Catch the Pulse

Pulses are smart food
GOOD FOR YOU | GOOD FOR THE PLANET | GOOD FOR THE SMALLHOLDER FARMER

In support of 2016 INTERNATIONAL YEAR OF PULSES
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In support of

2016 INTERNATIONAL YEAR OF PULSES

ICRISAT
Science with a human face
International Crops Research Institute for the Semi-Arid Tropics
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International Year of Pulses 2016

The UN General Assembly declared 2016 as the International Year of Pulses (IYP) with the aim to **heighten public awareness of the nutritional benefits of pulses as a part of sustainable food production aimed towards food security and nutrition.**

Pulses are under-recognized for their value and their importance in diversification and complementing other foods. They are critical for both farmers and consumers.

Pulses are Smart Food as they are:

▸ **Good for You**
  - Pulse crops such as lentils, beans, pigeonpea and chickpea are a critical part of the general food basket
  - They are an important source of plant-based protein and amino acids
  - As part of a healthy diet they help address obesity, manage chronic diseases like diabetes and coronary conditions

▸ **Good for the Planet**
  - Highly water efficient, pulses are smart crops that grow in drought prone areas
  - Helps improve soil fertility by fixing nitrogen and promoting soil microbes
  - Pulses make a positive contribution in reducing release of greenhouse gases

▸ **Good for the Smallholder Farmer**
  - Pulses can better withstand climate change thus reducing risk for the smallholder farmer
  - Multi-use crop – food, fodder, fuel, building material – helps improve livelihoods of farmers
  - Particularly important for female farmers who are a major part of the labor force in pulses farming
The pulses, pigeonpea and chickpea, in addition to groundnut, millets and sorghum, are the mandate crops of ICRISAT. Research focus is on (a) improved grain quality, nutritional traits, food safety, nitrogen fixing properties, hybrids, and (b) drought tolerance and adaptation to diverse dryland agroecosystems and to differing rotations with cereal crops. Breeding is enhanced with modern genomic and molecular tools, precise phenotyping and crop simulation modeling.

ICRISAT works along the whole value chain of pulses in an integrated manner to create a win-win situation for the farmer, consumer and the planet.
Protein

Benefits of pulses include:
• Zero cholesterol
• Low saturated fat

* 1 cup = 164 g

1 Based on data from [http://ndb.nal.usda.gov/ndb/foods](http://ndb.nal.usda.gov/ndb/foods)

Instructions to view this stereogram are on page 28.
Protein deficiency is mainly observed among the poor, infants and young children in developing countries.

Pulses are an affordable source of protein.

Chickpea has the highest protein bioavailability among pulses.

An extra short duration pigeonpea variety (ICPL 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, Jaipur district, Rajasthan, India.

Project: Enhancing the livelihoods of resource-poor farmers of Rajasthan through the introduction of ecofriendly pigeonpea varieties

Investor: Directorate of Agriculture, Government of Rajasthan, under the Rashtriya Krishi Vikas Yojana

Partner: Swami Keshwanand Rajasthan Agricultural University, Bikaner, Rajasthan and ICRISAT

CGIAR Research Program: Grain Legumes


2 ICPL 88039 is the first variety of its kind among the global pigeonpea cultivars. Besides its extra-short maturity, this variety is less sensitive to the number of hours of sunlight compared to medium-duration varieties. These aspects help it to adapt well to different geographies including high altitudes (up to 2,000 m above sea level) and wide range of latitudes (up to 40°N and S).
Pulses are smart food

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1 Half cup pulses/day provides 7-17 g fiber accounting for 18-45% of recommended daily fiber intake in men and 28-68% in women. Calculation based on data from United States Department of Agriculture, National Nutrient Database for Standard Reference Release 28

*1 cup = 448 g
While high fiber diet is healthy, drinking plenty of water is recommended as fiber works best when it absorbs water.

**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
- Lowers risk of heart disease (reduces blood pressure and heart inflammation), stroke, hypertension, diabetes (slows sugar absorption and improves blood sugar levels), and gastrointestinal 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

**Cooked chickpea** has 12.5g dietary fiber, meeting 50% of daily requirement

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**ICRISAT**

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.

**Project:** Multidisciplinary legume based farming systems in the central dry zone of Myanmar to improve food security and farmer livelihoods

**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.

**CGIAR Research Program:** Grain Legumes

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Vitamins

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

Instructions to view this stereogram are on page 28.
Major vitamins found in cooked pulses are Vitamin B6, Vitamin E, Vitamin K, thiamin, riboflavin and folic acid (as folate).

Chickpea and pigeonpea are mainly cooked before consumption, and water soluble vitamins are less in the cooked form.

Pigeonpea is also popular as a green vegetable.

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

Percentage of daily recommended intake found in 100 g of cooked chickpea and pigeonpea:

- Cooked chickpea:
  - 44.5% Folic acid (as folate)
  - 24.5% Vitamin E
  - 10.5% Thiamin
  - 10.3% Vitamin B6
  - 4.3% Vitamin K

- Cooked pigeonpea:
  - 28.7% Folic acid (as folate)
  - 13.3% Thiamin
  - 5.4% Riboflavin
  - 3.7% Vitamin B6

ICRISAT 3762: The first pigeonpea hybrid crop released for Odisha in 2014.

ICRISAT with the support of the Odisha government promoted improved chickpea and pigeonpea cultivars, production technologies and seed systems while strengthening farmer capacities in various districts of the state. Early duration varieties for central Odisha and medium duration varieties for south-western regions will be released in the next 2-3 years.

Only one-third of farmers in Odisha grow pulses and seeds are saved for the next season. Low, unstable yields discourage them from growing pulses in large areas. Since 2011, high yielding varieties and hybrids are being popularized along with demonstrations of improved crop management technologies and seed systems in 8 districts of the state. New chickpea varieties appropriate for Odisha are being identified. This will help improve pulse consumption from the current level of 26.6 g/day/capita, which is lower than the intake of 35 g/day/capita recommended by the Indian Council of Medical Research.

Projects: Promotion of improved chickpea varieties in rice-based cropping systems of smallholder farmers in Odisha; introduction and expansion of improved pigeonpea production technology in rainfed upland ecosystems of Odisha.

Investor: Department of Agriculture, Government of Odisha, India

Partners: Department of Agriculture, Government of Odisha; Orissa University of Agriculture and Technology, Bhubaneshwar; Odisha State Seeds Corporation.

CGIAR Research Program: Grain Legumes


Pulses provide iron, potassium, magnesium, calcium, phosphorus, sulfur and zinc, to our diet.
Iron deficiency anemia is a serious health issue\(^1\)\(^,\)^\(^2\)^\(^,\)^\(^3\),\(^4\) and ranges from 50-70%, in women and children, with pregnant women being particularly susceptible. Zinc deficiency is prevalent in 31% of the world’s population\(^5\). The poor are most affected as their diet is generally low in bioavailable zinc and may contain inhibitors of zinc absorption. Chickpea and pigeonpea are great sources of iron, manganese and zinc.

**Percentage of daily recommended intake of minerals in 100 g of cooked chickpea and pigeonpea**\(^6\)

<table>
<thead>
<tr>
<th></th>
<th>Cooked chickpea</th>
<th>Cooked pigeonpea</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>52.2%</strong></td>
<td>Manganese</td>
<td><strong>25.4%</strong></td>
</tr>
<tr>
<td><strong>27.5%</strong></td>
<td>Iron</td>
<td><strong>13.5%</strong></td>
</tr>
<tr>
<td><strong>19%</strong></td>
<td>Phosphorus</td>
<td><strong>13.2%</strong></td>
</tr>
<tr>
<td><strong>16.5%</strong></td>
<td>Zinc</td>
<td><strong>10.5%</strong></td>
</tr>
<tr>
<td><strong>14%</strong></td>
<td>Magnesium</td>
<td><strong>10%</strong></td>
</tr>
</tbody>
</table>

Magnesium is critical for proper maintenance of body weight and for a number of metabolic syndromes related to cardiovascular disease\(^7\).

Minerals required for bone formation and for bone related metabolic processes include calcium, magnesium, phosphorus, potassium, manganese, copper, iron, and zinc\(^8\).

Green pigeonpea 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\(^9\).

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\(^1\) Indian National Science Academy. 2011. Micro-nutrient security for India—priorities for Research and action (insaindia.org/download%20form/Micronutrient_final_with_cover.pdf)


\(^8\) Palacios Cristina. 2006. The Role of Nutrients in Bone Health, from A to Z. Critical Reviews in Food Science and Nutrition Vol.46 (8)

Carbon footprint

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Instructions to view this stereogram are on page 28.

\[ \text{Pulses} = 0.5 \text{ kg}^* \]
\[ \text{Beef} = 9.5 \text{ kg}^* \]

\(^*\text{CO}_2\) equivalent

1 http://www.cicilsiptic.org/pulses.php?id=25
Pulses production has lower carbon footprint than most animal sources of protein.

- Low water use results in low energy use
- Reduces non-renewable energy in the entire crop rotation by 22-24%\(^1\)
- Pulse-Pulse-Wheat cropping has 34% less carbon footprint compared to a Cereal-Cereal-Wheat cropping pattern\(^2\)

Better farming practices, including use of pulse crops, can lower the average carbon footprint by 24 to 37%\(^3\).

Nitrogen fertilizers contribute to carbon footprint as its energy footprint is over 7.5 times more than other fertilizers such as phosphate and potash\(^4\).

Pulses help reduce use of chemical fertilizers by fixing nitrogen.

**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 introgressed with wild ancestors from a unique, diverse, and recent collection in Turkey, is underway. Trait differences across 20 wild chickpea populations that affect the crop’s responses to drought, heat and climate-resilient nitrogen fixation is being studied.

**Project:** Global Hunger and Food Security Research Strategy: Climate Resilience, Nutrition, and Policy – Feed the Future Innovation Lab for Climate Resilient Chickpea

**Investor:** United States Agency for International Development (USAID)

**Partners:** The University of California (UC) and ICRISAT

**CGIAR Research Program:** Grain Legumes

\(^1\) Life Cycle and Socio-Economic Analysis of Pulse Crop Production and Pulse Grain Use in Western Canada. Saskatchewan Research Council Publication No. 12135-1E11, March 2011. (not published as of February 2012)

\(^2\) http://www.cicilsiptic.org/pulses.php?id=25


\(^4\) http://www.pulsecanada.com/environment/sustainability/non-renewable-energy
Water footprint

Well adapted to semi-arid regions, pulses use
- less water
  and are
- drought tolerant

Instructions to view this stereogram are on page 28.
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.

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 than that used for pulses.

In Muduvatti 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 piloted by an ICRISAT-led consortium of 11 partners in India, as a business model, treats grey water through constructed wetlands and render it safe for agricultural use.

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

**Green, blue and grey water use**

Water used to produce 1 ton (in m³) of pulses

<table>
<thead>
<tr>
<th></th>
<th>Green water</th>
<th>Grey water</th>
<th>Blue water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total water used</td>
<td>4,055</td>
<td>3,180</td>
<td>734</td>
</tr>
</tbody>
</table>

Good for the planet
Pulses produce about 21 million tons of nitrogen per year\(^1\)

Access to good pigeonpea seeds transformed the lives of John Msuku and his family. As part of ICRISAT’s smallholder farmer seed production clubs in Chambogho, 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,” he 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.

Project: Malawi Seed Industry Development Project (MSIDP)
Partners: Ministry of Agriculture, Irrigation and Water Development, Smallholder Producer Groups, the private sector and ICRISAT
Investor: Irish Aid
CGIAR Research Program: Grain Legumes

4 Story first appeared on the Thomson Reuters Foundation website. Read the full story here http://www.trust.org/item/20151009123820-sbq6o/

Pulses fix atmospheric nitrogen through a symbiotic relationship with nitrogen fixing soil bacterias 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.

Pigeonpea adds
8-16 kg N/ha;
2.5-5 kg P/ha;
13.5-24 kg K/ha
(in entire crop cycle as leaf drop)

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

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

Growing pulse crops in rotation enables the other crops to benefit from these large, diverse population of soil organisms.

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“I would never have thought chickpea could bring me such high returns,” said 53-year-old Ms Temegnush Dhabi 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 grain legume varieties developed under the projects.

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Project: Tropical Legumes II
Partners: 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
CGIAR Research Program: Grain Legumes

Multiple use of pulse crops

Instructions to view this stereogram are on page 28.

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

- As \textit{green manure}, pigeonpea produces 13,619 kg/ha of dry matter and 23 kg of N/t of dry matter\(^1\).
- Pigeonpea leaves and forage, high in protein and easily accessible, are largely used as \textit{fodder} for cattle and other animals.
- The stems and branches of pigeonpea are used to prepare \textit{baskets}, fencing and thatch, and serve as an additional income source for women.
- In Thailand, pigeonpea is host to insects that produce \textit{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\(^2\)
- Farmers in Africa grow pigeonpea for its \textit{firewood} more than for its grain. The calorific value of the pigeonpea stalks is about \(\frac{1}{2}\) that of the same weight of coal\(^3\).
- A \textit{wind breaker/shade crop} for young cocoa plants in Nigeria\(^4\).
- Pigeonpea acts as a \textit{cover crop} or support crop for vanilla in Southeast Asia and as a substrate for mushroom production in China\(^5\).

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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 reconstruction projects, growing on roadsides, hillsides and riverbanks. Southern China’s shortage of quality fodder has been resolved by introducing pigeonpea.

New varieties and hybrids

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

Instructions to view this stereogram are on page 28.
I.CRISAT 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 resulted 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.

Projects: Tropical Legumes I & II
Investor: Bill & Melinda Gates Foundation
Partners: The International Center for Tropical Agriculture, International Institute of Tropical Agriculture, National Agricultural Research Systems (NARS) partners in target countries; private sector and NGO partners and ICRISAT
CGIAR Research Program: Grain Legumes

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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.
Strengthening Value Chain

Huge untapped potential of pulses can be enhanced by

- Increasing production
- Value addition
- Building better marketing options

Instructions to view this stereogram are on page 28.
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.

Mini dal mills increase income

A group of 20 women belonging to the Garima self-help group, in Padasoli village, Tahsil-Bassi of Jaipur, 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.

The women plan to increase the members in the group, register the SHG and create awareness among women in the neighboring villages.

Additional benefit to the women is the use of dal husk for livestock feed, and the income from the sale of pigeonpea stalks as fuel wood (₹20,000/ha).

**Project:** Enhancing the livelihoods of resource-poor farmers of Rajasthan through the introduction of ecofriendly pigeonpea varieties

**Investor:** Directorate of Agriculture, Government of Rajasthan in collaboration with Swami Keshwanand Rajasthan Agricultural University, Bikaner, under the Rashtriya Krishi Vikas Yojana

**Partners:** Swami Keshwanand Rajasthan Agricultural University, Bikaner and ICRISAT

**CGIAR Research Program:** Grain Legumes
On-farm diversity

Short duration pulses have paved the way for crop diversification & intensification

Instructions to view this stereogram are on page 28.
Diversification strategies include crop rotation, double cropping and intercropping.

- Diversity is the **relative abundance** of each crop in the overall cropping pattern
- Major **benefits of farm diversification** to smallholder farmers are increased revenue, low input costs, adaptability to climate variation, and resilience to overcome risks and uncertainties
- **Pulses** are grown as a sole crop, intercrop, catch crop, relay crop, cover crop, green manure crop, etc, in **different agroecological regions**
- **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

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**ICRISAT**

Studies\(^1\) in Wenchi 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.

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Instructions for viewing the stereograms

Stereograms create the illusion of a third dimension. The trick to viewing a stereogram is to diverge one’s eyes as if looking through the paper showing the picture (which is, admittedly, easier said than done until you get the hang of it). Given below are three methods to make it easy for you to view the stereogram.

One common rule – keep your hands steady and don’t let anyone interrupt you. It may even be a good idea to find a quiet well lit room.

**You don’t need special glasses, just your own eyes!**

**Method one**
Hold the image right up to your nose, relax your eye muscles allowing the image to blur and slowly move the image away from you.

**Method Two**
Hold your finger before your eyes and focus on it. Then let your eye muscles relax and your finger will appear to double. Apply this principle to the images and the 3D image will appear magically!

**Method Three**
Look at the picture but don’t focus. Allow your eyes to relax and try to look through the picture as if you were looking at an object further away.

Every photograph has to be converted to a depth map before a stereogram can be made.*

The depth map for each stereogram is given below. This gives you an idea of what you will see in 3D on each page.

* Depth map is a black and white image used to determine the height and depth of the hidden image. White comes forward the most while black recedes the most, and shades of grey fall in-between - to give a 3D image.
The CGIAR Research Program on Grain Legumes (Grain Legumes) aims to improve health, food and nutrition security, environmental sustainability, and income for smallholder farmers through increased legume productivity, production and consumption. Grain Legumes is a global partnership involving four CGIAR Research Institutes namely ICRISAT (Lead center), CIAT, ICARDA and IITA, together with several public and private institutes and organizations including the USAID’s Feed the Future Innovation Labs for Collaborative Research on Grain Legumes (Legume Innovation Lab) and Peanut Productivity and Mycotoxin Control (Peanut & Mycotoxin Innovation Lab). The program focus is on chickpea, common bean, cowpea, faba bean, groundnut, lentil, pigeonpea and soybean in the smallholder communities of Africa, Asia, and Latin America.
A Big Thank You

We would like to thank all who helped in creating this calendar.

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ICRISAT works in agricultural research for development across the drylands of Africa and Asia, making farming profitable for smallholder farmers while reducing malnutrition and environmental degradation. We work across the entire value chain from developing new varieties to agri-business and linking farmers to markets.

ICRISAT appreciates the support of CGIAR donors to help overcome poverty, malnutrition and environmental degradation in the harshest dryland regions of the world. See http://www.icrisat.org/icrisat-donors.htm for full list of donors.