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Introduction

Home to more than 2 billion people, the harsh drylands are critical to global agriculture. Here 65% of the land is agricultural and farmers face some of the biggest challenges, which are getting tougher with climate change.

The drylands lose 23 hectares per minute of cultivable land to drought and desertification! Poor soil fertility, pests and disease, extreme climate variabilities and a lack of resources, plague farmers in an already poverty-driven environment.

In close collaboration with its partners, ICRISAT has consistently worked to find solutions to overcome these challenges.

These are critical to reducing poverty, hunger, malnutrition and environmental degradation in the semi-arid regions.

We believe that demand-driven innovations and a holistic approach encompassing the whole agricultural value chain have been a game changer for smallholder farmers and rural communities.

Read the impact our scientific interventions and programs in Asia and sub-Saharan Africa have had on bridging the gap between healthy families and hungry families.
Holistic Scaling Up, Karnataka, India

*Karnataka has the second largest area under rainfed agriculture but its soils are highly degraded and crop yields are low. A holistic approach with soil and nutrient management, improved cultivars, seed treatment, and soil and water conservation measures can bridge the yield gap.*

**Interventions**

- Integrated soil-water-crop management practices
- Knowledge-based entry point to enhance awareness on soil fertility
- On-farm diversification
- Identifying and popularizing high-yielding, drought-resistant crop cultivars
- Capacity building in best management practices
- Empowering farmers as extension agents
- Innovative ICT-based extension system
- Promotion of rural infrastructure for timely input delivery
- Promotion of mechanization
- Monitoring & Evaluation

The Bhoochetana project is implemented with the local organizations and people having ownership of the process.

**Impacts**

- 4.75 million farmers have benefited over 5 years
- 7.4 million ha: Rainfed area covered by improved management practices
- Benefit-cost ratio: 3-14:1
- 20 – 66% increase in crop yield
- US$ 353 M: Net benefit accrued in 5 years
- >5% rise in agriculture growth since 2009.

Genomics: Accelerating Genetic Gains

A new green revolution is crucial if the world’s growing population is to be fed. Genomics provides breeders with new tools and techniques to study the whole genome of plants. By studying the genotype and its relationship with the phenotype, more efficient cultivars can be developed that have the greatest potential to increase yield.

Impacts

▪ Genome sequence and re-sequencing will hasten genetic gains significantly in ICRISAT’s mandate crops by reducing the time to develop better lines by precision and targeted approaches

▪ Improved chickpea lines with enhanced tolerance to drought, resistance to Fusarium wilt and Ascochyta blight and for groundnut with enhanced resistance to rust and improved oil quality have been developed and provided to national programs. For more information: (Plant Science 242: 98-107, http://www.sciencedirect.com/science/article/pii/S0168945215300662)

▪ Genes/genomic segments/QTLs associated with priority traits such as biotic/abiotic stress tolerance, yield, etc, are being used by many breeding programs.

Interventions

▪ Decoded genomes of three legumes (chickpea, groundnut and pigeonpea) and two cereals (sorghum and pearl millet) have provided vast information on genome architecture and organization on genes/genomic regions controlling priority traits in these important crops of smallholder farmers in the semi-arid tropics.

▪ Deploying genomics-assisted breeding could strengthen the crop improvement pipeline by increasing the efficiency and speed of precision breeding in all the ICRISAT mandate crops.
Sorghum in Eastern and Southern Africa

Sorghum yields in Eastern and Southern Africa are affected by both biotic and abiotic constraints. Improved crop management and new varieties with increased resistance to pests and diseases can significantly increase crop yields.

Interventions

- High-yielding sorghum cultivars (OPVs and hybrids) with resistance to the main biotic and abiotic stresses and with farmer-preferred/market traits released and used by farmers
- 14 cultivars released in Eritrea, Sudan, Ethiopia, Tanzania, Kenya and Zimbabwe
- End use grain quality analysis: 26 lines identified with desirable malting qualities; 10 varieties found suitable tested for feed quality
- Improved agronomic packages identified, validated and promoted
- Trained farmers, extension staff, agro dealers, and seed companies in Good Agricultural Practices
- Promoted new cultivars, quality seed and fertilizer use with small seed packs
- Trained farmers and extension staff in value addition and market enterprise practices
- Trained farmers, extension staff and small seed dealers in seed production.

Impacts

- Community seed production units initiated in Ethiopia, Kenya, Tanzania and Uganda; women the main producers
- Farmers access more quality seed of improved varieties leading to increased production
- Farmers have access to mechanized threshing
- Over 45,000 farmers trained
- 8000 farmers in Kenya marketing grain to the malting industry every year
- 40% improvement in grain price realized in Kenya
- 55% more yields in Tanzania from fertilizer + improved *Striga*-resistant sorghum variety + tied ridges
- Up to 4.4 t/ha yields in Ethiopia from ridging + microdosing compared to the national average of 2.1 t/ha
- Training in diversified recipes led to increased utilization at the household level
- Fish farmers in Makueni County, Kenya, incorporate sorghum in fish feed, substituting maize.
Chickpea in Andhra Pradesh and Telangana States, India

Large areas of chickpea in the semi-arid tropics often experience short winters, terminal moisture and heat stresses, wilt disease and pod borer problems, leading to low yields. New chickpea varieties adapted to warmer, short-season environments are bringing increasing prosperity and offering hope to farmers.

Interventions

- Across India, developed 43 high-yielding, early- to medium-maturing, wilt-resistant chickpea varieties; released in India through ICRISAT partnership with State Agricultural Universities
- High adoption in central and southern India
- Accounted for about 49% of the total indent of chickpea breeder seed in India (2013-14)
- Chickpea variety NBeG 47, the first machine harvestable variety released in Andhra Pradesh suitable for the state’s variable climate. This was derived from a cross between ICCV 2 X PDG 84-16.

Impacts

- ICRISAT-India partnership varieties (JG 11, JAKI 9218, KAK 2, and Vihar) cover over 90% of the chickpea area in Andhra Pradesh
- Chickpea performance:
  * 9-fold increase in production (95,000 to 884,000 tons)
  * 5-fold increase in area (102,000 to 602,000 ha)
  * 2.4-fold increase in yield (583 to 1,407 kg/ha).
Chickpea in Myanmar

Chickpea farmers in Myanmar are handicapped by end-of-season drought and heat stress that affect yields. Early-maturing varieties well adapted to the short-season environments have helped farmers as well as restarted the country’s export of chickpea.

Interventions

Six varieties (Yezin 3, 4, 5, 6, 8 and 11) released in Myanmar from ICRISAT-bred materials. These are high yielding, mature early, with improved resistance to fusarium wilt, and have good seed quality.

Impacts

- 96%: Area under high-yielding varieties developed through Department of Agricultural Research (DAR)-ICRISAT partnership:
  * 44% Yezin 3 (ICCV 2)
  * 20% Yezin 4 (ICCV 92944)
  * 17% Yezin 6 (ICCV 88202)
  * 15% Yezin 8 (ICCV 97314)

- Adoption of these cultivars led to:
  * 4.8-fold increase in production (117,000 to 561,000 MT)
  * 2.2-fold increase in area (164,000 to 363,000 ha), and
  * 2-fold increase in productivity (712 to 1544 kg/ha) over the past 15 years

- High adoption of recommended practices
- Myanmar now ranks 4th in chickpea production.
**Pigeonpea in Eastern and Southern Africa**

Legumes are highly susceptible to pests and diseases, increasing the risk for smallholder farmers and constraining the adoption of improved cultivars. Breeding for resistance, grain quality and nutritional traits, drought tolerance and avoidance and helping farmers find reliable market outlets and incentives to invest in productivity-enhancing technologies can make a great difference to their livelihoods.

**Interventions**

- Release and promotion of high-yielding, wilt-resistant medium-duration varieties including a new set of climate resilient medium-duration varieties adapted to diverse agro-ecological regions, photoperiod insensitive, intercropping compatible, tolerant to Fusarium wilt, and with consumer preferred grain traits
- Enhanced productivity through sustainable Intensification: P-microdosing, intercropping with cereals and double up legumes
- Promoted innovative seed systems
- Improved market linkages through producer marketing groups, participation of large traders in regional and international exports and value addition.

**Impacts**

- 40% productivity gains from greater access to superior seed; in Malawi productivity was 1309 kg/ha
- Access to ever growing Indian grain market through trader participation
- 15 large-scale dhal processing plants set up in Malawi, Tanzania, Kenya and Mozambique
- 25-40% higher local producer prices following producer-wholesaler linkages
- Production and dissemination of 4250 tons of quality seed covering about 0.5 million ha in the last 8 years
- 80% rise in farmers’ incomes in Kenya, Malawi, Mozambique, Tanzania and Uganda
- Expanding green pea markets in urban and semi-urban centers
- Greater household utilization and nutritional benefits to women, youth and children under five.
Pigeonpea Hybrids

Pigeonpea yields have remained low in India over the past five decades and efforts to break this plateau have failed. A non-conventional hybrid breeding approach that breaks the productivity barrier is the answer to India’s increasing pulse imports.

Interventions

- A first-ever legume hybrid was developed for pigeonpea, using new breakthroughs in science
- New hybrids along with dedicated efforts to work with private industry have led to the seeds being commercially available
- Identified male sterile sources and developed heterotic hybrid combinations with resistance to fusarium wilt and sterility mosaic disease
- Parental lines shared with public and private partners to strengthen their efforts in hybrid breeding and to develop high-yielding hybrids for different agro-ecologies
- Seed production technology standardized to harvest appreciable quantities of hybrid seeds from the female parent
- Three pigeonpea hybrids were released: ICPH 3762 in 2010 in Odisha; ICPH 3762 in 2014; and ICPH 2740 in 2015 in Telangana under the name Mannem Konda Kandi.

Impacts

- 30-40% yield advantage in farmers’ fields under rainfed and irrigated ecosystems
- 10 commercial hybrids (3 from the public sector and 7 from the private sector) being released in India
- Area under cultivation increased from 40,000 ha (2013) to 127,000 ha (2015) due to collaborative efforts
- 200,000 ha expected to be covered in 2016.
Finger Millet in Eastern Africa

Finger millet is an important subsistence crop in small scale cereal-based farming systems. However production has been low due to lack of improved technologies, including varieties. The crop, one of the most nutritious of major cereals, could be the key to solving Africa’s malnutrition problem among women and children.

Interventions

▪ Germplasm characterized and sources for resistance to blast, *Striga* and drought identified

▪ Germplasm profiled and identified for nutrient content: Accessions with high nutrient content identified for different nutrients

▪ Farmer preferred high-yielding varieties with resistance to main biotic and abiotic stresses released and used by farmers: Ethiopia (7), Kenya (5), Tanzania (2) and Uganda (1)

▪ Improved agronomic packages validated and promoted

▪ Training imparted in Good Agricultural Practices, value addition and market enterprise practices and seed production to farmers, extension staff, agrodealers and seed companies.

Impacts

▪ Community seed production units started in Ethiopia, Kenya, Tanzania and Uganda, women being the main producers

▪ Grain price of finger millet improves

▪ Farmers access more seed of improved varieties leading to increased production

▪ More income to farmers from seed production as they sell at 1.5 times the cost of grain

▪ 40% yield increase in farmers’ fields with improved varieties and up to 60% with improved varieties and appropriate agronomic packages

▪ Yield increase (2010-2015): 2.0-2.3 t/ha in Ethiopia; 0.6-1.0 t/ha in Kenya; 0.7-0.9 t/ha in Tanzania; and 1.8-2.3 t/ha in Uganda

▪ Availability of greater diversity of finger millet products leading to increased consumption.
Extra-Early Pearl Millet Hybrid

Downy mildew in pearl millet can result in great losses in grain and stover harvest. Scant and unreliable rainfall is another factor that drastically reduces yield and yield stability. Improved hybrids promise to protect farmers from the past “boom-bust” cycle of hybrid cultivation in India.

Interventions

Inter-institutional collaboration integrated conventional, participatory and marker-assisted breeding methods to develop extra-early pearl millet hybrid HHB 67 Improved, which has enhanced downy mildew resistance and yield.

Impacts

- >875,000 ha grown to improved varieties mainly in drought-prone areas of Rajasthan, India
- Net income from improved seed: USD 1460/ha; total net benefit of USD 6.4 million in 2011
- 186 person day/ha: Jobs from seed multiplication
- USD 13.5 M net improved benefits in 2011 alone, compared to previous varieties
- Generated 900,000 days of employment each year, 45% of whom were women laborers.
**Biofortification**

Where predominantly cereal-based diets and malnutrition exist, agricultural approaches can marginally enhance the nutritional value of some foods by elevating their macro and micronutrient content. Biofortified sorghum and pearl millet varieties and hybrids are the answer in areas where malnutrition is prevalent.

**Interventions**

- Development of open-pollinated varieties and hybrids with higher Iron (Fe) and Zinc (Zn) levels.
- Bioavailability (absorption) studies of iron in pearl millet:
  - Three studies that covered different age groups in different countries – young women in Benin (2013), teenagers in Maharashtra and very young children (2013) in Karnataka, India – have shown that the bioavailability of pearl millet is estimated at 7.4% for regular pearl millet as well as biofortified high-iron pearl millet
  - Studies used the ICRISAT-developed high-iron biofortified pearl millet variety ICTP 8203 Fe, released as Dhanshakti in Maharashtra, India, in 2013 and for all-India cultivation in 2014
  - Dhanshakti included in the Nutri-Farm Pilot Program launched by the Indian government.
Impacts

Pearl millet

- High Fe (771 ppm), early-maturing, open-pollinated pearl millet variety Dhanashakti commercialized in India; being adopted by >35,000 farmers
- Standardized a non-destructive, cost-effective and rapid X-ray Fluorescence Spectroscopy (XRF) screening method that benefited NARS partners in screening their breeding materials
- High Fe (>90 ppm) advanced breeding lines and germplasm-derived progenies identified; supplied to NARS partners
- High-yielding and high-Fe hybrid ICMH 1201 being commercialized by a seed company since 2014; adopted by 25,000 farmers, mostly in Maharashtra and Rajasthan

- All India Coordinated Pearl Millet Improvement Project (AICPMIP) initiated a coordinated Initial Hybrid Biofortification trial to encourage the incorporation of Fe and Zn traits into partners breeding programs and promote high-Fe hybrids for fast-track release.

Sorghum

- Developed improved breeding lines with high yield and high grain Fe and Zn by exploiting the large variability in core collections
- ICRISAT-bred biofortified sorghum line ICSR 14001 with 50% higher Fe and Zn than base level outyielded all other entries in the state multilocation in Maharashtra state, India
- ICSR 14001 proved superior under on-farm testing; under testing by the All India Coordinated Sorghum Improvement Project (AICSIP) towards its commercialization.
Early-Maturing Groundnut

For farmers dependent on rainfed agriculture, mid- and end-of-season drought can be deadly. Developing early-maturing groundnut varieties that can circumvent these conditions, produce higher yields over traditional varieties, apart from having higher shelling turnover and pod and haulm (fodder) yields, are a boon to farmers.

Interventions

Through farmer participatory varietal selection, groundnut variety ICGV 91114 was identified as a farmer preferred variety and released in three states in India – Andhra Pradesh, Odisha and Karnataka.

Impacts

▪ On-farm impact study on adoption of ICGV 91114 in Ananthapur district of Andhra Pradesh showed:
  * 23% increase in pod yield
  * 36% higher net incomes
  * 30% reduction in yield variability

▪ Study by the International Livestock Research Institute (ILRI) showed 11% increase in milk yield when cereal fodder is supplemented with ICGV 91114 compared to TMV 2

▪ National breeder seed indent for ICGV 91114 was 14% of the total indent for all the varieties during 2014, indicating its growing popularity.
Genebank

Climate change, desertification, land degradation and a host of other factors threaten to impact the productivity and resilience of crops in the drylands, with severe consequences for food security. Evaluating germplasm for traits of economic importance and using them in crop improvement programs with the help of modern tools can stave off hunger and preserve crop diversity for the future.

Interventions

- Management of genebanks in India, Niger, Kenya and Zimbabwe, with more than 120,000 germplasm accessions from 144 countries
- Conserving and evaluating germplasm.

Impacts

- Identified germplasm with new sources of tolerance to drought, salinity, heat and water logging, disease resistance, early maturity, high yield, seed size, and quality (oil, protein, iron, zinc, calcium).
- > 1.4 million samples of nearly 100,600 germplasm accessions shared with collaborators in 145 countries
- > 800 varieties released in 79 countries by national partners using germplasm and breeding lines from ICRISAT
- From 1976 to 2014, 225 improved varieties of sorghum (43), pearl millet (85), chickpea (43), pigeonpea (23) and groundnut (31) have been released by Indian partners (using breeding material from ICRISAT), raising production and incomes of smallholder farmers
- 41,796: National germplasm accessions repatriated by ICRISAT to the National Bureau of Plant Genetic Resources (NBPGR), India.
Hybrid Parents Research Consortium (HPRC)

Farmers are constrained by the lack of access to seed of improved hybrids at affordable cost. By exploiting the complimentary expertise of private sector seed companies to develop improved cultivars, it has been possible to diversify the genetic base of hybrid breeding programs.

Interventions

ICRISAT’s Hybrid Parents Research Consortium partners with Private Sector (PS) seed companies in India, and abroad to deliver improved hybrids and varieties to poor farmers. It does this by:
- Evaluating breeding materials for various traits and adaptation at targeted sites in target ecologies
  - Flowering period heat-tolerant breeding materials
- Biofortified hybrids, ICMH 1201
- Dhanshakti (biofortified variety of pearl millet developed by ICRISAT)
- Drought-tolerant hybrids identified in HOPE project upscaled
- Medium-duration sorghum hybrid parents with high yield and resistance to shoot fly
- Development of postrainy season adapted sorghum hybrid parents and hybrids
- Hybrid parents for sweet stalk traits for biofuel and single cut forages
- Identification of high green biomass breeding lines, germplasm and cultivars
- Development of fusarium wilt and sterility mosaic disease-resistant parental lines and hybrids for different agro-ecologies
- Serving as a platform to evaluate promising pipeline hybrids across agro-ecological zones
- Providing services to screen private sector lines and hybrids
- Providing specialized training in breeding, entomology, pathology and molecular marker technology
- Supporting nucleus seed supply
- Facilitating networking.
Impacts

Pearl millet

- 60-70% of the 70-80 pearl millet hybrids grown in India are based on ICRISAT-bred A-lines, or on proprietary A-lines developed from improved lines bred at ICRISAT

- Increased productivity: 3-year mean grain yield rose from about 539 kg/ha (1986-90) to 1186 kg/ha (2010-15)

- Generated social benefits: USD 23.5 M in Gujarat, USD 108 M in Rajasthan and USD 38.4 M in Uttar Pradesh

- 22 of 29 hybrids released by the public sector in India (2000-2014) are based on ICRISAT-bred hybrid parents

- 40 of 48 hybrids evaluated in the Initial Hybrid Trial of the All India Coordinated Pearl Millet Improvement Project (AICPMIP) during 2014 are based on ICRISAT-bred hybrid parents

Sorghum

- Of the 14 new hybrids commercialized by PS partners, 8 developed using ICRISAT-bred materials (A-/B- or R-lines)

- About 25% of partners used ICRISAT-bred sorghum R-lines directly to make two hybrids; another 25% of PS partners used the ICRISAT-bred lines (up to 50% R-line) to develop two hybrids. About 25% of partners directly used ICRISAT-bred A-lines to develop five hybrids; other 25% used the selections from ICRISAT-bred A/B pairs to make two hybrids while another 12% used <25% ICRISAT-bred line to make one hybrid

- 12 hybrids generated using ICRISAT-bred hybrid parents by six seed companies.

- ICRISAT contributed about 80% of sorghum A- and B- lines, and 60% of R-lines to the working collection of private seed companies (2000-2010).

Pigeonpea

- Seed production technology standardized for alfisols and vertisols to harvest appreciable amounts of hybrid seed from female parental lines

- 8 hybrids directly released by the private sector using ICRISAT parental lines

- ICPH 4503: The first white-seeded hybrid for India released by Biogene, Gujarat state, India

- 500 parental lines shared with the private sector.
Develop Seed Industries in Malawi

Inadequate seed production systems and the lack of access to seed by smallholder producers are a bottleneck to the adoption of improved crop varieties. Crop improvement together with seed access can transform the lives of smallholder farmers and help them build a robust seed distribution system.

Interventions

- Helped seed industries develop in Africa for new improved varieties to reach farmers
- Arranged contract farming for seed production
- Imparted long-term training in seed production
- Developed an agro-dealer network
- Made seed available to the Government Farm Input Subsidy Programs (FISP)
- Set up farmer clubs, farmer field schools and farmer marketing groups.

Impacts

- 2.2 million households reached directly
- 4,500 tons or 54% of seed: Contribution to the Farm Input Subsidy Program of the government in 2013
- The 2013 seed infusions into the FISP translate into:
  * USD 5.7 M per annum from seed and grain sales
  * USD 3.3 M worth of consumed legumes and grain in households
  * 10-fold increase (42 tons in 2008 to 400 tons in 2014) in groundnut foundation seed production
  * 8308 tons of improved groundnut and pigeonpea seed sold by the private sector local seed companies through the FISP
  * 1400 kg of sorghum seed: ICRISAT’s contribution to the Malawi government for the 2015-2016 cropping season
  * Benefited neighboring countries Tanzania, Zambia and Mozambique.
Microdosing in Africa

Impoverished soils and low yields are the bane of Africa’s small farmers. Chemical fertilizers are a critical input. The fertilizer microdosing technology using a bottle cap can boost productivity, improve the tolerance of sorghum and pearl millet to drought and temperature stress and make plant nutrient use more efficient to raise yields.

Interventions

- Small doses of fertilizer (ranging from 2 to 6 grams) are placed in the holes at planting
- Small packs of fertilizer are sold in community-managed input stores – linked to agrodealers – installed in villages for easy access to farmers.
- The warrantage or inventory credit strategy: Farmers place part of their harvest in a local storehouse in return for inventory credit to meet pressing postharvest expenses and engage in dry-season, income-generating activities. The stored grain can be sold later in the year at much higher prices for profit.
- This has been implemented in Mali, Burkina Faso, Niger and Zimbabwe.

For more information: http://www.icrisat.org/Timelines/microdosing/

Impacts

- 25,000 smallholders farmers in Mali, Burkina Faso and Niger trained
- Subsidized fertilizer has been authorized for use on millet and sorghum farms in Niger and Mali
- Village-level input stores were created for distribution of government-supplied fertilizer in Niger and Mali
- 39% of the total cropping area covered
- 300,000 farmers practising the technique in Zimbabwe
- 393 farmer’s field days were held (2009-2012); 57,338 participants registered
- 44-120% increase in sorghum and millet yields
- 30% increase in family incomes between 2009 and 2012
- USD 7 M savings in food imports
- Generated a net present value of USD 26 M and an internal rate of return of 36% by 2013
- Policy impact in Mali and Niger
- 133 showcase fields established in Burkina Faso, Mali and Niger
- Fertilizer use rates increased from 7.41 kg/ha to 11.45 kg/ha in the baseline study
- 21- 68% rise in proportion of farmers using mineral fertilizer
- 13 km to 6 km reduction in average distance to an input shop
- 77% farmers used at least one type of mineral fertilizer compared to 48% in a control village.
Watersheds with a Holistic Approach

Rainfed areas are hotspots of poverty, food insecurity and prone to severe land degradation, water insecurity and with poor social and institutional infrastructure. Watershed development programs address these issues through the management of natural resources with multiple benefits.

Interventions

- Integrating on-farm and non-farm activities, soil and water conservation initiatives, diversification, identifying the highest producing crop varieties, training for on-farm management, processing and marketing linkages applied successfully in Telangana (India) Ethiopia, China, Mali and Thailand.

Impacts

Kothapally watershed, Telangana, India

Soil and water:
- Construction of water harvesting structures led to nearly 53,475 m³ of water storage capacity
- 37 recharge wells are functional
- Farmer grow 2-3 crops per year
- 10 women self-help groups took up vermicomposting.

Productivity enhancement:
- Irrigated area increased from 60 ha in 1999 to 200 ha in 2013
- Average crop yield of maize rose by 2.2 to 2.5 times
- Pigeonpea production rose from 200 to 900 kg/ha
- Farmers’ average income rose three-folds
- Net income ranged from USD 376 to USD 1083 per acre.

Crop-livestock integration:
- Improved breed, fodder quality and feed availability increased milk yields from 2-8 litres/day
- Farmers deliver 1300 litres of milk/day
- Artificial insemination: 4-5 more dairy animals per household.
Lucheba watershed, China
- 94% increase in average household land area with irrigation
- 34% reduced rainfed area
- 6-19% increased yield levels of crops (rice and maize)
- 192% increase in farm income from crops, largely vegetables
- 32% increase in household income
- An investment of USD 472,191 led to net present value of USD 14.7 M and 31.14 benefit cost ratio.

For more information: http://goo.gl/FHL9yR

Yewol watershed, Ethiopia
- Terracing minimized erosion: Five years after the terraces were constructed (2011-2015), the irrigated land downstream increased from 200 to 940 hectares because of improved recharge upstream allowing extra water to flow downstream. Moreover, farmers started small scale mountain agriculture upstream.
- Rainwater harvesting structures meant more water, recharging of the groundwater and streams downstream
- Production and productivity rose by about 35% with the introduction of better crop varieties for fodder and food
- Greater groundwater access to communities
- On-farm diversity led to a more sustainable system and better nutrition for the soils and the people
- Less drudgery for women: Water available on farm
- Equipment installed to monitor water flow and siltation.

For more information: http://goo.gl/F5Xd3S; https://goo.gl/vpg02n

Kani watershed, Mali
Fields treated with contour bunding had benefits:
- More recharging capacity of wells
- Slowing down of runoff rate
- Reduced soil erosion and washing away of nutrients
- Water could be accessed at reasonable depth during the dry season.

For more information: http://goo.gl/dVXGGH

Tad Fa watershed, Thailand
Contour cultivation, vegetative bunds and fruit trees grown on steep slopes
- Soil loss reduced
- Seasonal water runoff was reduced to less than half.

For more information: http://goo.gl/jiO59e
## Combating Aflatoxin

According to the FAO, 25% of all crops are affected by aflatoxins. When consumed they can affect the absorption of other nutrients, causing malnutrition. Countries in Africa have lost their export markets due to it. New sources of resistance, novel screening methods and good agricultural practices can cut down contamination.

### Interventions

- An **aflatoxin testing kit** developed in-house uses a competitive enzyme-linked immunosorbent assay (cELISA) to rapidly detect the presence of aflatoxins. It has drastically reduced the cost of testing crops from USD 25 to USD 1 per sample.
- An **aflatoxin testing laboratory in Zambia** is currently operational and provides service to stakeholders.
- **Good agricultural practices (GAPs)** identified to reduce pre- and post-harvest aflatoxin contamination, such as the triple layer plastic bags based on “Purdue Improved Crop Storage” technology.
- **Mapping aflatoxin exposure** and its impact on nutrition and growth of children in Malawi and Tanzania.

### Impacts

- **ELISA testing kit**: Used by The National Smallholder Farmers’ Association of Malawi (NASFAM) successfully, in conjunction with high-performance liquid chromatography (HPLC).
- Malawi regained its groundnut export to Europe. In just one area of Malawi, over 4,000 farmers are exporting groundnuts to Europe under the fair trade agreement.
- Peanut butter processors in Zambia are testing their products. A company has started labelling its product as ‘tested for aflatoxins and safe for consumption’.
- The Zambia Bureau of Standards is establishing national standards for aflatoxin in peanut butter.
- Several resistant sources in groundnut have been identified in Africa and Asia.
- Result demonstrations (2013-15) in farmers’ fields showcasing a set of GAPs versus farmers’ practices showed 62-94% reduction in aflatoxin contamination in groundnut; increase in yield by around 30%, additional net income of around USD 25 per acre.

For more information: [http://www.icrisat.org/aflatoxin-timeline/](http://www.icrisat.org/aflatoxin-timeline/)
ICT/Digital Agriculture

The rural farmer and other actors along the agriculture value chain are handicapped by the lack of information about new technologies. Information and Communication Technologies supporting the development and delivery of timely, targeted information and services can make farming more sustainable. They can also deliver safe, nutritious and affordable food, facilitate market integration and access to finance to make agriculture attractive and profitable.

Interventions

Krishi Gyan Sagar, an ICT-enabled application to provide personalized advisories to smallholder farmers.

Krishi Vani is a voice message based agro-advisory for farmers. Using a special SIM card in their mobile phones, farmers can get up to 35 voice messages per week free in the regional language.

YouTube for the farm: Short videos created by farmers in the local language on topics relevant to neighboring farmers.

Eye in the sky: In West Africa, the Imagery for Smallholders – Activating Business Enterprises and Leveraging Agriculture (ISABELA) initiative promotes the use of imagery by smallholder farmers and intermediaries to make agriculture a profitable undertaking, using satellite imagery, UAV (unmanned aerial vehicle) imagery, ground-based digital sensors, web-2-mobile platforms.

Climate information through mobiles: In Ghana, tailored climate information services are provided to farmers helping in their decision making vis-à-vis climate variability.


Impacts

Krishi Gyan Sagar
- Piloted in 4 districts in Karnataka; 10,000 farmers registered.

Krishi Vani
- Piloted in 171 villages in Telangana and Karnataka
- Subscribers: Karnataka (200), Andhra Pradesh (5500) and Telangana (1800), benefiting 40,000 farmers.

YouTube for the farm
- 48% of video viewing farmers adopted the new technologies.

Eye in the sky
- 300,000 smallholder parcels delineated in two sub-divisions in Mali and Nigeria
- Spectral, temporal and textural libraries developed for over 10 key crops in West African production systems.

Climate information through mobiles
- About 1000 farmers (33% of them women) are accessing and applying forecast information
- Survey showed 97% of farmers willing to pay for access to climate information.
Facilitating Agribusinesses

Small entrepreneurs struggle with lack of access to resources, technologies, expertise and market information. Leveraging and aggregating programs and services to promote agribusinesses and enhancing partnerships through entrepreneurship development, innovation and value addition can open up opportunities for farmers to take their products and technologies to a global market.

Interventions

- Promoting 16 Farmer Producer Organization (FPOs) in Telangana, Andhra Pradesh and Tamil Nadu
- 22 Agri Business Incubators supported through the Indian Council of Agricultural Research (ICAR) in India
- 6 value-chain incubators set up in Kenya, Uganda, Zambia, Ghana and Mali with support from UniBRAIN project of FARA
- Set up Food Processing Business Incubators in Ghana, Mali, Uganda, Cameroon and Angola
- Set up Food Testing Laboratories in Nigeria, Gambia, Republic of Congo, Zimbabwe and Rwanda
- Founding member of the Network of Indian Agri-Business Incubators; Global Agri-Business Incubation Network; and African Agribusiness Incubation Network.
- Scaled up 19 grassroots innovations to prototype/market-ready product/service stage
- Working with women entrepreneur associations in Telangana to promote start-ups.

For more information: [http://www.aipicrisat.org/](http://www.aipicrisat.org/)

Impacts

**In India**

- 74 agribusiness start-ups incubated
- Over 900 jobs created through start-up clients
- > 800,000 farmers benefited by products and value-addition services offered by clients
- Facilitated USD 13.2 M as investment to start-ups
- Facilitated commercialization of 331 agro-technologies for ICAR institutions; 1218 ventures provided incubation support in these institutions.

**In Africa (UniBRAIN project)**

- 294 start-ups supported through FARA-UniBRAIN incubators
- USD 1.3 M mobilized for incubatees
- 58 agro-technologies commercialized
- 21 innovations supported
- 4535 entrepreneurs trained
- 4665 jobs created.
Nutrition Metrics

17 million children suffer from severe acute malnutrition, the greatest single threat to the world’s public health. Village-level surveys that provide data and insights into anthropometric and dietary diversity indicators can play a vital role in improving the nutritional status of women and children.

Interventions

Critical data is imperative for a better understanding of agriculture-nutrition linkages, and to analyze nutritional trends and how agriculture can play a vital role in improving the diet quality of women and children and in reducing micronutrient deficiencies like anemia. Our studies are filling this agriculture-nutrition information gap through improved nutrition metrics and data.

Impacts

- Three universities applying the robust methodologies and metrics for minimum nutrition data for agriculture developed, tested and validated for use in socio-economic surveys
- Awareness creation on agriculture, nutrition, health and sanitation linkages – About 2068 individuals impacted in 8 villages of Andhra Pradesh, Telangana and Maharashtra
- 23 scholars and policymakers used data and metrics (2014-2015).
Tracking **Rural Poverty** in the SAT of India

Small farmers in the semi-arid tropics of India are in the grip of a vicious circle of hunger and poverty. Insights into the social and economic changes in the village and household economies through longitudinal surveys are helping identify and understand constraints and enable decision making to improve their plight.

**Interventions**

Capturing data at the individual, household and village levels, disaggregated by gender, class and social groups through the Village Dynamics in South Asia Project, provides valuable insights into people’s lives, behavior, health, prosperity, needs and aspirations to help design and initiate science-led interventions.

**Impacts**

- Bridged the “data gap” through a longitudinal panel data covering 6 states in India
- 1,162 unique users from 45 countries of Asia, Africa, Europe and North America have downloaded the newly released data (499 students, including 324 PhD students from more than 200 universities/ institutes) as of November 2015
- Longitudinal household panel data from six villages in Maharashtra and Telangana states of India revealed a decline in poverty rate (from 99.6% in 1975/76 to 95.8% in 1983/84) and further from 69.7% in 2005/06 to 13.9% in 2012/13.
We believe all people have a right to nutritious food and a better livelihood.

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 investors 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.

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