



# Improving food security and nutrition in Africa



Few regions present bigger development challenges than the African drylands – home to nearly 300 million people, and the vast majority of Africa's poor. Food security and rural welfare in these areas are limited by a range of factors, biophysical, socio-economic and policy-related. And many of the biggest challenges – poverty, drought, land degradation, food insecurity – will be exacerbated by climate change.

Nevertheless, dry areas hold the key to Africa's food security – which is why ICARDA's research focuses on dryland agriculture. ICARDA has worked in Africa for over 30 years.

Together with our partners, we've developed new crop varieties, more resource-efficient farming techniques, income opportunities for farmers and pastoralists, tools to improve investment targeting, platforms to improve South-South collaboration...

This brief describes some of these innovations. It highlights the opportunities for investment by the African Development Bank to replicate these successes across larger areas, and help build a food-secure, poverty-free Africa.

## Rust-resistant wheat

Research in Africa is helping to protect wheat crops against virulent new strains of stem rust disease. One example is the strain Ug99, which originated in Uganda, spread to Kenya (cutting the wheat harvest by half in many areas), then to Ethiopia and North Africa, and now threatens parts of Asia and Europe. Most of the world's commercial wheat varieties are susceptible to Ug99.

### ICARDA in Africa

ICARDA is expanding its work in Africa, in scope as well as geographical coverage. Research is structured under two regional programs, with offices in five countries and implementing partners in many more.

- Nile Valley and sub-Saharan Africa: Egypt, Eritrea, Ethiopia, Sudan, South Sudan
- North Africa: Algeria, Libya, Mauritania, Morocco, Tunisia
- Offices in Egypt, Ethiopia, Morocco, Sudan, Tunisia

A collaborative program in Kenya and Ethiopia screened thousands of genotypes for rust resistance. High-yielding wheat lines resistant to multiple rust diseases have been developed, multiplied and distributed. A fast-track seed multiplication program in Ethiopia produced 155 tons of seed last season, distributed to 3700 farmers across the country. 'Trap' nurseries have been established in Egypt, Eritrea, Ethiopia, Kenya, Sudan and Uganda (among 32 countries worldwide) to monitor the spread of new pathogen strains.

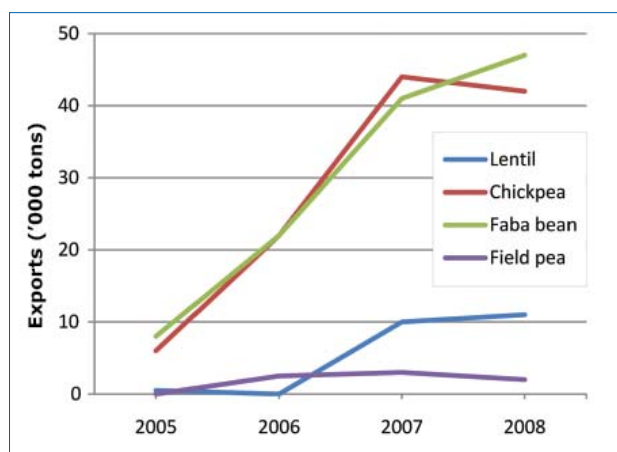
## Legume crops: protein plus profits

Collaborative research has helped increase production of legume crops – the main source of protein for millions of African households. ICARDA has a global mandate for research on some of Africa's most important legumes: lentil, faba bean, grasspea and kabuli chickpea. Ethiopia has released eleven new lentil varieties, of which nine are derived from ICARDA material. The new varieties have largely resolved the two biggest production constraints: waterlogging and fungal diseases. With good crop management, they consistently give yields six times as high as traditional varieties.

Between 2001/02 and 2007/08, Ethiopia's legume production grew by nearly two-thirds. Yields of chickpea and field pea increased by 30%. Lentil yields increased by 37%. Legume exports grew by more than 600% in 3 years (see chart).

## Water-saving technologies

Researchers have developed innovations that maintain or increase yields while saving huge quantities of water. Supplemental irrigation – the



*New high-yielding varieties have dramatically increased Ethiopia's legume exports.*

provision of small amounts of water, carefully timed for maximum effect – gives higher and more stable yields, reduces production risk, and doubles or triples water productivity. Supplemental irrigation 'packages' have been developed for cropping systems in Ethiopia, Morocco and Tunisia, as well as several countries in Asia. Burkina Faso, Niger and other countries have launched their own programs based on ICARDA's model.

Another example is raised-bed planting, which reduces irrigation time, percolation losses, and the quantity of water needed. In pilot areas in Egypt, the new system increased water productivity by 30%, and farmers' net income by 15%. A national project aims to scale out these and other technologies – developed jointly with Egyptian partners – on 2 million hectares.

## Rainwater harvesting

Food production in Eritrea has fallen by 60% over the last decade, largely because of frequent droughts. One solution: rainwater harvesting, which substantially increases crop yield as well as water productivity. A collaborative program in Eritrea used GIS analysis to help design water harvesting systems – providing a development model for drought-prone areas throughout Africa.

Researchers analyzed a range of biophysical and socio-economic parameters to develop 'suitability maps' that clearly identify which areas are best suited to which type of water harvesting system. Site suitability was assessed for six different water-harvesting systems and various land-use scenarios. Eight high-potential watersheds were identified. Pilot projects have begun on two of these sites, with more to follow.

## Conserving soil, water and rangelands

In agro-pastoral communities across Africa, productivity is declining rapidly as a result of overgrazing, inappropriate cultivation, erosion and recurrent droughts. The PADEL project in Mauritania, funded by the African Development Bank, introduced low-cost interventions that were successfully implemented by one pilot community, and soon spread to other communities nearby.

Community water and soil conservation groups were set up. Farmers and technicians were trained to build and maintain water-harvesting and erosion-control structures. New fodder and rangeland species were tested, multiplied in community nurseries, and then planted widely, to rehabilitate degraded rangeland

areas. Contour ridges captured 14 cm of soil per meter length per year. Bunds and terraces captured 60% of rainfall runoff. In the first season, a small dam collected 45,000 cubic meters of water – enough to irrigate 6 hectares of crops. Runoff strips saved 15,000-30,000 m<sup>3</sup> of water. In all, one community harvested 60,000 to 80,000 m<sup>3</sup> of water every year.

## Integrated land and water management

The Matrouh Project in Egypt is another example of science-based, community-led management of natural resources. The project targeted 20,000 km<sup>2</sup> in a drought-prone region. Following detailed studies of topography, soil and hydrology in 64 watersheds, researchers designed a 'package' that combined watershed management, crop and horticulture technologies, fodder production and rangeland rehabilitation. The package was implemented by 38 communities with technical back-up from project staff.

Fig and olive production increased by 60%, vegetable production by 27%. Net incomes rose by 52%. Among barley farmers, 40% increased yields by at least 70%, many by 100%. One-fifth of farmers have replaced barley monoculture with crop rotations. Over 7 million fodder shrubs and 69 km of windbreaks were planted, and degraded rangeland areas re-seeded. Communities built check dams to reduce erosion, and harvested enough water to irrigate more than 300 hectares. Investments in water harvesting yielded annual returns of more than 300%.

## Building skills

ICARDA and its partners have helped build R&D capacity in countries across Africa. For young researchers we offer training courses, internships and support for graduate study. For extension staff and



*ICARDA training programs have helped create or expand biotechnology research in several African countries.*

## Impacts in Africa

Farm surveys covering 850 households in Egypt, Ethiopia and Sudan measured the impacts of wheat and faba bean research on food security, income and poverty.

### Nutrition

In Ethiopia, farmers who adopted the new faba bean varieties produced double the food that non-adopters did. Per capita wheat yields increased from 164 to 322 kg in Sudan, 537 to 1219 kg in Egypt. Food consumption increased by at least 27% in every household, and by more than 80% in some cases.

### Income

With higher yields, farmers had larger surpluses for sale. Adopters earned much higher net returns than non-adopters. The increases per hectare were \$1190 (43%) for wheat in Egypt, \$164 (52%) for faba bean in Sudan, and \$180 (55%) for faba bean in Ethiopia.

### Poverty

Households were classified into three groups: poor (per capita income < \$1 per day), intermediate, and relatively better off. Using faba bean as an example: 3% of adopters in Ethiopia, and 12% in Sudan, moved up from 'poor' to 'intermediate'. In Egypt, 14% of adopters moved up one category.

farmers we offer on-the-job training, farmer field schools and other opportunities. Between 1999 and 2011, nearly 2300 researchers from nine African countries – including more than 500 women – benefited from these programs. Forty-three researchers from seven countries completed their Masters or PhD theses, co-supervised by ICARDA scientists. Another 28 researchers are conducting thesis research linked to ICARDA projects in Africa.

## Understanding poverty

To better target future investments, ICARDA helped develop the first comprehensive 'poverty maps' for North and South Sudan. The study quantified poverty incidence in different regions; examined the effects of natural resource endowments, infrastructure, gender and other factors; and identified previously unrecognized pockets of vulnerability in both countries.

Detailed maps were produced of agro-ecological, climatic, and soil indices for different ecological zones in each country. Technology and policy interventions





*Spineless cactus provides multiple benefits – livestock fodder, erosion control, soil nutrients, re-greening degraded areas.*

were identified for each zone. Despite the challenges, both countries have enormous potential to increase food production: yields can be increased by at least 46% in every ecological zone – and up to five-fold in some areas – using currently available technologies. National policy makers plan to use the poverty maps to focus on the most vulnerable areas.

## New sources of livestock fodder

The introduction of two new plant species has significantly improved fodder supplies in Morocco and Tunisia. Saltbush (*Atriplex*) and spineless cactus (*Opuntia*) were introduced as ‘alley crops’ to replace the traditional barley-fallow system. Both are hardy species, able to thrive in dry areas and poor soils.

In Morocco, the new *Atriplex* system increased barley grain yield by 17% and barley straw yield by almost 100%. The extra feed enabled owners to increase flock size by 25% and reduce feed costs by 33% on average. *Atriplex* has been adopted by almost 60% of smallholder farmers, and 95% of those with larger holdings. In Tunisia, the introduction of spineless cactus increased biomass yield by 57%, and reduced feed costs by 13%. The technology was adopted by 30% of farmers – and even by 20% of farmers who owned no livestock (they grew fodder for sale).

## Technology packages for food security

An ICARDA-led project for the Arab region targets seven countries, including four in Africa: Egypt, Morocco, Sudan and Tunisia. The portfolio includes

new crop varieties, improved irrigation methods, crop and soil management and socio-economics research. The first year of implementation focused on scaling out technology ‘packages’ for wheat.

In Egypt, wheat yields increased by 30%, water-use efficiency by 80%. In Sudan, the combination of heat-tolerant varieties and raised-bed planting increased yields from 1.6 to 3.4 tons per hectare. In Morocco, yields under irrigation increased by 60%. In other trials, ‘deficit’ irrigation reduced water consumption by 30% with no loss of yield. In Tunisia, yields increased by 28% with small amounts of supplemental irrigation. Zero-tillage reduced production costs significantly, increasing net returns by 24%.

The project is being used as a model for a government-funded technology roll-out program in Egypt, with demonstrations at 600 sites.

## New horizons

A new AfDB-funded project, Support to agricultural research for the development of strategic crops in Africa, targets ten low-income countries. The project will focus on four crops – cassava, maize, rice and wheat. The partners include ICARDA, the International Institute of Tropical Agriculture and AfricaRice. The project aims to contribute to lasting improvements in food security, natural resource management, and research and extension capacity. It also aims to create a model that shows how investors, researchers, development agencies, farmers and policy makers can work together to ensure food security in Africa.

### ICARDA offices in Africa

- Addis Ababa, Ethiopia
- Khartoum, Sudan
- Rabat, Morocco
- Cairo, Egypt
- Tunis, Tunisia