PEOPLE. PLANET. PULSES
Pulses for a healthy planet.
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PULSES
for a healthy planet

Pulses are **protein-rich** food crops that improve human diets, while their cultivation benefits the health of the soil through their unique ability to **fix nitrogen** in the soil. In addition, several pulse crops are **resilient** to adverse climatic conditions such as drought, and grow in the dry regions of the world.

**Pulses play significant roles both in human diet and in agriculture, and contribute to sustainable farming.**
The United Nations General Assembly declared 2016 as the International Year of Pulses (IYP). IYP 2016 aims to heighten public awareness of the nutritional benefits of pulses as part of a sustainable food production system, aimed towards ensuring food and nutrition security.

IYP 2016 focuses on establishing connections throughout the food chain that would better utilize pulse-based proteins, further the global production of pulses, optimize crop rotations and address the present day challenges that concern the trade of pulses.
Vision

Improved health, food and nutritional security, environmental sustainability and income for smallholder farmers through increased legume productivity, production and consumption to combat poverty, hunger, malnutrition and environmental degradation.

The CGIAR Research Program on Grain Legumes is a global partnership investment in agricultural research on grain legumes that covers the entire spectrum of food value chain from the lab to the field to the farm, and focuses on increasing their productivity, and further enhancing their adaptability for climate change and soil-nitrogen-fixing capacity.

The partnership includes four CGIAR centers (International Center for Tropical Agriculture [CIAT], International Center for Agricultural Research in the Dry Areas [ICARDA], International Crop Research Institute for the Semi-Arid Tropics [ICRISAT], and International Institute of Tropical Agriculture [IITA]) working hand-in-hand with National Agricultural Research Systems and other strategic partners to deliver improved pulse varieties to the smallholder farmers of Africa, Asia and Latin America who grow chickpea, common bean, cowpea, faba bean, groundnut, lentil, pigeonpea and soybean, in addition to ensuring sustainable natural resource management.

While improving the production, productivity, adaptive ability and market availability of legumes through innovative research themes in line with the aims of IYP, the Grain Legumes Program takes the opportunity of the International Year of Pulses to create awareness about the importance of pulses in improving food and nutrition security and environmental sustainability. We highlight the research achievements in the Grain Legumes program that advance towards improving the lives of smallholder farmers in Asia and Africa.
What are pulses?

Legume usually refers to plants (of the family Fabaceae) whose fruit or seed is enclosed in a pod.

The term ‘Pulses’ is commonly used in reference to leguminous crops that are commonly harvested solely for dry seed. The United Nations Food and Agriculture Organization (FAO) recognizes 11 types of pulses: dry beans, dry broad beans, dry peas, chickpeas, cow peas, pigeonpeas, lentils, bambara beans, vetches, lupins and other minor pulses.

Pulses exclude green beans and green peas, which are considered as vegetable crops. Also excluded are seeds that are mainly grown for oil extraction (like groundnut and soybean), and seeds which are used exclusively for sowing forage.

The CGIAR Research Program on Grain Legumes focuses on improving eight legumes, including six pulses, namely, chickpea, common bean, cowpea, faba bean, lentil and pigeonpea. Groundnut and soybean are the other two legumes that the program focuses on.
What pulses can do...

Ensure Food Security
Pulses are produced and consumed widely in developing countries more than anywhere else. Growing pulses is a cost-effective option for improving the diets of low-income consumers who cannot easily afford other protein sources like meat, dairy products and fish. Farmers often fit pulses into underutilized niches in farming systems as intercrops, relay crops and end-of-season second crops – raising more food from less land. As steady sources of human nutrition and animal feed, as well as contributors to soil sustainability, pulses play a major role in food security.

Sustainably Utilize Natural Resources
Pulses biologically fix nitrogen from the atmosphere and enrich the soil, essentially making their own fertilizer, thereby lowering carbon footprint. This reduces the costs and the environmental impacts of chemical fertilizer use, as well as the climate change impacts of fossil fuel that is burned to manufacture chemical fertilizers. Inclusion of pulses in farming systems increases the effective capture, productive use and recycling of water and nutrients such as the end-of-season residual soil moisture in maize, rice and wheat fallows.

Improve Nutrition and Health
Pulses are rich in protein, and micronutrients such as iron and zinc. They supply amino acids that are deficient in cereals, sharply improving overall protein quality when consumed together. The high iron and zinc content is especially beneficial for women and children at risk of anemia. Pulses also contain bioactive compounds that show evidence of being helpful in combating cancer, diabetes and heart disease.

Reduce Rural Poverty
Farmers, especially smallholder farmers in developing countries, both consume and sell pulses, thus benefiting in terms of nutrition and in terms of income. Pulses yield high-value grains (attracting 2-3 times higher prices than cereals), oil, and high-value fresh pods, peas and leaves that attract top prices in urban and export markets. A wide range of food products are processed locally from these raw materials, creating remunerative employment, especially for rural women.
Ten pulse facts

1. **Pulses are protein powerhouses**
   - Pulses provide 1/3 of human protein requirement.
   - Wheat: 1/2 cup, 1 unit; Rice: 3/4 cup, 1 unit.

2. **Pulses are nutri-dense and fiber-rich**
   - Carbohydrates, Folate, Iron, Protein, Vitamin A, Antioxidants.

3. **Improves health**
   - Zn Fe: Zinc and iron rich, combats anemia.
   - Pulses are high in fiber.
4. Pulses reduce cardio & diabetic risk

Heart Friendly

5. Pulses are key components of the food basket

Reduces cholesterol level

The World Food Programme (WFP) includes 60 grams of pulses in its typical food basket, alongside cereals, oils, sugar and salt.
6. Pulses are climate smart

7. More protein from less water
   - Pulses (1250 Liters)
   - Chicken (4325 Liters)
   - Mutton (5520 Liters)
   - Beef (13000 Liters)

8. Pulses fix nitrogen and improve soil health
   - 72-350 Kg/year
   - Prevent soil erosion
9. Pulses reduce carbon footprint

Reduce fertilizer dependence

10. Pulses have longer shelf-life
CHICKPEA
(Cicer arietinum L.)

Chickpea is the world’s second-largest smallholder-cultivated food legume, and a rich and cheap source of protein that helps people improve the nutritional quality of their diets.

Chickpea is classified into Desi chickpea and Kabuli chickpea. Grains of Desi chickpea are generally smaller in size, light to dark brown in color, and have a thick seed coat, while grains of Kabuli chickpea are generally bigger, have a whitish-cream color and thin seed coat. Desi chickpeas are by far the most prominent, accounting for over 80% of global production.

This highly adaptable food and forage crop is cultivated in many different cropping systems and is grown more widely than any other legume, after soybean. Through symbiotic nitrogen fixation, the chickpea crop meets up to 80% of the soil’s nitrogen needs, so farmers can apply less nitrogen fertilizer than they do for other non-legume crops.

Chickpea is grown in about 57 countries across the globe under varied environmental conditions. South and Southeast Asia dominates worldwide chickpea production with 80% of regional contribution. Developing countries account for over 95% of its production and consumption.

Chickpea grain is an excellent source of high-quality protein, with a wide range of minerals and essential amino acids.
Why is Chickpea important?

Instances of impact

THE CHICKPEA GENOME
Led by ICRISAT, sequencing of the chickpea genome and the re-sequencing of 90 chickpea genotypes, including several wild species were completed.

Countries in focus

Research focus

EARLY-MATURING CHICKPEA IN MYANMAR AND INDIA
Chickpea varieties developed and released for early maturity, high yield, and resistance to Fusarium wilt through partnership of ICRISAT and national research programs in India and Myanmar have increased the production of chickpea by 7.2-fold in Myanmar and 5.8-fold in Andhra Pradesh between 1999 to 2013.
Common bean is the pulse that is considered to be the most significant for **direct human consumption**. More than 14 million hectares of common bean is grown worldwide, yielding an approximate annual produce of **12 million** metric tons, of which 9 million tons are from Latin America and Africa. **It is** a highly nutritious food, containing **protein, fiber, complex carbohydrates, vitamins** and **micro-nutrients**. More than 300 million people in the tropics depend on the crop as a source of essential nutrition.

In many areas, common bean is the second **most important source of calories** after maize.

Common bean is grown for its **green leaves, green pods**, and immature and/or **dry seeds**. The dry seeds are the ultimate economic produce of the bean plant. They are appreciated throughout the developing world because of their **long storage life**, good nutritional properties and ease of storage and preparation. Furthermore, millions of smallholder farmers in Latin America and Africa rely on the production and sale of beans as a main source of household income.
Instances of impact

HEAT TOLERANT BEAN

Bean researchers at CIAT have discovered 30 new lines of “heat-beater” beans that can keep production from crashing in large swaths of bean-dependent Latin America and Africa. The newly discovered heat-tolerant beans may also handle increases in average temperatures by 4 °C (about 7.2 °F).
Cowpea is a protein-rich food and feed crop grown in the semi-arid tropics covering Africa, Asia, Europe, United States and Central and South America. It originated and was domesticated in Southern Africa; spreading later to East and West Africa and Asia.

Cowpea complements staple cereal and starchy tuber crops, and serves as fodder for livestock, apart from providing long-term soil improvement benefits through nitrogen fixation, and household benefits in the form of hard cash and income diversity.

Cowpea is highly drought tolerant with deep roots that help stabilize the soil and dense foliage that shades the soil surface, preserving moisture. These attributes cause it to grow equally well in a wide variety of soils. Being a legume it replenishes low fertility soils when the roots are left to decay. It is mostly grown in the hot drought-prone savannas and arid Sahelian agro-ecologies, where it is often inter-cropped with pearl millet and sorghum. More than 5.4 million tons of dried cowpea is produced worldwide, with Africa alone producing nearly 5.2 million tons.

All parts of the cowpea crop are used, as all of it is rich in nutrients and fiber. In Africa, people consume the young leaves, immature pods, immature seeds, and the mature dried seeds. The stems, leaves, and vines serve as animal feed and are often stored for use during the dry season.
Why is Cowpea important?

Instances of impact

**BIOLOGICAL CONTROL OF THE POD BORER**

Researchers at IITA along with national partners recently introduced two parasitic wasps (parasitoids), *Therophilus javanus* and *Phanerotoma syleptae*, to act as natural enemies fighting the pod borer *Maruca vitrata* in cowpea. An overall 30-50% reduction in pod borer damage is anticipated depending on prevailing local conditions, thereby reducing the damage by 50% through biological control. This can bring about a financial gain of USD 1.5 billion, without taking into account the savings by reduction in pesticide and related health and environmental costs.

Countries in focus
Faba bean, also known as fava bean, broad bean, field bean, horse bean, is an erect, leafy, winter or summer harvested annual crop. It is one of the oldest crops that originated in the Fertile Crescent and spread around the world from Egypt to North Africa and towards Nile Valley to Abyssina (now Ethiopia).

Cultivated faba bean is used as human food and animal feed (for small ruminants, pigs, horses, poultry and pigeons) in both developed and developing countries (mainly in North Africa.) In addition to boiled grains, it is consumed as vegetable; green seeds/pods, dried or canned. It is a staple breakfast food in the Middle East, Mediterranean, China and Ethiopia.

Although the global average grain yield of faba bean has almost doubled over the past 50 years, the total area sown to the crop has declined by 56% over the same period, owing to the cheap availability of fertilizers (devaluing some of the short-term economic benefits of biological nitrogen fixation) and competition with policy-backed cereal and high-value urban cash crops.

The optimal temperature for plant growth for faba bean is 15-27°C, especially during the reproductive phases of flower and pod development. Faba bean's tolerance of frost is better compared to other grain legumes. The crop adapts to low rainfall environments.
**Why is Faba bean important?**

**Instances of impact**

**REJUVENATING FABA BEAN IN EGYPT**

ICARDA scientists have been developing improved higher yielding varieties of faba bean which are better adapted to both biotic and abiotic stresses. Improved varieties, combined with integrated pest/disease management techniques, have achieved yields that are 22.5% higher than more traditional varieties. In some cases even up to 38% higher yields have been achieved.

The recommended technology package and improved varieties have increased grain yield by 256 kg/ha and reduced production costs by 350 USD/ha. The end result is an increase in net revenue by 550 USD/ha.

**Countries in focus**

Morocco  
Egypt  
Ethiopia  
Syria  
Sudan

**Research focus**

- Heat-tolerant faba beans
- Herbicide tolerant and machine-harvestable faba beans
- High nitrogen-fixing faba beans
LENTIL
(Lens culinaris Medikus)

Lentil, one of the world’s oldest cultivated plants, originated in the Fertile Crescent and was domesticated in the Middle East before spreading east through Western Asia to the Indian subcontinent. It is a short-statured, annual, self-pollinated, high-value crop species.

Lentil is relatively tolerant to water-limiting environment and is grown in as many as 52 countries throughout the world. The crop has great significance in cereal-based cropping systems because of its nitrogen-fixing ability and short duration. It provides sustainability to rice- and maize-based systems in South Asia and wheat-based systems in North America, Australia and North Africa.

Protein content in lentil ranges from 22 to 35%, and it remains one of the cheapest sources of protein, especially for people who cannot afford meat and fish. It is also a natural source of micro-nutrients (iron, zinc, and selenium) and multi-vitamins.

Lentil straw is used as fodder and is sometimes more valuable in terms of market price during drought years. In addition to everything else, lentil is a low carbon footprint produce as it uses less water, ten times less than a comparable animal source of protein.
Instances of impact

EXTRA-SHORT-DURATION LENTIL FOR RICE-BASED CROPPING SYSTEMS IN BANGLADESH

ICARDA, together with national partners in South Asia, has released extra-early maturing lentil varieties that can be harvested between 90-100 days. These varieties, with their agronomic traits and resistance to key diseases have been widely adopted in rice-based cropping systems in Bangladesh, India and Nepal. Adoption of these varieties (BARI M4, BARI M5, BARI M6 and BARI M7) by Bangladeshi farmers has led to an increase in lentil production from 119,639 tons in 2011 to 173,886 tons in 2015, at an annual growth rate of 10.9%.

Countries in focus

Research focus

Heat-tolerant lentils
Extra-early maturing lentils
Herbicide-tolerant, machine-harvestable lentils
PIGEONPEA  
(Cajanus cajan L.)

Pigeonpea is a staple grain legume grown by millions of resource-poor farmers on marginal lands across the semi-arid regions of Asia, Eastern and Southern Africa. Pigeonpea is highly valued by farmers and consumers owing to its versatile uses.

It is also a major contributor to food security in areas witnessing the early effects of global climate change. Pigeonpea enriches soil through symbiotic nitrogen fixation and adds valuable organic matter to the soil. Its inherent ability to release soil-bound phosphorus to meet its own needs as well as those of subsequent crops makes it a preferred component of cropping systems.

By virtue of its deep root system, pigeonpea ensures soil protection, and deep-rooted nutrient recycling ability. Pigeonpea is generally intercropped with cereals like sorghum, millets, maize, soybean, cotton, and oilseeds like groundnut, delivering important sustainability benefits to these cropping systems.
Why is Pigeonpea important?

Instances of impact

HYBRID PIGEONPEA IN INDIA

Heterosis or hybrid vigor offers opportunities for significant step changes in crop yields, and this has been recently exploited in pigeonpea. Studies in pigeonpea over the last two decades by ICRISAT and its partners has resulted in the utilization of cytoplasmic male sterility for the development of hybrid pigeonpea with more than 20% yield advantages over prevailing best checks. Two hybrids, ICPH 2740 ad ICPH 4503 with yields of 3.2–3.5 t/ha, have been released in India by ICRISAT and its partners in 2015.

Countries in focus

Research focus
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