Latur, where ADM claims to be improving the standard of living of soya farmers, ADM purchased 68,089 million tonnes of soya from farmers for a stated expense of ₹ 240 crore.

Since 2003, when ADM commenced its Soya “Value Chain” building exercise in Maharashtra, farmer suicides have spread to encompass more than the Bt-Cotton



growing regions - to soya farmers. “Forty-five days, 93 suicides. 2015 has started quite ominously for farmers in the perennially parched Marathwada region”, read a news report in early 2015. Just like Monsanto pushed irrigation-dependent Bt-Cotton in rainfed areas of India, ADM has pushed water intensive soya cultivation in these same regions for corporate profits, pushing farmers to suicide. In the same news report, Umakant Dangat (Divisional Agriculture Commissioner) who is thanked in ADM’s Soya report for his facilitation of the ADM led corporate takeover of Maharashtra’s agriculture since 2003, says “Farmer suicide is one of the biggest challenges before the administration. Crop failure and debts are considered the main reasons for farmers’ suicide”. Essentially, ADM has joined Monsanto in continuing the genocide of Indian farmers.

The other impact of soya expansion in India has been a reduction in cultivation of pulses. By handing over entire regions to corporations like ADM, more and more land is being used to grow raw materials for industry instead of growing food. Pulses are integral to the Indian diet, and for some, the only source of protein. A reduction in cultivated area of pulses and a move to soya monocultures has resulted in a shortage of pulses and the resulting skyrocketing of pulse prices in India - leaving the poorest without access to protein.

Source: <http://www.mapsofindia.com/indiaagriculture/oil-seeds/soyabean-growing-states.html>

Monsanto, biopiracy and patent monopolies on soya

The global spread of soya is directly linked to the introduction of GMOs, Intellectual Property Rights and Patents in Seed. IPRs expanded to cover living systems and organisms is a distortion of “Innovation” and “invention”, since living organisms and seeds are not invented. They can be modified, but not created from scratch like machines are. Life forms have been redefined as “manufacture”, and “machines”, robbing life of its integrity and self-organisation, its ability to reproduce and multiply. This distortion was introduced by corporations such as Monsanto in the TRIPS (Trade Related Intellectual Property Rights) Agreement of WTO. Corporate influence on Patent Law began with the drafting of the Trade Related Intellectual Property Rights (TRIPS) Agreement of the WTO by the Intellectual Property Committee (IPC) of the multilateral corporations.

James Enyart of Monsanto is on record illustrating just how deeply the TRIPs agreement is aligned to corporate interest and against the interests of nations and their citizens:



“Once created, the first task of the IPC was to repeat the missionary work we did in the US in the early days, this time with the industrial associations of Europe and Japan to convince them that a code was possible....

Besides selling our concepts at home, we went to Geneva where [we] presented [our] document to the staff of the GATT Secretariat. We also took the opportunity to present it to the Geneva based representatives of a large number of countries... What I have described to you is absolutely unprecedented in GATT. Industry has identified a major problem for international trade. It crafted a solution, reduced it to a concrete proposal and sold it to our own and other governments... **The industries and traders of world commerce have played simultaneously the role of patients, the diagnosticians and the prescribing physicians.**”

Monsanto which had no presence in the seed sector prior to the 1990's has emerged as the most dominant player in control over seeds by using 3 strategies – influencing international IPR law, criminalising farmers' seed saving, buying up companies that introduced GMOs and had patents on seeds, and entering into licensing arrangements with potential competitors.

Monsanto controls soya seeds through patents on GM soya. Soya is an Asian crop. As a food it was evolved in Asian cultures. Because of its anti nutritive factors, traditional foods made from soya were always fermented such as miso, tofu, tempeh etc. The very fact that Monsanto “owns” soya seeds through patents is an act of Biopiracy of the biodiversity heritage of Asia, and through this Biopiracy, Monsanto has collected billions of dollars as royalty. In just two decades it has become the world's biggest seed corporation.

Biopiracy is an example of false claims to “inventions”. Over the past decade, through new property rights, corporations like Monsanto have gained control over the diversity of life on earth, and farmers indigenous knowledge of the breeding of soya diversity in Asia over centuries. Adding genes through genetic engineering to a soya seed is not the invention of the seed - it is the appropriation of 10,000 years of Asia's farmers' innovation.

Monsanto, which claims to have ‘invented’ the seeds it sells, cannot even claim to have carried out the genetic engineering of soya. Soya, along with the first transgenic varieties of cotton, peanuts, and other crops were genetically modified by Agracetus. On March 2nd, 1994, the European Patent Office granted a patent (Publication number 0 301 749 B1) on genetically-transformed soybeans to Agracetus. The sweeping patent covered all forms of genetically-transformed soybeans, *regardless of the technique employed or the germplasm involved*. Agracetus being a competitor, Monsanto was not happy being excluded from a “species monopoly” on soya. Monsanto “vigorously and formally”

opposed the patent, alongside the environmental groups it now undermines. Monsanto had been licensing the technology from Agracetus since 1991. In 1996 Monsanto purchased Agracetus from WR Grace, it's parent company, claiming the Agracetus patents as the property of Monsanto. The 1994 arguments used by Monsanto, against Agracetus, were used by the EPO to strike down the "species monopoly" patent - now belonging to Monsanto - on 3rd May, 2007.

Source: GM Patent Rejected After 13 Years, Nature, 4 May 2007

Revoked!! Monsanto Monopoly Nixed in Munich, Etc Group Release, 2007

<http://www.ictsd.org/bridges-news/biores/news/controversial-monsanto-soy-patent-revoked-0>

WR Grace itself has a history of Biopiracy. The European Patent Office (EPO) had granted patent (0436257 B1) to the United States Department of Agriculture and the multinational corporation W. R. Grace for a method of controlling fungi on plants by the aid of an extract of seeds from the Neem tree. The patenting of the fungicidal properties of Neem was a blatant example of biopiracy and indigenous knowledge.

Dr Vandana Shiva and the Research Foundation for Science, Technology and Ecology joined hands with Magda Alvoet, President of the European Parliament's Green Party, and Linda Bullard, President of the International Federation of Organic Agriculture, in 1994, and challenged the patent on the grounds of "lack of novelty and inventive step". We demanded the invalidation of the patent among others on the ground that the fungicide qualities of the Neem and its use has been known in India for over 2000 years, and for use to make insect repellents, soaps, cosmetics and contraceptives; Neem patent was finally revoked in 2005.

Monsanto first entered the maize seed business when it purchased 40% of DEKALB, also in 1996; it purchased the remainder of the corporation in 1998, the same year in which it purchased Cargill's international seed business, which gave it access to sales and distribution facilities in 51 countries. In 2005, it

finalised the purchase of Seminis Inc, a leading global vegetable and fruit seed company, for \$1.4 billion. This made it the world's largest conventional seed company at the time.

In 2007, Monsanto and BASF announced a long-term agreement to cooperate in the research, development, and marketing of new plant biotechnology products, and in 2015 it tried to buy the second biggest seed corporation, Syngenta.

Monsanto started selling Roundup Ready Soybean to US farmers in 1996. The patent came off patent in 2015.

But already in 2009, Monsanto was ready with new patented soya bean, Genuity® Roundup Ready 2 Yield® the next-generation of the Roundup Ready soybean. And Monsanto has clearly declared that "In addition to the trait patent, most Roundup Ready soybeans are protected by other forms of intellectual property, such as varietal patents. These variety patents will continue to be valid after (and usually long after) the Roundup Ready trait patent expires."

Source: <http://www.monsanto.com/newsviews/pages/roundup-ready-patent-expiration.aspx>



Monsanto's biopiracy of soya bean has not stopped inspite of the revocation of the broad species patent. On 26th Feb 2014 Monsanto was granted a patent EP 08742297 for screening and selecting soyabean plants. The soybeans concerned are wild and cultivated species stemming from Asia and Australia. According to the patent more than 250 plants stemming from "exotic" species were screened for biodiversity in climate adaption and variations in maturity. The usage of hundreds of DNA sequences representing genetic variations are claimed by Monsanto for future conventional breeding in soybeans. The patent is also applied in other regions such as the US, Canada, China and South Africa, however the EPO seems to be the first to grant this scandalous patent.

According to Christoph Then of No Patents on Seeds, “This is nothing else than biopiracy on large scale. Monsanto tries to control access to genetic information for example needed to develop soybean adapted to climate change. By correct interpretation of European patent law, the EPO is not allowed to give patents on conventional breeding. What we need is now a strong reaction from European governments to stop these patents.”

Examples of Monsanto’s biopiracy patents

- **Monsanto’s biopiracy of Indian Wheat:** European Patent Office in Munich revoked Monsanto’s patent on the Indian wheat variety, Nap Hal. Monsanto, the biggest seed corporation was assigned the patent (No. EP 0445929 B1) on wheat on May 21st, 2003 by the EPO under the simple title, “plants”. On January 27th, 2004 The Research Foundation for Science, Technology and Ecology along with Greenpeace and Bharat Krishak Samaha filed a petition at the EPO challenging the patent rights given to Monsanto, leading to the patent being revoked.
- **Monsanto’s Biopiracy of Indian Melons:** In May 2011 the US company Monsanto was awarded a European patent on conventionally bred melons (EP 1 962 578). These melons which originally stem from India have a natural resistance to certain plant viruses. Using conventional breeding methods, this type of resistance was introduced to other melons and is now patented as a Monsanto “invention”. The actual plant disease, Cucurbit yellow stunting disorder virus (CYSDV), has been spreading through North America, Europe and North Africa for several years. The Indian melon, which confers resistance to this virus, is registered in international seed banks as PI 313970. With the new patent, Monsanto can now block access to all breeding material inheriting the resistance derived from the Indian melon. The patent might discourage future breeding efforts and the development of new melon

varieties. Melon breeders and farmers could be severely restricted by the patent. At the same time, it is already known that further breeding will be necessary to produce melons that are actually protected against the plant virus. DeRuiter, a well known seed company in the Netherlands, originally developed the melons. DeRuiter used plants designated PI 313970 – a non-sweet melon from India. Monsanto acquired DeRuiter in 2008, and now owns the patent. The patent was opposed by several organisations in 2012. On 20th Jan 2016 the patent was revoked by the European Patent Office.

- **Monsanto’s Biopiracy of Climate Resilience:** Corporations like Monsanto have taken 1500 patents on Climate Resilient crops. The climate resilient traits will become increasingly important in times of climate instability. Along coastal areas, farmers have evolved flood tolerant and salt tolerant varieties of rice such as “*Bhundi*”, “*Kalambank*”, “*Lunabakada*”, “*Sankarchin*”, “*Nalidhulia*”, “*Ravana*”, “*Seulapuni*”, “*Dhosarakhuda*”. Crops such as millets have been evolved for drought tolerance, and provide food security in water scarce regions, and water scarce years.

Monsanto applied for blanket patents for “Methods of Enhancing Stress Tolerance in plants and methods thereof” (The title of the patent was later amended to “A method of producing a transgenic plant, with increasing heat tolerance, salt tolerance or drought tolerance”). These traits have been evolved by our farmers over millennia, through applying their knowledge of breeding. On 5th July, 2013, Hon Justice Prabha Sridevi, Chair of the Intellectual Property Appellate Board of India, and Hon Shri DPS Parmar, technical member, dismissed Monsanto’s appeal against the rejection of these patents that claim Monsanto has invented all resilience.

When India amended her patent acts, safeguards consistent with TRIPS were introduced. Article 3 defines what is not patentable subject matter.

Article 3(d) excludes as inventions “the mere discovery of any new property or new use for a known substance”.

Article 3(j) excludes from patentability “plants and animals in whole or in any part thereof other than microorganisms; but including seeds, varieties, and species, and essentially biological processes for production or propagation of plants and animals”.

This was the article used by the Indian patent office to reject a Monsanto patent on climate resilient seeds. While the Indian patent office rejected a Monsanto patent, the US Supreme Court ruled on behalf of Monsanto against a farmer called Bowman who had not bought seeds from Monsanto but purchased soybeans from an Indiana grain elevator. The US Supreme court ruling creates intellectual property in future generations of a grain or seed. This is biologically and intellectually incorrect because all that Monsanto has done is add a gene for resistance to its proprietary herbicide Round up, to (i) claim ownership of any plant/animal that gene finds its way into and (ii) to enforce a RoundUp monopoly. Adding a gene of RoundUp resistance does not amount to “inventing” or “creating” a soya bean seed, its future generations and the species the gene pollutes.

Source: http://www.supremecourt.gov/opinions/12pdf/11-796_c07d.pdf

More free trade. More factory farms. More meat in diets.

Ninty percent of the soyabean grown today goes for animal feed and biofuel, not for feeding people and, hence, not for alleviating hunger or poverty. Free trade rules have increased soya cultivation for animal feed and meat production, reducing the cultivation of actual food in the face of climate change and food scarcity. The average German now eats four times as much meat as in 1850 and twice as much as 100 years ago. While the “efficiency” of factory farming points to the confined space in which animals are kept in “Concentrated Animal Farm Operations” (CAFO), it hides the shadow acres for the animal feed.

“Meat eats Land”

Germany’s own agricultural area comprises approximately 17 million ha. Given a virtual land grab of 7 million ha, this means that Germany utilises additional land outside of the EU equating to more than 40 % of its own agricultural land base. One agricultural commodity in particular is responsible: the production of soyabeans alone accounts for 40 % of Germany’s virtual land grab.

In 2008-2010 the EU imported on average approximately 35 million tonnes (Mt) of soya and soya products (including 13 Mt of soyabeans, more than 21 Mt of soyabean meal and 380.000 tonnes of soyabean oil). Soyabeans are further processed into soyabean oil and soyabean meal. Soyabean meal is used almost exclusively to feed livestock. About 88 % of net imports of soyabeans and soyabean products originate in South America, primarily in Brazil and Argentina. At 6.4 Mt, Germany’s share in these net imports and thus its share in total EU foreign trade in soyabean products is very significant.

If one calculates the area required to produce the imported soyabean products, the resulting total hectarage, i.e. the soyabean land footprint, is very large. Between 2008 and 2012 the EU, on average, utilised an area of almost 15 million ha, 13 million ha of which are located in South America. Of these, 5.5 million ha are located in Argentina and 6.4 million ha in Brazil. Considering the total area used for soya production in these two countries, it is obvious that the EU “claims” a very significant share of these areas. Of the 17 million ha of agricultural land used for soyabean production in Argentina, 33% produce soya for the EU. The figure for Brazil is approximately 30%, of a little under 22 million ha in total. If these 15 million ha were to be transferred to Germany it would mean that about 90 % of the country’s agricultural area would be producing soyabeans.

Germany imports 6.4 Mt of soyabean products, resulting in a production footprint of 2.6 million ha. How is soya used in Germany? The bulk of it, i.e. soyabean meal, is fed to livestock. Germany’s total annual consumption of soyabean meal is 4.6 Mt. The bulk of this is fed to pigs and poultry: soyabean meal comprises 30 % or more of the concentrate feed used in these sectors. For example, it takes almost 1 kg of soya – together with other feedstuffs used to make up an “average” feed ration – to produce 1 kg of poultrymeat, 650 g soyabean meal for 1 kg of pork and “only” 230 g for 1 kg of beef. Soyabean meal generally plays a lesser role in the feeding of ruminants.

Acknowledgment: http://www.wwf.de/fileadmin/fm-wwf/Publikationen-PDF/Meat_eats_land.pdf

Table 2:

Dish	Total area needed	o/w area needed for meat component	o/w area needed for soya
Roast pork	3.12	2.23	0.66
Hamburger	3.61	3.38	0.11
Chicken curry	1.36	0.76	0.38
Grilled sausage	2.26	1.96	0.35
Pasta & tomato	0.46	0.00	0.00

Converting Soya and grains into animal protein is a net negative production. The US Dept of Agricultural Economic Research Service puts the figure of 16 kg grain to produce 1 kg of beef.

Source: *Eat Less Meat, Compassion in World Farming and Navdanya*, 2004, Pg 22.

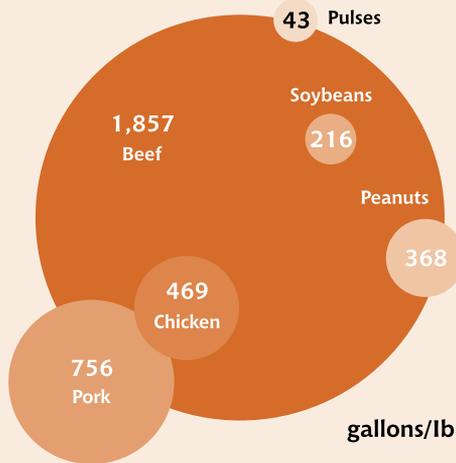
The land and water footprint of factory farmed meat production is also very high. This diversion of land and water from food for people, to feed for animals, is a major contributor to hunger in the world. And it is also the cause of disease and ill health for those eating less plant based diets. The FAO and WHO have concluded that 'traditional', more plant based diets ... swiftly replaced by high fat, energy-dense diets with a substantial content of animal foods has played a 'key role' in the upsurge of diet related preventable diseases.

Source: *Diet, Nutrition and the Prevention of Chronic Diseases*. Report of Joint WHO /FAO expert consultation, 2002, cited on pg 12 *Eat Less Meat*.

A shift away from growing soyabean for animals in factory farms to growing biodiversity of pulses as part on local agriculture systems would rejuvenate health of people, health of animals, and health of soil. It would stop land grab, stop deforestation and also contribute to dramatically reducing emissions that lead to climate change. Factory farming and chemical agriculture are responsible for 50% of the Green House Gases. Nitrogen oxide, emitted through the use of

Graph 5: Water Footprint

It only takes **43 gallons of water** to produce **one pound of pulses**.



It takes **1,857 gallons of water** to produce **one pound of beef!**

synthetic nitrogen fertilisers, is 300 times more potent as a GHG than CO₂. Methane, emitted from factory farms where the soya animal feed is used, is 20 times more potent than CO₂. The industrial food cartel - Monsanto, BASF, Bayer, DOW, Syngenta, Pioneer, Cargill, Archer Daniels Midland, PepsiCo, CocaCola et al - is the single biggest driver of deforestation and climate change and must be held accountable.

Soya expansion, deforestation and climate change

Two of the most common arguments used by the agrichemical/GMO industry is that the vast monocultures they promote are necessary to feed the hungry and protect wilderness. The expansion of GM soya monocultures counters both myths. 85% of the soya is used as animal feed, not food for people. Further, the soya expansion is a major factor in the destruction of the forests in South America. GM Soya beans, grown industrially are destroying forests and biodiversity, not conserving wilderness.

About 85 percent of the world's soybean crop is processed into meal and vegetable oil, and virtually all of that meal is used in animal feed. Some two percent of the soybean meal is further processed into soy flours and proteins for food use... Approximately six percent of soybeans are used directly as human food, mostly in Asia.

Source: *More Soy, Less Forest – and No Water*. 2009, <http://gentleworld.org/as-we-soy-so-shall-we-reap/>



As the WWF report states “To grow soybeans, vast expanses of land are needed. Production is overtaking huge areas in fragile ecosystems such as the Brazilian Cerrado (a relatively flat, mixed woodland and savannah area of central Brazil), the Amazon, the Chaco, and the Atlantic Forests of South America. This threatens wildlife and biodiversity. It also adversely affects people, the global climate, water reserves and soil quality. In South America, almost 4 million hectares of forests are destroyed every year, 2.6 million of them in Brazil alone. Although this is lower than in the 1990s, it is still far too high and can largely be blamed on heavily soy-dependent livestock farming.”

Source: http://wwf.panda.org/what_we_do/footprint/agriculture/soy/consumers/

Roundup Ready Soybean in Latin America: A Machine of Hunger, Deforestation and Socio-ecological Devastation

Miguel A. Altieri and Walter A. Penuel

The biotech industry and their research allies celebrated in 2014 the continual expansion of biotech crops for the 19th consecutive year of commercialization. Global biotech crop hectareage continued to grow with 18 million farmers planting more than 181 million hectares in 2014, up from 175 million in 27 countries in 2013. The biotech industry considers this adoption a triumph because they claim that in 28 countries, biotech crops have met the expectations of millions of large, medium and small farmers in both industrial and developing countries. They also claim that biotech crops are also delivering benefits to consumers and society at large, through more affordable food, feed and fiber that require less pesticides and hence contributing to a more sustainable environment (James 2014). It is difficult to visualize how such biotechnological expansion has met the needs of small farmers or consumers when 79% of the global area of transgenic crops (84.5 million hectares) is devoted to herbicide resistant (roundup ready), a crop mostly grown by large scale farmers for export (not for local consumption and therefore contributing nothing to regional food security) and in importing countries devoted for animal feed for meat production

consumed mostly by wealthier sectors of the population. Biotech proponents claim that 18 million farmers planted biotech crops in 2014, 90 percent of whom were small, resource-poor farmers. Of these 7.1 million small farmers in China and 7.7 million in India grew over 15 million hectares of Bt cotton which is not a food crop, and in India the adoption of high price Bt cotton has been linked to more than 270,000 rain-fed farmers who caught in a cycle of unmanageable debt have committed suicide since 1995 (Catacora et al 2012).

In Latin America, countries producing soybean include Argentina, Brazil, Bolivia, Paraguay and Uruguay (Pengue 2015). The expansion of soybean is driven by prices, government and agroindustrial support and importing countries demand, especially China, the world's largest importer of soybean and soybean products, a market that encourages rapid proliferation of soybean production. Soybean expansion is accompanied by massive transportation infrastructure projects that unleash a chain of events leading to destruction of natural habitats over wide areas beyond to the deforestation directly caused by soybean cultivation. In Brazil soybean profits justified improvement or construction of 8 industrial water ways, 3 railway lines and an extensive network of roads to bring inputs and take away produce. These have attracted private investment in logging, mining, ranching and other practices with severe impacts on biodiversity not accounted for by any impact assessment study (Fearnside 2001). In Argentina, the agroindustrial cluster area for transformation of soybean into oils and pellets is concentrated in the Rosario region on the Parana river, turning it into the largest soy transformation area of the world, with all the associated infrastructure and the environmental impacts that these entail.



Soybean expansion and deforestation

Between 1990 and 2010, the harvested area almost doubled in Brazil from 11.4 to 23.2 million ha. In Argentina, during the same period, it more than tripled from 4.9 to 18.1 million ha. Soybean production takes up a significant portion of total arable land in Brazil (35%), Argentina (61%) and Paraguay (62%). By the end of 2014 GM soybean occupies the largest area of any crop in Brazil with more than 25% of the total cultivated land or 29.1 million hectares. In Paraguay soybeans are planted on more than 25 % of all agricultural land in the country, RR@soybean was grown on 1.0 million hectares in Bolivia and in Argentina soybean acreage reached 20.8 million hectares. All this expansion is occurring dramatically at the expense of forests and other habitats. Although many studies have shown that deforestation is predominantly a result of pasture expansion, recent research supports the hypothesis that an increase of soybean has displaced pasture leading to deforestation elsewhere. In more specific terms, soybean production has expanded northwards in Argentina and Paraguay, and has taken important land area in the Cerrado ecosystem in Brazil, from where it has advanced towards the Amazonian ecosystem. Since the early 1970s, the latter region has been occupied by medium- and large-scale landholdings for beef production in a process highly stimulated by land speculation. Since the late 1990s, soybean production has taken over a portion of the pasture implanted by such ranches, particularly in Mato Grosso. As a result, an important portion of the Cerrado has been converted to agriculture, which has put more pressure on Amazonian forests. In turn, agricultural production in Argentina is expanding beyond traditional farmlands of central and eastern Argentina into the arid northwest, affecting in some cases protected forests (Antoniou et al 2010).

Soybean and the expulsion of small farmers and loss of food security

Biotech promoters always cite the expansion of soybean acreage as a measure of successful adoption of the transgenic technology by farmers. But these

data hides the fact that soybean expansion leads to extreme land and income concentration. In Brazil, soybean cultivation displaces 11 agricultural workers for every one finding employment in the sector. This is not new as in the 1970s, 2,5 million people were displaced by soybean production in Parana state and 0,3 million in Rio Grande do Sul. Many of these landless people moved to the Amazon where they cleared pristine forests pushed by structural forces. In the Cerrado region where transgenic soybean is expanding there is relatively low displacement because the area is not widely populated (Donald 2004).

In Argentina the situation is quite dramatic as 60 thousand farms went out of business while the area of roundup ready soybean almost tripled. In 1998 there were a total of 422,000 farms in Argentina while in 2002 there were 318,000 farms, a reduction of 24,5%. In one decade soybean acreage increased in 126% at the expense of lands devoted to dairy, maize, wheat and fruit production. In the 2003/2004 growing season, 13,7 million hectares of soybean were planted at the expense of 2,9 million hectares of maize and 2,15 million hectares of sunflowers (Pengue 2005). Thus by biotech industry standards huge increases in the soybean area cultivated and more than a doubling of yields per unit area are considered an economic and agronomic success; for the country such increases mean more imports of basic foods, therefore loss of food sovereignty, and for poor small farmers and consumers such increases only mean increased food prices and more hunger (Jordan 2001).

Soybean expansion in Latin America is also related to biopolitics and the power of multinationals. The manner in which since in the period 2002-2004, millions of hectares of roundup ready soybean were planted in Brazil (while a moratorium was still in effect) raises questions about how big multinationals maneuver to expand their products over extensive areas in developing countries. In the early years of transgenic soybean introduction into Argentina, Monsanto did not charge royalties to farmers to use the technology. Now that farmers

are hooked, the multinational is pressuring the government for payment of intellectual property rights, despite the fact that Argentina signed UPOV 78 which allows farmers to save seeds for their own use. Paraguayan farmers have just signed an agreement with Monsanto to pay the company \$2 per metric ton. Trends to control the seeds used by farmers is increasing, despite the fact that the company claimed that it would not charge for royalties when the crop was just expanding in the mid 1990s.

Another new and key factor fueling soybean are land grabbing foreign investors who have taken millions of hectares of farmland in Latin America for the production of soybean for feed and biofuels for export. Many land grabbers are Brazilian investors, backed by their government, who are buying land to produce food and biofuels in a growing number of other countries in Latin America and Africa (GRAIN 2010).

Soybean cultivation and soil degradation

Soybean cultivation has always led to soil erosion, especially in areas where soybean is not part of a long rotation. Soil loss reaches an average of 16 t/ha in the US Midwest, a rate that is still greater than is sustainable, and it is estimated that in Brasil and Argentina soil loss levels average between 19-30 t/ha depending on management, slope and climate. No-till agriculture can reduce soil loss, but with the advent of herbicide resistant soybean, many farmers now cultivate in highly erodible lands. Farmers wrongly believe that with no till systems there is no erosion, but research shows that despite improved soil cover, erosion and negative changes in soil structure can still be substantial in highly erodible lands if weed cover is reduced. In fact weed resistance to glyphosate, are forcing many farmers to more tillage and still more herbicides to keep superweeds at bay – a recipe for accelerated soil erosion (Pengue 2005)



Large scale soybean monocultures have rendered Amazonian soils unusable. In areas of poor soils, within two years of cultivation fertilizers and lime have to be applied heavily. In Bolivia, soybean production is expanding toward the east and many such soybean growing areas are already compacted and soil degradation is severe. 100,000 hectares of land with soils exhausted due to soybean were abandoned for cattle grazing, which in turn further degrades the land. As soils are abandoned, farmers move to other areas to once again plant soybeans and thus repeat the vicious cycle of soil degradation (Friends of the Earth 2013).

In Argentina intensive soybean cultivation has led to massive soil nutrient depletion. It is estimated that continuous soybean production has extracted about 1 million metric tons of Nitrogen and about 227,000 metric tons of Phosphorous. The cost to replenish such nutrient loss via fertilizers would cost an estimated US\$ 910 million (Pengue 2005). Increases of N and P in several basins of Latin America which potentially can lead to eutrophication, is certainly linked to the increase of soybean production in the various rivers' watersheds.

Large scale soybean production is generating a strong nutrients' "anemia" that is affecting the best soils of south American countries. Nitrogen cascade (as result of fertilization and nitrogen fixation) is one side of the problem and the other, is represented by "virtual soils" represented by the exportation of the main soil nutrients, affecting the food basket of humankind (Pengue, 2009, 2010).

A key technical factor in the rapid spread of soybean production in Brazil was the development of soybean-bacteria combinations with pseudosymbiotic relationships that allowed soybean production without fertilizers. This productive advantage of Brazilian soybeans can quickly disappear in the light of findings reporting direct toxic effects of the herbicide glyphosate on the N fixing rizhobium bacteria, which potentially would render soybeans to depend on chemical N fertilization. Moreover the common practice of converting

uncultivated pasture to soybeans results in a reduction of the economically important rhizobia, again making soybean dependent on synthetic N.

Soybean monocultures and ecological vulnerability

Research suggests that reduction of landscape diversity due to the expansion of monocultures at the expense of natural vegetation have historically led to insect pest outbreaks and disease epidemics. In such species poor and genetically homogenous landscapes insects and pathogens find ideal conditions to grow unchecked by natural controls. The result is increased use of pesticides which after a while are not effective due to the development of pest resistance or ecological upsets typical of the pesticide treadmill. In addition pesticides lead to major problems of soil and water pollution, elimination of biodiversity and human poisonings. In the Amazon high humidity conditions under warm conditions induce fungal populations, resulting in the increased use of fungicides. In Brazilian regions under till soybean production, the crop is increasingly being affected by stem canker and sudden death syndrome. Soybean rust is a new disease increasingly affecting soybeans in South America, fueled by humid conditions and monoculture uniformity, rust commands increased fungicide applications. Since 1992 more than 2 million hectares are now infected by cyst nematodes. Many of these pest problems can be linked to the genetic uniformity and increased vulnerability of soybean monocultures, but also to direct effects of roundup on the soil ecology, through depression of micorizhal fungal populations and elimination of antagonists that keep many soil-borne pathogens under control (Altieri 2004).

In Brazil 25 % of all pesticides are used in soybean, which in 2002 received about 50,000 metric tons of pesticides. As the soybean area rapidly expands, so does the growth in pesticide use which is increasing at a rate of 22% per year. While biotech promoters claim that one application of roundup is all that is

needed for whole season weed control, studies show that in areas of transgenic soybean the total amount and number of herbicide applications have increased. In the USA the use of glyphosate went up from 6,3 million pounds in 1995 to 41,8 million pounds in 2000, and now the herbicide is used on 62% of the land devoted to soybeans. In Argentina roundup applications reached an estimated 160 million liter equivalents in the 2004 growing season. Herbicide usage is expected to increase as weeds start developing resistance to Roundup.

Yields of transgenic soybean average 2,3 to 2,6 t/ha in the region but 6% less than in conventional varieties especially under drought conditions. Due to pleiotropic effects (splitting of stems under high temperatures and water stress) transgenic soybeans suffer 25% higher losses than conventional soybean. 72% of the yields of transgenic soybeans were lost in the 2004/2005 drought that affected Rio Grande do Sul which led to a 95% drop in exports with dramatic economic consequences. Most farmers have already defaulted on 1/3 of government loans.

Weed resistance, appearance of crop diseases

By creating crops resistant to its herbicides, biotech companies can expand markets for its patented chemicals. Observers gave a value of \$75 million for herbicide-resistant crops in 1995 and by the year 2000 the market was approximately \$805 million, representing a 61 percent growth. Globally, in 2002 herbicide resistant soybean occupied 36.5 million hectares making it by far the number one GE crop in terms of area (James 2004). Glyphosate is cheaper than other herbicides, and although it is reducing the use of other herbicides in the final analysis, overall companies sell much more herbicide (especially glyphosate) than before. The continuous use of herbicides and especially of glyphosate (also known as "Roundup" by Monsanto), which herbicide-resistant crops tolerate, can lead to serious ecological problems. It is well documented that when a

single herbicide is used repeatedly on a crop, the chances of herbicide resistance developing in weed populations greatly increases. About 216 cases of pesticide resistance have been reported in one or more herbicide chemical families (Rissler and Mellon 1996)

Given industry pressures to increase herbicide sales, acreage treated with broad-spectrum herbicides will expand, exacerbating the resistance problem. As the area treated with glyphosate expands, the increased use of this herbicide will result in weed resistance, even if more slowly. This has already been documented with Australian populations of annual ryegrass, quackgrass, birdsfoot trefoil, *Cirsium arvense*, and *Eleusine indica*. (Altieri 2004) In the Argentinian Pampas 16 species of weeds, among them 2 species of Verbena and one species of Ipomoea, already exhibit resistance to glyphosate (Pengue 2005). Current emergence of Jonsongrass resistance (called SARG) put in alert the whole industrial agricultural complex (Pengue 2009). Millions of hectares in Argentina are under pressure of weed resistance appearance.

Herbicide resistance becomes more of a problem as the number of herbicide modes of action to which weeds are exposed become fewer and fewer, a trend that transgenic soybean reinforces due to market forces. Due to the high levels of use of glyphosate several weed species in soybean fields have shifted in Brazil to those that can more successfully withstand glyphosate or to those that avoid the time of its application. Five weed species *Conyza bonariensis*, *Conyza canadensis*, *Lolium multiflorum*, *Digitaria insularis*, and *Euphorbia heterophylla* have evolved glyphosate resistance. A glyphosate-resistant biotype of *Sorghum halepense* has evolved in GRS in Argentina and one of *D. insularis* in Paraguay (Cerdera and Duke 2006). In South America there is a tendency for farmers to increase herbicide rates or to resort to other herbicides like 2,4-D to overcome glyphosate weed resistance, thus increasingly becoming victims of a “pesticide treadmill” (Binimelis, Pengue and Monterroso 2009).

In many instances it has been shown that increased applications of glyphosate predisposes crop plants to infectious diseases. Glyphosate inhibits the biosynthesis of the aromatic amino acids, thereby reducing biosynthesis pathogen defense compounds, for example lowering phytoalexin levels and thus increasing susceptibility to plant pathogens. The damage from *Corynespora* root rot, previously considered minor is now becoming economically damaging in Roundup Ready® soybeans since application of glyphosate to Roundup Ready® soybeans greatly increases severity of this disease. This fungal root rot is more severe when glyphosate is applied to soybeans under weedy conditions even though the weeds may not be hosts for *Corynespora cassiicola*. The weeds serve to translocate and release more glyphosate into the rhizosphere environment to reduce the population of Mn-reducing organisms and increase Mn oxidizing organisms. This change in soil biology limits manganese availability for plant uptake and active defense reactions, and acts synergistically with *Corynespora* to increase disease (Johal and Huber 2009).

Ecological impacts

A recent report by Friends of the Earth, Europe (2013) examines in detail the negative effects on ecosystems and associated biodiversity. The main use of glyphosate is to eliminate common weeds which can be important food sources for insect, bird and animal species in agricultural areas. Weeds provide food and nectar sources for insects, which in turn feed birds. Weed seeds can also be vital winter foods for many declining bird species, such as corn bunting and skylark. Evaluations (FSE) of GM crops in the UK between 1999 and 2003, showed a significant loss of weeds and weed seeds in the GM glyphosate resistant sugar beet, compared to the conventional crop. The UK government's scientific advisory committee spelled out the significance of the results, stating that GM glyphosate resistant beet results in adverse effects on arable weed populations [which] would be likely to result in adverse effects on organisms



at higher trophic levels (e.g. farmland birds), compared with conventionally managed beet.

Large scale cropping of GE crops encourages aerial application of herbicides and much of what is sprayed is wasted through leaching affecting soil microorganisms such as mycorrhizal fungi and even earthworms. But companies contend that glyphosate degrades rapidly in the soil, do not accumulate in ground water, have no effects on non-target organisms, leave no residue in foods and water or soil. Glyphosate has been reported to be toxic to some non target species in the soil-both to beneficial predators such as spiders, mites, and carabid beetles, and to detritivores such as earthworms, including microfauna as well as to aquatic organisms, including fish (Rissler and Mellon 1996).

Glyphosate is very systemic in the plant and is being released through the roots into the soil and many studies show that long-term use of glyphosate can have toxic effects on microorganisms and can stimulate them to germinate spores and colonize root systems. Glyphosate seems to act in a similar fashion to antibiotics by altering soil biology in a yet unknown way altering the whole soil biology. Many researchers are seeing differences in bacteria in plant roots and changes in nutrient availability. The repeated use of glyphosate may create a selection pressure in soil microbial communities that could affect the nutrient dynamics such as K. Other researchers are showing that glyphosate can immobilize manganese, an essential plant micronutrient. The most obvious impact is on rhizobia, a bacterium that fixes nitrogen. It has been shown that glyphosate can be toxic to rhizobia. Studies have demonstrated that glyphosate reduces the ability of soybeans and clover to fix nitrogen. Other studies document how glyphosate reduces growth of beneficial soil-dwelling mycorrhizal fungi, which are key for helping plants extract phosphorous from the soil (Cerqueira and Duke 2006).

Human health effects

Glyphosate is a systemic herbicide (it moves through the plant phloem) and is carried into the harvested parts of plants. Exactly how much glyphosate is present in the seeds of HT corn or soybeans is not known as grain products are not included in conventional market surveys for pesticide residues. The fact that this and other herbicides are known to accumulate in fruits and tubers because they suffer little metabolic degradation in plants, raises questions about food safety, especially now that more millions of liters of this herbicide are used annually in the United States, Brasil and Argentina (Rissler and Mellon 1996). It is known that glyphosate disrupts the endocrine system and the balance of gut bacteria, it damages DNA and is a driver of mutations that lead to cancer. Even in the absence of immediate (acute) effects, it might take 40 years for a potential carcinogen to act in enough people for it to be detected as a cause. Swanson et al (2014) searched US government databases on herbicide resistant soybean, glyphosate application data and disease epidemiological data. They performed correlation analyses on a total of 22 diseases in these time-series data sets. These data show very strong and highly significant correlations between the increasing use of glyphosate, GE crop growth and the increase in a multitude of diseases. Many of the graphs show sudden increases in the rates of diseases in the mid-1990s that coincide with the commercial production of glyphosate-resistant GE crops.

The dilution of glyphosate in Roundup formulation may multiply its endocrine disruptor effect. Researchers exposed human liver HepG2 cells to study xenobiotic toxicity of 4 different formulations of glyphosate based herbicides and measured cytotoxicity, genotoxicity as well as anti-estrogenic and androgenic effects and found that all parameters were disrupted in 24 hours at sub-agricultural dosages in all formulations (Gasnier et al 2009)

Conclusions

Soybean expansion in Latin America represents a recent and powerful threat to biodiversity, local communities and periurban areas in Brazil, Argentina, Paraguay, Uruguay and Bolivia. These crops are major users of Round Up which has been shown to pollute rivers and surface waters, contaminate organisms including humans but also food and ecosystems. The use and presence of glyphosate herbicides is further increased by the expansion of herbicide resistant crops. Transgenic soybeans are much more environmentally damaging than other crops because in addition to the effects derived from the production methods, mainly heavy herbicide use and genetic pollution, they require massive transportation infrastructure projects (waterways, highways, railways, etc.) which impact ecosystems and make wide areas accessible to other environmentally unsound economic and extractive activities. New events of transgenic soybean (RR2Bt) are opening the ecological borders in the north of Argentina, Paraguay and Brazil, helping and promoting the deforestation. Appearance of pest resistance is rising.

In the last two decades, the best agricultural lands have been put into transgenic soybean production by large-scale producers closely linked to foreign investors, particularly Brazilians. Foreigners now control millions of hectares of prime agricultural and ranching lands in Paraguay and Bolivia. This land grabbing processes poses several socio-economic challenges. Foreign control over land and resources for industrial agriculture is undermining regional and national food security. Bolivia imported a record \$1.1 billion in food between 2006-2010 (over 600,000 tons in 2009 alone). While food imports maintain domestic price stability and satisfy the increasing urban demand, they discourage domestic production, in particular, that of smallholder farmers. Meanwhile, the great majority of the profits obtained by foreigners in the commercial soy and ranching sectors are repatriated to their country of origin—particularly Brazil and Argentina.

Production of herbicide resistant soybean leads to environmental problems such as deforestation, soil degradation, pesticide and genetic pollution, as well as to socio-economic problems such as severe concentration of land and income, expulsion of rural populations to the Amazonian frontier and to urban areas, compounding the concentration of the poor in cities. Soybean expansion also diverts government funds otherwise usable in education, health and in the search for alternative agroecological methods.

The multiple impacts of soybean expansion also reduce the food security potential of target countries as much land previously devoted to grains, dairy or fruits is now devoted to soybean for exports which is used in many countries as animal feed and also increasingly as biofuel. As long as these GMO soybean south American countries continue to embrace neoliberal models of development and respond to demand signals (especially China) from the globalized economy, the rapid proliferation of soybean will increase, and so will the associated ecological and social impacts.

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The Case of the Disappearing Dal: How India was transformed from being the Biggest Producer of Diverse Pulses to becoming the Biggest Importer of nutritionally inferior substitutes

Pulses: missing '*dal*' from '*thali*'

India is ranked as the highest in terms of diversity and production of pulses. Not only was it the largest producer but it was also the largest consumer of pulses in the world. It accounted for nearly 25% of global production and 27% of world consumption. Yet because of the rice and wheat monocultures of the Green Revolution, and increasing dependence on imports to meet the gap, today India has emerged as a major importer of pulses. But the imports cannot substitute for the diversity, nutrition and quality lost by not growing our own pulses for the ecological health of our soils, the economic health of our farmers, and nutritional health of our people.

Amongst the rich diversity of pulses India produces we can count *tur/arhar* (pigeon pea, 18 per cent), *chana* (gram/chick pea, 40 per cent) *urad* (black gram, 11 per cent), *moong* (green gram, 9 per cent), *masur* (lentil, 8 per cent), *matar* (peas, 5 per cent) and rajma (kidney bean) as major ones and horsegram (*kulath/gehath*), cowpea (*lobia/chori*), grasspea (*khesari*), moth bean (*moth*), rice

bean (*navrangi*) and lablab (*val*) as minor ones, to the tune of 13-15 million tons annually from an area of 22-23 million ha with an average yield of 600-650 kg/ha (Ali & Kumar, 2007)

In India pulses are cultivated in both *kharif* (autumn harvested crop) and *rabi* (spring harvested crop) season, though production in *rabi* season accounts for a higher share of total pulses produced in the country.

Globally, India accounts for about 33% of the world pulses area. About 90 per cent of the total global pigeon pea, 65 per cent of chickpea and 37 per cent of lentil areas fall in India with the corresponding global production of 93 per cent, 68 per cent and 32 per cent, respectively. However India's rank in productivity is low, 24th in chickpea, 9th in pigeon pea, 23rd in lentil and 98th in total pulses. The growth rate of area under pulse crops was just 0.04

per cent during the period 1967-68 to 2009; as a result pulses' share in the total food grain production reduced from 17 per cent in 1961 to 7 per cent in 2009. Government has acknowledged the need to urgently bring more area under pulses during this *kharif* season on a sustained basis, as the country urgently needs to bring an additional 20 lakh hectares under pulses in order to boost production by 20 lakh tonnes at least (Economic Times, 2007).

The dismal situation is largely a consequence of the Green Revolution policies promoting monocultures of rice and wheat, and driving out pulses and oilseeds from farming systems. In India the irrigated area under pulses is only 12% while in the case of wheat and rice it is more than 60% of the total area.



Lentil

Pulses: Beyond the reach of *aam admi*, the common man

Pulses (dal) are an essential part of Indians' diet of Indians across the country, whether in the rice or the wheat belts. For the poor, it is often the only source of protein.

With the Green Revolution, focusing on irrigated rice and wheat, and wheat yields going up 3.5 times, pulses have been comparatively neglected in our agriculture and food security policies, registering only a 0.5 increase. Despite being a country in which our cultivation and consumption of pulses have been vital to our indigenous agriculture and food systems, India has allowed the humble dal to go out of the reach of the common man. This situation is due to several factors, most importantly shrinking biodiversity through Green Revolution, unfair pricing policies regarding pulses, trade liberalization and corruption as well as profiteering in the imports of pulses as a globally traded commodity.

The major pulse producing states of India are Madhya Pradesh (23 per cent), Uttar Pradesh (18 per cent), Maharashtra (14 per cent), Rajasthan (11 per cent), Andhra Pradesh (9 per cent) and Karnataka (6 per cent) where pulses are predominantly grown as rainfed crops. Domestic production of pulses after its peak of 14.94 million tons in 2003-04 had declined to 13.38 million tons in 2004-05 and to 13.11 million tons in 2005-06 due to adverse climatic conditions prevalent in the major production states as well as lack of attention to pulses in government policies.

Rainfed pulses in northern plains are now becoming a high risk crops mainly due to wide fluctuations in temperature and rainfall characteristics (uncertain, erratic and inadequate rainfall). The cultivation of pulses in these regions has now turned to a big gamble for traditional farmers growing pulses (Ali et al 2009).

Climate modeling systems envisage that as the twenty first century progresses, there will be higher levels of warming in northern parts of India with rapid increase in night temperatures which will in turn adversely affect the crop productivity. **Indigenous varieties have climate resilience and climate resilience is enhanced with diversity.**

The winter legumes under rainfed conditions in northern plains are experiencing a kind of hidden stress that is atmospheric drought, associated with insufficient or lack of dew precipitation, as a result of higher night temperatures. The moisture available in the air termed as “invisible water reservoir of nature”, can be easily accessed by the crops provided nights are cool enough to form dew.

A significant regional shift in area of pulses has been witnessed during post-Green Revolution period. The pulses under cultivation in northern plains is now almost half as compared to that during 1971-1975. On the contrary, the area in central and southern Indian has been progressively increasing and has now almost doubled.

The Government network for reaching scientific advice and suitable seeds to farmers is weak in Uttar Pradesh and Madhya Pradesh and Bihar which have high potential for pulse production (Mishra 2010).

Fluctuation in yields is also high because pulses are especially susceptible to pests and diseases and are grown in rainfed areas. Pulses are rich in proteins so pests love them. Every year 2-2.4 million tonnes of pulses worth Rs. 6000 crore are lost due to pest attack. More than 250 insect species are reported to affect pulses in India. Nearly a dozen cause heavy losses. Podborer causes the most harm, followed by pod fly.

Pulses are also extremely sensitive to heat and cold. Too much energy quickens flowering but reduces the seed potential. Cool season pulses like chickpea are often subjected to chilling temperature in North India; however there has not been a breakthrough in chill and frost tolerant varieties.

Table 3 shows the pulses acreage, production and productivity during 1970-71 and 2013-14. The average yield of pulses in the country is about 700 kg/ per hectare, where as the yield in developed nation is as high as 1700 kg/ per hectare.

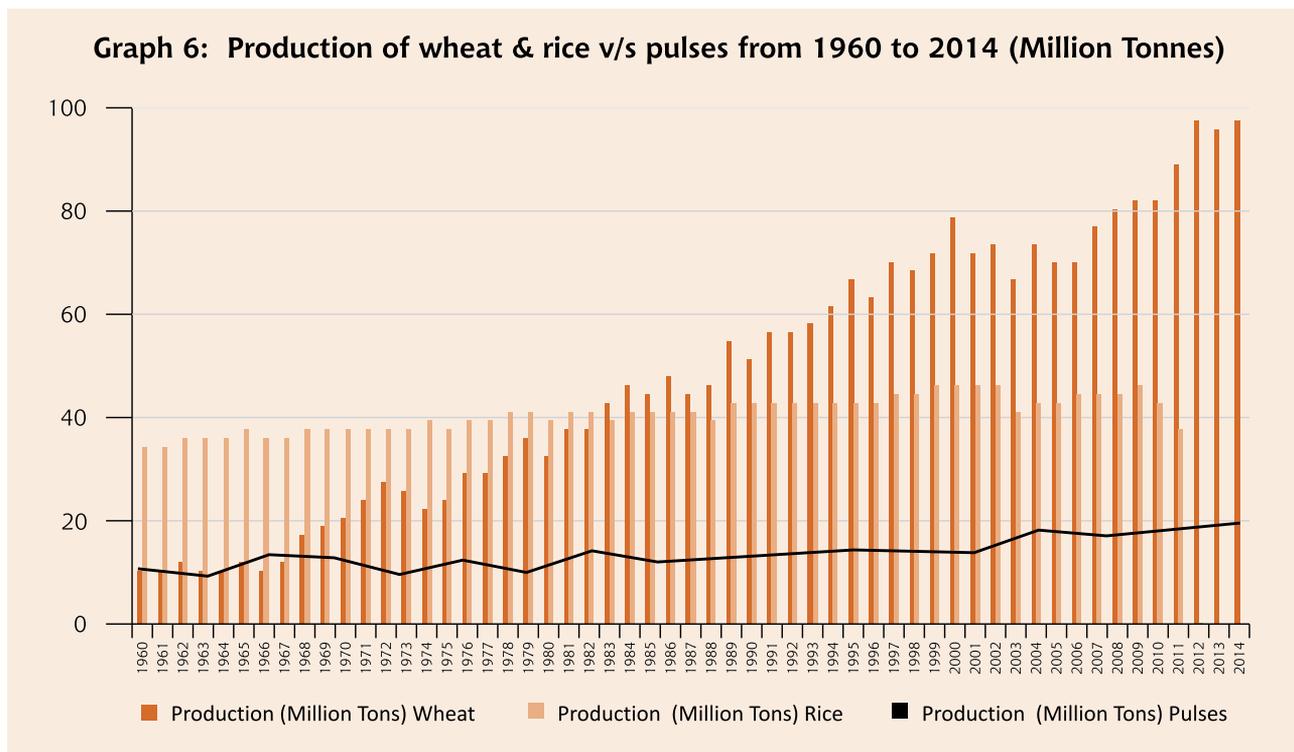
Table 3: Pulses acreage, production and productivity from 1970-71 to 2013-14.

Year	Area (Million Hectare)	Production (Million Tonnes)	Productivity Kg/Hect.
1970-71	22.6	11.8	524
1980-81	22.5	10.6	473
1990-91	24.7	14.3	578
1999-2000	21.11	13.41	635
2000-01	20.34	11.07	544
2001-02	22.00	13.36	607
2002-03	20.49	11.12	543
2003-04	23.45	14.90	635
2004-05	22.76	13.12	577
2005-06	22.39	13.38	598
2006-07	23.19	14.19	612
2007-08	23.63	14.76	625
2008-09	22.09	14.56	659
2009-10	23.28	14.66	630
2010-11	26.40	18.24	691
2011-12	24.46	17.08	699
2012-13	23.3	18.3	764
2013-14	25.2	19.3	735

Source: Directorate of Economics of Statistics, Department of Agriculture and Co-operation, Ministry of Agriculture, New Delhi

*Economic Survey 2014-15

The output of pulses has stagnated at 13-14 million tonnes for many years.



Source: for wheat <http://www.indexmundi.com/agriculture/?country=in&commodity=wheat&graph=production>

Source: for rice Source Directorate of Economics and statistics <http://www.airea.net/page/62/statistical-data/all-india-area-production-and-yield-of-rice> in http://www.crii.nic.in/crii_vision2030_2011.pdf

Table 4: Per capita availability of Pulses during 1961-2011.

Year	Per capita net availability per day in grams
1961	69.0
1971	51.2
1981	37.5
1991	41.1
2001	30.0
2002	35.4
2003	29.1
2004	35.8
2005	31.5
2006	32.5
2007	35.5
2008	41.8
2009	37.0
2010	35.4
2011	43
2012	41.7
2013	41.9

Source: Economic Survey 2014-15

The shortage of pulses results in a nutritional emergency, a fact admitted by the Economic Survey 2008-09. During the last five decades, the net availability of pulses has reduced to less than half, from highest at 74.9 gms per day in 1959, 69.0 gm per day in 1961 to 29.1 gm per day in 2003. Indian Council for Medical Research (ICMR) recommends 65 gms of pulses for an adult every day. Though the per capita availability has gone up to 41.9 gm per capita per day in 2013. This, the increased availability, is the result of imports of inferior quality dals like yellow pea; moreover with rising prices the poor have no access to dals.

Major pulse producing states

According to Table 5 total pulses production in 2011-12 in the country was about 17 million tones. With 4.161 million tones pulse production in 2011-12, Madhya Pradesh ranks first, with Rajasthan being second, closely followed by Uttar Pradesh.

Table 5: Major pulse producing states 2011-12

State	Production (Million Tonnes)	Share (Percentage)*
Madhya Pradesh	4.161	24.35
Rajasthan	2.432	14.23
Uttar Pradesh	2.403	14.06
Maharashtra	2.268	13.27
Andhra Pradesh	1.230	7.20
Karnataka	1.134	6.63
Gujarat	0.780	4.56
Other	2.672	15.64
Total	17.088	

Source: Directorate of Economics and Statistics, Department of Agriculture & Co-operation, Ministry of Agriculture, New Delhi

*Percentage estimated by Navdanya.

During 2011-12, the productivity of the pulses in the country was recorded as 699 kg/Hectare with highest in UP (993 Kg/Hec), Bihar (976 Kg/Hec) and Jharkhand (885 Kg/Hec).

Minimum support prices for pulses

We have seen how the productivity of pulses have declined over the years with the main contributing factors being the Green Revolution and the subsequent negative impacts in terms of shrinking diversity as well as deteriorating climate given that chemical agriculture contributes to climate change.

Wherever Navdanya works it has corrected the trend of disappearing diversity of pulses through the conservation of pulses such as *naurangi* and *kulath*. So doing, since these are legumes, nitrogen is also naturally put back into the soil. Moreover healthy and nutritious pulses are reintegrated into diets.

Minimum Support Price (MSP) for any crop is only one of the mechanisms to increase production, and price alone cannot do the magic. The farmer should get an assured price and assured market. It is one of the reasons that the production of mainly four crops – wheat, rice, sugarcane and cotton has gone up. These are the only four crops where the market is assured whether through FCI, other Government agencies or private traders. In the case of pulses, there is no assured procurement of the produce. Very often farmers growing pulses have to resort to distress sale. Giant corporations have now entered into partnering with Government and are further driving down prices as the case of ADM & soya shows.

There is a vast difference between the minimum support price (MSP) of pulses and the wholesale price. Pulse growers receive less than 25 per cent of the price that the consumer pays for the product due to a long chain of assorted middlemen, transporters, wholesalers, millers and retailers who bring the produce from farms to consumers.

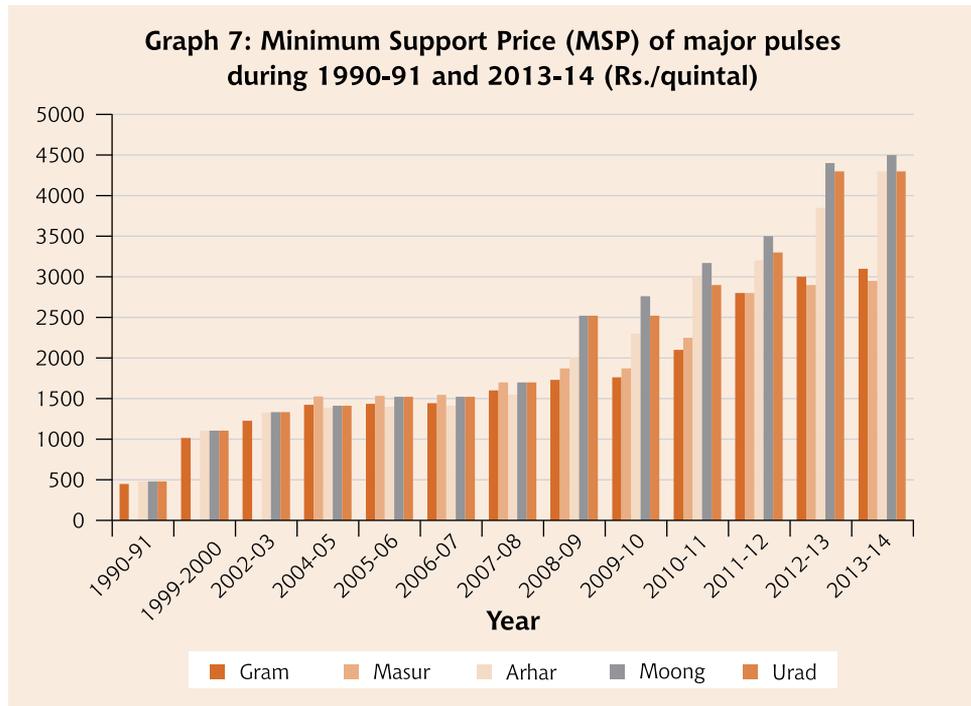
The government's target of producing 15 million tonnes per year has not been achieved for several years, forcing imports of around two million tonnes every year. Per capita availability of pulses has actually been declining – a sad comment on a country which is the largest producer of pulses in the world, with 25 per cent of global production (Shiva 2006).

The disadvantages and risk involved in growing pulses are not compensated by MSP. For pulses like moong, the MSP of Rs. 4500 per quintal (Rs. 45 per Kg) is higher than the MSP of Rs. 1500 for 100 Kg of paddy. While paddy yields about 3000 Kg per Hectare, pulses have a national average of 700 Kg. In recent years, Government has sharply hiked up the MSP. Experience has shown that Government agencies such as National Agricultural Cooperative Marketing Federation (NAFED) play an almost negligible role in procuring the pulses. The volume of the procured pulses is so small that it cannot influence the decision making of farmers about pulse cultivation.

Notwithstanding the substantial increase in the MSP for pulses, the difference in the gross earnings between growing pulses and wheat is still so large that it is far more lucrative for the farmers to grow wheat. Thus the price signals given by the increased MSPs for pulses proved to be inadequate to achieve their targeted objectives of increasing yield and the area of cultivation.

While the rising MSPs for pulses in recent years reflect the policy intention of the Government to promote the cultivation of pulses, these increases failed to create adequate incentives to bring about commensurate increases in either the area under cultivation or the yield per unit area.

The MSP of major pulses during 1990-91 and 2012-13 is given in Graph 7.



Source: Economic Survey 2013-14

The pulse crisis as an opportunity for global agribusiness

Pulses are vital to the Indian diet. Rise in prices of pulses have been of grave concern for the Government and consumers alike. Official measures such as ban on exports, zero duty imports, storage control, subsidized imports through public sector trading enterprises and so on have yielded very little result.

There has always been a marked difference between the farm gate prices of dal and the retail rates, but in the recent years, the gap has widened. At the retail end, there is enormous profit to be made by simply ignoring changes in the wholesale market and sticking to the same (usually higher) price until stock last or consumers stop buying.

Margins at the retail level is as high as 30% and even higher, and on occasions, profits are more than the price growers get. The figures are mind-boggling as we shall see later on.

Table 6: Rising pulses prices (retail in Rs. per kg) in the major cities of India

City	Tur/Arhar		Moong		Udad		Masoor	
	May '15	May '14	May '15	May '14	May '15	May '14	May '15	May '14
Delhi	108	75	107	101	110	71	94	25
Shimla	110	75	110	75	-	-	-	-
Ahmedabad	92	65	-	-	86	28	80	35
Guwahati	93	63	105	95	106	35	87	21
Vijaywada	92	64	109	96	94	29	71	40

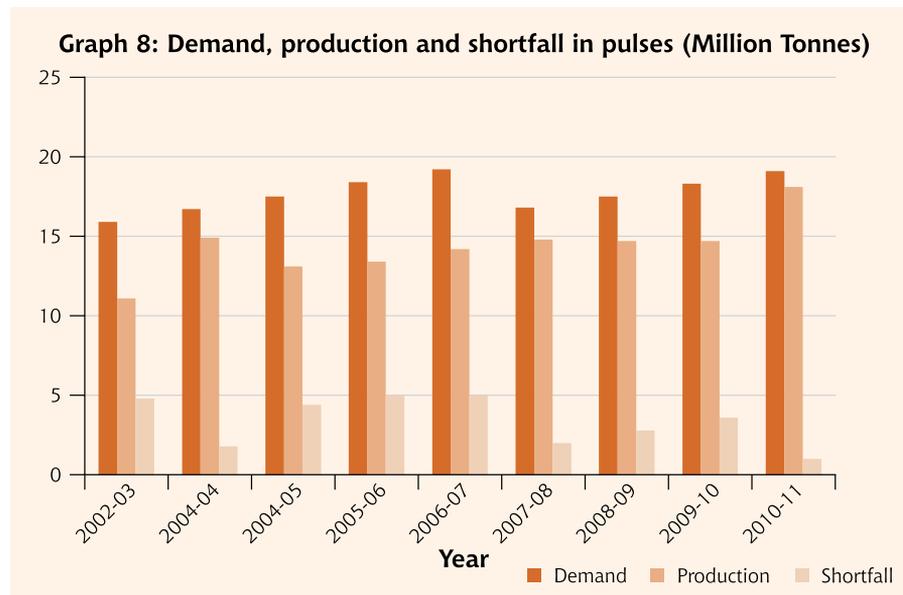
Source: From field studies

The main reason for the runaway price rise is the steady decline in its per capita availability, to less than 10 kg a year now, combined with speculation linked to imports and domestic distribution.

The Union government took a decision to go in for large-scale additional import of pulses, other than the pulses already imported by private traders. The reason given was that in recent times, prices of pulses have escalated further compared to earlier prices.

“Within one month, the price of the inferior variety of *arhar* dal went up from Rs. 60 to Rs. 110,” says Sunita a domestic worker living in a hut colony of South Delhi. The price of the superior variety of *arhar* is Rs. 138 per kg. With most of the pulses selling at over Rs. 100 per kg. the *aam admi*- common man is wondering if ‘dal’ is going out of his ‘*thali*’ (platter).

Pulses production is estimated to have fallen to 18.4 million tonnes in 2014-15 crop year (July-June) from 19.80 million tonnes in the previous crop year due to deficient monsoon 2014-15 and unseasonal rains and hailstorms during March-April this year.



Source: CAG 2012

India imports significant quantities of pulses from Canada (80%) USA (13%) Australia, Myanmar, Nepal also export to India Other countries, including Ukraine, France, China and Tanzania are also offering varying quantities of pulses to India (ASSOCHAM, 2008).

Source: <http://timesofindia.indiatimes.com/india/Cartel-hoarding-dal-stocks-abroad-to-jack-up-prices-IB/articleshow/50725245.cms>

For many pulses, large shares of import, including *desi* chickpeas, pigeon peas, mung beans, and kidney bean, come from Myanmar. Canada and Australia are major suppliers of dry peas and *kabuli* chickpeas to the Indian market, each supplying about one- third of India's pea imports.

The pulses imported during the 20-year period from 1991 to 2011 were dun peas, *moong*, *tur*, *urad* and yellow peas. *Moong*, *tur* and *urad* were imported primarily from Myanmar, dun peas from Australia and *masur* from Australia and yellow peas, from Canada. Yellow pea, which is neither *tur* or *chana*, has few takers. The import of pulses increased considerably from about 3.5 lakh tonnes in 2000-01 to about 45 lakh tonnes in 2014-15. The global pulses market is not a large one, compared to that of wheat, maize, oilseeds or even rice. In 2005, the total world trade in pulses was estimated at 3-3.5 million tonnes with India being the world's largest buyer of pulses.

Other non pulse growing countries are now exporting inferior quality pulses to India. It is unfortunate that the pulses crises in India, paradoxically a global leader in terms of pulses' production, as mentioned earlier, has been turned into an opportunity by agribusiness to create an import dependence as the case of imports of pulses from Canada illustrates. The millionaire farmers of Canada, a country which has a recent history of agriculture and has only



Vetchling

started to grow pulses now, are profiting by the pulses scarcity of India. It is a case of agribusiness gaining and farmers losing since the pulses are being grown on mega farms. The family farmers of Canada are being destroyed just like the Indian farmers are.

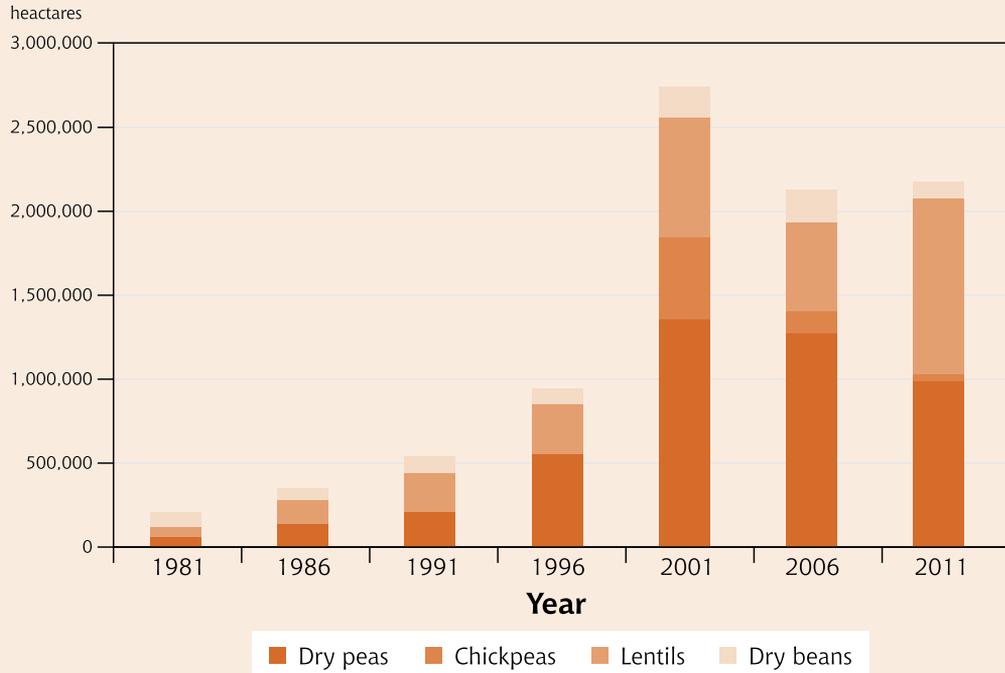
Pulse cultivation in Canada has jumped 11 fold since 1981 and is now 2.2 million ha. In 2011, Saskatchewan was home to the largest pulse area in the country with 1.7 million hectares. This represented 79.3% of the total pulse area in Canada. Saskatchewan accounted for 68.3% of dry pea area, 86.9% of chickpea area, and 96.0% of lentil area. Concentration of landholdings have also increased.

Pulses are grown mostly by large farms and these farms have increased in size significantly between 1981 and 2011. In 1981 average farm size was 266.5 hectares. By 2011 it had increased four fold to an average of 1,070.3 hectares

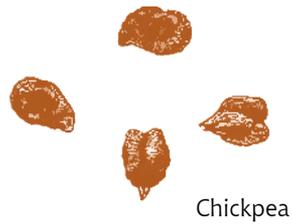
More than a third of farms growing pulses (36.7%) in 2011 had a total farm size of over 1,000 hectares. These 4,440 farms accounted for over two-thirds of Canada's pulse acreage (1.5 million hectares or 67.7%).

Smaller farms (those with less than 250 hectares) made up 16.3% of farms growing pulses, and accounted for 3.2% of the total national pulse area. This is a change from three decades earlier when smaller farms made up 63.0% of farms reporting pulses and accounted for 42.3% of the national pulse area. Larger pulse farms (over 1,000 hectares) at that time represented only 2.8% of farms reporting pulses and accounted for 7.1% of total pulse area. The following graph shows pulse seeded areas by variety:

Graph 9: Pulse seeded areas by variety, Canada, 1981 to 2001



Sources: Statistics Canada, Census of Agriculture, 1981 to 2011





Peanut

Table 7: Pulses: number of farms and average areas by farm size, Canada, 1981 and 2011

Farm size	Number of farms		Percentage of total pulse area		Average total farm area		Average pulse area	
	1981	2011	1981	2011	1981	2011	1981	2011
	number		percent		hectares		hectares	
All pulse farms	6,392	12,110	100	100	266.5	1,070.3	30.3	178.2
Less than 250 hectares	4,029	1,975	42.3	3.2	110.9	120.7	20.3	34.9
250 to 499 hectares	1,456	2,149	28.8	7.6	346.3	365.9	38.3	75.9
500 to 999 hectares	729	3,546	21.7	21.5	672.1	730.2	57.5	130.9
1,000 to 1,999 hectares	155	2,981	5.9	31.8	1,290.8	1,384.6	73.5	230.2
2,000 hectares or greater	23	1,459	1.2	35.9	2,719.5	3,577.4	104.4	531.4

Sources: Statistics Canada, Census of Agriculture, 1981 and 2011

According to the 2011 Census of Agriculture, the largest proportion of farms reporting pulses (25.5%) earned \$250,000 to \$499,999 in gross farm receipts. There were 1,715 farms reporting one million dollars or more of gross farm receipts. These million-dollar pulse farms represented 14.2% of farms reporting pulses and earned 53.2% of the total gross farm receipts for farms reporting pulses. Three decades earlier, these million-dollar farms made up less than 1% of all farms growing pulses. Smaller farms earning less than \$100,000 dominated in those days, accounting for 54.7% of all farms reporting pulses

Canada was the worldwide leader in production of lentils and dry peas in 2011. Canada produced over a third of the world's lentils in 2011 (1.5 million tonnes). Canada had the largest amount of dry pea production in tonnes in 2011, producing 2.1 million tonnes of dry peas, or 21.7% of the total global production (Table 8).

In 2011, the value of pulses exported was \$873.0 million for lentils, \$1.1 billion for dry peas, \$65.6 million for chickpeas, and \$207.6 million for dry beans. Canada exported pulses to 129 countries, but the main export destinations for pulses were Turkey (for lentils and chickpeas), India and China (for dry peas), and the United States (for dry beans).

A large part of pulses produced in Canada are intended for exports. Exports of dry peas, lentils and chickpeas accounted for almost 40% of the annual production (five-year average 2007-2011).

Source: <http://www.statcan.gc.ca/pub/96-325-x/2014001/article/14041-eng.htm>

Table 8: Pulses contribution to global markets, 2011

Pulse variety	Production	Share of global total	Global ranking
	tonnes	percent	rank
Lentils	1,531,900	34.8	1st
Dry peas	2,115,600	21.7	1st
Chickpeas	90,800	0.8	9th
Dry beans	144,600	0.6	27th

Source: Food and Agriculture Organization of the United Nations (consulted June 11, 2014)

Price fixing and corporate corruption: CAG report on corruption in pulse imports

Free trade is based on 2 assumptions. First, that it encourages countries to improve their comparative advantage and specialize in what is appropriate to their climate and socio-ecological endowments. A central assumption of free trade is “comparative advantage”- that countries will produce what they are good at producing. On this logic, India should be growing pulses for itself, and also exporting to the world. However, India which has diverse climates, and grows food throughout the year, often in 4 cropping seasons, is today importing dal from Canada which was never a pulse growing country, and which due to its cold climate, has a limited cropping season. Second, that it benefits the poor consumer by lowering food prices.

Source: <http://www.producer.com/2015/07/voracious-indian-demand-great-for-pulse-prices/>

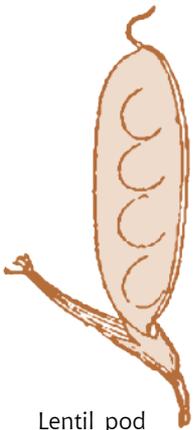
As the experience with pulse imports by India shows, both assumptions are false. Every import of pulses has been justified by government as a means to lower pulse prices. In Dec 2015 Union Food Minister of India Minister Ram Vilas Paswan said.

“In a bid to keep the spiralling price of pulses under check by ensuring adequate availability in the market, the Centre will step up its efforts to expedite imports of pulses”

Source: <http://www.thehindu.com/todays-paper/tp-national/centre-will-expedite-pulses-import-paswan/article8043444.ece>

Road Transport Minister, Nitin Gadkari, told reporters: “The Cabinet discussed about rising pulses’ prices and expressed concern about the same. Prime Minister has directed to import pulses in large quantity to keep domestic prices under check,”

Source: http://economictimes.indiatimes.com/articleshow/47612668.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst



Lentil pod



But prices keep going up with imports for 2 reasons. The first is that when a country as large as India imports huge quantities, it makes international prices go up. In April 2006, when India announced its intention to purchase 1.5 million tonnes, international prices shot up considerably and till September 2007, Government agencies could contract only for 2,54,000 tonnes pulses (Raj. 2007).

As the Indian traders recognize, the announcement by the Indian government to contract large imports of pulses to counter the sharp spike in prices, will in fact do the opposite. It will raise international rates and not help the country unless the imported pulses are subsidised.

Source: <http://bso.blackseagrainsconference.com/en/2015/presentations/prs/F>

The second reason is that big traders are speculating on the price of pulses, hoarding the imported pulses to artificially drive up prices. This was pointed out by the Comptroller and Auditor General of India (CAG) and has been confirmed by the India Today group.

Source: http://saiindia.gov.in/english/home/Public_Folder/PAC_Reports/Civil/82nd%20report.pdf
<http://www.dailymail.co.uk/indiahome/indianews/article-3377979/Tax-department-raids-Delhi-Mumbai-bust-price-manipulation-dal-racket.html>

Major trading houses are accused of working as a cartel, illegally holding stock, delaying imports, amplifying scarcity, manipulating prices. Importers and traders were illegally maintaining two kinds of records, one official and another illicit, for all trades and transactions.

As Times of India reports: “This is how rigging takes place, explain trade sources. A select group of bigger players gather intelligence about the crop output in the beginning of the season. On that basis, the rates are polled again from a select group of suppliers. The prices are inflated and deliberately the lower quotations are weeded out. As futures contracts are introduced in a commodity exchange’s system, the same higher rates are used. As the volume grows, the cartel can establish a benchmark price

at the desired level. Since the future market depends on spot rates, the cartel corners a part of stock in the physical market at the same higher rates. This happens a few days before the settlement date of the futures contracts. This helps in matching the spot and future prices. Since last minute cornering of physical stock increases spot rates, the artificially jacked up future prices are maintained, explained a trader.”

Source: <http://timesofindia.indiatimes.com/city/nagpur/I-T-officials-raid-traders-to-probe-chana-price-rigging/articleshow/50373558.cms>

30 December 15: The Intelligence agencies have warned the government about how the cartels are buying pulses at a higher price in Canada and hoarding to drive prices up.

Source: <http://timesofindia.indiatimes.com/india/Cartel-hoarding-dal-stocks-abroad-to-jack-up-prices-IB/articleshow/50725245.cms>

When staples like dal become commodities for speculation, prices rise. In fact, every time there is a crisis in food sector, this becomes an opportunity in the global casino of speculation on food. Agribusiness has a history of price fixing to increase its superprofits.

As the Business Week of Oct 23, 2000 states:

Price fixing, an ugly issue that let to recently stiffened jail terms for a couple of former ADM executives, is far easier when fewer players are in the business. For smaller players, the result of reduced competition could be higher costs for feed and supplies and, arguably, lower prices for their goods.

Source: *Yoked to Death: Globalisation and Corporate Control of Agriculture* by Vandan Shiva, RFSTE

India, which consumes nearly 22 million tonnes of pulses annually, sources yellow peas and lentils mainly from Canada and the United States

Source: <http://www.thehindubusinessline.com/economy/agri-business/indian-drought-bonanza-for-canadian-growers-of-pulses/article7761440.ece>
<http://www.livemint.com/Money/53oBT8PZiZzJZOFVZiboGN/Global-pulses-prices-climb-on-Indian-imports.html>

There is a gap between demand and production ranging from 1.0 to 5.0 million tonnes. With stagnant area under cultivation and production, India has permitted unrestricted imports of pulses with low duties for about 20 years now. India is now the world's largest pulses importer.

During 2012-13, about \$2.3 billion (4.1 metric tonnes) was imported. In the following year, it was \$1.7 billion for 3.05 metric tonnes of import. Between April and August, the first five months of the 2014-2015 financial year, import amounted to \$0.96 billion (1.07 metric tonnes), a rise of 18.2 per cent in value terms over the previous year (IIPR,2011).

For the year 2015-2016, imports of pulses were supposed to rise to 5.5 million tonnes costing India \$4.5 billion, versus the \$2.6 billion spent to import 4.5 million tonnes in the year ended March 2015.

The total demand of pulses is over 22-23 million tonnes projected to go up to 30 million tonnes by 2030. Madhya Pradesh, Uttar Pradesh and Maharashtra, between themselves, grow close to half of the total output. Until recently with domestic production stagnating at 13-14 million tonnes, domestic production was not meeting this gap. The gap could be met by increasing pulse production or through imports. The government chose the import route, but imports rarely went beyond 2 million tonnes. However in 2015 the imports had jumped to 5 million. And this is happening at a time when domestic production increased to 18 million tonnes. The import drive is clearly not need based, but pushed by agribusiness corporate interests who stand to profit from speculation.

At an estimate, in two years, the country consumed an aggregate quantity of about 35 million tonnes of various pulses, domestic or imported, the total value of which was an estimated Rs. 1.4 lakh crore, assuming an average wholesale price of Rs. 4000/quintal or Rs. 40 per Kg. At the retail level, however, consumer paid a staggering of Rs. 2.1 lakh crore for the same quantity, assuming a conservative

price of Rs. 60 per Kg. easily a profit margin of 50%. Allowing for 25% to cover distribution expenses overhead and other expenses, additional profits made at the retail level amounts to Rs. 35,000 crores (Business Line 2010).

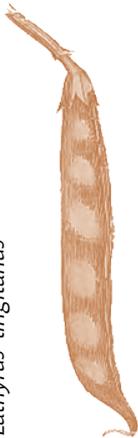
With soaring prices, pulses are becoming increasingly unaffordable for the common man in the country. The price elasticity of demand for pulses is high. Higher prices lead to demand compression in the domestic market. So, the slower growth in consumption in the country does not seem to be the result of real weakness in demand, but due to high price driven demand compression at the consumers' end.

The analysis of wholesale and retail prices trends clearly brings out the fact that there was a substantial and widening gap between wholesale and retail price of *arhar*, *masur*, *moong* and *urad* dal for the period from 2006-11. In other words, the retail prices of pulses increased at a much faster rate than the corresponding wholesale prices. Even though the designated agencies imported pulses on Government account, the retail prices kept on increasing.

A study by Multi-Commodity Exchange in 2007 shows that the consumer in Mumbai paid Rs. 3,800 a quintal, while the farmer got only Rs. 2,250. In the case of *urad*, the consumer paid Rs. 5,600 a quintal, the farmer was paid Rs. 3,000 (Subramani, 2007). The retail price of pigeon pea in most major markets went as high as Rs. 120/- kg in 2010-11 (Roy & Joshi, 2014).

The retail prices of pulses increased at a much faster rate than the corresponding wholesale prices during the period 2006-11. This growing divergence between wholesale and retail prices pointed towards increasing control of the market by private traders. The divergence continued, despite the imports of pulses by designated agencies on Government account under two schemes viz. the 15 per cent subsidy scheme and the scheme for distribution of pulses through the Public Distribution System.

Lathyrus tingitanus





In view of the demand and supply, Government launched two schemes, one in May 2006 and the other in November 2008 for import and distribution of pulses.

(i) 15 per cent subsidy scheme

The scheme introduced in May 2006, a subsidy scheme, originally envisaged that National Agriculture Cooperative Marketing Federation of India (NAFED) would import pulses, subject to reimbursement of losses upto 15% of the landed cost. Later on Metals and Mineral Trading Corporation (MMTC), State Trading Corporation (STC) and PEC were also added as designated agencies for import of pulses. Upto half of the targeted quantity to be imported was to be yellow peas. Ministry of Consumer Affairs was the nodal agency. The scheme was extended year after year till 31st March 2011

(ii) Scheme of distribution of imported pulses through PDS

In November 2008, Government introduced another scheme for import of pulses for distribution through PDS, at an over all subsidy of Rs.10/kg. The scheme was extended till 31st March 2012. The pulses were to be imported upto four lakh tonnes with a subsidy of Rs.400 crores. The maximum quantity distributed was one kg per family, primarily restricted to BPL families.

The Audit by Comptroller and Auditor General (CAG) of pulse imports

Audit by Comptroller and Auditor General (CAG) found that Ministry of Consumer Affairs did not assess the requirement of pulses in the country in order to calculate the correct amounts needed to be imported. Targets for imports were, therefore, set without adequate data on domestic consumption of pulses. There were significant shortfalls by the importing agencies in the actual imports vis-a-vis the targets. Delays in clearance of imported pulses at the ports led to an avoidable expenditure. These delays also had the effect of further delaying the arrival of imported pulses into the market, leading to failure in arresting their rising prices.

In the absence of a proper distribution plan, the importing agencies disposed off the pulses through the normal process of tendering. The tender conditions, with their high minimum bid quantities and earnest money deposits ensured that basically large private players, who were also major players in the pulses market, would submit the bids, thus restricting the channels of distribution of imported pulses and keeping most of the smaller parties out of the loop. The prices offered by the bidders were substantially lower than the import prices paid by the agencies as well as the prevailing wholesale prices, pointing towards possible cartelisation. Table 9 shows the losses suffered by importing agencies

Pulses imported by the designated agencies were thus sold by them at substantial losses, after considerable delays. The pulses sold were not lifted by the private buyers on time, as a result of which, their availability in the market was restricted for long periods.

Table 9: Losses suffered by importing agencies.

[Profit/(-)Loss, Rs. in crore]

Year	STC	MMTC	PEC	NAFED	TOTAL
2006-07	0.17	0.00	0.02	-5.50	-5.31
2007-08	17.21	10.73	-17.15	-28.09	-17.30
2008-09	-208.81	24.32	-316.28	-52.70	-553.47
2009-10	-16.17	-205.21	-57.14	-177.20	-455.72
2010-11	-25.23	-38.34	-82.17	-23.78	-169.52
Total	-232.83	-208.50	-472.72	-287.27	-1201.32

Source: CAG Audit



The CAG Audit observed that of the total losses of Rs. 1201.32 crore incurred by the implementing agencies, Rs. 897.37 crore (75 per cent) was on account of yellow peas alone. (Table 10) The main reason for the huge losses on disposal of yellow peas was that the agencies imported 6.26 lakh tonnes of yellow peas

at rates ranging from Rs. 15182 to Rs. 28388 per tonne. The agencies could sell only 0.87 lakh tonne during the year 2008-09, leaving a large balance stock of 5.39 lakh tonnes which had to be sold at far lower rates ranging from Rs. 10637 to Rs. 17680 per tonnes during 2009-10, to private parties.

Table 10: Losses suffered by importing agencies on account of yellow peas vis-a-vis other pulses during 2006-11

[Profit/(-)Loss, Rs. in crore]

Agencies	Yellow Peas	Other Pulses	Total
STC	-129.39	-103.44	-232.83
MMTC	-129.10	-79.40	-208.50
PEC	-389.00	-83.72	-472.72
NAFED	-249.88	-37.39	-287.27
Total	-897.37	-303.95	-1201.32

Source: CAG Audit

Regarding the import of yellow peas this is what the CAG observes:

“Without taking into consideration the food patterns, the Government in 2007 imported yellow peas. When the peas found no takers, they were sold after prolonged delays, at very low rates, with heavy losses to the importing agencies.

The MoCA and F&PD decided in 2008 that the agencies need not go for further contracts of yellow peas, but the Union Cabinet in 2009 decided to allow the agencies to import these. The agencies continued to import even when they had huge unsold stocks, resulting in a loss of Rs. 897.37 crore, 75 per cent of the total loss of Rs. 1,201.32 crore.”

Source: <http://www.infodriveindia.com/india-import-data/yellow-peas-import-data.aspx>



Lathyrus tingitanus

Losses in import and sale of yellow peas

The CAG analysis clearly shows that in the importation of yellow pea the implementing agencies did not take into consideration food preferences and earlier losses due to unsold stock balances.

In spite of the CAG warning on the quality of pulse imports and cartelisation of traders, the government has continued to import yellow pea.

Imported yellow pea was thus sold by the agencies after considerable delays and heavy losses. The Government directed the agencies to continue importing the pulses in spite of the fact that the agencies had huge unsold stock balances. This showed flawed judgment and lack of co-ordination on the part of the Government.

The outcome of these deficiencies was a huge loss of Rs. 897.37 crore suffered in the import of yellow peas by the importing agencies which amounted to 75 per cent of the total loss of Rs. 1201.32 crore, suffered in the process of implementation of the 15 per cent subsidy scheme.

CAG found that the second scheme for distribution of pulses to BPL households through PDS was launched without any evaluation of the first scheme. In fact, the second scheme was launched even as huge unsold stocks of yellow peas were lying under 15 per cent subsidy scheme.

Under the second scheme during 2008- 09 agencies could import only 0.12 lakh tonnes and distributed only 0.09 lakh tonnes. Even during 2009-10 agencies imported only 2.33 lakh tonnes and distributed 2.18 lakh tonnes. Again during 2010-11, agencies could not import the required quantity of pulses.

Deviating from the trend in the Government of trashing CAG reports, the Food and Civil Supplies Ministry had decided to take a serious view of the top auditor's report on the Rs. 1200- crore Pulses Scam (Jigeesh, 2012).

However, Government did not learn any lesson from the earlier two scheme of pulses' import. The Government again revived the blueprint for import of one million tonnes to be distributed through PDS Under the new dispensation, subsidy on imports has been enhanced from Rs10/kg to Rs 20/kg or 20,000/tonne, equivalent to \$ 195.50 to \$385 tonne respectively (Narang, 2012).

Yellow peas or *safed matar* accounts for one out of every two bags of pulses imported annually. Consumption has jumped 25% in the last five years, with an 8% spurt in the last one year. As the CAG report clearly points out, this is not the preferred dal of Indians. They are being forced to eat it because instead of promoting the domestic production of the diverse dals Indians eat, Government is importing yellow pea dal and subsidizing it. Since the yellow pea is less nutritious than our dals, it is contributing to a degradation of the Indian diet.

Source: <http://www.infodriveindia.com/india-import-data/yellow-peas-import-data.aspx>
http://articles.economictimes.indiatimes.com/2009-08-02/news/27657478_1_yellow-peas-pec-and-nafed-palm-oil

With an artificially created dal crisis the government is importing and producing fake i- dal made of soya flour coloured yellow, a yellow pea dal, which is not *tur*, nor *chana*, but is being sold as a substitute for both. Dal imports are sending a signal to our farmers to not grow dal. This will aggravate the dal crisis and make our real dals more expensive.

Source: http://india.blogs.nytimes.com/2012/06/08/indias-dal-increasingly-not-from-india/?_r=0

Not only are we loosing foreign exchange, we are loosing nutrition. Compared to the 20-30% protein in our indigenous dals, yellow pea has only 7.75 % protein, which translates into a deficiency. A problem of industrial agriculture and “free trade” is that it erases quality and nutrition from food, and profits for seed giants and grain trading agribusiness giants become the only criteria. Malnutrition, hunger and poverty are built into the design of the industrial

globalized food system (Vandana Shiva, *Hunger by Design* in *Making Peace with the Earth*, Women Unlimited 2012).

Tender conditions favouring large private buyers

The CAG Audit scrutinized the detailed records of the sales and the tender process of four importing agencies at selected branch offices in Chennai, Kanpur, Kolkata, Mumbai, Tuticorin and Visakhapatnam, relating to sale of 8.38 lakh MT during 2006-11, which accounted for 31 per cent of the total sales of pulses imported by these agencies. The scrutiny revealed that the tender conditions of the agencies for sale of pulses stipulated minimum bid quantities which ranged between 200 to 1000 MT and corresponding Earnest Money Deposits (EMDs) which ranged between five to 30 per cent. The successful bidders were required to lift the awarded quantities by remitting the entire payment within 15-90 days from the dates of award.

The agencies justified fixing of high minimum bid quantities by stating that they wished to ensure that only serious bidders participated in the tenders.

As a result of these bid conditions, 6.08 lakh MT, representing a massive 73 per cent of the quantity of sales test-checked in audit was sold to just four private parties (LMJ International as well as LMJ Overseas; R Piyarelall Import and Exports Pvt Ltd / RP Foods Pvt Ltd⁹; Prime Impex and SRS Pvt. Ltd). As per the information obtained from the Directorate General of Foreign Trade, three of the above-mentioned four buyer groups (except LMJ) were also amongst the top 10 importers of pulses in the country during this period.

“This points to cartelisation and hoarding,” said a CAG official.

While the CAG assessed the loss to the nation in terms of a financial audit linked to waste and corruption related to pulse imports, a social, ecological, and a food sovereignty audit shows how high the hidden costs of “free trade” in food really are.

Losses due to import of pulses

- Loss of foreign exchange for imports - During 2012-13, about \$2.3 billion (4.1 metric tonnes) was imported. (IIPR,2011)
- For the year 2015-2016, imports of pulses are supposed to rise to 5.5 million tonnes costing India \$4.5 billion.
- Losses due to waste and corruption according to CAG report Rs 1,200 crore for 2.2 million tonnes import in 2012
- For 5.5 million tonnes this translates into more than Rs 3000 crore in 2015 or \$ 500 million
- Losses to people's health and nutrition due to import of nutritionally inferior pulses is 1 million tonnes of protein
- Losses to Soil Health due to not growing nitrogen fixing pulses 1.1 billion kg of soil nitrogen

Rejuvenating pulse sovereignty

The degeneration of our soils, our agriculture, our health through the disappearance of our pulses is not an inevitability. Imports of inferior pulses such as yellow dal, or proposals to grow toxic pulses such as GMOs and Kesari dal are false solutions.

Source: http://articles.economictimes.indiatimes.com/2015-12-15/news/69062159_1_genetically-modified-seeds-niti-aayog-msp

<http://www.radhamohansingh.com/master.php?pageid=56a0d393219c9>

Over the last 3 decades Navdanya has conserved and rejuvenated the biodiversity of our crops, including pulses, promoted biodiversity in our agriculture and our food. By reintroducing pulse diversity the health of soils, the productivity of our farms, the incomes of our farmers and the nutrition per acre for all people have increased.

Sikkim

Table 11: Analysis of the yield from organic mixed cropping versus the yield from conventional mono cropping in Kharif season in Sikkim.

	Protein (kg)	Carbohydrate (kg)	Fat (kg)	Energy (kcal)
Mixed Cropping				
Maize (4 Qt)	44.4	264.8	14.4	13,68,000
Radish (2 Qt)	1.4	6.8	0.2	34,000
Mustard leaves (saag) (1 qt)	4.0	0.6	2.4	34,000
Peas (2 Qt)	14.4	31.8	0.2	1,86,000
Total (9 Qt.)	64.2	304.0	17.2	16,22,000
Mono Cropping				
Maize (5 Qt.)	55.5	331.0	18.0	1,710,000
Total	55.5	331.0	18.0	1,710,000

Source: Navdanya, *Biodiversity Based Organic Farming: New Paradigm for Food Security and Food Safety*, 2006.

Rajasthan

Table 12: Comparative study on macronutrients produced in mono cropping (pearl millet) versus mixed cropping (pearl millet, moth, sesame) per unit land

	Protein (kg)	Carbohydrate (kg)	Fat (kg)	Total energy (kcal)
Mixed cropping				
Pearl Millet (9 qtl.)	104.4	607.5	4.5	32,49,000
Moth (3.5 qtl.)	82.6	197.75	3.85	11,55,000
Sesame (0.4 qtl.)	7.32	10.0	17.32	2,25,200
Total = 12.9 qtl.	194.32	815.25	25.67	46,29,200
Mono cropping				
Pearl Millet (12 qtl.)	139.2	810.0	6.0	43,32,000
Total = 12 qtl.	139.2	810.0	6.0	43,32,000

Source: Navdanya, *Biodiversity Based Organic Farming: New Paradigm for Food Security and Food Safety*, 2006.

Uttarakhand

Table 13: Comparative study of macronutrients produced per acre farmland-mixed cropping versus mono cropping.

	Protein (kg)	Carbohydrate (kg)	Fat (kg)	Total energy (kcal)
Mixed Cropping				
Mandua = 3qt.	21.9	216.0	3.9	9,84,000
Jhangora = 2 qt.	12.4	131.0	4.4	6,14,000
Gahat = 4 qt.	88.0	228.8	2.0	12,84,000
Bhatt = 5 qt.	216.0	104.5	97.5	21,60,000
Total = 14 qt	338.3	680.3	107.8	50,42,000
Mono Cropping				
Paddy = 12 qt.	90.0	920.4	12.0	41,52,000
Total = 12 qt.	90.0	920.4	12.0	41,52,000

Source: Navdanya, *Biodiversity Based Organic Farming: New Paradigm for Food Security and Food Safety*, 2006.

Navdanya measured total output on 200 farms in 4 ecosystems on the basis of Biodiversity Based Productivity, not the misleading monoculture “yield” which hides diversity of output. In order to provide a more comprehensible picture, we took the average (arithmetic mean) of nutrients produced per acre farmland from the above case studies. The sample mean of our report should be a fairly good estimator of the population mean. The population in our case is the total arable land in India. Hence, the average production of nutrients per acre of farmland is a reasonably fair point estimator of the average production per acre farmland on a national scale. Moreover, we have collected data from different states ranging from an arid state, Rajasthan, to an organic state, Uttaranchal. As a result the margin of error should be fairly low. The purpose of all the statistic is to allow the reader a glimpse of the actual scenario, effect of two forms of agriculture on a national level. The questions are how to maximize nutrient production, how to minimize environmental risk, and how to ensure a sustainable alternative to solve the national and global food crisis.

Table 14: Average production of macronutrients per acre farmland- organic mixed cropping versus conventional mono cropping

	Protein (kg)	Carbohydrate (kg)	Fat (kg)	Total energy (kcal)
Average production of nutrients from organic mixed farming	240	833	66	4,914,270
Average production of nutrients from conventional mono cropping	116	785	23	3,711,475

Source: Navdanya, *Biodiversity Based Organic Farming: New Paradigm for Food Security and Food Safety*, 2006.

According to the table, if we switch an acre of farmland from conventional mono-cropping to organic mixed cropping, we shall be able to produce 124 kg of protein more than earlier. The quality of mixed cropping protein is better than that of monocropping protein. The organic mixed cropping protein is complete because it provides all the essential amino acids- it is comparable to animal protein. Vegetarian protein may be an inadequate source of all essential amino acids individually. However, when vegetarian proteins are mixed, they become an adequate source of all essential amino acids. For example, the protein in *roti* or dal, individually, is incomplete because it does not contain all the essential amino acids, but when *roti* and dal are consumed together, they become a complete source of all essential amino acids. Hence, the protein produced in an acre of farmland from organic mixed cropping is more complete than protein produced in an acre from conventional mono cropping.

On an average, organic mixed cropping produces 124 kg of protein more than conventional mono cropping, per acre farmland. 124 kg of protein is enough to fulfil the protein requirement of 2000 adults for a day. According to Central Water Commission, Govt. of India, total cultivable land (2003-04) in India is 183 M. Ha., which is approximately equal to 452202848 acres. If all of this land is used for organic mixed cropping instead of conventional mono cropping, the country shall produce 56073153 metric tons of protein more than that produced

earlier. This is enough to fulfil the protein requirement of 2.5 billion adults for the entire year. A fact worthy of notice is that we have only taken the difference of 124 kg protein per acre between organic mixed cropping and conventional mono cropping. The additional amount of protein that we would produce by switching from conventional agriculture to organic agriculture is sufficient to fulfil the protein requirement of 2.5 billion adults for the entire year. If we consider the entire amount of protein produced in the country through organic mixed cropping, by projecting our sample average to the total cultivable land, we would produce enough protein to fulfil the protein requirement of approximately 5 billion adults for the whole year. This is enough protein to feed our entire population and to eradicate protein energy malnutrition from the planet.

Indigenous pulse production rejuvenates the seed sovereignty and food sovereignty of farmers. This increases their incomes by reducing costs of production and increasing the value of what they sell because it is of higher nutritional and taste quality, and can be sold directly to consumers through fair trade, unlike industrial commodities like soya which must be sold to industry as raw material for animal feed and solvent extracted oil. The comparison of soya production in India with small farmers producing indigenous kidney beans shows how indigenous pulses are beneficial to small farmers

Indigenous pulses bring farmers higher income than soya

Kidney beans (rajma)

Navdanya started encouraging farmers to conserve local seeds and to promote organic farming in the region. Before becoming member of Navdanya, the farmers gave kidney beans to the local trader at the rate decided by him. Now the group decides its rate collectively. The rate of kidney beans in the village has gone up to Rs. 100/kg from Rs. 35/kg in a span of 12 years. Farmers are empowered efficiently and are happy with organic farming and production that is also going up by year. Diseases and pests are now quite rare and uncommon.

Table 15

Farmer: Mohan Singh

Name of the Crop: Rajma (Kidney beans)

Village Pokhri, Tehsil Chakrata, District Dehradun

Land area: 15 Nali (3000 sq. meter) 1 Nali = 200sq. Meter

Item	Quantity	Total (Rs.)
Costs for field preparation		
Ploughing Cattle	2	2000
Seeds	50kg	4500
Irrigation	Nil	
Chemical Fertilizers	Nil	
Other Fertilizers (FYM etc.)	100qtl	7000*
Pesticides and weedicides		Nil
Weeding	20 man days	4000*
Harvesting	10 man days	2000*
Threshing, winnowing etc.	5 man days	10000*
Total cost in Production		29500
Transportation and labour Cost		1000*
Other costs (if any?)	Gunny bags (20)	400
Total expenditure Per Field		30900
Total Expenditure Per Hectare		102897
Total Production		
Grains	1000kg @ Rs 95	95000
Straw	2000kg @ Rs 2	4000
Other (weeds)	1000 kg x 2	2000
Mandwa	100 x 15	1500
Chaulai	110 x 50	5500
Maize	80 x 20	1600
Other Straw	800 x 2	1600
Gross income Per Field		Rs 111200
Net income Per Field		
(Gross income- Total expenditure)		Rs 80300
Gross Income Per Hectare		Rs 370296
Net Income Per Hectare		Rs 267399

*Source: Navdanya *Wealth per Acre: A True Cost of Food Systems*, 2014.

Mandal, Saha, Ghosh, Hati, and Bandyopadhyay (2002) conducted a study to examine energy requirement and energy input output relationship of soybean based crop production. For the purpose of our case study, we will extract input requirement, total cost of production, gross revenue, and net profit associated with growing soybean from the above mentioned study, adjust these values for inflation, and compare it with our own experience with organic farmers who grow native kidney beans (rajma).

Table 16: A true cost study of food systems

SOYBEAN

Type of input	Amount of Input	
Land preparation	One summer ploughing with two ploughing with 35 Hp tractor drawn cultivator	
Fertilizer/Manure	5 Ton/Ha of farmyard manure, 30 Kg/Ha N, 60 Kg/Ha P ₂ O ₅ , 30 Kg/Ha K ₂ O	
Sowing	By tractor drawn seed drill with seed rate of 80 Kg/Ha	
Weeding and thinning	Manual labour	
Irrigation	Rainfed	
Plant protection	Chemical control by spraying phosphamidon 85% EC at 0.02%	
Harvesting	Manual	
Threshing	By 35 Hp tractor driven thresher	
Soy Bean	Nominal Value (2000-01) In INR	Real Value (Adjusted For Inflation Till 2013) In INR
Gross Cost of Production Per Ha	10924.00	27949.70
Gross Return From Economic Product Per Ha	7905.00	20225.42
Gross Return From By Products Per Ha	4138.00	10587.32
Total Return Per Ha	12043.00	30812.74
Net Profit	1119.00	2863.03

Source: Navdanya *Wealth per Acre: A True Cost of Food Systems*, 2014.

Let us Reclaim the Pulse of Life

Both the Health of Soil and the Health of People and Animals are calling for the rejuvenation of the diversity of our pulses in agriculture and in our diets.

Pulses are an alternative to the soil destroying fossil fuel based, synthetic fertilisers. The Diversity of pulses offer a healthy alternative to the health destroying factory farmed meat, and to the expansion of GMO monocultures.

Healthy Soils. Healthy People

Let us Resolve to:

Grow Diversity. Eat Diversity

Grow Organic. Eat Organic

Grow Local. Eat local



Vigna catianga

The disappearance of diversity of beans and pulses from agriculture and our diets has been driven by a monoculture paradigm focusing on a few globally traded cereals. This has impoverished the soil, and our health. We now need a paradigm shift from monocultures to diversity.

Let us bring back the diversity of cereals and pulses to our farms and our food baskets. Biodiversity produces more when measured in terms of Nutrition per Acre. “Yields” of monoculture commodities do not accurately assess the total nutritional output of a farm. “Harvest Index” only measures what leaves the farm. Crops and varieties with high biomass, and lower harvest index produce more benefits, return more nutrition to the soil, and secure the future of our food. Higher “yields” of nutritionally empty commodities are in fact a recipe

for nutritional deficiencies. Transforming plants into mere commodities for the market, at the cost of soil health, animal health, and people's health, is a recipe for desertification and disease.

Grow and eat open source, indigenous, native, heirloom varieties of pulses, rich in diversity, nutrition and taste. Avoid nutritionally empty, chemically grown pulses and patented GM soya and products derived from it.

Eat more pulses. Eat more
plant proteins. Eat less meat

Factory farming of animals for meat is the single biggest reason for expansion of GMO monocultures and also a major contributor to climate change. By shifting to a pulse based plant protein diet, we improve both our own health and the health of the planet.

When we grow organic we let pulses fix nitrogen nonviolently in the soil, instead of increasing dependence on synthetic fertilisers produced violently by heating fossil fuels to 550°C. Chickpea can fix up to 140 kg nitrogen per hectare and pigeon-pea can fix up to 200 kg nitrogen per hectare (source: <http://www.rmsag.com.au/2015/nitrogen-contribution-from-pulse-crops/ftp://ftp.fao.org/docrep/fao/010/a0701e/a0701e00.pdf>).

Navdanya studies show that organic farming has increased nitrogen content of soil between 44 to 144%.

Synthetic fertilisers are part of a fossil agriculture and food system which accounts for 50% greenhouse gas emissions leading to climate change. Nitrogen fertilisers lead to emissions of nitrogen oxide which is a greenhouse gas that contributes 300 times more to global warming than carbon dioxide. They also increase water demand in Agriculture and are responsible for “dead zones” in oceans and waterways. Chemical fertilisers are leading to a decline in productivity because they are destroying soil health. During three and half decades fertiliser productivity has declined from 48 kg food grains/kg NPK

fertilizer in 1970-71 to 10 kg food grains/kg NPK fertilizer in 2007-08 (Aulakh, M.S. and Benbi, D.K. 2008; Subba Rao, A. and Reddy, K.S. 2009).

Integrating pulses in organic agriculture is the only sustainable path to food and nutritional security. Eating organic pulses is an alternative to GM soya, and to the degradation of our diet by eating inferior globally traded pulses, such as the yellow pea, which have a mere 7.5% protein compared to the indigenous pulse diversity which has between 20-30% protein, and other nutrients in addition.

Pulses can play a key role in rejuvenating local, ecological agriculture and local diversified food economies. Farmers will grow diversity of pulses locally when eaters eat local biodiversity. Become a co-producer and support farmers to integrate pulses in their farming systems. Create local food systems linking farmers as producers who grow real pulses to eaters as co-producers who eat real food.

Reduce dependence on long distance imports of foods from unknown sources, produced and processed with heavy cost to the planet, small farmers and our health, costs that are hidden from us. We have a right to know what we are eating – where it comes from, who produced it, how it was produced, what is in it. And the only way we can know what we eat is by eating local.

Know your food. Know your farmer. Become a Food Smart Citizen.
Join Navdanya's Annapurna movement.

Reclaim Food Freedom. Reclaim the Pulse of Life.

Join the Dal Satyagraha

Boycott imported oilseeds, pulses and GMO products which are nutritionally deficient, and chemically and industrially grown. Demand that Government stops the imports and the subsidies that are making inferior food products artificially cheap, robbing Earth Citizens of health and nutrition, taste and quality, as well as the joy of eating.



Pigeon pea

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As an offering to The Year of the Pulses and to commemorate the 30th anniversary year of Navdanya, we bring you *Pulse of Life, the Rich Biodiversity of Edible Legumes*. The book is our response to the spread of monocultures through chemical, industrial and unfair farming systems, which have destroyed our food systems, our farmers, and not in the least, our health. It is also an attempt to bring back to memory and reconnect with the amazing diversity of pulses and other legumes Mother Earth has so generously provided for us. As in the earlier titles of our series *The Biodiversity and Food Heritage of India*, here too we connect the Seed to the Table, focusing on the cornucopia of edible legumes existing across the world and the equally rich ways of processing, cooking and ecological usages they have given rise to. We have also touched upon the threats to this immensely rich gift of Nature.

Pulses and other legumes, which can both heal our body and our planet as well as provide nutrition security in times of climate change, deserve to be put centre stage.

Earlier titles in our series include:

- Akshat – Rice
- Kanak – Wheat
- Dalhan – Pulses
- Masale – Spices
- Bhoole Bisre Anaj – Forgotten Foods
- Sherbats – Indigenous Cold Drinks



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