IMOD

Inclusive Market-Oriented Development

Demand driven innovation benefiting the poor

ICRISAT IMOD Exemplars - Volume II

ICRISAT
Science with a human face

International Crops Research Institute
for the Semi-Arid Tropics

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Main Photo: Entrepreneurs establish stalls during livestock market days, selling an array of foodstuff that farmers pay for with the income from livestock sales*; Andre F van Rooyen, ICRISAT*.

Picture 1: A woman farmer proudly displays the ICGV 91114 she harvested; *L Vidyasagar, ICRISAT.*

Picture 2: Taste test of sweet sorghum juice at a Trade Exhibition; *Heraldo Layaoen*.

Picture 3: A chickpea farmer in Ethiopia; *Christopher Ochieng Ojiewo*, *ICRISAT*.

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Message from the Director General

ICRISAT's inclusive and market-oriented vision

In the quest to make smallholder farming more profitable and sustainable, markets offer the best possibility of generating more demand driven and sustainable innovations and solutions to the issues surrounding food security and livelihoods. Markets are fast becoming the focus of policy goals like inclusive growth as they determine the welfare of consumers and producers. However, smallholder farmers face serious disadvantages in marketing their produce. They have small marketable surpluses that are costlier to trade in distant urban markets due to higher transport and transaction costs and poor bargaining prowess. As a result, smallholder farmers are often bypassed in the process of transformation of agriculture and agri-produce marketing systems. Hence, traditional solutions to improve productivity and yield alone may not directly result in higher income unless these are appropriately linked to markets.

For smallholder farmers to truly benefit they should be enabled to become part of the agriculture value-chain. They need support mechanisms to help them access value chains and directly benefit from the market. To this extent the Inclusive Market Oriented Development (IMOD) strategy, the cornerstone of ICRISAT's Vision 2020, becomes even more relevant. IMOD's explicit goal is to include the poor in agriculture value chains. This requires major demand driven innovations and new and deeper partnerships with a wide range of partners.

The IMOD pathway has the potential to reduce poverty since markets create demand for a wide diversity of high-value foodstuffs and agro-industrial products. This stimulates small-scale enterprises that raise rural incomes and create opportunities to invest in, and beyond agriculture. Smallholder farm families have to be empowered and assisted along this pathway.

This is the underlying strategy with which we conduct our research for development activities across sub- Saharan Africa and South Asia which is home to 700 million impoverished dryland farmers subsisting on less than a $1 a day.

Along with the critical support of donors, development agencies, research institutions and the private sector, ICRISAT has demonstrated that IMOD is a viable strategy helping smallholder farmers in the drylands move out of the poverty trap.

This second volume of IMOD Exemplars highlights some more of our inclusive and market oriented initiatives across sub-Saharan Africa and Asia. It is a validation of our approach and will continue to guide our work in future.

David Bergvinson
Director General

Message from an ICRISAT partner

A lot has been said about the challenge of feeding 9 billion people by 2050, globally. That nearly a third of those – over 2 billion – will be in sub-Saharan Africa (SSA) - demands that Africa be part of the solution. While the rest of the world has managed to significantly reduce the numbers of poor, the number of people living in extreme poverty in SSA increased (UN MDG Report, 2014). This seemingly bleak picture presents an opportunity for SSA. In a McKinsey study, it is estimated that 600 million hectares of uncultivated arable land – roughly 60% of the global total – is available in SSA.

It is impossible to discuss the possibility of increased agricultural productivity without discussing 'drylands'. Globally, over 325 million people live in the drylands and face a plethora of challenges related to desertification, which is exacerbated by climate change. In Africa, approximately 45% of the population lives in the drylands. The drylands face three major challenges: engaging farmers in these regions to increase productivity and incomes; appropriate farming technology to increase food supply; and creating better infrastructure.

Cognizant that no single organization has the requisite knowledge and resources to solve the challenges of increased agricultural productivity, Africa Harvest and ICRISAT have created a web of diverse partnerships and successfully implemented model projects in Kenya and Tanzania. Based on the Inclusive Market-Oriented Development (IMOD) strategy, the partnerships – that include national agricultural research systems (NARS) and others - have revolutionized the Sorghum Value Chain in Kenya and Tanzania.

Our experience is that the IMOD strategy has immense potential to exploit economies of scale, diversify cropping patters, promote integrated farming systems and actively involve women and youth in enterprise development.

In one of these projects, funded by the International Fund for Agricultural Development (IFAD) and the European Commission (EC), Africa Harvest and ICRISAT worked together to address bottlenecks in the pipeline from research to commercialization. The project - Sorghum for Multiple Uses (SMU) for Food & Sustainable Livelihoods in Eastern Africa – resulted in increased availability of improved sorghum seeds.

The "supply side" challenges were resolved through stronger public/private sector networks that include Africa Harvest, ICRISAT and NARS on one side and seed companies, agro-dealers, grain aggregators, transporters and end-market users on the other hand. The effect of these partnerships was timely supply of seeds to farmers and opening up new markets.

ICRISAT and NARS continue to work at the frontiers of R&D, especially with regard to developing improved varieties of sorghum, millets and other crops that suit diverse ecological zones and market needs. In line with the IMOD strategy that emphasizes "inclusive market", ICRISAT and NARS focus on increasing productivity and availability of food at the household level, reduce input costs for commercial end users, diversify market opportunities, increase household incomes and enhance access to nutritious foods.

Dr Florence Wambugu
Chief Executive Officer – Africa Harvest

Introduction

Volume I of the ICRISAT IMOD Exemplars illustrated different situations where smallholder farmers were liberated from a vicious cycle of subsistence, food insecurity and poverty through demand driven innovations. Access to markets and commercialization of the farm and non-farm economy can appreciably reduce poverty. However, due to lack of market access and limited infrastructure, government policy reforms and research breakthroughs have been ineffective in stimulating commercialization of smallholder agriculture and the rural non-farm economy. Imperfections in agriculture commodity markets continue to undermine smallholder market participation. Thus, underdeveloped output markets diminish the farmer's incentive to invest in improved agricultural technologies. For markets to serve smallholder farmers and the rural poor effectively, it is critical to define and develop innovations and strategies that promote market coordination and reduce transaction costs. Addressing this long-standing development challenge requires a consolidated global effort to develop innovative mechanisms that make markets and institutions work for the poor.

It is imperative to identify how best to engage the rural poor in markets and in producer organizations to increase productivity and incomes. This requires (1) an aggressive Inclusive Market-Oriented Development (IMOD) strategy; and (2) a broader approach to identify bottlenecks at different stages and reduce market failures. This calls for contrasting options and approaches to innovations markets and institutional arrangements at different levels, spanning micro, meso, macro and international dimensions.

The case studies in Volume II of ICRISAT IMOD Exemplars demonstrate the research for development innovations at ICRISAT. The innovations stimulate institutions and markets that are more inclusive and pro-poor. Kindling these changes through improved institutions and market linkages is a multi-dimensional global challenge.

Eleven exemplars are featured – six from sub-Saharan Africa and five from South Asia. They illustrate the stimulation of market-oriented development through: a) understanding the factors that ignite market-oriented agricultural and rural transformation; (b) adapting best practices in engaging small farmers and the rural poor in markets and profitable value chains; (c) rigorously evaluating pro-poor innovations in market institutions to motivate and accelerate participation in remunerative high-value marketing channels; (d) developing knowledge support systems for evidence-based decision-making to unlock the potential of markets for the poor; and (e) establishing research-to-policy platforms to facilitate pro-poor transformation. These exemplars cover various innovations like the cluster-based approach in enhancing inclusive value chains, technology transfer through business incubators, innovation platform processes, market driven breeding initiatives for dryland cereals and grain legumes, integrated seed systems, and scaling up through market or demand driven innovations. The ICRISAT IMOD exemplars gathered in this volume show the effective application of cutting-edge science to generate knowledge on socio-economic mobility, innovation, and agricultural transformation in different geographical, political, and socio-cultural settings. This highlights strategies for enabling markets and institutions to work for the poor, thereby stimulating agricultural transformation and upward socio-economic mobility in rural areas.

I express my sincere thanks to all ICRISAT scientists in West and Central Africa, Eastern and Southern Africa and South Asia, and their partners, who have contributed to the publication of this Volume of ICRISAT's IMOD exemplars and colleagues in Markets, Institutions and Policies Program and the Strategic Marketing and Communications team for their invaluable support and technical advice.

Cynthia Bantilan

Research Program Director - Markets, Institutions and Policies

IMOD in ICRISAT – Vision in Practice

Without doubt, ICRISAT's Inclusive Market-Oriented Development (IMOD) framework is gathering traction. As we know, IMOD is an evolutionary market driven cum science led approach wherein small farm holders from the semi-arid tropics in Asia and sub-Saharan Africa are enabled to increase productivity through bridging the existing large yield gaps and generating marketable surpluses. It is at this stage that inclusive and innovative market oriented interventions are needed to ensure that farmers get a fair price for their marketable surplus to enhance their incomes and to re-invest or diversify. The IMOD approach can be described as a process of movement along a development pathway – from an impoverished subsistence farming, to a prosperous market-oriented farming.

In 2014, ICRISAT appointed a panel of Development and Agriculture experts from Asia, Africa and the USA to undertake a Center Commissioned External Review to evaluate the IMOD Implementation in ICRISAT. The panel of experts have unequivocally endorsed the vision of IMOD and its activities and has further recommended measures to strengthen and enhance it further. These have been developed into region and country specific work plans for ICRISAT and its stakeholders. The document on "Implementing IMOD and the Frequently Asked Questions (FAQ) on IMOD", details on how to map and measure IMOD.

ICRISAT has developed and continues to develop, enrolling partnerships with additional agencies such as government outreach departments, NGOs , development agencies and the private sector to achieve its R4D objectives. This "Common Shared Vision" (CSV) approach calls for large scaling-up models as economies of scale as collective and coordinated actions are integral parts of the IMOD strategy.

To integrate and mainstream the IMOD approach within ICRSIAT and its partners and extended stakeholders, on a regular basis, numerous workshops and capacity building programs covering "Markets, value chains, inclusiveness, empowering gender, agri-business, value addition, farmer organizations and seed systems " are being conducted and supported with a lot of strategic communications on IMOD linked material. New and emerging models including those involving the innovative use of ICT technologies and small farmer "last mile" reach are also conducted. Specific IMOD activities are brainstormed and formulated along with partners, and integrated into work plans during global, regional and annual planning meetings, research program workshops and how they link to the ICRISAT mission goals and development outcomes.

The Director General and key and senior ICRISAT scientists are brand ambassadors of IMOD and have played a key role in forging new partnerships with multi-sectorial organizations involved in the agriculture value chain.

With the publication of IMOD Exemplars – Volume II of "Market driven innovation benefitting the poor", ICRISAT is sharing and demonstrating once again, cases of how such inclusive and market oriented approaches can sustainably transform the lives of small and disadvantaged farmers across Eastern and Southern Africa, West and Central Africa and Asia, and highlight the role of partnerships. By making IMOD core to its Strategic Vision 2020, ICRISAT is continuously demonstrating how science and markets can converge in a "win–win" manner to create economic wealth for the small scale famers and quality produce for the consumers.

Special thanks to the contributing Focal Scientists and the coordination efforts of the Technology Uptake and IMOD Specialists, Hemant Nitturkar in Mali and Dyutiman Choudhary in Kenya.

M Srinivas Rao
Specialist, Markets, Research and Innovation and
Coordinator- CCER on IMOD Implementation, and
P Parthasarathy Rao
Asst. Research Program Director,
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Acronyms

ABI	Agri-Business Incubator
AF	Accion Fraterna
AISAM	Agri-Inputs Suppliers Association of Malawi
AMEDD	Association Malienne d'Eveil au Development Durable
ANGRAU	Acharya NG Ranga Agricultural University
ASE	Amhara Seed Enterprises
B2B	Business-to-business
BAGRI	Banque Agricole Du Niger
BPD	Business Planning and Development
CBO	Community-based Organization
CBT	Contour bunding technology
CDARMA	Centre de Développement de l'Artisanat Rural et du Machinisme Agricole
CEO	Chief Executive Officer
CMDT	Compagnie Malienne de Development des Textiles
COO	Chief Operating Officer
CPWF	Challenge Program for Water and Food
CRP	CGIAR Research Program
CRS	Catholic Relief Services
DA-BAR	Department of Agriculture-Bureau of Agriculture Research
DANIDA	Danish International Development Agency
DARS	Department of Agricultural Research Services
DoA	Department of Agriculture
DOST-PCARRD	Department of Science and Technology – Philippine Council for Agriculture Resources, Research and Development
EIAR	Ethiopian Institute of Agricultural Research
ESA	East and Southern Africa
ESE	Ethiopian Seed Enterprise
EU	European Union
FAO	Food and Agriculture Organization
FARA	Forum for Agricultural Research in Africa
FF	Farmer facilitator
FISP	Farm Inputs Subsidy Program
FPVS	Farmer participatory variety selection
FPBIC	Food processing business incubators
GCP	Generation Challenge Program
GDP	Gross Domestic Product
IAFS	India Africa Forum Summit
ICARDA	International Center for Agricultural Research in the Dry Areas
ICAR	Indian Council of Agricultural Research
ICM	Integrated crop management
ICT	Information and Communication Technology
IDC	ICRISAT Development Center
IDM	Integrated disease management Development
IFAD	International Fund for Agricultural Development
IFDC	International Fertilizer Development Center
ILRI	International Livestock Research Institute
IMOD	Inclusive Market-Oriented Development
INM	Integrated nutrient management
INP	Innovations and Partnership

Acronyms

INRAN	Institut National de la Recherche Agronomique du Niger
IP	Innovation Platform
IPM	Integrated pest management
ISOPOM	Integrated Scheme of Oilseeds, Pulses, Oilpalm and Maize
KVK	Krishi Vignan Kendra (farmer knowledge center)
LAAS	Liaoning Academy of Agricultural Sciences
MASA	Malawi Seed Alliance
MAU	Marathwada Agricultural University
MMSU	Mariano Marcos State University
MoFPI	Ministry of Food Processing Industries
MPKV	Mahatma Phule Krishi Vidyapeeth
MSP	Minimum Support Price
MSIDP	Malawi Seed Industry Development Project
NAIP	National Agricultural Innovation Project
NARES	National Agricultural Research and Extension Systems
NARS	National Agricultural Research Systems
NASFAM	National Smallholder Farmers Association of Malawi
NGO	Non-Governmental Organization
NSTEDB	National Science and Technology Development Board
OSE	Oromia Seed Enterprises
PAC	Pampanga Agricultural College
PEA	Project Executing Agency
PIPHR	Presidential Initiative on Poverty and Hunger Reduction
PVS	Participatory Variety Selection
QDS	Quality Declared Seed
RDT	Rural Development Trust
RSK	Raitha Samparka Kendra (farmer's interaction center)
RUMARK	Rural Market Initiative
SCBI	San Carlos Bioenergy Inc.
SHG	Self-help group
SRI	Sorghum Research Institute
SSA	Sub-Saharan Africa
SSR	Single Sequence Repeat
SSU	Seed Services Unit
STAM	Seed Trade Association of Malawi
SWC	Soil and water conservation
SWOT	An approach analyzing strengths, weaknesses, opportunities and threats
TCL	Tata Chemicals Ltd.
TL II	Tropical Legumes 2
TNAU	Tamil Nadu Agricultural University
UniBRAIN	Universities, business and research in agricultural innovation
UPLB	University of the Philippines Los Baños
USAID	United States Agency for International Development
VS	Variety Selection
WAARI	West African Agri-Business Resource Incubator
ZFC	Zimbabwe Fertilizer Company
ZTE	ZTE Energy Development company Ltd.

General Country Information

16.36 million
Population

9,428,000 ha
Total land area (2007)

5,586,000
Cultivated land (2007)

60.4%
Arable land

34.7%
Agriculture GDP on total GDP

$3.705 billion
GDP

Major crops grown: Cassava, maize, potato, sugarcane

Agricultural population: 10,990,000

Rural population: 84%

Issues related to poverty:

Prominence of rain-fed agricultural production systems; climatic shocks with its potentially severe implications for household welfare; animal and plant diseases lead to major crop and livestock losses; price volatility of maize, tobacco and fertilizers is a major source of vulnerability to households; Health shocks mostly due to HIV/AIDS, malaria, tuberculosis, and anemia are pervasive in Malawi.

Michinji population – 458,556 (2008)

Michinji rainfal (avg) – 1099 mm

Poverty (% population) – 55.5

Ultra poor (% population) – 31.9

Land area – 3356 sq km

Source: National Statistical Office, Statistical year Book, Government of Malawi, 2012; FAO stat website (Malawi); World Bank poverty database

Young women of Karonga, Northern Malawi preparing green pigeonpea for a meal.

The human face at the center of all

Integrated Seed Systems Development in Malawi

Contributed by

Moses Siambi, Director-ESA, ICRISAT, Nairobi, Kenya

Grain legumes are protein rich foods that balance cereal-based diets and are the least resource demanding option to improve the nutrition of poor people. In Malawi, smallholder farmers generally consume and sell grain legumes, benefiting from food and income gains. Grain legumes also contribute enormously to sustainable intensification and raising of food production in smallholder farming systems.

However, though the production of legume crops supports the livelihoods of many resource poor farmers, the seed systems and seed provision are underdeveloped due to various constraints ranging from poor seed/crop management practices to lack of proper institutional

mechanisms for the delivery of quality seeds. In Malawi, over the last decade, both national and international agricultural research centers have developed and tested several improved legume varieties that are adapted to the range of agro-ecological zones to be found across the country. However, adoption of these cultivars cover about 52% of land area and about 423,000 farmers' resulting in low productivity and poor cash incomes. For example, ICRISAT studies revealed that the proportion of area under improved groundnut was estimated at less than 40%, and that under pigeonpea varieties was estimated at less than 10%. One of the major reasons attributed to the poor adoption of improved varieties is the absence of appropriate seed delivery mechanisms, with the result that farmers rely heavily on traditional cultivars. The problem is compounded by poor access to, and information on, improved cultivars by farm households.

The Solution

In order to design appropriate models of seed production and delivery, it is necessary to understand farmers' preferences towards the adoption of improved varieties as well as the demand for quality seed. Farmers' demand towards improved seed varieties is often influenced by **the market demand of crops** and their purchasing ability. Several of the above issues could be tackled by designing innovative partnerships and models of input delivery systems through proper seed demand assessment for quality planting material. Sound institutional policies related to seed systems at the national level would tremendously improve the accessibility of quality seeds and technology. It is generally assumed that when farmers are provided increased access to 'quality/improved' inputs such as seeds, adoption will improve due to a reduction in the purchase risk of buyers.

Dr Geoffery Kanaji, Legumes Research Coordinator, DARS, MoA Kenya flanked by ICRISAT scientists in a pigeonpea field in Karonga, Northern Malawi.

Photo: Felix Sichali, ICRISAT

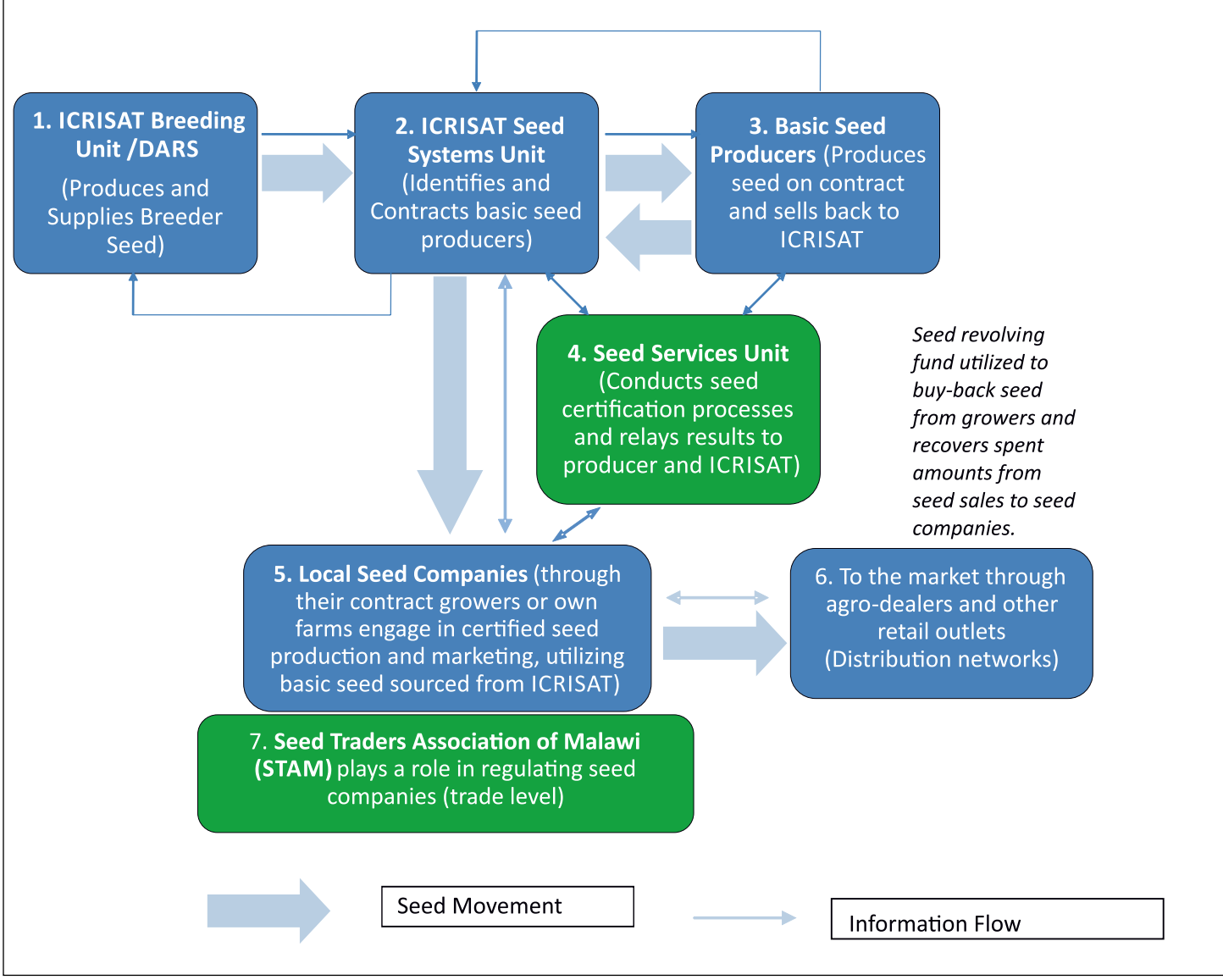


Figure I. Building an integrated, farmer-benefiting seed system (Model for Malawi Seed Industry Development Project).

In 2008, ICRISAT embarked on an ambitious five-year Malawi Seed Industry Development Project (MSIDP) funded by Irish Aid, aimed at improving the legume seed system in Malawi. The goal was to increase smallholder farmer yields and incomes by providing reliable and affordable high-quality seed of improved varieties, which are market driven. This was linked to the policy of the Government of Malawi to provide quality inputs to farmers (that had included some of ICRISAT mandate crops).

ICRISAT worked closely with partners to establish seed production through farmers groups, (engaging local seed companies and smallholder farmer groups for processing and packaging), and to facilitate distribution of improved seeds through agro-dealers and retailers. It established a seed services unit to ensure quality assurance. Together with the partners it facilitated the establishment of the Seed Trade Association of Malawi (STAM).

Figure I explains the functioning of the intervention model.

The functioning of the integrated model is explained below:

- Box 1,2 - ICRISAT Breeding Unit / Department of Agricultural Research Services (DARS) produce breeder seed and supplies to Seed Systems Unit for further multiplication into basic seed. Communication between breeding and the Seed Systems Unit takes place in both a formal and informal manner. The breeding team gets feedback from partners such as the MSIDP, but also interacts with farmers on the ground. Then the process to develop the required variety starts. Once the screening and selection stages are completed, on-station and on-farm trials are conducted jointly with scientists from National Agriculture Research Services. On-farm trials are more important as they involve farmers themselves as the process

An all women's group of groundnut seed producers in Phalula, southern Malawi proudly pose for a picture in one of their member's fields.

of Participatory Variety Selection is effected. Here farmers will actually select varieties they consider as suitable for their respective agri-ecological zone. While the Breeding Unit informs the Seed Systems Unit about the varietal traits and agri-ecological zone suitability (among others), the Seed Systems Unit (through contract growers) embarks on basic seed multiplication from breeder seed and provides feedback to the Breeding Unit on any complaints/comments arising from basic seed producers. The Unit also gives feedback to the Breeding Unit on seed inspection and certification outcomes as reported by the Seed Services Unit. A feedback form is, in this case, used as a formal communications tool between Breeding and Seed Systems Units.

- Box 2,3 - Seed Systems Unit through a relevant project (in this case, MSIDP) engages growers on contract arrangement to produce basic seed, which is bought back by ICRISAT using funds from the Seed Revolving Fund. An average of about 1,000 seed producers per year have been engaged directly by ICRISAT within the Seed Systems Unit in box 2,3 with approximately 49% being female producers. Local seed companies (box 5) also engage their own seed producers. The Seed Revolving Fund is treated as a business account and demands that all decisions made, including pricing, are business focused. This is done to ensure the sustainability of the fund.
- The Seed Services Unit (SSU) is the legal seed regulatory organ of the Malawi Government under the Ministry of Agriculture. It carries out

land verification prior to seed planting by seed producers, seed inspection, quality testing and issuance of certificates to seed producers whose seed meets the set quality standards. Based on the 2013 Seed Services report to MSIDP, about 8,000 tons of legume seed were tested (groundnut, pigeonpea, soybeans, cowpeas, chickpea and beans). On an average, it takes between 10-20 days maximum to test the material. The SSU also communicates in writing to producers whose seed has failed to reach the pass mark. Seed producers are also free to launch complaints with the SSU on any seed issue, hence providing for a two way communication.

- Local Seed Companies (includes individuals) involved in certified seed production and marketing purchase basic seed from ICRISAT (in box 2), which had been produced by ICRISAT and contracted growers (in box 3). They (seed companies) produce certified seed either from their own farms or identify growers to produce seed under contract arrangements. Ten registered local seed companies, nine smallholder farmer groups and three large-scale producers were engaged in foundation and certified seed production and marketing. As in box 4, the SSU assumes the quality assurance role in the whole process and a two way communication is also enhanced. Besides communication with the SSU, seed companies also communicate with ICRISAT on their seed demand, feedback on seed performance and any pertinent areas relating to their seed business –with ICRISAT responding/providing required information accordingly.
- Certified seed from companies is then packaged in their own branded and unitized packets and routed to the market (which includes smallholder farmers) mainly through agro-dealers and other retail outlets. There is also two way communication between seed companies and agro-dealers on areas relating to seed production and marketing – and any feedback from grain producing farmers.
- The Seed Trade Association of Malawi (STAM) is a member based Association and regulates seed companies at trade level. ICRISAT is a key member of STAM.

Involving both the public and private sector,

Ms Witness Ngwira (right) listening to Malawi Government Extention Officer Mr Bellings Mwalungira in her pigeonpea seed production field under ICRISAT at Hara in Karonga, Malawi.

MSIDP project trained basic seed growers, local seed companies and agro-dealer representatives in aspects of seed production and marketing. It offered technical backstopping in relevant areas of research to the partners, supported the SSU in building its capacity to operate efficiently as a seed regulatory body and supported STAM to launch awareness campaigns on importance of farmers' use of certified seed. While MSIDP focuses more on developmental areas, the Seed Revolving Fund (SRF) takes over basic transactions – seed that is produced by the project's trained farmers is sold back to ICRISAT using SRF funds. The current assets are worth about MK 200 million. Basic seed bought back from contracted farmers is then sold to seed companies for their own certified seed production. Any profits made from such transactions are ploughed back into the fund to provide for its growth.

The Success

ICRISAT's agricultural research activities place the "Human Face" at the center of all decision making processes. With this intervention, ICRISAT developed legume crop varieties that could, among other traits, tolerate drought and mature within reasonably short periods. This was supported by research on agronomic technologies that are relevant and customized to the farmers across Malawi.

Between 2008-2013, amounts of 1017 tons of groundnut foundation seed and 207 tons of pigeonpea foundation seeds were produced. In addition, 5,710 tons of groundnut and 335 tons of pigeonpea certified seeds, 362 tons of rice and 17 tons of bean seeds were also produced. The project also contributed to the Government of Malawi's national programs:

- Farm Inputs Subsidy Program (FISP) is a Government funded program aimed at assisting vulnerable smallholder farmers to access farm inputs. Involved inputs are fertilizer, maize and legume seeds. 1.5 million households are each year identified to benefit from the subsidy program. About 4,500 metric tons legume (groundnut and pigeonpea) or 54% of the two crop species' national volume were sold to benefit about 2.2 million smallholder farmers in about 60,000 hectares of land during the five year period.
- Sold 781 tons of groundnut certified seed and 50 tons of rice certified to the Presidential Initiative on Poverty and Hunger Reduction (PIPHR).

These seeds were sold by partners through members of the Malawi Seed Alliance (MASA), facilitated by ICRISAT. The formation of MASA was facilitated by ICRISAT through the Malawi Seed Industry Development Project with an aim of building the local and upcoming seed producers and marketers into vibrant seed business entities geared to support rural smallholder farmers by supplying high quality certified seed. A 200-ton capacity warehouse was constructed with support from Irish Aid on the ICRISAT premises, contributing to maintenance of high seed quality through proper storage.

The computerized seed information management system developed for the Malawi Government's Seed Services Unit (SSU) was upgraded with new modules on seed inspection, sampling, testing and issuance of certificates, enhancing the quality of information available to MASA members and the seed industry.

Genotyping to identify varieties and maintain genetic purity was done.

- Groundnut: 6 released and 13 local varieties were screened with 21 SSR markers from the Generation Challenge Program (GCP) (http://gcpcr.grinfo.net/)
- Pigeonpea: 4 released and 70 genebank accessions with 48 SSR markers, while 20 from the GCP and 28 others were reported in recent publications.
  - The interventions increased groundnut and pigeonpea foundation seed production from 70 metric tons in 2009 to 418 metric tons in 2013. Certified seed production (total of groundnut, pigeonpea, rice, and beans) increased from 270 metric tons in 2009 to 2,405 metric tons in 2013.
- While smallholder farmers in different parts of the country were deeply rooted in the production of their traditional crops, with some farmers only

Women at work at the NASFAM Mchinji warehouse.

growing one or two crop species in a season, the intervention helped farmers to spread their agricultural risks and hedge against any unforeseeable and adverse climatic conditions from crop diversification. The interventions have covered 128,000 hectares of land, about 33% of cropped area under groundnut and pigeonpea in Malawi. Smallholder farmer yields increased from 300 kg to 800 kg/ha by planting improved groundnut varieties, and from 400 kg to 1,000 kg/ha by planting improved pigeonpea varieties., instead of the local groundnut and pigeonpea varieties. End of project evaluation in 2013 revealed that the incomes generated from the increased production were spent on:

- Purchase of assets, including livestock, and construction of better houses.
- Childrens' education.
- Further investment in agriculture by purchasing farm inputs.
- Livestock, diversifying production and embarking on other viable income generating activities utilizing proceeds from seed sales.
- Strengthening the capacity of the Malawi Government's seed certification arm – the Seed Services Unit - through migration from manual to a digitized system and laboratory seed testing improvement through procurement and installation of testing equipment – all aimed at improving seed quality assurance and better service delivery.
- Reaching out to about 70 percent of the rural population (particularly the 3 million farming households) through STAM awareness campaign messages, on the importance of using certified seed of improved varieties utilizing Zodiak and MBC radios (according to STAM, Zodiak claims 76 percent listenership, while the MBC claim is higher).
- Reinforcing farmer/brand loyalty particularly through the introduction on the market of a MASA brand, which is a beacon of quality seed, but also increased demand from local seed producers and markers to become MASA members.

Members of Kanyankhunde groundnut seed producing group in Mzimba, Northern Malawi in their field.

How this was Market-Driven

The project was entirely market-driven, focusing on seed as the first step of intervention in improving the whole agricultural value chain. Public-private sector partnerships were also a critical component of the initiative .

In order to scale up the production of improved pigeonpea varieties, ICRISAT took to the field by identifying and engaging more smallholder farmers to multiply certified pigeonpea seed. With more certified seed of improved varieties on the market, commercial production of the crop would, in subsequent years, be increased to cater to domestic, regional and international markets. The ICRISAT-developed seed brand – MASA – packaged high quality certified groundnut and pigeonpea seed for the market. ICRISAT organized distribution of 7,672 metric tons of improved legume and cereal seeds. Local seed companies are using MASA to market certified seeds of legumes, benefitting both Government programs as well as customers.

Overall, ICRISAT stressed on four important market linked strategies for adoption and seed sector development including (1) Understanding farmers' needs by ecological zone in view of market requirements, (2) Producing high quality legume seed to meet the unveiled farmer needs, (3) Making the produced seed available to the farmer in the right and attractive form and placing it in conveniently located sales outlets for easy access, and (4) pricing the certified legume seed at competitive prices. These were the key strategies that make the interventions market-oriented. Figure 2, shows the contribution of MASA to the Farm Inputs Subsidy Programme (FISP) of the Government of Malawi.

Incorporating Inclusiveness

The ICRISAT intervention addressed the biggest constraint of smallholder farmers, which was limited access to improved high yielding and fast maturing varieties. ICRISAT's intervention was innovative by engaging smallholder farmer groups, with 49 percent women members, to produce seed through contract arrangements. These groups of farmers have produced wonders as evidenced by the high quality certified seeds that are flowing

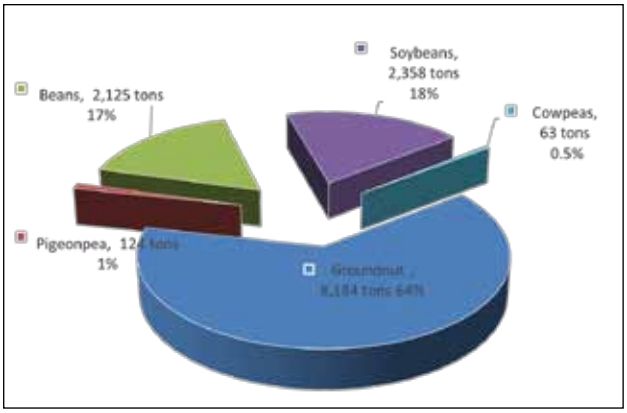


Figure 2: Contribution of MASA to FISP.

into the seed value chain. Many farmers started growing pigeonpea due to availability of improved seeds, replacing crops such as tobacco. Access to seeds was important as it improved smallholder farmers' nutrition and enhanced their incomes. Such was the promise of improved groundnut and pigeonpea in the area, that farmers united to act collectively and monitored the quality of the seed production management activities in each other's fields. Engaging the farmers in seed production and establishing the seed revolving fund removed the barrier of the private sector's reluctance to engage in the production of self-pollinated legume crops. This led to a win-win situation for the farmers and seed companies.

MSIDP partnered with organizations that have particular roles within the legumes (groundnut and pigeonpea) value chain (please refer to Figure 1). Through this partnership, legume foundation and certified seeds of a diversified range of varieties suitable for different agro-ecological zones were multiplied. More than 16 training programs on various topics of seed sector development were organized by ICRISAT with women's participation ranging from 20-50 percent aiming to equip stakeholders with knowledge and skills essential for the efficient and effective management of their respective seed businesses. Upcoming local seed companies, agro-dealer umbrella organizations, Ministry of Agriculture and Food Security, contract growers and smallholder farmer groups were represented at the trainings. The information barrier that often restricts smallholder farmers from benefitting from new interventions, was thus

A truck loading groundnut foundation seed from an ICRISAT dispatching warehouse at Chitedze Research Station in Lilongwe, Malawi. Seed destined for AFRISEEDS,a local seed company partner.

Photo: Felix Sichali, ICRISAT

removed. This facilitated access of smallholder farmers to the right seed varieties suitable for their respective areas, and which improved their yields. Farmers involved in the seed business in the project acquired real assets and children have been sent to better schools (Please refer to the Success Story). These attributes made the interventions inclusive and focused on uplifting livelihoods of smallholder farmers as well as competitive seed systems in Malawi.

Lessons Learned

Lessons from implementing the integrated seed sector development interventions in Malawi are:

- The seed system model developed under the project shows that production of high quality seed by local seed companies – including smallholder farmer groups – contributes significantly in meeting national seed demand when supported by training and appropriate infrastructure and incentives.
- To operate at appropriate scale, the government must provide buy-in and provide institutional support to ensure the growth of legume-based seed companies.
- Public-private partnerships are critical to the development of a stable and sustainable seed system that caters to the needs of smallholder farmers and should be market driven.

This is in essence the Inclusive Market-Oriented Approach of ICRISAT. The Success Story is about a small-scale farmer and how IMOD can lead to prosperity and food security in the drylands.

The Way Forward

The interventions initiated by MSIDP are ongoing as they were designed to respond to an attractive policy by the Government of Malawi to increase yields and boost food security of smallholder farmers by improving their access to inputs. The project has strengthened the entire seed value chain functions and actors are involved in building a competitive seed system in Malawi. The seed production to marketing system that was institutionalized with proper monitoring, communication and feedback channels leads to improved coordination among actors and generates competitiveness in the sector. A capable and equipped SSU was ensured to enhance appropriate governance of the seed sector interventions. STAM further catalyzes the voice of the seed industry to liaise with the Government for policy and institutional support. The formation of the Malawi Seed Alliance was meant to ensure that the successes of the MSIDP should not remain in project form but translate into a sustainably organized system beyond the project span. As the MSIDP enters the second phase of another five years of its operations, the focus will be to strongly build the strength of Malawi Seed Alliance through a well calculated exit strategy. As the process of building the capacity of Malawi Seed Alliance, which will later take over from the project, will run through a period of five years, MSIDP will also collaborate with other research and development partners to not just up-scale, but also to replicate this successful seed model to other crop species. The Project will also facilitate the development of innovative models for grain marketing targeting the trade and consumer markets. Clearly the grain legumes seeds sub-sector in Malawi has received a tremendous boost from the intervention that is ongoing.

Specific Information

Name of the project:- Malawi Seed Industry Development Project (MSIDP), Irish Aid

Project duration: June 2008 to June 2013

Key scientist(s) involved: Moses Siambi

Key partners: Seed Services Unit of the Ministry of Agriculture and Food Security, Seed Trade Association of Malawi (STAM), Agri-Inputs Suppliers Association of Malawi (AISAM), Rural Market Initiative (RUMARK), National Smallholder Farmers Association of Malawi (NASFAM).

This work was undertaken as part of the CGIAR RESEARCH PROGRAM ON Grain Legumes

Success Story: A single mother of three transforms her home and her life

By Felix Sichali, ICRISAT Malawi

Ms Mary Kumwenda is a mother of three children, two of whom are her biological children aged 5 years and 9 years, and a third child, aged 13, is a daughter of Mary's sister who passed on a few years ago. The husband of Mary's sister also died, hence Mary's decision to bring the child into her family.

Mary has been a member of Madede seed multiplication club in Mzimba District of Malawi for three years. She joined the club in 2012 and was issued with 20 kg of groundnut seed for further seed multiplication under the Malawi Seed Industry Development Project, a project funded by Irish Aid and implemented by ICRISAT. After harvest, she sold the basic seed back to the project and realized MK 78,000.

"Before I joined the groundnut seed multiplication club, my only source of income was through piece works in other smallholder farmers' fields," said Mary. "Life was very tough for me then, but I saw the signs of hope after coming into contact with the Madede club leadership that was engaged in the seed multiplication program."

Having realized MK 78,000 during her first year in the club, the mother of three decided to increase the area under seed multiplication, and in 2013 she was allocated 40 kg as seed input. The year turned in her favour with very reliable rainfall received. This led Mary to sell her seed harvest and realize MK 321,000. Mary saw beyond what most young mothers of her age could see – a sense of entrepreneurship.

"I reinvested the proceeds from my seed sales into other small businesses, which included making fritters and selling them within my village. I also used the money to buy fertilizer for my maize field," she said. "This gave me additional income and also kept my family food secure throughout the year." Besides, Mary also used the maize harvest, which had been boosted up from proceeds of the groundnut seed sales, to hire labor to work in her groundnut seed field. This is how innovative Mary is – investing and reinvesting, with groundnut seed multiplication remaining the main source of income.

Bursting with ambitious plans, Mary decided to fulfill her dream by building a new house, well cemented and with an iron sheet roof. She plans to occupy it by the end of 2014, after fitting window panes, which she expects to buy using seed sale proceeds from the year's crop. Pointing at her old and new houses, Mary proudly says, "Before I say goodbye to 2014, my children and I will have moved from that small grass thatched house to that beautifully constructed house, which is plastered and floored with cement and roofed with iron sheets."

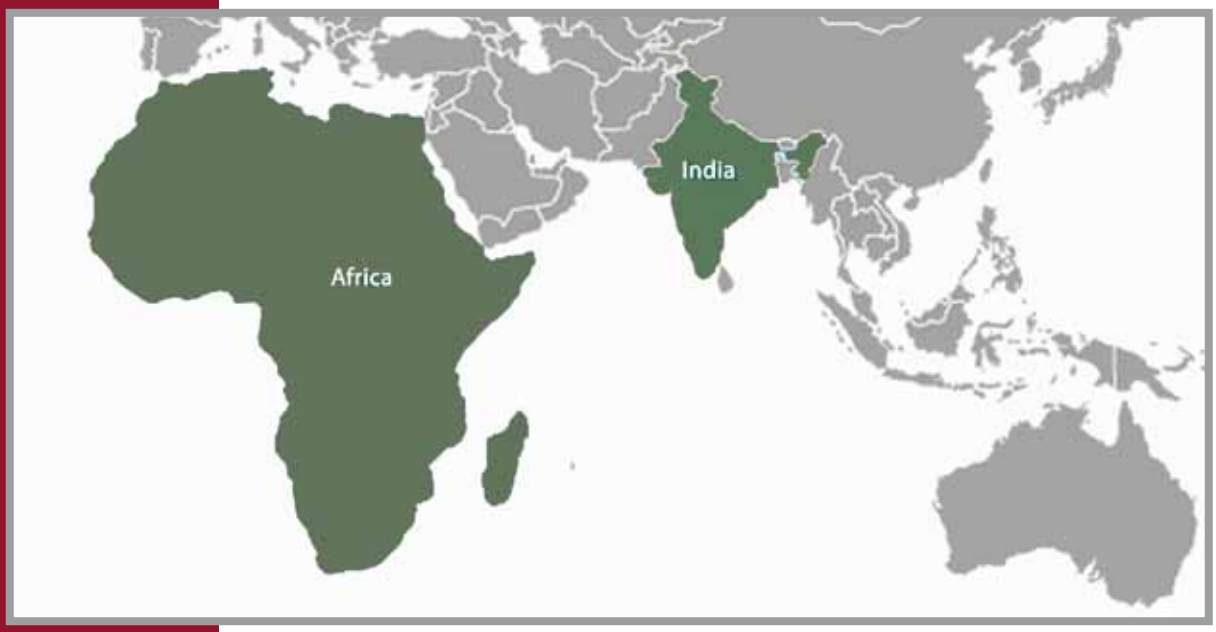
Ms Mary Kumwenda is a role model for other young women in the surrounding villages. Born in 1973 and dropping out of secondary school when she was in Form 2 due to early pregnancy, she has never given up in life. After the death of her first husband who was the father of her first child, she decided to move on and married another husband. "This second husband was very abusive and I gathered courage and decided to divorce him." said Mary.

Mary now lives peacefully as the head of her family. All her three children attend school. Indeed an inspiring transformation from a casual laborer in a fellow farmer's field to an independent owner of a good house and a female head of her happy family – thanks to the MSIDP.

Mary Kumwenda outside her small grass thatched house (left) and the newly constructed house (right).

Photo: Felix Sichali, ICRISAT

General Country Information



3,287,000 km²
India (Area)

1,124 million
India (Population in 2011)

$7,256,571 billion
India (GDP, 2011)

30,221,532 km²
Africa (Area)

1.1 billion
Africa (Population, 2011)

30.51 persons per km²
Africa
(Population density, 2011)

INDIA

- Per Capita Income (current) Rupees ($) per annum: 61,185 (1,340)
- Density of Population: 342 per km²

AFRICA

Country	Population (in thousands)	Per Capita GDP (Euro dollars)	Agricultural and Food Production Index (2004-2006=100)	Human Poverty Index (HPI-1) Value (%)	Human Development Index (New 2014 Estimates for 2013)
Angola	20,163	5,777	187.58	37.2	0.526
Cameroon	20,469	1,290	144.57	30.8	0.504
Ethiopia	86,539	461	135.96	50.9	0.435
Gambia	1,825	511	85.91	40.9	0.441
Ghana	10,481	1,467	128.61	28.1	0.573
Kenya	42,749	952	121.73	29.5	0.535
Malawi	15,883	291	162.03	90.5	0.414
Mali	16,319	659	142.59	54.5	0.407
Niger	16,644	400	137.56	55.8	0.337
Nigeria	166,629	1,727	101.85	36.2	0.504
Republic of Congo	69,575	261	114.41	24.3	0.564
Rwanda	11,272	599	156	32.9	0.506
Uganda	35,621	665	115.35	28.8	0.484
Zambia	13,884	2,003	138.23	35.5	0.561
Zimbabwe	13,014	659	105.04	34.0	0.492

Source: Department of Economics & Statistics – Statistics of India (Data: 2011-12)
Ten Facts about Africa - African Development Indicators 2011
African Statistical Yearbook 2013

Photo: ICRISAT

ABI Program wins Best National Incubator Award of DST for the year 2005.

Incubating confidence

IMOD at play: Scaling up technology transfer through business incubators

Contributed by:

Kiran K Sharma, Chief Executive Officer, Agribusiness and Innovation Platform, ICRISAT, India

The Indian National Agricultural Research System (NARS) is considered as one of the largest publicly funded research systems in the world. However, gaps in its extension machinery have held back many of its research developments from realizing their full potential and reaching its intended target group - the *farmers*. This has also led to technology fatigue in the system and is detrimental to the agriculture sector on which more than 60 percent of the population depends for its livelihood.

The Solution

To address these gaps, it is imperative that technology transfer goes beyond mere transfer

Dignitaries interact with a lady entrepreneur, also an incubatee of AgBIT business Incubator, during the launch of the agribusiness incubator at AgBIT, Zambia.

of knowledge to helping farmers use the technology and derive livelihood-enhancing results. For this, new technologies developed by researchers needs to be scaled up and customized to ground conditions so that farmers can gainfully apply and benefit from such technologies. Further, with the increasing value-chain orientation in agriculture, agricultural research institutions need to develop mechanisms that allow them to connect with a diverse set of stakeholders for inclusive growth. At the same time, grassroots-level innovations also need to be nurtured and mainstreamed, and feedback needs to be gathered to help complete the R&D cycle. Hence, what we are looking at are holistic technology transfer models that go beyond mere knowledge transfer to facilitation of dynamic and flexible interactions amongst multiple stakeholders to help improve farm livelihoods and the rural economy.

In 2003, ICRISAT started the Agri-Business Incubation (ABI) program under its Agribusiness and Innovation Platform (AIP) to help accelerate technology exchange by nurturing agriculture-focused commercial enterprises. This program was initiated in partnership with the National Science & Technology Development Board (NSTEDB) of the Department of Science & Technology, Government of India. The ABI Program was the first agribusiness incubator in the country and also in the CGIAR Consortium. The primary aim of the incubator was to promote agribusiness ventures through technology transfer, and nurture innovative ideas from the grassroots level. Through its incubation support services that included technical and scientific consultancy, infrastructural support, access to funding sources, mentoring avenues and the like, the ABI Program has so far incubated more than 800 farmer entrepreneurs, apart from funding 23 agribusiness ventures and commercializing ten technologies from ICRISAT and its partners.

The scalability of the approach was proven when ICRISAT helped set up a similar ABI in the Tamil Nadu Agricultural University (TNAU), and later in another 21 Business Planning & Development (BPD) units (or agribusiness incubators) in research institutes and state agricultural universities under the NARS. This was achieved through the World Bank funded National Agricultural Innovation

Project (NAIP) of the Indian Council of Agricultural Research (ICAR). ICRISAT was the handholding and mentoring partner in all these initiatives. For the NARS, this was a new initiative in their approach of technology transfer and interfacing with farmers, which has given considerable results.

The Success

In a short span of four years, the incubators, under the mentoring support, of ICRISAT were able to achieve the following:

A total of 1218 agribusiness ventures were provided with incubation support, of which 91 ventures have successfully graduated from the incubators. Most of these ventures belong to the rural community. It is estimated that about 219,973 jobs have been created through these ventures while about 140,000 farmers are expected to have benefited by their products and services.

- The incubators have commercialized 331 technologies from ICAR and partner institutions across the country in different sectors to 518 licensees. This novel approach to technology transfer involved shortlisting and profiling of technologies, its valuation and better marketing strategies through incubators to attract entrepreneurs and enterprises to take up these technologies. It is estimated that US$1.6 million was generated as revenue to NARS through technology transfer.
- Entrepreneurs, including farmers, women and youth, were provided training by the incubators to understand the technology and its application. It was found that, augmented with incubation support services, the success rate of technology adoption is far higher.
- The incubators also helped 52 innovators with technical and scientific support on their ideas/ prototypes and in their filing of patents.

B2B meetings for technology transfer, Agri-Investors Meet 2013.

Photo: Chandra Mohan, New Delhi

Mr Sultan Singh, incubatee of ZTM-BPD Unit, CIFT with Dr S Ayyappan, DG, ICAR at the former's fish processing plant in Haryana.

The role of ICRISAT as a handholding and mentoring partner to these incubators was to help NARS embrace and understand the concept of business incubation in the agricultural sector. The nationwide business incubator network also allows the farmer/entrepreneurs to access technologies from different sectors of agriculture from any part of the country, thus enhancing scalability of the technology manifold, while at the same time ensuring sustainability of the agribusiness venture through business incubation services. This helps generate confidence amongst the farming community to embrace entrepreneurship and to become part of the economic growth cycle.

How this was Market Driven

The incubator at ICRISAT and those which were set up with NARS, are a multi-functional and dynamic platform that allows for engagement amongst different stakeholders including farmers, entrepreneurs, women and youth, agro-processing and agro-machinery companies, financial institutions and other ancillary institutions connected with the sector.

Such engagements are mainly driven by the need to address market opportunities and can happen at different levels in the agricultural value chain, thereby benefiting not just the farmers, but also women and youth, thus providing a scope for local economic development. The platform helps farmers and entrepreneurs access the market through enablers such as technologies, business development support, mentoring, infrastructure, and funding. For the bigger and larger players in the sector such as agro-companies and funding institutions, the incubators offer partnering opportunities for business development, procurement of raw material and semi-finished products, farmer linkages and the like, thus helping them bring down their transaction costs.

Incorporating Inclusiveness

The incubators allow for an inclusive approach to development of the local economy. From the perspective of an Agricultural Innovation System, the incubator is an ideal platform that can connect with farmers, scientists and other research institutes on the one side (back-end of the chain) and on the other side, with agro-companies, government agencies, private sector players, funding agencies, supply chain providers and others connected to the system (the front-end). This can facilitate in the creation of innovative partnerships for development of the sector and of better delivery models for transfer and application of technology, creation of revenue sources, nurturing innovations and helping the farming community to access the market. Through its incubation support activities, the incubator is able to minimize risks involved in the business venture and maximize the success rate of the ventures. More than 20% of the ventures under incubation are woman-led enterprises, while farmer groups are being targeted to cover more farmers and area, and to minimize costs.

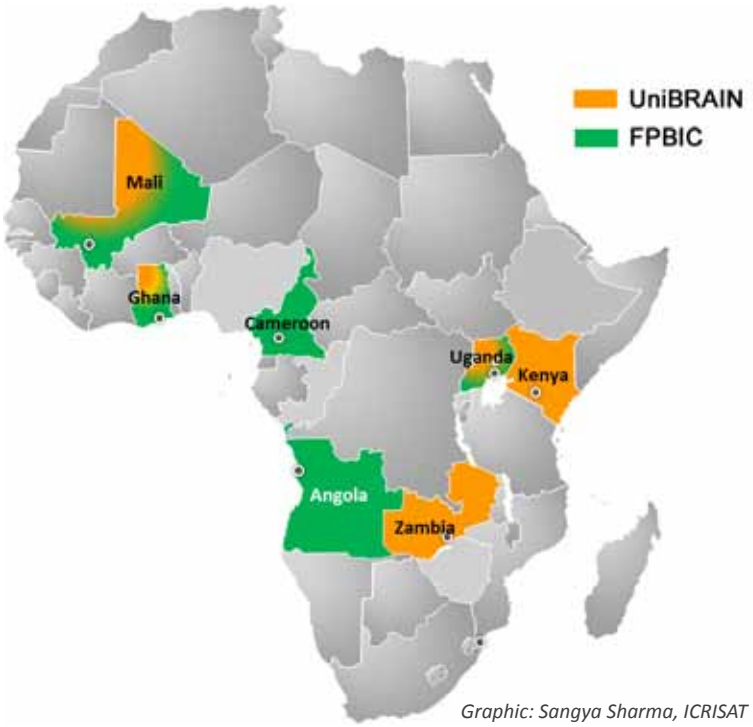
Lessons Learned

We found that promoting technology transfer through a market-driven approach resulted in a higher rate of technology commercialization and revenue generation than with the traditional mode.

- Through IMOD, the research scientists got the market feedback, which has resulted in orienting their research to the market needs.

Women entrepreneurs promoted by WAARI, Mali display their agri-products during the inauguration of the agri-business incubator of WAARI at Mali.

Photo: Bhubesh Kumar, ICRISAT



AIP operations in Africa – UniBRAIN, FPBIC locations.

- To deploy the IMOD strategy, strong leadership and vision is needed, which will bring together the various stakeholders while ensuring that the interest of the farmers is best served.

The Way Forward

- ICRISAT is scaling up its incubator-led initiatives in Africa through its ongoing projects with the Forum for Agricultural Research in Africa (FARA) for handholding and mentoring its Universities, Business and Research in Agricultural INnovation (UniBRAIN) initiative, under which six Agribusiness Innovation and Incubation Consortia (AIIC) are being supported in five African countries (Ghana, Mali, Uganda, Kenya and Zambia). ICRISAT and FARA along with its local African partners, are helping in setting-up of these incubator consortia addressing value chains like sorghum, banana, mango, livestock and agroforestry. The project is funded by DANIDA.
- The Ministry of Food Processing Industries (MoFPI), Govt. of India, under the India-Africa Forum Summit-II (IAFS-II), is establishing five Food Processing Business Incubation Centers (FPBICs) in Mali, Ghana, Uganda, Cameroon and Angola, for which ICRISAT has been selected as an Implementing Agency. This initiative will help the local entrepreneurs in addressing critical technical areas and provide for skill enhancements for scaling-up their business in the area of food processing. This is aimed at enhancing production of quality food products in the region and will also facilitate generation of foreign exchange earnings by way of export, and thereby augment growth of the economy.
- ICAR is planning to scale up the number of incubators under its institutes across the country during the 12th Five Year Plan of the Government of India. This will coincide with the upcoming World Bank funded project for the ICAR that will aim to promote entrepreneurship in the sector and revamp agricultural research and education. ICRISAT has already provided a road-map to ICAR on how to move forward on this front.
- The success of agribusiness incubators within the country has garnered attention of different state government agencies and civil society organizations, who wish to have ICRISAT's intervention and partnership in setting up similar such agribusiness incubator platforms in their area of operation. This will help in reaching out to many more farmers and rural communities in the country and in promoting more agribusiness ventures that will aid in transforming the local economy as envisaged in the IMOD concept.

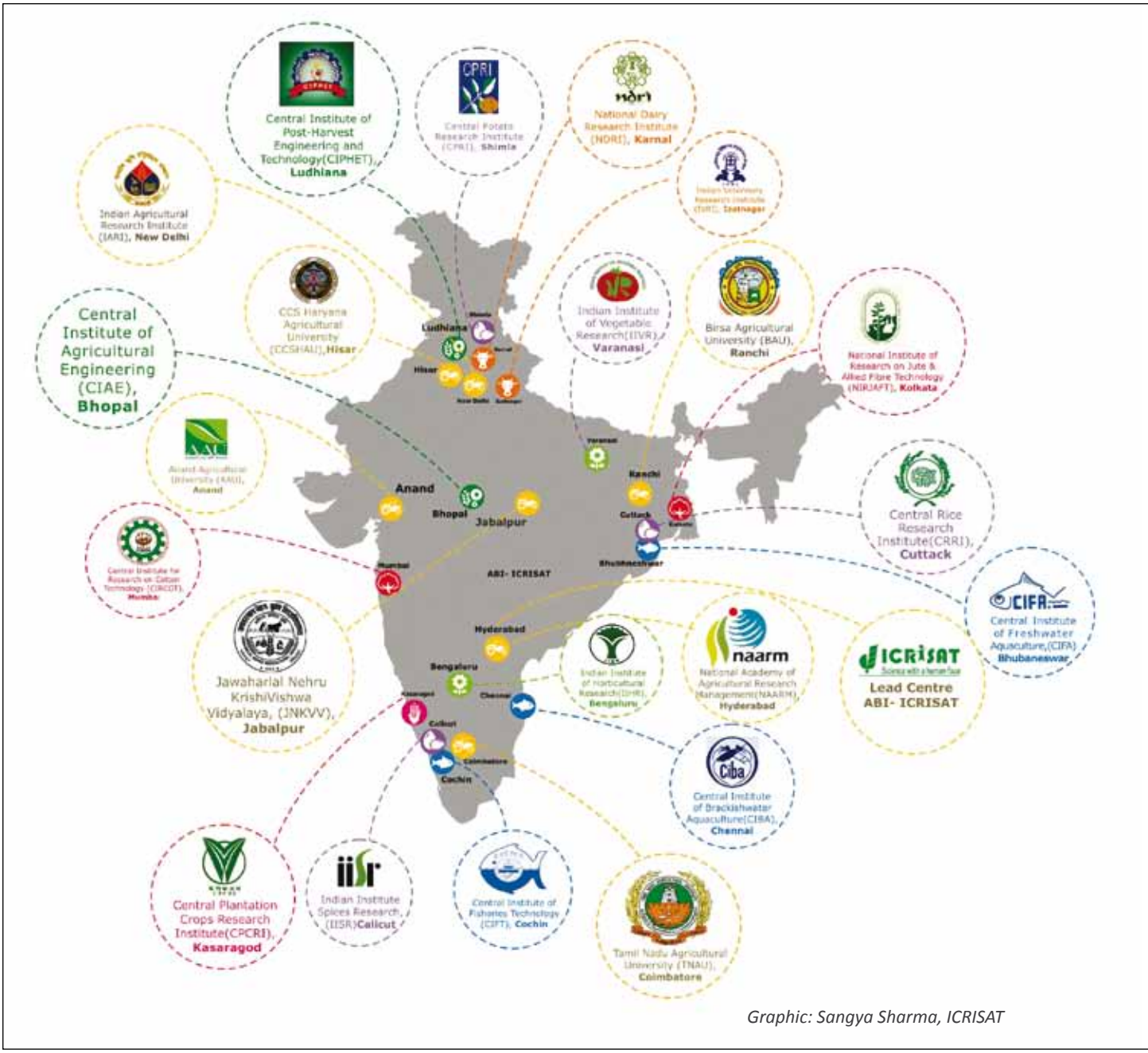
Key Information

Name of the project: Agri-Business Incubation (ABI) Program of Agribusiness and Innovation Platform (AIP), ICRISAT as handholding and mentoring partner for the sub-project of the National Agricultural Innovation Project (NAIP) of the Indian Council of Agricultural Research (ICAR)

Key scientist(s) involved: Dr Kiran K Sharma, CEO, AIP; Mr S Karuppanchetty, COO, ABI/AIP; Mr Aravazhi Selvaraj, COO, INP/AIP; Mr Jonathan Philroy, Deputy Manager, ABI/AIP

Key partners: National Agricultural Innovation Project (NAIP) of Indian Council of Agricultural Research (ICAR)

This does not fall directly under any CRP though activities undertaken by AIP and its programs do connect with CRP activities.



Graphic: Sangya Sharma, ICRISAT

Location of agribusiness incubators mentored by ABI Program under the NAIP Project of ICAR.

General Country Information

$7.496 billion
Zimbabwe (GDP-2013)

$441.15
Zimbabwe (per capita GDP)

300-650 mm
Zimbabwe (Avg Rainfall p.a)

10,712 km²
Gwanda district (Area)

115,778
Gwanda
(Rural population, 2012)

26,510
Gwanda
(No. of households, 2012)

10.8 persons per km²
Gwanda
(Population density, 2012)

Average rainfall for 100 years from 1902-2002 – 477 mm p.a.

Total livestock (2010-2011)

	Total numbers	FAO conversion rate	TLU
Cattle	117218	0.7	82052.60
Sheep	19176	0.1	1917.60
Goats	118123	0.1	11812.30
Pigs	1630	0.25	407.50
Donkeys	43681	0.5	21840.50

Goat population contributes 11% of the Tropical Livestock Unit.

Crops grown

The principal cereal crops are maize, sorghum and pearl millet. Legume crops grown include groundnuts and cowpeas.

The average cropped area per household is one hectare, averaging 0.1 to 0.3 tons per hectare.

Sources: Zimbabwe Statistical Agency 2014. http://www.zimstat.co.zw/ accessed 10/9/14; ICRISAT GIS lab 10/9/14

Much work was done through the innovation platform to train farmers. Increased learning and knowledge sharing is a key characteristic of the innovation platform process.

Innovation platforms to livelihoods

Goat Markets in Zimbabwe

Contributed by:

Andre F van Rooyen, Senior Scientist - Crop Livestock (Resilient Dryland Systems)

Agricultural systems in Africa are notoriously low input-low output systems. This results in low production, and often very little to sell off to generate the much needed cash income. Moreover, markets in rural areas are extremely poorly developed and farmers often find themselves ill informed about market requirements, grades and standards, price structures and associated policies. In addition, small land holdings and poor labor productivity result in very little excess for market-related sale. In semi-arid areas, where crop production is very risky, households sell their small livestock to pay for food, education and human health. Goat markets were poorly developed and transaction costs for all were

Photo: Andre F van Rooyen, ICRISAT

Farmers and personnel from support services discuss development strategies during a visioning session of the innovation platform. IPs make use of visioning processes to describe the future state in order to design development pathways, based on changes that need to be managed to achieve these goals.

very high, resulting in very low income/profits. Low reproductive rates and high mortality, primarily a result of poor dry season feeding, limits the number of animals a household can offer for sale, while poor animal condition and breed results in low prices at informal markets.

The Solution

While many have argued that addressing productivity and improving breeds is the best entry point, ICRISAT argued that building/establishing functioning markets and working along the value chain would provide both the incentive and the cash to make the investments to improve productivity. We also believed that once animal husbandry improved to the extent where mortalities were controlled, breed improvement would then be a viable intervention, but not before. An innovation platform was set up to assemble all relevant stakeholders to address the market challenges, establishing the needs of the market intermediaries in order to reduce transaction costs so that new market strategies benefit all involved – ensuring longer term sustainability. This forum continued beyond market development, and once the markets were established, the innovation platform addressed production challenges focusing on dry season feed, animal housing and veterinary challenges. Working towards complementary objectives, the multi-stakeholder team can each address their core business and together address the functioning of the larger system.

Sustainable Success

An almost immediate outcome of the market development was that goat prices doubled in the first few months. Reduced transaction costs incurred by buyers, in combination with competitive bidding at the collection points, resulted in increased prices for farmers. The price further

increased as farmers realized that they get higher prices for better quality animals and they began to invest in improved feeding and selling of younger animals. The income from goat sales allowed farmers to increase investments in production and generated the much needed feedback loops that would ensure long-term sustainability in the system. Such re-investments further resulted in improved production, reduced mortalities and improved animal quality. Thus, farmers could sell more animals at a higher price. They could also use the cash to create a buffer against farming-related risk, and pay for education and human health related expenses.

The innovation platforms were able to guide the process and deal with the dynamics of the system, moving the agenda forward, and because of its real multi-disciplinary nature, it was able to address challenges and opportunities as they unfolded and evolved. Moreover, the innovation platform was able to share knowledge, provide effective stakeholder participation and bring the private sector to the development arena, where all could benefit from dialogue and mutual understanding, while working towards a complementary objective - commercialization of the goat sub-sector.

Market Linkages

This work was based on the hypothesis that farmers will only invest in increased agricultural production if they realize real benefits from such investments. Establishing functional markets where they would obtain both the returns and the incentives for increased investment was thus the starting point. The project therefore ensured that markets were developed in such a way that all could participate and get a fair price for the animals offered. The approach also considered other stakeholders, as we had to ensure the overall functionality of the value chain. Functional and equitable value chains will ensure the farmer gets a fair price while creating opportunities that will make the overall system

A farmer enthusiastically explains to his peers the value of fodder production, processing and storage. Farmer to farmer learning is a critical mode of knowledge and information sharing.

Photo: Andre F van Rooyen, ICRISAT

Leguminous fodder crops such as mucuna, provide excellent opportunities to increase dry season feed for goats while significantly improving soil fertility. Mucuna is mixed with cereal crop residues to increase the dry season feed supply, significantly reducing mortalities during the dry season.

attractive to processers and retailers. Without these participants, the system would fail.

By developing functional markets, the price per animal increased and a quantitative value chain analysis conducted in 2012 proved that working on establishing functional value chains can increase the profits generated per animal to much higher levels, than working on-farm alone.

Incorporating Inclusiveness

In Zimbabwe, goats primarily belong to women, and developing functional markets where women can sell their produce is critical. Results continue to indicate that the most important commodities bought with income from goat sales remain food, education and human health, with the remainder reinvested in agriculture, indicating that these markets contribute to a very wide array of livelihood requirements. The contribution that these markets make towards food security, education and human health is paramount. Not only do women benefit financially, but also the income (and benefit) goes to include the larger household, especially the elderly and sick. Of critical

Photo: Andre F van Rooyen, ICRISAT

importance is the payment for education, the only real future for today's youth.

Important to note is the fact that these markets generate/increase reinvestments in agriculture at large, both towards crop and livestock production. With increased investment in agriculture, farmers are less reliant on grazing alone, and substantial investments are made into producing feed and fodder on farm – relieving rangelands of excess grazing pressure.

Lessons Learned

Farmers will make smart investment decisions if the contextual environment is correct. In other words, if it makes economic sense, farmers will invest in agriculture. Price signals therefore drive investments in a specific production system. Developing functional markets and value chains will create an environment in which farmers can generate income and purchase food, rather than producing it themselves.

This requires a strong process based approach, rather than single and isolated technology focused interventions. We need to understand that we are working in complex systems and that complex systems theory can take us a long way in understanding what is actually happening in the system. Understanding the different system components, how they function and interact to generate synergies is crucial.

Thus, functional markets will lead to increased technology uptake, increased production and sound decision making with regards to agricultural investments and reinvestments.

A critical lesson from this work is that, with improved value chains, on-farm profitability can increase far beyond what is possible by only increasing on-farm productivity. This provides therefore a very strong case for increased investments in value chains, their efficiency and equitability to ensure increased revenues accruing to farmers.

The Way Forward

Scaling up: Governments and development organizations need to understand that in some scenarios it is easier to become financially secure than food self-sufficient. With enough income you can be food secure, but more importantly you can also fund a wider array of other livelihood necessities. The policy implication is that livestock (and many other cash crops) in association with functional markets can get many people out of poverty. The private sector is by nature keen to contribute, but the contextual environment (support systems, markets and support policy frameworks) must first be in place.

Scaling out: Facilitating the development of functional markets, will go a long way towards increasing farmers' investments in increasing productivity and sales. In this process, we need to ensure that systems remain profitable, and this can be done by ensuring value chains are efficient and certain players do not take more than a reasonable profit. In this study, illustrating that total throughput was more important than per unit profit. NGOs have already built more livestock sale facilities than ICRISAT and partners, the functionality of these needs to be determined and strengthened.

Innovation Platforms: Although IPs are highly effective, they are resource intensive, requiring significant investments in terms of human

Entrepreneurs establish stalls during livestock market days, selling an array of foodstuff that farmers pay for with the income from livestock sales. The income generated from goats are used to purchase food, support education and human health, all commodities available at these markets.

resources, time and funds to manage and facilitate them. On the positive side, IPs are highly effective in bringing multiple stakeholders with similar and/or complementary objectives together. The value of the IP process needs clear description, where it is imperative to use the process as

Markets, both infrastructure as well as the institutions, which manage and support the auction system, were developed and established.

intended, to innovate and strengthen local capacity, rather than just manage project work plans. Increasing the number of skilled and experienced facilitators is crucial in out-scaling the positive impact of the process.

Supporting technologies and increasing impact

Feed systems: Much work remains to be done to improve the local feed systems, and the commercialization of feed production. There is a dire need to increase the legume component in these systems to improve soil fertility.

System integration: To increase the system's efficiency we need to ensure greater integration between crops, livestock and markets. Using dual-purpose crop varieties will contribute to the development of more integrated systems - Integrated crop-livestock-market systems.

Key Information

Name of the project: LiLi Markets YEU04 2007-2010; Goat Production in Zim (EU/ORAP) 2008-2010; CPWF, Challenge Program for Water and Food 2010 to 2013; IFAD YEU12 Dec 2010 to 2013.

Key Scientist(s): Dr Andre F van Rooyen, Dr Sabine Homann Kee-Tui and Dr Patricia Masikati.

Key partners: ILRI, Zimbabwe, Namibia and Mozambique NARES.

CRP: No direct funding from CRP Dryland Systems, but related to it.

General Country Information

275,068 km²
Andhra Pradesh (Area)

76,210,007
Population

19,130 km²
Anantapur (Area)

4,083,315
Population (2011)

8573.64 billion
AP GDP (2013-14)

Rainfall: 544 mm

Crops grown: Groundnut, maize, jowar, rice.

Issues related to poverty: Recurring droughts and poverty become apparent in its severe rural indebtedness, high seasonal migration, low literacy levels, rapid depletion of underground water resources, the highest number of farmer suicides in the country, and the trafficking of women in certain areas.

Area, production and productivity of groundnut.

	Area (000') ha	Production (000') tons	Productivity per ha (in kg)
Total Groundnut Cultivation(INDIA) (2007-2008)	6917000	8216000	1188
Total Groundnut Cultivation (Andhra Pradesh) (2008-2009)	1766354	973264	551
Total Groundnut Cultivation (Ananthapur) (2008-2009)	870456	100012	115

Photo: D Yadagiri, ICRISAT

A farmer and his son admire groundnut ICGV 91114.

Bless my fields

ICGV 91114, short duration and drought tolerant variety – a boon to groundnut farmers in Anantapur district of Andhra Pradesh

Contributed by

HD Upadhyaya, Director, Genebank and Principal Scientist

Anantapur, the largest groundnut growing district (about 0.8 million ha) in Andhra Pradesh, is also the most drought-prone district in peninsular India. Globally, it is also the largest groundnut growing district, wherein smallholder farmers (<2.0 ha) predominate (66%) and who cultivate groundnut. The annual rainfall is only about 500 mm, and every third year is a drought year. Rainfall is erratic with prolonged dry spells of 45–50 days. Soils are light textured, gravelly, shallow alfisols, with low fertility. Farmers prefer groundnut, as it survives long dry spells and provides a valuable source of fodder during drought years. The average groundnut yield

Farmers visiting plots of ICGV 91114 in Anantapur.

in the district during the last decade (2001-10) was 470 kg/ha. In spite of the several improved varieties released in the past, groundnut production in the region is predominated by age-old varieties such as TMV 2, JL 24, and Pollachi Red, largely due to non-availability of quality seeds of the newly released varieties.

The Solution

There is immense scope to increase groundnut yields, and thereby incomes of smallholder farmers, in Anantapur through cultivation of improved groundnut varieties. ICGV 91114 is a short duration, drought tolerant and high yielding variety that has moderate levels of resistance to the rust and late leaf spot diseases. It was identified as one of the most promising varieties through farmer participatory varietal selection (FPVS) in Anantapur. A study conducted by ICRISAT in the district has shown that adoption of ICGV 91114 increases the net income of the farmers by 36% compared to the largely cultivated TMV 2. ICGV 91114 produces additional pod yields (23%) and fodder yields (17%), and reduces pod yield variability by 30%. Its adoption in 35% of the 0.8 million ha under groundnut in Anantapur by 2020/2021 is likely to generate a surplus of ₹694 million a year, of which 65% would accrue due to higher yield and 35% due to reduction in yield variability. Further studies have shown an increase in milk yield by 11% compared to TMV 2, when ICGV 91114 fodder was fed to milch-cattle.

The Success

ICRISAT, in collaboration with Accion Fraterna (AF), a local non-governmental organization, introduced 10 varieties including ICGV 91114 in two villages (Dhanduvaripalli and Rekulakunta) in Anantapur through FPVS trials in the 2002 rainy season. In spite of very low rainfall (146 mm) during the crop season and a continuous dry spell of 45 days soon after sowing, ICGV 91114 outperformed TMV 2 by

producing 28% greater pod yield and 7% greater haulm yield. In subsequent tests in another village (West Narsapuram) in the 2003 rainy season, which was also a drought year (rainfall during the crop season was 168 mm), ICGV 91114 produced 12% greater pod yield and 25% greater haulm yield, compared to TMV 2. Impressed with ICGV 91114's higher yield during the two consecutive drought years, a woman farmer of West Narsapuram village took up seed multiplication on 0.63 ha during the 2003-2004 postrainy season under irrigated conditions. She produced 1200 kg of pods (1920 kg/ha) and after meeting her own seed requirement, sold the remaining seeds to other farmers in the village for cultivation. In the 2004 rainy season, 84 farmers from these three villages grew ICGV 91114. The total rainfall during the cropping season was 225 mm, with a 36-day dry spell soon after sowing. ICGV 91114 again outperformed TMV 2 (pod yield, 1433 kg/ha) by producing 10.6% greater pod yield, but with similar haulms yield as of TMV 2 (1982 kg/ha).

In three years of evaluations, ICGV 91114 on an average produced 13% greater pod and 8% greater haulm yields over TMV 2 (pod yield, 730 kg/ha; haulm yield, 1483 kg/ha). Convinced of its superior performance over TMV 2, 111 farmers from 23 villages across 10 mandals (administrative sub-divisions of Anantapur) took up seed production during the 2004-2005 postrainy season, with technical support from ICRISAT and AF. After saving enough seed for their own use, these farmers sold their surplus produce as seed to other farmers, which helped spread of ICGV 91114 to 41 villages in 18 mandals. All these efforts led to the release of ICGV 91114 in 2006 as 'Anantha Jyothi' by the Government of Andhra Pradesh. Farmers prefer ICGV 91114 largely because of its high pod and haulm yields, short duration (90-95 days in the rainy season), and tolerance to mid- and end-of-season drought. Besides, it has an average 75% shelling out-turn, 48% oil and 27% protein content; and its haulms are more palatable and digestible than that of TMV 2.

Market Driven

Seed, fertilizer and labor account for over 80% of the total groundnut production cost. For ICGV 91114, a study revealed a total production cost of ₹9235/ha, 17% more than that of TMV 2, and 6% less than that of JL 24. The estimated gross revenue from pods and haulms was ₹22,060/ha, which was 27% more than that of TMV 2 and 9% more than that of JL 24. More importantly, the difference in net revenue was even greater. ICGV 91114 yielded 36% more net revenue over TMV 2 and 24% more over JL 24. The marginal rate of return on investment in cultivating ICGV 91114 was close to 239% as compared to 220%

A woman farmer proudly displays the ICGV 91114 she harvested.

Photo: L Vidyasagar, ICRISAT

for TMV 2 and 206% for JL 24. Clearly, ICGV 91114 is comparatively more profitable than TMV 2 and JL 24. Thus, switching over to ICGV 91114 from TMV 2 and JL 24 would generate an additional net revenue of ₹3325/ha over TMV 2 and ₹2451/ha, over JL 24, while the unit cost of production of ICGV 91114 was 13% and 5%, lower than JL 24 and TMV 2. Because of its large and uniform kernels, ICGV 91114 received a marginally (2.5%) higher price than that of TMV 2 in the market, while it attracted the same price as JL 24. The income generated from adoption of ICGV 91114 (in comparison with those cultivating TMV 2) has helped farmers to create new assets or improve the existing ones (land, housing, livestocks, irrigation equipment and farm machinery). Ultimately, the productivity gains achieved through improved technology helped to move the groundnut growers from a subsistence level to being market oriented. Access to improved technology also enhanced farmers' engagement with marketers and increased the total market value captured by the poor.

Incorporating Inclusiveness

The IMOD approach envisages enhancing incomes of farmer as well as tapping potential market opportunities to maximize gains. A sustainable seed-chain was needed for production and dissemination of quality seeds of ICGV 91114 in Anantapur. Strategic efforts have already been made to establish an informal seed production system at the village level by providing seed to selected farmers who cultivate ICGV 91114 and distributing the excess seeds to neighboring farmers. To date, we have distributed 9.5 tons of seeds in the district. Further, up-scaling would need to be nurtured to become seed production independent and fully functional. Inclusive innovations such as enhanced collective actions among groundnut growers improved the availability of ICGV 91114 seed and its dissemination in the district.

The bulky nature of seed pods and high transportation costs are serious constraints in procurement and distribution of groundnut seeds. A strong institutional arrangement and commitment from the stakeholders involved in the seed business is needed to achieve targets. The seed buy back arrangements made with seed producers will be followed-up by seed processing, storage, transport and distribution, which needs minimal infrastructural support. Establishment of an informal village support system for seed multiplication and dissemination will further encourage cultivation of ICGV 91114 in Anantapur. Inclusiveness in engaging purposive partners and institutional innovations reduced the transaction costs in the spreading of improved technology.

Involving farmers in variety selection though FPVS has enabled researchers to know farmers preferences on one hand, and on the other hand the farmers realized the sense of involvement and ownership in selection of varieties of their choice. The farmers thus own a variety and also voluntarily engage themselves in the informal seed production. Traders and oil millers play an important role in groundnut trade business. The involvement of these stakeholders in the selection of the varieties through FPVS has helped identify ICGV 91114 with trade-specific characteristics (ie, high shelling percentage, uniformity in pod/seed size and shape for adopting to local oil millers) to enhance end use and secure a better price for the farmers.

A holistic approach to adopt integrated crop management (ICM) practices is in place, through the 'Bhoochetana' program and other state government schemes, which is expected to bring in a maximum 20% additional yield, while ensuring environmental sustainability. ICRISAT is deeply engaged in back-up research to develop new varieties/ICM practices, and on-farm evaluations

A farmer's son, with hope in his heart and the means of a bright future in his hands.

to ensure continuous feeding of newer and better production practices adapted to smallholder farming conditions, which would make significant contributions to reducing farmers' vulnerability to income shocks from frequent crop failures. The improved ICGV 91114 cultivar has reduced the farm yield and income variability shocks and increased smallholder production efficiency gains in groundnut cultivation in Anantapur. The farmers in the district have increased their resilience through managing the risks in groundnut cultivation. Women farmers contribute a significant labor force to groundnut cultivation in Anantapur. ICGV 91114 being an erect bunch type facilitates easy harvesting and minimizes losses at harvest due to basal podding.

Lessons Learned

Drought tolerant varieties provide a cost-effective long-term solution against the adverse effects of drought. Returns to investment in breeding for drought tolerance are likely to be higher compared to those of other drought management strategies.

Farmers of Anantapur with ICRISAT scientists and partners admiring ICGV 91114.

A continued breeding effort to develop short-duration (to avoid drought) and drought tolerant varieties and their wider dissemination would provide a cushion to the livelihoods of smallholder farmers who are more vulnerable to income shocks from recurrent crop failures. It therefore warrants enhanced allocation of resources for drought tolerance and short-duration breeding research.

Identification of appropriate institutional collaborations is critical for multiplication and distribution of quality seeds. The adoption of FPVS and informal seed production has proved an effective alternative to the replacement of traditionally grown varieties with ICGV 91114 in Anantapur. Policy intervention is the driver to achieve increased adoption of new varieties. Although released in 2006, the acreage of ICGV 91114 had been growing slowly due to various difficulties in the seed chain. However, when a policy to stop seed subsidies for TMV 2 was passed,

Photo: ICRISAT

the breeder seed indent for ICGV 91114 increased by several folds during 2013-2014. More concerted efforts are needed to promote informal village seed systems through proper economic incentives.

The Way Forward

It would be wise to continue the generation of short duration and drought tolerant groundnut varieties through farmer participatory approaches. We need to adopt innovative ways to multiply and saturate the quality seeds of promising varieties, available to smallholder farmers at the village level, and to integrate seed technology with appropriate crop management practices to maximize production gain and minimize cost of production. Suitable information dissemination strategies about production technologies and an appropriate policy support will act as a catalyst to amplify the groundnut production in the district. Adequate storage and processing infrastructural facilities, including innovation in value chains, would further enhance the farmers' welfare gains in the region.

Key Information

Name of the projects: 1) IFAD 532 Project: Farmer Participatory Research into Integrated Crop Management of Grain Legumes in Rainfed Asia

Project duration: 1 May 2002 to 30 June 2006

Key scientist(s): Dr SN Nigam, Dr HD Upadhyaya, Dr Suresh Pande, J Narayan Rao and D Yadagiri (ICRISAT); Mr B Raghu Rami Reddy and Mr K Abdul Kareem (RDT); Dr T Yellamanda Reddy & Dr S Vasundhara (ANGRAU)

Key partners: Accion Fraterna (AF), Rural Development Trust (RDT), Ecology Centre, Upparapalli Road Anantapur 515 001, India; Agricultural Research Station (ANGRAU), Anantapur 515001, India.

2) ISOPOM Project: Development and Popularization of 'Model' Seed System (s) for Quality Seed Production of Major Legumes to Ensure Seed-Sufficiency at the Village Level

Project duration: 1 September 2006 to 30 June 2010

Key scientist(s): Dr S Vasundhara and Dr B Ravindranath Reddy (ANGRAU)

Key partners: Agricultural Research Station, Acharya NG Ranga Agricultural University (ANGRAU), Anantapur 515 001, Andhra Pradesh, India

This work was undertaken as part of the CGIAR RESEARCH PROGRAM ON Grain Legumes

General Country Information

1,267,000 km²
Niger (Area)

17,138,707
Niger (Population, 2010)

$11.63 billion
Niger (GDP, 2011 est.)

31,002 km²
Dosso region (Area)

2,016,690
(Population, 2010)

- Rainfall (Dosso): 400 to 900 mm (annually)
- Cultivated land (km²): 144,911 (2005)
- Cultivated land (%): 11.44. (2005)

Crops grown

- Rainfed crops: Millet, sorghum, cowpea, peanut and bambara nuts
- Irrigated crops: Rice, vegetables and fruit trees are grown in river valley and flood plains

Issues related to poverty

- Periodic droughts, desertification, high population growth, poor education and health care, lack of infrastructure, and environmental degradation

Percentage population in agriculture

- Nearly 53% of the population is actively involved in crop production

Manual processing of groundnut oil in Guidan Gaba.

Extracting prosperity

Cluster-based approach enhancing groundnut value chains for women farmers in the Dosso region of Niger

Contributed by:

Dr Jupiter Ndjeunga, Principal Scientist, Markets, Institutions and Policies, ICRISAT, Niger

In the Dosso region of Niger, which is about 200 km from the capital Niamey, thanks to the interventions of ICRISAT, women farmers have access to good quality seed and are producing good quality grains. However, while the interventions have been successful in the production sub-sector, the processing and marketing sub-sectors remain the main weaknesses in the groundnut value chain, resulting in poor realizations and no benefits from market linkages. The women in sub-Saharan Africa, and particularly in Dosso, face a lot of drudgery when processing agri-produce because they use hand tools and are not equipped with good processing equipment. Also, limited knowledge of value

Women watch as a groundnut oil processing machine is being operated.

addition, customer requirements and poor access to markets have always resulted in low returns, trapping the farmers in poverty and subsistence living. Since 2007, ICRISAT, through the Tropical Legumes II (TL II) project, has been working with more than 27 farmer association seed producers, totaling 870 members (90% women) in the Dosso region of Niger, to evolve and develop these 3 major upgrading options: (1) access to modern varieties, (2) training in seed production technologies, and (3) access to inputs (such as varieties, good quality seed and fertilizers) and production markets for groundnut seed by linking women seed producers to the market.

The Approach

ICRISAT felt that it was imperative to look at the full value chain, and adopted an approach of analyzing the strengths, weaknesses, opportunities and threats (SWOT), with the objective of enhancing incomes of this farming group. This detailed analysis indicated that the major considerations included (1) the consistent supply of high quality grains to processors, (2) the lack of proper equipment to process groundnut into oil, oil cakes or pastes, (3) the lack of training in business and marketing skills, (4) the lack of access to credit for working capital or trade, and (5) the poor linkages to traders who can sell the products.

The ICRISAT project team decided to establish a pilot economic experiment as a proof of concept for enhancing the groundnut value chain, keeping in focus the smallholder women farmers in Dosso. The project team believed in the power of aggregation as a good entry point to access the value chain, and felt that formation of farmer clusters would be the first step in this direction. Five clusters were formed in the Dosso region, each with about 100 women processors. The cluster based approach has the advantage of helping farmers/processors pool the demand for raw material and to sell the processed products collectively. The villages covered in

this approach were Moussa Dey, Guidan Gaba, Sambera and Gaya on the basis of the relatively larger production of groundnut in the area and the resultant volume of groundnut oil, cakes and pastes processed. Four other villages were selected as control sites with socio-economic characteristics similar to the project villages, but where groundnut is processed manually.

The Solution

The consistent supply of groundnuts – linking grain producers to processors – formed the building blocks of a win-win situation!

In the Dosso region, the processors source the raw material from the spot markets. In the Guidan Gaba village, the processors purchase grain from the neighboring markets, especially the Malgorou market, while the processors in Gaya source groundnut from Tanda, Sia, Ouna, Malgorou markets, and from as far as the Malanville markets in the neighboring country (the Benin Republic). Grain supplied in the market is of variable quality and prices vary significantly. At harvest in 2011, the price of a bag of groundnut was 10,000 FCFA, which went up to 22,000 FCFA/bag unshelled in March/ April 2012. This price variation poses significant threats to processing activities.

To reduce supply risks and the price volatility, the women groundnut processors were linked to associations in villages such as Faska, Hankoura, Tounga, Wassangou and Karakara, where there is a large surplus of good quality groundnut grain. In addition, a tour was organized by the project management with processors in villages where there was a surplus supply of groundnut kernels. This exercise resulted in establishing links between the deficit and surplus zones/regions.

Furthermore, in order to address this constraint, producers of grain and processors in the Gaya region had a meeting to ensure a consistent supply of 1,800 tons of seed to processors, and to reduce price variability. Formal contracts were established between the two parties in each cluster. Contractual attributes include the variety, the mode of payment (cash or credit), the price formulated at 20% above the on-going market rate at time of purchase, and the quality of the raw material (less than 2% physical impurities). These contractual arrangements are consistently being monitored to address any difficulties in

Seed company representatives with women groundnut seed growers.

Photo: Jupiter Ndjeunga, ICRISAT

Women in Moussadey manually decorticating groundnut.

meeting the contracts. However, to facilitate such contractual arrangements, access to credit was made important.

Pilot testing processing equipment

A need assessment on processing equipment showed that the lack of decorticators and oil/cake processing machines were the major constraints. The ICRISAT TL II project supplied two mechanical decorticators on an experimental basis, and two small-scale oil processing machines to each of the five clusters. An ex-ante profitability analysis of equipment showed high returns from using decorticators and processing machines. Decorticators helped processors save an average 2.7 minutes of their time per kg of groundnut and reduced costs by 2.5 FCFA per kg. In addition, the use of processing equipment, especially milling, reduces the time by 0.75 minutes and costs by 6.25 FCFA per kg. For oil extraction, processors gained an average 5.5 minutes and 18.75 FCFA per kg of shelled groundnut. The use of both decorticators and oil processing machines by processors contributes to reducing labor time by 22.2 minutes/kg and costs by 27.5 FCFA/kg of shelled groundnut.

Linking groundnut processors to financial institutions – the key role of credit

Access to reliable credit was also a constraint to the women processing clusters. ICRISAT networked

with organizations such as IFDC to remove the constraint, and created linkages for the women farmers with micro-finance institutions. Processing groups of Guidan Gaba and surrounding villages were traditionally poorly connected to credit institutions. The Guidan Gaba village was therefore chosen for the first intervention. IFDC had provided a working capital of 50,000 FCFA (~US$100) to each processor in the village for purchase of groundnut grain. This amount was used to buy about 4 bags of shelled groundnut kernels. This scheme will eventually be expanded to other project sites. In the past, the farmers have had some poor credit experiences with the financial institutions such as ASSU DENDI. For example, the group GANI KORI JI YA in Guidan Gaba had already contracted a loan of US$2,600 at 12% interest for a 5 month period (25% annual interest rate). Similarly, the processing group of Gaya Town contracted about US$2,000 per group consisting of 10 women under the same conditions. Credit is not readily available, and when accessible it is of relatively low volume with high interest rates. The period of repayment does not match with producers' cash flow and producers incur high costs to fulfill monthly payments, as they need to travel long distances to the credit center.

Therefore, together with our partner IFDC, the Project has established contacts with the Agricultural Bank (BAGRI). In addition, a rural project funded by LUX Development is ready to provide a guaranteed line of credit to BAGRI at the level of US$100,000. This will allow farmers to access working capital at a cheaper rate and at the required volume to purchase raw material and equipment in line with their production and processing cycle.

Training in business skills and marketing

All members of the management committee of each cluster were trained in small-scale business and marketing skills. This was essential to understand situations of market demand and supply, price volatilities, product standards and storage. This will help in more market aligned production and processing.

Linking traders with processors

Access to markets of processed groundnut products is a major challenge for many groundnut processors in the Dosso region. There are no assured markets for processors. Processors sell five types of processed products – groundnut oil, paste, oil cakes, Kuli Kuli (a Hausa snack popular in Nigeria), and roasted nuts. All processors target the local market by selling to traders who supply the urban markets. Often, because of lack of coordination between processors or collective action, processors sell the products individually and cannot bargain with traders. This results in a low volume of processing and subsequent low sales of groundnut products, which then prevents capital accumulation. The major markets are those of Gaya, Dosso, Niamey, Baleyara and Malanville (Benin). Traders complain of poor product quality, especially of groundnut oil. In fact, in some villages, processors often mix groundnut oil with palm oil. This practice considerably reduces the quality of the oil, and provides high disincentive to purchase groundnut oil.

To help address this problem, the ICRISAT project team approached two large traders in urban Niamey who were willing to purchase about 5,000 liters of assured quality groundnut oil. This was a big step forward in acquiring assured buyers.

In addition, the project provided technical courses to processors on how to make good groundnut oil. This will translate into a demand for grains (raw material) of about 2,080 tons of shelled groundnut per year and about 520,000 liters of groundnut oil. This is far below the potential of processors estimated to about 1,760,000 liters per annum. As such, there is huge potential to grow.

Signs of Success

Training of the management teams at cluster level

To ensure the sustainability of such interventions in each cluster, the team organized several capacity building and training programs, and developed a structure for future programs. A management team,

including the President of the woman's association, the treasurer and the auditor was established (or strengthened where already in existence) and trained on small-scale business and management skills. In addition, in each cluster, a man and a woman were trained to operate the decorticator and processing equipment (and undertake small repairs). During 2011/12, a partner, CDARMA, which is a processing equipment company, has been providing technical back-up in the use and maintenance of the processing equipment.

Monitoring and evaluation

Very simple data forms were supplied to equipment operators to collect daily information on the use of the equipment, the costs and revenues generated. Similarly, six women processors were given simple forms to fill the expenses and revenues derived from processing and sale of the products. This was to ensure discipline in collecting and monitoring critical information for the overall benefit and appreciation of the group.

Profitability of processing machines

The team arranged a profitability analysis on the use of processing machines by women farmers in the project sites. Survey results showed that, on average, a woman processes a bag and a half (1.5 bags) of groundnut per day and would generate gross profits estimated to about 625 FCFA/day based on the opportunity costs of time saved, but could process about 8 times (11.42 bags/day) more if manually processing equipment was used rather than the traditional method doing it alone and manually. This was a significant improvement, which was easily demonstrable to the members and which enabled sustenance of these new market led practices.

Markets make the difference

The uniqueness of this intervention is that it was inclusive, covering smallholder farmers and women, and the entire process was market driven. To begin with, women processors demand some specific varieties with high oil content, and these varieties were introduced through ICRISAT and partners based on farmers' preferences. The processing equipment was purchased to reduce drudgery facing women processors and to free up time that could be productively used in other high return activities. Groundnut processors were linked to financial institutions to more easily access working capital. In particular, subsistence women farmers benefitted from this project. An average woman farmer generates about 625 FCFA/day based on the opportunity costs of time saved.

ICRISAT was a major facilitator in establishing and nurturing linkages between grain producers and processors, between financial institutions and processors, and between traders and processors. Farmers benefitted in terms of labor saving time for processing.

Inclusiveness brings rewards

Women processors are a disadvantaged segment of the rural population so have de facto been included in the project. They are now engaged in managing the processing machines through management committees set up and trained in monitoring the use of equipment and repairs. They are also confidently taking decisions on when to replace the equipment.

Lessons Learned

Access to credit and capital remains one of the major bottlenecks to agricultural and economic transformation of rural communities. Access to working capital to purchase grains, or capital to purchase processing equipment, is still difficult. Training at small-scale business management and marketing skills has proved to be important. Often, communities get confused between profit and gross revenues, but have now learned to tell the difference. The change in mindset is also critical as farmers, used to getting free goods and services from development projects causing a dependency syndrome, are now learning the joys of self-help.

The Way Forward

ICRISAT envisions the growth and spread of these clusters to other regions. Returns generated from this experimental setting will be used to open new sites. Ultimately, the private sector including some women processors will be able to purchase equipment for their own use and/or to rent to those who cannot afford to purchase the equipment.

Key Information

Name of the project: Empowering women farmers through access to processing equipment

Project duration: January 2012 to December 2014

Key scientist(s) involved: Jupiter Ndjeunga (ICRISAT), Mountari Adamou (INRAN)

Key partners:

Institut National de la Recherche Agronomique du Niger (INRAN). Mr Adamou Mountari, National TL II Coordinator in Niger.

International Fertilizer Development Center (IFDC). Mr Mohamadou Garba, IFDC representative in Niger.

Centre de Développement de l'Artisanat Rural et du Machinisme Agricole (CDARMA). Head of Rural Handicraft and Agricultural Equipment.

This work was undertaken as part of the following two CGIAR Research Programs:

CGIAR RESEARCH PROGRAM ON Grain Legumes

CGIAR RESEARCH PROGRAM ON Policies, Institutions and Markets

Women involved in groundnut kernel sorting.

Photo: Abdoulaye Amadou, ICRISAT

General Country Information

9596961 km²
China (Area)

1,377,065,000
China (Population, 2012)

$10,355 billion
China (GDP, 2013 at current prices)

1,183,000 km²
Inner Mongolia (Area)

65788 km²
Bayannur City (Area)

2948 km²
Wuyuan County (Area)

CHINA

GDP per capita: $3583.38 (2013)

Crops grown: Wheat, rice, corn, sorghum, millet, potatoes, soybeans, barley, oats, buckwheat, field peas and beans.

Sweet Sorgum (As an energy crop)---Produces 7000 litres of ethanol per hectare

Average rainfall per year— 645 mm (2010—2014)

The target area of the project is Wuyuan County, Bayannur City, Inner Mongolia Autonomous Region.

Inner Mongolia: Population (2010) – 24,706,321

Bayannur City: Population (2010) – 1,669,915

Wuyuan County: Population – 341,000

Bayannur City has a temperate and monsoonal climate with four clearly distinct seasons, abundant sunshine, and rainfall very suitable for the development of cultivation. Bayannur is possessed of more than 1,000 mu of arable land. As the largest automatic-flowing irrigation area in Asia, Hetao Plain is flat in topography, fertile in land, long in sunlight time and big in diurnal amplitude. (The average temperature is 23˚C in summer and -10˚C in winter). It is rich in agricultural and livestock resources, which play an important role in Bayannur as it has a processing industry for agricultural and livestock products.

Wuyuan County is located in the north of Bayannur City. In recent years the sweet sorghum ethanol system has taken off in the county with the setting up of a distillery with a crushing capacity of 1800 to 2000 tons of sweet sorghum stalk per day. Sweet sorghum is a new feedstock that the government is promoting (besides cassava and sweet potato) as a non-grain feedstock that does not compete with land growing food and feed crops.

ICRISAT scientists interacting with sweet sorghum farmers in Inner Mongolia, China.

Fuel of the future

Enhancing Sweet Sorghum Ethanol Value Chain in China

Contributed by

Ch Ravinder Reddy, Senior Scientist, Dryland Cereals, ICRISAT, India

P Parthasarathy Rao, Assistant Research Program Director & Prinicipal Scientist, Markets, Institutions & Policies, ICRISAT, India

Zou Jianqiu, Director, Chinese National Sorghum Improvement Center, Liaoning Academy of Agriculture Sciences, Shenyang, PR China

The world is fast moving towards industrialization and urbanization, leading to rapid economic development. Energy is the most critical input for this development, and energy security has become as important as food and nutritional security for all nations. Since the advent of industrialization in the seventeenth century, fossil fuels have been major energy sources. However, in recent times, scientific breakthroughs have led to alternatives, and the demand for developing renewable energy sources such as biofuels is increasing. This is mainly due to the limitations of fossil fuels in terms of availability and cost, and to the environmental pollution associated with their extraction and use.

ZTE GM explaining the use of bagasse, a by-product of sweet sorghum at an ethanol distillery.

The Solution

During the last 1-2 decades, the emphasis on promoting alternative energy sources, such as biofuels, has been accelerating. Corn, sugarcane, sugar beet, Atrophy, and Panama are some of the well-known biofuel feedstock crops used for production of ethanol and biodiesel – the two most prominent biofuels. Sweet sorghum is one such viable alternative biofuel feedstock for bioethanol, and, unlike corn and other grains, it is unique because of the negligible food-fuel tradeoff associated with its use.

Sweet sorghum offers an opportunity to increase the incomes of dryland smallholder farmers through the sale of sweet sorghum stalks (stems) to the ethanol distillery, while at the same time using the grain as food or feed. Thus, sweet sorghum for ethanol production contributes to national energy security and provides additional incomes to farmers, without compromising the food or fodder needs, and thereby establishing a "win-win" situation. By providing competitive, remunerative options for cultivation by smallholder farmers in dryland areas, the development of sweet sorghum can help to ensure that the ongoing "biofuel revolution" aids smallholder farmers in particular for sustainable development, rather than bypassing or marginalizing them.

Market-Oriented Approach

A. Methodologies

Keeping this solution in mind, ICRISAT has initiated projects to optimize on this opportunity. Innovative strategies will be adopted to develop the value chain model and to address all the issues holistically by harnessing the strengths and synergies of consortium partners. The concerns of all the stakeholders will be addressed to ensure that the value chain becomes stronger and successful. The farmers' participation and collective action is critical in the value chain development.

Organizing the farmer groups, input (seed and fertilizers) supply, technical backstopping, micro-entrepreneurship development in villages, linking farmers to markets, providing for better utilization of by-products, and capacity enhancement of

stakeholders, are the specific innovations targeted in the project.

The following specific innovations/principles form the pillars of the strategy in the value chain development:

- Utilization of sweet sorghum as a feedstock for ethanol production without compromising food or fodder needs,
- Development of supply chains – a centralized model involving stalk supply to industry, and a decentralized model involving localized crushing and syrup supply to industry, to benefit more farmers from the biofuel markets,
- Farmer associations for integrated, efficient, dependable production and delivery of high-quality feedstock at competitive cost,
- Backward linkages of distilleries, input dealers and credit agencies with farmers to provide the latest technical information, inputs at lower prices and capital if required,
- Formation of farmers into commodity groups or associations to enhance their bargaining capacity and market intelligence,
- Contract farming – guaranteed minimum price, as per contractual agreements between individual farmers or farmer groups and distilleries to help ensure predictable and reliable returns to the farmers while controlling costs for the processor,
- Capacity-building of farmers and others in the supply chain on production technology; quality issues, value-addition, risk reduction, etc, and
- Efficient by-product utilization through the making of livestock feed.

From the market perspective, distilleries need a reliable stream of quality feedstock at a predictable price and in high volumes, while small-scale farmers need incentives in the form of fair and reliable shares of the benefits, and technical and credit support. The project envisages assistance to smallholder and marginal farmers to benefit from the biofuel production chain, and reduction of environmental pollution, making the smallholders competitive rather than marginalized in this new market opportunity. The strategy involves innovative value chain development, organizing farmers into groups, linking them to input and credit suppliers, and ultimately linking to the ethanol distilleries. Management options to increase the production system efficiency will enhance sweet sorghum's competitive positioning vis-à-vis other feedstocks such as sugarcane molasses, sugar beet and corn, for ethanol production.

Increased production system efficiency, coupled with value chain models through institutional innovations that engage thousands of poor farmers as feedstock suppliers, would help the farmers in aggregating viable volumes to profitably market their produce.

B. Sweet sorghum stock supply chain models

Value chain models can be structured in a variety of ways depending on the crop, the objectives and resources of the company. Two models were implemented to enable the smooth supply of sweet sorghum stalk to the distillery for crushing and ethanol production. Model 1 is where the company leased the land from farmers and grew sweet sorghum. Model 2 is a contract farming model where the farmers grew sweet sorghum and supplied stalk to the company based on a formal contractual agreement signed between company and farmers. Eventually, the company increasingly depended on the contract farming model for procuring the feedstock for ethanol production.

Model 1: Company Leased Land

Sweet sorghum was a new crop to the areas (Yonglian No.2 community; Yonglian No.3 community; Tuanjie No.4 community; Tuanjie No.7 community; Villages – Hongguang; Fendou; and towns – Dashetai; Dashetai) where the model was implemented, and the main objective of the model was to popularize the crop, gain experience in sweet sorghum production practices, develop awareness about the new crop among farmers and ascertain adaptability, yields and economics of sweet sorghum production.

The company interacted directly with the farmers to lease their lands for cultivation of sweet sorghum,

Model 1: Company leased land

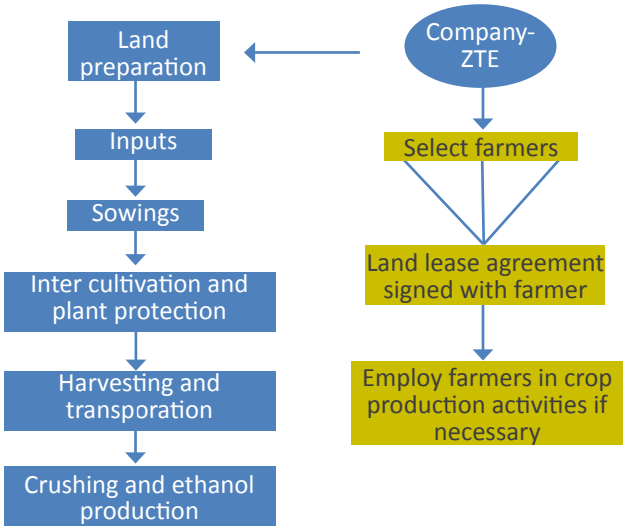


Figure 1. Sketch of company leased land model 1. (Source: ICRISAT).

and signed a lease agreement for 1–5 years with payment of lease amount on a yearly basis. To achieve the objective of the model, the company took over all the activities of crop production, commencing from land preparation and sowing, to harvesting and transportation of stalks to the distillery, all of which was carried out by its own staff members. Depending on the labor availability, farmers (land owners) were employed for crop production activities, but it was not an obligation on the part of the company to create employment for the farmers who had leased their land to the company. The company deployed machinery to increase efficiency and reduce delays in sowing, harvesting and transportation of stalks (reducing losses in juice production and for continuous and timely supply) to the distillery for crushing.

In China, the company had leased and cultivated 30,000 Mu (2000 ha) from farmers of Bayannao'er, Wuyuan County, Inner Mongolia, in the first year (2010,) by signing a land lease agreement with farmers on payment of lease amount of RMB 550 per mu per year ($3355) for a term of 1 to 5 years. In year 2 (2011), the company reduced cultivation in the leased area to 10,000 Mu (666 ha) because it had achieved some of its objectives such as demonstration of sweet sorghum cultivation, and adoption of cultivars in target areas. Also, it realized that it was less cost effective to produce the crop on its own, compared to the contract farming model where the crop is produced by the farmers. Based on the economics of production, the company had planned to withdraw model 1 (Figure 1) gradually and increase the area under contract farming, model 2.

Model 2: Contract Farming

This model was implemented for scheduling uninterrupted feedstock supply to the distillery during the crop season. Under this model, clusters of villages within a radius of 50 km from the distillery were targeted. The aim was to transport the raw materials (stalks) to the distillery within 24 hours of harvesting to prevent loss in juice recovery and quality. The company appointed 'middlemen' (local village leaders, agents or farmers who acted as intermediaries between the company and the growers for facilitating selection of farmers, providing seed, timely harvesting, loading and transporting stalks to the distillery, and making payments to the farmers (Figure 2). The middlemen also liaised with technical staff members of the company and farmers to provide training on crop production practices, and to schedule stalk supply to the distillery. The company entered into buy-back agreements with the farmers for purchase of stalks at a pre-agreed price. The company staff and the extension agency of the local agricultural department worked in co-ordination to maximize the production of stalks and grain, increase the harvest window, and strengthen the technical capabilities of the farmers at the cost of the company.

The ZTE Energy Development company Ltd. (hereafter referred to as ZTE) contract farming model, measured in terms of new options for farmers, increase in productivity and the introduction of modern technology, was a success in year 1 (2010). The company focused on selecting region specific desired cultivars through research, and popularized these through extension services. The research and development center of the

company undertook multi-location on-farm evaluation of genotypes for identifying suitable sweet sorghum cultivars, and also undertook genetic and agronomic manipulation to increase the harvest window. It was thus successful in bringing about a big change in the farmers' production system and towards its objective of ensuring supply of quality produce to its distillery at the right time in required quantities.

The company targeted an area of 3000 ha in year 2 in Bayannao'er, Wuyuan County, Inner Mongolia, within a radius of 50 km from the distillery. The company appointed 30 middlemen to select farmers and entered into a stalk buy-back agreement with selected farmers to purchase the stalks at RMB 285 per ton ($45) of green stalk. The price of stalks depended on the mode of transportation (by the farmer or company) and distance from the distillery. Details of the specific components of the model are given in Figures 2, 3 and 4.

C. Crop production

Sweet sorghum is a warm-season crop that matures early under high temperatures and short days. The soils of Inner Mongolia are light sandy loams with a pH range of 8-9, predominantly alkaline-saline soils, and crops are grown under canal irrigation provided from the Yellow River. The temperature during the crop growing period ranges from 12 to 30°C in Inner Mongolia, where there are 140-150 frost free days from April to August, when the crop can be grown. Different cultivars developed by the Sorghum Research Institute (SRI), China (Liaotian 1,3,5,7 and 9) were tested, prior to releasing them for large-scale cultivation on the research station and on farmers' fields, for their adaptability and stalk and sugar yield. The crop is generally sown in the last week of March or the first week of April. It takes 130-140 days to reach maturity. Stalk yield ranged from 60 to 80 t/ha and grain yield from 2.7 to 4.9 t/ha; sugar content ranged from 18 to 20 Brix%.

Details of the sweet sorghum grown under contract farming models and the stalk yields achieved by the farmers by growing seed of different cultivars supplied by private and public sector seed companies during the project period are given in Table 1.

ICRISAT scientists participating in a capacity building program at Inner Mongolia, PR China.

Photo: SRI China

Table 1. Details of cultivars grown, crop area, yields of stalks and ethanol from 2010-2013.

Particulars	Year							
	2010		2011		2012		2013	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Area sown (in ha)	1333	333	1333	667	1340	1433	1180	620
Yield t/ha	52	70	57	75	61	75	68	66
Amt. of stalk crushed (t)	69,000	23,000	76,000	50,000	80,000	110,000	80,000	41,000
Stalk procurement price	NA	265 Yuan /t	NA	295 Yuan /t	NA	305 Yuan/t	NA	340 Yuan/t
Cultivars grown	Chuntain Nos. 1 and 2; sugar grace, Liaotian No. 1.	Chuntain Nos. 1 and 2; sugar grace, Liaotian No. 1.	Liaotian Nos. 1 and 3; chuntain No 2; sugar grace	Liaotian Nos. 1 and 3; Chuntain No 2; sugar grace	Liaotian Nos, 1 and 3; sugar grace	Liaotian Nos, 1 and 3; sugar grace	Liaotian No. 1; sugar grace	Liaotian No 1 ; sugar grace
Total ethanol produced (in t)	3000	1000	3300	2200	4000	5500	4000	2000

*NA Not applicable

The company and farmer groups negotiated the price per ton of stalk and entered into an agreement. They settled on a pre-agreed price and assured procurement of stalks with a penalty clause on failure to procure stalks, and without imposing the farmers' quota system.

D. Provision of inputs and extension services

The contractual agreement included considerable production support to farmers by the company in addition to free training and extension services. These services were provided by the company to ensure required stalk yields and quality (high sugar content).

All the crop production practices (starting from land preparation, sowing, intercultural operations, and pest and disease management) had to be carried out by the farmers at their own cost, including the purchase of seed from the middlemen. Farmers were linked to appropriate input dealers for procurement of quality fertilizers and pesticides, for which the farmers had to pay (Figure 2).

E. Harvesting and transportation

The company appointed around 30 middlemen, selected from the project area, with each middleman taking care of 5-6 villages. The middleman was either a village head (appointed by the government) or a local village leader. The company offered machinery for sowing and harvesting to the middlemen free of cost, who in turn provided services to the farmers against a small fee. The middlemen charged the farmer RMB 10 per ton of stalk harvesting and loading, and the company paid RMB 1.3 per km to middlemen for transporting stalks to the distillery (Figure 3). This

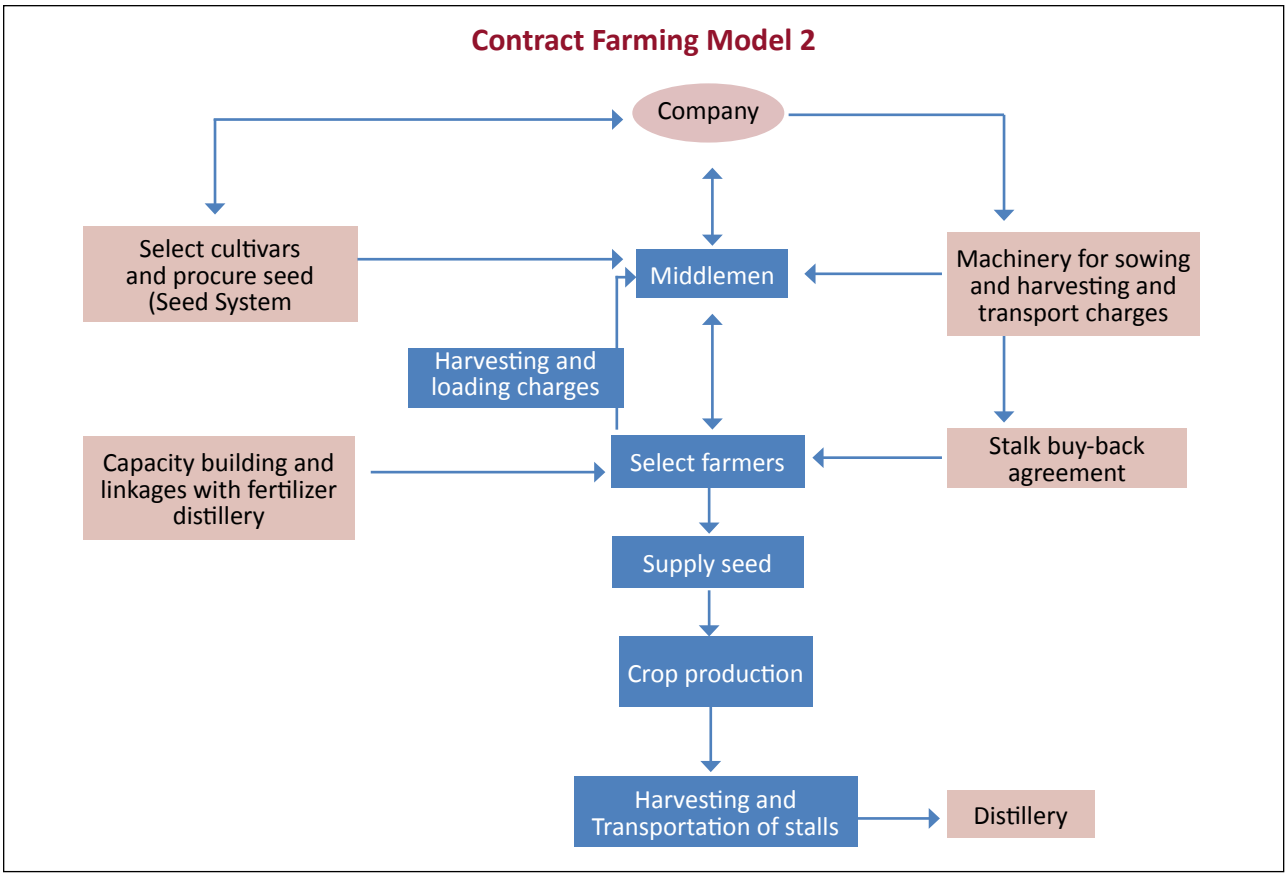


Figure 2. Contract farming model 2. (Source: ICRISAT).

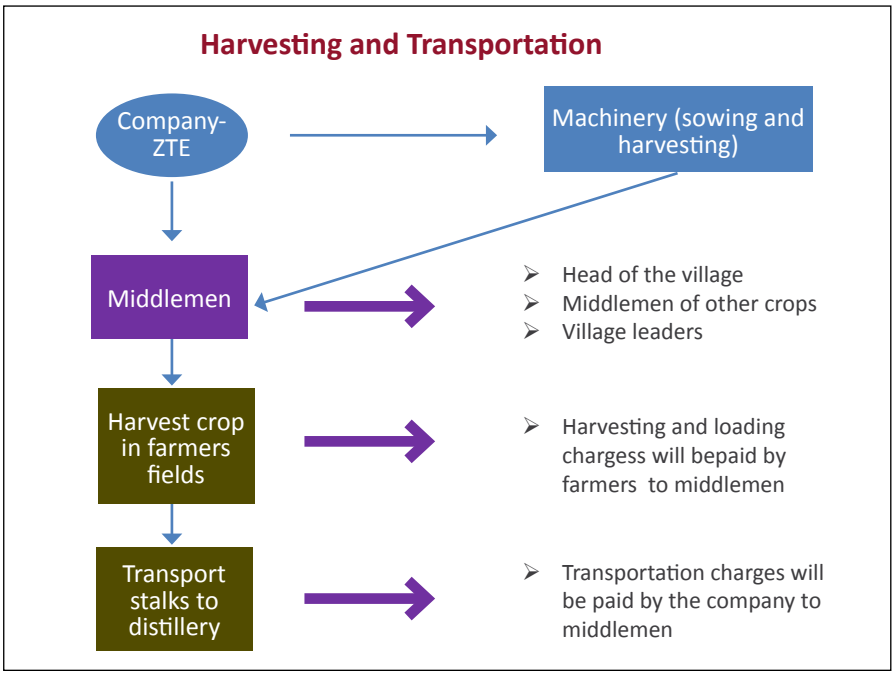


Figure 3. Actors and actions taken to harvest stalks and transport them to the distillery. (Source: ICRISAT).

An ICRISAT scientist with the sweet sorghum research team at the Sorghum Research Institute, Shenyang, PR China.

became a business model for the supply chain and revenue stream of the middlemen. The harvesting schedule was prepared based on dates of sowing and maturity period of cultivars.

F. Mitigating risk and environment issues

To reduce the risk of crop failure, the company proactively established an R & D center prior to introduction of sweet sorghum, which was a new crop in the region. Testing of new cultivars and their adaptation and yields were ascertained prior to entering into contract agreements with farmers who took up sowing on a large scale. Such risks are more likely when the agribusiness ventures into crop diversification.

Physical and social environments usually receive little attention from either agribusinesses or the

Photo: SRI China

government. Environmental issues can vary from country to country, but also from county to county. However ZTE proactively took all environmental and social aspects into account before launching sweet sorghum as a feedstock crop for ethanol production Sweet sorghum replaced crops such as sunflower and maize in some areas. Moreover, sweet sorghum is a dual purpose crop where the grain is harvested for food, feed and alcohol production, and the stalks are used for ethanol production. Hence, there is no tradeoff between food and fuel. There is no deforestation as the crop is grown on plain lands and hence there is no soil erosion either. There is no depletion of water resources because the new crop, as the target area, is irrigated by the Yellow River as are all crops in the project villages. Sweet sorghum also adapts very well to saline soils, and hence there is no soil degradation. There is no scope for a multi-cropping system in Inner Mongolia as the region has only a 4-5 month frost-free period in a year, during which only a single crop can be grown. The farmers are well aware of crop rotation practices, soil health and ecology.

The Success

- In China, large tracts of land are not available for commercial development, nor is it possible for the company to buy land. In such cases, using land owned by smallholder farmers and involving them in contract farming is a cost-effective way of procuring raw material. Sufficient land is also not available for leasing, since farmers own small areas of land. Hence, the company is moving from production on leased land (model 1) to purchasing stalks produced under contract farming (model 2), which is more cost effective for production.
- Sweet sorghum is a new crop in these areas. Because of the nature of the commodity and also because of non-existence of an alternative market for sale of the crop, it was assumed that the farmers would not fail to supply agreed quantities. Moreover, the risk of farmers dishonoring the agreement was also remote.
- Capacity building of 1063 farmers growing sweet sorghum under integrated crop management (ICM) practices including 7 training programs on integrated pest management (IPM) and 5 training programs on integrated nutrient management (INM), has enhanced stalk productivity by 30%, ie, from 52 t/ha in 2010 to 68 t/ha in 2014. The net income of farmers growing sweet sorghum was higher than that of farmers who grew corn and sunflower in Inner Mongolia.
- Farmers are now confidently cultivating sweet sorghum, due to capacity building and technical support (new improved cultivars and integrated crop management) of ICRISAT and the Sorghum

Research Institute (SRI). In addition, the farmers get additional technical support from the staff of ZTE, the local government and the agriculture department, who were also given training by ICRISAT and SRI. Good crop production protocols have been standardized on-farm by conducting demonstrations on farmers' fields for achieving higher stalk and grain yields on saline/alkaline soils of Inner Mongolia.

- Sweet sorghum was successfully grown and popularized by implementing different contract farming models. Linkages between farmers and the company were fostered through implementation of models, and buy-back of stalks was assured through agreements. Farmers are willing to grow sweet sorghum by devoting a part of their land for its cultivation, because of company support and assured market, and it is more remunerative than growing sunflower and maize.
- ZTE has procured a license from the Government of China for the production of ethanol on a commercial scale. Under this license, the company is allowed to test the ethanol produced by blending it with petrol in automobiles. The two-year mandatory requirement ended in June 2014 upon completion of 2 years of testing. Now that testing of the blended ethanol in automobiles is completed successfully, ZTE will obtain Government permission for commercial marketing of ethanol. Thus, ZTE will soon start commercial marketing of ethanol produced by using sweet sorghum. (There is technical validation and acceptance now, which is a successful feature).
- Sweet sorghum is replacing crops such as sunflower and maize in Bayannao'er, where lands are predominantly saline sandy soils and are not generally suitable for the cultivation of high value crops. Thus, sweet sorghum is a suitable crop for

ZTE energy company demonstrating by-products of sweet sorghum ethanol value chain.

Photo: SRI China

biofuel feedstock without any trade-off for food and fuel. This is the key success factor of this project.

Outlook

In China, the sweet sorghum crop duration is long (140 days) and it produces high yields. Developing cultivars with different maturity durations ensures feedstock supply for longer periods. One more advantage in China is that the temperatures are low (12-20°C) at the time of harvest, and if harvested sweet sorghum stalks can be supplied to the distillery within 48 hours, there will be no deterioration in stalk sugars. There is no postrainy season in China as the temperatures are very low for crop cultivation. ZTE has the provision to make and store syrup after harvest, which can be used for processing during the winter season. Sweet sorghum is also an excellent rotation crop in Inner Mongolia where continuous planting of sunflower has led to build up of pests and disease. ZTE streamlined the stalk supply chain models (contract farming), where the farmers produced stalks with a buy-back agreement. In both the models, higher productivity was recorded (50–70 t/ha) over a period of four years. This high productivity was not only because the crops were grown on saline-alkaline soils but also due to the adoption of improved cultivars, best-bet practices (ICRISAT"s contribution), coupled with irrigation and favorable environment for crop growth.

The most important and encouraging aspect is the fact that the China biofuel industry is supported by government policy to enhance and sustain production of ethanol from non-grain feedstocks like cassava, sweet potato and sweet sorghum. These crops can be grown on marginal lands, and thus do not compete with food crops for land use. Going by the infant industry argument, the government has also announced some subsidies for biofuel crop production and ethanol production using non-food grain crops. The government is keen to achieve its target of renewable energy under its five year plan. The Government of China is implementing the blending mandate of 10% ethanol with gasoline in selected provinces and cities. This assures demand from oil companies for biofuels.

For scaling up, there is a need to identify marginal lands where sweet sorghum can be grown, ie, sweet sorghum growing domains where it would also be possible to set up distilleries benefitting from government programs. At present, such statistics related to marginal lands are limited. In addition, social, environmental and sustainability issues of growing sweet sorghum need to be addressed in depth.

It can be said with confidence that with the leads obtained from implementation of the projects in China and the measures suggested above, the sweet sorghum ethanol value chain will be rendered sustainable, both economically and environmentally. This can be made possible by the collective action of researchers, farmer cooperatives, the ethanol industry and policymakers. Considering large environmental and economic benefits to society, it is important to pursue sweet sorghum ethanol at a higher scale for many years, to learn more, and improve the efficiency of the value chain.

Key Information

Name of the project: *Enhanced Livelihood Opportunities of Smallholders in Asia: Linking Smallholder Sweet Sorghum Farmers with the Bioethanol Industry (CFC/FIGG/41)*

Project duration: 1 June 2010 to 31 May 2014

Key scientist(s) involved: Belum VS Reddy, Ch Ravinder Reddy, and P Parthasarathy Rao (PEA, ICRISAT); Regional coordinators of the project are Dr Zou Jianqiu in China.

Key partners in China: Sorghum Research Institute, LAAS, PR China.

Special project under Dryland Cereals

General Country Information

16,455,903
Mali (population)

$ EU 659
GDP (per capita)

328,000 mt
Groundnut production (FAO 2012)

90,120 km²
Koulikoro (Area)

2,418,305
Koulikoro (Population, 2009)

Groundnut remains the major source of livelihoods for small-scale farmers in Mali, Niger and Nigeria. Groundnut is planted on about 36% of total cultivated area in Mali, 15% in Niger and 34% in Nigeria. Groundnut contributes to 64% of household cash revenue in Mali, 66% in Niger and 54% in Nigeria.

Mali is ranked globally at 17th position in terms of groundnut production.

Three regions in Mali account for over 75% of Mali's groundnut producing area: a) Kayes accounts for 33% of groundnut area and 35% of groundnut production in Mali; b) Koulikoro accounts for 21% of groundnut area and 24% of groundnut production; and c) Segou accounts for 21% of groundnut area.

Key issues in groundnut production:

Poor productivity - less than 1 ton per ha due to abiotic (eg, drought, poor soil fertility) and biotic (eg, disease and pests) factors, another key issue is losses due to aflatoxin infestation

Lack of awareness, affordability and/or availability of improved varieties due to weak seed system

Shortage or lack of access to efficiency enhancing production and processing equipment such as plough and seed shelling machine

Lack of remunerative and reliable market linkages.

Koulikoro

The region of Koulikoro is bordered by Mauritania on the north, the region of Kayes on the west, by Guinea and the region of Sikasso on the south, and by the region of Ségou to the east. The climate of the region's south has the high rainfall typical of the Sudan, while north of the Kita-Bamako axis, it tends to a Sahelian aridity.

Photo: Hailemichael Desmae

A woman farmer's seed production plot in Wacoro village in Koulikoro district.

The power of collaboration

Women farmer groups, private industry and science partners together show a way forward in enhancing improved groundnut technologies

Contributed by

Hailemichael Desmae,
Scientist – Grain Legumes, ICRISAT, Mali

In Mali, groundnut is a very important crop; it is a source of human nutrition, livestock feed (haulms) and income generation. It covers 37% of the total cultivated area in some regions of Mali and is a key means of generating rural livelihoods. It is an important cash crop as well, with 46% of the producing households being net-sellers. The share of total household income from groundnuts is relatively high in some regions – for example, 39% in Kolokani region and as high as 79% in the Kita region. Also, 85% of private/individual or communal groundnut plots belong to women. During the dry months, it is a common sight around villages and towns to see piled up bundles of dried groundnut haulms for sale at high

A list of items for sale at the Faso Kaba shop.

prices for animal feed. Because of its ability as a legume to fix nitrogen in the soil, groundnut is also an important component in Mali's farming systems, providing a source of nitrogen for cultivation of cereals such as sorghum and pearl millet, through rotation or intercropping, to which fertilizers are usually not applied. Groundnut production is concentrated in the West, South, and Center of Mali due to climatic conditions (rainfall ranging from 400–800 mm per year) suitable for its production. This corresponds to the regions of Kayes, Koulikoro, Sikasso, and Segou that together account for 97% of the total area under groundnut and 98% of total groundnut production in Mali, which is globally ranked 17th with a total production of 328,000 metric tons (FAOstat 2012).

Paradoxically, in spite of its importance, the productivity of groundnut in Mali remains low with yields of around 1 t/ha compared with the global average of 1.5 t/ha and over 3 t/ha in the USA and China.

The main production constraints include:

- Abiotic (drought, poor soil fertility) and biotic (disease and pests) factors
- Lack of awareness on availability of improved varieties (a majority still grow the old varieties)
- Lack of access to the seeds of improved groundnut varieties due to weak seed systems
- Poor agricultural practices and lack of awareness of good cultivation practices
- Market constraints including low prices after harvest, due to overproduction in a short period
- Shortage or lack of access to production and processing equipment such as that for ploughing and shelling
- Land ownership problems – land is owned by men, and women are allocated poor lands.

The Solution

ICRISAT, along with its partners, undertook a situational analysis of the groundnut cropping systems in Mali. This helped to prioritize the solutions needed to address the bottlenecks holding back the economic benefits groundnut cultivation can have in the communities of West Africa. ICRISAT focused on the development of a basket of interventions that included science based solutions in terms of improved varieties, management practices for better yields and local capacity building to develop a sustainable seed system that could serve the local community. To ensure a wide reach and sustainability of the initiative, ICRISAT partnered with the national agricultural research extension system (NARES) Institut d'Economie Rurale (IER, the premier research institution in Mali for the implementation of the national agricultural research policy), and with the International NGO Plan Mali, which focuses on livelihood issues of women and children, and other local stakeholders to develop a set of interventions critical for success.

These included:

- **Participatory Varietal Selection (PVS).** During 2002-2005 and 2009-2013, ICRISAT engaged with farmers to assess their preferences for varieties through a series of participatory variety selection trials that compared between 4 and 10 groundnut varieties (3 to 9 improved varieties and a local check variety) in Koulikoro region. ICRISAT and its partners fostered partnerships with local farm associations (men and women groups) in the selection process to ensure increased adoption of improved groundnut varieties. Between 8 and 46 Participatory Varietal Selection (PVS) trials were conducted each year during the above project period involving a minimum of 200 farmers to a maximum of 1500 farmers every year. The farmers were trained on managing PVS trials, crop management and post-harvest management, including aflatoxin management. Field days were organized every year, which brought in between 30 and 246 nearby farmers each, to see these trial locations and create awareness for the wider reach of farmers.
- **Capacity building in production and seed production.** Training in good practices of growing groundnut and seed production technologies were provided to farmers by ICRISAT and its partner. For example, in the year 2013, 46 farmer groups were formed, and 46 mother trials and 133 baby trials were conducted involving a total of 1590 farmers. Capacity building activities were conducted in all the 46 locations twice in the growing season – once, at the beginning on the planting and crop husbandry practices, and the second one coinciding with the harvesting period to train the farmers on improved post-harvest handling and aflatoxin management methods. The women groups produced 58 tons of groundnut seeds and the individual farmers and private seed companies together produced about 31 tons.
- **Skill building in business practices.** ICRISAT organized training on management of small businesses and marketing skills for women farmers in Wacoro (Dioila), Bougoula and Sanambélé, all in the Koulikoro region. In 2013, two training programs were held for 24 and 30 seed entrepreneurs who were trained on good business practices, book keeping, ways to secure funding from financial institutions and effective marketing. For this purpose, ICRISAT contracted a local financial services expert who conducted the training program in the Bambara language and which was customized to the needs of the local seed farmers/entrepreneurs.

The Success

The problems were multifaceted and hence a multi-pronged and holistic approach was essential

Improved drying practices for groundnut pods in Foh, Sikasso in Mali.

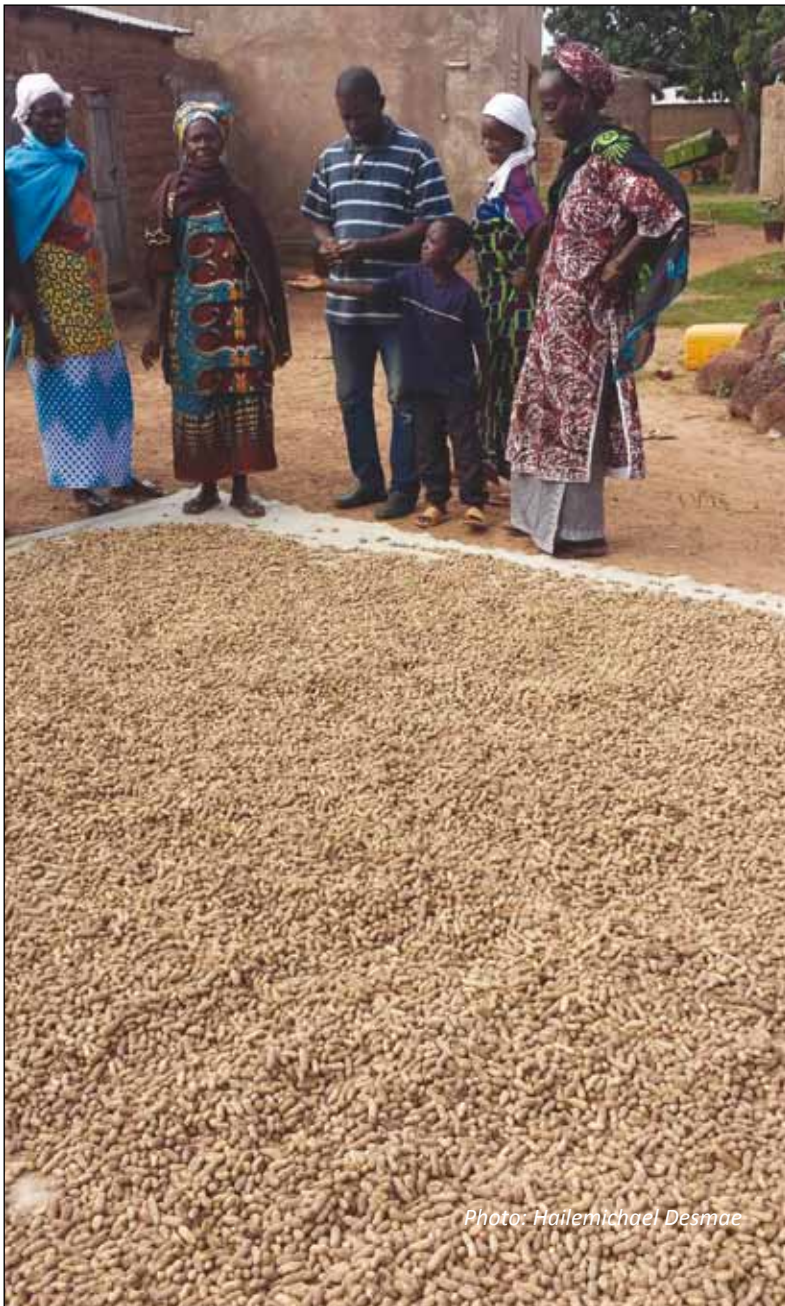


Photo: Hailemichael Desmae

Selling fresh groundnut pods on the streets of Kuchala in Sikasso district, Mali.

to address them. These resulted in the following successful experiences**:**

Seeds of Improved Varieties. The primary constraint to improving groundnut production is inadequate availability and access to seed of improved varieties. As reported by 83 percent of the farmers, the majority of the seed (80%) is sourced from past harvests, as seed of improved varieties were not available. But over the years, many varieties were selected for their high yields, early maturity and resistance/tolerance to diseases through participatory on-farm trials. The varieties have on average a yield advantage of 42% (range from 24% to above 100%) over the local varieties grown by farmers (Table 1).

Production practices. ICRISAT has developed integrated crop management technologies (ICM) that enhance groundnut productivity and production on farmers' fields in combination with improved varieties. These include technologies on soil fertility management (type and rate), planting density (spacing), pest and weed management, harvesting and storage, and seed treatment.

The farmers experienced the benefits of these technologies, and the improved yields have encouraged them to adopt the technologies. We aim to further work on this so the good agricultural practices become a habit for the smallholder farmers.

Local small business skills development. In 2008, ICRISAT purchased around 1.5 tons of improved seed from a farmers' association – the Wacoro women's group located in Wacoro village, Koulikoro region in Mali. Other private companies and individuals also purchased seed from the association. An important breakthrough came in the year 2013, when Mali's first woman seed entrepreneur, Maïmouna Coulibaly, was brought into the fold. Her seed production and marketing venture, called Faso Kaba, which roughly translates to *motherland corn*, contracted to buy all the production of seed done by the Wacoro women's group. "When the seeds are good, so are the yields. But people need to like the taste to buy it at the market. When we do food tastings we find out what works," she says. The women groups of the

Table 1: Characteristic features of recently released/recommended improved groundnut varieties for Mali.

No.	Variety	Year of Release/ recommended	Pedigree	Average yield potential	Target ecology/ region	Special attributes
1	Nieta Tiga	2010	ICGV 86124	1.8 – 2.0 t	Sudano-Sahel, Sahel, pre-Guinea	High yield, drought resistant
2	Yiriwa Tiga	2010	ICGV 86015	1.7 – 2.0 t	Sudano-Sahel, Sahel, pre-Guinea	High yield, drought resistance
3	ICGV 86024	2012	ICGV 86024	1.6 – 2.0 t	Sudano-Sahel, Sahel, pre-Guinea	High yield, drought resistance, foliar disease resistance
4	Waliyar Tiga	2003	ICG 7878	1.1 t	Sudano-Sahel, Sahel, pre-Guinea	Foliar disease resistance
5	Bagui-tana	2011	ICGV-IS 96802	1.5-1.8 t	Sudano-Sahel, Sahel, pre-Guinea	Rosette resistance
6	Khawaye	2012	55-21	1.5-1.8 t	Sudano-Sahel, Sahel, pre-Guinea	Drought resistance
7	Fleur 11	2003	Fleur 11	1.8 t	Sudano-Sahel, Sahel, pre-Guinea	Drought resistance

villages of Bougoula and Sanambélé started the participatory variety selection in 2009 and sold more than 500 kg of quality seed to ICRISAT in 2013. The income helped some of the group members to buy oxen for ploughing and to replace the grass thatched roofs of their homes with iron (steel) sheets. Some even paid the cotton debts of their husbands. Today, most members of the association in the villages of Wacoro, Bougoula, Sanambélé and Fanzan are involved in seed production. Faso Kaba helps the association with the seed certification process and has big plans for the future. ICRISAT is also working with Faso Kaba to improve their business practices and mentor them towards scaling up their business.

How this was market driven

Once the farmers were convinced that the improved varieties offered significant advantages (on average 42% yield gain as per Table 1 and resistance/ tolerance to early leaf spot and late leaf spot diseases) over the traditional varieties, the demand for the seed increased. The women farmers groups that were trained by ICRISAT to produce seeds of the improved groundnut varieties had started growing and selling to other farmers in the region. It started small and increased in quantity, but the problem of marketing still remained. There were also those who were convinced, wanted to buy, but did not have resources to buy. Some innovative arrangement was needed to address these issues. The entry of a commercial seed company in 2013 in the form of Faso Kaba brought new life to the initiative. During the dry season in 2013, ICRISAT organized a meeting of the seed producers and the seed company to discuss how to create market linkages between them. At the beginning of the 2013 crop season, a formal contract was signed between Faso Kaba, the women's group of Wacoro, and ICRISAT. The goal of the contract was for the

women's group to produce groundnut seed on 34 ha with the assurance that the seed company will buy back the production. As of now, Faso Kaba has started contract growing with farmer groups in Koulokini, Wacoro (exclusively women farmers group), Kenja, Jalacorba, Manday and Siby. Faso Kaba has also started providing foundation seeds, some inputs and extension advice to these contracted farmers, and both parties have started benefiting in the arrangement. In place of getting between 600 and 750 FCFA per kilogram of pods, the seed growers are getting about 800 to 1000 FCFA per kilogram by growing seeds of improved varieties and by following the improved practices. Since yields have also increased, the per unit price benefit has gone up as well. In Faso Kaba, they have an assured market, and for the company, there is an assured supply line. This arrangement, where all players in the chain are benefited, is likely to grow and become sustainable.

The successful activities are being replicated in other regions of Mali through the Bill & Melinda Gates Foundation and USAID fund support.

Incorporating Inclusiveness

Looking at the overall potential of the seed marketing arrangement, ICRISAT organized a capacity building program in seed industry practices for Mme Maimouna Coulibaly Sidibe at the ICRISAT headquarters in Patancheru. After returning from training in India she said, "I want Faso Kaba to be able to train Malian farmers to become local seed entrepreneurs producing improved varieties. They could then supply the seeds to farmers in their districts, helping build local seed industries. Faso Kaba would ensure the supply of improved varieties, provide quality control, and help market the seeds.'' Some of the farmers who earlier could not afford to buy seeds of improved groundnut varieties, were now actually producing improved seeds, thanks to the contract growing arrangement with Faso Kaba.

The interventions are benefiting a large number of women and their families, including children, as groundnut is also a major source of protein in their diets. Women are economically contributing to the family finances. Through the ICRISAT mentoring and also on its own initiative, Faso Kaba is bringing in innovations to increase the reach of the technological advancements. They have started distributing sample seeds to convince skeptical groups of farmers, selling small seed packages for the poor farmers to try out and experience the increased income, and in some cases providing inputs on loan in a contract growing arrangement. The interventions are thus reaching the hitherto unreached.

Mother trial plot of one of the women's groups in Dougoumousso village in Sikasso district, Mali.

Photo: Hailemichael Desmae

Lessons Learned

- One of the key lessons learned from this experience is that the presence of a sustainable private enterprise in the value chain has the potential to bring in sustainability to the technology uptake and also opens up opportunities for further scaling up and out. The seed company has its challenges and needs support for a few initial years, but once they become successful, this can

act as an inspiration. This is also a scalable model.

- The need for capacity building at all levels of the value chain was another major learning from the experience in this project.
- The NGOs and private sector players are the key to scaling up and out of our technologies. It was clear that there is a big need to hand hold, mentor these entities and also build a supportive ecosystem that supports such initiatives. For example, in this case, Faso Kaba is incurring huge expenses in hand shelling the groundnut seeds and this is eating into their profits. They need help in identifying affordable mechanization technologies for shelling and also low cost, high impact, packaging solutions to enhance the attractiveness of their seeds. Another area of support that comes down to the ecosystem building is that although they see a big market for groundnut seeds and have already built a contract growing network, their work is hampered by non-availability of the required foundation seeds and next level scale up financing options.

The Way Forward

- ICRISAT plans on working towards further strengthening the partnership with NGOs and farmers. There are plans for more extensive and topical farmer training initiatives and creating stronger links between producers and seed companies through the TL III project and USAID funding support.
- Faso Kaba has seen the potential of the groundnut seed market. From a zero contribution to its business, in the short association with ICRISAT the contribution of groundnut seeds to the overall revenues of the company has grown to 10%, and they see huge potential in this crop going forward. One of the key bottlenecks is now the non-availability of foundation seeds for the varieties in demand, which needs to be addressed.

Key Information

Name of the project: Tropical Legumes II (TLII) project

Project duration: 2008 to 2014

Key scientist(s) involved: Dr Bonny Ntare, ICRISAT, Mali; Dr Hondié Kodjo IER Kayes, Mali

Key partners: Women and men associations of Kolokani, Wacoro, Bougoula, Sanambélé, Fanzan and Dialakegny.

Institute and NGOs: Plan-Mali, Sahelé21, Coalition des Alternatives Africaines Dette et Développement (CAAD), Groupe De Recherches D'Actions & D'Assistance Pour Le Development Communautare (GRAADECOM), Association Malienne pour la Souveraineté et la Sécurité Alimentaire (AMASSA), BØrnfonden, Aga Khan Fondation

Seed company: Faso Kaba

This work was undertaken as part of the CGIAR RESEARCH PROGRAM ON Grain Legumes

Mme Maimouna Coulibaly proudly shows off a groundnut seed packet being marketed by Faso Kaba.

Photo: Hemant Nitturkar

General Country Information

191,791 km²
Karnataka (Area)

61 million
Population (2011)

10.5 million ha
Arable land

7.5 million ha
Rainfed area

Location: 11°30' North and 18°30' North latitudes and 74° East and 78°30' East longitude

Population Density: 319 persons per km²

Average Rainfall: 1139 mm; varying from 593 mm in northern dry region to 3085 mm in the coastal region.

Per capita availability of land: 0.17 ha

- 60% of population depends on agriculture for their livelihoods

Per capita income (at current prices): 69,493 INR (1158 US$) (2011-12)

Major crops

Cereals: Paddy, sorghum, finger millet, pearl millet, maize

Pulses: Pigeonpea, chickpea, greengram, blackgram

Oilseeds: Groundnut, sunflower and soybean

Vegetables: Potato, tomato, chillies and onion

Horticulture: Mango, grapes, pomegranate

Plantation: Coconut, arecanut, coffee and spices

Women in a blackgram field at Gulbarga, Karnataka.

Towards the land of plenty

Bhoochetana: Unlocking the Potential of Dryland Agriculture through Scaling-up

Contributed by

SP Wani, Director, ICRISAT Development Center
ICRISAT-India

Globally, rainfed areas are hot-spots of poverty, malnutrition and degradation of natural resources. In India, of 142 million ha of arable lands, 60% is rainfed. Karnataka State has the second largest area under rainfed agriculture only after Rajasthan in the country. Yields of farmers' field crops in dryland areas are quite low (1-1.5 t/ha), which are lower by two to five folds of the potential achievable yield. Recently, the findings from the comprehensive assessment of water for food and water for life revealed that the UN Millennium Development Goal of reducing the number of poor people by half can be met only through efficient use of the scarce water resources for agriculture. Food production can

be increased substantially in rainfed areas through enhanced water use efficiency measures, improving soil health status and other new technologies in an integrated approach. Currently, rainwater use efficiency in dryland agriculture varies between 35-45%, and the soil health condition in vast tracts of semi-arid regions does not look too promising for increasing productivity. It is evident that the vast potential of rainfed agriculture could be unlocked by using available scientific technologies, including improved cultivars.

The Solution

In 2009, a high level committee comprising Additional Chief Secretary Cum Development Commissioner, Economic Advisor to the Hon'ble Chief Minister, Senior officials from the Department of Agriculture, Watersheds, Economics and Statistics, University of Agricultural Sciences, Bengaluru, Dharwad and Raichur, and ICRISAT scientists, brainstormed to address the issue of low agricultural growth rate in the state. ICRISAT presented the vast potential of rainfed agriculture in Karnataka, based on the evidence gathered from 3700 farmers' fields, which is yet to be harnessed through the scaling-up phase of the existing Sujala-ICRISAT initiative. The high level committee invited ICRISAT to propose a strategy for enhancing productivity of rainfed crops in Karnataka. *Bhoochetana* (rejuvenation of the land) is a process driven mission mode program based on partnership between knowledge-generating institutions such as agricultural universities, national and international research institutions and knowledge transforming extension agencies such as the Department of Agriculture and Department of Watersheds. Soil testing was the entry point activity. A statistically proven stratified soil sampling technique was adapted to collect nearly 100,000 representative samples from 30 districts covering about 5 million hectares of cultivated land. This is one of the major pillars for unlocking the potential of agriculture in the state of Karnataka through Bhoochetana.

The responsibility of soil testing was shared between ICRISAT and the Department of Agriculture, Government of Karnataka. Farmers were trained to take soil samples from the selected farmers' fields with handholding from 'Farmer Facilitators' and Lead Farmers in the village. The soil samples were sent to ICRISAT for analysis. Based on the soil testing results, crop-specific nutrient recommendations were prepared and results were shared among consortium partners and stakeholders. For easy dissemination, soil health cards were prepared and distributed to the sampled farmers with suitable recommendations. Taluk-wise recommendations were developed by ICRISAT and widely disseminated by the district, taluk and Raitha Samparka Kendras (RSK - farmers' interaction center) level officers of the Department of Agriculture with the help of consortium partners. They used various capacity building initiatives, awareness campaigns among farmers through posters and field publicity material (brochures, wall writing etc.,) to popularize various components of Bhoochetana in the villages.

The project adopted the principle of consortium, convergence, capacity building and collective action to address the issues of efficiency, economics, equity and environmental protection. A consortium comprising knowledge generating institutions such as the University of Agricultural Sciences, ICRISAT and Krishi Vigyan Kendras (KVKs, district-level Farm Science Centers) along with knowledge disseminating institutions such as government line departments, who have all joined efforts to reach millions of smallholder farmers to enhance crop productivity. The project also adopted an innovative farmer-centered and farmer managed process oriented approach that ensured participation of smallholder farmers in the project. This project helped to create new institutional arrangements such as farm facilitators (FFs), lead farmers, convergence, and creation of a Bhoochetana cell in the state to deal with agricultural extension services. Innovative institutional arrangements were formulated to bring in expertise and experiences of diverse stakeholders that proved advantageous for implementation of the project. Improved input delivery systems at the block level through RSKs

and decentralized godowns at the village level ensured supply of inputs to the farmers. Soil health mapping and balanced nutrient management using deficient micro-and secondary nutrients were used as an entry point to unlock the potential to bridge the large yield gaps. An integrated approach involving stress tolerant and high-yielding cultivars, improved agronomic practices such as seed treatment, soil and water management, use of organic manures and integrated pest management options and the like, were put into place.

An innovative extension (knowledge dissemination) system, the 'farmer facilitator' concept was introduced to take knowledge to the farmers' doorstep. Since the inception of the initiative, FFs and lead farmers from within the farming community are the new para extension agents who are effectively disseminating knowledge, which has made huge impacts on the state's agricultural scenario. After realizing the importance of FFs in the extension system, this concept was adopted by other departments of the Government of Karnataka. Enabling policies and incentives along with regular monitoring and review systems were also introduced.

The Success

Analysis of nearly 100,000 soil samples revealed widespread (60-100% farmers' fields) multinutrient deficiencies, which was one of the major bottlenecks leading to stagnation in crop productivity before 2009. Soil health mapping indicated individual nutrient deficiencies scattered differently, which provided a basis for designing new fertilizer recommendations at cluster of village level (block) against current state level blanket

Pigeonpea field in Srigeripura, Khudhur RSK, Magadi Taluk, Karnataka.

Photo: ICRISAT

Mr Neelakant Patil showing off a well-grown sorghum earhead from his Bhoochetana plot, Karnataka.

recommendations, to meet varying soil fertility needs. Secondary nutrients and micronutrients were included in the recommendations, while the amounts of macronutrients were also optimized as per soil test values. This approach was based on the principle of participation and mutual synergistic support, which can be defined as the process in which these distinct and independent institutions from different backgrounds and expertise join forces to carry out various activities for a common goal with cumulative effect.

1. The unique mechanism of scaling-up with comprehensive planning, review, and monitoring along with new institutions like FFs, lead farmers, RSKs, and supporting policies, enabled the consortium to cover large rainfed areas in the state. The detailed strategy for increasing the area coverage as well as impact was worked out through capacity building, raising awareness and enhancing timely availability of inputs in the districts. Until 2013, about 15,000 capacity-

Photo: ICRISAT

building trainings were organized at district, taluk and cluster village level covering more than 0.43 million participants including, officers, extension workers, and farmers. In addition, more than 5000 field days were organized with good representation of men (> 0.2 million) and women (0.076 million) farmers. Total area covered by the end of the first phase was 3.73 million ha with new integrated technologies such as improved soil, water, seeds, pest management. The scaling up process in Bhoochetana adopted a multi-level refinement strategy to increase the effectiveness of technologies and reach a great number of people. With effective monitoring and evaluation, the knowledge acquired from the initial years was used to scale up the model to create larger impacts in the entire state. The process occurred in an iterative and interactive cycle, as the experience from scaling up feeds back into new ideas and learning.

2. The project adopted a consortium approach involving state agricultural universities, Krishi Vigyan Kendras, line departments, private companies, international agricultural research organizations and farmers. The participation of these partner institutions in the project activities enabled extension of support to the farmers in increasing farm productivity and improving their incomes and livelihoods. Soil health mapping and recommendations to meet varying soil fertility needs proved an effective entry point activity to build rapport with farmers and for building on it through synergies with improved varieties, soil-water conservation measures and other best agricultural practices.
3. New institutional arrangements such as farm facilitators, lead farmers, convergence of schemes/programs and creation of the Bhoochetana cell were the drivers for achieving success in Bhoochetana. In the absence of a regular extension system, the new knowledge could not reach the intended stakeholders, resulting in poor adoption of new scientific knowledge in agriculture. About 10,000 farmer facilitators and nearly 45,000 lead farmers are now engaged in disseminating the information at the cluster village level.
4. A robust monitoring and evaluation system has been put in place to strengthen, upgrade and update changes required for success. An innovative ICT based video conferencing practice was introduced to ensure an easy flow of information, decision making and review and monitoring of activities at the village level. Implementing this kind of ICT based monitoring

Farmers applying fertilizer for a groundnut crop, Karnataka.

mechanisms are as extensive and creative as possible to triangulate information. Although these monitoring challenges exist in all parts of the state, the introduction of large-scale productivity enhancement programming will hopefully increase the minimum standards for monitoring and introducing new mechanisms that are required and can be applied, for all service delivery in Karnataka.

5. The policy-supported initiative, Bhoochetana in Karnataka, has become an exemplar of science-led interventions improving on-farm productivity by 23 to 66% with favourable benefit to cost ratios between 2 to 14 for scaling up. Crop productivity was found to be decreasing with decreasing rainfall from 2009 to 2012, but yields under improved management were consistently higher compared to farmers' practice even during rainfall deficit years in 2011 and 2012. The mission project so far has contributed a net income of ₹1.267 crores (about US$ 243 million) to the state's GDP.

How this was Market Driven

The main beneficiaries of the project were smallholder farmers with small marketable surplus along with enhanced nutritional value of the products. Prior to these interventions, farmers were getting low yields, which were used to meet domestic consumption without being able to meet their domestic expenditure. Under this project, farmers were motivated to adopt improved technologies to improve crop yield, and essential nutrition rich cereals were incentivized with additional Minimum Support Price (MSP) with the aim to promote production of nutrition rich cereals in the state. Smallholder farmers obtained an average of 23-66% higher yield due to the improved management practices with additional

income of ₹9953/ ha (US$166/ha). ICRISAT played an important role as technical backstopping agency with other consortium partners to educate farmers with new knowledge, and the government supported the initiative with additional human and financial resources through a convergence approach, and new institutional arrangements were put in place to facilitate project implementation.

Incorporating Inclusiveness

The consortium approach, through its process oriented planning approach, ensured the highest clarity of roles for partners, and created a system where the farmers and partners in the consortium were involved for implementation of project activities under the overall coordination of ICRISAT. The project is based on partnership-principle-promoted participatory planning, monitoring and evaluation of activities by treating farmers as primary stakeholders. In this project, the knowledge gap was identified and accordingly knowledge and experience of participating partners were recognized to provide opportunities to fully utilize their skills. State agricultural universities are strong in region specific products and technologies, and their expertise as master trainers was utilized for capacity development of farm facilitators and agricultural officers. Efforts were made to bring all stakeholders together, irrespective of their position, to update and upgrade their knowledge.

To begin with, smallholder and marginal farm holders were included in stratified sampling, and their capacity was developed to collect large quantities of soil samples in all 30 districts with handholding from farm facilitators and other consortium partners. Farm facilitators were selected based on the criteria of practicing farmers, to utilize locally available resources and educate a large number of farmers. Women FFs were selected based on the above criteria to incorporate a gender dimension in the program. A series of awareness building programs were held in villages through knowledge sharing. Bhoochetana is a demand driven approach rather than a supply driven one, as farmers had to register to obtain inputs. Thus, the program had promoted a participatory approach and incorporated inclusiveness in all stages of its implementation.

Line planting of paddy field at Uttara Kannada district, Karnataka.

Lessons Learned

The IMOD approach has been used in all the stages of project activities including the planning phases of this project. The biggest strength of this project is the partnership approach, which primarily focuses on knowledge development as well as economic development with soil, water and crops, which are strong intermediaries. The key factor of IMOD that has significantly influenced the project so far is the inclusiveness approach, which primarily focuses on the economic development of smallholder farmers of the community. It is learned that this better approach can help in organizing communities for effective utilization of new innovative technologies to increase productivity of dryland agriculture. Inclusiveness is the key to achieving success. Thus, clear and timely information flow of written communication to lower levels of the implementing authorities has to be ensured. For this purpose, smallholder and marginal farmers need to be enabled through training, exposure visits, demonstrations, ensuring availability of necessary inputs and handholding support.

Involving partners and farmers from the planning and implementation of activities would help immensely as that provides comfort levels as well as builds trust for their active participation in implementing project activities. This also helped them to gain an understanding of the project objectives, which led to stronger ties and opportunities to test and improve the system productivity.

Continued communication and interaction between DoA staff, consortium partners, farm facilitators and farmers was a key factor for creating successful outcomes in Bhoochetana. During the project, the annual planning and review meeting seemed sufficient for implementation of project activities. However, intensive contact by the DoA staff, consortium partners and farmers contributed to the strong ownership of the project. A holistic integrated system approach with multi-stakeholder partnership is needed to unlock the potential of rainfed agriculture. The Bhoochetana initiative has come to the attention of different state and national governments. In 2011, the Krishi Karman Award for the highest productivity of coarse cereals through Bhoochetana was presented to the Government of Karnataka. This award was instituted to recognize the state's contribution to the increase of food production in the country. The Agriculture Leadership Award – 2011 as a best performing state by the Agriculture Today magazine was presented to the Government of Karnataka.

The Way Forward

This novel approach as a proof of concept for demonstrating productivity enhancement through a science-based approach has benefited a large number of farmers in Karnataka, and has laid a strong foundation for scaling-up the initiative to cover even irrigated areas of the state during the ensuing years. The integrated approach often offers to minimize risks related to production, maximizes water use efficiency and minimizes production costs. The modifications in crop management often require significant changes in technological and economic support to the farmers especially in regions where farmers are not accustomed to using micronutrients to rejuvenate the soil and enhance yields. Thus, rainfed areas of semi-arid regions could be more favorable for adoption of this integrated approach because farmers are more receptive towards new interventions and are familiar with integrated technologies to enhance the crop yield.

Innovative institutional arrangements such as selecting farm facilitators and lead farmers from within the farmer's community, followed by extensive training, has proved very effective in providing holistic solutions in real time. The smallholders in the rainfed semi-arid tropics in India are unaware of soil health issues and available technologies, and are not in a position to implement the science-led strategy on their own to maximize their crop yield. There is, therefore a strong need for desired policy orientation by the respective governments to promote capacity strengthening and innovative science-led

technologies through appropriate incentives, so that poor smallholders in the semi-arid tropics can achieve inclusive market-oriented development.

Comprehensive soil health mapping is needed to unlock the potential of rainfed agriculture. This will generate crucial knowledge to improve soil health as well as enhance crop productivity. We therefore need to change the mindset of all actors to implement the strategy through a holistic approach rather than a compartmental one. Importantly, champions need to be identified for scaling up the program.

The success of Bhoochetana caught the attention of many policy makers and bureaucrats across states and countries. The Bhoochetana approach is being scaled up in Andhra Pradesh and Telangana in India and in the Philippines. Also, a number of other Indian states have shown interest in adopting the approach. The Government of Telangana and Andhra Pradesh have adopted the principles of the Bhoochetana program to enhance the productivity of agricultural systems with technical backstopping by ICRISAT. Similarly, the Bureau of Agriculture, of the Philippines also adopted Bhoochetana in three pilot sites for productivity enhancement with national and international partners such as ICRISAT.

Key Information

Name of the project: Bhoochetana: Mission Project on Rainfed Agriculture: Bridging Yield Gaps through Science-led Interventions for Sustainable Use of Natural Resources in Karnataka

Key scientist(s) involved: Dr Suhas P Wani, Director, ICRISAT Development Center (IDC); Dr K Krishnappa, KL Sahrawat, G Pardhasaradhi

Key partners: Department of Agriculture, Government of Karnataka; Watershed Development Department, Government of Karnataka; University of Agricultural Sciences, Bengaluru, Dharwad, Raichur and Shivamogga; Community Based Organisations; Farmers

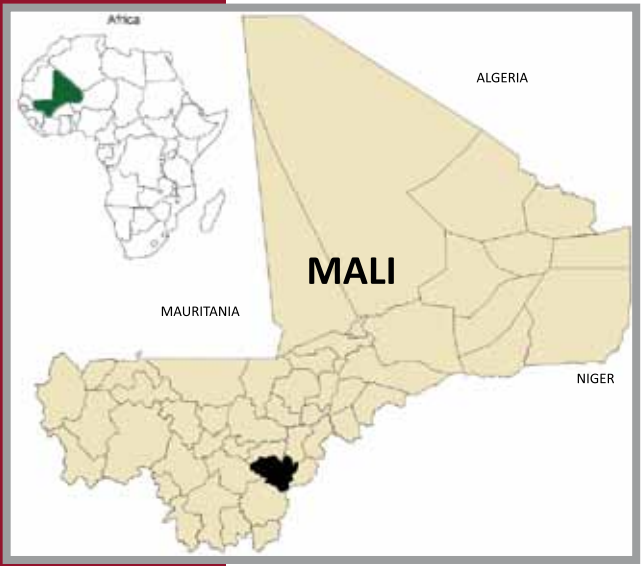
Project duration: First phase: 2009-2012

Second phase: Ongoing since 2013

This work was undertaken as part of the CGIAR RESEARCH PROGRAM ON Dryland Systems

Finger millet field in Hassan district, Karnataka.

General Country Information



1,240,192 km²
Mali (Area)

16,455,903
Mali (Population, July 2014 est)

$18.98 billion
Mali (GDP, 2013 est)

8,740 km²
Koutiala (Area)

575,253
Koutiala (Population, 2009)

Land suitable for agriculture (Mali): 14%

Rainfall (Koutiala) : 845 mm (mean annual)

Evaporation (Koutiala): 1752 mm (mean annual)

Average size of household (Koutiala): 17

Average cultivated land per household (Koutiala): 9.7 ha

Crops grown

Major crop: Cotton

Other crops: Millet, sorghum and maize

Major challenges of agricultural productivity

Water scarcity, soil erosion associated with soil fertility and land degradation, health issues as a result of improper use of agricultural inputs, and lack of fodder and animal traction.

Issues related to food security

Lack of sufficient grain to satisfy household needs because of poor land productivity

Lack of livestock and crop production via small-scale irrigation

Lack of other sources of income apart from agriculture.

Photo: Birhanu Zemadim Birhanu, ICRISAT

Participatory approach in constructing CBT in Finkoloni village in Koutiala district.

Contours of a success story

Expanding Contour Bunding Technology for Improved Livelihood Benefits in Mali

Contributed by

Birhanu Zemadim Birhanu,
Scientist - Land and Water Management,
ICRISAT, Mali

Mali is a sub-Saharan country whose economy is based primarily on agriculture and animal husbandry. It is divided into three major regions – the Saharan region with less than 100 mm of rain per year is dominated by thorny brush and annual herbaceous vegetation; the Sahelian region that receives 550 mm of rain per year and supports a high density of cattle; and the Sudano-Sahelian region that receives about 1,000 mm of rain per year and supports much of the agriculture in the country. Rainfed agriculture is the mainstay of rural peoples' livelihoods in Mali, engaging almost 70 percent of Mali's labor force and contributing about 40% to the GDP. The rainfall shortages,

combined with degraded and poor soils, result in low farm level productivity, and this situation is being exacerbated due to increasingly erratic rainfall and increased climate variability. Hence, Mali counts amongst the poorest countries in the world. This situation can also be found in many countries in West and Central Africa, so the problem is acute and widespread.

Sustaining soil moisture (in-situ) and water harvesting (ex-situ) practices could improve existing crop and livestock productivity. One among the many practices is the use of Contour Bunding Technology (CBT) that was introduced in the early 90s by the Malian cotton industry, Compagnie Malienne de Development des Textiles (CMDT) to farmers in Sikasso region, southern Mali. The CBT technology proved to be successful in increasing yields of cotton, a major cash crop in the region, by 30%. Similarly, with CBT adoption, farmlands that were once degraded were converted to usable farmlands, and the practice improved the retention of soil nutrients and increased the yield of cereal crops by 30 to 50%. Despite its proven advantage, the adoption of CBT has been minimum. Farmers experienced difficulties in constructing and maintaining the CBT structure after the intervention by CMDT was stopped due to lack of funds. In many instances the evaluations of soil and water conservation (SWC) projects have rarely been convincing. The usual shortcomings have been incompleteness of information in project planning (like baselines, long-term targets, exit plans), limited information from specific SWC monitoring and evaluation reports and from general agronomic surveys, and by a poor attribution of change to project interventions. The last point is also particularly tricky.

In the given situation, apart from the urgent need to increase the adoption of the proven soil and water conservation technologies in the project areas, it has become very important to examine ways to increase the technology uptake generally so that critical issues in agriculture are addressed. ICRISAT's endeavor has been to address this twin challenge that has the potential to transform traditional farming practices.

The Solution

Globally, many technologies have been successfully used for soil and water conservation. In Mali, ICRISAT researchers discussed with stakeholders, and based on their inputs, decided to concentrate on contour bunding technology. Learning from past experiences, other key innovations in this project were to involve a technically qualified and locally stationed NGO run by a passionate team, and to do a baseline study by involving the local population

to carry forward the past experiences from the long and the then useful CMDT project. The local NGO, called Association Malienne d'Eveil au Development Durable (AMEDD) Mali, was contracted by ICRISAT to decide on how to commence /start-up the practice and develop test cases on farmers' fields. ICRISAT commissioned AMEDD to collect baseline information regarding the application of CBT in three regions of Mali (Mopti, Koulikoro and Sikasso). The study showed that more than 1700 hectares of farmers' fields were covered by CBT in the three regions, with the greater adoption in the Sikasso region. The CBT application brought understanding on the natural resources management in the rural communities. In the area of CBT application, 96 percent of the farmers witnessed improved crop productivity. Moreover, farmers saw that soil and water were conserved and soil erosion was reduced at a rate of 81%, gully formation was reduced by 73% and soil fertility was improved by 84% in

Adama Dembele and his maize crop in a contour bunded field.

Photo: Birhanu Zemadim Birhanu, ICRISAT

A cotton field in southern Mali with contour bunding.

degraded areas with CBT application. These are few case examples; however if nothing is done on existing farmlands that are degraded and eroded, agricultural productivity would further reduce by 20 to 30% in the coming 10 to 20 years, and the rate of erosion and degradation would quicken.

The Success

Construction of CBT on farmers' field required commitment of farmers to contribute to the technology by paying 5000 CFA Francs (currency in Francophone West Africa, which is equivalent to US$10) per ha to the local NGO for demarcating the contours and explaining the technology. The farmers then had to build the contours and maintain the structure after that. Farmers who volunteered to have CBT on their farm fields demonstrated that the payment to AMEDD is manageable and are willing to have more farm fields covered with CBT. With the CBT application, household level profits were 25% more than the business as usual for 748 farmers covered in the studied areas for 1700 ha of land. Thirty percent of these farmers are women. In the area of CBT application the water availability improved by 46%, and crop yields were improved by 38%. Similarly, fertility of the soil was improved at a rate of 15%. At present we observe that the crops in our experimental plots on CBT farmlands are performing better with regard to biomass and fruiting. Similarly, farmers are witnessing improved soil moisture in farm fields and are expecting better production in the current harvesting year. It is expected that the CBT farm area will improve rural incomes by 40%. Apart from improving the crop productivity, the CBT technology helped to reduce erosion and loss of important nutrient components from farm fields. Similarly, runoff was minimized and the infiltration rate was improved. This helps to recharge shallow wells, commonly used for domestic and livestock needs in Sikasso region. The CBT practice would help to reduce extended

dry spells and improve seed germination, thus contributing to resilience and overall management of natural resources.

How this was market driven

In a distinct departure from past practices, this initiative decided to go by market principles right from commencement. The local NGO AMEDD, who was asked to work out a reasonable price for reaching out, enrolling and demarcating CBT on one hectare of land in farmers' field, decided on a figure of 5000 CFA Francs, and all farmers in the project were charged the same. As the demand for more CBT is increasing, the NGO will increase its staff to deliver the needed service to smallholder farmers. Farmers with CBT fields know the principle of *better yield, more income,* and they are the primary beneficiaries of the technology. Similarly, the increase in production of staple crops, maize, sorghum and millet through CBT application, would improve the household food security. The current ICRISAT work involves understanding and documenting the benefits of CBT in farmers' fields and working on uptake strategies and scaling out options. Lessons learned would be documented and shared with farmers living in different villages. Farmer field days are organized to share experiences and reports are produced for wider dissemination.

How inclusiveness was incorporated

The CBT technology is very appropriate and useful for the most marginalized and degraded land owners. The need for CBT in farm lands was initiated by individual farmers after observing a recurrence of drought, erosion and decline of crop productivity. The information is shared with extension agents and local NGOs working in the region. Once the information is communicated, market forces were allowed to play for the dialogue to happen and agreement to be reached between the owner of the farm and the constructor. Hence inclusiveness was ensured in the activities by involving real actors on the ground.

A farmer in Finkoloni village laying out contour lines with draught animals.

A field agent supervising Andropogon grass on bunds in southern Mali.

Previous experience demonstrated that farmers were willing to adopt practices that help to improve their agricultural productivity. While the training and technological layout of the construction was provided by ICRISAT and AMEDD, farmers constructed the contour bunds in their farm fields. Farmers also adopted other structural measures, for example, planting Andropogon grass on bunds to protect the structure from being damaged by heavy floods (a common phenomenon in Sikasso region of Mali).

Lessons Learned

AMEDD, the local NGO has been identified as a champion for the CBT application. The local NGO has offices and is equipped with relevant human resources and office equipment in the Sikasso region. It works closely with the local communities, Institute d'Economie Rurale (IER) and with ICRISAT to address developmental issues in areas of agricultural and natural resources management in the region. Being present within the community and addressing developmental demands were key factors that influenced the success of CBT application.

Photo: Birhanu Zemadim Birhanu, ICRISAT

The Way Forward

Currently, the CBT technology is being experimented in six villages. Data on biophysical, crop-livestock and socio-economics is being collected. Results of data analysis will guide options and opportunities to target and scale-up the technology. Training programs, including video demonstration and methods of construction, are organized for farmers and their households. At least two farmer field days will be organized based on growing seasons for feedback sessions and will include visits to the experimental plots so that members of the other communities learn from proven experiences. Based on the lessons learned, at least one video program is prepared on the benefits and method of construction in local languages to reach many farmers, including their households. Similarly radio programs and community level discussion programs will be organized to help understand farmers' needs and possible intervention measures like CBT.

Realizing that the presence of a local, long term champion force should be present for sustained scaling up and out of any technology, this project has fully involved the passionate team at AMEDD Mali. Going forward, ICRISAT intends to increase the capacity of such key agents of change. Also, identifying and packaging of entrepreneurial opportunities for rural youth will be an additional focus area. The learnings from this project will be shared with various stakeholders in an effort to increase the understanding of why proven technologies sometimes do not get adopted widely and what the key ingredients for scalable and sustainable technology adoptions are.

Key Information

Name of the project: Managing Natural Resources to Increase Watershed Productivity in Mali

Project duration: January 2014 to December 2017

Key scientist(s) involved: Birhanu Zemadim, Bougouna Sogoba, Kalifa Traore

Key partners: Institute d'Economie Rurale (IER), AMEDD.

This work was undertaken as part of the following two CGIAR Research Programs:

CGIAR RESEARCH PROGRAM ON Dryland Systems

CGIAR RESEARCH PROGRAM ON Water, Land and Ecosystems

General Country Information

$7,256,571 billion
India (GDP, 2011)

38.97 million acres
Total cultivated land (India)

7.0 million tons
Total sorghum cultivation, 2010

300,000 km²
Philippines (Area)

99,926,700
Population (2014 est)

$456.418 billion
Philippines (GDP, 2013)

115,000 km²
Agricultural land (2007)

INDIA (Sweet sorghum)

India is the second largest producer of sweet sorghum in the world with 7.0 million metric tons annually as per 2010 data.

Rainfall requirements: Mostly in an annual rainfall range of 400-750 mm. Sweet sorghum is grown in areas that are too dry for maize.

Earnings from sweet sorghum: By planting sweet sorghum, dryland farmers can earn an income of ₹1,763 ($40) per ha.

PHILIPPINES

Rainfall: The summer monsoon brings heavy rains to most of the archipelago from May to October. Annual average rainfall ranges from as much as 5,000 millimeters (196.9 in) in the mountainous east coast section of the country, to less than1, 000 millimeters (39.4 in) in some of the sheltered valleys.

Total cultivated land (Philippines): 9.671 million hectares (2002)CAF

Crops grown: Rice, sugar, coconuts, pineapples, corn, rubber.

Issues related to poverty: The main causes of poverty in the country – low to moderate economic growth for the past 40 years; low growth elasticity of poverty reduction; weakness in employment generation and the quality of jobs generated; failure to fully develop the agriculture sector; high inflation during crisis periods; high levels of population growth; high and persistent levels of inequality (incomes and assets), which dampen the positive impacts of economic expansion; and recurrent shocks and exposure to risks such as economic crisis, conflicts, natural disasters, and “environmental poverty.”

A mobile cane crusher in action in the Philippines.

A sweet tale of success

Sweet sorghum is more than food for smallholder farmers in India and the Philippines

Contributed by

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Biofuels are among renewable energy sources that offer great promise for future energy requirements. Yet, biofuels are also considered as one of the factors affecting global food prices. However, the certain finality of fossil fuel depletion and the continued environment pollution caused by excessive use of fossil fuels make it imperative to find alternative renewable sources of energy that complement fossil fuels with limited/ little impact on the environment. The rapidly growing global population (9 billion by 2030) and the emerging economies in Asia, South America and Africa, coupled with urbanization and declining fossil fuel resources, has concentrated attention on alternative sources

ICRISAT scientists with Dr Thelma Layaoen, Pathologist at the sweet sorghum screening trial at Mariano Marcos State University (MMSU) Philippines.

of energy, which are economically efficient and ecologically sustainable. A case in point – India imports over 76% of its crude oil requirement and hence its economy is heavily influenced by international crude price volatility. The income opportunities for smallholder farmers in semi-arid tropics can be enhanced by involving them in cultivation of dedicated energy crops.

Sweet sorghum offers an opportunity to increase the incomes of smallholder farmers through the sale of its stalks (stems) to the ethanol industry, while the grain is still used as food or feed. Thus, sweet sorghum for ethanol production contributes to the national energy security and provides additional income to farmers, without compromising food or fodder needs. By providing competitive, remunerative options for cultivation by smallholder farmers in dryland areas, sweet sorghum development can help ensure that the ongoing "biofuel revolution" aids smallholder farmers for sustainable development, rather than bypassing or marginalizing them. The policy makers in India, China and the Philippines have recognized that sweet sorghum feedstock has an important role in augmenting renewable energy through conversion of its juice (or its biomass/bagasse) to biofuels in conjunction with sugarcane. Sweet sorghum is therefore feedstock for food, fodder, energy and other industrial applications. It is also the only feedstock where ethanol can be produced either through grain, sweet juice, syrup or biomass, in other words, it is relevant to first, second and third generation biofuels. Currently, blending of 5% ethanol with gasoline in India, and 10% blending in the Philippines is mandatory. However, the existing ethanol production falls very short in meeting the blending requirements in both countries.

The Problem

Sweet sorghum is fairly new to the sorghum farmers in India, as, since time immemorial, they were only familiar with cultivation of grain sorghum, where the economic product is grain, while the stover is used to feed livestock. The cultivation practice of sweet sorghum is slightly different from that of grain sorghum, as sweet sorghum requires better crop management. Farmers were unable to harness the full benefits of sweet sorghum as they were not aware of sweet sorghum cultivation practices, multiple uses and also marketability of the produce.

Similarly, sweet sorghum is a newly introduced crop to the Philippines, where only a few farmers are aware of cultivating red or brown sorghums to meet the limited demand of the grain sorghum market of that country.

Sweet sorghum cultivation for ethanol production is limited primarily because of the following constraints:

- Lack of awareness among the farmers about the cultivation practices and its use for ethanol production,
- Many of the farmers interested in growing sweet sorghum are located far from a centralized distillery, and do not know the alternative method of producing syrup in their backyards,
- No market access for remote sweet sorghum farmers to take advantage of emerging opportunities,
- Non-availability of seed of sweet sorghum cultivars for commercial cultivation,
- Inability to make feedstock available on a continuous basis,
- Absence of strong linkages among farmers, researchers and industry, and policy makers, and
- Lack of appropriate government policy framework to encourage farmers/industry to play an effective role in the sweet sorghum production and marketing (by farmers) and ethanol production and marketing (pricing) by the industry.

The Solution

ICRISAT's first priority was to focus on productivity. The productivity of sweet sorghum is highly influenced by season and local weather. Hence, ICRISAT conducted several multilocation and multi-season cultivar trials in partnership with national agricultural systems (NARS) to identify locally adapted cultivars in the targeted states of Maharashtra, Andhra Pradesh and Karnataka in India. In the breeding methodology, emphasis was given to breed for biomass quality, attempting to enhance sugar content and grain yields. In the sites of multilocation trials, farmers were invited to select their preferred cultivars, and the same were promoted in their field demonstrations, which helped on-site specific capacity building of more than 3500 farmers both in the Philippines and in India. Stakeholders such as the state department of Agriculture, KVKs, SHGs, CBOs, NARS, entrepreneurs, NGOs and policy makers also enthusiastically participated in these activities.

In the Philippines, ICRISAT partnered with the Department of Agriculture - Bureau of Agriculture Research (DA-BAR) and the Department of Science and Technology, Philippine Council for Agriculture Resources, Research and Development (DOST-PCARRD), which have funded several projects to identify the best locally adapted ICRISAT-bred sweet sorghum cultivars. The results of these projects have unequivocally proved the economic viability

Taste test of sweet sorghum juice at a Trade Exhibition.

Photo: Heraldo Layaoen

and sustainability of the sweet sorghum value chain for biofuels, and 25 bio-products. ICRISAT has established a strong partnership, particularly with the Mariano Marcos State University (MMSU) and Bapamin enterprises, an NGO promoting sweet sorghum vinegar commercially in northern Philippines. ICRISAT provided the improved varieties and technical know-how, while MMSU trained farmers in capacity building and seed multiplication, and Bapamin enterprises promoted sweet sorghum by developing several new and innovative products, notably vinegar, a sweetener and a hand sanitizer, which are now quite popular and have found a niche in the Philippine market, with a turnover of US$ 25,000 per annum. The sweet sorghum variety, SPV 422, is grown for its white bold grain, which fetches a 20-30% higher price than the traditional red/ brown sorghum.

Sweet Success

- Over 1800 ha of sweet sorghum varieties (ICSV 93046, CSV 24SS, and Amrutha) is grown by approximately 3000 smallholder and marginal farmers for fodder in the states of Maharashtra, Karnataka and Andhra Pradesh.
- Sweet sorghum is being increasingly considered as an alternative feedstock for biofuel production (Sweetfuel report, 2009-14) by sugar mills to augment the operational window in India and in the Philippines.
- The area of sweet sorghum is spreading to different provinces such as Luzon, Mindanoa, and Visayas in the Philippines due to the efforts of DA-BAR and NARS (UPLB, MMSU, PAC, Bapamin, etc). Currently, the area grown to sweet sorghum in the Philippines is about 1500 ha.
- 15 kiloliters of ethanol from sweet sorghum syrup was produced as an innovative first step in 2012 by the San Carlos Bioenergy Inc. (SCBI) valued at US$16,000.
- Over 10,000 liters of sweet sorghum based vinegar was sold in the Philippines in 2013, with a gain of over 100% compared to that of 2012 (US$ 11,500), and which has a good market acceptance.
- The sale of the hand sanitizer produced from sweet sorghum has grown by 840% to reach 400 kiloliters in 2013. This is expected to double in 2014 (gaining US$ 7,500).
- The projected sale volume of syrup, powdered sweetener and energy drink was promising in 2013 and is expected to grow manifold in 2014.

There is a huge demand for ethanol and fodder. The principle of IMOD is used in linking smallholder farmers in a 40 km radius of the centralized

Sweet sorghum products.

distillery of Tata Chemicals Limited (TCL), Nanded, Maharashtra by ICRISAT. Farmers received inputs for cultivating the crop from TCL, while ICRISAT provided seed of improved sweet sorghum cultivars and capacity building of farmers and TCL personnel. Incomes of about 2000 farmers increased by 35 to 60% based on the productivity of stalks.

A plantation of SPV 422 in the Philippines.

The sweet sorghum crop is new to smallholder farmers. Hence a unique selling point was created for their produce through linking them to the industry, which depended solely on farmer's produce. The product chain in India is ethanol, bagasse, bio-power, while in the Philippines it is ethanol and vinegar. However, TCL could not continue operations further as the ethanol selling price was restricted to ₹ 27/liter (USD 0.4), too low to be viable to the industry although farmers were benefiting. The Filipino farmers are continuing sweet sorghum cultivation even after the closure of the project through support of a farmers cooperative, the Bapamin enterprises.

The factors that influenced success are economic viability accrued due to enhanced productivity of improved cultivars, besides proper selection of farmers who are progressive. The other factor was the multi-product nature of the value chain- ethanol, vinegar, bio-power, bagasse. Also of importance is the fact that the partnerships worked on a "shared vision".

The Way Forward

- Promote sweet sorghum as complementary feedstock in sugar mill areas
- Promote sweet sorghum as a fodder crop involving the dairy industry and capitalizing on the shortage of forage and fodder in India
- Create more evidence based success stories to popularize the technology and to leverage higher policy support
- Strengthen the market for vinegar and sanitizer while promoting the sweetener and energy drink in the Philippines
- Expand the area of sweet sorghum as a biofuel feedstock by linking with bioenergy firms in the Philippines.

Key Information

Name of the project: Linking the poor to global markets: Pro-poor development of biofuel supply chains

Project duration: January 2008 to June 2011

Key scientist(s) involved: India: P Srinivasa Rao, Belum VS Reddy, Ch Ravinder Reddy; Philippines: Heraldo Layaoen, Tony Arcangel, Rex Demofelis, Honorio M. Soriano Jr, Geraldine C. Sanchez

Key partners: ICRISAT, Tata Chemicals Ltd, MPKV Akruthi Agricultural Association (NGO), MAU, ANGRAU, - India

DA-BAR, DOST- PCARRD, Mariano Marcos State University (MMSU) Philippines, SCBI, Bapamin farmers cooperative, Batac.

This work was undertaken as part of the CGIAR RESEARCH PROGRAM ON Dryland Cereals

General Country Information

94.10 million
Ethiopia (Population, 2013)

100,000 ha
Total land area (2012)

$46.87 billion
GDP

13,257,540 ha
Cultivated land (2014)

Labor force in agriculture – 36.09 million

Rural population (2010) – 68.3 million

Number of rural poor (2010) – 26.8 million

Arable land overal (%) – 15.35

Major crops grown – Chickpeas, sorghum, millet, maize, wheat, barley, teff and beans

The chickpea revolution in the country stimulated by large scale adoption of market preferred large seeded kabuli chickpea varieties has contributed to 86% increase in production as a result of 39% increase in area and 34% increase in productivity during the past decade.

Nearly 47% of the country's 113 m ha land area is covered by semi-arid and dry sub-humid climatic zones

Issues related to Poverty:

An ineffective and inefficient agricultural marketing system; Underdeveloped transport and communications networks; Underdeveloped production technologies; Limited access of rural households to support services; Environmental degradation and frequent droughts; Lack of participation by rural poor people in decisions that affect their livelihoods.

Source: Agriculture Statistics report, Government of Ethiopia, 2014; FAO stat website (http://faostat.fao.org/CountryProfiles/Country_Profile); IFAD - ruralpovertyportal.org; http://www.ethiopia.gov.et/web/Pages/Economy

Photo: Christopher Ochieng Ojiewo, ICRISAT

Drs Seid Kemal and Chris Ojiewo examining Ascochyta blight screening plots at Minjar, Ethiopia.

Pathways to nutrition

Chickpea Revolution in Ethiopia

Contributed by

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Traditionally, undernourishment in Ethiopia is partly due to poor dietary habits because of poverty-driven dependence on cereal based diets, as well as numerous and long religious fasting periods, when people abstain from eating animal products. In this context, chickpea is a cheap source of protein (>20% protein), supplementing the cereal-based diets, particularly in rural areas, and for the majority of the population, substituting for meat during fasting periods. Moreover, chickpea, which covered about 240,000 ha of the cropped land in the 2012/13 cropping season, is often grown as a cash crop, providing valuable income for farmers. Chickpea is mainly eaten in the form of 'shiro',

Chickpea intercropped with sorghum in Kobo.

a homogenous stew eaten as an accompaniment to 'injera', a sourdough flatbread with a slightly spongy texture eaten by all households and at almost all meals. The additional advantages of chickpea production is that it improves soil health, reduces cereal pests (diseases, insects and weeds), maintains soil fertility by fixing atmospheric nitrogen and increases crop yield by enhancing water use efficiency.

However, chickpea production is still dominated by smallholder farming households with limited access to inputs, including quality seed of improved legume varieties. New varieties with yield potential of more than two tons per hectare have been developed and released, but many farmers continue to get yields below 500 kg/ha due to use of unimproved old varieties combined with poor agronomic practices. Chickpea farmers are constrained by lack of both physical and economic access to good quality seed due to limited physical, financial and human resources at the NARS level in Ethiopia. Chickpea is a self-pollinating crop with

Photo: Christopher Ochieng Ojiewo, ICRISAT

a fairly low seed multiplication rate, and on-farm seed saving is a well-established tradition among farmers, most of whom are women, who self-source about 80% of their annual seed needs. The private sector involvement in chickpea seed production and marketing is therefore limited, considering also the high transaction costs for seed transport, processing and storage. Chickpea is predominantly grown as a rainfed crop on residual soil moisture and experiences increasing soil moisture deficit at the critical stages of pod filling and seed development. Thus, terminal drought is a major constraint to chickpea production. Planting early to catch up with the peak of rainfall is not an attractive option due to the associated problem of ascochyta blight, which can wipe out a whole crop. Farmers end up either planting too early, or planting too late and losing most of the crop to ascochyta blight or terminal drought. Besides, there is limited use of external inputs such as fertilizers that facilitate healthy crops. Thus, resultant poor prices, and lack of market information and exploitation by intermediaries discourage farmers from putting all efforts in following integrated crop management technologies for chickpea production.

The Solution

The first intervention towards a solution was based on science. Beyond evaluating local germplasm, the chickpea breeding program of the Ethiopian Institute of Agricultural Research (EIAR) is involved in variety development through parental crossing using advanced breeding lines acquired from ICRISAT and ICARDA. Besides, some of the elite lines from these two institutions have been evaluated and released directly as superior varieties. In addition to yield increase, there have been significant improvements in seed size, quality, disease resistance levels, abiotic stress tolerance levels and other attributes of agronomic and market advantage compared to the landrace varieties. In particular, mention must be made of resistance to major diseases such as aschochyta blight in the kabuli variety 'Arerti' and fusarium wilt resistance in ICRISAT-developed varieties, which have improved farmers' resilience, revolutionized production, and expanded adoption of the new varieties. These new varieties have been promoted in participatory variety evaluation and selection, whereby several advanced lines are tested against standard varieties in the farmers' field and stakeholders jointly participate in selecting the best bet variety based on agreed criteria and priority traits. Under the ICRISAT-led Tropical Legumes II (TL II) project, much attention was placed on seed systems, which includes additional up-scaling approaches using the national seed road maps, small seed packs, community seed production through farmer seed producer groups and emerging seed

companies, and revolving seed funds. Many farmers have rated seed availability as the top constraint that limits variety adoption. Through the TL II project, alternative stakeholders along the seed value chain were identified to enhance availability of certified and quality declared seed, while EIAR availed the foundation seed. Further, on-farm demonstration of improved varieties and accompanying production packages have been implemented in many chickpea growing locations.

The Success

The joint research efforts by ICRISAT, ICARDA and EIAR have resulted in the release of 24 varieties of chickpea over the past four decades. Adoption of these varieties resulted in increased chickpea production to 322,839 t and productivity to 1.73 t/ha in 2012, compared to 2003-05 production and productivity levels of 168,000 t and 0.98 t/ha, respectively. The change in production is about 92% over the 2003-05 base figures, and both gains in area (33%) and productivity (77%) have contributed to these rapid increases. Past reports indicate that prior to the genesis of the Tropical Legumes II and Treasure Legumes projects, farmers' adoption of chickpea varieties and other production technologies was limited. Some of the reasons given were primarily market related issues that included (i) lack of sufficient surplus for markets due to low productivity of traditional varieties; (ii) low market demand for non-standardized, mixed, small-seeded and low quality grains produced from local varieties; (iii) underdeveloped delivery systems of input and seeds of improved varieties to farmers in affordable quantities and prices; (iv) high transaction costs and lack of reliable market outlets; and (v) vulnerability of most common varieties to insect, disease and pest problems. However while addressing these problems in a holistic manner along with key partnerships with stakeholders, chickpea variety adoption in the recent past has been on a fairly steady increase. In Ethiopia, 80% of chickpea is marketed locally while some 20% is exported mainly to the Asian and Middle East countries. Most of the kabuli varieties are consumed in Middle Eastern recipes. A nationwide technology scaling up program was launched four years ago, with emphasis on continuous improvement of chickpea for increased productivity.

How this was Market Driven

The local demand for chickpea in Ethiopia is high, creating a ready market for the producers. The excess produce is exported to Asia and the Middle East. Ethiopia accounts for more than 60% of Africa's global chickpea market, with the net household income from the trade estimated at US$1500 to 2000/ha. The country's average annual chickpea export was 34,308 t, with estimated annual foreign currency earnings equivalent to US$20.93 million each year between 2005 and 2010. Producer prices have increased from US$0.2/kg in 2001 to US$.6/kg in 2009. A recent assessment of the potential economic and poverty impact of 11 improved chickpea varieties released by EIAR in collaboration with ICRISAT estimated a total benefit of US$111 million over 30 years. It was estimated that consumers get 39% of the benefit and producers 61%. The benefit:cost ratio was estimated at 5:1 and an internal rate of return of 55%, indicating that investment in chickpea variety development and dissemination is highly profitable. The generated benefit was estimated to lift more than 0.7 million producers and consumers out of poverty.

Incorporating Inclusiveness

In Ethiopia, like everywhere else in the world, there are cultural preferences for particular ingredients, dishes, and ways of preparing food. As such, to be effective, the research on chickpea needs to take those consumer and market preferences into account. Researchers used their understanding of the biological characteristics of the ingredients to tease out the underlying genetic components and then used that information to develop farmer and market preferred chickpea varieties. To make this process work effectively, farmer participation and inputs in the research process was a requisite. On-farm evaluation required the development

of efficient mechanisms for monitoring progress and making sure that researchers and farmers understand each other. There was continual flow of information from farmers to researchers and back to farmers, including participatory appraisal, followed by testing of best bets, identification of best-in-class lines, and then multiplication and dissemination of those lines, keeping in mind the market preferences. Inclusion of women farmers through participatory variety evaluation and selection led to faster identification and adoption of improved varieties suited to small production niches (since more women are engaged in smallholder chickpea production and marketing, their experience gives them an advantage over men in variety trait identification, besides intelligence on consumer and local market preferences). The choice of best varieties was location-specific because different varieties respond differently in various environments, and there are also cultural differences in varietal preferences. As a result, farmers (and consumers) need to choose the varieties themselves to identify the varieties most likely to be accepted in their communities.

Improved varieties of chickpea were brought to farmers' doorsteps by conducting many on-farm participatory variety selection trials based on agronomic traits and market preferences, followed by large-scale demonstrations involving a selected few varieties. Several advanced lines were planted alongside standard varieties in farmers' fields; stakeholders jointly participated in selecting the best-bet variety based on stakeholder-determined criteria and priority traits. About 10,500 chickpea farmers in Ethiopia, participated in a total of 136 participatory varietal selection (PVS) trials conducted over the period from 2008-2014. In addition, 2,209 field demonstrations were organized to disseminate promising varieties and production technologies. During the PVS, 15 released or pre-released varieties were included along with a farmer's variety as a check. Participants outlined a number of preferred traits, which they arranged in order of priority. They then select preferred varieties according to the prior agreed preference criteria. This facilitated short-listing of varieties to be proposed for release or to be promoted. Thus researchers consulted with farmers who advised about the varieties best suited to their particular needs. The selection criteria included varieties that have less need of chemical sprays, tolerance to drought, are sweet tasting, easy to prepare in the

This lady farmer is happy to be growing an improved chickpea variety in her field.

Photo: Christopher Ochieng Ojiewo, ICRISAT

An ICRISAT stakeholder recording the success story of a progressive farmer.

kitchen, and marketable. For this end-user driven varietal development approach to be successful, it is also important for farmers to know what the market (consumers) wants from different chickpea varieties. Workshops, conferences and field days brought farmers, consumers, businesses, and the surrounding communities together to find out what varieties of chickpeas are preferred.

Open field days facilitated training of participants on how to produce and save the seeds they will need. To ensure that increased demand for seeds due to farmers' awareness of new varieties is met, research agencies worked closely with established institutions and private sector seed enterprises and conducted a total of 161 field days in which more than 2,500 farmers participated. Emerging seed companies and farmer seed grower groups evaluated and started growing the varieties chosen by farmers on their own farms. In this way, the farmers' decisions about the best varieties were communicated directly to seed producers, and they in turn responded to the demand. The companies also started doing the research necessary to make sure the new varieties met regulatory requirements for seed production and certification. Bringing farmers and researchers together throughout the year (and making sure that they continue to learn from one another), helped ensure that both groups contribute to the varietal outcomes. The engagement of farmers, the national programs, 7 regional research centers, processing industries, 5 seed enterprises, 20 seed growers associations, seed departments of regional bureaus of agriculture and NGOs enhanced sustainability and the adoption of new improved varieties.

Lessons Learned

The estimated level of adoption is now between 25-30%. The main drivers of adoption were:

- a) increased market demand and prices in the export market, especially of the kabuli types;

- b) reduction in the production costs with the new varieties;
- c) generally lower input levels compared to other crops;
- d) soil improvement, reduced need of nitrogen fertilizers and improved yields of subsequent crops when chickpea is used as a rotation crop, and
- e) increased consumption leading to increased local demand.

Farmers' voices were supported and amplified so that the seeds of their chosen varieties were made easily available throughout the country.

Less restrictive seed laws - allowing for community seed production and quality declared seed (QDS) - also helped local seed producers and companies gain access to the very lucrative seed market.

Quality seed of adapted varieties is an essential input for the production of chickpea. Breeding quality seed requires mastery of both the technical knowledge of seed biology (including the skills to overcome any biological restrictions) and the managerial skills to run a seed business. Training seed company personnel in these often-overlooked skills, as well as developing better systems for seed drying and packaging, made a huge difference in both the quality and quantity of locally sold chickpea seed. Seed suppliers, for example were trained on better methods for preserving seeds, better packaging and truthful labelling with appropriate information for the farmers.

In addition to technical and managerial support needs, there are policy-related constraints to the supply of quality chickpea seeds. One of the biggest problems is the private sector's lack of access to foundation seeds—the approved seeds formally available for seed production—from the seriously underfunded public sector. Through the TL II Project, ICRISAT and partners developed innovative strategies for a "Shared Vision" that brought farmers, researchers, and seed dealers together to ensure adequate production and timely provision of foundation seed through a National Seed Road Map Strategy. The strategy involved players in the chickpea seed value chain including ICRISAT, ICARDA and national and regional seed enterprises (Ethiopian Seed Enterprise-ESE, Oromia Seed Enterprise-OSE, Amhara Seed Enterprises-ASE), NGOs (World Vision, CARE, Catholic Relief Services, TechnoServe), seed growing associations of revolving seed schemes (such as Lemelem Chefe, Hawiboru, Biftu, Chala, Megeretu Denkaka, Ude, Memerhager), and emerging private seed companies (Amwari plc) have helped to step up availability of various classes of seed. Similarly, regular discussions and common platforms with ICRISAT's strategic partners including NARES, private seed companies, NGOs, grain traders, input suppliers and farmer associations in production and marketing led to improved access to chickpea seed. Through such partnerships, farmers and extension agents were trained in legume seed production, storage, processing and marketing.

One example of a successful strategy for legume seed dissemination was the promotion of mini-packs of improved seeds, which ensured continuous supply and access to seeds by smallholder farmers. The use of customized mini-packs is based on the premise that farmers want access to new improved varieties but may not be able to afford the seed if packed in large quantities; farmers who cannot afford large packs are actually willing to pay for high quality certified seed at affordable sizes. The mini-packs approach also ensures that seed is marketed at accessible places, and by trustworthy or responsible local vendors who may be held accountable in case of compromised quality. Adopted by the TL II Project, the approach has helped speed up dissemination of chickpea varieties in Ethiopia. The private sector - especially emerging small seed companies, retailers and agro-dealers - enthusiastically embraced this approach. The TL II and its partners distributed over 1 million small seed packs (200-500 g) of chickpea and other legume seeds to smallholder farmers through seed retail outlets during 2012/13.

The Way Forward

- Production of some of the high-yielding and market preferred varieties of chickpea is affected

by ascochyta blight (AB) and fusarium wilt (FW) diseases. Considerable progress has been made by ICRISAT (fusarium wilt) and ICARDA (ascochyta blight) in introgressing resistance genes against the two diseases into breeding lines. However, at the moment, there is no variety that combines resistance to AB and FW in Ethiopia. We will confirm this resistance under sick plot (FW) and hot spot (AB) conditions in Ethiopia to identify unique lines with stable resistance under Ethiopian conditions. The resistant lines will be used to cross elite chickpea varieties/ genotypes to further enhance the agronomic traits of already popular/ superior varieties and to broaden the genetic base, enhance productivity, stabilize production, improve profits and cash in on the gains already made.

- Besides, in Ethiopia, like in many African countries, seed multiplication, distribution and trade are only allowed for varieties that have been officially released and registered. Plans are underway to fast-track the release of varieties that have been identified as superior by chickpea breeders, farmers and other stakeholders, but which have not yet been officially released and registered. Variety release, registration and commercialization will improve accessibility and availability of seeds of these superior varieties through formal trade. Some varieties of chickpea have been released in the neighboring countries (Kenya and Tanzania) and could easily be released in Ethiopia based on regional harmonization of variety release and registration procedures.
- Efforts will continue to strengthen existing seed producer groups by offering training and identifying and accessing quality seed. ICRISAT will support in the introduction of community seed systems through enabling local seed producers and establishing revolving seed delivery systems among farmer group members. Revolving seed delivery ensures wider reach of farmers with improved technologies over time without incurring additional cost. It will enable the emergence of a locally sustainable seed system. Where seed producer groups do not exist, we will form new ones.
- For commercial seed production, the raw material, that is the 'starter' seed has to be available in sufficient quantities at convenient locations and in good time. For public crop varieties, the responsibility to provide this foundation seed lies in the hands of public research institutions, which, many times, lack the capacity to multiply and provide it on time. ICRISAT will continue to collaborate with EIAR and its network of partners to multiply seed of popular varieties and provide foundation seed to seed producer groups and upcoming seed companies to produce commercial class seed.
- Small-scale seed producers may not reach a wide coverage of farmers apart from local ones around them. As such, if their production capacity improves and they are able to produce in excess of the needs of local farmers, they are likely to have carry-over seeds into the next season, which may not be of good quality. ICRISAT will help in linking these seed production farmer groups to major seed companies to ensure that all their produce is sold, possibly through contractual farming. ICRISAT will also link the major seed companies to major grain exporting/trading companies that have expressed willingness to produce large quantities of grain of specific varieties but who have been limited by lack of sufficient quantities of seed.
- ICRISAT will continue to identify and document chickpea market preferences and segmentation at the local and export markets in comparison/ coherence with farmer/producer preferences and challenges. The information gaps with regard to market demands and current producer trends will be used to refine the chickpea value chain efficiency. ICRISAT will identify the standards and grades being used in the international chickpea market and introduce those to the chickpea producers and marketers in order to meet these international practices. We will also identify the stages at which the good agricultural practices should be applied to ensure that post-harvest and market quality is enhanced and maintained.
- ICRISAT will establish and strengthen innovation platforms (IPs) as a forum for multiple stakeholders (men and women farmers, community organizations, input suppliers, transporters, market actors, traders, processors, wholesalers, retailers, support services) to develop, implement

and learn along functional legume value chains. Using participatory visioning, ICRISAT will design pathways for inclusive market-oriented development of chickpea value chains, including market opportunities, critical bottlenecks to chickpea marketing, as well as gender implications. They will then generate solutions (markets, technologies, social organization) that will improve the configuration and performance of the chains. ICRISAT will also map the currently existing actors and their relationships as compared to desirable configurations, to identify options for better alignment of stakeholders.

- The IPs will engage stakeholders in the legume value chains at different scales (community, district, provincial level) and define capability/ skills/knowledge gaps of farmers and support services. ICRISAT will then design training and capacity development activities, on (i) managing the IPs, including facilitation and coordination, roles and contributions, (ii) knowledge brokering, including updating on emerging market opportunities, new partnerships, (iii) technical aspects like seed systems, agronomy, natural resource management, and (iv) input and output marketing. Integrating technical knowledge and IP operations will help actors to become more effective in IP activities. The IP will thereby enhance stakeholders' capacity to make informed decisions on technical, institutional and policy options.

Key Information

Name of the project: Tropical Legumes Project II (TL II)

Project duration: September 2007 to December 2014

Key scientist(s) involved: Chris Ojiewo, NVPR Ganga-Rao, Kai Maush, Damaris Odeny, Said Silim, Pooran Gaur, Emmanuel Monyo, Rajeev K Varshney, CLL Gowda

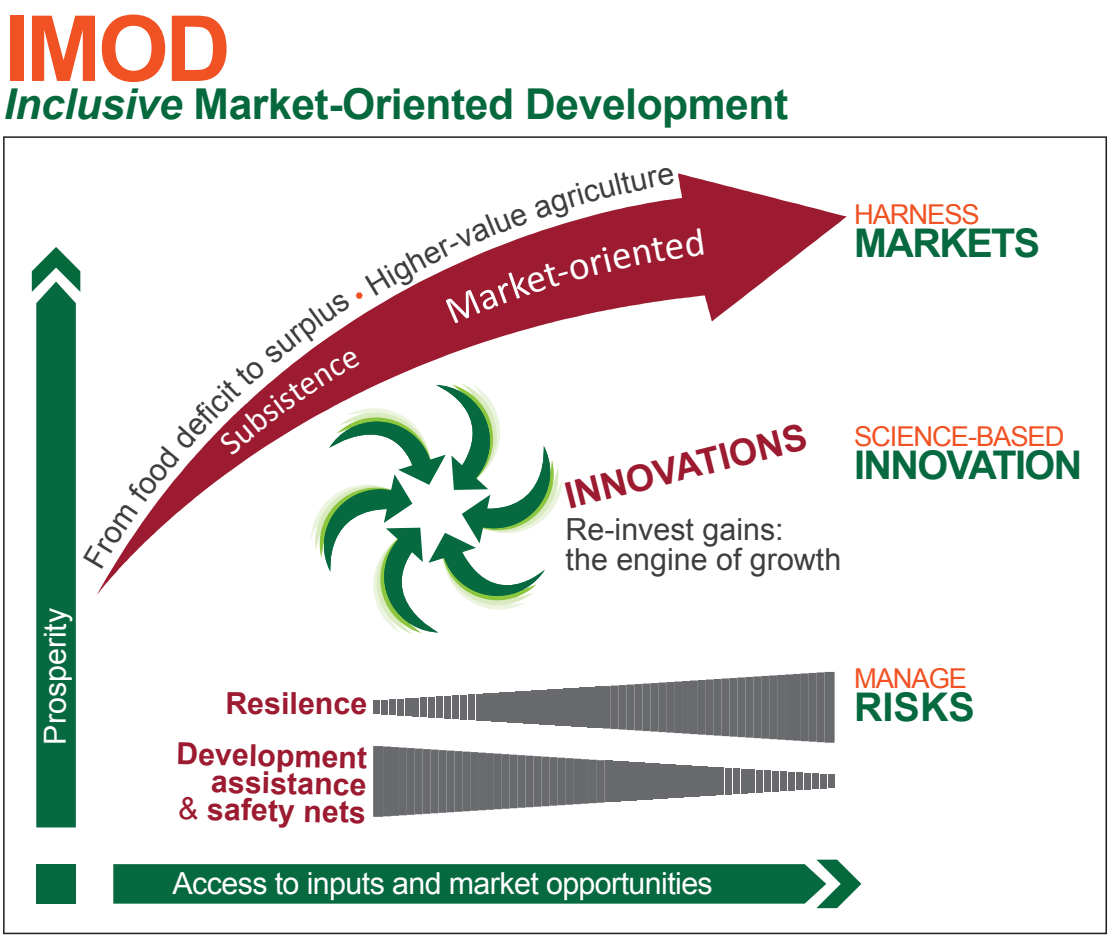
Key partners: Asnake Fikre, Million Eshete, Setotaw Ferede, Redwan Mohamed, Sherif Aliye, Chichaybelu Mekasha, Dagnachew Bekele, Lijalem Korbu, Seid Kemal, Zewdie Bishaw, Negussie Tadesse, JC Rubyogo, Yayis Rezene, Gashaw Sefera, Awol Mohamed, Getachew Tilahun, Mintesinot Worku, Tesfaye Gebre, Fekede Gemechu.

This work was undertaken as part of the CGIAR RESEARCH PROGRAM ON Grain Legumes

A new irrigation facility recently established at DZARC with ICRISAT's support, is put into action.

Photo: Christopher Ochieng Ojiewo, ICRISAT

Inclusive Market-Oriented Development (IMOD)



Inclusive Market-Oriented Development is a development pathway in which value-adding innovations (technical, policy, institutional and others) enable the poor to capture larger rewards from markets, while managing their risks. The larger rewards motivate the adoption and impact of these innovations.

The IMOD development pathway is a progression of development states in which the poor move from subsistence agriculture – characterized by poverty, food insecurity, malnutrition and land degradation - to market-oriented agriculture, characterized by prosperity, food and nutritional security, resilience and sustainable land management.

About ICRISAT

International Crops Research Institute for the Semi-Arid Tropics

ICRISAT is a member of the CGIAR Consortium

The **International Crops Research Institute for the Semi-Arid Tropics** (ICRISAT) is a non-profit, non-political organization that conducts agricultural research for development in Asia and sub-Saharan Africa with a wide array of partners throughout the world. Covering 6.5 million square kilometers of land in 55 countries, the semi-arid tropics have over 2 billion people, of whom 644 million are the poorest of the poor. ICRISAT innovations help the dryland poor move from poverty to prosperity by harnessing markets while managing risks – a strategy called Inclusive Market-Oriented Development (IMOD).

ICRISAT is headquartered in Patancheru, Telangana, India, with two regional hubs and six country offices in sub-Saharan Africa. It is a member of the CGIAR Consortium. CGIAR is a global research partnership for a food secure future.

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