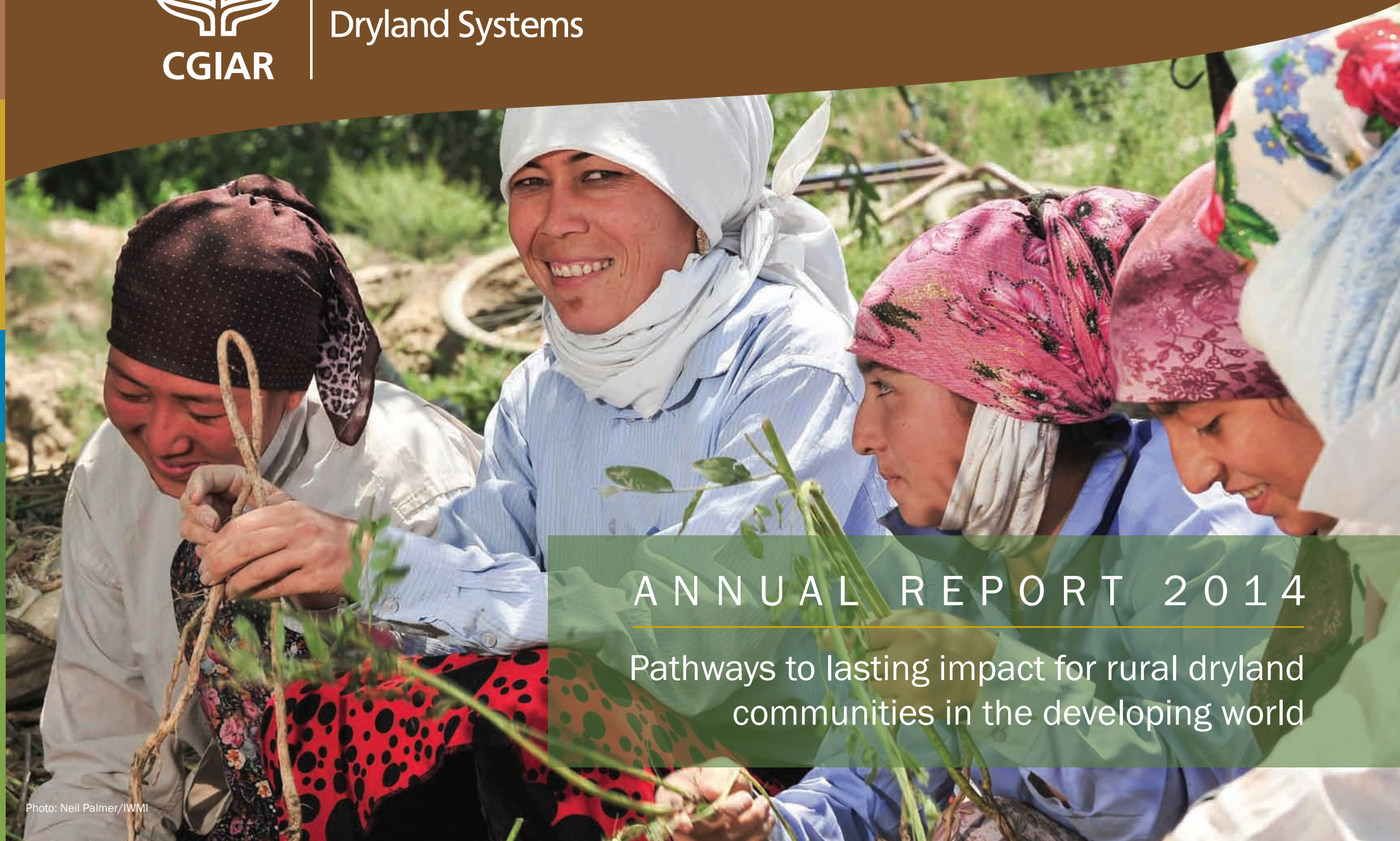




RESEARCH  
PROGRAM ON  
Dryland Systems



## ANNUAL REPORT 2014

Pathways to lasting impact for rural dryland  
communities in the developing world



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Photo: Biodiversity International



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Photo: IWMI/N. Palmer





Photo: ICARDA/Rajita Majumdar

# Dryland Systems at a glance

The CGIAR Research Program on Dryland Systems is a global agricultural research partnership to realize the potential of dryland communities. The program brings together eight CGIAR centers, and numerous international, regional, and national partners to engage in integrated agricultural systems research. Unique partnership platforms contribute to improved food security, equitable and sustainable natural resources management, and better livelihoods in the world's dry areas.

## Our vision

We envision prosperous rural dryland communities with higher incomes, better access to food, improved nutrition and health, and increased capacity to manage natural resources in equitable, sustainable, and innovative ways.

## Our mission

We seek to improve the lives of 1.6 billion rural people, and to mitigate land and resource degradation in 3 billion ha covering the world's dry areas by providing scientific evidence generated through our unique integrated agricultural systems research.

## Our beneficiaries

Dryland Systems works to benefit the poorest, hungriest, least healthy, and most marginalized people living in rural drylands. In many areas, the degraded natural resources on which their livelihoods depend contribute directly to their low levels of well-being.

Our research primarily targets the needs of smallholder farmers, agropastoralists, pastoralists, and livestock producers. Others who add value along the chain from producer to consumer also stand to benefit from our work. In particular, we target women farmers and young people in search of dryland agricultural opportunities to improve their livelihoods, as well as other marginalized communities excluded from mainstream development. In our work to improve nutrition and food access, we particularly target women and children in the poorest households.

Most of our beneficiaries live in the world's two regions where poverty and hunger are most prevalent: Sub-Saharan Africa and South Asia. We believe that our efforts to address the needs of impoverished and marginalized dryland communities will be critical contributions to achieving the proposed United Nations' [Sustainable Development Goals](#).

Other groups not directly targeted by our program are also likely to benefit from our research work. For example, systems research on climate change in drylands will help people cope with expected increases in droughts and other severe weather events. Similarly, systems research on access to scarce natural resources in drylands can help reduce the potential for conflict in the world and thus contribute to peace, prosperity, and thriving trade among countries and regions.



# Message from the Director General, International Centre for Agricultural Research in the Dry Areas



**Mahmoud Solh**

***Director General***

International Center for Agricultural Research  
in the Dry Areas (ICARDA)

Home to around 2.2 billion people, the world's dry areas face pervasive rural poverty, hunger, and land degradation. Most drylands are found in the developing countries where the majority of the world's poorest, food-insecure, and most marginalized communities live. Yet drylands receive very little attention and/or investment from researchers, development agencies, policymakers, or the private sector. The cost of inaction in these regions is high in economic terms, human suffering, and insecurity. To address dryland issues is to address sustainable development goals. The CGIAR Research Program on Dryland Systems is of critical importance for many global challenges, such as food and water security, nutrition, poverty, land degradation, climate change, population growth, and the development aspirations of the regions concerned.

Development programs in the drylands have often failed in the past due to misconceptions or to undue simplification of the issues that ignore

their complexity and variability biophysically and socio-culturally, and their biophysical and socio-cultural interactions. The work of Dryland Systems aims to overcome these misconceptions and fill knowledge gaps to inform development policies at local, national, and global levels so that rural dryland communities of the developing world are no longer ignored, misunderstood, or marginalized.

Dryland Systems brings together eight international agricultural research centers worldwide and many national partners under the coordination of the International Center for Agricultural Research in the Dry Areas (ICARDA), which has been working in non-tropical dry areas since 1977. As Lead Center, ICARDA aims to address dryland challenges through the articulation of a new paradigm of holistic integrated systems research inherent in the Dryland Systems program. This involves combining production systems interventions with policy, institutional, and market interventions as a means of ensuring higher farming profitability, increased food security, and better dryland livelihoods, while maintaining the natural resource endowment for future generations.

For ICARDA, Dryland Systems represents a unique opportunity to streamline research activities and operations in dry areas, and to engage in greater interdisciplinary collaboration with new and existing partners. Dryland Systems helps provide the knowledge, tools, and practices that all partners

# Message from the Program Director, Dryland Systems

can use to generate large-scale impact in reaching out to farmers and farmer associations, national and global policymakers, civil society and private sector participants, academic institutions, and development agencies.

I would like to take this opportunity to sincerely thank all our donors and partners, as well as all the people who have invested in the successful implementation of the Dryland Systems program.

## Message from the Program Director



**Richard Thomas**

***Program Director***

CGIAR Research Program on Dryland Systems

Dryland Systems is an essential component of the CGIAR research portfolio. The program's research findings aim to catalyze equitable and sustainable development in marginalized rural dryland communities of the developing world. We aim to create real opportunities for men, women, and young

people in drylands by enhancing their capacity for improving their lives, while preserving natural resources and biodiversity, and adapting to climate change. Commonly referred to as the 'forgotten billion'<sup>1</sup>, rural dryland communities in the developing world have suffered a history of neglect, being bypassed by private and public sector investment, and marginalized in the discourse on sustainable development.

We aim to overturn this neglect and to shape the drylands discourse by producing a robust body of scientific knowledge that includes technological, policy, and institutional innovations to address major dryland challenges. Our research aims to be useful to diverse stakeholders for articulating and delivering evidence-based development outcomes for impoverished rural dryland communities.

In 2014 we made significant advances in refining our systems research approach and sharpening the results-based management of the program. Our holistic systems analysis is helping us build a comprehensive picture of various dryland development constraints and opportunities so that we can identify the most appropriate research-in-development interventions. We started reorganizing the program under an agricultural livelihoods systems framework that tailors intervention options to specific development contexts. Used for the first time by our teams in Central Asia, South Asia, and Africa, the options-by-context analysis is proving to be a robust integrated approach that

<sup>1</sup> Middleton, N., L. Stringer, A. Goudie and D. Thomas. 2011. The Forgotten Billion. MDG Achievement in the Drylands. United Nations Development Programme, New York, USA and United Nations Convention to Combat Desertification, Bonn, Germany.

takes into account the immense diversity of drylands. It allows us to address both biophysical and socio-economic issues that affect overall systemic improvements in food security, sustainable natural resource management, health, and livelihoods. Development of several integrated systems modeling approaches – ranging from crop sub-systems modeling, bio-economic modeling, and gender role assessments to participatory modeling – is in progress. These approaches lie at the very heart of the process to improve the integrity of agricultural production systems in drylands.

Our 2015 Program of Work and Budget incorporates over 30 recommendations on the science of systems research from the Science and Implementation Meeting organized by the Independent Scientific Advisory Committee in July 2014. The program revised its Impact Pathway, and the Task Force that is working to align the program's research portfolio to the new CGIAR Strategic Results Framework is articulating a new Theory of Change.

In 2014, following recommendations from the Consortium Office and audit, the program introduced a new governance and management structure, and strengthened the Program Management Unit. A prototype web-based Monitoring, Evaluation, and Learning (MEL) platform was launched, which will enable better reporting, coordination, risk management, and performance evaluation, as well as improved knowledge sharing and learning across the program. Other CGIAR Research Programs have expressed interest in adopting and adapting our MEL platform for their needs.

The Research Management Committee established two Dryland Systems working groups – one for data management and open access, and the other for gender and youth. Three other groups – communications and knowledge sharing, capacity development, and integrated systems analysis and modeling – were also established in early 2015. The working groups ensure program coordination globally among all partner centers by developing joint work plans that cut across disciplines. They help to integrate and ensure equity among participating centers, and forge strong links with other CGIAR Research Programs, especially those engaged in systems research.

In response to cuts in the 2014 and 2015 budgets, the program reduced the number of action sites from 23 to 13. We suspended activities in West Asia and at one action site in Central Asia. The funding cuts posed major constraints in developing and sustaining meaningful partnerships, and in maintaining the credibility of the program. However, our response has been to revisit our research activities and strategically select those that will deliver the greatest impact, while leveraging partnerships for greater synergy, shared costs, and increased capacity development for future sustainability.

Dryland Systems is making use of the 45 innovation platforms (IPs) that we have established so far. Through these inclusive and interdisciplinary IPs, we engage with the next and end users of our research to mainstream holistic systems research thinking to ensure our findings shape desired development outcomes. This work ensures that our research has a real impact on the ground, empowering rural dryland communities to strengthen



their resilience, increase food security, and ensure social equity and sustainability in the management of common resources. Thus, we aim to create an enduring basis for identifying the key system drivers that can bring about scalable livelihood improvements in drylands at local, national, and global levels.

I am extremely grateful for the incredible work and unfailing enthusiasm of our partners and staff in helping to sharpen the program's strategic vision and research focus, despite the many challenges we faced. The year ahead will no doubt test us in new ways but I look forward to working together in 2015 to deliver integrated systems research that helps rural dryland communities realize their often misunderstood potential.

*“In our interconnected world, drylands are important to us all for climatic, economic, and geopolitical reasons.”*

**Gnacadjia and Kjorven 2011<sup>2</sup>**

<sup>2</sup> Gnacadja, L. and Kjorven, O. 2011. Foreword. Page 7 in Middleton, N., Stringer, L., Goudie, A., Thomas, D. 2011. The Forgotten Billion. MDG Achievement in the Drylands. United Nations Development Programme, New York, USA and United Nations Convention to Combat Desertification, Bonn, Germany.



Photo: World Agroforestry Centre

# Our research



A sound understanding of the complexity and dynamics of dryland ecosystems – which are incredibly varied and diverse in terms of both biophysical elements and political and socio-economic issues – is necessary to help rural dryland communities achieve viable pathways to development, prosperity, health, and well-being. For many years researchers have tended to focus on particular aspects of dryland agriculture, such as crops or irrigation, rather than on the agro-ecosystem as a whole.

While our work will remain anchored in traditional improvement programs for crops and livestock, the CGIAR Research Program (CRP) on Dryland Systems takes a holistic ‘systems’ research approach. This seeks to understand the interactions and trade-offs between the whole spectrum of elements that constrain or improve dryland agricultural productivity to identify the most appropriate research-in-development interventions. Our program combines scientific evidence and indigenous knowledge to address and increase the visibility of dryland issues that have a considerable impact on emerging global issues such as food security, land degradation, and climate change.

Our research aims to provide the evidence required to help put dryland issues firmly on the development agenda at national, regional, and global levels. Dryland Systems research informs the interventions required by providing international public goods – tools, methods, practices, policies, and technologies – to enhance the economic and social well-being of rural dryland communities, enhance their resilience in the face of climate



variability and change, and strengthen their adaptive capacity to manage natural resources in an equitable and sustainable fashion. Gender and youth issues, as well as options for alternative and diverse livelihoods, direct our research efforts to understand and support sustainable dryland ecosystems in the long term.

The value of integrated systems research (Table 1) is that it:

- Offers a comprehensive understanding of drylands development challenges by examining place-based social, financial, technical, and environmental contexts
- Develops and formulates appropriate technologies, practices, institutions, and policies for solving those challenges
- Facilitates scaling-out and scaling-up for greater development impact
- Allows multi-stakeholder engagement for greater ownership of impact
- Builds capacities to innovate for more sustainable development impact
- Applies continuous monitoring, evaluation, and learning
- Strengthens the science–policy interface that has prevented governments and international bodies from delivering changes on the ground to rural communities
- Provides credible evidence for increased investment in drylands.

## Definition of integrated systems research

*A holistic and interdisciplinary research approach that integrates components of human and agro-ecological systems across all dimensions to improve agricultural livelihoods in drylands.*

Integrated systems research entails:

- Developing and testing – with farming households and development partners – feasible combinations of technical, market, governance, and policy options to improve agricultural livelihood systems
- Focusing on total farm productivity – including closing yield gaps of system components
- Monitoring and evaluating appropriate system-level indicators that capture change and the rate of change (for whom, where, to what extent and how) to support land users' adaptive capacity and management
- Continuous learning and knowledge sharing across various scientific disciplines.

## OUR RESEARCH

The program studies two main environments: first, areas where production is inherently low, and, secondly, regions where agriculture can be sustainably intensified. Within these environments the research focuses on agricultural livelihood systems (ALSs) grouped as follows:

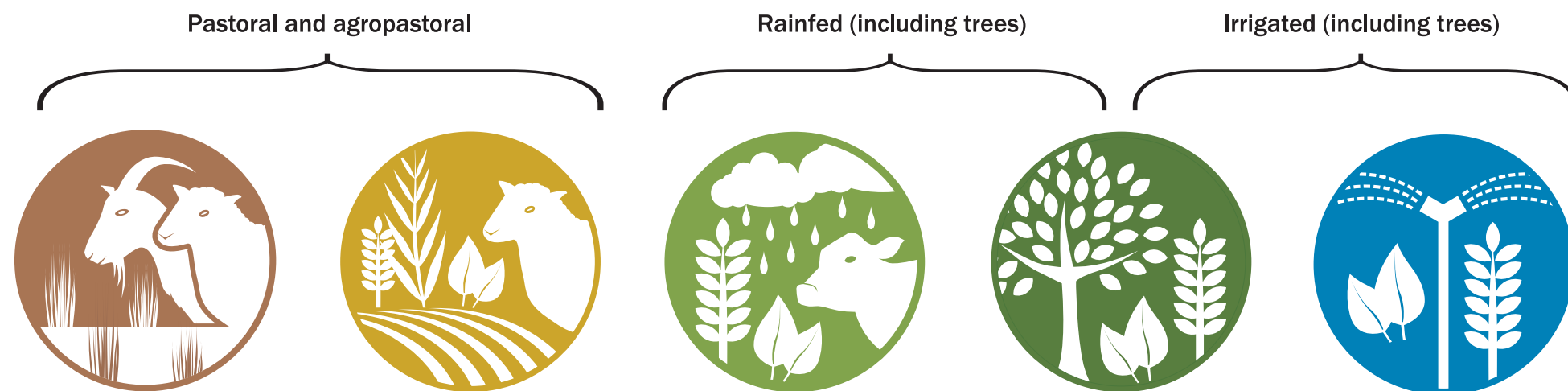
- Pastoral and agropastoral systems
- Rainfed systems (including tree-based systems)
- Irrigated crops systems (including tree-based systems).

**Table 1: Comparison of the Systems Approach With Conventional Approaches**

Conventional approaches	Integrated systems research approach
Focus is on single commodities and single livelihood components	Focus is on farming <i>systems</i> and livelihood <i>portfolios</i>
Aimed at improving productivity and closing yield gaps, regardless of risk	Explicit consideration of trade-offs among multiple aims – improving productivity, reducing risk, and social, economic, and environmental sustainability. Aimed at multiple wins where possible, or balance among trade-offs where not
Focus is on discrete value chains, overlooking externalities	Attention given to interactions between value chains, explicitly considering externalities
Focus is on innovations and investments responding to specific drivers of change within sectors at discrete scales	Focus is on interactions between multiple drivers of change, and innovation and investment options across sectors and scales
Linear, research- <i>for</i> -development approaches	Iterative research- <i>in</i> -development approach
Mono- or multi-disciplinary	Inter- or trans-disciplinary



**Figure 1: Dryland Agricultural Livelihood Systems**



### **Definition of Agricultural Livelihood Systems (ALS)**

ALSs are defined as the sets of farming and other human activity systems that determine the livelihood opportunities for agricultural households, communities, and enterprises (Figure 1).







At one end of the ALS spectrum – pastoral and agropastoral livelihood systems where resources are scarce – we work to build resilience. We provide farmers with innovative practices and technologies to mitigate risks and vulnerability in the face of climate variability and extreme events, such

as drought, flooding, and outbreaks of pests and diseases. In such systems, intensification is possible for subsistence farmers but it generally involves significant trade-offs that must be considered so that resources are not over-exploited.

At the other end of the ALS spectrum – rainfed, tree-based, and irrigated systems where resources are richer and more diverse – we work to provide farmers with innovative practices and technologies to intensify sustainable production and therefore increase yields, maximize incomes, add value to products, enter into commercial agriculture, and diversify livelihood options.

For each system, we formulate research hypotheses to respond to the grand challenges in drylands (Table 2).

**Table 2: Grand Dryland Challenges in Major Agricultural Livelihood Systems**

Grand dryland challenges	Agricultural livelihood systems					
	  Pastoral and agropastoral systems	  Rainfed crop-livestock systems	  Irrigated crop systems			
Climate change	<div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div></div>	<div><div></div></div>			
Water allocation and management under scarce conditions	<div><div></div><div></div></div>	<div><div></div><div></div></div>	<div><div></div><div></div><div></div></div>			
Land degradation	<div><div></div><div></div><div></div></div>	<div><div></div><div></div></div>	<div><div></div><div></div><div></div></div>			
Institutions and governance	<div><div></div><div></div><div></div></div>	<div><div></div><div></div></div>	<div><div></div><div></div></div>			
Market access	<div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div></div>	<div><div></div><div></div></div>			
Gender equity and youth employment	<div><div></div><div></div></div>	<div><div></div><div></div></div>	<div><div></div><div></div><div></div></div>			
Agricultural production intensification and diversification	<div><div></div><div></div></div>	<div><div></div><div></div><div></div></div>	<div><div></div><div></div></div>			

● = Same   ●● = Significant   ●●● = High



The program aims to deliver packages of technical, market, governance, and policy options that can sustainably improve livelihoods in these systems.

## Dealing with diversity

Drylands are diverse both within and between dry regions; they vary climatically, topographically, environmentally, economically, socially, and culturally. For example, the steppes of Central Asia and African savannas are very different from the Mediterranean littoral and plains of India and Pakistan. Despite this diversity, drylands face common challenges.

To deal with both differences and similarities, the program has 13 'action sites' that represent the main ALS encountered across 3 billion ha in five flagship regions: West Africa Sahel and the Dry Savannas; North Africa and West Asia; East and Southern Africa; Central Asia; and South Asia. The extensive network of Dryland Systems partners then rapidly scales-out technologies and practices that have proved successful across similar dryland environments.



### Diverse dryland environments

#### West Africa Sahel and the Dry Savannas (WAS&DS)

Farming communities struggle with drought, soil erosion, and poor infrastructure. Poverty and a lack of support services make things worse. Cropped areas are expanding and pastures are shrinking, making pastoral and agropastoral livelihoods less viable. In this region, the program develops links between smallholder farmers and regional livestock markets. The program introduces new ways to manage land and water to make scarce resources more productive. In innovation platforms in Mali and Ghana, work helps farmers increase crop yields and diversify production into vegetables.

#### North Africa and West Asia (NAWA)

Climate change is likely to hasten degradation of aquifers in NAWA. Agropastoral lifestyles are dying out as young people migrate from rural areas and as farms fragment and become too small to be viable. Work helps those who remain on the land add value to their produce and take advantage of nearby European markets. Research in four innovation platforms in NAWA – Morocco, Tunisia, Egypt, Jordan – help farmers to improve the production of small ruminants, cereal, and food legumes, and to make the best use of scarce water.

#### East and Southern Africa (ESA)

Arid and semi-arid agricultural areas suffer recurrent drought. Poor infrastructure, poor services, and weak connections with markets exacerbate rural communities' vulnerability to drought. Here, the program works to help farmers adapt to adverse environmental conditions. Work in four innovation platforms in ESA – Kenya, Ethiopia, Malawi, Zimbabwe – helps farmers improve the production of cattle, goat, maize, and groundnut.

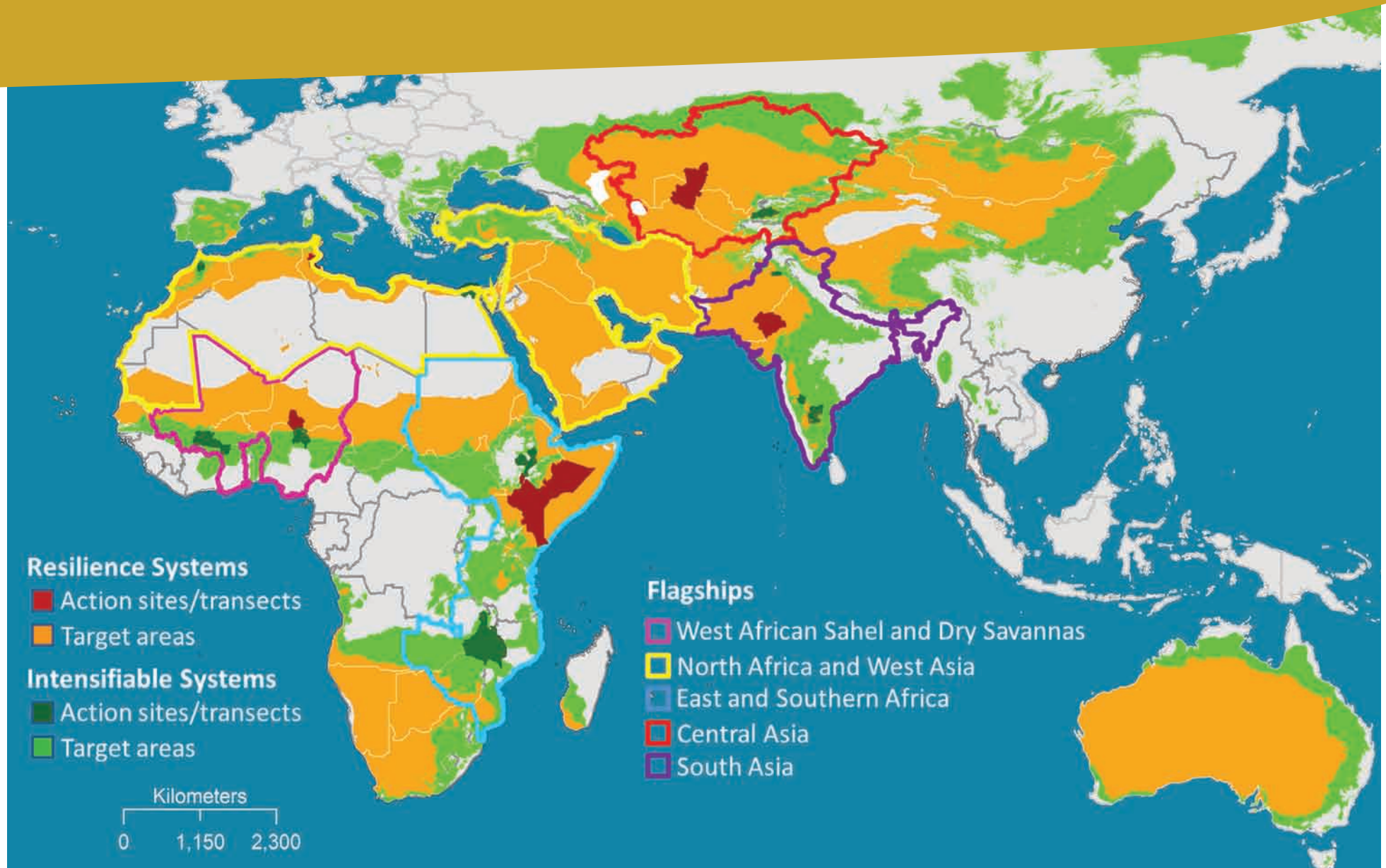
#### Central Asia (CA)

In CA, the program works to help mechanize the relatively large farms. The program helps farmers learn irrigation techniques that will make the most of the region's significant saline water resources while preventing land salinization and degradation. Research in three innovation platforms in CA – Tajikistan, Kyrgyzstan, Uzbekistan – helps farmers improve water use and manage salinity. Scientists develop crop varieties that are tolerant to drought, heat, and salinity.

#### South Asia (SA)

SA is another region where work helps farmers to become mechanized. This region has a major problem with salinity in irrigated areas. Work to introduce practices to use water resources sustainably raises productivity. Four innovation platforms in SA – India and Pakistan – promote improvement packages that have proved effective. Here, work encourages women and young people to set up their own microenterprises.

# Where we work



Source: Chandrashekhhar Biradar, ICARDA Geoinformatics Unit



# Highlights of 2014



In 2014, Dryland Systems produced an array of international public goods (IPGs) with the specific aim of reducing poverty and improving the livelihoods of rural dryland communities in the developing world. To ensure uptake of research outputs, program partners established 45 innovation platforms (IPs) and learning alliances. These play a critical role in helping stakeholders and beneficiaries increase their knowledge and skills, enabling them to adopt sustainable and innovative practices and technologies that will have a positive impact on dryland livelihood systems.

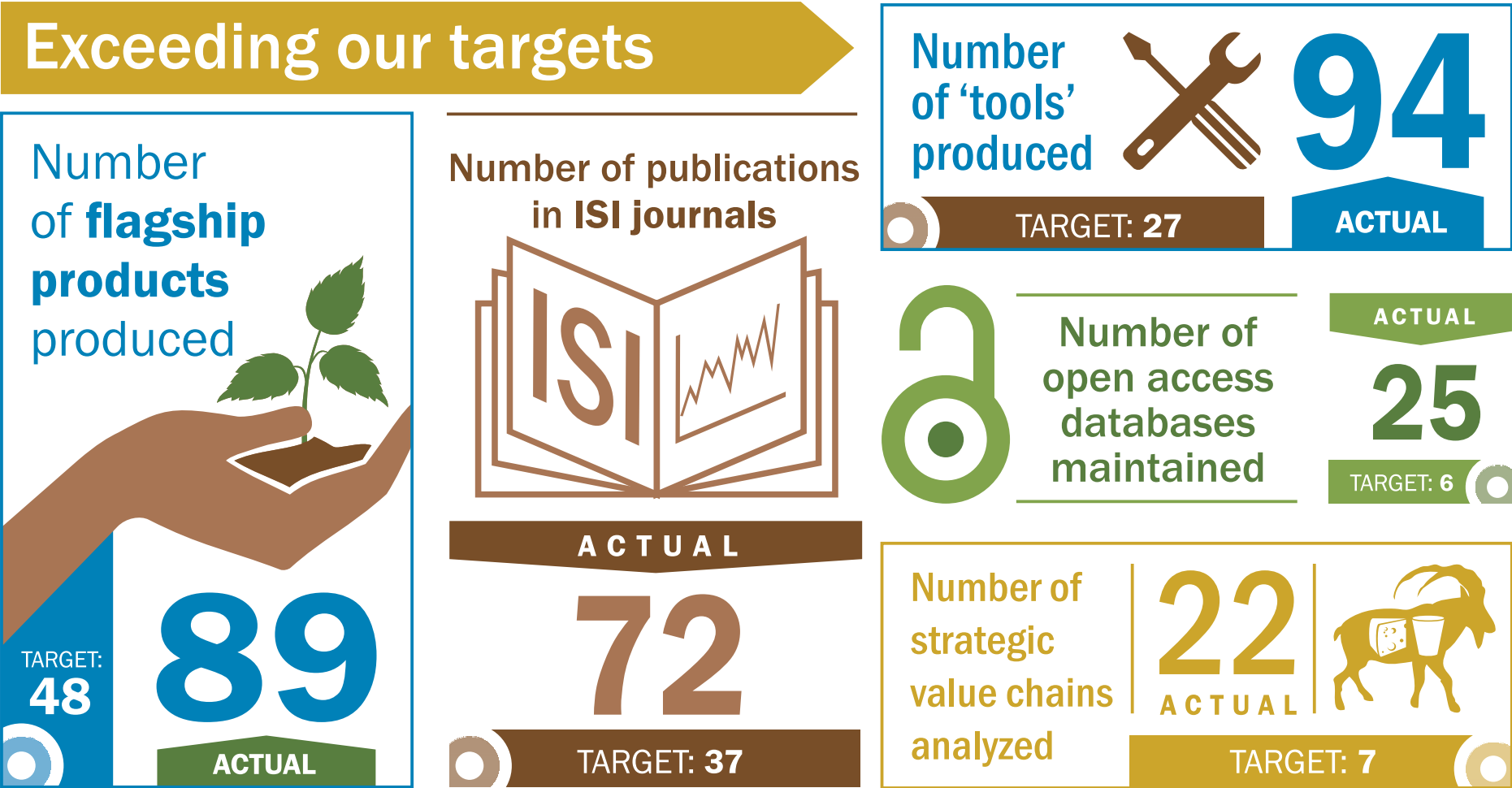
## Definition of international public goods (IPGs)

IPGs are products, goods, methods, services, software, knowledge, etc. that are freely available for use by all.

## Scientific knowledge on systems thinking for drylands development

In 2014, program researchers [published 127 articles](#), including 72 in journals indexed by the Institute of Science, three books, several policy and technical briefs, and two strategic papers on new systems approaches (Figure 2). Publications are important in shaping thinking and practice on drylands development in terms of advancing understanding of integrated system-based approaches to optimize economic, social, and environmental

Figure 2: Program Indicators Achievements



co-benefits in dryland ALSs, where the majority of the world's poor live. For example, the UK Department for International Development used the book *Treesilience: An Assessment of the Resilience Provided by Trees in the Drylands of Eastern Africa*, a Dryland Systems research output, to design a development project in Karamoja, Uganda.

### Positive response to launch of open-access databases

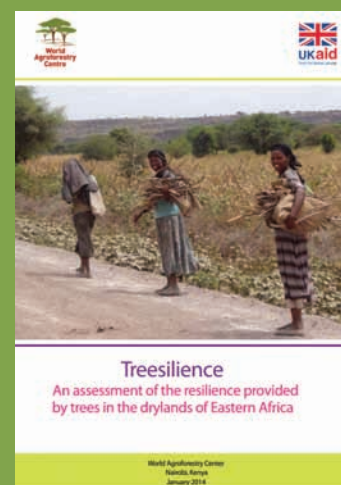
In 2014, the program established 25 databases giving unrestricted online access to spatial data (Figure 2). Over 15,000 people in 119 countries accessed Dryland Systems databases through the open-access [Geoinformatics Portal](#), and requested and downloaded data.

Comprehensive, multidimensional gender-responsive livelihood data for more than 3,000 household farms across Dryland Systems research sites are now available for development workers to use. CGIAR centers, Total LandCare, the Lunar University Network for Astrophysics Research, the South Africa Bean Research Network, the Malawi National Bean Program, and projects funded by the German Federal Ministry for Economic Cooperation and Development plan to use such data and related socio-ecological systems analysis of yield gaps in the Chinyanja Triangle and Zambezi River Basin to develop policy recommendations for sustainable intensification.

### Role of trees in enhancing resilience to drought, floods, and other extreme events in the drylands of Eastern Africa

A summary of research findings and recommendations in relation to the role of trees in enhancing resilience to drought, floods, and other extreme events in the drylands of Eastern Africa can be found in *Treesilience: An Assessment of the Resilience Provided by Trees in the Drylands of Eastern Africa*, a book that resulted from an intensive one-week 'write shop'.

A key recommendation emphasizes supporting and expanding efforts to develop knowledge on trees and resilience in East African drylands. Security of tenure is an important issue to resolve. At the very least, institutions need to build capacity to support sustainable tree management and to integrate trees into development projects.





The unique feature of these databases is their structure. The way the data are organized enables options-by-context analyses, which provide users with a comprehensive picture of all the elements that need to be taken into account (constraints, opportunities, who/whom, where, what, and how) to generate appropriate interventions that increase the overall performance of an ALS. For example, farmers and agricultural agencies in CA can choose the development options best suited to their particular conditions by consulting the open-access database for CA. Similarly, the farm type-options databases for SA and Africa can help identify options to adapt farming practices to local conditions.

## Farmers adopt natural resources management practices

In 2014, around 352,000 men and 117,348 women farmers took part in on-farm trials applying new technologies and sustainable natural resources management (NRM) practices. Farmer-to-farmer extension, IPs, and partnerships spread sustainable practices to other farmers. The program field-tested a total of **65 NRM technologies and practices, including sustainable land management (SLM)** practices, in over 7.5 million ha and rolled them out for large-scale implementation by private and public sector partners. Improved understanding of how SLM practices and technologies (ranging from the use of improved cultivars, integrated soil and water management, diversification of crop production to crop–tree–livestock

systems) will help boost sustainable agricultural productivity in the drylands and conserve vital land and natural resources, and ensure food security in poor and marginalized dryland communities living under the threat of extreme climate variability and change.

## New crops boost production and incomes in drylands

System-based diagnoses across major dryland agricultural systems showed that community-led seed production of multi-stress-tolerant crop varieties is key to stabilizing and increasing food production in the face of high dryland environmental risks. More than 620 tonnes of quality seeds from crop cultivars tolerant to common environmental stresses in drylands (for example, heat, drought, and salinity) were produced in community-led seed production units and disseminated to farmers. The transaction costs were minimal.

New genetic resources (improved crop varieties) are now available for dryland communities in [CA](#) and West, North, East, and Southern Africa that face critical food security challenges – challenges that the effects of climate change will further exacerbate. The program established village-based seed enterprises to integrate community-based seed production systems into inclusive food value chains. This integration offers women and young people across target drylands the opportunities to achieve higher

## HIGHLIGHTS OF 2014



Photo: IWMI/H.J. Appleby

incomes and become involved in agro-entrepreneurial activities. This is a clear example of how specific commodity research outputs (in wheat or legumes) are combined and contextualized in the systems research process (for example, in holistic system diagnoses, and combined technological and institutional interventions) to improve agricultural production in drylands on a large scale.

## Research findings inform national agricultural policy

New heat-tolerant wheat yielding 4–6 t/ha (significantly more than the 1–2 t/ha averaged by traditional varieties) influenced changes in agricultural policy in Nigeria. The Nigerian Agricultural Transformation Agenda prioritized the domestic production of wheat as a solution for curbing dependence on imports and ensuring food security. The Nigerian Government seeks to increase the area used to grow wheat from 70,000 to 340,000 ha and reduce imports by 45% over five years.

## Rise of innovation platforms

The 45 IPs operating across program action sites are a solid foundation for developing sustainable dryland agricultural systems. Platform partners are vital in helping design and scale-up context-specific SLM and inclusive food value chains across and between regions.

## Climate Change and Drought Atlas for Jordan

The Climate Change and Drought Atlas for Jordan contains 339 maps that show how the climate has changed in Jordan over the past decades, how it is likely to change in the future, and what policymakers and communities can do to adapt to widespread water scarcity and more droughts that are anticipated over the coming years.

The atlas maps out the likely impact of climate change on rainfed and arid lands, providing information that will help Jordan and other countries with similar conditions to develop adaptation strategies for the future. The atlas links climate-smart technologies and practices to an assessment of climate change mapped to geographic information systems. The atlas predicts Jordan will experience less precipitation and higher temperatures, meaning crops will need more water, growing periods will be shorter, and climatic zones will shift.

To help the region better adapt to climate change, the program is introducing drought-tolerant barley, promoting farming practices such as conservation agriculture, modifications to seeding, and participatory plant breeding, and helping farmers improve the ways they feed and manage livestock.



# Pathways to impact



Dryland Systems is part of the global effort to tackle poverty, hunger, and environmental degradation. We work to deliver results on the ground by designing research-in-development activities that contribute to reducing rural poverty in drylands, increasing food security, improving nutrition and health, empowering and providing new opportunities for women and young people in agriculture, and sustaining the management of natural resources in an equitable fashion.

Our approach is to tackle grand dryland challenges on a large scale, aiming for clear outcomes and focusing on people, results, and efficiency. Our program results framework aligns with the new direction of the [CGIAR Strategy and Results Framework 2016–2025](#), and responds directly to the proposed United Nations post-2015 Sustainable Development Goals.

Our program calls for collective action among all partners and stakeholders to engage in integrated systems research that focuses on distinct development goals. In doing so, we seek to identify the most innovative and sustainable solutions with benefits that reach far beyond the original problem.

Our integrated systems approach recognizes that in drylands everything is interconnected, as well as recognizing the interconnections between drylands and major global issues. Our pathways to impact run through what the program calls ‘intermediate development outcomes’ relating to resilience, wealth and well-being, food access, NRM, gender empowerment, and capacity to innovate.

# Dryland Systems contributes towards universal sustainable development

The United Nations' [Open Working Group proposal for universal Sustainable Development Goals](#) outlines 17 goals, of which the following seven are directly addressed by Dryland Systems' work:

- **GOAL 1:** End poverty in all its forms everywhere
- **GOAL 2:** End hunger, achieve food security and improved nutrition and promote sustainable agriculture
- **GOAL 3:** Ensure healthy lives and promote well-being for all at all ages
- **GOAL 5:** Achieve gender equality and empower all women and girls
- **GOAL 6:** Ensure availability and sustainable management of water and sanitation for all
- **GOAL 13:** Take urgent action to combat climate change and its impacts
- **GOAL 15:** Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, halt and reverse land degradation and halt biodiversity loss.

In addition, Dryland Systems contributes to aspects of five other goals:

- **GOAL 8:** Promote sustained, inclusive and sustainable economic growth, full productive employment and decent work for all
- **GOAL 10:** Reduce inequality within and among countries
- **GOAL 12:** Ensure sustainable consumption and production patterns
- **GOAL 16:** Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels
- **GOAL 17:** Strengthen the means of implementation and revitalize the global partnership for sustainable development.

Source: [Universal Sustainable Development Goals, Understanding the Transformational Challenge for Developed Countries, report of a Study by Stakeholder Forums, May 2015](#)



Photo: National Academy of Sciences of the Kyrgyz Republic/K.Musuraliev

The intermediate development outcomes are shaped by the research evidence we produce in the form of IPGs that include, but are not limited to, improved crop varieties, better farming methods, innovative technologies, incisive policy recommendations, geospatial databases, and a wide variety of knowledge repositories and data tools.

Our research outputs are freely available to local, national, and international stakeholders in both the public and private sectors. These groups transform our research outputs into products tailored to the needs of rural dryland households in developing countries. We are not starting from scratch because we use data and information gathered previously ('back casting') to draw out conclusions that guide the development of appropriate models of interventions. This will help cut the lead-time to achieve development impact.

Our research activities align with local, national, and regional priorities to ensure that we deliver research outputs that are of a relevant scale and value. We design research activities to contribute to achieving global impacts on poverty and hunger among millions of marginalized men, women, and children living in rural drylands.

### Dryland Systems research pathways to impact

- **RESILIENCE:** making an impact means research to provide vulnerable rural dryland households with innovative practices and technologies to reduce the loss and risks associated with climate change, land degradation, and limited natural resources
- **WEALTH AND WELL-BEING:** making an impact means research to generate higher and more sustainable incomes, nutritious food, a healthier environment, and a better standard of living for men, women, and children in drylands of the developing world
- **FOOD ACCESS:** making an impact means research to provide women and children in dryland households with adequate, diverse, and nutritious foods all the year
- **NATURAL RESOURCES MANAGEMENT:** making an impact means research to develop an equitable and sustainable management of land, water resources, energy, and biodiversity in drylands for generations to come
- **GENDER EMPOWERMENT:** making an impact means research to give women in drylands equal rights and access to productive assets, inputs, information, and market opportunities, and to capture a more equitable share of higher incomes, food, and other benefits
- **CAPACITY TO INNOVATE:** making an impact means research to improve and sustain the power of vulnerable rural communities in drylands to constantly innovate, seize new opportunities, and meet challenges.



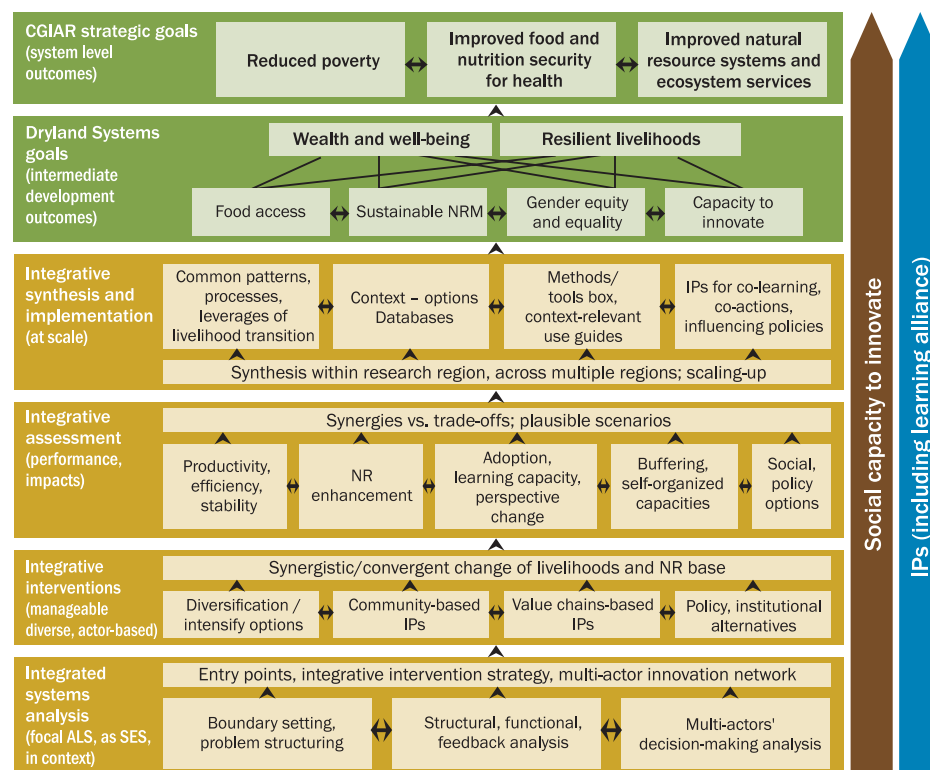
Dryland Systems governance involves members of developing and developed country institutions, such as national agricultural research and extension services (NARES), the private sector, civil society, CGIAR, farmers' organizations, bilateral and multi-lateral donors, and international organizations. The program has a wide upstream and downstream reach that includes participants and institutions with a key role in defining the drylands development agenda.

In parallel with providing scientific leadership on drylands issues at a global level, the program advocates strongly for greater research and investment in drylands to advance national and regional priorities. By working with a diversity of local, national, and international partners, we also enhance knowledge, skills, and capacities to catalyze collective action among stakeholders to transform ALSs for greater development impact in drylands (Figure 3).



Photo: ICARDA

**Figure 3: Generic Impact Pathway of the Dryland Systems Program**



ALS: Agricultural livelihood system; IP: Innovation platforms; NRM: Natural resources management; SES: Socio-ecological systems.

Boxes in gold shows activities and outputs of interrelated phases of integrated systems research. Boxes in green show development outcomes driven from integrated systems research-in-development.



## Resilience

The program's research for making an impact on **resilience** seeks to create robust livelihoods for vulnerable households in marginalized rural drylands where natural resources are scarce.

### Crop-production packages build resilience to dryland stresses

Stress-tolerant crop varieties enhance the productivity and adaptability of dryland farming systems. In 2014, program teams provided farmers with improved stress-tolerant cultivars and agronomic management practices. The crop-production packages help build resilience and reduce vulnerability to environmental stresses, and climatic variability and changes.

#### Building resilience in CA

In **CA**, the program helped farmers build resilience by introducing improved irrigation techniques that will make the most of the region's significant saline water resources, while also preventing land salinization and degradation. Moreover, the scientists evaluated, tested, and developed crop varieties that are tolerant to a number of dryland stresses. Crops developed included: **200 improved varieties of winter wheat** for tolerance to salinity and frost; **13 yellow rust-resistant winter wheat varieties**; **12 clones of potato** for saline soil at summer temperatures; **11 clones of potato** and **10 chickpea varieties** that can cope with heat stress; and **four varieties of mung bean** for saline soil. Preliminary results showed that yields of the new varieties were equal to or higher (from 10% to 150%) than those of the varieties used currently.

In **Turkmenistan**, scientists released [Davlatli](#), a wheat variety resistant to salinity, frost, heat, and drought, to the State Variety Testing Commission.

**Diverse crops and types of farming improve and buffer farming systems**  
Diversifying a farming system involves two stages: first, broadening the types of crops or livestock used, and secondly, broadening the types of farming.

In **Niger** and **Nigeria**, scientists tested dual-purpose crops – cereals, oilseed, and legumes – for diversifying crop–livestock systems. Experiments tested the use of crop residues for fattening sheep.

In **Burkina Faso**, **Ghana**, and **Niger**, scientists evaluated the use of trees to improve and buffer farm productivity. Tests involved input from female and male farmers.

### **Innovations safeguard farmers against dryland hazards**

The arid and semi-arid agricultural systems in ESA, a Dryland Systems flagship region, suffer recurrent drought. Poor infrastructure, poor services, and weak connections with markets exacerbate rural communities' vulnerability. Here, the program's teams developed innovations to help farmers adapt to adverse environmental conditions.

## **Reversing salt-induced land degradation**

About 62 million ha (20%) of the world's irrigated lands (up from 45 million ha in the early 1990s) are affected by salt-degradation.

The UN Sustainable Development Journal *Natural Resources Forum* published the study, [Economics of Salt-induced Land Degradation and Restoration](#), in October 2014. This was a review of the economics of salt-induced land degradation and restoration conducted under the framework of the CGIAR Research Program on Dryland Systems and the Water, Land, and Ecosystem Program.

*"We can't afford not to restore the productivity of salt-affected lands."*

**Manzoor Qadir, principal author**

The study describes successful methods for draining saline land and reversing soil degradation. These include planting trees, deep plowing, growing salt-tolerant varieties of crops, incorporating plant residues into topsoil, and digging a drain or deep ditch around salt-affected land.





## Wealth and Well-Being

The program's research for creating an impact on **wealth and well-being** seeks to generate higher and more sustainable incomes and a better standard of living for households in drylands of the developing world.

### Growing wheat for well-being

Africa faces a growing food deficit. As the demand for non-traditional foods such as pasta, noodles, and bread grows, African countries import more and more wheat. **Nigeria**, for example, imports 4 million tonnes of wheat, which cost US\$4 billion a year.

Dryland Systems is a partner in Agricultural Research for Development on Strategic Commodities in Africa (SARD-SC), an initiative funded by the African Development Bank (AfDB). To reverse the rise in imports of wheat to Africa and boost domestic production, SARD-SC considers all aspects of wheat production across 11 countries in Sub-Saharan Africa.

## Insurance boosts the resilience of Kenyan pastoralists

Drought is a pervasive risk in the arid and semi-arid lands of northern Kenya and southern Ethiopia, which are home to 70 million rural people who are mainly pastoralists. Severe droughts are a catastrophe for herders.

Insurance companies consider conventional policies are not viable in the region. For households without insurance that rely partly or entirely on livestock, herd losses are devastating.

Dryland Systems partner, the International Livestock Research Institute, joined forces with Cornell University and the University of California Davis to develop an innovative [index-based livestock insurance](#) that pays out when satellite data show that forage is insufficient. In partnership with the private insurer Takaful Insurance Africa, the research team developed [innovative sharia-compliant insurance](#) especially for Muslim pastoralists in northern Kenya. In March 2014, for the first time in Africa, the insurer made major payments to 30 women and compensation payments to 71 women, for the loss of sheep, goat, cattle, and camels after a long, dry season.

Hassan Bashir set up [Takaful Insurance Africa](#) three years ago. Unlike ordinary insurance schemes prohibited by Islam, the scheme takes only a management fee from clients.

*"It is a fair and ethical way to protect pastoralists' livestock assets from natural hazards."*

**Hassan Bashir, Takaful Insurance**

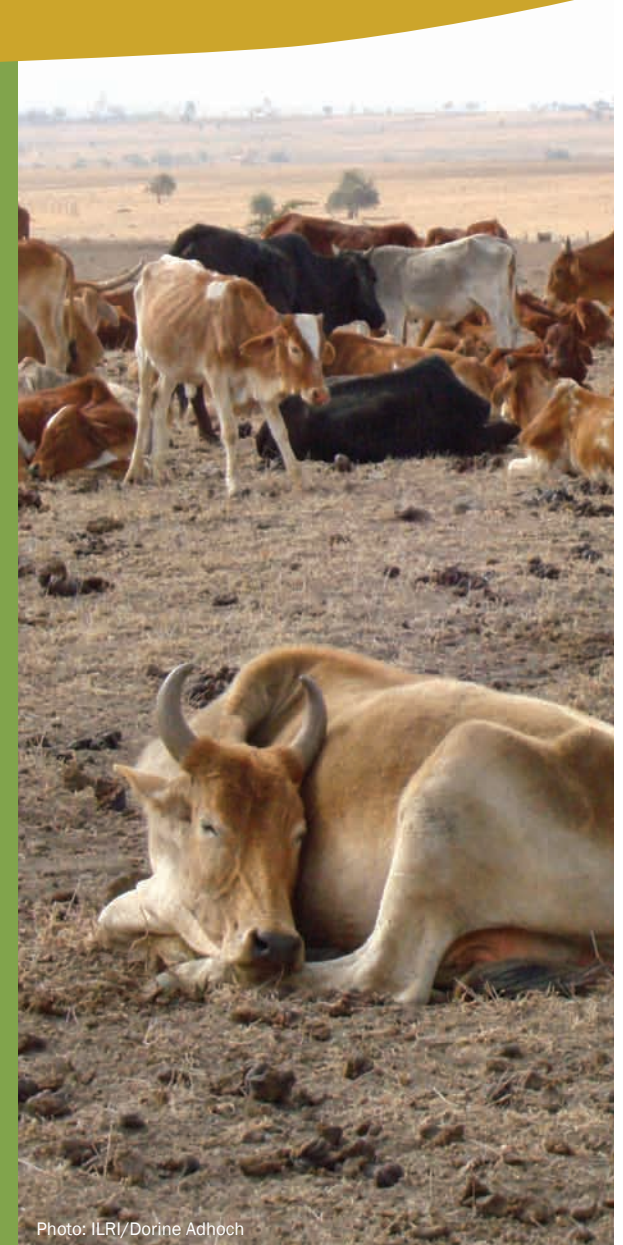


Photo: ILRI/Dorine Adhoch

“We are bringing all stakeholders together – including farmers, farmer organizations, policymakers, and the millers who buy the wheat.”

**Solomon Assefa Gizaw, project leader**

In Nigeria, new varieties of wheat yielding 5–6 t/ha have convinced policymakers that domestic production is a solution to the country’s growing dependence on wheat imports. Recognizing the importance of this work, the government allocated funds from the federal groundnut and sorghum value chain development program to cover the cost of 950 demonstrations in 438 villages in 73 local administration areas in 16 states. The shift to a policy supporting domestic production will guarantee higher incomes for Nigerian farmers, improving their wealth and well-being, and will strengthen national food security.

Likewise, in **Sudan** the government seeks to expand the country’s wheat-growing area from 137,000 to 340,000 ha, having noted the high yields that the country’s farmers are now achieving from new wheat varieties introduced by the program.

Operating from research ‘hubs’ in **Nigeria, Ethiopia, and Sudan**, Dryland Systems research-for-development networks share knowledge and information, and arrange regular meetings and forums for agricultural professionals. In 2014 six meetings brought together over 180 professionals involved in working towards a new era of self-sufficiency in wheat.

#### **Trees and water harvesting for prosperity**

Precipitation in semi-arid areas averages 400–800 mm a year. Semi-arid land covers 27% of **Ethiopia**, 43% of **Kenya**, 50% of **Burkina Faso**, 17% of **Mali**, and 7% of **Niger**. Poverty and population density are particularly high in semi-arid areas, and many families rely on food aid. Donors and African governments strive to move from providing emergency relief to boosting resilience and development.

Trees can play a vital role in maintaining and restoring soil fertility. They improve microclimates for crops, and reduce soil and water runoff, thereby increasing infiltration and recharging groundwater. Harvesting and storing water on farms during the rainy season in traditional Zai, Tassa, or planting pits, earth and stone contour bunds, half-moons, and trapezoidal bunds also makes a big difference. Capturing and storing water in watersheds, such as in lined and unlined ponds, sand dams, and check dams, sees farmers through the dry season.



Combining tree planting and water harvesting boosts local economies. In **Niger**, trees provide roofing for huts and handles for tools, and bring in extra income. Sales of wood have risen so much that farmers have now organized themselves into a cooperative rural wood market.

**“This provides extra income in addition to the fact that we get necessary wood supply for our household.”**

**Farmer, Dan Saga, Maradi region, south-central Niger**

The impact of introducing trees into the dryland farming system in Niger has been multidimensional. The most visible result has been better food security and nutrition for households due to the extra cash farmers get from selling wood. Secondly, farmers have been able to diversify, producing fuelwood, fodder, fiber, and food from trees. Thirdly, biodiversity has soared, the environment has regenerated, and tree cover has expanded. As the Sahel gets greener, more young people are staying in the rural communities to work in the agricultural sector. In Dan Saga, the community has embraced the tree-planting technology and developed community by-laws to exclude grazing around trees and prohibit woodcutting.

*“Trees are so important to have a good harvest; trees represent the granary – we get four times the yield that is possible without the trees. We now have a wood market through which we sell our excess wood as a cash crop.”*

**Ali Neino, Dan Saga,  
Maradi region,  
south-central Niger**



Photo: Ollivier Girard/CIFOR

### Using kitchen gardens and polytunnels to improve household welfare

In **Pakistan** research teams worked with local communities to improve wealth and well-being in irrigated and rainfed ALSs. Demonstrations showed farmers how to capture and store water and increase efficiency of irrigation to reduce losses of water and soil.

Researchers used various ways to co-learn with farmers: partners produced a manual and videos; and teams arranged farmer days, training, radio, and TV programs, and produced training videos and more than 67,000 brochures in English, Urdu, and local languages. The farmers learned how to harvest rainwater from roofs, where to site micro-catchments and ponds, how to prevent soil erosion, the value of green manure, how to make compost, how to use drips and sprinklers, and how to plant on ridges to save irrigation water.

Quite a few of the practices, such as composting organic waste from the farm and household, are women-friendly and the resulting product can be used as a good organic fertilizer. Kitchen gardens and polytunnels that are fertilized with this compost produce more, meaning women have surplus vegetables and seedlings that can be sold for extra income, and thus benefit household welfare.

### Food access

The program's research for impacting on **food access** seeks to provide women and children in dryland households with adequate, diverse, and nutritious foods throughout the year.

#### Sustaining food production in variable conditions

In the Sahel, where rainfall is variable and uncertain, the program works with national researchers, development partners, and farmers in a new regional program in the Sahel and the Horn of Africa, [Enhancing Food and Water Security for Rural Economic Development](#). This regional partnership seeks to trigger rural economic growth in semi-arid drylands in five countries: Mali, Burkina Faso, Niger, Ethiopia, and Kenya. Across these countries, cropping is expanding and pastures are shrinking, with pastoral and agropastoral livelihoods becoming less viable. Partners work to consolidate the production of sorghum and millet – key nutritious grains farmed mostly by women. In addition, the partnership links smallholder farmers to regional livestock markets to develop viable value chains that offer farmers opportunities for more trade and better incomes.

#### Diversifying food crops

Introducing new legume crops into dryland farming systems provides diversification and makes diets more nutritious, improves soil fertility, and reduces the negative impacts of intensification on soils. However,

because it is mainly women who grow legume crops, this strategy enables women to have access to better and more nutritious food, and also to earn higher incomes and take part in decision-making processes on farms and in communities.

New bean varieties and soil fertility practices for cereal–legume rotations tested in more than 120 [on-farm trials](#) in **Malawi** yielded 189% more crops than the long-term national average. Scientists are now monitoring and evaluating several hundred similar cereal–legume rotations to diversify food crops in on-farm trials across West, North, and East Africa.

### **Trees, women, food, and hope**

Growing high-value trees among traditional vegetables is changing the fortunes of Nigerian farmers in rainfed areas. A greening program, known as ‘bio-reclamation of degraded lands’, reverses land degradation. Farmers are converting large areas of degraded lateritic soils in **Nigeria** into productive land by harvesting water, adding organic residues, and planting fruit trees and indigenous vegetables.

Multipurpose woody shrubs and trees provide food, medicine, and fodder. The gum arabic tree, an acacia, produces high-quality gum as well as fuel and fodder. Other acacias provide firewood and mulch, and trap nitrogen in the soil; the protein-rich seeds feed poultry. Traditional leafy vegetables can be inter-cropped with trees and are important for nutrition and as a market garden crop.

Vegetable waste is also used to feed livestock. Cassia trees provide herbal medicines and okra shrubs bear pods that are eaten as a vegetable.

Scientists working in **Niger** have identified combinations of trees and vegetables that suit the conditions and tastes in different regions. In collaboration with many non-governmental organizations (NGOs), Dryland Systems scientists are working with farmers to plant more trees across Niger. The impact has been multidimensional: more food is being produced from the same area of land; women are able to feed their families better and more nutritious food and the extra income generated by selling surplus vegetables and high-value tree products is improving livelihoods.



## Natural resources management

The program's research for causing an impact on NRM seeks to develop equitable and sustainable management of land, water resources, energy, and biodiversity in the drylands of the developing world for generations to come.

### Conservation agriculture improves food security

Rising temperatures and declining precipitation mean dryland farmers need proven farming practices that sustain yields, conserve resources, and increase efficiency. Conservation agriculture – the practice of not plowing farmlands and leaving crop residues in the field to improve soil fertility and conserve water – sustains production and keeps costs down.

“Zero tillage has provided more profit, and in the last two or three years we have not had to use fertilizer. It also provides more water storage in the soil so you don't have to use as much water – you just have to plant and wait.”

**Sarmad Karim Khalil Kakay, Iraqi farmer**

In Iraq, the area of conservation agriculture is now over 15,000 ha. Farmers' yields have increased by 160 kg/ha, resulting in an additional US\$100/ha of earnings. In Syria, farmers who adopted zero tillage cut costs by 38%, produced 465 kg/ha more crops, and earned an additional US\$187/ha.

Conservation agriculture, practiced in North and South America, Australia, Russia, and China for many years, is catching on in **Morocco, Tunisia, Algeria, Jordan, and Tajikistan**, stimulated by the Dryland Systems capacity development programs.

### Integrated practices for optimum resource use

Improving the water-use efficiency of relay crops – where farmers plant a second crop into a first crop before harvesting the first crop – sustains soil fertility and reduces the need for energy for spreading fertilizer, thus cutting costs and increasing farmers' profits.

In **CA**, research teams evaluated the water- and energy-use efficiency of different integrated crop production systems. Growing mung bean as a relay crop after winter wheat helped farmers produce an additional 1.4–1.5 t/ha wheat using less water. Prices offered for wheat were three to four times higher than for wheat grown conventionally because the quality was better. Mung beans fix nitrogen, which improves soil fertility and produces better quality wheat grain. Farmers who grew mung bean also used less energy because they needed to apply less fertilizer.

In **West Africa**, scientists carried out 288 tests of practices combining rainwater harvesting, leafy vegetables, and high-value trees in 88 villages. Thirty-one farmer field schools involved more than 620 farmers (16% female).

In **SA**, scientists demonstrated and evaluated improved cultivars, and soil and water conservation for different crops, in more than 750 on-farm trials. The trials showed that new combinations of improved varieties and soil-nutrient management practices increase crop yield by 10% to over 150%, depending on the crops and site conditions.



Photo: ICRISS, Hyderabad

*"We're confident that we can achieve long-term adoption and improved sustainability in Iraq. We were able to reach a critical mass of farmers in the areas where we worked, who, convinced of the benefits of conservation agriculture, will go on to share their knowledge and expertise with others."*

**Stephen Loss, Senior Scientist, International Center for Agricultural Research in the Dry Areas (ICARDA)**



Photo: ILRI/Barrett

## Building the capacity of communities for ecosystem-based management

Effective approaches to natural resource and ecosystem governance tailored to drylands have proven elusive in the past. Mount Marsabit is a mountain ecosystem in Kenya of vital importance to thousands of people, including pastoralists and agropastoralists. Analysis showed that coordination and planning is mainly technical, bridging government line agencies but not involving customary and other community institutions in decision making.

As a result of research and the dialogues triggered by the Dryland Systems program, local stakeholders opted for a small, ecosystem-level forum for managing the Mount Marsabit ecosystem. This option departs from typical approaches, which tend to correspond to an administrative area rather than an ecosystem.

The research process also engaged top officials involved in legal and institutional reforms on natural resource governance from several departments and agencies under the Ministry of Environment, Water and Natural Resources. Policymakers and other senior government officers appreciated the opportunity to learn what was happening 'on the ground'.

*"You know, these communities respect the traditions leadership systems. You have to go through these systems, the elders in the community, to have your ideas accepted. They are the ones who will convince the rest..."*

**Non-governmental organization worker**



## Gender equality and empowerment of women

The program's research to make an impact on gender equality and women's empowerment seeks to give women in drylands better rights and access to productive assets, inputs, information, and market opportunities, and enable them to capture a more equitable share of higher incomes, food, and other benefits.

Gender matters because development stalls if it does not address the views and needs of both women and men. Full development cannot be realized if women are not given the opportunity to contribute. Gender relations affect who grows, prepares, and processes food, who manages cash crops and livestock, and who spends household income and how. Women play an important role in assessing which types and varieties of staple foods, vegetables, fruit, nuts, fodder, livestock, fuelwood, and water sources best fit their circumstances, and in deciding how to feed and nourish their families. In the precarious situations in many dryland areas, communities will thrive when all their members, irrespective of gender, age, or other social characteristics, are empowered fully to contribute to and benefit from agricultural systems.

In 2014, the program completed gender studies on the distribution of resources, land-use decisions, access to finance and training, and preferences and decisions along value chains of goat, cattle, sheep milk and meat, olive oil, vegetables, and fruit. Research across dryland regions examined

gender roles, gender equity in making decisions, access to and control over household and non-household income, labor, and resources for agricultural production. Program teams also studied the relationship between land tenure and inputs, work opportunities for women, and the gender gap in agricultural wages.

**“Ignoring gender issues in dryland systems is just not an option any more. Because of their very nature, dryland communities cannot afford to continue with persistent inequalities.”**

**Karin Reinprecht, Dryland Systems Gender Program Coordinator**

Researchers identified areas where women, men, and young farmers can grow and market produce to increase their income. Research on kitchen gardens and vegetable plots, which are usually the domain of women, examined crops to diversify diets, improve food security, and provide women, children, expectant mothers, and the elderly (especially in vulnerable households) with more nutritious foods, and to improve vegetable growing as a source of income for women.

Researchers analyzed the roles of women to identify where they can influence water-use efficiency and soil conservation – important aspects of adapting and building resilience to climate change in dryland areas. In **India**, scientists produced a report on the impact of climate change on gender vulnerability for three action sites. With scientists' support, women in **Egypt** engaged in innovative and ecologically friendly cactus production as a strategy for coping with water scarcity and adaptation to climate change.

To improve food security, the program increased the capacity of women in conservation farming and managing food banks, seeds, and tree nurseries. Women adopted and adapted innovations to their needs and the resources available to them, which led to an increase in food production and higher earnings.

Program activities involved women and young people in IPs, making decisions about research topics, and extension services. They also took part in community development committees and activities to build capacity for collective action.

Female and male stakeholders involved in program IPs in **Ethiopia**, **Zimbabwe** and **Mozambique** prioritized key constraints and pooled skills and resources to achieve a greater impact by harnessing synergies.

### **Innovative seed systems trigger agro-enterprises among women**

In several countries in **North and West Africa**, the quality of seed resources and their accessibility are key constraints for improving crop productivity. The program established village-based seed enterprises to integrate community-based seed production systems into inclusive food value chains and open up opportunities for women and young people to set up their own agro-entrepreneurial activities. To kick-start seed systems, the program's scientists established areas for producing quality seeds for crops preferred by women farmers in the region.

### **Multidimensional gender livelihood data**

Comprehensive multidimensional gender-responsive livelihood databases containing information on more than 3,000 household farms across Dryland Systems research sites are available for development use. Research teams in **Malawi, Mozambique, Zambia, India**, and the **Fergana Valley in CA** used multidimensional gender data collected from several thousand farm households to identify where, who, and what needs to be addressed to increase agricultural productivity and use of resources, build natural and human capital, and develop flexibility in coping with change.

## Capacity to innovate

Program research for making an impact on capacity to innovate seeks to improve and sustain the power of vulnerable rural communities in drylands to continually identify and scale-out sustainable and innovative solutions to seize new opportunities and improve their lives.

Dryland Systems makes use of the 45 inclusive, interdisciplinary IPs that the program has established so far to engage with the next and end users of our research. We do this to mainstream holistic thinking on systems research and ensure that our research is having the desired development outcomes and impact in rural dryland communities. The feedback mechanisms inherent in the IPs allow Dryland Systems to design better, targeted research-in-development interventions that involve and are owned by major stakeholders – the people who will sustain the process of scaling these interventions up and out in the long run.

### Learning alliances foster new tools

Initially piloted in **Egypt** and **Morocco**, the program rolled out the concept of learning alliances to Jordan and **Tunisia**. These aim to develop business models that ensure the appropriate uptake of knowledge and innovative technologies by dryland communities. In Tunisia the program developed a user-friendly local environment information system, which was used to evaluate and assess the risk of desertification using geographic information systems at the Béni Khédache–Sidi Bouzid site. In close collaboration with local stakeholders, our researchers calibrated and applied an integrated

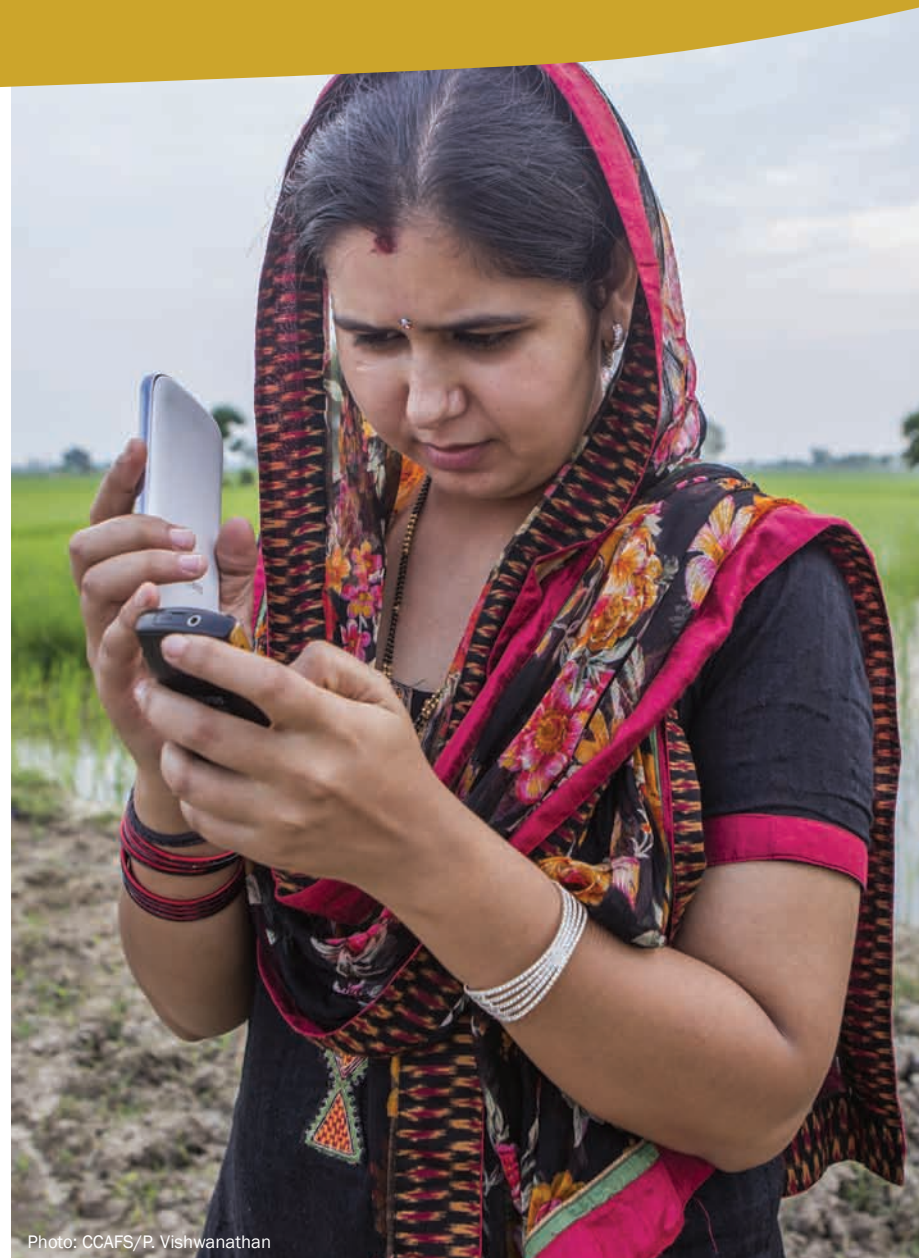


Photo: CCAFS/P. Vishwanathan



impact assessment framework based on extended cost-benefit analysis and a sustainable livelihoods approach. Analyses showed the likely impact of water harvesting techniques on rural livelihoods and farming profits under different climatic and socio-economic scenarios.

### **Inclusive innovations for value chain development**

In **CA**, scientists worked with local communities to assess and implement interventions that will help add significant value to the small ruminant meat value chain. Meat from small ruminants is of considerable importance to the region's economy and local incomes.

### **Mechanizing irrigated wheat in NAWA**

The **NAWA** region imports more cereals than any other region, of which most is wheat – a staple in the Arab diet. Arab countries have faced stark challenges in increasing agricultural productivity due to scarce arable land and water, low and variable rainfall, frequent droughts, and poor public and private investment – particularly in rainfed agricultural systems. Weak extension systems and a lack of implementation of agricultural policies and new technologies exacerbate these challenges. Government policies that encourage agricultural production have often affected the natural resource base negatively.

The Arab Food Security Initiative aims to improve yields and stabilize wheat production and productivity across the region. The program's research teams work to introduce improved wheat varieties and agronomic practices for irrigated and rainfed production systems to 10 countries in the region –

**Egypt, Morocco, Sudan, Syria, Tunisia, Yemen, Jordan, Algeria, Iraq, and Palestine.** In 2014, teams reached 25,700 farmers via training, field days, farmer schools, and travelling workshops.

This initiative successfully encouraged the development and validation of mechanized raised-bed machines for smallholders in the Nile Delta. These machines, which were developed by a team of scientists from ICARDA and Egypt, shape raised beds and simultaneously plant the seed, are easy-to-maintain and are cost-effective. Thanks to the development of machines specifically tailored to meet the needs of smallholders, the use of raised-bed irrigation is spreading quickly on small to medium-sized farms.

On-farm wheat yields across all 10 countries increased on average by 28%. In **Egypt**, mechanized raised-bed planting transformed irrigated wheat farming. The use of machines resulted in water savings of 25%, yields increasing by 30%, and water-use efficiency improving by 74%. In Al-Sharkia alone, the area of mechanized raised-bed wheat production increased from 1,670 ha in 2010 to 21,250 ha in 2014.

Tests in 385 farmers' fields showed large savings in water and a superior grain yield. Teams are replicating the raised-bed technology in other provinces in Egypt and in **Ethiopia, Iraq, and Morocco.**

Yields of wheat in rainfed systems in **Yemen** rose by 45% with supplemental irrigation. Farmers in rainfed areas of **Jordan** and **Tunisia** enjoyed gains of 24%. No-till systems increased wheat yields by 16% in **Syria**, 20% in **Jordan**, and 50% in **Morocco.**



Photo: ILRI/Susan MacMillan

## Laying the groundwork for farmers and scientists to observe, learn, and innovate together

Masongaleni is a town in Makueni County, Eastern Kenya, one of the driest areas of the country. Entrepreneurial villagers have set up tree nurseries to supply farmers with saplings for agro-forestry but the nurseries are often short of water. Progressive farmers and scientists worked together to observe what happened, to learn, and to innovate together. They tested lined ponds to collect rain that would otherwise run off and be lost.

*“This pond liner is easily torn by protruding roots or stones. It is also easily eaten by rodents or reptiles that find their way into the pond. Despite repairs that I have tried to make to patch up the liner, I actually lost all the water from the pond.”*

*“Having lost hope for not knowing what to do, I merely watched as all the water disappeared into the ground. But, with time, I noted that the mangoes surrounding the pond were performing very well. This is the time I realized that the water that had percolated underground was not lost after all. The mango trees were directly benefitting from the water.”*

**William, owner of a tree nursery**

Some farmers are now digging a second pond next to their first one, and using thicker pond liners.

# Strategies for women and youth



Program research strategies to empower women and young people seek to improve their access to productive assets, inputs, information, and market opportunities, and help them gain an equal share of incomes, food supplies, and other benefits. In 2014, the program approved a Gender Strategy to integrate gender into research and empower women in drylands. The Dryland Systems [Gender Strategy](#) fully aligns with the overall CGIAR gender strategy and principles. It directs research to identify agro-livelihood opportunities, analyze the distribution of resources and vulnerability to risk, and understand social issues that affect gender roles, values, norms, and rules. With the participation of partners, the program also developed a [Youth Strategy](#) in 2014, which is now being implemented.

## Gender issues as a core activity

Our [Gender Strategy](#) sets out the challenges and targets for including gender aspects and addressing gender issues as a core activity and outcome of Dryland Systems research.

The Gender Working Group set up in 2014, produced [Guidelines for Gender-Responsive Research for Biophysical Scientists](#), which propose practical steps for taking gender into account throughout the research project cycle and outline specific methods, such as gender-responsive systems research. The aim of integrating gender considerations into mainstream biophysical research processes is to empower rural women, encourage gender equity, and out-scale equitable gender development interventions.



## The Dryland Systems approach to gender

- Contributes to developing and implementing effective interdisciplinary ex-ante diagnostic methods that integrate gender analysis and ensure gender equity in targeting and prioritizing Dryland Systems research
- Improves knowledge and understanding of the key cultural, ideological, and institutional factors in drylands that lead to gender inequalities, and identifies effective gender-responsive and transformative ways of addressing these to increase production, incomes, and food security, and women's share of these benefits
- Contributes to the design of processes, technologies, and related policy and institutional frameworks for vulnerable households in marginal dryland areas that reduce gender disparities and improve access to agricultural and domestic technologies – to reduce female drudgery and improve the resilience and well-being of resource-poor men and women
- Integrates gender differences and equity goals in the development and testing of technologies to intensify production and add value along selected crop–livestock value chains, focusing on entrepreneurial men and women who have the potential to move out of poverty in the short to medium term.

## Youth Strategy encourages young scientists

Dryland Systems was the first CRP to draft a [Youth Strategy](#), setting a precedent that may direct serious attention to this critical stakeholder group by other CRPs. The Youth Strategy may also inspire joint efforts by the Dryland Systems program, other CRPs, and partners to engage young people in innovative agricultural development, provide them with opportunities, and help them to build livelihoods in agriculture.

The program will implement the Youth Strategy in 2015. Developed through a participatory, multi-stakeholder process, the strategy directs the program to make a concerted effort to develop young female and male scientists to lead technical initiatives and develop knowledge in their countries. Leadership is a critical factor in sustaining agricultural growth.

For example, the Dryland Systems Young Agricultural Scientist Program selects motivated young men and women from partner countries to work alongside Dryland Systems scientists so that they can develop expertise in enhancing wheat productivity and the use of research methods applicable to other dryland crops. Topics cover plant breeding, biotechnology, plant protection, agronomy, irrigation, water and soil management, plant nutrition, conservation agriculture, cereal quality and seed technology, agricultural economics, and socio-economics.



Photo: ILRI/Mann

### Researching gender in ESA

The feminization of agriculture means more women work in farming than before, often because men migrate from rural areas to work in urban areas. In ESA, men move to search for work and may spend two to three years away from their homes. In their absence, women take on non-traditional roles, make decisions usually made by men and become responsible for farming activities. However, agricultural extension services seldom meet the requirements of female farmers.

The percentage of women who have access to land and other resources is higher in ESA than in other regions. But when it comes to profits, income, and other financial issues, men seem to make the decisions, confining women to their traditional roles. This means that even if women are involved in farming activities they do not accrue the benefits from their access to land.

In the highly populated Chinyanja Triangle in Mozambique, Malawi, and Zambia, the gender research team focuses on agricultural water management. Most work involves both men and women and is not gender specific. Scientists have reviewed the literature, undertaken baseline studies, and disaggregated data on ownership and assets. A baseline survey benchmarked the different roles of men and women and their preferences. Partner national agricultural research and extension systems, NGOs, and development projects expand the reach of research and enhance opportunities for gender-responsive impacts.



Photo: Neil Palmer/IWMI

Young interns involved in the Young Agricultural Scientist Program work in the field. For example, in **Morocco**, young people help the farmers' association that produces seed to work with commercial seed producers. In **Jordan**, interns in professional, national, and local institutions, such as the Jordanian Cooperative Corporation, help expand conservation agriculture.

In 2014, the Young Scientist Training Program mentored and trained 34 young scientists.



# Capacity development to achieve outcomes

**Figure 4: CGIAR Elements of Capacity Development**



CRP: CGIAR Research Program

In 2014, Dryland Systems developed a strategy for building capacity to achieve impact that fully aligns with the CGIAR capacity development principles and strategy (Figure 4). Participatory methods for developing the strategy included key informant interviews, surveys, reviewing documents, a survey of trends in capacity development, and meetings involving stakeholders.

## Impact strategy

The Capacity Development [Strategy](#) presents 60 different ways to build capacity. Elements of capacity building range from knowledge sharing and communication, mentoring, coaching, internships, degree and non-degree research, developing policy and processes, restructuring governance, supplying equipment, developing infrastructure, and mediating partnerships, to developing strategy.

## Goals

The strategy has three goals that align with the goals of major international networks for capacity development. The goals target core individuals and organizations in poor, rural, dryland communities and focus on (1) increasing knowledge, skills, and capacities, (2) maximizing the potential impact of capacity development interventions through diverse partnerships, and (3) ensuring sustainability of capacity development through appropriate resource mobilization.



Photo: ICRAF

### Systems research training in NAWA

In 2014, the program established a key partnership for training in systems analysis and modeling in NAWA. The partnership between Montpellier SupAgro, the Mediterranean Agronomic Institute of Zaragoza, Wageningen University, and the University of Madrid advances systems research in Mediterranean regions. Work to integrate the production of small ruminants, cereals, and food legumes, and to make the best use of scarce water, helps farmers add value to their produce and take advantage of nearby European markets.

### Pooling and consolidating knowledge in CA

The program's web-based knowledge platform [www.cacilm.org](http://www.cacilm.org) pools and consolidates best practices in sustainable land management. Best practices may be innovations generated by farmers, examples of sustainable management of water, land and forest resources, sustainable farming methods, pasture use, improved livestock and crop production, and promising scientific developments concerning climate change. Scientists will use the knowledge platform in the second phase of the Central Asian Countries Initiative for Land Management.

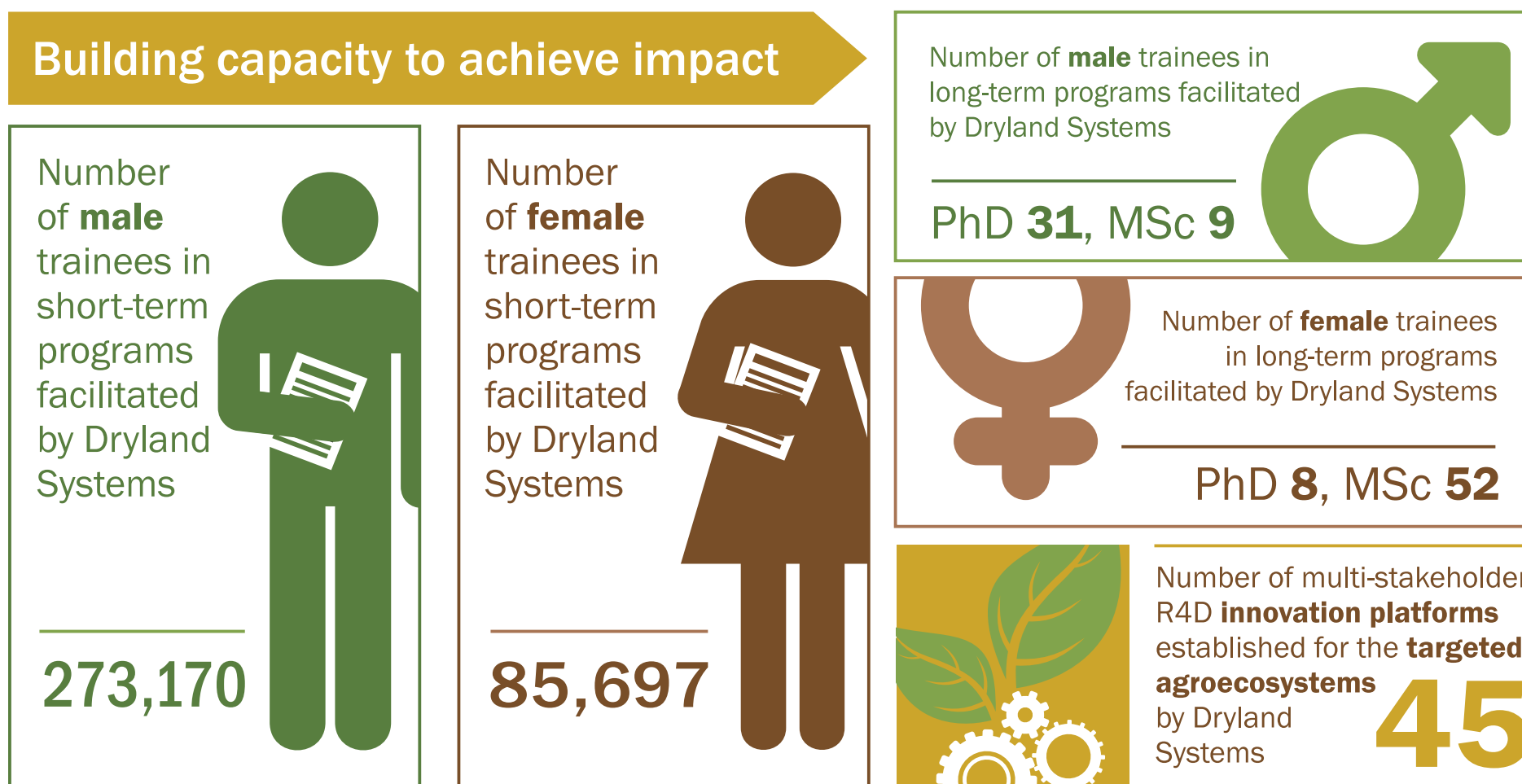
### Action and results

An Action Plan and a Results Framework for the Capacity Development Strategy set out milestones for capacity development, and activities and outputs. Strategic partnerships with international, regional, and local organizations, the private sector, and civil society will ensure impact and outreach, and mobilize resources to sustain capacity development in the long term.

In 2014, the program arranged short-term training for over 368,000 short-term trainees (23% women) from local communities, NARES, government organizations, and NGOs (Figure 5). Training courses covered sustainable intensification, integrated soil and water management, vulnerability assessments, and integrated systems assessment and modeling. Program scientists supervised 39 doctoral students (eight women) and 61 Masters students (52 women) (Figure 5).



Figure 5: Capacity Development Achievements



# Partnerships



Partnerships are fundamental to the work of the program. In addition to the eight CGIAR centers that are partners in the program, Dryland Systems relies on a diverse array of local, regional, and global partnerships to mainstream integrated agricultural systems research and ensure the program's research outputs are effectively used by next and end users. Partners are critical to scaling-out the best practices and technologies identified through systems research and, therefore, making an impact. We work with over 227 partners to set research priorities and select action sites, and involve partners in program governance.

## Core partners

- International Center for Agricultural Research in the Dry Area (ICARDA)
- Bioversity International
- International Center for Tropical Agriculture (CIAT)
- International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)
- International Livestock Research Institute (ILRI)
- International Potato Center (CIP)
- International Water Management Institute (IWMI)
- World Agroforestry Centre (ICRAF).



### Enabling mutual knowledge sharing, learning and development

The program has adopted a two-pronged partnership approach. First, we establish international partnerships across target regions, countries, and agroecosystems to facilitate learning and share knowledge. Secondly, we strengthen links between organizations and networks locally, nationally, and regionally to enhance technology transfer and inform the development of strategies to scale-out and scale-up proven research-in-development interventions.

The West African Sahel and Dry Savannas Region worked with a host of national research actors and development partners to [link farmers' knowledge to process-based science](#) to sustain production in sorghum and millet-based systems in the face of variable and uncertain rainfall and, thus, reduce vulnerability in the **Sahel**.

In **CA**, several national and regional organizations consolidated and disseminated scientific knowledge to scale-up SLM, promote adaptation to climate change, and improve agricultural productivity. In particular, partners targeted key policy and decision makers, NGOs, national and regional rural development and extension agencies, farmers, farmers' organizations, and international donors.

In **SA**, partners in the program, the Central Arid Zone Research Institute (CAZRI), the Swami Keshwan and Rajasthan Agricultural University, and the Rajasthan State Agricultural Implementing Test Center at Hanumangarh, test and validate systems modeling scenarios. Dryland Systems also works

### A partner in the Thar Desert, India

GRAVIS, a Dryland Systems partner, works with rural communities in the Thar Desert, India. Communities in the Thar Desert are poor; farmers struggle to grow crops in parched, drought-stricken conditions. The GRAVIS path to sustainable livelihoods and agricultural production blends indigenous and scientific knowledge, combining age-old practices with modern, scientific inputs introduced by the Dryland Systems program.

While resourceful and knowledgeable about their environment, farmers in the Thar Desert are not familiar with new practices and cropping systems. The program fills the knowledge gap by helping families and communities fulfil the Gandhian philosophy of self-reliance.



with village development committees to enhance market access and institutionalize SLM and water management practices in many rural local communities in **India**.

### Partners in innovation platforms

The program implements its IPs in partnership with a wide range of stakeholders to ensure the research-in-development continuum (Figure 6):

- NARES
- Community-based organizations (farmers/water-user associations)
- Development agencies
- Civil society organizations
- The private sector
- CGIAR research centers
- National, regional, and international organizations
- Advanced research institutions (ARIs).

### Use of research outputs and outcomes by partners

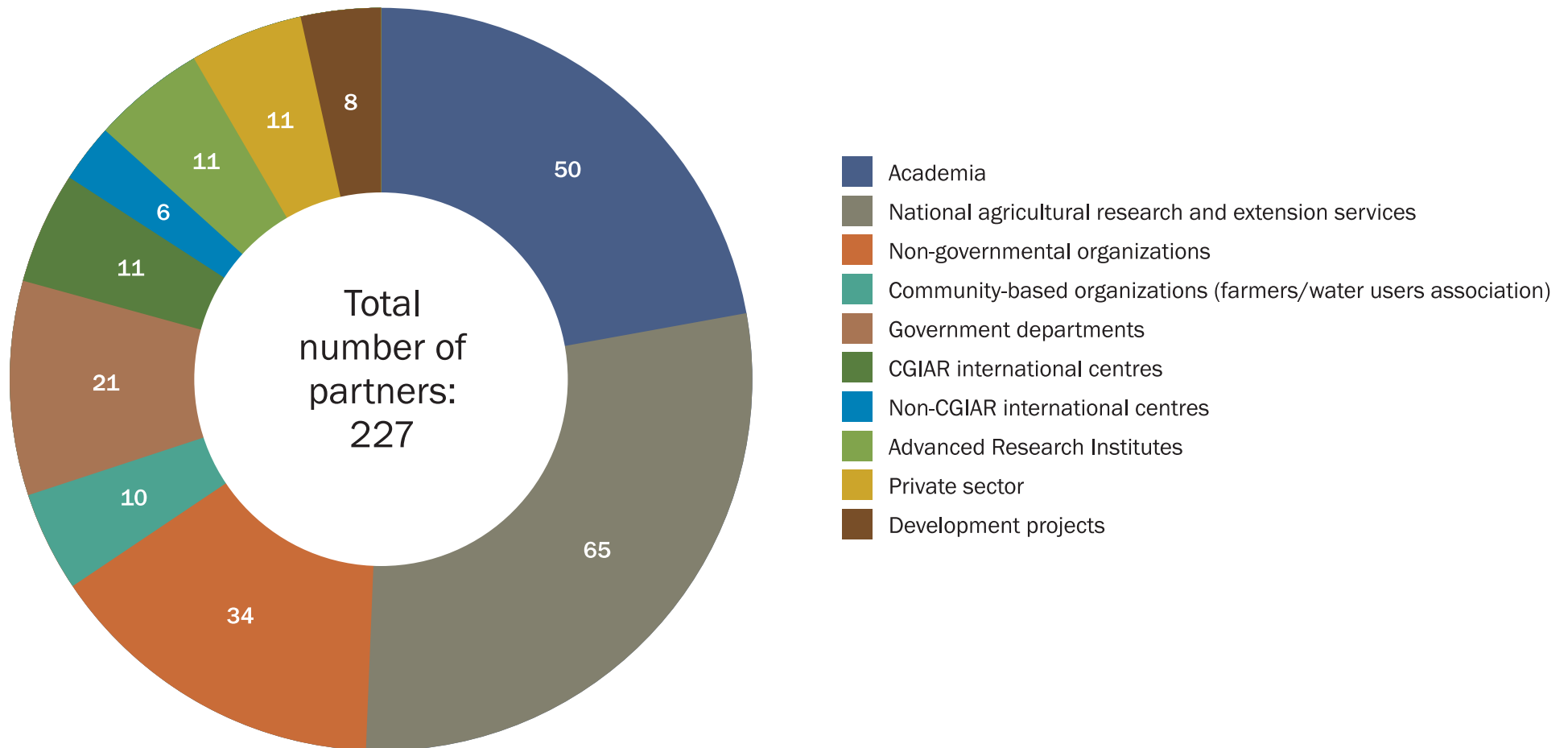
During 2014, many program partners, including but not limited to NARES, NGOs, ARIs, academic institutions, private sector organizations, national governments, and other CRPs, reported evidence of the direct influence that Dryland Systems research outputs have had on increasing agricultural production and influencing policies. Partners reported that they have used research outputs in several countries and regions, such as Egypt, Tunisia,

Morocco, [Turkmenistan](#), India, and [East](#) and [West](#) Africa, to increase agricultural production or influence policies.

### Strategic partnerships with CRPs

In 2014, Dryland Systems used the research outputs of five CRPs – Wheat, Dryland Cereals, Grain Legumes, Water, Land and Ecosystems, and Climate Change, Agriculture, and Food Security – to bring together a number of national research institutions, private farmers, government organizations, and CGIAR centers to implement systems research activities on improved seed systems and on-farm adaptive trials. In SA, the program collaborated with three commodity CRPs on dryland legumes, dryland cereals, and livestock and fish to evaluate fodder varieties from a systems perspective.

**Figure 6: Dryland Systems Partners by Category**



# Financial summary for 2014

The total 2014 Dryland Systems budget was US\$55 million, including the carry-over from year 2013. Of these, US\$18 million were from the CGIAR Fund (Window 1 & Window 2) and US\$36.7 million from Window 3/bilateral sources.

Window 1 & Window 2 funds were reduced in the final Financing Plan to US\$15.41 million for year 2014. The total 2014 expenses were based on US\$45.80 million distributed as: US\$17.58 million from Window 1 & Window 2 including firm commitments; US\$28 million from Window 3 and bilateral.

**Table 3. 2014 Financial Summary (US\$ '000)**

	<b>Planned expenditure</b>	<b>Actual expenditure</b>	<b>Executed (%)</b>
Total expenditure	55,023	45,805	83
Windows 1 + 2 funds	18,253	17,589	96
Window 3 + bilateral funds	36,770	28,216	77
Gender research	2,246	2,246	100

**Table 4: 2014 Expenditure by Flagship (US\$ '000)**

<b>Flagship</b>	<b>Budget</b>	<b>Actual expenditure</b>	<b>Executed (%)</b>
WAS&DS	13,018	8,671	67
NAWA	9,856	9,703	98
ESA	15,525	12,237	79
CA	4,339	4,271	98
SA	9,950	8,645	87
Management/coordination	2,335	2,278	96



**Table 5: 2014 Expenditure by Partner Center (US\$ '000)**

Center	Budget			Actual expenditure			Executed (%, total budget)
	Total	Windows 1/2	Window 3/bilateral	Total	Windows 1/2	Window 3/bilateral	
ICARDA	21,104	8,376	12,728	21,078	8,361	12,726	100
Bioversity	879	679	521	854	679	637	97
CIAT	879	391	488	854	341	513	97
CIP	438	438		430	430		98
ICRAF	9,569	586	8,983	3,522	544	2,978	37
ICRISAT	11,193	4,925	6,268	9,938	4,753	5,185	89
ILRI	9,535	1,929	7,606	7,714	1,587	6,127	81
IWMI	1,105	929	176	944	895	49	85

**Table 6: 2014 Expenditure by Category (US\$ '000)**

Category	Planned expenditure	Actual expenditure	Executed (%)
Personnel	15,308	13,328	87
Collaborator costs – CGIAR centres	1,530	1,206	79
Collaborator costs - partners	8,381	5,449	65
Supplies and services	16,762	13,773	82
Operational travel	5,422	4,848	89
Depreciation	1,412	1,723	122
<b>Sub-total of direct costs</b>	<b>48,815</b>	<b>40,327</b>	<b>83</b>
Indirect costs	6,208	5,477	88
<b>TOTAL – ALL COSTS</b>	<b>55,023</b>	<b>45,804</b>	<b>83</b>

## Dryland Systems donors

Rural dryland communities in developing countries face mounting development challenges relating to poverty, food security and nutrition, climate change, water scarcity, and land and resource degradation, as well as social and political unrest. Tackling these challenges requires significant resources and long-term financing for sophisticated programs.

Thanks to the support and contributions from our valued [CGIAR Fund Donors](#) and 25 bilateral donors who share our commitment to eradicating poverty, hunger, and malnutrition, Dryland Systems is making progress with new initiatives and innovations for the benefit of smallholder farmers in dry areas. We are extremely grateful to all our donors who make this work possible, and we will continue to strive to be more efficient, collaborative, and impact-oriented so that together we can truly transform the lives of the impoverished rural dryland communities.

### CGIAR Fund Donors to Dryland Systems

- Australia
- Belgium
- Netherlands
- Sudan
- Switzerland

### Bilateral Donors

- African Development Bank (AfDB)
- Agricultural Research Center of Egypt (ARC)
- Arab Fund for Economic and Social Development (AFESD)
- Asian Development Bank (ADB)
- Australian Agency for International Development (AusAID)
- Australian Centre for International Agricultural Research (ACIAR)
- Austrian Development Agency (ADA)
- Bill & Melinda Gates Foundation
- UK Department for International Development (DFID)
- Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)
- Directorate-General for International Cooperation (DGIS), Government of The Netherlands
- DuPont Pioneer
- European Union (EU)
- Food and Agriculture Organization (FAO)
- Government of India
- Government of Iran
- French National Institute for Agricultural Research (INRA)
- International Fund for Agricultural Development (IFAD)
- Kuwait Fund for Arab Economic Development (KFAED)
- McKnight Foundation
- Office Chérifien des Phosphates (OCP)
- OPEC Fund for International Development (OFID)
- United States Agency for International Development (USAID)
- United States Department of Agriculture (USDA)
- Government of Russia





# Governance

Governance of the program is the responsibility of the Research Management Committee and the Independent Steering Committee under the fiduciary responsibility of the lead center. The Program Management Unit supports these two committees (Figure 7).

## Independent Steering Committee

The Independent Steering Committee is responsible for the overall strategic direction of the program to ensure appropriate allocation of resources; approves the annual work plan, strategies and governance documents; and monitors program implementation in terms of science quality and excellence.

## Research Management Committee

The Research Management Committee (RMC) is directly responsible for the overall coordination and management of the program's research implementation. The RMC is composed of representatives of the eight partner centers, the five flagship coordinators, and is chaired by the program director. The Committee reviews the annual work plans and budgets developed at flagship and global levels to ensure consistency, integration, and appropriate budget allocation across the program. Once cleared by the RMC, work plans, budgets, strategies, and other governance documents are submitted to the Independent Steering Committee for approval.

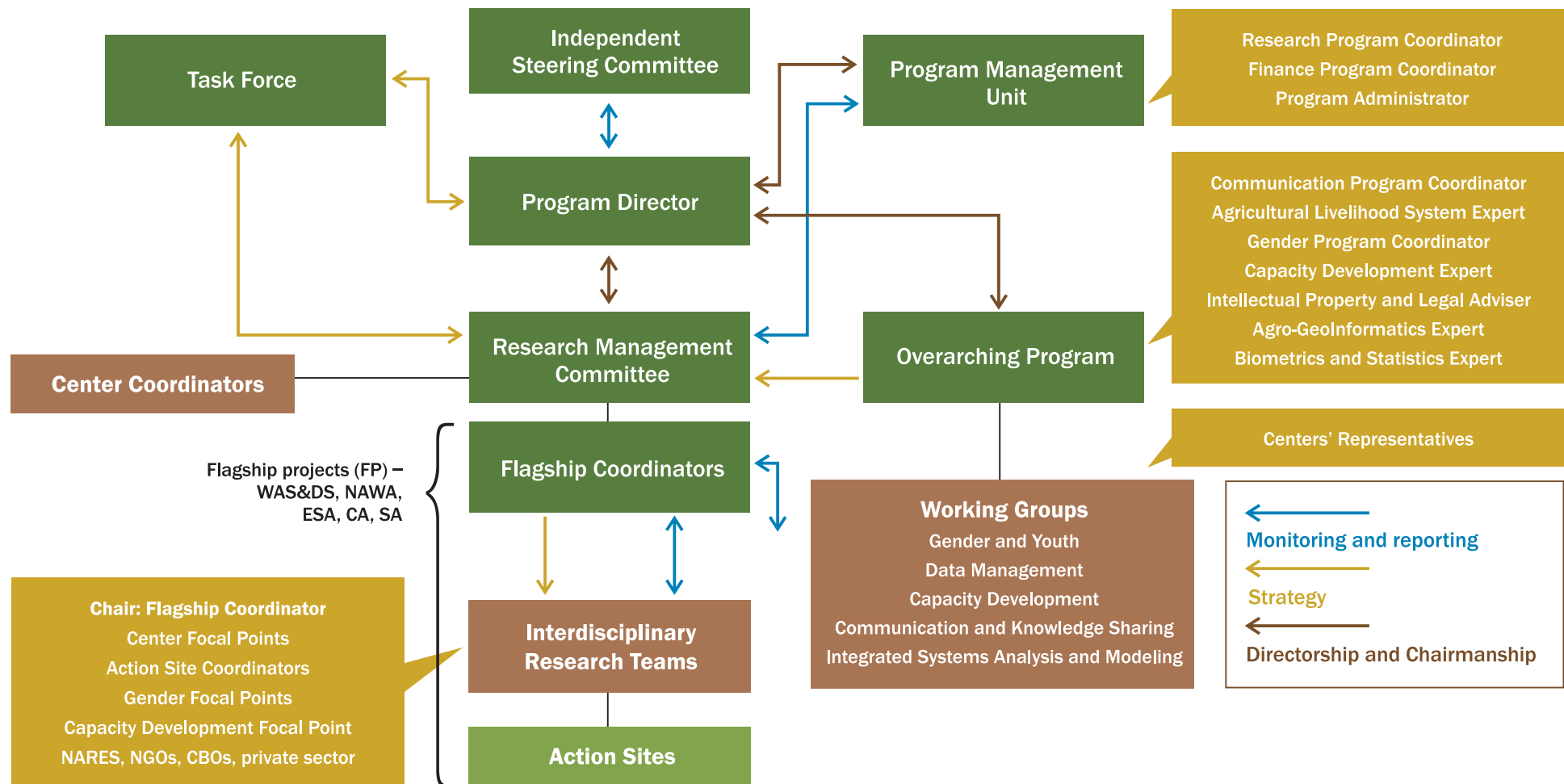
## Interdisciplinary research teams

The interdisciplinary research teams in each of the five flagships work to identify needs and research priorities at local and regional levels, and draft, monitor, and implement annual plans of work and budgets. Chaired by flagship coordinators appointed by the center coordinating the flagship, the teams are composed of representatives of each partner center (center focal points), local stakeholders (NARES, NGO, private sector), and action site coordinators.

## Working groups at program level

To ensure coherence and organizational learning, the program established two working groups (WGs) on cross-cutting issues: one on data management and open access and the other on gender and youth. Three further WGs – communications and knowledge sharing, capacity development, and integrated systems analysis and modeling – were set up in 2015. The WGs are composed of staff from participating centers and their partners. Each group determines its own terms of reference and works to develop and implement shared work plans and strategies.

**Figure 7: Dryland Systems Governance and Management Structure**



**Key:** CA: Central Asia; CBOs: Community-based organizations; ESA: East and Southern Africa; NARES: National agricultural research and extension services; NAWA: North Africa and West Asia; NGOs: Non-governmental organizations; SA: South Asia; WAS&DS: West Africa Sahel and the Dry Savannas

# Dryland Systems people



## Independent Steering Committee

Mahmoud Solh	Chair, ICARDA Director General
Richard Thomas	Representative, Dryland Systems Program Director
Murari Mohan Roy	Representative, CAZRI
Mohammed Badraoi	Representative, INRA
Tony Simons	Representative, ICRAF
Jimmy Smith	Representative, ILRI
William Dar	Representative, ICRISAT
Harry Palmier	Representative, Global Forum on Agricultural Research (GFAR)
Abdel Hamid	Representative, FAO
S Ayyappan	Representative, Indian Council of Agricultural Research (ICAR)
Bernard Hubert	Representative Agropolis International
Francis Boa-Amponsem	Representative, HR-Buffett
Khalida Bouzar	Representative, IFAD
Aduugna Wakjira	Representative, Ethiopian Institute of Agricultural Research (EIAR)



## Research Management Committee

Richard Thomas	Chair, Dryland Systems Program Director
Hichem Ben Salem	Center Coordinator, ICARDA
Mauricio Bellon	Center Coordinator, Bioversity
Lulseged Tamene Desta	Center Coordinator, CIAT
Philippe Monneveux	Center Coordinator, CIP
Anthony M. Whitbread	Center Coordinator, ICRISAT
Jan de Leeuw	Center Coordinator, ICRAF
Polly Ericksen	Center Coordinator, ILRI
Everisto Mapedza	Center Coordinator, IWMI
Antoine Kalinganire	Flagship Project Coordinator, WAS&DS
Ali Nefzaoui	Flagship Project Coordinator, NAWA
Sikhalazo Dube	Flagship Project Coordinator, ESA
Jozef Turok	Flagship Project Coordinator, CA
Suhas Wani	Flagship Project Coordinator, SA
Adekunle Adewale	Representative, Forum for Agricultural Research in Africa (FARA)

## Program Management Unit

Richard Thomas	Program Director
Enrico Bonaiuti	Research Program Coordinator
Rima Dabbagh	Finance Program Coordinator
Sara Jani	Program Administrator

## Overarching Program

Tana Lala-Pritchard	Communications Program Coordinator
Quang Bao Le	Agricultural Livelihood Systems Expert (started in 2015)
Karin Reinprecht	Gender Program Coordinator (started in 2015)
Iman Kaffass	Capacity Development Expert
Francesca Re Manning	Intellectual Property and Legal Adviser
Chandrashekhar Biradar	Agro-GeoInformatics Expert
Murari Singh	Biometrics and Statistics Expert

# Selected publications



The following is a selection of key Dryland Systems publications and research outputs produced in 2014:

Martini, A.M., B. Dhehibi, B., and A. Aw-Hassan. 2014. [Determinants of small scale dairy sheep producers' decisions to use middlemen for accessing markets and getting loans in dry marginal areas in Syria](#). *Experimental Agriculture* 50(3): 438–457.

Salvati, L., C. Kosmas, O. Kairis, C. Karavitis, S. Acikalin, A. Belgacem, A. Solé-Benet, M. Chaker, V. Fassouli, C. Gokceoglu, H. Gungor, R. Hessel, H. Khatteli, A. Kounalaki, A. Laouina, F. Ocakoglu, M. Ouessar, C. Ritsema, M. Sghaier, H. Sonmez, H. Taamallah, L. Tezcan, and J. de Vente. 2014. [Unveiling soil degradation and desertification risk in the Mediterranean basin: a data mining analysis of the relationships between biophysical and socioeconomic factors in agro-forest landscapes](#). *Journal of Environmental Planning and Management* DOI: 10.1080/09640568.2014.958609.

Coulibaly, Y.N., R. Mulia, J. Sanou, G. Zombre, J. Bayala, A. Kalinganire, and M. van Noordwijk. 2014. [Crop production under different rainfall and management conditions in agroforestry parkland systems in Burkina Faso: observations and simulation with WaNuLCAS model](#). *Agroforestry Systems* 88: 13–28.

De Leeuw J, M. Njenga, B. Wagner, and H. Iiyama (ed.). 2014. [Treesilience: An Assessment of the Resilience Provided by Trees in the Drylands of Eastern Africa](#). ICRAF, Nairobi, Kenya.

De Leeuw, J., A. Vrieling, A. Shee, C. Atzberger, K.M. Hadgu, C.M., Biradar, H. Keah, and C. Turvey. 2014. [The potential and uptake of remote sensing in insurance: a review](#). *Remote Sensing* 6: 10888–10912.

Duncan, A.J., S.A. Tarawali, P. Thorne, D. Valbuena, K. Descheemaeker, and S. Homann-Kee Tui. 2013. [Integrated crop livestock systems – a key to sustainable intensification in Africa](#). *Tropical Grasslands–Forrajes Tropicales*, Special Issue IGC 2013(2): 202–206.

Tamene L., Q.B. Le, and P.L.G. Vlek. 2014. [A landscape planning and management tool for land and water resources management: an example application in northern Ethiopia](#). *Water Resources Management* 28(2): 407–424.

Robinson, L.W., P.J. Ericksen, S. Chesterman, and J. Worden. 2015. [Intensification in drylands: what resilience and vulnerability can tell us](#). *Agricultural Systems* 135: 133–140.

Holzworth, D.P., N.I. Huth, P.G. deVoil, E.J. Zurcher, N.I. Herrmann, G. McLean et al. 2014. APSIM - Evolution towards a new generation of agricultural systems simulation. *Environmental Modelling & Software* 62: 327–350.

Qadir, M., E. Quillérrou, V. Nangia, G. Murtaza, M. Singh, R.J. Thomas, P. Drechsel, and A.D. Noble. 2014. [Economics of salt-induced land degradation and restoration](#). *Natural Resources Forum* 38: 282–295.  
doi: 10.1111/1477-8947.12054.



# Acronyms

ACIAR	Australian Centre for International Agricultural Research
ADA	Austrian Development Agency
ADB	Asian Development Bank
AfDB	African Development Bank
AFESD	Arab Fund for Economic and Social Development
ALS	Agricultural livelihood systems
ARC	Agricultural Research Center of Egypt
ARI	Advanced research institution
AusAID	Australian Agency for International Development
CA	Central Asia
CAZRI	Central Arid Zone Research Institute
CIAT	International Center for Tropical Agriculture
CIP	International Potato Center
CRP	CGIAR Research Program
DFID	UK Department for International Development
DGIS	Directorate-General for International Cooperation
EIAR	Ethiopian Institute of Agricultural Research
ESA	East and Southern Africa
EU	European Union
FAO	Food and Agriculture Organization
FARA	Forum for Agricultural Research in Africa
GFAR	Global Forum on Agricultural Research
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
ICAR	Indian Council of Agricultural Research
ICARDA	International Center for Agricultural Research in the Dry Areas

ICRAF	World Agroforestry Centre
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IFAD	International Fund for Agricultural Development
ILRI	International Livestock Research Institute
INRA	French National Institute for Agricultural Research
IP	Innovation platforms
IPG	International public goods
IWMI	International Water Management Institute
KFAED	Kuwait Fund for Arab Economic Development
MEL	Monitoring, Evaluation, and Learning
NARES	National agricultural research and extension services
NAWA	North Africa and West Asia
NGO	Non-governmental organization
NRM	Natural resources management
OCP	Office Chérifien des Phosphates
OFID	OPEC Fund for International Development
RMC	Research Management Committee
SA	South Asia
SLM	Sustainable land management
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
WAS&DS	West Africa Sahel and the Dry Savannas
WG	Working group



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