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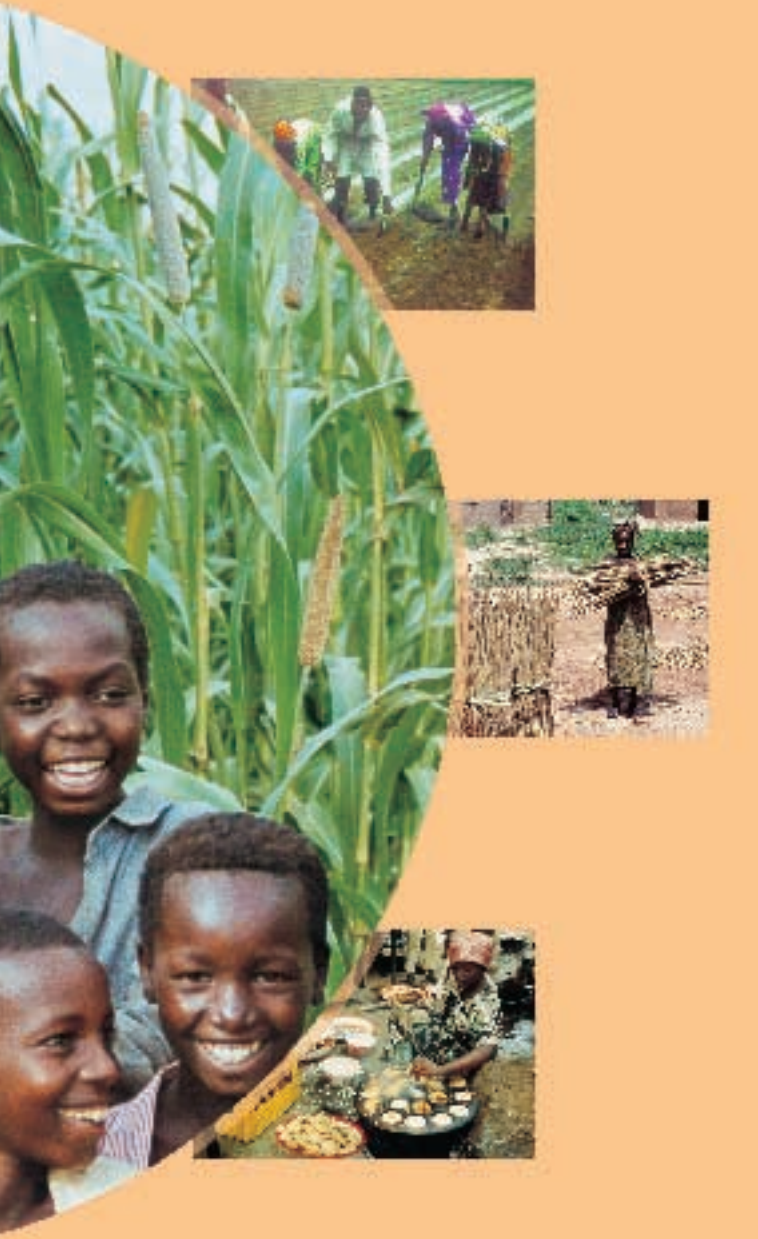
Research Impacts

For informed research targets and technology design



International Crops Research Institute
for the Semi-Arid Tropics

Publications with impact

Impact Series no. 1

Returns to Research and Diffusion Investments on Wilt Resistance in Pigeonpea

M C S Bantilan and P K Joshi

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1996

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Impact Assessment of Crop and Resource Management Technology

A Case of Groundnut Production Technology

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A M Yapi, A O Kergna, S K Debrah, A Sidibé, and O Sanogo

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Evaluating ICRISAT Research Impact

Summary Proceedings of a Workshop on Research Evaluation and Impact Assessment

13-15 Dec 1993, ICRISAT Asia Center

Edited by M C S Bantilan and P K Joshi

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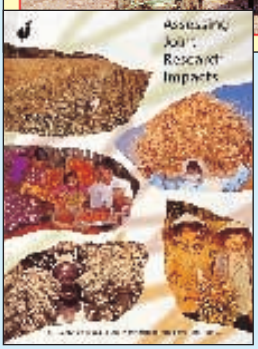
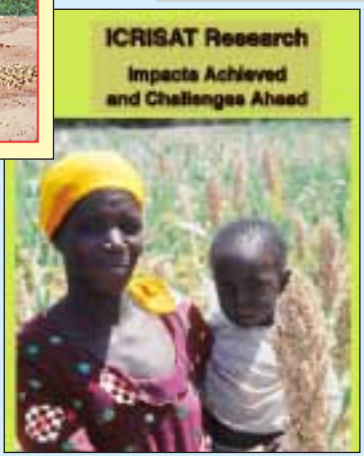
1994





Challenges of the Semi-Arid Tropics (SAT)

Stubborn poverty

The SAT is home to one-sixth of the world's population, where poverty is stubborn and widespread. Most farmers in this region operate at subsistence level, and majority lack access to basic nutrition and health facilities.

Fragile environment

Farmers face the daunting challenges of drought and high temperatures which limit crop potential. In addition, soils are impoverished, with inherently low fertility, and wind and water erosion result in loss of top soil.

Desertification

With drought-adapted ecosystems becoming nonproductive, the need arises to assess current land management practices, develop improved and ecologically-sound strategies for soil and land management, and provide incentives to people to adopt improved practices.

The Semi-Arid Tropics is home to more than 300 million poor. Here, two years out of five in many areas are drought prone.

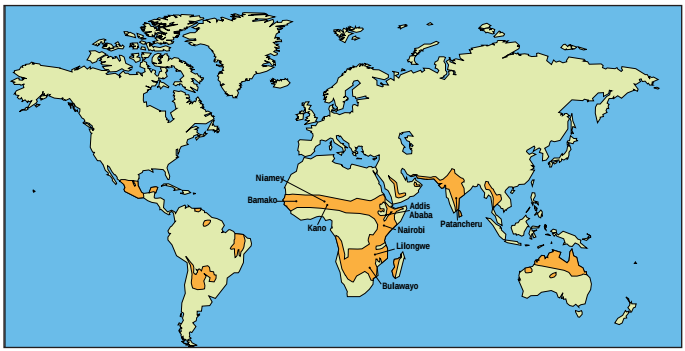
Our strategy

The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) combats the challenges in the SAT by forming partnerships with NARS, governments, NGOs, donor agencies, farmers, and private sector organizations, and linking these partners to advanced research institutions worldwide.

The human angle

More than half the SAT population is engaged in activities related to agriculture. ICRISAT and its partners help developing countries alleviate poverty and hunger; develop technologies for sustainable increases in food production; control plant pests and diseases; and protect the environment through better management of natural resources. ICRISAT's mission is 'Science with a human face", tailoring research to improve the living standards of the poor in marginal environments around the world.

ICRISAT's locations worldwide



Donors: World Bank, USA, Japan, CEC, Switzerland, United Kingdom, Germany, Norway, Canada, African Development Bank, Australia, Sweden, Denmark, Netherlands, CFC, Asian Development Bank, EcoRegional Fund, and India.

The mandate crops

ICRISAT's research centers around cereals and legumes. Sorghum is cultivated throughout the SAT and is a major source of both food and fodder. Pearl millet is the food staple in the driest parts of the SAT while finger millet is a favored cereal in Africa. Groundnut is consumed as food and edible oil, and used as fodder. Chickpea is a traditional source of protein in Asia and northern Africa, while pigeonpea is a staple food for south Asians. By combining these cereals and legumes in the cropping systems, farmers reap benefits.

The benefits

- Crop diversification
- Reduced risk
- Improved soil fertility
- Sustainable utilization of natural resource base
- Disruption of pest cycles
- Improved nutrition

Donors: Austria, Belgium, France, IFAD, Nigeria, Italy, China, Iran, Rockefeller Foundation, Korea, Inter-American Development Bank, OPEC, UNDP, Philippines, Brazil, and others.

The growth cycle

Since most SAT farmers operate at subsistence level, new technologies can help them generate surplus production that they increasingly invest in more productive management methods. This leads to a self-reinforcing cycle of economic growth and ultimately to higher standards of living. Impact assessment at ICRISAT attempts to measure dimensions most important to the poor and to the broad mission of the Consultative Group on International Agricultural Research (CGIAR).

Dimensions of impact

- Food security
- Biodiversity
- Increased farm income
- Sustainable productivity
- Benefits to women
- Spillover effects
- Stronger NARS

ICRISAT/ NARS impact assessment studies.

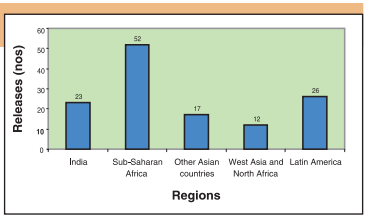
Crop	Asia	Africa
Sorghum	China, India	Botswana, Cameroon, Chad, Mali, Niger, Nigeria, Zambia, Zimbabwe
Pearl millet	India	Mali, Namibia, Niger, Zimbabwe
Chickpea	Bangladesh, India, Nepal	
Pigeonpea	India, Sri Lanka, Thailand	Malawi
Groundnut	India, Indonesia, Vietnam	Malawi, Uganda
Vertisol technology	India	

National research programs in Asia and Africa were strengthened through training, apprenticeships, establishment of research networks, and information exchange. Since 1974, ICRISAT has trained over 3700 scientists and technicians from 98 countries.

Varietal releases (1975-98)

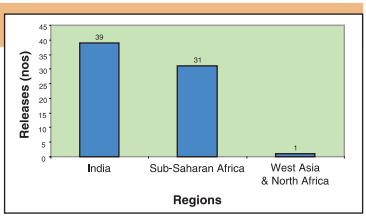
Sorghum

Total number of releases : 130.



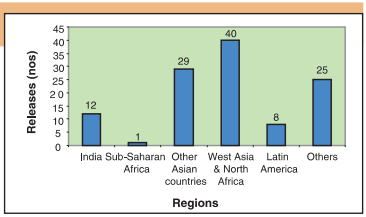
Pearl millet

Total total number of releases : 71.



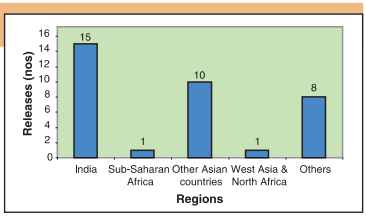
Chickpea

Total number of releases : 115.



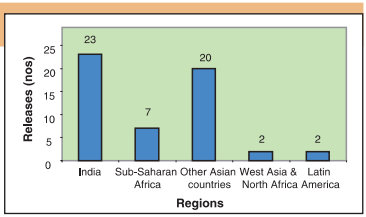
Pigeonpea

Total number of releases : 35.



Groundnut

Total number of releases : 54.



Four hundred and five ICRISAT/NARS varieties were released in 170 countries up to 1998. Over 113 000 germplasm accessions from 130 countries are held in trust. About 624 000 samples were distributed to 141 countries.

Adoption and impact of improved sorghum varieties in Africa.

Country	Variety	Region	Year	Adoption rate (% area)	Impact
Botswana	SDS 3320 (Phofu)	National	1997-98	21	Broad acceptability of variety for early maturity, large head, and large white grain, and strong stem resistant to lodging.
Cameroon	S 35	Mayo Sava	1995	49	36% grain yield gain, and 26% cost reduction compared to local. Widely adopted for early maturity.
		Diamare	1995	14	6% grain yield gain, and 7% cost reduction compared to local.
		Mayo Danay	1995	12	4% grain yield gain compared to local.
Chad	S 35	Guera	1995	38	6% grain yield gain, and 7% cost reduction compared to local. Widely accepted for early maturity, and fodder/food quality.
		Mayo-Kebbi	1995	27	53% grain yield gain and 18% cost reduction compared to local.
		Chari-Baguermi	1995	24	46% grain yield gain, and 26% cost reduction compared to local.
Malawi	Improved cultivars	National	1997-98	10	Widely accepted for early maturity.

Continued...

Improved sorghum varieties ICSV 111 and ICSV 400 are grown in 30% of the areas in target locations in Nigeria.

Adoption and impact

Country	Variety	Region	Year	Adoption rate (% area)	Impact
Mali	Improved cultivars	Segou	1995	29	51% grain yield gain, and 25% cost reduction compared to local. NPV from improved sorghum varieties was estimated as US$ 16 million with an IRR of 69%.
Zambia	Improved cultivars	National	1997-98	38	Broadly accepted for early maturity and bold grain.
Zimbabwe	Improved cultivars	National	1997-98	31	Widely accepted for early maturity.
Sudan	HD1, Ingaz, Tabat	National	1995-96	3	300% yield gain compared to local.
Nigeria	ICSV 111, ICSV 400	Kano	1996-97	28	40% yield gain for ICSV 111 and 33% yield gain for ICSV 400 compared to the best local.
	ICSV 111, ICSV 400	Katsina	1996-97	10	27% yield gain for ICSV 111 and 7% yield gain for ICSV 400 compared to the best local.
	ICSV 111, ICSV 400	Jigawa	1996-97	30	63% yield gain for ICSV 111 and 62% yield gain for ICSV 400 compared to the best local.

Adoption and impact of improved sorghum varieties in India.

Country	Variety	Region	Year	Adoption rate (% area)	Impact
India	All improved cultivars	National	1998	65	JKSH 22, a private sector hybrid containing ICRISAT materials is popular.

"When rains do not come on time or when they stop too soon, our own varieties give us nothing, so we sow this one," says farmer Toralet of Niergui village (Guéra), displaying a few panicles of S 35. "This is the sorghum that never fails," he adds.

Adoption and impact of improved pearl millet varieties in India.

Region	Variety	Year	Adoption rate (% area)	Impact
Rajasthan	All improved	1996	56.26	228% grain yield gain,12% fodder yield gain, 47% cost reduction, 60% change in total labor use, 140% change in female labor use, and net farm income of Rs 1134 ha^{-1} compared to local.
	BK 560	1996	17.61	62% grain yield gain, 34% reduction in fodder yield, 25% change in female labor use, and net farm income of Rs 922 ha^{-1} compared to local. Widely adopted for downy mildew resistance.
Haryana	All improved	1996	85.96	182% grain yield gain, 68% fodder yield gain, 47% cost reduction, 44% change in female labor use, and net farm income of Rs 2062 ha^{-1} compared to local.
	HHB 67	1996	38.69	129% grain yield gain, 23% fodder yield gain, 51% cost reduction, 21% change in female labor use, and net farm income of Rs 1484 ha^{-1} compared to local.
Gujarat	MH 179	1995	31.17	247% grain yield gain, 72% fodder yield gain, 54% cost reduction, 170% change in female labor use, and net farm income of Rs 2818 ha^{-1} compared to local. Widely adapted due to disease resistance, short duration, high grain, and fodder yield.
	MH 169	1995	23.73	448% grain yield gain, 108% fodder yield gain, 65% cost reduction, 218% change in female labor use, and net farm income of Rs 7350 ha^{-1} compared to local.

Continued...

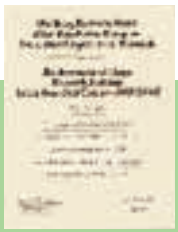
Pearl millet variety SOSAT C 88 is flourishing in Nigeria and is grown by over 10 000 farmers.

Adoption and impact

Region	Variety	Year	Adoption rate (% area)	Impact
Maharashtra	All improved	1994	94.3	95% grain yield gain, 7% fodder yield gain, 43% cost reduction, and 16% change in female labor use compared to local.
	ICTP 8203	1994	33.49	50% grain yield gain, 36% cost reduction, and net farm income of Rs 386 ha^{-1} compared to local. Widely accepted for downy mildew resistance.
	MLBH 104	1994	22.85	61% grain yield gain, 39% cost reduction, 3% change in female labor use, and net farm income of Rs 383 ha^{-1} compared to local.
Tamil Nadu	Pioneer	1994	29.23	144% grain yield gain, 24% cost reduction, and net farm income of Rs 3048 ha^{-1} compared to local.

Adoption and impact of improved pearl millet varieties in Africa.

Country	Variety	Region	Year	Adoption rate (% area)	Impact
Mali	Improved cultivars	Segou	1995	29	63% grain yield gain, and 38% cost reduction compared to local. IRR of 50 % .
		Koulikoro	1995	20	65% grain yield gain compared to local.
		Mopti	1995	17	52% grain yield gain compared to local.
Namibia	Okashana 1 (ICTP 88908)	National	1997	49	24% grain yield gain compared to local. IRR of 50%.
Zimbabwe	SDMV 89004	National	1996	16	Widely accepted for early maturity and bold grain compared to local. Estimated IRR is 44%.



King Baudouin Award 1996: CGIAR's highest award was given to ICRISAT for the development of downy mildew-resistant, yield-increasing pearl millet.

Adoption and impact of improved chickpea varieties in India.

Region	Variety	Year	Adoption rate (% area)	Impact
Andhra Pradesh	ICCV 2	1995	17	108% grain yield gain, 29% cost reduction, 11% change in female labor use, 440% higher farm income, and 58% price premium compared to local. IRR of 17.5 - 21.2%.
Madhya Pradesh	ICCV 2	1995	13	123% grain yield gain, 33% cost reduction, 25% change in total labor use, 65% change in female labor use, 624% higher farm income, and 103% price premium compared to local.
Gujarat (Jamnagar)	ICCV 1	1995	25	67% grain yield gain, 32% cost reduction, 10% change in total labor use, 35% reduction in female labor use, and 143% higher farm income compared to local.

Adoption and impact of improved pigeonpea varieties in India.

Region	Variety	Year	Adoption rate (% area)	Impact
Karnataka	ICP 8863	1993	59	43% yield gain and 42% unit cost reduction compared to local. IRR of 65%, NPV of US$ 62 m.
Western Maharashtra	ICPL 87	1995	57	Two main reasons for widespread adoption: (a) short duration allows double cropping and (b) rotation with pigeonpea helps maintain soil fertility.

King Baudouin Award 1998: Given to ICRISAT for work on pigeonpea improvement.

Adoption and impact of improved groundnut varieties in Africa, 1999.

Country	Variety	Adoption rate (% area)	Impact (% gain in grain yield)
Botswana	Sellie	60	10
	55-437	10	5
Malawi	CG 7	10	50
Mozambique	Natal Common	30	5
	Sellie	40	10
Namibia	Sellie	50	10
South Africa	Sellie	40	10
	Anel	15	10
	Akwa	20	20
Swaziland	Sellie	70	10
Uganda	Igola-1	10	25
Zimbabwe	Falcon	30	10
	Flamingo	10	10
	Sellie	10	10

Rosette virus-resistant groundnut variety CG 7 is adopted in 10% of the groundnut area in Malawi.

Adoption and impact of natural resource management technologies in India.

Region	Technology component	Year	Adoption rate (% area)	Impact
Groundnut Production Technology				
Maharashtra	Raised bed and furrow	1994	31	IRR of 25.3%. Gender impacts: higher labor productivity; easy weeding and harvesting. Sustainability: moisture conservation and improved drainage.
Vertisol Technology				
Vidarbha Maharashtra	Dry seeding - Summer cultivation	1996-97	75	**Dry seeding - Sorghum:** Yield increase: 38.4% Income increase: 98.5% Employment increase: 13.6% Cost saving: 17.1%

The Broad Bed Maker (BBM) is a simple, cheap, and efficient plow allowing animal power to create flat raised beds which overcome waterlogging and soil hardening in heavy clay soils. The BBM is used by about 30 000 farmers in Ethiopia.

A food secure future

Early-maturing varieties have helped revolutionize smallholder farming across the SAT

- Reduced risk of crop failure because plants escape end-of-season drought;
- Improved yield stability and better pest and disease resistance ensure adequate supply of food in most years;
- Earlier harvests provide food during the traditional “hunger period”;
- Savings in food aid far greater than research costs.

Plowing in the profits

The adoption of short-duration pigeonpea cultivar ICPL 87 in southern India led to 93% yield gains, 12% reduction in production costs, 30% increase in farm incomes, and improved soil fertility.

ICRISAT developed the world’s first pigeonpea hybrid, ICPH 8, which reached farmers’ fields in 1991.

The war against wilt

Fusarium wilt is one of the more serious fungal diseases of chickpea and pigeonpea. ICRISAT has been breeding for resistance to fusarium wilt, allowing farmers in three Indian states to continue cultivating it as a component of diversified cereal/legume cropping systems.

Internal Rates of Return (IRR)

Technology	Country	IRR (%)
Chickpea	India	18-21
Groundnut	India	25
Groundnut Production Technology	India	25
Pearl millet	Mali	50
	Namibia	50
	Zimbabwe	44
Pigeonpea	India	65
Sorghum	Cameroon	75
	Chad	95
	Mali	69
	Zambia	11-15
	Zimbabwe	22

ICRISAT's wilt-resistant releases: ICP 8863 (as Maruthi) in Karnataka, ICP 9145 (as Nandolo wa-nswana) in Malawi, ICPL 87119 (as Asha) in India, and ICPL 85063 in Andhra Pradesh, India.

Cereals

- Macia was released in Mozambique, and also in Botswana, Tanzania, and Namibia.
- ICSV 1079 developed in Burkina Faso, is cultivated by farmers in Benin, Ghana, and Nigeria.
- S 35 was developed in India and adopted in Cameroon and Chad.
- ICMV 221 and WC-C75 were originally developed for India. ICMV 221 was also released in Kenya and Uganda, and WC-C75 in Zambia.
- Millet 'Iniadi' germplasm from Togo became the most popular open-pollinated variety in India.
- Okashana 1 was developed for India and released in Malawi, Zimbabwe, Namibia, and Botswana.

Legumes

- ICG 221 developed for India, spilled over into Swaziland.
- ICPL 87091 developed in India, was released in Kenya, Tanzania, and Uganda.

ICRISAT chickpea and sorghum research generated benefits in Australia worth A$ 36.4 million.

Groundnut Production Technology, India

Women contribute significantly to agriculture in the SAT, and to be truly effective, crop improvement strategies must involve them directly. For instance, new groundnut varieties and improved crop management methods resulted in

- Easier weeding
- More employment opportunities
- Greater involvement in decision making.

Okashana 1 in Namibia

Pearl millet variety Okashana 1, developed through ICRISAT/NARS partnerships with women participants, was released in Namibia in 1989. Today, it is grown on approximately 50% of the country's pearl millet area. This adoption led to a nearly 20% increase in total production. What was obtained as a result was a 50% Internal Rate of Return to public investment, depicting how close collaboration can result in reduced research costs and speedier variety development.

According to a case study in Maharashtra, an R & D agenda incorporating an analysis of gender disaggregated farmer perspectives could lead to more appropriate and acceptable technologies for wider adoption.

The Barind bonanza

After harvesting rice in the Barind in northern Bangladesh, farmers leave their fields fallow, because after the rains cease, the soil turns rock hard and uncultivable. ICRISAT and its Bangladeshi partners found that chickpea, which can survive on residual moisture, can be profitably grown during this traditionally fallow period. Thanks to this technology, chickpea cultivation in the Godagari area has shot up from 95 ha in 1984/85 to over 10 000 ha currently.

A silent revolution

In Andhra Pradesh, India, chickpea cultivation spread from 60 000 ha in 1990 to 146 000 ha in 1999, while production rose from 57 000 t to 130 000 t. Traditionally, chickpea was not an important pulse crop in this region. This silent revolution was attributed to the introduction of improved short-duration and fusarium wilt-resistant varieties (ICCV 2, ICCC 10, and ICCC 37) which did well with limited available moisture.

Adopting Integrated Pest Management (IPM) techniques, farmers in India, Nepal, Bangladesh, and Vietnam have greatly reduced the use of insecticide in pilot test areas, by up to 100% on some farmer's fields.

Watershed management

Improved watershed management technology led to a harvest of 4 t of grain per hectare from drylands, reduced soil loss by 60-75%, rainwater loss through runoff by 50-60%, and increased recharge of groundwater by more than 40%. ICRISAT in partnership with NARS and supported by the Asian Development Bank (ADB), is demonstrating this package to farmers of India, Thailand, and Vietnam.

The BBF mantra

The key to increased productivity and long-term sustainability is better soil drainage, which can be achieved through Broadbed and Furrow (BBF). The system permits several types of productivity gain, promising a substantial increase in incomes and living standards. For instance in Maharashtra, the adoption of this system in combination with a high-yielding ICRISAT groundnut variety made it possible to quadruple production.

The HATA, a donkey-drawn hoe, delivers seed and fertilizer, and has been shown to double yields of millet in Niger.

Impact on technology design

Village-Level Studies have established that:

- Adoption rates are closely related to the degree to which households are integrated into the wider product market
- It is preferable to address factor market distortions and imperfections in order to benefit small and marginal farmers
- Growth in income among the poor will not necessarily ensure nutrition security; other measures are required
- Land fragmentation is not a major constraint to improving crop productivity.

Impact on policy

- Findings on the scope for credit societies and chit funds to finance agricultural investment in the SAT had an effect on rural credit policy.
- The need for more flexible lending policies for dryland agriculture was recognized by the Indian government.

In India, VLS findings were used to incorporate development components in relief works, especially those pertaining to minor irrigation and water harvesting structures.

Future priorities

- Top priority – drought, genetic tolerance, water and nutrient-use efficiency;
- Soil and water management – watershed and catchment approaches, community-level initiatives;
- Crop diversification – more diverse, more resilient farming systems;
- New tools – GIS, simulation modeling, biotechnology, farmer participatory methods;
- Build even stronger partnerships; and
- Networks and information exchange to promote spillover benefits.

And the endeavor goes on

Research by ICRISAT and its partners will continue to generate worldwide impact, to benefit both farmers and consumers. And ICRISAT will continue to document and analyze these impacts in order to derive lessons for future adoption of new technologies. Clearly, the best is yet to come.

Research to reduce poverty, malnutrition, and environmental degradation is truly "Science with a human face". And the benefits are flowing.

Acknowledgements

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