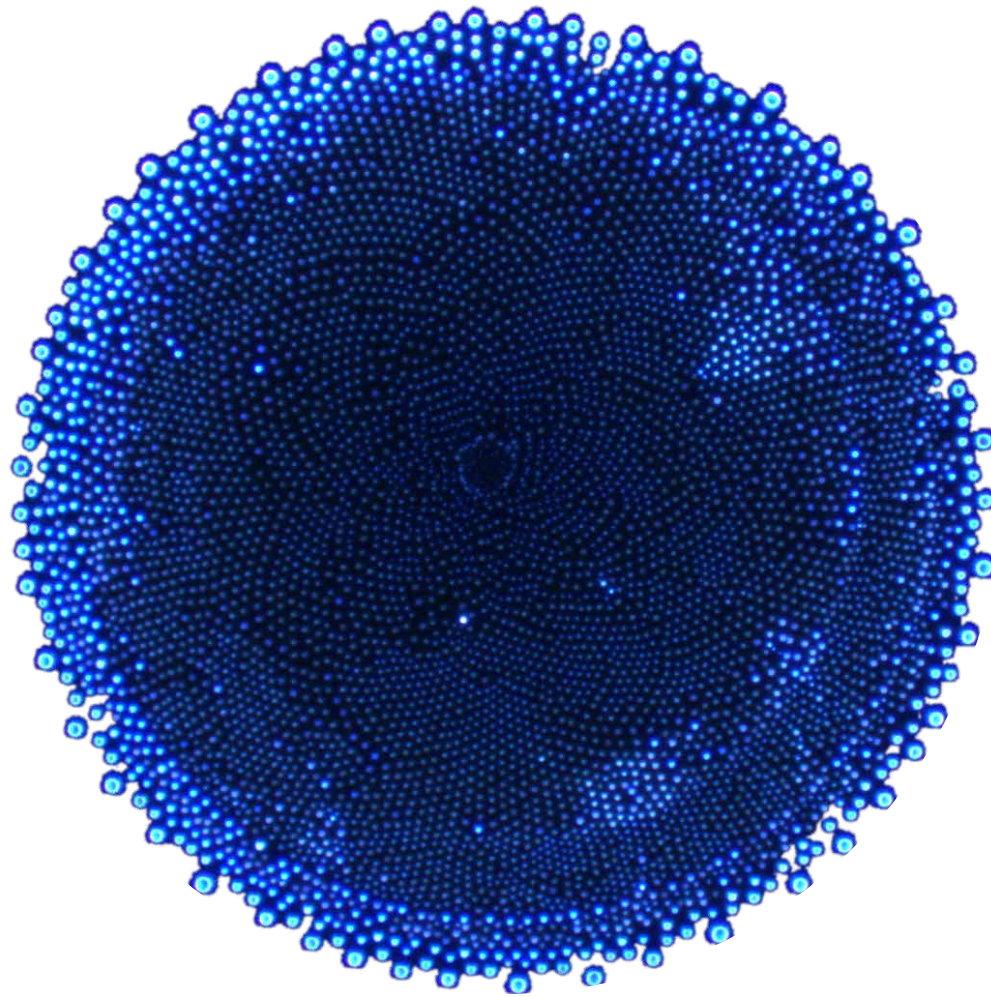


boondh

The journey of a raindrop in the drylands



Citation: Boondh: The journey of a raindrop in the drylands. 2019. Patancheru 502 324, Telangana, India: International Crops Research Institute for the Semi-Arid Tropics. 40 pp.

Front Cover

Devin K Brown, Senior Research Engineer, Institute of Electronics and Nanotechnology, Georgia Institute of Technology. This award-winning photo shows a dried drop of water under a microscope. (Used with permission)

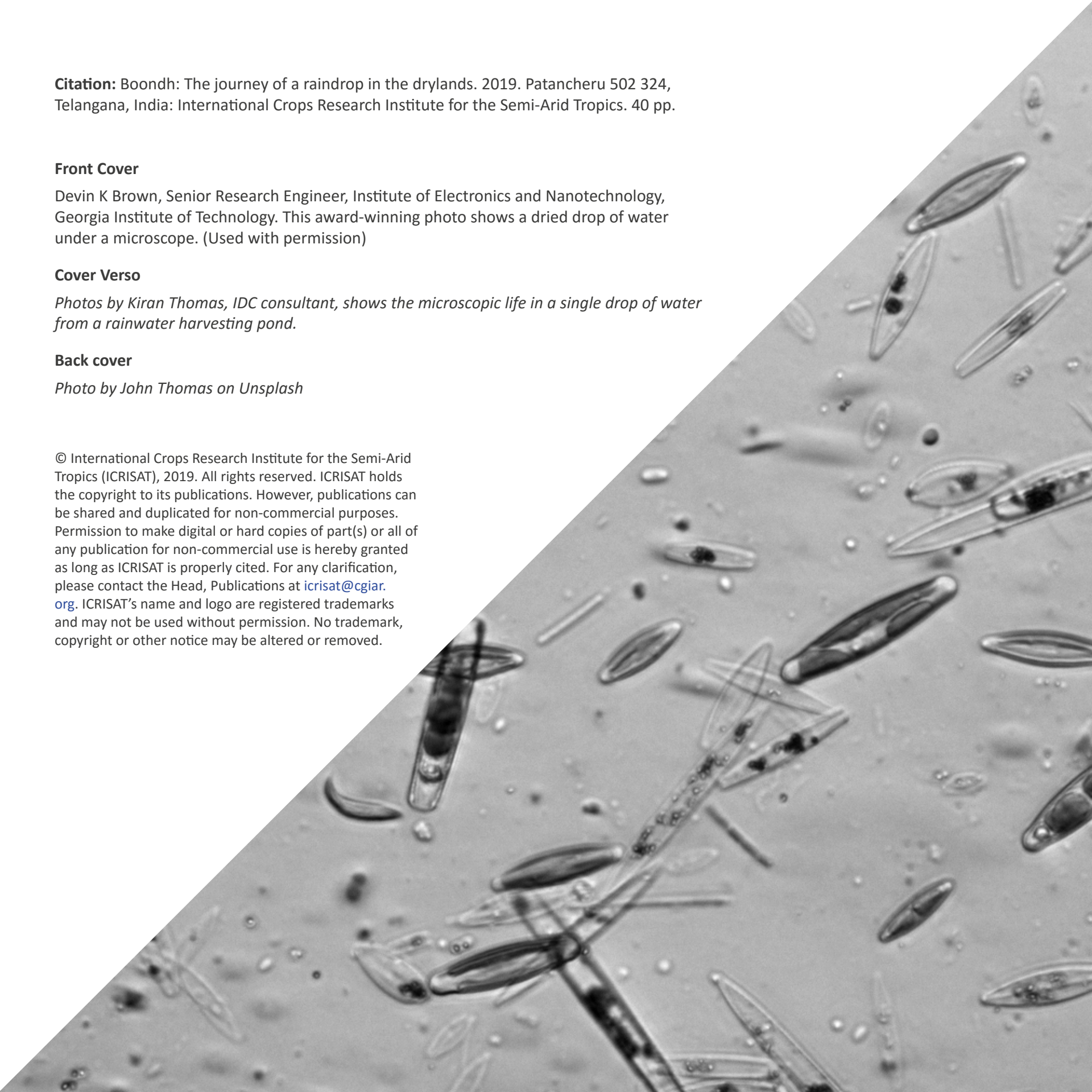
Cover Verso

Photos by Kiran Thomas, IDC consultant, shows the microscopic life in a single drop of water from a rainwater harvesting pond.

Back cover

Photo by John Thomas on Unsplash

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boondh

The journey of a raindrop in the drylands

***Lessons learnt from watersheds in India
and mutual learnings across countries***

Message from the **Director General**



Dr Peter Carberry
Director General, ICRISAT

When the work we do, quietly in labs or sweating in farmers' fields, is turned into an interesting read – a visual treat with a dose of science and a hint of debate – it can be inspiring. Often it's the informal chats with ICRISAT staff over coffee or lunch that enthuse me on our research and its impacts.

As I leaf through this coffee table book that gives snapshots of the extensive work we had done in the area of Integrated Watershed Management (IWM), I am proud of our excellent research and outreach. On-station research at ICRISAT over several decades demonstrates that the productivity of rainfed agriculture can be **enhanced three to five-fold** over current yields through IWM.

With the support of the Indian National and State Governments, the Indian Council of Agricultural Research and other national research institutions, non-government organizations and private sector companies, many watershed initiatives have registered substantive success in India. The most recent **commendation from NITI Aayog**, the National Institution for Transforming India, was on the impact of community best practices for watershed management in Jhansi, India. It is a fine example of involving the private sector in Corporate Social Responsibility projects.

South-South cooperation in agriculture is also high on ICRISAT's agenda and I find that the accumulated lessons that guide India in its policies of watershed development and management at the national level are most relevant to many African ecologies.

At ICRISAT we strive to make agriculture profitable and sustainable for the smallholder farmers in the semi-arid tropics in an inclusive and holistic way and accelerate the use of modern technologies for higher and quicker impact. This book gives you a glimpse of how the ICRISAT Development Center achieves these goals.



Photo: ICRISAT

Saving rain for a dry day!

Rain! The very word spells hope to millions of dryland farmers in India. Farmers looking to the skies for the first monsoon shower has been the muse of many Indian art forms and still continues to be.

Saving rain for a dry day is what farmers who have seen many a monsoon have valued. They were not the only ones though. One look at all the ancient water structures in India — huge step wells, tanks and irrigation canals — and there's no doubting that the rulers then knew the importance of conserving water.

In more recent times, the tradition continues. The Government of India places great importance on its watershed initiatives for harnessing rainwater, preventing environmental degradation and providing livelihoods. These programs take on greater significance as India's drylands face a monsoon that's getting more fickle and providing sustenance to an ever-growing population is a major challenge.

Water scarcity, land degradation and technological and socioeconomic constraints are the leading causes for lower productivity and declining income in the dryland regions. The depleting natural resource base has greatly increased farmers' vulnerability to drought and natural disasters.

ICRISAT takes pride in being a science partner in the Government's initiatives leading multi-institutional teams in 13 model watersheds in various agroecological zones in 9 states of India. Over the years, we have worked in consonance with the Government's integrated watershed management approach for improving farmer livelihoods in these regions. Our holistic approach (see page 1) encompasses all aspects of a watershed, from people and livelihoods to landscape management. The goal is to rehabilitate ecosystems and build the resilience of farming communities.

This book gives you glimpses of our work in 13 project sites and also features pathbreaking initiatives that were successfully implemented at other sites in India.

**Read on to embark on a journey with *Boondh* (Hindi word for droplet).
Along the way listen to life-changing stories from farmers.**



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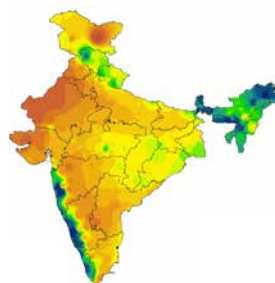
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diagnosis



Photo: L Vidyasagar, ICRIAT

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Every drop counts

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More crop per drop

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Enterprises for added income

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The ties that bind

Watershed management approach

Rehabilitating ecosystems and building resilience of farming communities



Community meetings
to identify key interventions,
facilitate watershed committee
formation and implement
capacity building



Soil

Entry point activity:

Free Soil Health Test

Techniques to improve fertility:

1. Reduce synthetic fertilizer
 - Use prescribed dosage of chemical fertilizers
 - Green manure
 - Vermicomposting
 - Tank silt
2. Moisture conserving techniques
 - Broad Bed and Furrow
 - Zero tillage.

Crops

Based on farmers interviews introduce climate-smart crops and varieties that are drought and heat tolerant, disease resistant, early maturing, nutrient rich, improve soil health and augment income.



CROSSCUTTING ISSUES:

• Integrating gender

• Attracting youth

Water

Based on geospatial analysis build structures to harvest rainwater and increase groundwater levels. Use techniques like drip irrigation for water use efficiency.

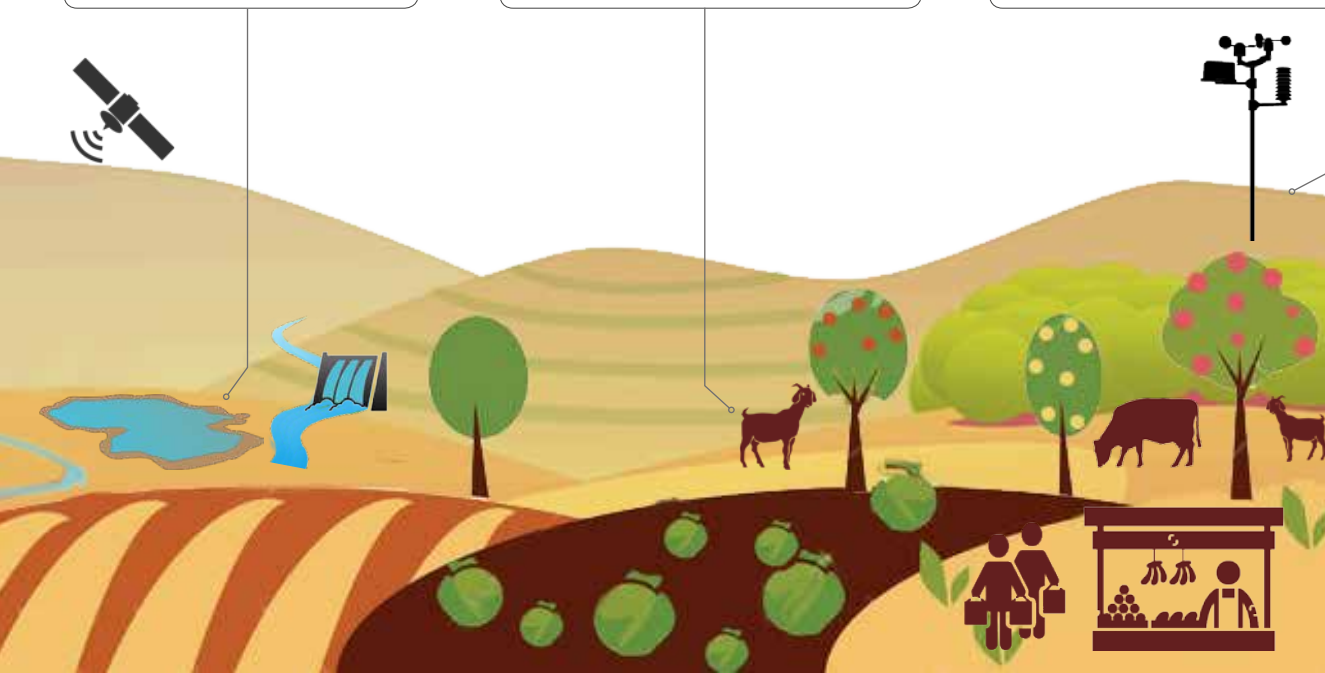
New livelihoods & Market links

Facilitate Self-Help Group formation

- Livelihood diversification through farm enterprises - selling vegetables, fruits, vermicompost, etc.
- Livestock/poultry/fisheries integration
- Agroforestry.

Climate

- Install weather stations, rain gauges and equipment to collect data on rainfall and temperature, monitor runoff rate, soil loss in watershed, etc.
- Train farmers to monitor and use data and make cropping decisions.

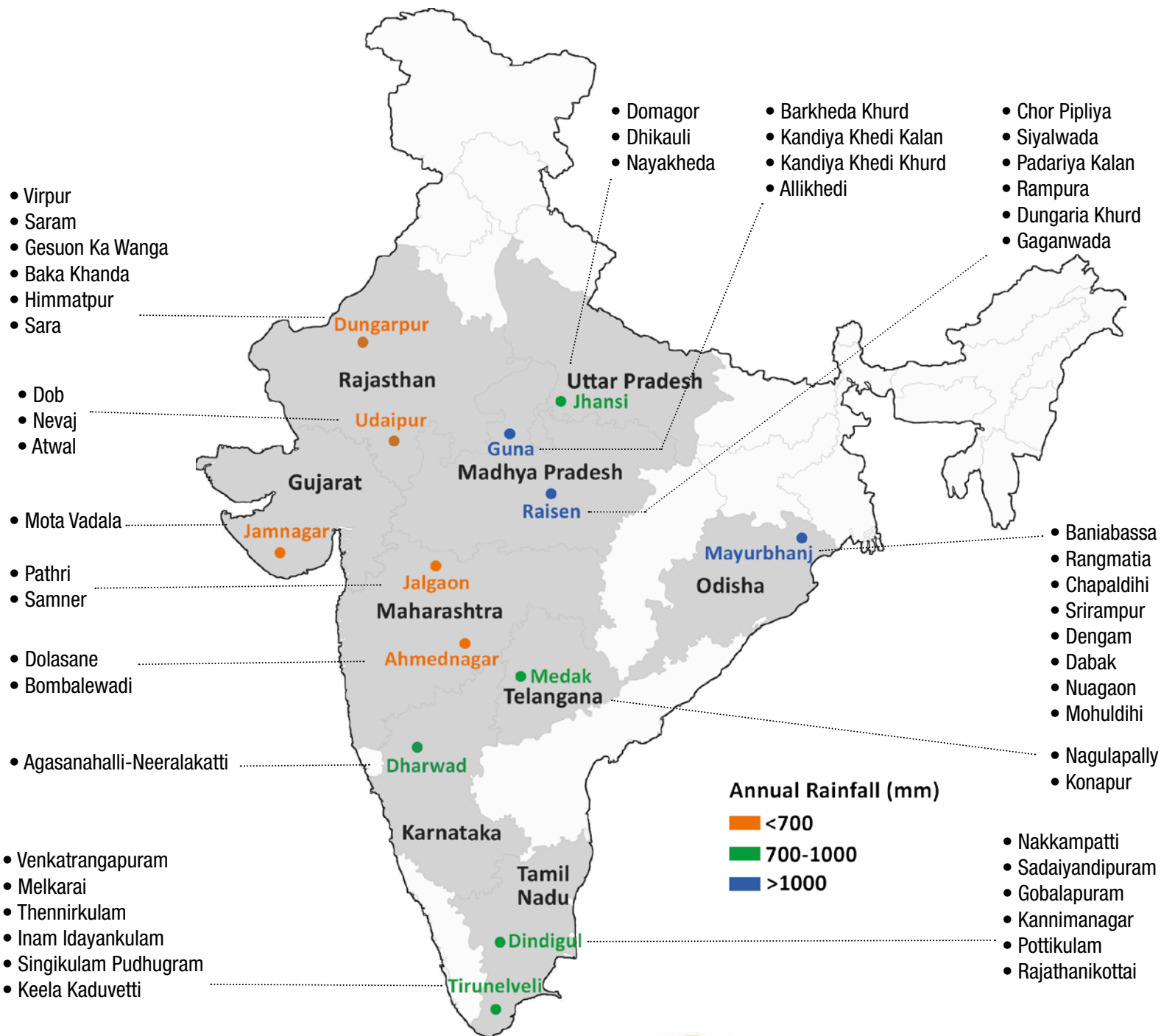


Monitoring, Learning & Evaluation for all watershed components

ICRISAT records and analyzes climate, crop data and increase in farm incomes

- Nutrition
- Communication
- Partnerships
- Digital solutions

13 model watersheds in 50 villages in 9 Indian states, covering 17,920 hectares



The model watershed projects were funded by:



सत्यमेव जयते

Department of Land Resources
Ministry of Rural Development



Impact of model watersheds

The Government of India's **Ministry of Agriculture & Farmers Welfare** and the **Department of Land Resources**, Ministry of Rural Development supported ICRISAT in establishing 13 model watersheds to serve as sites of learning and capacity building in three different rainfall zones in India. An assessment* on the impact of the work implemented during 2010-16 is summarized below.

SOIL

Rectified severe nutrient deficiencies

1,416 soil samples were analyzed



Micronutrient	% of nutrient-deficient fields
Organic Carbon	25-95%
Available phosphorus	22-71%
Sulphur	33-79%
Zinc	40-71%
Boron	32-89%

Based on soil test results, site-specific nutrient recommendations were prepared and implemented.

WATER

Increased water availability

78,000 - 1,820,000 m³
additional surface water storage capacity created

10-48%
Mean annual runoff reduced

18-61 t/ha
Mean annual soil loss reduced



CROPS

Introduced new varieties and cropping techniques

12-82%
increased yields
over farmers' practices

115-186%
increased cropping
intensity



PEOPLE

Capacity building

Multi-institutional teams train farmers. Extension workers, government and non-government personnel received trainings based on the requirement.



NEW ENTERPRISES

Income-generating avenues

- Livestock farming
- Poultry
- Horticulture
- Floriculture
- Agroforestry
- Farm enterprises



LANDSCAPES

Installed water and climate monitoring tools

39 monitoring units set up

The **13 watersheds** received one each of:

- Automatic weather station
- Digital runoff recorder
- Automatic sediment sampler

Project staff were trained to handle the equipment.

<250 wells geo-referenced

At each watershed **12-20 open wells** (representing upstream, middle and downstream parts of the watershed) were numbered, **geo-referenced and monitored** using groundwater meters.



*All figures taken from closure reports submitted to the Government of India.



Community-based approach

Creating a voice and stake for **landless farmers, youth and women**



People first

Engaging all stakeholders to work together



Bringing in the expertise

A multi-institutional team of scientists from various CGIAR agricultural research centers, state agricultural universities and NGOs visited several project sites. At each site, farmers meetings were conducted and detailed discussions were held with government officials, local institution officials and community members.



Capacity building at various levels

- Orientation programs for the watershed committee members and self-help group members;
- Exposure visits to other watershed programs.

Trainings for field staff and community members on:

- Groundwater monitoring;
- Collection of rainfall data from rain gauges;
- Techniques of broadbed and furrow cultivation system;
- Day-to-day maintenance of runoff and soil loss measuring equipment;
- Agriculture productivity enhancement technologies;
- Organic manure (Nadep* method)/ vermicompost preparation; and
- Need-based specialized trainings.

*N.D. Pandharipande method



Convergence with existing government schemes

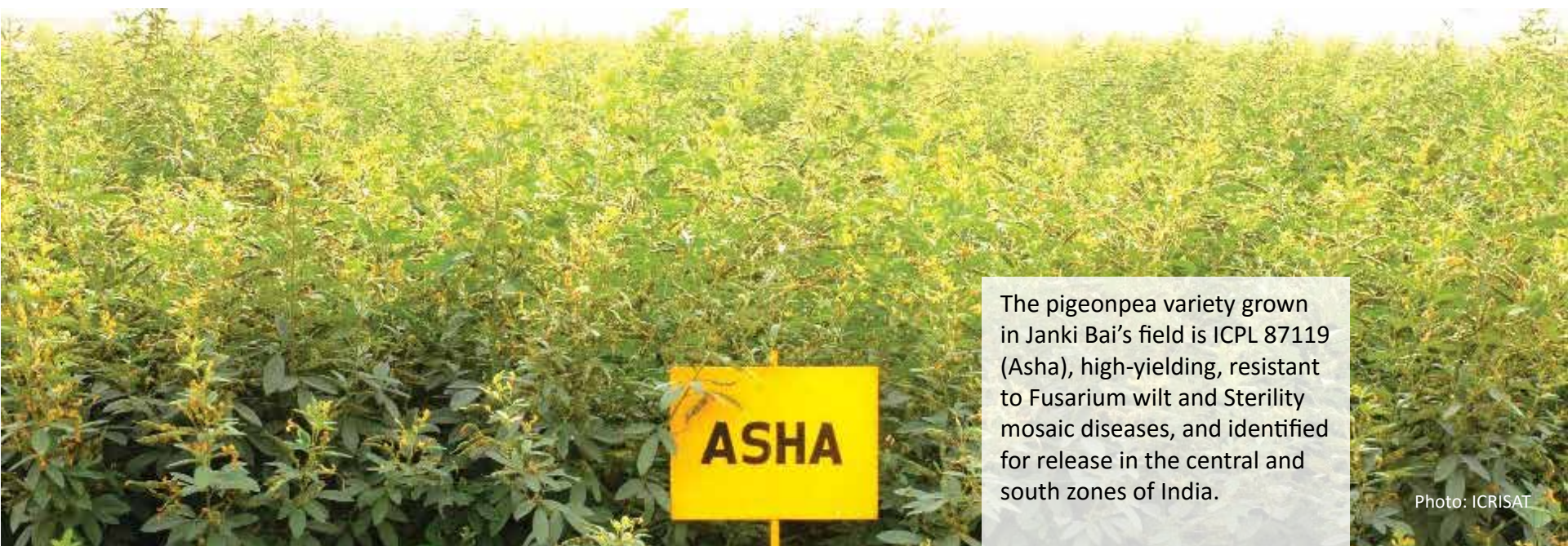
- Joint forest management with the Forest Department;
- Productivity enhancement with the Agriculture and Horticulture Department;
- Livestock development with the Animal Husbandry Department;
- Construction of water harvesting structures through the Mahatma Gandhi National Rural Employment Guarantee Act (MNREGA) scheme.
- These activities strengthened the watershed program and enhanced its impact and sustainability.



Inclusion of farm women

It is mandatory that 50% of the watershed committee members are women. All activities strived to integrate gender. Mahila *Melas* were held to encourage women participation in the watersheds and other rural development activities.

Farmer days and farmer *melas* were also organized, which were attended by farmers, scientists, development workers and government officials.



The pigeonpea variety grown in Janki Bai's field is ICPL 87119 (Asha), high-yielding, resistant to Fusarium wilt and Sterility mosaic diseases, and identified for release in the central and south zones of India.

Photo: ICRISAT

Sacrificing a piece of land for a pond, benefits her entire farm and neighbors too

The watershed project in Dungaria, a remote village in **Madhya Pradesh**, helped farmers conserve rainwater, grow new crops and build a community spirit

Battling water scarcity and poverty: Five years ago, Janki Bai couldn't even dream of growing rice in her field. She has 10 acres (4 ha) of land. Going by the land size you might presume she is wealthy, but sadly her land lay fallow most of the year. "This is a dry area. We used to grow just one crop," says Janki, who along with her husband Kamal Singh grew the local variety of chickpea and pigeonpea.

The income they got from the farm and by loaning out their two bullocks was insufficient to meet the needs of their family of eight. To supplement their income the couple worked as farm laborers.

Water harvesting ushers in positive changes: Though the Padarlya-Siyalwada Model Watershed project started in 2010, it was not until 2013 that Janki decided to put in a proposal to the watershed committee for digging a pond in her field. She sacrificed an acre (0.4 ha) of land for the pond and paid for 5% of the cost (₹10,000, US\$ 160)*. "The digging of the pond required a lot of labor," says Janki, adding that men and women were paid equal daily wages of ₹100 each. Instead of the market rate of ₹50 (US\$ 0.81) for women and ₹70 (US\$ 1.13) for men.

The work on the pond started in March 2014 and was completed in June 2014 just in time for the monsoon showers. Rainwater from the hills reaches Janki's pond via diversion drains and the water storage capacity of this earthen structure is 4,000 cubic meters.

The pond not only benefits Janki's 9 acres (3.6 ha) but also the neighboring land as the groundwater gets recharged and tube wells in other farms within half-a-kilometer radius are benefited. Another major achievement for Janki was to grow rice. Prior to sowing rice, soil tests were done on Janki's farm. To prevent soil erosion in the uplands in her field, earthen and vegetative bunds were built; boulder checks were also built to prevent silting of



Photo: Nagasrinivas Reddy

<https://www.youtube.com/watch?v=rLi6DQs9k-o>

the pond. Janki used fertilizers prescribed by ICRISAT following soil tests on her land to make up for nutrient deficiency. She also used eco-friendly compost.

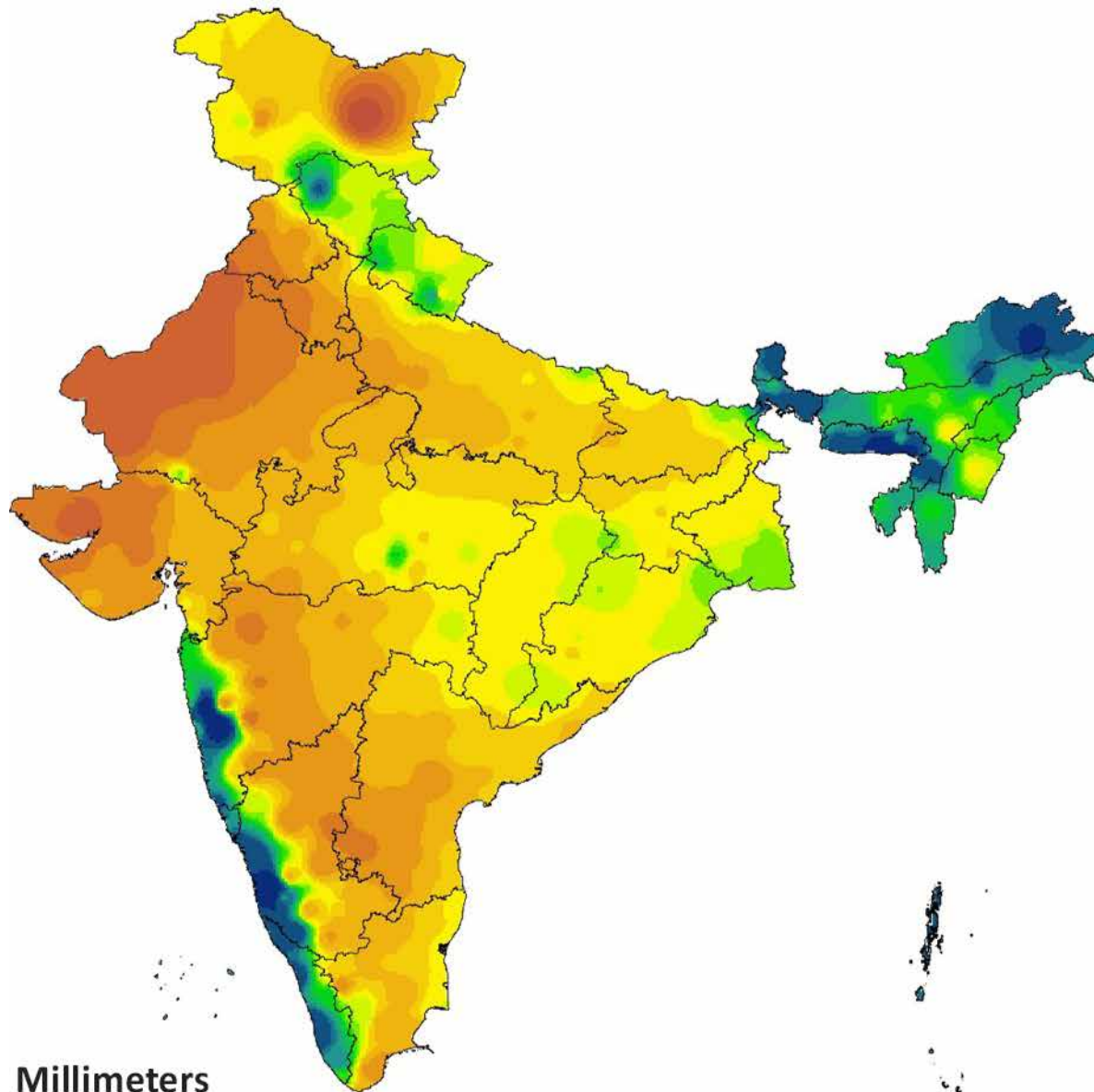
"Once we built the pond, we started growing rice. We had a good harvest and we are able to run our house well. We have now planted wheat and pigeonpea (Asha variety)," she says pointing to the seedlings.

For the first time in our village, men and women were paid equal wages.

— Janki Bai, farmer, Dungaria village

*Dollar rate as on January 2015

Annual Rainfall



Millimeters

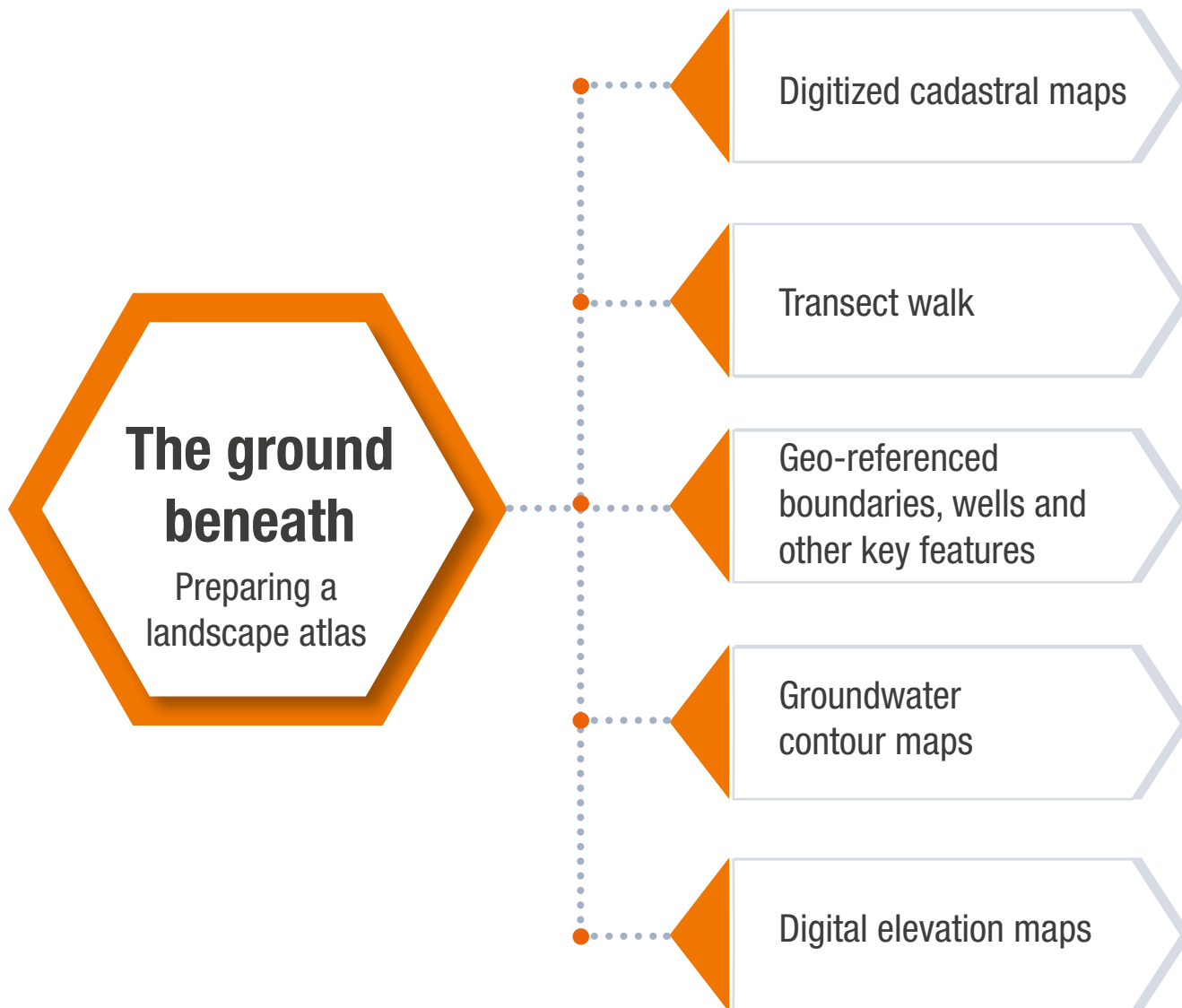


http://maps.icrisat.org/gallery/RSGIS_gallery/GIS/Images/India_WaterBalance/india_annual_rainfall.jpg

ICRISAT RSGIS Unit

Cutting-edge technology

Satellite imaging captures data that helps scientists strategize water conservation efforts



The ground beneath



Detailed baseline surveys

Participatory Rural Appraisal and Rapid Rural Appraisal were conducted in each watershed, which included biophysical and socioeconomic aspects. The secondary data pertaining to the area were also collected with help from different service providers.



Geo-referencing of structures

The watershed boundary, open wells, villages and other key features were geo-referenced. Total station survey was used to carry out more detailed topographic surveys.



Installation of monitoring tools

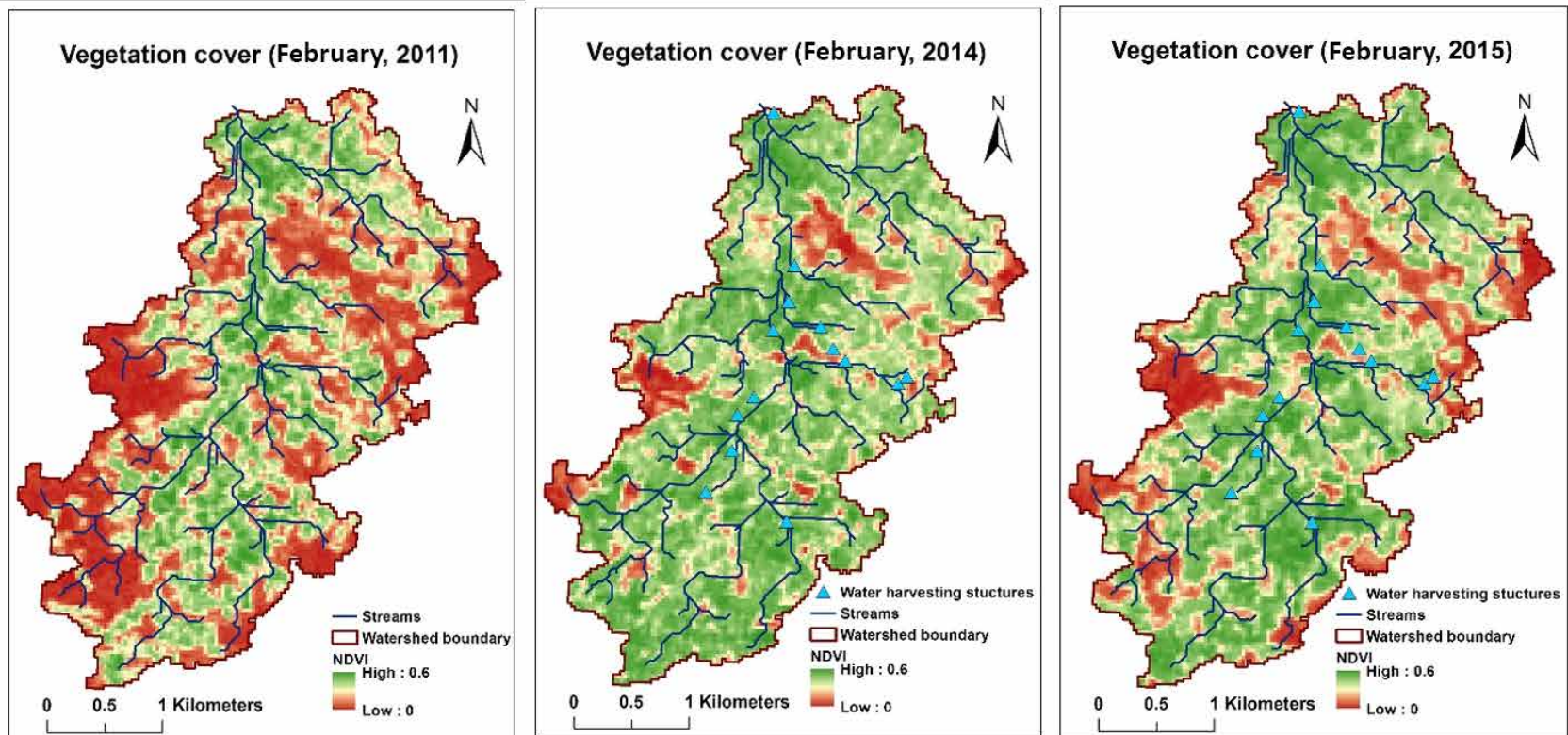
Each of the watersheds was equipped with an automatic weather station, digital runoff recorder and automatic sediment samplers. Project staff were trained to handle the equipment. At each model watershed, 12-20 open wells (representing upstream, middle and downstream parts of the watershed) were numbered, geo-referenced and monitored.



Digital maps

Digitized cadastral maps of the watershed area were used along with transect walk, primary and secondary data to prepare detailed project reports. Digital elevation maps and groundwater contour maps were prepared. Lineaments (water carrier) and dyke (water barrier) lines were marked.

Land use changes in micro-watershed project in Jhansi



Change in land use: Significant fallow land, especially at upstream locations, was converted into cropland.

82% of the area was under cultivation even in the postrainy (*rabi*) season.

Doubling farmers' incomes in drought-stricken Bundelkhand region

The mere mention of Bundelkhand to many Indians brings to mind images of parched land, dead cattle and women trekking miles for a pot of water. Successive droughts have ravaged this region. Yet, even here, one can find exceptions.



In one micro-watershed project based in Parasai-Sindh in Jhansi, farmers did not just survive the drought – they had enough water for humans, crops and cattle and also had doubled their farm income. This was possible through a Corporate Social Responsibility project and the results have been featured in a [recent publication*](#). Interventions included the revival of old wells, facilitating building of watershed structures at appropriate locations and introduction of drought resilient technologies and cropping systems. This resulted in a major turnaround towards the end of the project in spite of deficit rainfall of -33% in 2017.

Growth engines

Decentralized water harvesting: Rejuvenation of the traditional water harvesting (*Haveli*) system and facilitating construction of low-cost water harvesting structures;

Introducing improved crop cultivars along with best crop management interventions;

Crop diversification including various agro-forestry interventions;

Enhancing land and water use efficiency through *in-situ* interventions and mechanization;

Improved animal breeds and grassland development;

Institution building (e.g., seed banks, Self-Help Groups, Farmer Producer Organizations, etc.).

Funder



Partners



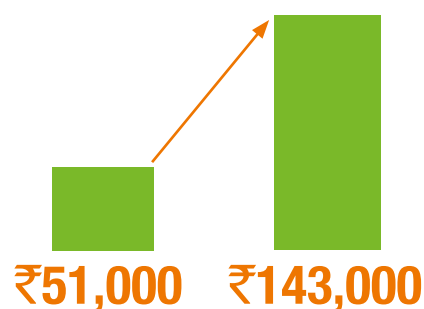
Monitoring



*Reference: Wani SP and Raju KV. 2018. Corporate Social Responsibility: Win-win Propositions for Communities, Corporates and Agriculture. CABI. ISBN 9781786394514.

Impacts

Increase in average annual household income in 4-5 years



The watershed showed drought resilience: Sufficient drinking and irrigation water was available despite the non-availability of government water supply through tankers.

36%
Runoff reduction

62%
Soil loss reduction

46%
Increase in groundwater recharge

10-70%
Increase in crop productivity

27%
Reduction in cost of cultivation (for wheat)

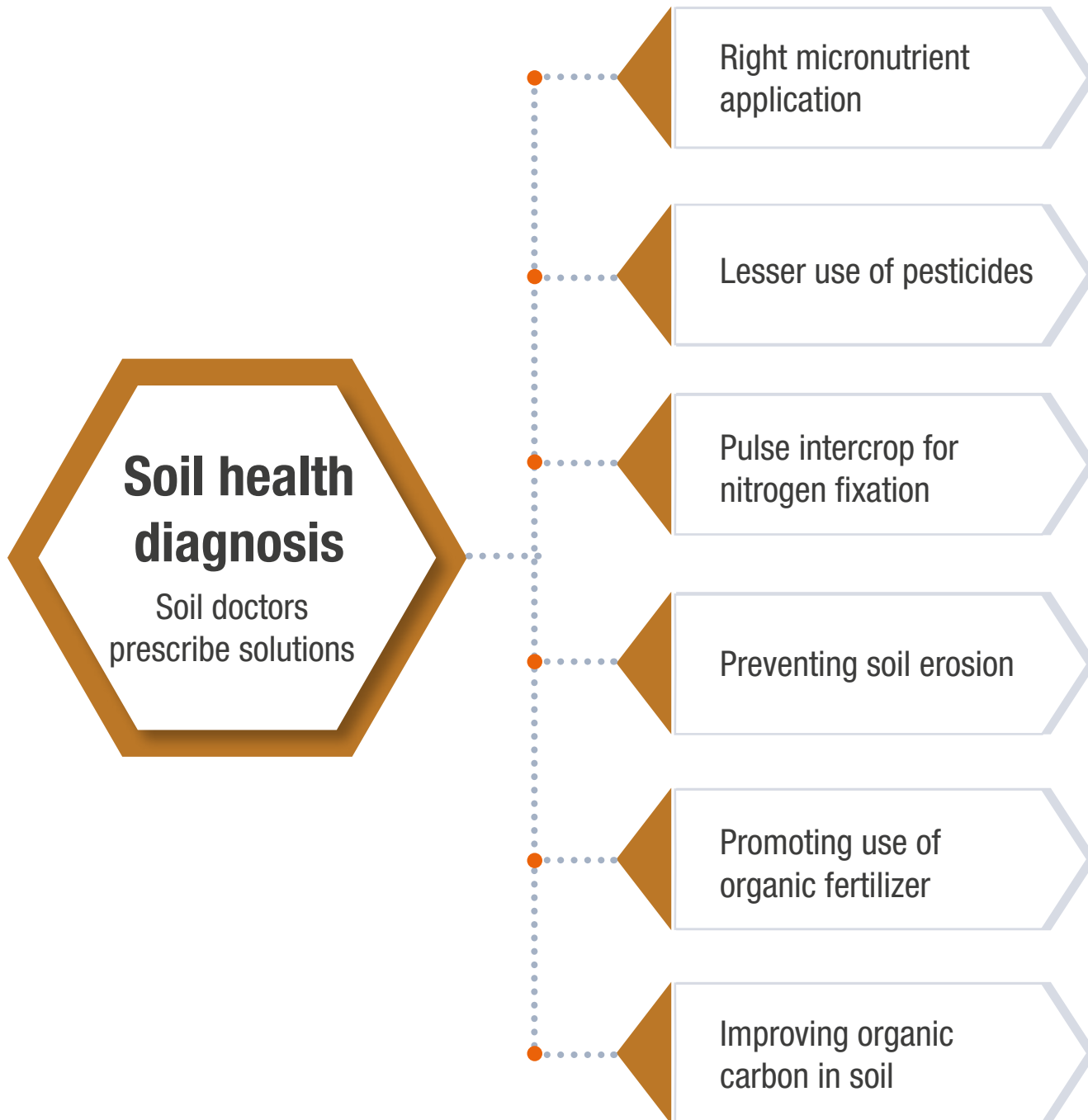




Photo: Srujan Punna, ICRIAT

Soil test as an entry-point activity

A free soil test replaces the earlier practice of giving cash incentives to farmers for watershed activities



Soil doctors prescribe solutions



Soil health cards

A participatory stratified sampling procedure was followed in the watersheds to gather soil samples. Analysis showed that all the watersheds were deficient in major and micronutrients including Boron, Zinc and Sulphur. Based on soil test results, site-specific nutrient recommendations were prepared and implemented.



Use of organic manure

This method focuses on the use of organic manure and replenishing major and micronutrients that are deficient in the soil. Planting *Gliricidia sepium* on field bunds, preparation of organic manure using the Nadep method and the use of vermicompost are practiced by farmers in the watersheds.



Promoting agroforestry


To improve organic carbon in the soil and to prevent soil erosion, agroforestry and silvipastures were recommended.



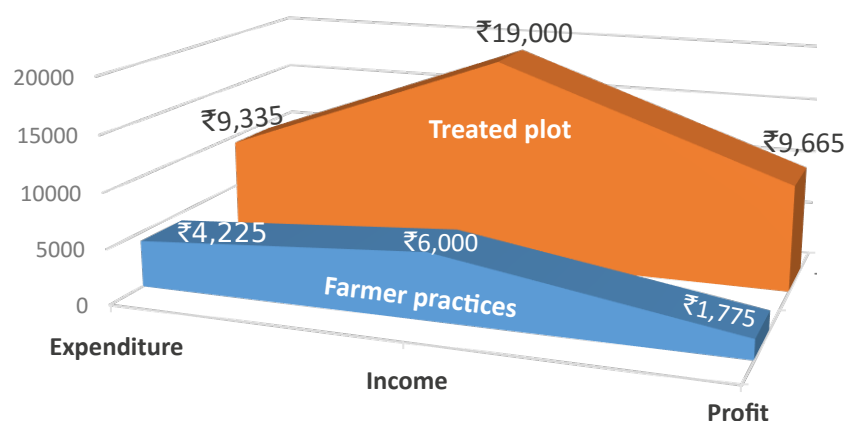
Nitrogen-fixing crops

Intercropping cereals with leguminous plants both for food and fodder is practiced at project sites.

Comparative study for treated and farmer practices of pearl millet crop (ICMV 221) on 0.4 hectare plot

	Expenditure (₹)	
	Treated	Farmer practices
 Ploughing	1,500	1,000
 Cow dung	3,500	1,500
 Seed	135 3 kg* x ₹45	175 5 kg x ₹35
 Weeding	2,000	1,000
 Fertilizer	550 Urea	550 Urea
	650 Zinc sulphate: 20 kg Borax: 2 kg	
Total	9,335	4,225

*(ICMV 221, subsidy)



ICMV 221 (Open-Pollinated Variety)

Maturity: 75-90 days

Yield potential: 3,750-5,000 kg/ha

- Tolerant to various soil conditions including light and acid soils.
- Grows best on well-drained clay-loam and sandy loam soils.
- Tolerant to drought, rust and low nitrogen levels.
- Highly nutritious (high levels of nitrogen, amino acids, calcium, iron and methionine). Good for children's porridge.
- Grows well in low and medium altitude areas (1000-1600 meters above sea level).



Halting soil erosion, adding micronutrients get Sonai's profits soaring fivefold

At 70, farmer Sonai from Dindigul district in Tamil Nadu is a great example to show that age is just a number and that learning is a lifelong process.

For years, Sonai did not know how to deal with the poor soil on his 3 acre (1.2 ha) plot located on a hillslope. When it rained, an upstream gully (rivulet) overflowed, stripping the soil of its nutrients as the water rushed towards the footslopes. The only crops Sonai could cultivate in the poor soil were sorghum and pearl millet with pigeonpea as an intercrop and often the yields were low.

Neighboring farmers too suffered the same plight and many of them sold their cattle due to fodder scarcity. Some even migrated to cities to eke a livelihood as laborers.

In 2010, when the Ammaiyanickanur Model Watershed Development Project was started in his village, he came to know of it through the local NGO CIRHEP and joined the Watershed Farmers Group. With the support of the NGO as advised by ICRISAT, he constructed a masonry check dam on the gully. He also applied micronutrients such as Borax, Gypsum and Zinc Sulphate and planted 50 teak seedlings on the land.

The next monsoon, the check dam effectively prevented soil erosion and allowed the rain water to seep through the soil. He also saw a rise in the water level in his well. Under the Program, ICRISAT, supplied seed of improved pearl millet (ICMV 221) and sorghum varieties at a subsidized cost. Sonai got a yield that was 25% higher as the new varieties commanded a very good price in the market than the conventional varieties. From the surplus

money, he built a house at a cost of ₹60,000. He was able to produce enough food for his family. Increased water availability helped him to go for a second crop. The fodder from the fields has reduced expenses on cattle maintenance and the cattle are healthier.



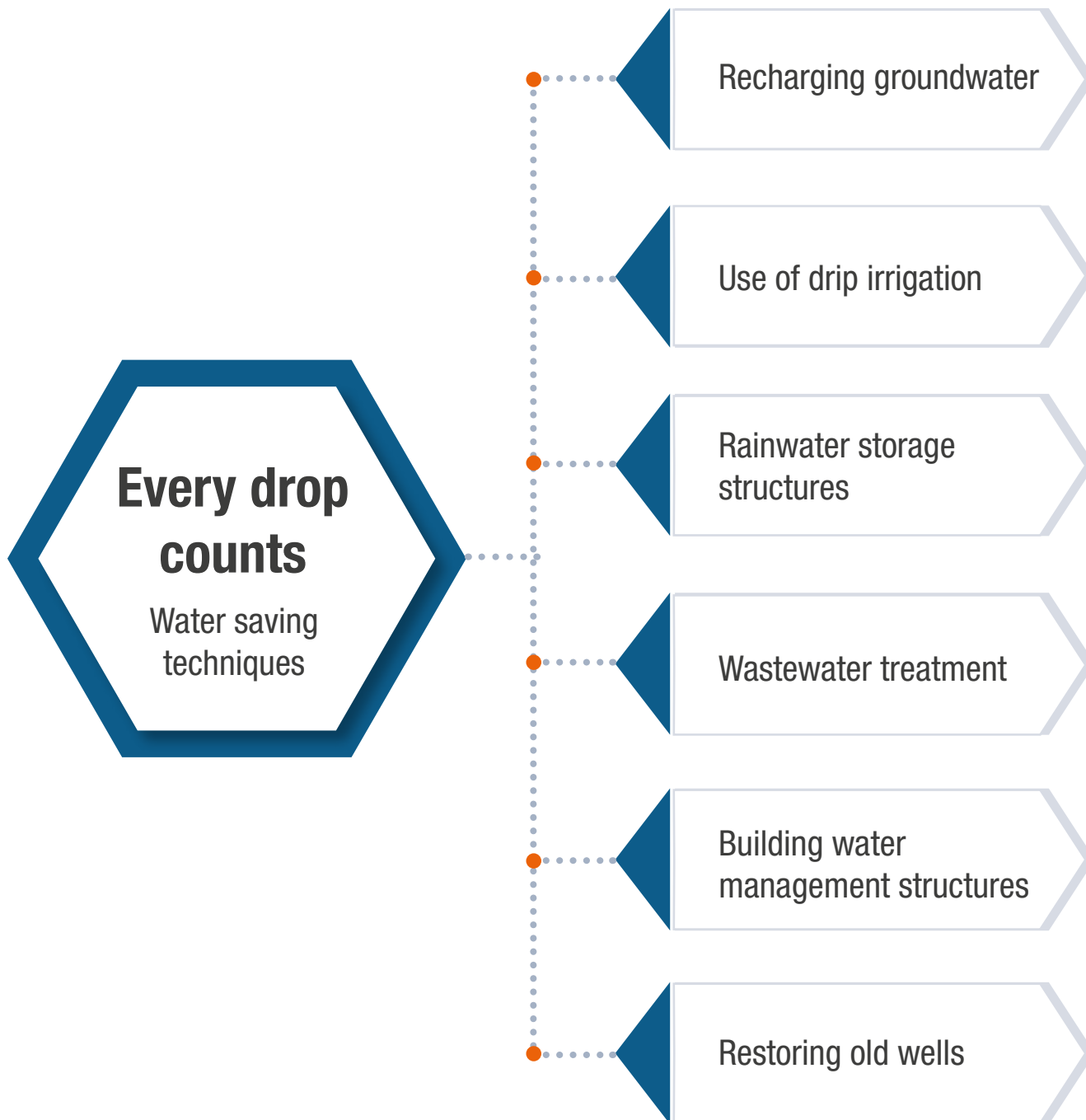
I earned extra income of ₹9,625 per hectare.
These varieties also yield better quality fodder.

– Sonai



Taming the monsoon

The success of rainfed agriculture in India depends on conserving soil moisture, alleviating waterlogging, controlling runoff and soil loss and improving crop yields



Every drop counts



In-situ soil and water management interventions

Several water harvesting, groundwater recharging and gully control measures were implemented in each of the watersheds.

These include –

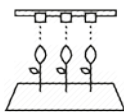
- Farm ponds
- Earthen check dams
- Loose boulder structures
- Field bunding
- Masonry check dams
- Diversion channels
- Earthen *nala* bunds
- Gully plugs
- Stone outlets
- Contour trenches
- Development of pasture lands
- Restoring old wells

These systems were highly effective in conserving soil moisture, alleviating waterlogging, controlling runoff and soil loss and improving crop yields.



Photo: Dr Ramesh Singh, CAFRI

The masonry check dam at the micro watershed project in Jhansi.



Drip irrigation

Utilizing the subsidies provided by the Government, many farmers had invested in purchasing equipment for their farms resulting in substantial water saving.

Due to various watershed interventions, surface and groundwater availability increased across the watersheds. Results showed that the groundwater level in the open wells/tube wells were significantly higher after the second year of implementation of the watershed program. This trend was observed along the entire toposequence of the watershed.

As part of ICRISAT's ongoing efforts to find new ways for effective use of water, wastewater treatment is a technology that's gaining acceptance in upcoming watershed projects.



Upscaling new technologies: Wastewater treatment

Wastewater has a high concentration of nutrients and many farmers use it to reduce expenditure on fertilizers. However, untreated wastewater carries pathogens and bacteria posing serious health risks to consumers, especially when vegetables are eaten raw.

Lack of access to clean water sources and unpredictable weather conditions are making things worse, especially for smallholder farmers. Many are forced to use and even depend on wastewater for irrigation to a much larger extent than previously thought.

Several decentralized wastewater treatment units have been established by ICRISAT in partnership with local governments and private companies to supply quality water for irrigation. With a pathogen removal efficiency of 87%, decentralized wastewater treatment units reduce health risks and provide water security to smallholder farmers.

Wastewater treatment units consist of constructed wetlands with a filter bed of locally available sand/gravel and are vegetated with specific wetland plants.

The constructed wetlands technology is an outcome of Water4Crops, a large Euro-India collaborative research project co-funded by the Government of India and the European Commission.

Farmer Sailu beats the stigma of using treated wastewater on farms

Many villagers warned me against consuming sorghum grown with village wastewater, but I use this treated water as I can see the benefits. Now after three years, others see I am healthy and improving my yields, so they have stopped their warnings.

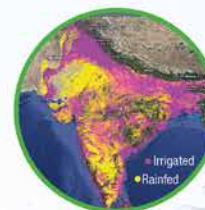
– Serigudam Sailu
Kothapally, Telangana, India

65% of global croplands'



Depend on untreated wastewater

885 million people at risk of consuming food grown with untreated wastewater²



– 15% of India's irrigated land under untreated wastewater²

Village-level wastewater treatment units



Treated wastewater
20,000 ltr/day
to grow crops on
1ha throughout the year



Treated wastewater allows Serigudam Sailu to grow coriander as an income source.

Continuous access to water means crop diversification for Serigudam

Coriander in rainy season as cash crop

600 kg sorghum
per 1/4 acre in summer

Village-level wastewater treatment units scaled out in **28 villages**

¹Global croplands website; ²Drechsel et al., 2017 in Environmental Research Letters.



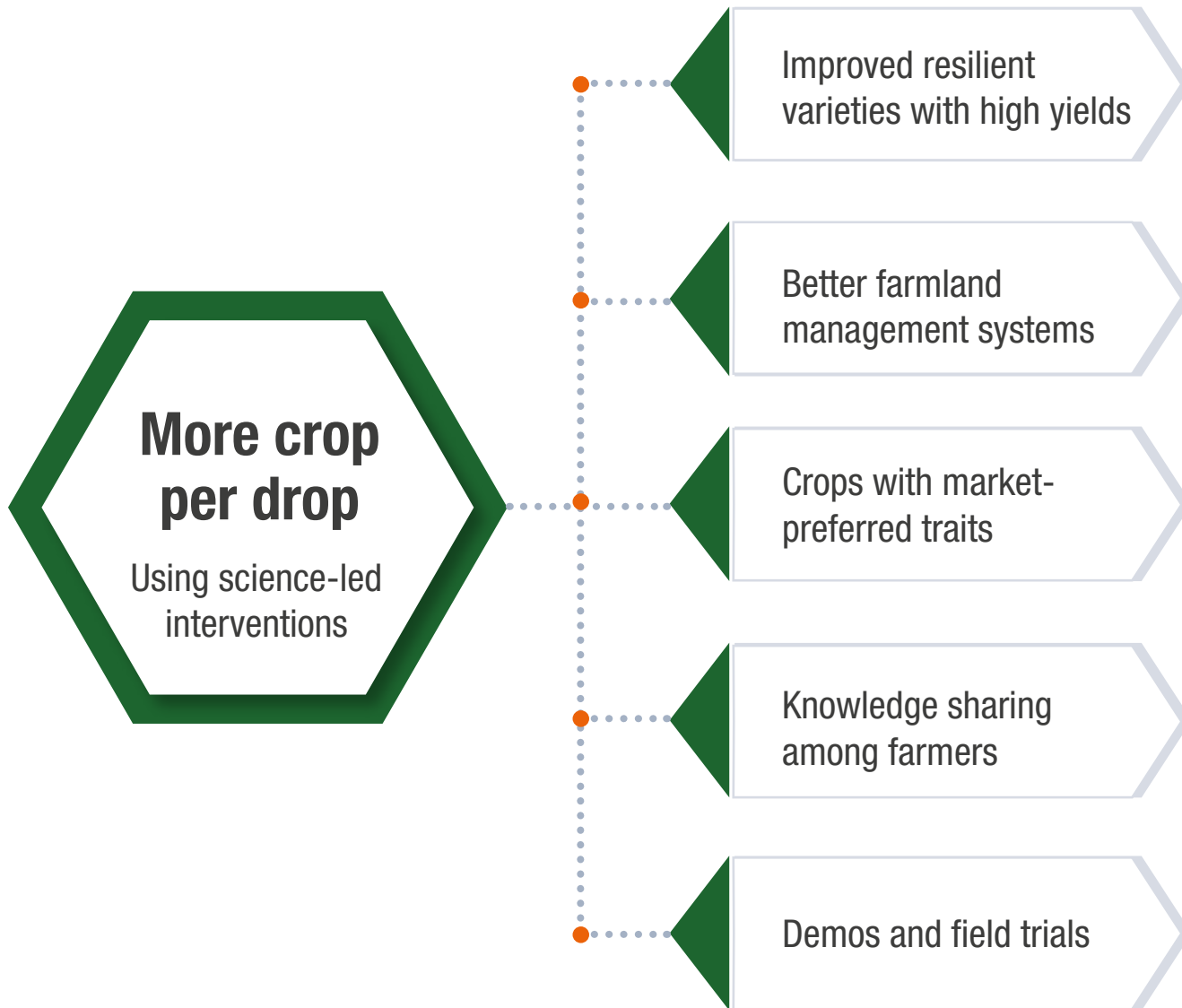
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BOHIGS
TEST

BOHIGS
TEST

Money matters

Tangible economic benefits to farmers improve community participation which is critical for sustainability of watershed interventions

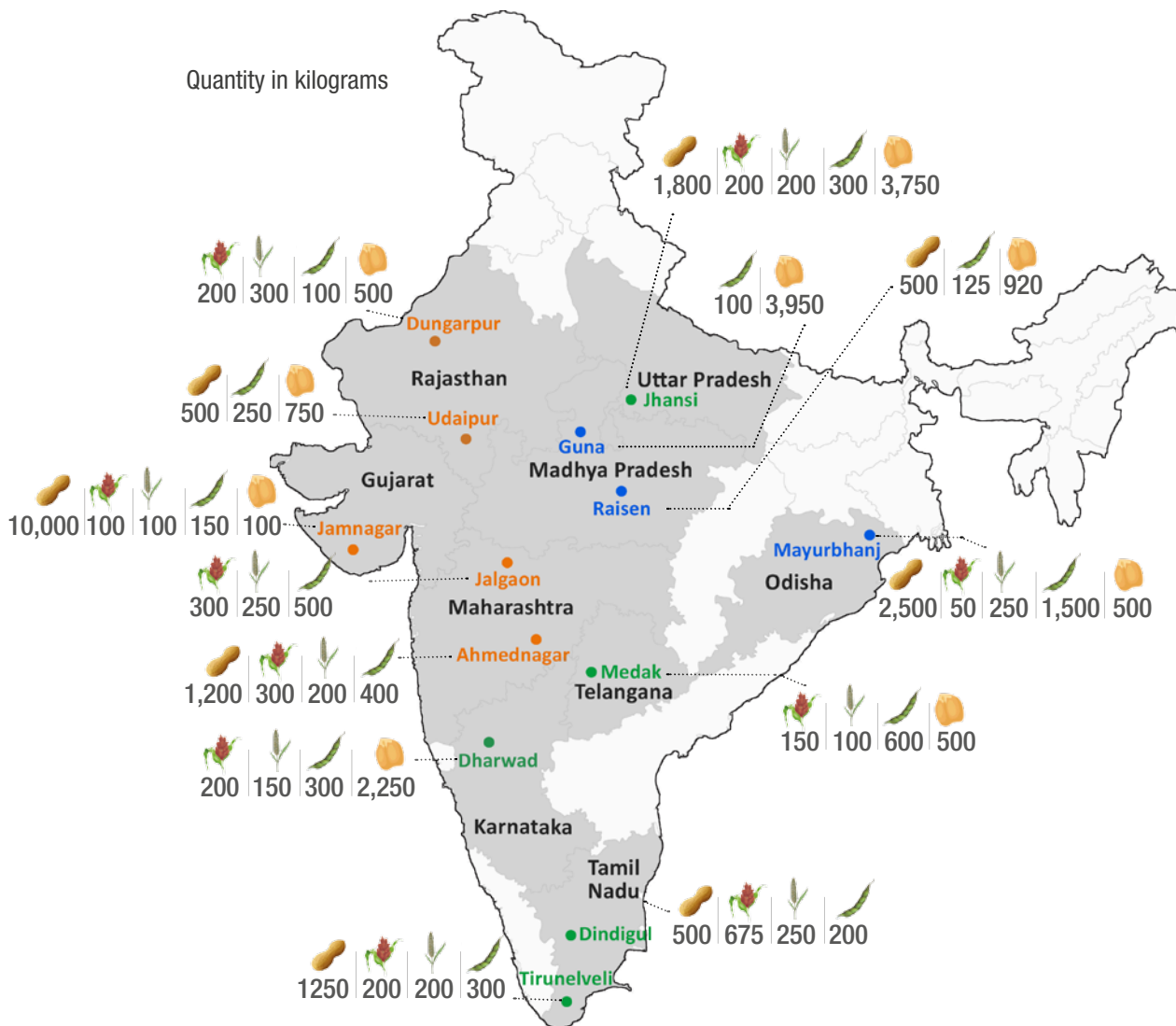


More crop per drop

Introduction of new varieties and cropping techniques results in

12-82% increased yields over farmers' practices

ICRISAT mandate crops total seed distributed during project period 2010-16:



Participatory demonstrations and research trials on improved agricultural practices were conducted on farmers' fields using improved crops/varieties.

Balanced crop nutrition including application of micronutrients, broadbed and furrow land management system, water management using drip irrigation and other improved practices resulted in increased crop yields.

Other crops

total seed distributed:



Increased water availability helps farmer Devidas Bhila Patil double his farm income

Devidas Patil's election as watershed committee chair in Pathri village, Maharashtra, changed his approach to dryland agriculture. Read how his fortunes changed with increased water availability, improved varieties and new crops on his 3 hectare plot. Today, he is an advocate of organic fertilizer; he's got an interesting formula too!

A model chair for a model watershed – that's Devidas Patil. Before the watershed project, he would only grow cotton, and other rainfed crops and earn an income of only ₹100,000/annum.

After the watershed project, sunken pits, cement *nala* bunds, continuous contour trench work, gabion structure and three check dams prevented soil erosion and excessive run-off which was a major problem in the villages. The interventions helped increase the water table by at least 30 feet.

Water availability post the watershed work did not mean squandering scarce resources but rather responsible usage by deploying a drip irrigation system that resulted in doubled yields and profits.

Yield differences

Without irrigation

 **500-750 kg/ha**
Chickpea
Sold at ₹50/kg

With drip irrigation

 **1,250-1,500 kg/ha**
Chickpea

 **1,750-2,000 kg/ha**
Sorghum
(fodder grass variety)
Sold at ₹12/kg

 **2,750-3,000 kg/ha**
Sorghum
(fodder grass variety)

New crop introduced

Devidas grows the local banana variety on 2 acres (0.8 ha) and is obtaining a net profit of ₹250,000 per hectare, an amount he had never procured in the past.

Advocate of organic fertilizer

For the past 3-4 years he has been using 'Jeevamruth' – organic fertilizer prepared on his farm. The cost on fertilizers is cut by about 35-40% and has resulted in an increased yield of 30%.

He prepares a mixture of 10 kg cow dung, 5 to 10 liters cow urine, 2 kg of jaggery, 2 kg of gram flour and material from old trees and stirs it clockwise two times a day for 5-8 days in 200 liters of water. This mixture is sufficient for 1 acre (0.4 ha).



Photo: A Seshadri, ICRISAT

Yield differences

Normal varieties

 **2,500 kg/ha**
Sorghum

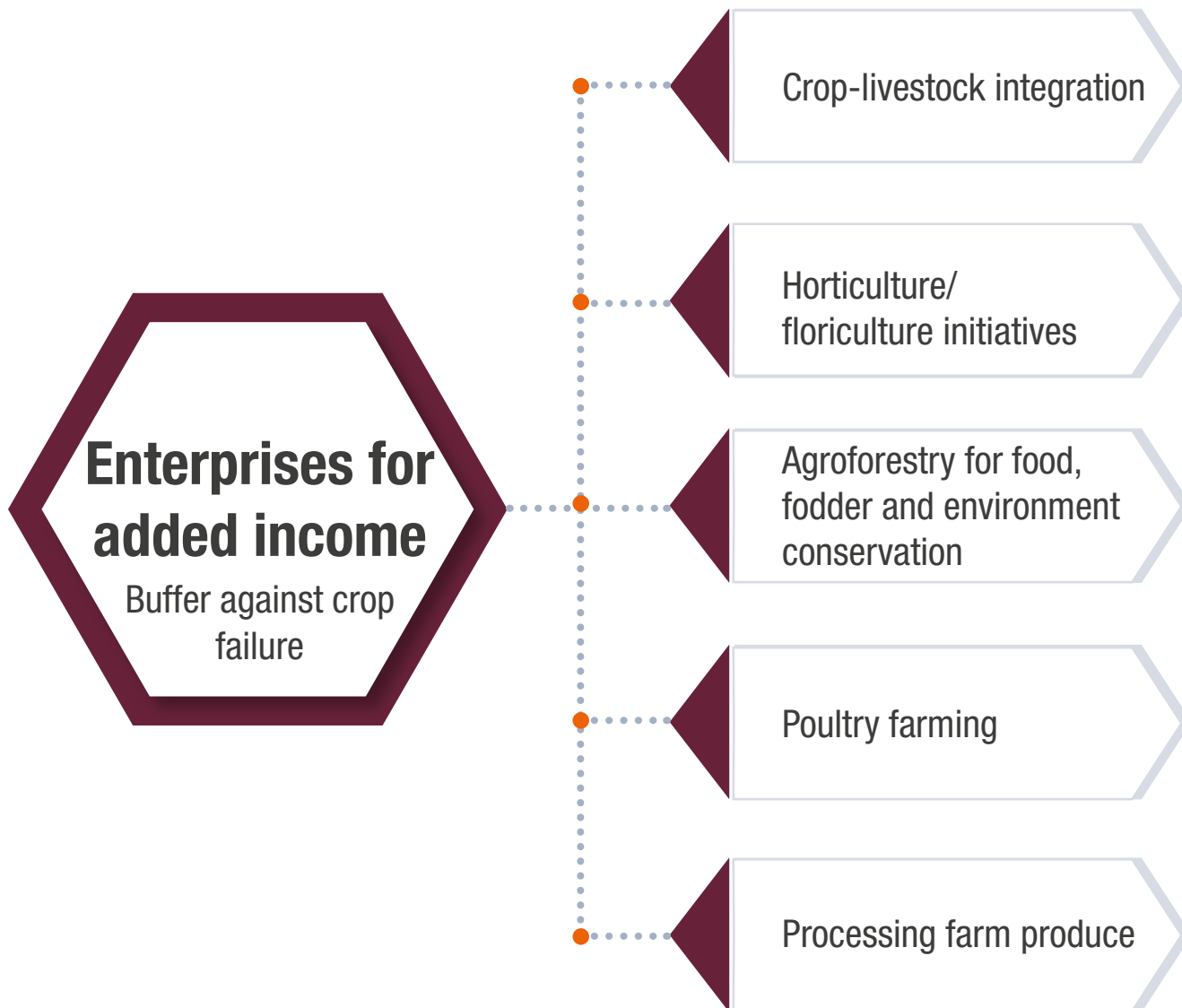
Hybrids

 **5,000 kg/ha**
Sorghum



On-farm diversification pays off

These activities, often linked to Government schemes, have strengthened the watershed program and enhanced its impact and sustainability



Enterprises for added income



Diversification into off-farm activities builds the resilience of farmers and acts as a buffer when the crops fail due to adverse weather or other reasons. The availability of water opens up many avenues to farmers besides growing their staple crops.



Convergence with various government schemes and State Government Departments was achieved across all watersheds: Joint forest management with Forest Department; productivity enhancement with Agriculture & Horticulture Department and livestock development with Animal Husbandry Department.

Vegetable cultivation



Sericulture



Floriculture and garland making



Kitchen gardening



Vermicompost sale

Photos: ICRISAT



Goat rearing



Dairy farming

Ashukananda Patil ups his farm income by 70% and positively impacts his community

Way back in 2008, Ashukananda couldn't have imagined that his 1.6 hectare farm which supported a single rainfed cotton crop could one day include a fodder and food crop and vegetables that not only enriched the family diet but also brought in a five-fold income growth. In a ripple effect, the fodder availability led to increased milk supply to the village dairy unit, which in turn profited 15 women in a thrift group



Poor quality soils coupled with uncertain and deficient rains have been the bane of farmers in Pathri village, Maharashtra. For farmer Ashukananda (see photo on top right), a single cotton crop that yielded a paltry annual income of ₹30,000 (US\$ 420) was all that he could glean from his small rainfed farm of 1.6 ha.

Though watershed activities were initiated in Pathri village in 2008-09, it wasn't until 2012 that Ashukananda could see a glimmer of hope.

Continuous contour trench work taken up in the nearby hills ensured that rainwater runoff was reduced and the water table in the region rose. A **farm pond** that he dug in his field for harvesting rainwater gave him the courage to try out new crops.

Vegetable farming was a rarity in his village. He was able to grow eggplants, tomatoes and onions on his farm by **addressing micronutrient deficiencies** of zinc and boron in the soil. Cotton yield too increased by 20-30% with micronutrient application.

Growing **sorghum for fodder** brought in money through higher milk yields from his cow (from 5 liters/day to 8 liters/day).

As of 2016, Ashukananda's average annual income was between ₹100,000 and ₹150,000.

Community impact: In the village, increasing use of sorghum as fodder by farmers had a marked effect on the dairy unit run by a **self-help group**. Improved fodder availability helped the group raise extra income through increased milk sales. The benefit passed on to 15 women members of the group.



Photos: A Seshadri, ICRISAT



Photo: Prashant Panjiar

Integrating key focus areas

Core values enrich watershed program outcomes and embracing new user-friendly technologies cut drudgery and speed up processes

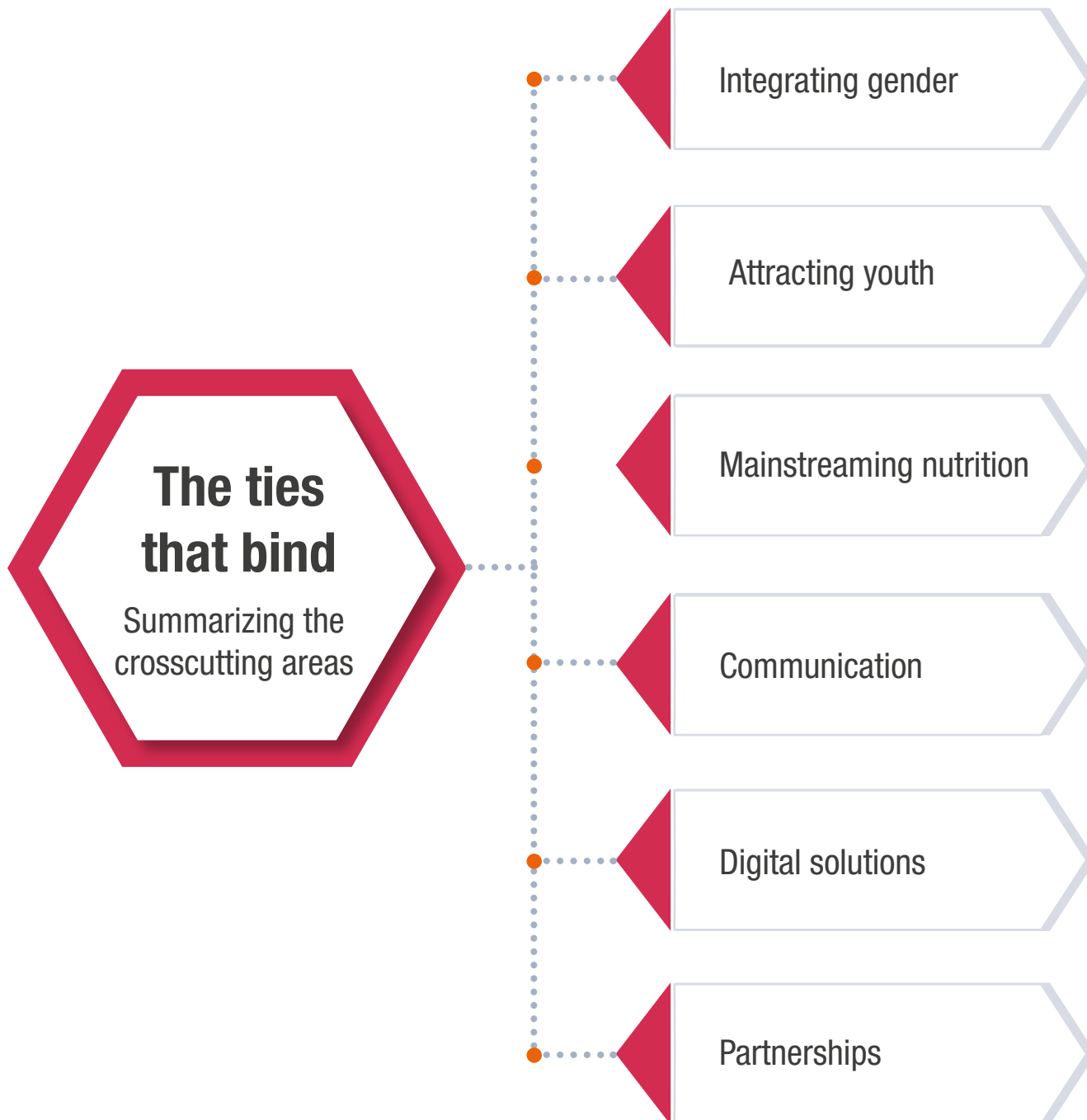




Photo: Prashant Panjiar

▶ Integrating gender

As president of the self-help group in a remote village in Rajasthan, Rameshwari Devi is a driving force -- helping women pool money, earn better and take charge of their lives [See slideshare.](#)



▶ Nutrition

As part of the Nutri-Kitchen Gardening program in watershed project areas, women and school children who choose to enroll are given a kit containing vegetable and fruit seeds to grow either in their school premises or in their backyards.



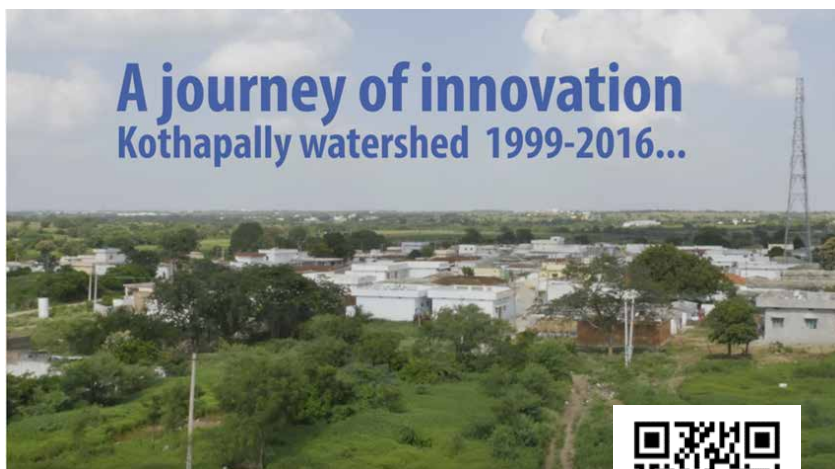
Photo: IDC, ICRISAT



Photo: IDC, ICRISAT

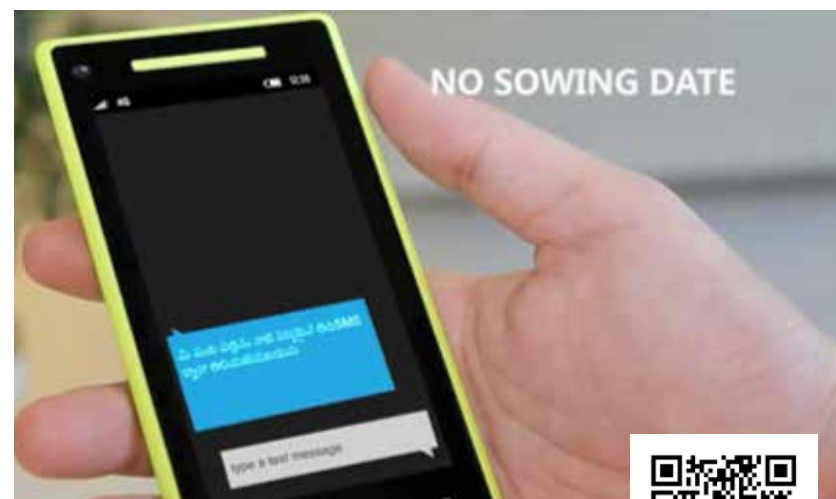
▶ Attracting youth

School students receive training on how to manage a weather station. Read [more](#)



▶ Communication

For a complete picture of the various activities and communication processes involved in watershed activities watch this [video](#).



▶ Digital solutions

Microsoft and ICRISAT's intelligent cloud pilot for agriculture in Andhra Pradesh increase crop yield for farmers. For more watch this [video](#).



▶ Partnerships



We partner with governments, national research institutes, civil society, the private sector and CGIAR partners.

Mutual learning: India-Africa



Photo: PS Rao, ICRISAT

HE Abraha Alle (second from right) with officials at the Narsapur reservoir in Telangana, India.
(Below) Farms adjacent to the reservoir.

Bridging two continents

A high-level ministerial delegation from Ethiopia visited India in early 2018 to observe and learn from best practices in dryland agriculture, rainwater conservation techniques and agribusiness development.

The visit was facilitated by ICRISAT to strengthen partnership and knowledge sharing between the two countries that have similar climates, landscapes and agricultural practices.

For [more](#)

Countries that can benefit from watershed initiatives: Rwanda, Uganda, Tanzania, Mozambique, Eritrea and Kenya.



Successes and potential in Eastern and Southern Africa

ICRISAT watershed examples from Ethiopia

Communities join hands to re-green Yewol mountains



2018 ← 2014

Others are still waiting

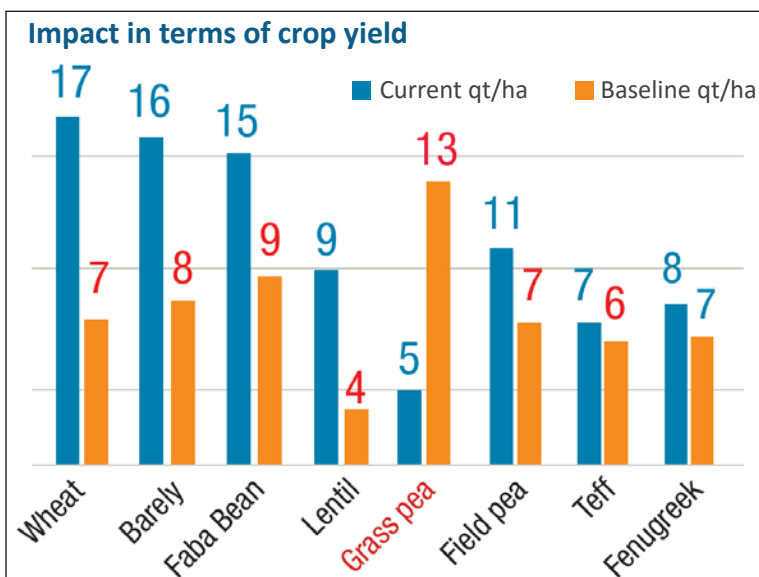
“Almost every initiative that has come to the watershed has been beneficial. But not everyone has benefited. There are possibilities to scale this approach out to other sites.”

*Derib Hassan,
District Administrator, Woreillo*

For [more](#)
on Yewol



Impact: 5 fold increase in irrigable land



Grass pea cultivation decreased with increased water availability and cultivation of market-oriented crops.

Water weirs bring life to 'desert' tracts in Afar



For [more](#)
on Afar



2015 → 2018

Potential for flood-based farming in the Afar region:

550,000-1,200,000 ha

Successes and potential in West and Central Africa

Contour bunds change farmers' fortunes in Kani watershed, Mali



Photo: ICRISAT

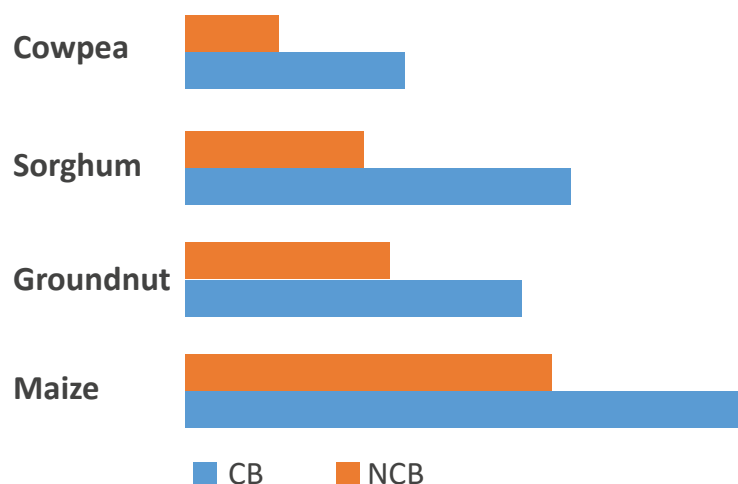
“ My farm was affected by erosion in 2014. Subsequently, the production dipped so low that I used to get less than 400 kg of sorghum per hectare in a season. Contour bunding with fast growing tree species helped control runoff and enhanced soil fertility. My yield increased to 1,600 kg per hectare. ”

– Mamadou Berthe, farmer

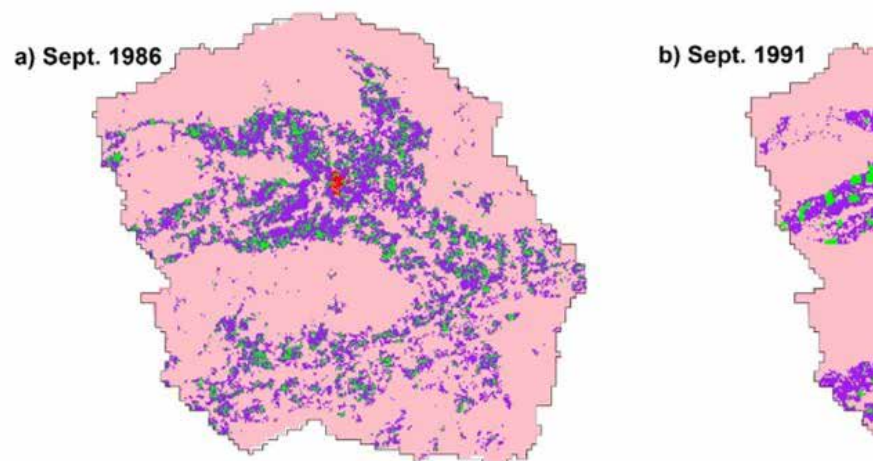


For [more](#)

Increase in grain yield with contour bunding (CB)



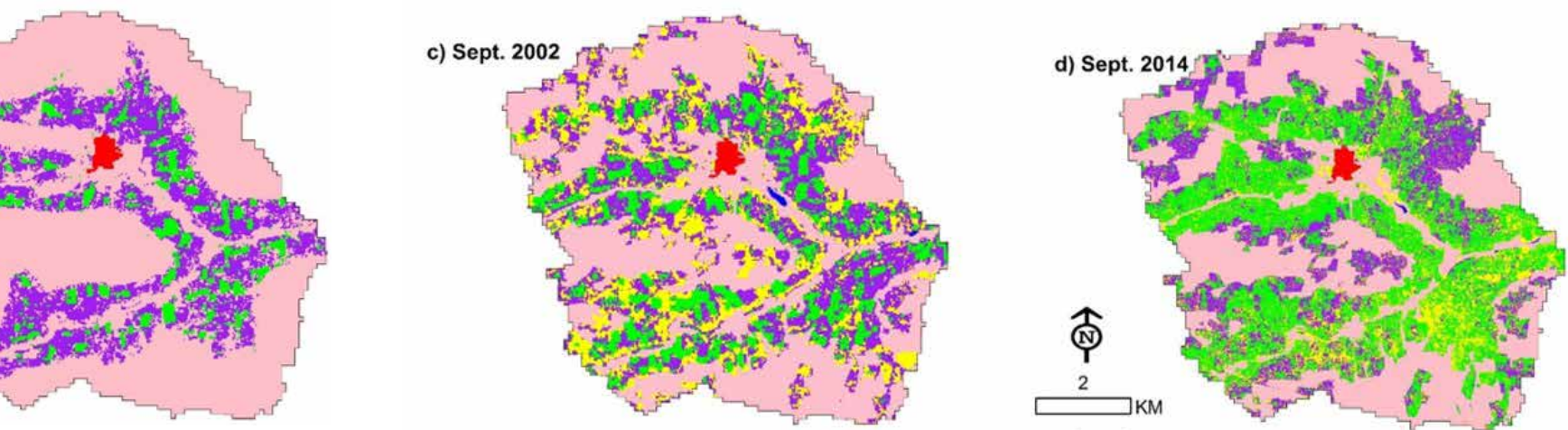
Land use changes and consumptive water use



Year 1986 represents land use conditions at the beginning of SWC implementation.

Exchange visit to Chad

WCA team observe the Cripto Pompe Irrigation System that works on the principle that water flows upwards due to air expansion and needs no pistons or motors to draw water.



About ICRISAT

The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is an international non-profit organization that undertakes scientific research for development.

Our Commitment

We innovate to help poor communities in Africa and Asia:

- Fight hunger and poverty
- Reduce malnutrition
- Revitalize the environment

We work across the whole value chain (see diagram on right) and have science-based solutions at all stages.

ICRISAT has specialized knowledge on the drylands, which covers 55 countries in Asia and sub-Saharan Africa and are inhabited by 2 billion people, 644 million of whom are poor. These regions are most vulnerable to climate change with very little rainfall, degraded soils and poor social infrastructure.

We have specialized skills on crops of immense value to the nutrition and economics of the semi-arid tropics – dryland cereals (sorghum and millets) and grain legumes (chickpea, pigeonpea and peanut).

The Solutions

We don't bring just one part of the solution. By analyzing key problems and opportunities, we work along the whole value chain:

Sustainable On-farm Intensification

- Managing soil and water
- Breeding higher performing crop varieties
- Diversifying farms
- Developing on-farm practices and technologies

Building Agribusinesses

- Introducing processing technologies
- Facilitating assistance to market access
- Driving market development

What is unique about our holistic approach?

- It is multidisciplinary, combining social understanding with biophysical advances and business.

We **believe** all **people** have a **right** to **nutritious food** and a **better livelihood**.

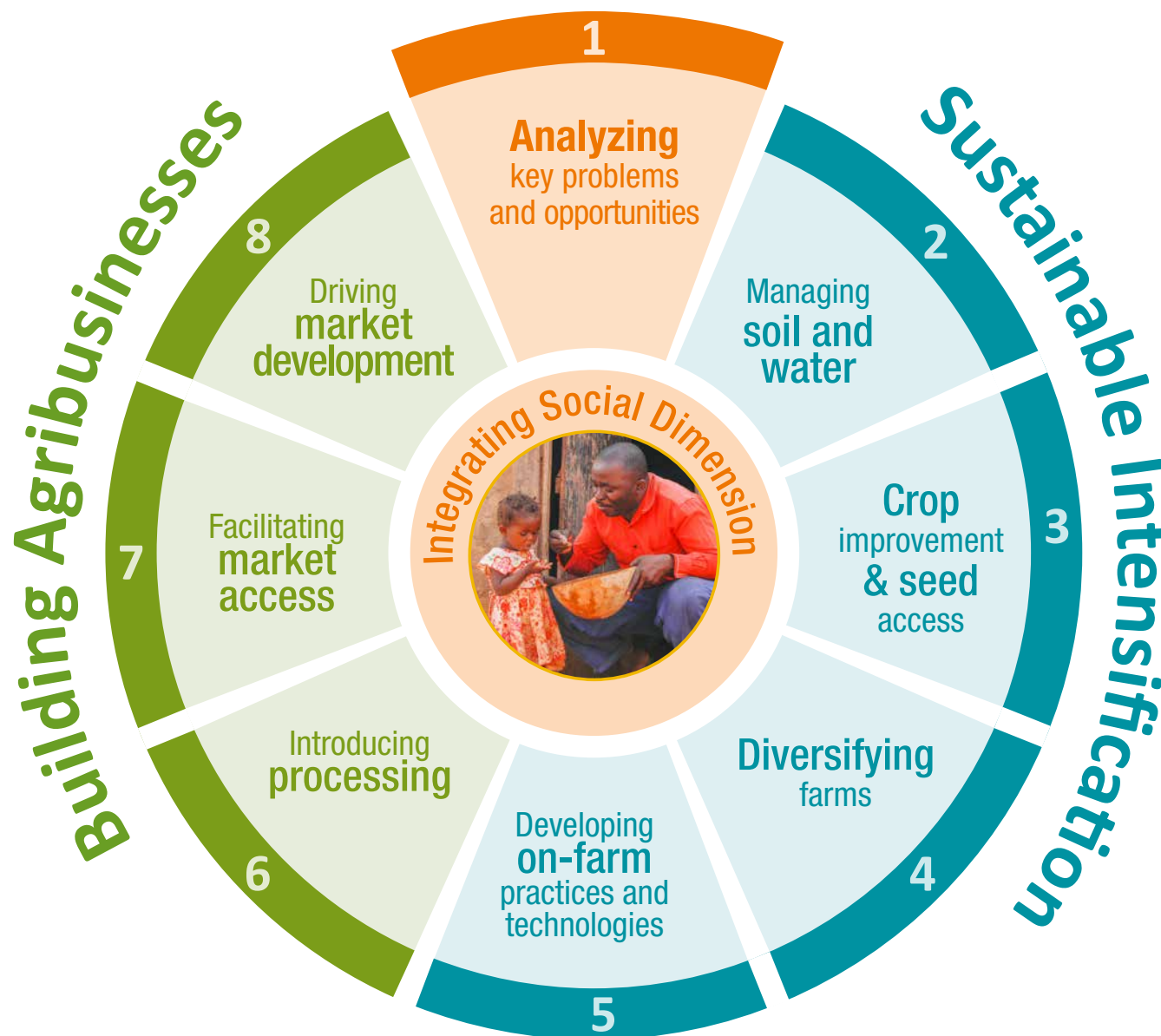
We achieve this through a holistic approach working across the agricultural value chain

- All solutions are science based and continue to be monitored and evaluated scientifically.
- It not only works at the different stages of the value chain but can make the linkages from farmer to agribusiness to markets.
- We take it further than a value chain approach – with an Inclusive Market-Oriented Development (IMOD) approach. This requires:
 - being 'inclusive' of the stakeholders in developing solutions, and ensuring that all stakeholders, including the smallholder farmers and the women, benefit from the development.
 - being market driven in the developments moving the poor farmers from subsistence to a commercially oriented profitable business.

ICRISAT's capabilities

- **Multidisciplinary high-class science** – from natural resource management, genetics, bioinformatics and phenotyping to economics and social science.
- **On the ground in Africa and Asia** – with offices in India (global headquarters), Kenya, Malawi, Zimbabwe, Mozambique, Ethiopia, Mali, Niger and Nigeria.
- **Strong networks** – we work in partnership at all levels: local, national, regional and international.
- **Participatory methods** – have been developed and are used as part of our work, involving the farmers through to the government and private industry where change is needed.
- Recognized as **independent** – as an international non-profit, non-government and non-religious organization that has worked in Asia and Africa for over 40 years, our scientific and independent credibility are well founded.

How we work across the agricultural R4D value chain



Crosscutting issues

- Mainstreaming nutrition
- Empowering women
- Attracting youth to agriculture
- Digital solutions
- Communications
- Partnerships

Approach for Adoption

- Participatory approach and partnering
- Building capacity at national and local levels
- Integrating communications
- Monitoring and evaluation
- Policy support – work closely with government to encourage the needed policies

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Dr SP Wani, Former Research Program Director, Asia and Former Director, ICRISAT Development Center

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Mr Sudi Raghavendra Rao, Former Manager, Watersheds

Mr B Nagaraju, Senior Scientific Officer

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Case studies:

Page 7: Jemima Mandapati

Pages 11, 15 and 27: Arun Seshadri

Page 19: Sangeetha Parthasarathy

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ICRISAT Development Center works for large-scale uptake of science-backed technologies to achieve major impact in reducing poverty, hunger, malnutrition and environmental degradation across Asia and Africa. About IDC: www.idc.icrisat.org





