Pulses are a Smart Food and important for achieving the Sustainable Development Goals

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Smart Food is defined as food that is: Good for you; Good for the planet; and Good for the small holder farmer. Read ahead for a range of facts and stories globally that show how pulses are a Smart Food.

Benefits of a high fiber (60-70%) diet:
- Soluble fiber helps lower "bad" cholesterol
- Aids weight loss (more filling with fewer calories)
- Maintains bowel health and lowers risk of colon diseases
- Whole pulses have more fiber content than refined, processed pulse products and are better than fiber supplements
- Several cultivars [both desi (brown-seed) and kabuli (white-seed) types] developed by ICRISAT and others include - Early (90-100 days), Extra early (85-90 days) varieties, and Super-early desi (75-80 days) breeding lines

Chickpea variety ICCV 2 is the first extra-short duration (85-90 days) kabuli variety with Fusarium wilt resistance and heat tolerance, and was initially released in Sudan, Myanmar and India. Adoption of early-maturing chickpea cultivars led to an increase in area and productivity in Myanmar. Six early-maturing chickpea cultivars (Yezin 3, 4, 5, 6, 8 and 11) developed from the breeding material supplied by ICRISAT covers over 95% of the total chickpea area in Myanmar.

Investor: International Fund for Agricultural Development-European Commission, Australian Centre for International Agricultural Research Partners: Indian Council of Agricultural Research, Department of Agricultural Research, Myanmar Agriculture Service, Yezin Agricultural University and ICRISAT.

Pulses provide substantial amounts of Vitamin E, Vitamin B6 and folic acid (as folate)

Germinated pulses have higher levels of Vitamin B12 which increases 48 hrs after germination and is highest after 96 hrs.

Pulses + Cereals provide balanced protein diet comparable to meat or dairy foods. Pulses are high in protein (23%).

1 Protein deficiency is mainly observed among the poor, infants and young children in developing countries
2 Pulses are an affordable source of protein
3 Chickpea has the highest protein bioavailability among pulses

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An extra short duration pigeonpea variety (ICP 88039) developed by ICRISAT, matures in about four months, compared to the traditional variety that takes up to six months to mature. Recently, under a project in Rajasthan the short duration pigeonpea variety was introduced, with the aim to expand pigeonpea production through farmer participation.

“Before, we could not afford to buy dal (split pigeonpea) for our everyday meal. Now, with improved varieties, dal has become more available and affordable in the village, and I can prepare and serve my children dal anytime," says Prem Devi, Padasoli village, Jalpur district, Rajasthan, India.

Investor: Directorate of Agriculture, Government of Rajasthan, under the Rashtriya Krishi Vikas Yojana
Partner: Swami Keshvanand Rajasthan Agricultural University, Bikaner, Rajasthan and ICRISAT

Rohrugi K, Baweja M and Baweja S. 1995: Effect of germination on vitamin B12 values of pulses (Leguminoseae seed). The Journal of Nutrition (http://jn.nutrition.org/content/65/5/454.full.pdf)
Magnesium is critical for proper maintenance of body weight and for a number of metabolic syndromes related to cardiovascular disease.

Minerals required for bone formation and for bone related metabolic processes include calcium, magnesium, phosphorus, potassium, manganese, copper, iron, and zinc.

Green pigeon pea seeds has 28.2% more of phosphorus, 17.2% potassium, 48.3% zinc, 20.9% copper and 14.7% iron compared to dal. The dal, however, has 19.2% more calcium and 10.8% more manganese.

Pulses are good for the planet.

Small water and carbon footprint.

Efficient use of water: Chickpea and pigeon pea need less irrigation and thrive on residual soil moisture.

Improve soil health: Pulse crops fix nitrogen, increase soil microbe diversity, provide green manure through leaf droppings and help conserve top soil. The less fertilizer needed as a result of the naturally added nitrogen, means the carbon footprint is low.

Pulses reduce production with lower carbon footprint than most animal sources of protein.

Better farming practices, including use of pulse crops, can lower the average carbon footprint by 24 to 37%.

Nitrogen fertilizers contribute to carbon footprint as its energy footprint is over 7.5 times more than other fertilizers such as phosphate and potash.

Pulses help reduce use of chemical fertilizers by fixing nitrogen.

"Leasyscan", a high-throughput phenotyping platform at ICRISAT, is being used to measure:
(a) leaf canopy development in low and high nitrogen soil
(b) maximum nitrogen concentration in leaf tissue and stem tissue, at flowering time.
An innovative climate change research initiative

A large genetic variation in chickpea, capable of fixing nitrogen symbiotically in early stages of growth, may exist. Further research is needed to capitalize on this.

Research on developing climate resilient chickpea using germplasm including cultivated chickpea interspersed with wild ancestors from a unique, diverse, and recent collection in Turkey, is underway.

Visit differences across 20 wild chickpea populations that affect the crop’s responses to drought, heat and climate-resilient nitrogen fixation is being studied.

Investor: United States Agency for International Development (USAID)

Partners: The University of California (UC) and ICRISAT

2 http://www.csciobase.org/pulses.php?ln=en
4 http://www.pulsescanada.com/environment/sustainability/non-renewable-energy

Well adapted to semi-arid regions

pulses use
- less water and are
- drought tolerant

More efficient to obtain protein from crop products than animal products.

Water used to produce 1g protein in milk, eggs and chicken meat is 1.5 times, for mutton it is 3.3 times and for beef 6 times more that what was used for pulses.

Dryland tropics are generally water deficient and water management is a primary requirement

Here it is critical to calculate water footprint of crops

Many pulses use water differently by extracting water from shallower depths, leaving deep soil water for the following crop

Water use characteristics of pulses effectively increases the water use efficiency of the entire crop rotation

4,050 liters of water to produce 1kg of pulses.

54,879 liters of water to produce 1kg of beef

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Green, blue and grey water use

Water used to produce
- ‘clean’ or ‘grey’ pulses
- ‘dirty’ or ‘polluted’ pulses

In Meduvu village, Kolar district, Karnataka, two farmers have water collection ponds to collect untreated wastewater and use it to irrigate their vegetable crops. These ponds, have been converted into a decentralized wastewater treatment system, using constructed wetlands. This system was piloted by an ICRISAT-led consortium of 11 partners in India, as a business model, treats grey water through constructed wetlands and renders it safe for agricultural use.

ICRISAT in collaboration with Coca-Cola Foundation and MYRADA, an NGO, work with the Meduvu village farmers on agricultural productivity and livelihoods.

Partners: District administration, Government of Karnataka, MYRADA and ICRISAT

Investor: Coca-Cola India Foundation for Rural Water Infrastructure
http://temp.waterfootprint.org/?page_id=7680


Pulses produce about 21 million tons of nitrogen per year

Pulses in the crop cycle play a major role in nitrogen fixation and in reducing carbon footprint worldwide.

- Pulses fix atmospheric nitrogen through a symbiotic relationship with nitrogen fixing soil bacteria living inside their root systems.
- Chickpea leaves 20.4 kg/ha of residual nitrate in the soil after harvesting which is the highest among pulses.
- Production and application of nitrogen fertilizer accounts for 57% to 65% of the carbon footprint of each crop.
- Pulses help in efficient use of soil phosphorus by breaking down insoluble phosphates in the soil.

Access to good pigeonpea seeds transformed the lives of John Musiku and his family. As part of ICRISAT’s smallholder farmer seed production clubs in Chambojho, Karonga district, North Malawi, he grew high-yielding certified seeds, contributing to a successful seed distribution system. In this unique agribusiness model, smallholder farmers grow certified seed that are loaned to other smallholder farmers.

John started in 1 ha land, to grow a new variety of pigeonpea, maturing in six months rather than nine and is less prone to water stress and risk of being eaten by livestock. John reaped a healthy harvest and re-invested to increase his production.

“I had never thought of agriculture having a business potential,” says, “I am happy to admit now I was wrong. Nothing goes waste. I use the stalks as fodder for my animals, and the leaves are good for fertilizing the soil,” says John who now has two houses, 6 ha land, oxen, pigs and goats.

“We have nutritious food to eat and a good life,” says Linley, John’s wife. The key for him was to diversify and keep evolving.

Partners: Ministry of Agriculture, Irrigation and Water Development, Smallholder Producer Groups, the private sector and ICRISAT

Investor: Irish Aid

Different compounds from pulses feed soil microbes and this benefits overall soil health.

Crops grow better in soils with diverse soil organisms as they help break down and cycle nutrients more efficiently.

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Presence of diverse soil organisms tend to ‘crowd out’ disease-causing bacteria and fungi, resulting in healthier plant growth.

Growing pulses crops in rotation enables the other crops to benefit from these large, diverse population of soil organisms.
PULSES HANDBOOK 2016

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“I would never have thought chickpea could bring me such high returns,” said 53-year-old Ms Temegnush Dhali in 2013, standing in her grain store, filled with bags of harvested chickpeas. “From 1.5 ha, I harvested 42 bags (about 4 tons) of grain.”

Temegnush a farmer for 29 years now, saw dramatic changes, when in 2008 she started working with researchers from the Ethiopian Institute for Agricultural Research and ICRISAT to test improved resistant chickpea varieties. Temegnush has since seen dramatic increases in her chickpea yields. Earlier, she grew teff (a popular cereal native to Ethiopia), that fetched a reasonable price at her local market, but required expensive fertilizer and was labor-intensive to harvest.

The project works closely with smallholder farmers to ensure that they access seed of improved legume varieties developed under the projects.

Partner: The International Center for Tropical Agriculture (CIAT), the International Institute of Tropical Agriculture (IITA), National Agricultural Research Systems (NARS) partners in target countries across sub-Saharan Africa and India, and ICRISAT

Investor: Bill & Melinda Gates Foundation


Pulses are GOOD FOR THE SMALLHOLDER FARMER

Resilience, diverse use brings in extra income
Survive weather fluctuations: Chickpea can thrive in desert-like regions; pigeonpea crops hit by unseasonal rain have potential for a second flush.

Diverse food basket and extra income: As an intercrop with cereals and other crops, pulses bring in extra income for farmers and also increase the yield of the main crop.

Pulses are
- Consumed by humans
- Used as livestock feed
- Green manure
- Fencing, and basket weaving

Leaves, pod coats and bran are fed to animals as dry fodder. Some pulse crops are also fed as green fodder.

Multiple Uses of Pigeonpea
- As green manure, pigeonpea produces 13,619 kg/ha of dry matter and 23 kg of N/ha of dry matter
- Pigeonpea leaves and forage, high in protein and easily accessible, are largely used as fodder for cattle and other animals
- The stems and branches of pigeonpea are used to prepare baskets, fencing and thatch, and serve as an additional income source for women
- In Thailand, pigeonpea is host to insects that produce lac, used for various products such as: • Color-fast dye used on animal fibers (wool and silk) and for coloring soft drinks and food • Shellac used for painting and furniture manufacturing
- Farmers in Africa grow pigeonpea for its firewood more than for its grain. The calorific value of the pigeonpea stalks is about 1/4 that of the weight of coal
- A wind breaker/shade crop for young cocoa plants in Nigeria
- Pigeonpea acts as a cover crop or support crop for vanilla in Southeast Asia and as a substrate for mushroom production in China

ICRISAT is a Pioneering Research Institute

About 90% of southern China is covered with mountains bare of vegetative cover, resulting in soil erosion and landslides. In 1997, the first set of newly developed ICRISAT medium-duration pigeonpea varieties was sent to China, which showed high adaptation in various agro-ecological zones of southern China. It helped conserve valuable topsoil and rejuvenate infertile marginal lands. It led to greening of 25 million ha of degraded mountain slopes, and is an afforestation crop in major government reforestation projects, growing on roadsides, hillsides and riverbanks. Southern China’s shortage of quality fodder has been reduced by introducing pigeonpea.


Pigeonpea genome sequence

Known as orphan crops, pulses receive much less attention from researchers and policy makers compared to major commercial crops.

There is a great scope for developing improved varieties of pulses, with higher resilience to drought, salinity and diseases, as they will play a vital role in the face of adverse climate change impacts on crop productivity.

ICRISAT has been involved in dryland crop research since the 1970s, including research on chickpea and pigeonpea, which are among its mandate crops

ICRISAT phenotype and genotype research makes adoption of these crops profitable for the smallholder farmers

Working with several partners, ICRISAT has decoded genome sequence of pigeonpea and chickpea

Large-scale genomic resources have been developed in these crops and resulting in being elevated to “genomic resources rich crops”

These genomic resources are being used to develop improved varieties through molecular breeding approaches

Several drought tolerant and disease resistant lines have already been developed in chickpea using molecular breeding approaches

Major contribution to work on developing improved varieties and hybrids has been under the projects, Tropical Legumes I & II. Some broad impacts in chickpea research are -

1. Wilt and sterility mosaic disease resistant varieties and recently released short and medium duration hybrids have made a significant impact in Asian countries
2. Long and medium duration varieties with Fusarium wilt resistance and consumer preferred large, cream colored seeds have created impacts in eastern and southern Africa
3. In India during 2013-14, 49% of the total indent for chickpea breeder seed was from ICRISAT-India partnership varieties

66 cultures based on germplasm and improved breeding lines developed by ICRISAT have been released in several countries

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www.commodityindia.com
**Huge untapped potential of pulses can be enhanced by**

- **Increasing production**
- **Value addition**
- **Building better marketing options**

**Smallholder farmers and rural poor, can benefit from development of institutions and strategies that promote market coordination and reduce transaction costs.**

- Helping smallholder farmers break the vicious cycle of subsistence production and poverty is a great challenge to ongoing research in reducing poverty and hunger worldwide
- Underdeveloped and imperfect agriculture commodity markets undermine smallholder farmers participation and hinder their ability to benefit from improved agricultural technologies and policy reforms
- Linking farmers to markets through efficient value chains will reduce intermediaries in the chain
- Strengthening value-adding by improved technology, infrastructure and inputs, processing and exports, can raise farmers' income and provide incentives to improve their management practices towards higher farm productivity

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Mini dal mills increase income

A group of 20 women belonging to the Garima self-help group, in Radasoli village, Tahsil-Bansi of Jajpur, Rajasthan, were trained in dal making and a mini dal mill was established through an ICRISAT project in 2012-13. The mini dal mill became operational from 2013 onwards, making dal initially for family use, but later they began selling dal in the local market and doubled their profit.

**Over 62,000 MT pulses procured by government agencies**

The government agencies have procured over 62,000 MT of pulses till now which include 50,424.07 MT of Tur and Urad from Kharif Marketing Season (KMS) 2015-16, and 11,754.06 MT of Chana and Masur from Rabi Marketing Season (RMS) 2016-17. This information was given by the Minister of Consumer Affairs, Food and Public Distribution, Shri Ram Vilas Paswan in a written reply in Lok Sabha.

The Minister says in addition, imports have been contracted for about 13,500 MT of Tur and 12,500 MT of Urad respectively. Domestic searches and surveys have also been conducted on a number of importers, traders and financiers engaged in pulses trade. Till now, request for allocation of pulses from buffer stock has been received from Andhra Pradesh, Telangana, Maharashtra, Tamil Nadu, and Rajasthan.

According to 3rd Advance Estimate pulses production declines marginally to 17.06 MT in 2015-16 from 17.15 MT last year, due to back-to-back drought and poor monsoon. Retail prices of pulses have been rising due to fall in production in the wake of poor monsoon and currently rates are ruling as high as INR 195 per kg.

**Intercropping helps obtain sustainable production even under adverse weather conditions**

- On hill slopes, pulses act as an excellent cover crop and are also grown on rice bunds
- **Relay cropping (paira) facilitates double crop and is sustainable.** Here, pulse seeds are broadcast in the standing crop of rice about two weeks before harvest, enabling use of available soil moisture. Pulse yield was more than when planted after harvesting rice
- **Catch crop** is a short duration crop grown between successive plantings of main crops or are crops sown to prevent minerals being flushed away from the soil. It may be harvested or plowed under to improve soil fertility
- **Ratoon cropping**, a multiple-harvest system, where instead of cutting the crop, pods are picked and plants allowed to bear next flush of pods. Short-duration pigeonpea has created ratooning interest

**Studies in Wenchii and Kade in Ghana indicate strong potential of pigeonpea in improving soil fertility and farm profitability.** Crop rotation with pigeonpea as a long-term soil fertility management strategy is popular, and according to farmers, crops grown after pigeonpea (especially maize), look greener, grow faster, and yield more.

- In Kade, Ghana, pigeonpea in the cropping cycle resulted in 100–200% increase in maize grain yield, over continuous maize.
- It gave a 108% return on investment compared to 31% by continuous maize without fertilizer application to maize crop.

The above responses were recorded under the International Development Research Centre funded, climate change adaptation in Africa project in 2008, where farmers evaluated three early maturing and three late maturing pigeonpea varieties obtained from ICRISAT, India.

For more information about pulses see: [www.icrisat.org/usy/]

For more information about Smart Food see [www.smartfood.org](http://www.smartfood.org) (coming soon)

**Vidya Ramesh**

Research and Writing at ICRISAT