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ICRISAT Development Center

Bhoo Samruddhi

A Compendium of Success Stories

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Bhoo Samruddhi

A Compendium of Success Stories

Editors

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Department of Agriculture
Government of Karnataka

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CGIAR
RESEARCH PROGRAM ON
Water, Land and Ecosystems

2015

Contents

Background

Across the world, rainfed areas are hotspots of poverty, malnutrition and degradation of natural resources. In India, of 142 m ha of arable lands, 60% is rainfed. Karnataka has the second largest area under rainfed agriculture only after Rajasthan in the country. Farmers' crop yields in dryland areas are quite low (1.0 -1.5 t ha^{-1}), about two to five times below potential yield. Recent findings from the 'Comprehensive Assessment of Water for Food and Water for Life' revealed that the millennium development goal of reducing the number of poor people by half can be met only through efficient use of scarce water resources for agriculture. Food production can be increased substantially in rainfed areas by applying enhanced water use efficiency measures, improving soil health status, and implementing other new technologies in an integrated approach. It is evident that the vast potential of rainfed agriculture can be unlocked by using available scientific technologies including improved cultivars.

Recognizing the problem, the Department of Agriculture (DoA), Government of Karnataka (GoK), has adopted science-led initiatives for achieving impact oriented development in the state. In this endeavor, it has sought to bring in international expertise to unlock the potential of rainfed agriculture in the state. Bhoochetana, the farmer-centric initiative taken up by GoK has benefited more than 4.3 million farm households in the state. In addition, the government has initiated a number of innovative measures to improve agricultural production and livelihood of farmers in the state during the last four years.

Realizing high impacts in terms of increased agricultural productivity, increased gross value of agriculture production and improved livelihoods, the state government requested ICRISAT to lead a consortium of CGIAR institutions working in India, and to operationalize impact oriented research for development with the aim of improving rural livelihoods. The ICRISAT-led consortium took up this challenge and established a "proof of concept" for translating strategic research knowledge into improving livelihoods through scaling up of the participatory research for development (PR4D) model. A number of meetings and stakeholder consultations were held to identify constraints and problems of all four pilot locations, and the project was begun in 2013-14.

Objectives

The specific objectives of this GoK-CGIAR initiative are:

- To form an action oriented consortium of CGIAR institutions to operationalize an action research scaling-up model in partnership with line departments in Karnataka to increase crop yields by 20% and farmers' income by 25% in four years;
- To establish four sites of learning pilot systems, to scale up approach-integrated participatory research for development to benefit small and marginal farmers in irrigated and rainfed agriculture areas representing the revenue divisions in the state; and
- To develop the capacity of agriculture-related development agencies and researchers in the state to enhance the impact of the development programs through science-led support systems.

Success Stories in Bhoo Samruddhi Project, Vijayapura District

During 2014-15, various technologies were scaled up as part of the Bhoo Samruddhi project in Vijayapura, with encouraging results. This section showcases the stories of some of the farmers who adopted these technologies.

District Coordinator - Raghavendra Rao Sudi

State of Karnataka

1

In Situ moisture conservation through broadbed and furrow system of landform treatment to sustain and enhance crop yields

Mr Shekappa, Beeraladinni Village

An effective land management system that enhances green water storage and use efficiency, the broadbed and furrow (BBF) system, was adopted in an area of 29 ha in three villages in Vijayapura District. Two cropping systems, Pigeonpea and pearl millet/pigeonpea intercrop were tested using this system.

The BBF system consists of a relatively flat bed or ridge approximately 100 cm wide and shallow furrow about 50 cm wide and 15 cm deep. This is laid out on a grade of 0.4% - 0.8% for optimal performance. The BBF system can be adopted in semi-arid tropics with deep black soils and for growing groundnut in red soils with a reduced gradient along the BBF (0.2% - 0.3%) that have an average rainfall of 600-800 mm.

Figure 1. BBF with pearl millet/ pigeonpea intercrop in Beeraladinni.

Mr Shekappa of Beeraladinni sowed the pigeonpea crop (local cultivar Gullyal) intercropped with pearl millet (HHB 67) using Tropicultor, a multipurpose wheel tool carrier provided by ICRISAT (Fig. 1). This was compared with the same crop sown in the adjoining field using the common practice of sowing in a flat bed. Four other farmers, Mallikarjungouda Biradar and Ramanagouda G Pati of Angadageri, Sidaramappa Patil and Mallappa Amagond of Havinal, adopted this in situ moisture conservation system with pigeonpea as the sole crop (Table 1 and Fig. 2). Those using the BBF system showed an increase in crop yield ranging from 7% - 18% during the year 2014-2015. Also, soil properties improved by practicing the system over the years.

Table 1. Crop yield in improved land management system (BBF), Vijayapura, 2014-15.

Village	No. of Farmers	Crop	Area (ha)	Yield (100 kg ha^{-1})		
				BBF	Traditional flat cultivation	% increase
Angadageri	2	Pigeonpea	22	8.0	7.5	7
Beeraladinni	1	Pearl millet/ Pigeonpea (2:1)	5	0.8	0.7	14
				5.0	4.3	18
Havinal	2	Pigeonpea	2	6.5	6.0	12
Havinal	1	Pigeonpea	10	7.0	7.5	10

Documented by: R Sudi and Ashok Biradar (ICRISAT)

The farmers showed their willingness to adopt the BBF system over the traditional practice but expressed their need of equipment that can form the BBF and simultaneously sow seed, to reduce field operation costs and energy. They appreciated the technical inputs that helped enhance their knowledge of improving water use efficiency and obtaining maximum benefit, and also removed their perception that, in by creating furrows, they would be losing some crop yield.

Table 2. Comparison of crop yields using BBF system in Mr. Shekappa's field.

Method	Grain yield (100 kg ha^{-1})		Gross income (₹)	Net income (₹)	Cost of cultivation (₹)	Benefit cost ratio
	Pigeonpea	Pearl millet				
BBF	5.0	3.5	30250	17750	12500	1.42
Traditional practice	3.3	2.0	24500	12000	11500	1.10

Benefits of BBF that the farmers observed:

- Soil and moisture conservation
- Good surface drainage that prevents waterlogging
- Better aeration in seed bed and root zone
- Reduced runoff and soil loss; no rill formation like that seen in flatbed cultivation.

Figure 2. BBF formation using Tropicultor and pigeonpea crop on BBF system, Angadageri.

2

Introducing cowpea to boost farmer's income

Mr. Bheemappa Hanumappa Chimmalagi, Beeraladinni Village

Vegetable cultivation in dryland agriculture is very limited; only those farmers who have a water source for irrigation grow vegetables. We encouraged farmers to grow cowpea along the borders of their fields with their main crop, onion. Mr. Bheemappa Hanumappa Chimmalagi (Sy. No. 67) of Beeraladinni tried this, and has had great success (Fig. 3). The farmer says, "the crop is very lush green and high-yielding. The cowpea curry is tasty and after three to four pickings, the plant can be used as green fodder since it is still green". The technology was suggested by The World Vegetable Center (AVRDC) scientists and implemented by ICRISAT. The farmer was given 500 g cowpea seed, and he obtained a total yield of 50 kg pods in the first two harvests, with the expectation of 2 more pickings. The farmer added if this new crop can be introduced with other main vegetable crops, other farmers will realize its value. The multiple uses of cowpea—as a vegetable, the crop residue as fodder and improved soil fertility at no additional cost—will definitely attract farmers.

Figure 3. Vegetable cowpea grown at Beeraladinni.

Documented by: Kumar Nagaraju, R Sudi and Ashok Biradar (AVRDC/ICRISAT)

3

Hybrid sorghum seed production program in Vijayapura district

Mr NS Khed, Sawalasangha Village, Vijayapura District

Farmers in Vijayapura constantly face the problem of lack of availability of fodder for livestock. To help meet this critical requirement, hybrid sorghum (ICSSH 28) was introduced in Vijayapura. A seed production program was introduced via the Bhoo Samruddhi program, and a local farmer, Mr. N. S. Khed, showed keen interest in taking up seed production to provide seed to his fellow farmers.

Figure 4. Hybrid sorghum seed production field in Sawalasangha.

A field belonging to Mr Khed, with an isolated 1.2 ha plot, was selected to grow sweet sorghum (ICSSH 28) hybrid seed during the rabi (postrainy season) 2014 at Sawalasangha. ICRISAT scientists and breeders explained to the farmers the benefits of growing sweet sorghum, as well as the benefits of seed production compared to commercial production, and monitored the seed production field.

The crop was sown in 2:4 male: female ratio and all other practices recommended in the package of practice were followed. Hand pollination was done thrice from 50% flowering by shaking the male plants. At harvest, the farmer obtained a yield of 500 kg hybrid seeds and 500 kg of male seeds from 1.2 ha of land even under water-scarce conditions. In the previous year, the same piece of land had yielded only 440 kg of sunflower (Table 3). This showed that seed production is more profitable than commercial production of crops. The farmer expressed his happiness that the hybrid cultivar was green even at its maturity/ harvest stage, and would help tackle their problem of fodder for livestock.

Table 3. Comparison of profit from commercial production and seed production

Practice	Crop yield (kg ha^{-1})	Gross profit (₹)	COC1 (₹)	Net profit (₹)	Comparative advantage (₹)
Seed production	330	12540	3500	9040	7630
CP (sunflower, previous year's crop)	147	4410	3000	1410	-

1 Cost of cultivation

Documented by: R Sudi, Ashok Biradar and P Srinivasa Rao (ICRISAT)

4

Enhancing soil fertility through legumes and *Gliricidia* on field bund

Mr Basanna C Salutagi, Havinal Village, Indi Taluka

The heavy use of chemical fertilizers in crop production, especially in sugarcane, both increases cost of cultivation and affects soil environment. This is a major constraint prevalent in sugarcane-growing areas of Vijayapur District. ICRISAT played a major role to overcome this in Havinal of Indi Taluka in this district—where sugarcane cultivation is increasingly predominant—by encouraging farmers to grow legumes crops like cowpea/ green gram after harvesting the sugarcane, and to plant Gliricidia sepum on field bunds. The latter helps enhance soil fertility, can be used as green manure, reduces the need for chemical fertilizers, and helps prevent soil erosion.

Figure 5. Gliricidia planted on field bunds at Havinal.

Farmer Mr Basanna C Salutagi (Sy. no. 476), adopted this system, growing cowpea/green gram in his sugarcane field after harvesting the sugarcane, and planting 1000 Gliricidia plants along the bunds of his 1.6 ha field.

As the field is irrigated, the Gliricidia plants have grown to 1.0-1.2 m, and he will be able to use the leaves as green manure from the second year onward. He feels that, while improving the soil quality, it will also act as mulch and save him at least one irrigation. He plans to plant more Gliricidia plants this year.

Documented by: R Sudi and Ashok Biradar (ICRISAT)

5

Extension system dissemination of information from farmer to farmer through videos

A farmer to farmer (F2F) dissemination route was explored for the effective dissemination of good management practices through a farmer-centric video documentation (Fig. 6). Digital Green (http://www.digitalgreen.org/) is the technology partner for this innovative dissemination route. The advantage of this F2F system is that, farmers tend to trust fellow farmers' experience when it comes to adopting improved management practices and this method is likely to be effective (Table 4). An added advantage is that their ideas have been explained in the local languages, making them easy to understand.

Table 4. Farmer-to-farmer dissemination through video production and screening activities, Vijayapura.

Particulars	No.
Training on F2F videos	4
Video produced	18
Video screenings	200
Viewers	1150
Viewer adoptions	240

This innovative digital extension system has effectively disseminated the technology to farmers. One such example this year was the seed treatment campaign in Nidoni, which led to large numbers of farmers adopting seed treatment (100% adoption, according to the department survey data 100% farmers). Having observed the effectiveness of this extension system, the District administration is keen to introduce it in other projects.

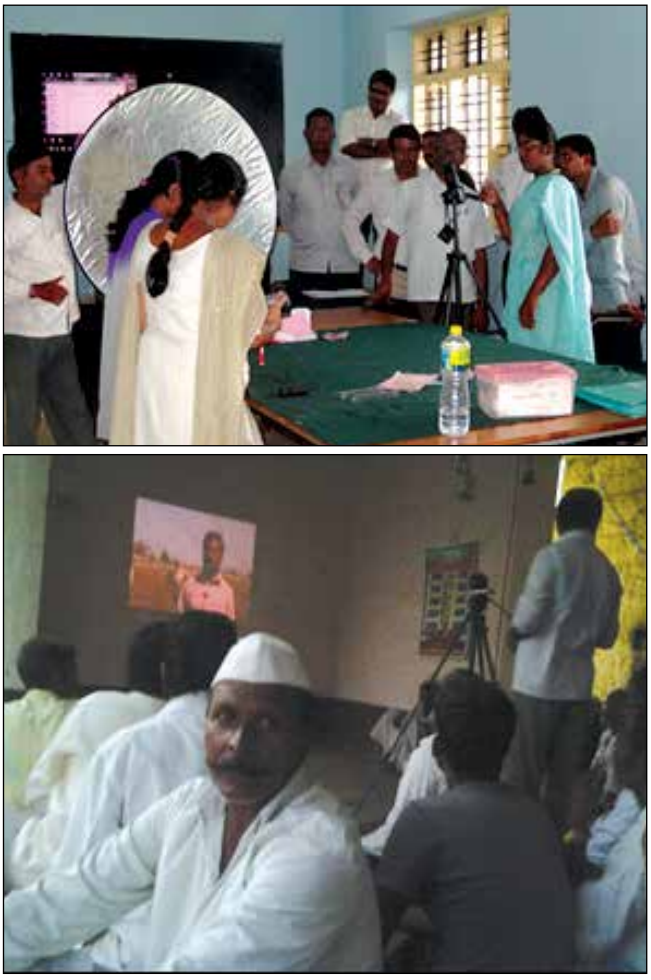


Figure 6. Video production and screening in Bhoo Samruddhi villages, Vijayapura.

Documented by: Ashok Biradar (ICRISAT)

Success stories in Bhoo Samruddhi project, Tumkur district

The number of technologies under the Bhoo-Samruddhi program at Tumkur was scaled up during the years 2013 and 2014. This section showcases the impact of various interventions in terms of crop productivity and net economic impact. These technologies are targeted to scale up in larger areas during the kharif (rainy season) in 2015.

District Coordinator - Kaushal K Garg

6

Higher productivity of groundnut using improved crop variety (ICGV 91114)

Mr Shankarappa, s/o Mr Mayanna Gowda, Doddagallihalli, Puravara Hobli, Madhugiri Taluka, Tumkur

Groundnut is one of the important crops grown in Madhugiri Taluka of Tumkur District. However, a large number of the farmers in the District are still using indigenous and low-yielding crop varieties. Mr. Shankarappa owns 3.2 ha of land, of which 0.8 ha is irrigated and 2.4 ha is rainfed. He was inspired to cultivate the improved groundnut variety ICGV 91114 in his field during the rainy season of 2014-15.

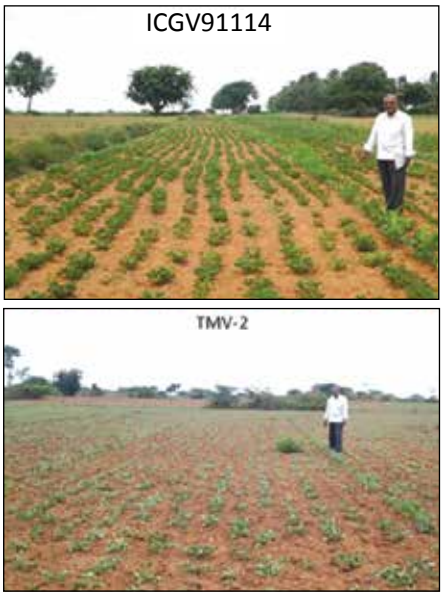


Figure 7. Comparing ICGV91114 and TMV-2 in selected field of Madhugiri Taluka during rainy season 2014-15.

ICGV 91114 is a short-duration, Spanish variety of groundnut which matures in 95-100 days in the rainy season and is tolerant to intermittent and terminal droughts. This variety has been released in Andhra Pradesh, Odisha, Karnataka and Gujarat. It has 52% oil content and 17% protein content. This variety has a shelling percentage of nearly 70%. Also, 100 seed weight is about 41g and potential pod yield is about 2 t ha^{-1}, with good fodder quality.

Improved crop varieties were compared with the local variety by growing both cultivars side by side under the same management conditions in the rainy season of 2014. Pod yield of ICGV 91114 was 10%-15% higher as compared to the traditional groundnut variety (TMV 2). Average groundnut yield of ICGV 91114 with application of micronutrients was 1600 kg ha^{-1}. Yield recorded for TMV 2 was 1380 kg ha^{-1} with micronutrient, and 1060 kg ha^{-1} without, micronutrient application (Table 5).

The farmers adopted to groundnut ICGV 91114 because of its ability to survive the mid- and end-season drought, its medium duration (95-100 days) and higher yields in the prevailing conditions (Fig. 7). Net income estimated with improved management condition (variety + application of micronutrient) was nearly ₹ 29,000 ha^{-1} compared to a mere ₹ 8,700 ha^{-1} under traditional practices, showing a huge difference and potential to increase yield and income in these areas (Table 5).

Table 5. Impact of improved groundnut variety and micronutrient application on crop yield and net income in Madhugiri Taluka, Tumkur District during 2014-15

Groundnut			
Variety	ICGV 91114	TMV 2	TMV 2
Micronutrient	Yes	Yes	No
Cost of cultivation (₹ ha^{-1})			
Field preparation	3750	3750	3750
Seed + sowing cost	12625	12625	12625
Fertilizer cost + Labor	6540	6540	5625
Weeding cost	3750	3750	3750
Pesticide spray	1150	1150	1150
Harvesting + Threshing	6750	6750	6750
Total cost of cultivation (₹ ha^{-1})	34565	34565	33650
Groundnut pod yield (kg ha^{-1})	1600	1380	1060
Market price (₹ kg^{-1})	40	40	40
Net income (₹ ha^{-1})	29435	20635	8750

Documented by: Kaushal K Garg and Sindhu Singh (ICRISAT)

7

Improved variety of finger millet gives higher income

Thimmappa, Herelkatte Village, Bellavi hobli, Tumkur Taluka, Tumkur District

Finger millet (Ragi, Elusine coracana) is an important cereal food crop in Tumkur and farmers continue to be interested in cultivating finger millet in rainfed areas due to its drought-tolerant nature. An improved variety of finger millet, Cultivar MR 1, was introduced by Mr. Thimmappa in the rainy season 2014-15 and compared with the traditional variety, GPU 28. Finger millet is a hardy crop that does not require much water, and higher yields can be achieved with landform treatment and mulching operations. The effect of applying micronutrients to the traditional variety was also studied.

The average yield from various field trials obtained was 2556 kg ha^{-1}, 63 % higher than the traditional variety. Net income under the improved management conditions was nearly ₹ 27000 ha^{-1} compared to ₹ 8000 ha^{-1} under traditionally managed cultivation (Table 6).

Table 6. Impact of improved variety and micronutrient application on crop yield and net income on finger millet, Tumkur Taluka, during the year 2014-15

Finger Millet			
Variety	MR 1	GPU 28	GPU 28
Micronutrient	Yes	Yes	No
Cost of cultivation (₹ ha^{-1})	12000	12000	11400
Finger millet yield (₹ ha^{-1})	2550	1625	1245
Market price (₹ kg^{-1})	15.5	15.5	15.5
Net income (₹ ha^{-1})	27525	13188	7898

Documented by: Kaushal K Garg and Sindhu Singh (ICRISAT)

8

Suitable hybrid maize along with good practices enhances net profits in Madhugiri taluka

Mr Ramesh and Mr Hanumanthayya Puttarangappa, Madhugiri Taluka, Tumkur

Mr Ramesh and Mr Hanumanthayya Puttarangappa, Madhugiri Taluka, Tumkur are 2 farmers who experimented with maize hybrids and found excellent results in their fields.

Maize is one of the predominant crops, both in rainfed and irrigated condition, in Tumkur. In general, performance of maize hybrids remained far below the expectation as the region is characterized by shallow red soils with arid climate. However maize yield can be enhanced by selecting a suitable hybrid as per availability of resources and introducing various improved management practices (eg, weed management). Mr Ramesh and Mr Hanumanthayya cultivated six maize hybrids in their field in Madhugiri Taluka.

The major interventions were weed management and target-based yield achievement through Site Specific Nutrient Management (SSNM) and by following the recommended package of practices (Fig. 8).

Figure 8. Improved maize hybrid cultivated in Madhugiri Taluka, Tumkur District.

Maize hybrid Zuari 1921 with nutrition management recorded the highest yield (5.8 t ha^{-1}), followed by Sri Ram Gold (5.6 t ha^{-1}) under similar management conditions. However,

Figure 8. Improved maize hybrid cultivated in Madhugiri Taluka, Tumkur District.

Documented by: SG Patil and Yogesh Kumar Singh (CIMMYT)

raising nutrient management level to the SSNM improved the performance of the most of the hybrids. Zuari 1921 provided the highest mean yield of 6.6 t ha^{-1}, followed by GK 3059 with a yield of 6.4 t ha^{-1} (Fig. 10).

Most hybrids were observed to record much lower yield under lower input management conditions (farmers' traditional practice) compared to SSNM-based application. Mr Ramesh recorded higher yields (5.9 t ha^{-1}) with the same hybrids by raising level of nutrient management to SSNM, followed by Mr. Hanumanthayya Puttarangappa. Mr Hanumanthayya recorded the highest mean yield of 6.7 t ha^{-1} followed by Gopalaiah with Cauvery 255+ which yielded 6.68 t ha^{-1} (Fig. 10). These results revealed that these hybrids respond differently according to the different levels of management and also environments in which they are grown. These studies have shown hybrids such as Zuari 1921, GK 3059, NK 6240, Sri Ram Gold etc. to be the most promising for the region.

F1: Hanumantarayappa Dasanna, F2: Putta Rangappa, F3: Beemaraju Ramakrishna, F4: Gangappa Venkataramappa, F5: Prabhakar Hanumantappa, F6: Ramesh Veerabhadraiah & F7: K.V. Gopalaiah Avula

Moreover, application of micronutrients enhanced maize yield from 5.8 t ha^{-1} to 6.4 t ha^{-1} and yielded an additional net income of about ₹ 6000-7000 ha^{-1}.

Table 7. Impact of micronutrient application on crop yield and net income

Maize		
Cultivar	Hybrid	Hybrid
Micronutrient	Yes	No
Cost of cultivation (₹ ha^{-1})	24000	23200
Maize yield (kg ha^{-1})	6440	5875
Market price (₹ kg^{-1})	13.1	13.1
Net income (₹ ha^{-1})	60364	53763

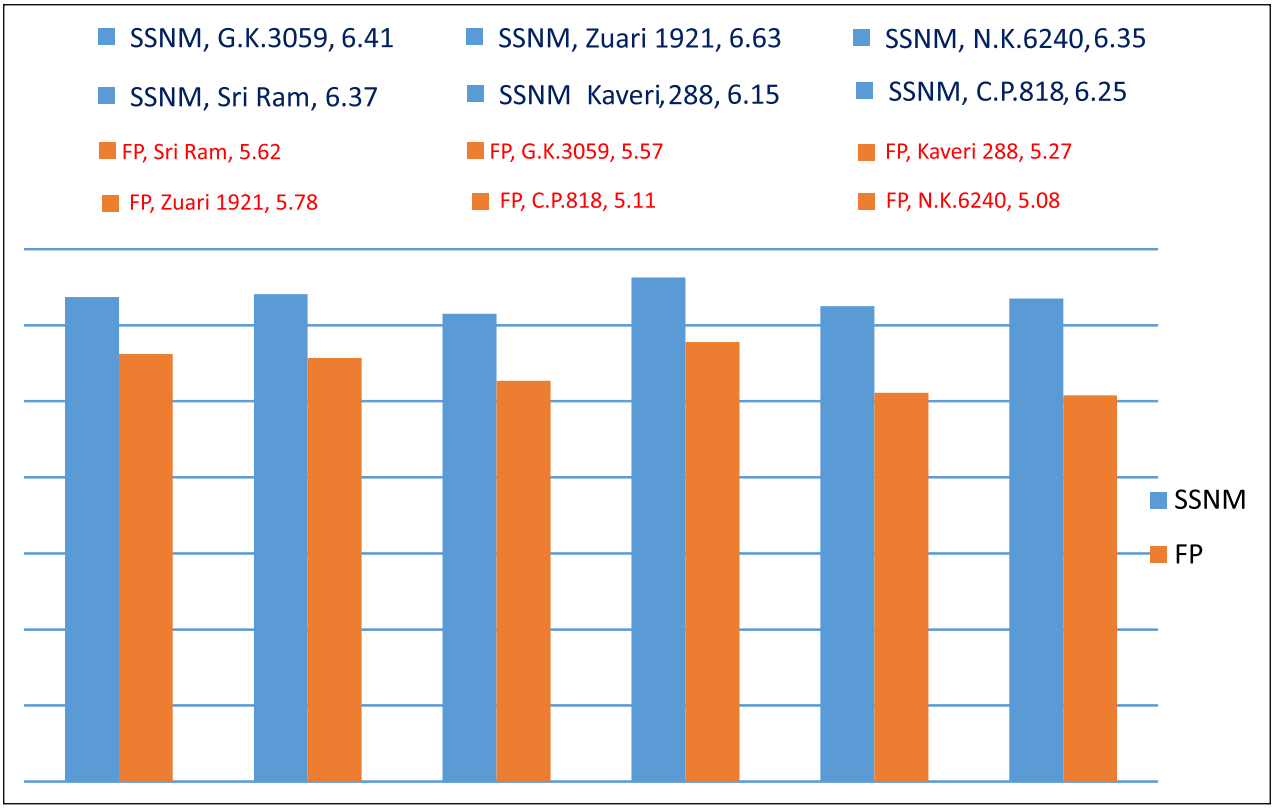


Figure 9. Performance of Maize hybrids in Puravar, Madhugiri taluka, Tumkur district.

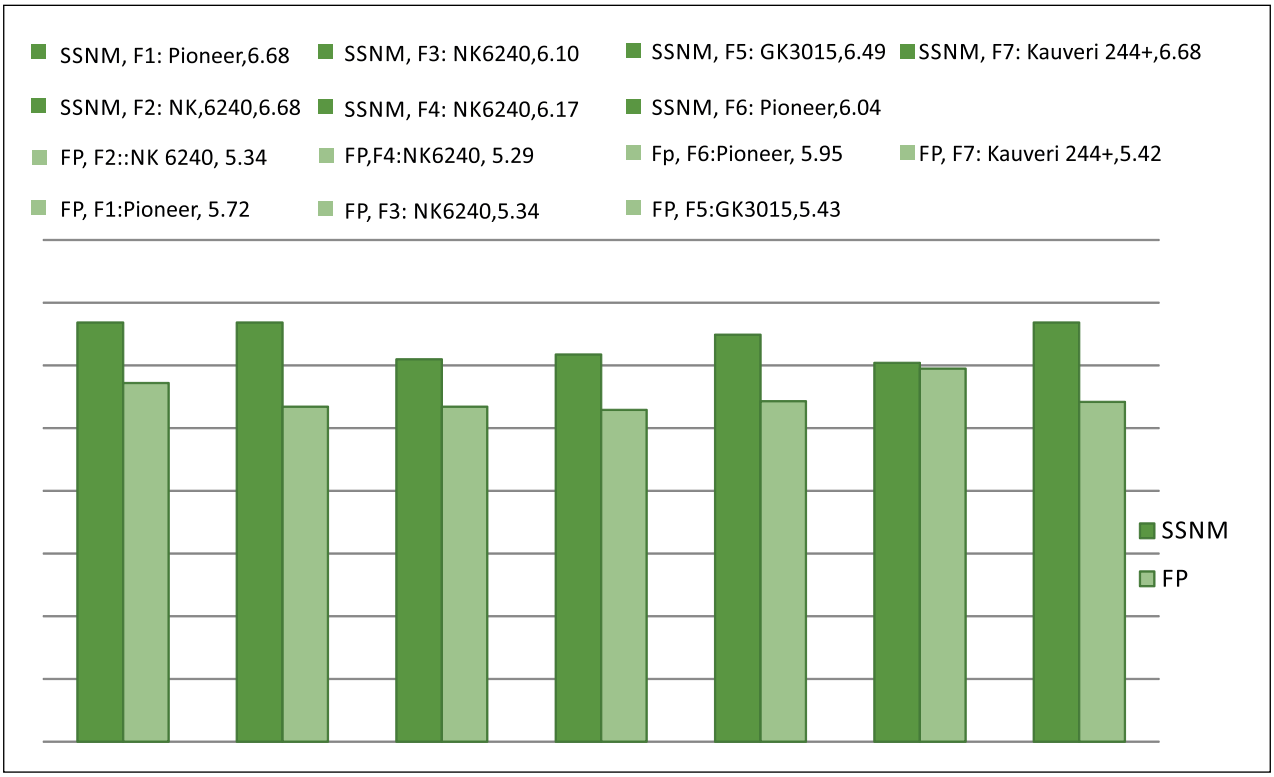


Figure 10. Performance of maize hybrids in Madhugiri taluka, Tumkur district.

9

Castor for crop diversification in Madhugiri

Mr Ramakrishna, s/o Dodda Rangappa, Taggihalli Village, Puravara Hobli, Madhugiri Taluka, Tumkur District

Mr Ramakrishna grew castor under the crop diversification program as an alternative to his existing field crops in degraded/ shallow red soils. Despite conditions of degraded and shallow soils with poor water holding capacity, castor generated a remunerative return.

Results showed a yield of nearly 900-1100 kg ha^{-1} seed, with net return of ₹ 24000-27000 ha^{-1}. Application of micronutrients resulted in an additional 100-150 kg seed yield and additional income of ₹ 2000-3000 (Table 8).

Table 8. Impact of micronutrient application on castor yield and net income

Castor		
Micronutrient	Yes	No
Cost of cultivation (₹ ha^{-1})	20190	18550
Castor yield (kg ha^{-1})	1062.5	965
Market price (₹ kg^{-1})	45	45
Net income (₹ ha^{-1})	27623	24875

Documented by: Kaushal K Garg and Sindhu Singh (ICRISAT)

10

Crop intensification in paddy fallow area using zero-tillage

Mr Guru Murti, Hiregundagal Village, Kora Hobli, Tumkur

Zero-tillage is a farm technology used in conservation agricultural practices and when used in dryland areas, the method results in high yields and a reduced per -ha cost of production when compared to conventional tillage methods. Zero tillage follows three principles: (a) continuous no-till which allows leaving high stubble standing (also creating soil health conditions that in the medium- to long term defeat weeds); (b) permanent soil cover; and (c) crop rotation. Zero-tillage also enhances optimal soil biological, chemical and physical features (including moisture retention).

Farmers in Hiregundagal grow paddy as this village is located close to a large tank which supports the high water requirements of this crop. However, despite good soil moisture content at the end of the paddy harvest, farmers here typically do not grow a second crop. Keeping their land fallow results in huge loss of soil moisture and a mono-cropping system despite potential for crop intensification. A zero-till machine provided the opportunity for them to grow a second crop without tilling the soil, helping them use available soil moisture more effectively. Mr. Guru Murti cultivated chickpea and green gram (1.2 ha) in his field at Hiregundagal during the 2014-15 postrainy season (Fig. 11). Mr. Dayananda Sagar, of the same village, sowed maize (including sweet corn) using zero-till in his field of nearly 4 ha area with supplemental irrigation. The farmers benefited by harvesting 750 kg ha^{-1} chickpea; 500 kg ha^{-1} green gram, 8160 kg ha^{-1} maize grain and 8090 kg ha^{-1} maize stover from these plots. Thereafter, a field day and exposure visit was organized in April 2015 to explain the benefits and disseminate the technology to other farmers (Fig. 12).

Figure 11. Crop sown using zero-till in Hiregundagal of Tumkur Taluka during postrainy season, 2014-15.

Figure 12. Line department officials, scientist from UAS Bangalore and farmers from Afghanistan visited zero-tillage plots at Hiregundagal, Tumkur Taluka.

Documented by: Yogesh Kumar Singh SG Patil and Kaushal K Garg (CIMMYT/ ICRISAT)

11

Improved irrigation method and proper irrigation scheduling enhances crop yield and income

Mr Bhargav, Mallenahalli Village, Madhugiri Taluka, Tumkur District

Agriculture is the largest consumer of freshwater, but inefficient management of water resources results in low crop yields and poor water use efficiency. Conservation and efficient use of water resources, both at micro and meso scale (farmers' field and watershed), is essential for enhancing crop yield, productivity and income. Due to the inherent variability of biophysical (soil hydraulic parameters, soil depth, etc.), topographical and land management (cropping sequence, time of sowing, etc.) factors, calendar-based irrigation scheduling does not always match crop water requirements. Enabling farmers to adopt more efficient irrigation methods and follow need-based irrigation scheduling can go a long way towards optimizing the use of available water resources.

Figure 13. Line department officials visited the farmer's field along with the CG scientist.

Despite installing drip irrigation setup in large farmers' fields, application of water is typically two to three times higher than the required amount. Therefore, along with promoting micro-irrigation, a capacity building program on irrigation scheduling is needed. Mr. Bhargav is a mulberry farmers who possesses a borewell irrigation facility in his field, and recently established a micro-irrigation set-up on 0.4 ha. He was taught about irrigation and fertigation scheduling and the impact was evaluated as reported in Table 9. Capacity building helped this farmer to save more than 40% water, and labor cost; while fertigation scheduling reduced fertilizer requirement and resulted in higher crop productivity and net return.

Table 9. Impact of irrigation and fertigation scheduling on water saving, crop yield and total income.

Parameter	Before Training	After Training
Frequency of irrigation	Once in 8 days	Once in 2 days
Water applied (L/irrigation)	50,000	12,500
No of irrigation	05	20
Fertigation	Fertigation – No	
	80kg N, 50kg P, and 50 kg K/acre in 2 split dose per year.	Fertigation – once in 15 days at the rate of 5 kg N, 2.5kg P, and 2.5kg K per acre.
Leaf Yield	Leaf yield per crop – 3500 kg (3ft *2ft spacing with old variety): Leaf yield per year (5 crops) – 25,000 kg	Leaf yield per crop – 5000 kg (5ft *2ft Spacing With V-1 New variety): Average yield per year (6 crops) – 35,000 kg
Impact of yield and net return	Total cocoon yield per crop – 100kg	Total cocoon yield per crop – 120kg
	Price per kg – ₹ 350	Price per kg – ₹ 350
	Total income per crop – ₹ 35,000	Total income per crop – ₹ 42,000
	Annual income (5 crops) – ₹ 1,75,000	Annual income (6 crops) – ₹ 2,52,000
	Cost of the cultivation per year – ₹ 1,00,000	Cost of the cultivation per year – ₹ 95,000
	Net income per year – ₹ 75,000	Net income per year – ₹ 1,57,000

Documented by: Andani Gowda and Kaushal K Garg (IWMI ICRISAT)

12

Hydrological monitoring helps designing optimum water harvesting protocol

Hydrological data on meso-scale watersheds is rarely available. Most of the inflow calculations for designing water harvesting structures (check dam at meso-scale watershed and farm pond at field) are either based on thumb rules or by empirical equations that are derived for different rainfall, soils and agroecological regions. As a result, in the absence of real field or watershed scale monitoring, we either over-design structures or underutilize the available water resources. Hydrological monitoring helps in designing suitable water harvesting protocols as per the water balance approach.

In this project, two monitoring stations were established to understand rainfall-runoff relationships for different landscape, rainfall, soil and land use conditions in one of the selected watersheds (Haralkatte) of Tumkur. This data will be used further to model hydrological components such as base flow and surface runoff. The information will also be used to establish hydrological process parameters for large watersheds in similar regions, so that water harvesting strategy can be defined suitably.

This monitoring is also helpful in understanding the impact of various land and water management interventions on water resource availability and further, on productivity.

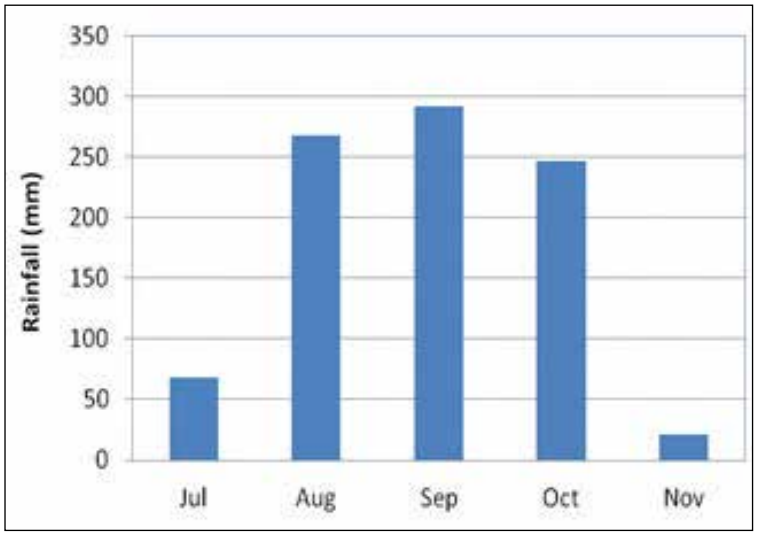
Two identical watersheds of similar land use and topography (Table 10; Fig 14 and Fig 15) were selected). These monitoring stations are comparing hydrology for treated and control watershed. Meteorological stations have been established at all the four BC-Plus Districts and data in these watersheds is being monitored at half-hour intervals.

Table 10. Location of monitoring station in Tumkur BC-Plus villages.

District	Rainfall	Village	Test Scenarios	Scale
Tumkur	600 mm	Haralkatte	Interventions impact: Check dam vs. No check dam	30-50 ha

DIVER consists of pressure transducers which precisely measure the pressure head at defined intervals (programmed at 15 min interval in the present case). Installing DIVER at the watershed outlet provides the inflow details. It has an inbuilt battery which is supposed to work for 10 years without being charged.

Tumkur received 897 mm rain during the monsoon season in 2014. The outflow measured at the treated watershed was found to be 7% of total rainfall compared to 10% in control watershed (Table 11 and Fig 16).



Documented by: Rajesh Nune and Kaushal K Garg (ICRISAT)

Table 11. Rainfall-Runoff relationships obtained from different monitoring stations

District	Location	Station at Tumkur	Rainfall (mm)	Runoff (mm)
Tumkur	Haralkatte	Control watershed	897	89 (10%)
	Haralkatte	Treated watershed	897	65 (7%)

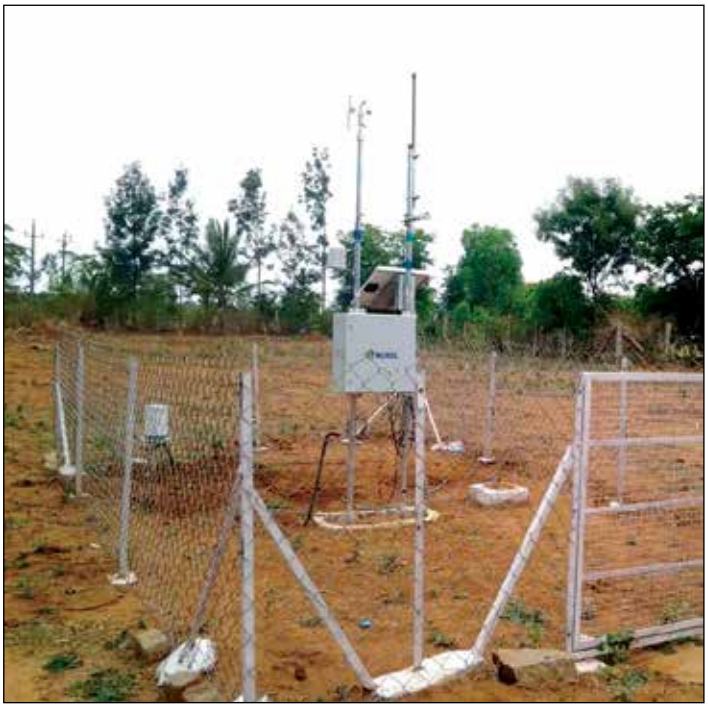


Figure 14. Weather station established in Haralkatte, Tumkur (left); Variation of rainfall from month to month in 2014; Total rainfall recorded (897 mm) in villages during monsoon period (right).

Figure 15. Runoff set up at Haralkatte in Tumkur.

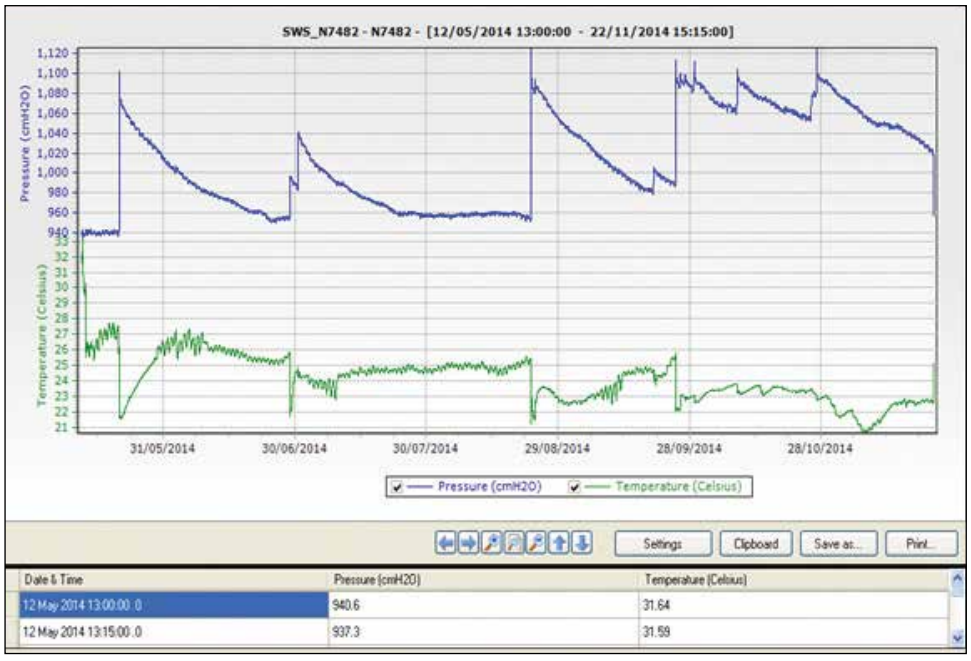


Figure 16. Hydrograph obtained against the rainfall received in the year 2014 at Tumkur district.

Success stories in Bhoo Samruddhi project, Raichur district

District Coordinator - Gajanan Sawargaonkar

State of Karnataka

13

Enhancing productivity through balanced nutrient management and improved variety of groundnut

Mr Bheemesh Nayak, Idapanur Village, Raichur

A good yield obtained from a good healthy crop ensures food security for the season and the farmer. However, a lot of effort is required to get assured production, especially at ground level. Most farmers do not adopt the correct techniques and practices required for good groundnut production. There is a knowledge gap that needs to be addressed. Many farmers manage groundnut crop nutrients generally by applying urea and diammonium phosphate (DAP) only. This shows their poor understanding of the concept of balanced nutrient management. The Bhoo Samruddhi program addresses this issue and the results are highly visible at the grassroots. Another important point which requires immediate action is the use of quality seed.

Figure 1: Farmer showing good groundnut crop (in right hand) obtained by better management practices).

This case study describes the circumstances that led to the adoption of soil test-based balanced nutrient management and improved cultivars by farmers, their capacity enhancement and the continuity of the technology. The analysis is based on factual data from the users and on the farmer's view. Idapanur is located in the Northern Transition Zone of Karnataka (16o 008'566''N and 770452'758''E) at an altitude of 583 m above MSL. The village is located 18 km from Raichur and is not well connected by road. It is a medium-sized village of 3500 people representing all strata of society, and has low rainfall and recurring drought. Farmer Mr. Bheemesh Nayak belongs to the ST category and a small land holding with sandy soil of poor quality and low nutrient content and agriculture is his main source of livelihood. He heard about the Bhoo Samruddhi project and showed keen interest in adopting the technologies. Having selected groundnut for this initiative, he received the seed from ICRISAT staff (Variety ICGV 91114) and purchased the other inputs from the DoA. One week before planting the seedlings, FYM was applied and mixed in soil and fertilizers were applied as basal dosage (gypsum 200 kg; borax 8 kg and ZnSo4 40 kg per ha). Sowing was done in rows with 30 cm spacing. The recommended plant population was maintained by planting seeds 10 cm apart. He performed two weedings, one with making a furrow. He followed the technical help and inputs recommended by farmer facilitators and DOA-ICRISAT staff from Hyderabad and the District coordinator who visited periodically. He also followed the integrated pest management as per the instructions given by scientists.

Bheemesh realized a significant improvement in the crop growth compared to his previous practices of nutrient application and traditional varietal use. With the improved technology, he obtained a yield of 2450 kg ha^{-1} with net income of ₹61,050 as compared to the previous yield of 1854 kg ha^{-1} with net income of ₹40682 ha^{-1}. He has expressed the opinion that using balanced nutrition including the

Documented by: Gajanan Sawargaonkar and Jnanesha AC (ICRISAT)

Table 12. Details of groundnut yield under improved management.

Particulars	Farmer's practice	Improved management practice	% increase in yield over farmer's practice
Variety	Local variety	ICGV114	
Pod yield (kg ha^{-1})	1854	2450	+24
Cost of cultivation (Rs. ha^{-1})	20500	21800	
Gross income	61182	80850	+24.3
Net income	40682	61050	+33.3
Benefit cost ratio	2.98	3.71	

deficient micronutrients has proved to be a viable practice which has given him 32% higher yield with benefit cost ratio of 3.71 as against 2.98 in farmer's practice.

"We never applied zinc sulfate, Agribor and gypsum in our fields, but the Bhoo Samruddhi project facilitated us to practically observe the effects of balanced nutrient management and improved cultivars. Now we are confident about using these techniques in the future," says Bheemesh Nayak

14

Participatory varietal evaluation of high-yielding pigeonpea hybrid

Mr Sreenivasa, S/o Muniyappa, Village Kasbe camp, Raichur Taluka, Raichur District

Mr Sreenivasa learned about the Bhoo Samruddhi project and showed a keen interest in the project. He is a 33 year-old farmer practicing subsistence farming since many years. After seeing the performance of pigeonpea Hybrid ICPH 2740 in the neighboring farmer's field, he was convinced that adopting high-yielding improved cultivars suited to his land is the key to successfully combating his situation of crop failure and low yield. Mr. Sreenivasa received the hybrid seed from ICRISAT (cultivar ICPH 2740) and purchased the other inputs from the DoA. One week before planting the seedlings, FYM was applied and mixed in soil and fertilizers were applied as basal dosage as recommended (gypsum 100 kg, borax 8 kg and ZnSo4 20 kg per ha). Sowing was done by making rows with 45 cm spacing, and the recommended plant population maintained by sowing seedlings at 45 cm apart. He performed two weedings and two harrowings. The ICRISAT scientist-DOA staff visited his farm and provided the required technical help and support.

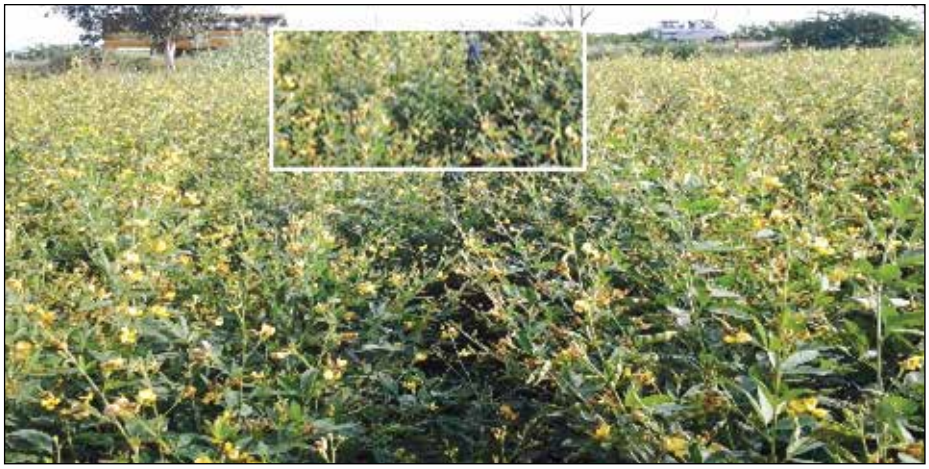


Figure 17. Pigeonpea Hybrid ICPH 2740 in farmers' field.

Sreenivasa observed that the Pigeonpea Hybrid ICPH2740 showed remarkable growth under better management conditions compared to his traditional variety with his practice of crop management. With improved technology, he obtained a yield of 2320 kg ha^{-1} with an income of ₹127,600 per ha as compared to yield of the control plot of 1500 kg ha^{-1} with income of ₹82,500 per acre.

In Sreenivas's opinion, the hybrid ICPH 2740 has a great potential under one or two irrigations and better crop management options and has proved to be a very viable practice which has given him 35 % more grain yield and much higher benefit cost ratio of 2.28 as compared to 1.72 under his previous practices.

Table 13. Economics of pigeonpea varietal evaluation trial.

Method	Grain yield (kg ha^{-1})	Gross income	Net income	Benefit cost ratio
Improved practice	2320	127,600	17900	2.28
Farmer's practice	1500	82500	8625	1.72

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15

Enhancing the yield of groundnut through Broadbed and Furrow (BBF) method of cultivation

Mr Badryya Swamy, Puchaladinni Village, Raichur

Water scarcity and stagnation are both major problems that significantly affect germination and yield for groundnut growers in Puchaladinni of Raichur District. A group discussion with the farmers was organized in the village to improve water use efficiency using the BBF technique. An improved variety of groundnut had already been introduced under the Bhoo Samruddhi project in the village for the rainy season of 2014.

Figure 18. Groundnut crop raised on broadbed and furrow.

The Tropicultor developed by ICRISAT was used for BBF preparation as well as for sowing of groundnut seeds at a distance of 25 cm apart with 45 cm furrows that served two purposes: drainage of excess water during high rainfall and storage of water during scarcity or dry spell. This method helps sow seeds in four rows simultaneously. Benefits of BBF are as follows

- Soil and moisture conservation
- Good surface drainage that prevents waterlogging
- Better aeration in seed bed and root zone
- Reduced runoff and soil loss; improved soil properties over the years
- Width of bed can be adjusted as per spacing of the crop
- Furrow provides trafficking zone for all intercultural operations, saving time, energy and money

Along with some farmers of Puchaldinni, Mr. Badryya Swamy also used the Tropicultor in his field; while some other farmers practiced their own method of flat sowing. The groundnut variety used was ICGV 91114. The results of BBF system on yield and yield-attributing characters were phenomenal and are as follows,

- Runoff water was absorbed in the field itself as there was more opportunity and time for infiltration.
- Waterlogging was alleviated through safe removal of excess water in a guided manner.
- Reduced soil loss and runoff loss was observed.
- Plants showed better growth due to better exposure to air and sunlight.
- Softness in seed bed preserved moisture for a longer time.

Documented by: Gajanan Sawargaonkar and LS Jangawad (ICRISAT)

Table 14. Performance of groundnut under different landform management.

Method	Pod yield (kg ha^{-1})	Gross income	Net income	Benefit cost ratio
Broadbed and furrow)	2354	77682	53182	3.17
Farmer's practice	1572	51876	31876	2.59

It is evident in this context that groundnut grown under BBF system gave 33% higher grain yield and net income of ₹53182 compared to the farmers' practice. Along with Mr Badryya Swamy, other farmers who visited the field also expressed their willingness to shift from their traditional practice of landform management to the BBF system of landform management. Mr. Swamy particularly feels that the technical inputs received through this project helped enhance his knowledge of improving water use efficiency and obtaining maximum benefit.

16

Participatory validation trials for identifying adapted high-yielding maize hybrids

Mr Jafar Ali Patel, Idapanur Village

Mr Jafar Ali Patel, a resident of Idapanur, owns 8 ha total cultivable land, but the soil is eroded and predominantly composed of sandy loam. He is a keen farmer, with ample water supply through borewells, but has been suffering from low yields. Seeing his enthusiasm, the CGIAR team decided to bring him into the agricultural mainstream as a part of the Bhoo Samruddhi program. As part of this participatory plan, the International Maize and Wheat Improvement Center (CIMMYT) evaluated the performance of some promising hybrids comprised of a few popular hybrids and some new ones on his land.

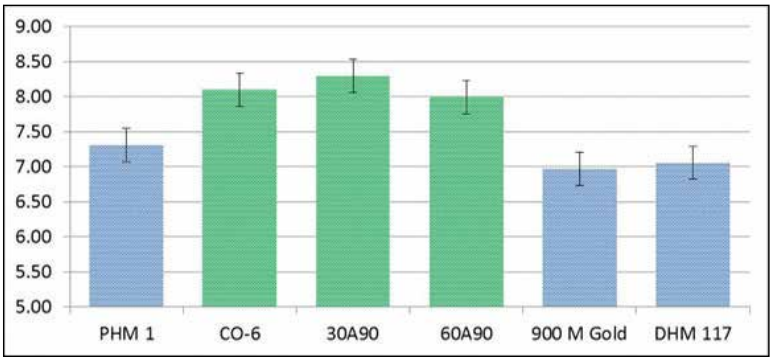


Figure 4. Performance of the top six hybrids under participatory varietal evaluation trials.

The validation trials evaluated 12 hybrids of maize (GK 3059, DHM 117, CO 6, 900 M Gold, 30 A 90, 60 A 90, CP 818, CP 808, Pioneer 3507, Pioneer 3441, NK 6240, DKC 9135) from public and private sector organizations for developing recommendation domains and out-scaling strategies. Participatory selection provides an excellent opportunity for farmers to identify hybrids suitable for their specific situation and typologies. During these validation trials, awareness was created among neighboring farmers from around the pilot domains. These farmers were enthusiastic and their opinion was sought, which definitely led to wider acceptability of the hybrids and associated technologies.

As revealed by the trials, CO 6 (from TNAU, Coimbatore) and 30 A 90 & 60 A 90 (both from Adhar Seeds) were the best among the hybrids evaluated. The participating village communities also ranked 30 A 90 and CO 6 as the most preferred hybrids which produced 19% (30 A 90) and 15% (CO 6) higher yield compared to the most common and widely cultivated hybrid (900 M Gold).

Mr Jafar Patel is very happy with the results and mentioned that he has found an important key to success, ie, selection of proper hybrid along with best management practices. This has proved a significant milestone in the lives of the farmers in the area.

Documented by: SG Patil and Yogesh Kumar Singh (CIMMYT)

17

Recycling of cotton/ pigeonpea waste through aerobic composting method

Mr Dharmareddy S/o Kalmesh Reddy, Idapanur village

Cotton is the major commercial crop in Raichur District, and is usually intercropped with pigeonpea. Continuous mono cropping of cotton and its exhaustive nature have, over the years, caused soil fertility to decline leading to a reduction in cotton yield as well. Conventionally, farmers burn the cotton/pigeonpea stalks after harvest, which leads to huge loss of nutrients and valuable carbon, in addition to increasing environmental pollution. Instead, composting crop stalks is a natural way of recycling organic materials back into the soil and generating vital nutrients for new plant growth. This is one of the best ways to build soil fertility. Staff from ICRISAT and DOA staff created awareness about the production of compost from cotton/pigeonpea stalk by using a tractor operated shredder for chopping stalks and then using Madhyam culture for preparing the compost unit.

Figure 5. Shredder machine for aerobic composting demonstrated in Idapanur, Raichur District.

Key Requirements for Compost Making

1. Any organic waste of plant or animal origin (crop waste, cattle and domestic animal waste, poultry waste, vegetable waste, kitchen waste, food and fruit processing plant waste, sugar factory waste including press-mud, municipal organic waste and other wastes that are organic in nature).
2. Composting microbial culture (Madhyam®, Bioculum® etc.). 1.0-1.5 kg is required per ton of organic material, which ICRISAT provided.
3. Water.
4. A shredder cum chipper machine for dry plant waste. A machine was provided by ICRISAT.
5. Material mixing machine when operation is being done on a larger scale: A tractor with a rotator or cultivator attachment is ideal.
6. Urea or nitrogen source when dry plant material is the major waste.
7. Compost nutrient enrichers (rock phosphate, phosphate solubilizers, nitrogen fixers etc.), if required

Documented by: Gajanan Sawargaonkar and Jnanesha AC (ICRISAT)

Mr Dharmareddy was extremely interested in adopting this technology and chaffed a 0.4 ha cotton/ pigeonpea field for the purpose. Within 65-75 days, he got nearly 1.5 t of compost worth ₹ 4500. Prior to this, he used to purchase compost for about ₹ 3000 t^{-1}. This experience showed the vast potential of utilizing cotton stalk for production of compost. This compost is rich in plant nutrients, including micro and secondary nutrients, while also taking much less time (2-2.5 months) than other methods (6-9 months). Besides him, more than 100 farmers in Idapanur have adopted this method of composting.

Advantages

1. Composting was done in the field itself
2. No transportation charges
3. No pit construction costs
4. Nutrient status of the compost is comparable to that of vermicompost

18

Enhancing the productivity of rice by direct seeded rice method

Mr Shivaprasad, Haravi Village, Manvi Taluka, Raichur District

Rice is the most important crop grown in Raichur District and has the unique capacity to grow in standing water. Therefore, this crop is grown in abundance in low-lying areas. Most farmers follow the practice of transplantation due to the availability of abundant water, less effort required for weed control, and due to improved availability of certain nutrients in a waterlogged environment. However, in the future, water scarcity is likely to become a serious problem due to the high demand for water for agriculture, industry and drinking purposes. Erratic and insufficient monsoons have further aggravated conditions, leading to insufficient water in barrages and delayed, erratic, untimely canal supplies, leading to delayed transplanting. In addition, climate change is expected to affect water availability. In this situation, an innovative technique of direct seeded rice (DSR) which can reduce the need for water for rice cultivation without reducing the productivity is the need of the hour. This project evaluated DSR technology, which reduces water, labor and energy needs, and facilitates on-time or early sowing, on Mr. Shivaprasad's farm in Haravi.

Figure 19. Farmer with good DSR yield using best management practices.

Haravi is located in Manvi Taluka of Raichur District in Karnataka state at 160050'621'' N and 770071'057'' E, at an altitude of 635 m above MSL, and is well connected by road. Farmer Shivaprasad owns an ancestral property of 4 ha medium black soil, on which he grows only rice in the rainy season and chickpea and sorghum during the postrainy season. His farm is located in the tail end command area where water supplies are limited and where farmers do not get sufficient water at the right time and are faced with ON-OFF canal water supply. The problem may become more serious

Table 15. Result of DSR trial in Haravi.

Particulars	Transplanted method	DSR method
Grain yield	6380 kg ha^{-1}	6450 kg ha^{-1}
Cost of cultivation	70000	55000
Gross income	102080	103200
Net income	32080	48200
Benefit cost ratio	1.46	1.88

Documented by: AN Rao, SG Patil and Jnanesha AC (IRRI/ICRISAT)

as farmers get water only in a 10-day cycle in Upper Krishna (UKP) and 20-day cycle in Tungabhadra Project (TBP), forcing them to complete transplanting within a limited period, which is difficult due to shortage of labor, machinery, and the like. Mr. Shivaprasad decided to try direct seeding of rice to take advantage of early rains received just one month before the canal supplies water. This was suggested keeping in mind that establishment/germination of rice could easily survive drought for one month before switching over to canal water as and when available.

The results obtained in the farmer's field in Haravi are very appreciable and it is clear from this that standing water is not essential for rice cultivation. Typically, 2500-4000 liters of water are needed to produce 1 kg rice grain. By adopting DSR technology, water use can be reduced to a great extent, saving large quantities of water that could be gainfully used to cultivate double the present area. In addition, soil health and environmental quality was maintained successfully, and the DSR method gave higher grain yield, net income and cost benefit ratio compared to the transplanting method. Using this method, farmers can also get higher yields with less water, energy, labor, fertilizer and ultimately, higher net profit per unit area as compared to transplanted rice. Thus, it is worthwhile to promote DSR for the reasons well known such as saving water (25-40 %), fertilizer (25-30 %), energy (40-60 l ha^{-1}), apart from several other advantages like saving labor, and environmental hidden costs, besides the accrued benefits like bringing more area under irrigation, decreased soil salinization where excessive irrigation was provided and sufficient time to grow a second crop in rotation.

19

Participatory varietal evaluation of high-yielding rice variety along with best-bet management practices in rainy and postrainy seasons

Mr Satyanarayana, Gilasur (Gileswar) Camp, Raichur District

Mr Satyanarayana of Gilasur (Gileswar) Camp was following a rice-rice cropping system. The normal rice yield Mr. Satyanarayana got prior to 2014 was around 6.4 t ha^{-1} in the rainy season and 7.3 t ha^{-1} in the postrainy season. During the 2014 rainy season, the IRRI/ICRISAT/ DOA (Government of Karnataka) components of Bhoo Samruddhi procured the seed of rice variety RNR 15048 from the Agriculture Research station (PJTSAU), Rajendra Nagar, Hyderabad (as a mini-kit of 4 kg) and gave it to Mr Satyanarayana.

Figure 7. Farmer participatory varietal trail of Paddy variety RNR15048

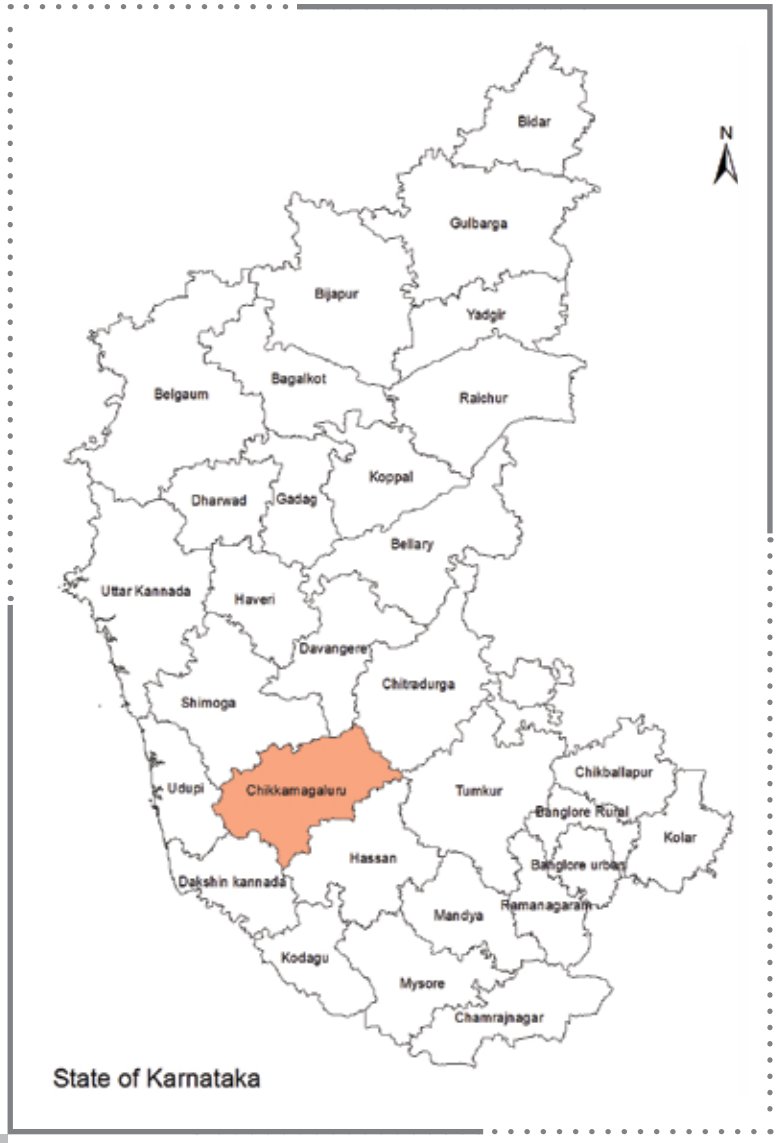
Mr Satyanarayana followed the advice given by IRRI/ICRISAT scientists about the improved package of practices of rice. This consisted of seeding with the onset of monsoon in the rainy season using seed drill at a spacing of 20 cm from row to row; applying 100 kg N + 50 kg P + 50 kg K2O; using the pre-emergence herbicide (pendimethalin) supplemented by hand weeding for managing weeds, weeding during critical period of crop-weed competition, need-based pesticide application and harvest using the combiner. The crop was excellent and the expenditure was also low compared to the usual way of transplanting paddy. He harvested a yield of 7 t ha^{-1} during the rainy season with this direct-seeding method of rice establishment.

After enjoying the success owed to adopting new cultivar and best management practices, Mr. Satyanarayana used the rainy season seed of RNR 15048 for the postrainy season crop as a transplanted rice with the best management practices, and obtained a yield of 9 t ha^{-1}. Other farmers in the village were also impressed by the performance of RNR 15048 in Mr Satyanarayana's field, and started procuring it as seed for the 2015 rainy season. While the cost of cultivation remained the same, Mr Satyanarayana made an additional income of ₹20,800 per year, compared to the previous year when he grew BPT 5204. Besides increasing Mr Satyanarayana's net profit, this exercise demonstrated that the cost of cultivation could also be reduced by optimizing the use of fertilizers, which are typically excessively used in Raichur District.

Documented by: AN Rao and Gajanan Sawargaonkar(IRRI/ICRISAT)

Success stories in Bhoo Samruddhi project, Chikkamagaluru district

District Coordinator - KH Anantha



20

Sparking a chain reaction in chilli cultivation

For the chilli farmers of Giriyapura in Chikkamagaluru District of Karnataka, selling their produce in the local market was an uphill task. The profits slumped year after year, owing to restrictive local market practices and intense competition. The World Vegetable Centre (AVRDC's) value chain approach to their problems has made all the difference.

Figure 20. Chillies are being produced by following IPM technologies and dried in farmer's field for marketing in Chikkamagaluru

"First, the buyers complained of the excessive use of pesticides and then the middlemen removed nearly 4% of the produce because of what they called 'wastage'. The scales were not electronic, which meant the weighing was not accurate," 40-year-old local farmer Mr Halappa says. "The market is dominated by middlemen who also offered low prices of not more than ₹ 80 per kg for the produce" he adds.

With support from the Karnataka government, AVRDC interventions in the village under the Bhoo Samruddhi (Bhoochetana Plus) project set out to address these issues of concern that affected farmers.

AVRDC began working with 25 farmers who were cultivating three varieties of chillies, Devanoor, Byadgi and Kadi, and were obtaining three harvests a year from 24 ha of land. The crops were sold as dry spices for use in local food, but could also be sold to processors for the extraction of high-value oleoresin from the pods. After refinement, the oleoresin is exported to the USA, Japan and Europe, but increasing contamination from pesticides has restricted the ability of local processors to meet the exacting standards of these markets.

In January 2014, the AVRDC team conducted two trainings in the village on integrated pest management (IPM) for chilli. As farmers started adopting the IPM practices, their yields increased, along with product quality.

"We managed to get at least 2000 kg of dry chilli per ha. In some fields the yield was almost 3600 kg. Things were looking up for us," said Mr. Hiranyamurthy, a veteran farmer from the village.

Random samples of locally produced chillies were then analyzed for their pesticide residues by the Spices Board Lab. Negative results were obtained. As farmers managed to bring down the pesticide residue levels of the produce, AVRDC linked the farmers group with a private oleoresin buyer, Paprika Oleos (India) Ltd. from Tamil Nadu who was seeking produce with assured low levels of pesticide residue.

Documented by: Ramesh Subramanian and Kumar Nagaraju (AVRDC)

The value-chain intervention helped farmers maximize profits as Paprika Oleos decided to purchase chillies at a price of ₹110-120 per kg, which was higher than the local market price.

"We began to experience significant gains. First, the quality of the crop is better when compared to that of other farmers in nearby villages. Then, weighing is more accurate as the buyer uses digital scales and we lose no produce to wastage. We are saving on transportation and handling charges and the buyer pays us in cash," Mr Halappa said.

"With each harvest, I am able to secure a profit of ₹60,000 per ha," he adds.

The farmers dry the chillies naturally on roof tops and in open spaces. The details of planting material, nutrient and pest management inputs, sampling for quality, harvesting, drying and sale are recorded for each crop, thus providing assurance for the processor and international buyers.

Mr Hiranyamurthy organized a monthly meeting for the farmers to discuss issues and share tips.

"We aim to form a cooperative society to support and encourage other chilli farmers in nearby villages. There are growing concerns about excessive use of pesticides in vegetable farming all across the Chikkamagaluru District. Our approach and practices are surely the solution to this issue. We hope to spread this message as widely as possible," the veteran adds.

21

Participatory paddy varietal popularization

Ms Rathnamma Shanthappa Hegde, Murolli, Agalagandi, Koppa Taluka, Chikkamagaluru District.

Ms Rathnamma grows rice on her farm in Koppa Taluka, and typically obtained yield of about 2.5-3 t ha^{-1} during the years prior to 2014. During the 2014 rainy season, the IRRI/ICRISAT/DoA (Government of Karnataka) components of Bhoo Samruddhi procured the seed of rice variety IET 21048 from the Zonal Agricultural and Horticultural Research Station, Mudigere and gave the seed to Ms. Rathnamma, along with other farmers of the area. Ms. Rathnamma was also advised by the Bhoo Samruddhi staff about the improved package of practices of rice, which she followed to a certain extent (use of 30 days old seedlings for transplanting, weeding during critical period of crop-weed competition, using basal dose of fertilizer (400 kg of 20:26:26 per ha), using 90 kg ha^{-1} of potash in two splits of basal and top dressing at panicle initiation). At harvest, Ms. Rathnamma got a yield of 5.5 t ha^{-1}, double her previous yield. Adoption of the improved variety of rice IET 21048 increased her income by ₹ 25000/- (additional yield of 2500 kg at a minimum price of ₹ 10 per kg) without any additional cost of cultivation. The crop cutting experimental data taken by the staff of DoA indicated that in other farmers' fields the variety IET 21048 yielded up to 8 t ha^{-1}, indicating the suitability of this variety to the prevailing environmental conditions in Koppa Taluka. Neighboring farmers were also impressed by the performance of IET 21048 and informed Bhoo Samruddhi that they intend to use the variety in future seasons.

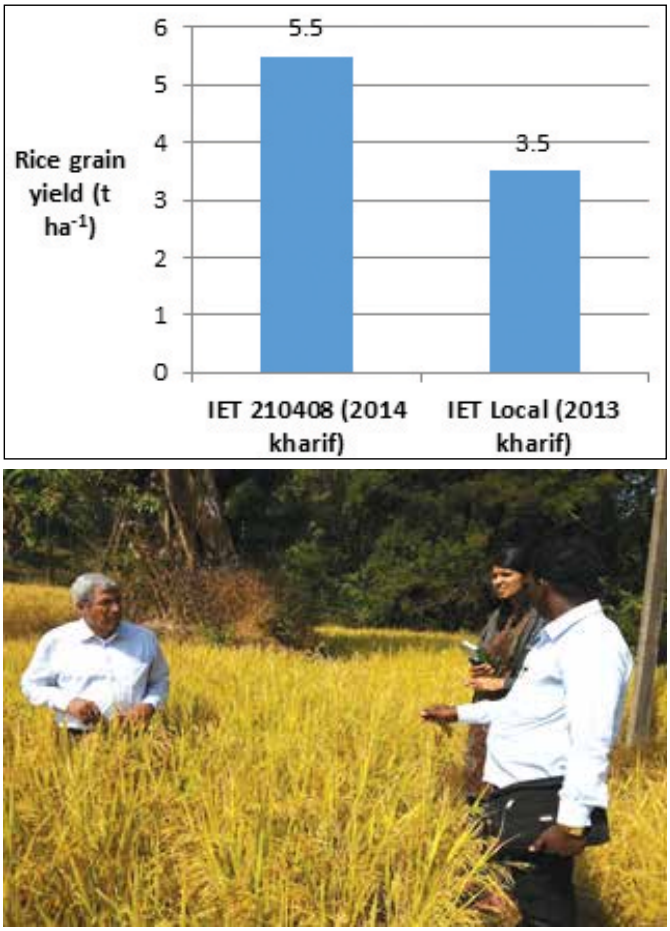


Figure 21. IET 21048 rice field being observed by the Bhoo Samruddhi and DoA staff.

Documented by: AN Rao and Mohammed Shafi Korabu (IRRI/ICRISAT)

22

Introducing grafted tomato & chilli in Chikkamagaluru

Soilborne diseases, especially bacterial wilt, pose a serious problem to growing vegetables in Karnataka state. Bacterial wilt is caused by Ralstonia solanacearum, a soilborne bacterium which enters plants through root injuries, multiplies and blocks the vascular bundles, thereby causing sudden wilting of the plants. Bacterial wilt is very common in solanaceous vegetables like brinjal, chilli and tomato.

Agricultural universities have released bacterial-wilt-tolerant varieties, but these generally do not have the yield potential or fruit size of commercial F1 hybrids of chilli and tomato grown widely by farmers. Grafting commercial F1 hybrids/ varieties suitable for cultivation in the state onto tolerant root stocks is a viable option to tackle the problem. AVRDC introduced grafted vegetable seedlings which are commercially grown in all western countries to solve various soil-related problems. The technology for grafting brinjal and tomato seedlings on to resistant Solanum torvum root stocks has been standardized at Kerala Agriculture University's Agricultural Research Station, Mannuthy, in collaboration with AVRDC. Solanum torvum, besides being resistant to bacterial wilt, is also immune to nematodes. Soilborne nematodes are a serious problem especially when repeated cultivation of a crop is followed in the same area.

The farmers who adopted grafted tomato observed positive results as follows:

- Grafted tomato success /survival rate was 98 % in field after transplanting, against 75-80 % in non-grafted seedlings.
- Initial establishment and vegetative growth up to 30-45 days was lower in grafted seedlings.
- In non-grafted seedlings, 12-15 % of plants were affected by tomato bacterial wilt, whereas in grafted seedlings there was no incidence of bacterial wilt.
- Yield in grafted seedlings was higher.

Figure 22. AVRDC Team with farmers in Chikkamagaluru District transplanting grafted tomato & chilli

Figure 23. Grafted tomato plot; Mr Mallikarjuna Agriculture officer Lakya hobli with Technical Manager and Mr Bharath, Research Technician AVRDC. (Chikkamagaluru).

Figure 24. Left row clearly displays Bacterial wilt in non-grafted tomato & right row Healthy Grafted tomato seedling, showing comparison to farmer by AVRDC Team.

Documented by: Kumar Nagaraju and Bharat (AVRDC)

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Participatory evaluation of maize hybrids to identify high-yielding hybrids for rainy and postrainy seasons

Maize is one of the most important crops in Karnataka, and the area under this crop is increasing due to its higher yield potential and relative freedom from pests and diseases compared to other crops. In the CGIAR pilot site/District domains, nearly 30-35 hybrids are being sold from each Raitha Samparka Kendra (RSK), but their yield potential significantly varies with high coefficient of variability. A farmer who selects a hybrid with a low yield potential ends up with a loss in yield and, thus, in income. Therefore, there was a need to identify a region/location specific hybrid suitable for the region.

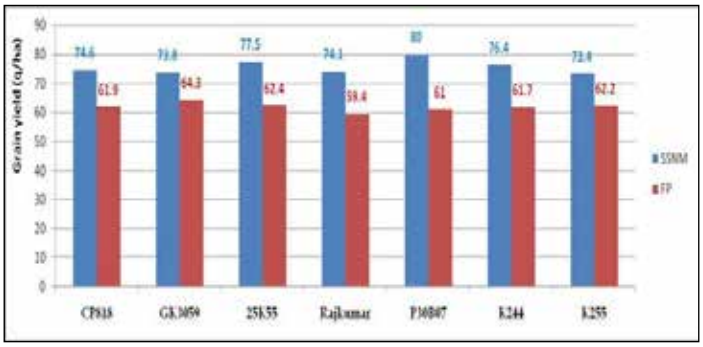

Figure 25. Performance of maize hybrids in Chikkamagaluru District

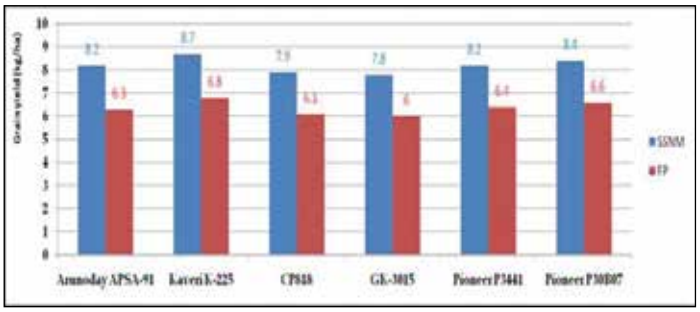

Figure 26. Performance of Maize hybrids in Emmedoddi, Kadur Taluka, Chikkamagaluru District

Keeping this in mind, District-wise participatory validation trials were initiated in all pilot Districts and GoK-CGIAR prioritized villages including Chikkamagaluru (Hiregouja, U Hosalli, Lakkamanahalli of Chikkamagaluru Taluka, Emmedoddi of Kadur Taluka). In consultation with the CIMMYT maize breeders and Hybrids sold in large-scale from RSK included in 6 Bhoo Samruddhi villages. Besides evaluating target yield based nutrient management concept introduced and compared with existing practices.

Significant variation was observed between hybrids as well as modes of nutrient management. Even top hybrids showed marked variability in their yield potential under similar management conditions, suggesting the need to identify the ones most suitable for the region. Site-specific nutrient management based on nutrient expert decision support system gave significantly higher yield than farmers' practices. In some villages, the highest yield (8 t ha^{-1}) was recorded by P 30 B 07 which is higher than the target yield aimed (8 t ha^{-1}). Not all the hybrids were responsive to the nutrient management and their yield levels were lower than 8 t ha^{-1}. Therefore, hybrids identified should preferably be not only suitable for the region but also responsive to the fertilizer management. The most promising hybrid was P 30 B 07, followed by others such as 25 K 55 and K 244.

Farmer participatory evaluations were also done in other locations such as Emmedoddi, Kadur Taluka and Lakkamanahalli, Chikkamagaluru Taluka. At Emmedoddi, the highest mean yield (8.7 t ha^{-1}) was recorded by Cauvery 225 followed by P 30 B 07 (8.4 t ha^{-1}), P 3441 (8.2 t ha^{-1}) and Arunodaya (8.2 t ha^{-1}) and most hybrids not only responded well but gave yields higher than the targeted yield. Also, variations in the performance of hybrids were quite noticeable in this village.

Documented by: SG Patil and Yogesh Kumar Singh (CIMMYT)

Figure 27. Hon'ble Minister for Agriculture, Shri. Krishna Byregowda held In-field interaction with Scientist and officials on participatory evaluation of Maize hybrids in Emmedoddi, Kadur Taluka.

Figure 28. Maize Field Day attended by Shri. YSV Datta, MLA, Kadur.

Lakkamanahalli lies 25 km east of Chikkamagaluru. The climate here is typically dry, with gravelly soil and poor inherent physical and chemical environment. P 30 B 07 was found promising in the area as it recorded the highest yield (6.7 t ha^{-1}) followed by 25 K 55. Hybrids such as K 3059, GK 3090 etc were also promising, while other hybrids proved significantly inferior. In general, yields were low.

The economics of the farmers' traditional practices vs improved method of raising crops were compared. The improved method yielded ₹ 96,000 ha^{-1}, while the farmers' practice generated only ₹ 69,600 ha^{-1}. After considering the cost of cultivation in both methods, there was a net increase of ₹ 22,878 ha^{-1}. An average yield increase of 150-200 kg ha^{-1} was observed. With 1.15 m ha area under maize in the state, it follows that adopting new production technology can contribute significantly to yields and revenues. Assuming a conservative yield of 100-150 kg ha^{-1}, an additional yield of 1 to 0.15 m T can be achieved, thus contributing ₹ 144 crore to the state.

Besides savings and increased farm gate income, farmers were educated about balanced and target based fertilization techniques. Farmers were advised on CA-based resource conservation technologies to achieve higher and long-term sustainable yield through laser guided leveling, zero tillage and residue management, besides site-specific management options for food security. All these options of CA-based technologies are now underway in all the CGIAR designated Districts.

24

ICGV groundnut variety brings a smile to farmer's face

Mr Ranganatha S/o Krishnappa, Kallenahalli Village, Sivani RSK, Tarikere Taluka

Groundnut is an important oilseed crop grown in some parts of Chikkamagaluru District during the pre-monsoon showers during May. The sowing operation starts at the end of May. ICRISAT supplied ICGV 91114 variety to local farmers to evaluate the performance of the variety in order to upscale it to larger areas in the district. Of them, Mr Ranganatha obtained the highest yield for this variety when managed along with soil test-based micronutrient application. Mr Ranganatha cultivated ICGV 91114 on 0.3 ha land and he compared the performance with that of the local variety cultivated during the previous year. He found that the performance of the new improved variety was far superior to that of the local variety, obtaining nearly 33% higher yield (Table 16). He also found that the ICGV variety is short duration and yields good quality pods of high weight.

The comparison of the performance of improved vs local groundnut varieties revealed that proper management of groundnut cultivation with the package of nutrients (right kind of nutrients at the right time) increased the yield of groundnut compared to application of single micronutrient, and also yielded a higher profit (₹ 19573 ha^{-1} vs. ₹ 12740 ha^{-1}).

Table 16. Economics of improved varietal groundnut production in Tarikere Taluka

Variety	ICGV 91114	Local variety
Micronutrients (kg ha^{-1})	250 kg gypsum; 10 kg Zn; 5 kg B	8 kg Zn
Seed quantity (kg ha^{-1})	80	130
Seed treatment	Yes	No
Seed and seed sowing	3427	3260
Cost of fertilizer and labor (₹ ha^{-1})	6667	8000
Cost of weed management	3000	4000
Pesticide cost	1333	No
Cost of harvesting and threshing	10000	5000
Yield (t ha^{-1})	2.0	1.5
Price of groundnut (₹ kg^{-1})	220	220
Gross income (₹ ha^{-1})	44000	33000
Total cost (₹ ha^{-1})	24427	20260
Net income (₹ ha^{-1})	19573	12740

Documented by: KH Anantha (ICRISAT)

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Strengthening innovation platform and decentralized coordinated extension system

The use of mass media for agricultural extension was initiated on India's public broadcasting service (Doordarshan) in 1967 through a short segment on agriculture 'Krishi Darshan', which contributed greatly to transfer of agricultural knowledge to farmers. However, in a country that has a 60% agrarian population, efforts are falling short to strengthen the agriculture extension system (AES), with limited human resources being the main constraint. Various information communication tools (ICT) have been introduced to bridge the gap between knowledge generator and farmer. The Government of India has created a dedicated web portal for farmers that offers various agriculture-related services including agro-advisory, weather and market information. On similar lines, a few private organizations like Thomson Reuters and Indian Farmers Fertilizers Cooperative Limited (IFFCO) - Kisan Sanchar Limited (IKSL) have also initiated smart services for the farming community. The rapidly evolving information technology industry and favorable environment for ICT in agriculture has boosted agricultural extension activities to a large extent.

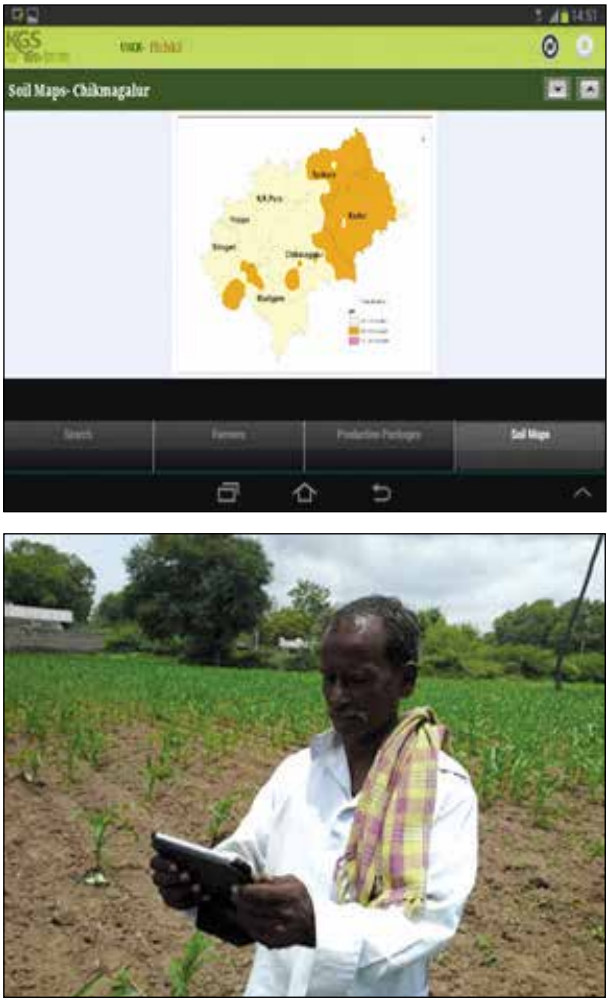

Figure 29. Screenshot of soil fertility map in KGS application. Farmer facilitator using KGS app on tablet device.

Integrated Mobile Applications

Krishi Gyan Sagar

Krishi Gyan Sagar (KGS), an android-based app, was designed to help in knowledge sharing from laboratory to farmers as well as for information collection from farmers to laboratory. The KGS has two platforms for two different user groups. The first part is an android app, designed as an information dissemination and data collection tool. The primary users for this app are farmer facilitators (FF). Each FF has jurisdiction of about 500 ha, which typically covers one or two villages. Once logged in, FFs can access information available via the KGS app and advise farmers. In addition, they can capture details of ongoing farming activity using various options available in the app. Availability of information in app is restricted based on the jurisdiction of the logged-in user. The other platform of KGS is the web application. Both the android app and the web app are backed by a common database server that stores data from remote users as well as the database administrator. The web app is more useful for policymakers and development agents for monitoring and report generation. Web app users can generate query based reports from data captured by FFs at field level.

Documented by: Mukund Patil, KH Anantha and Mohammad Shafi Korabu (ICRISAT)

Krishi Vani

Krishi Vani is a mobile phone/phablet based application. The Krishi Vani platform was initiated in collaboration with IKSL and Bharti Airtel, and has been piloted in 171 villages from Telangana and Karnataka, benefiting 40,000 farmers. Through this application, developed by IKSL and enabled by Green SIM from Airtel, generic advisories are delivered to groups of farmers in specific locations. These SIM cards are specially configured for receiving voice messages and other agro advisory services. Every day, four free voice messages are delivered to the subscribers. The contents of these voice messages is advised by subject matter specialists and cover diverse areas like soil management, crop management, dairy and animal husbandry management, horticulture and vegetable management, plant protection, market rates, weather forecast information, human and cattle health, employment opportunities and government schemes.

Dissemination from farmer to farmer through videos

In addition, for the effective dissemination of good management practices a farmer-to-farmer (F2F) dissemination route is being explored through a farmer-centric video documentation. Digital Green (http://www.digitalgreen.org/) is the technology partner for this innovative dissemination route. The advantage of the F2F system is that farmers trust the advice of fellow farmers to adopt improved management practices. Also, since the videos are made in the local languages, farmers can easily understand these. This system has two processes, video production and video screening. The subjects of the videos are decided based on location, crops, and stage of the crop. Since these videos are accounts of real life stories, the field staff identify the progressive farmer who has adopted the particular improved agricultural practice. The farmer shares his/her experience about the technology on camera, while the FF plays a supporting role as an interviewer. The interviews are scripted in such a way that they duration of the video is short. However, the message conveyed is very clear so that other farmers can easily adopt the technology. Digital Green has trained ICRISAT staff in the video production process.

The processed videos are given to the FFs, along with battery operated portable projectors (PICO projector) and necessary accessories, for screening in the villages. The FF screens the video to small gatherings of about 20-30 farmers. At the end of the video screening, the FF collects feedback from farmers regarding earlier videos they have been shown. The feedback system also captures the adaptation rate of screened technologies. Digital Green has developed an online/offline data management framework (COCO) that captures data related to the key processes of the Digital Green approach – video production, dissemination and adoption of practices. Altogether, 48 videos were produced by ICRISAT staff and were screened in target villages by FFs. Based on the feedback from the farmers, one in seven farmers has adopted the screened technology.

Figure 30. Screenshots of You tube video demonstrating use of trichoderma and pheromone traps.

Table 17. List of videos produced for farmer to farmer dissemination

S.No	Districts	Video identified
1	**Chikkamagaluru**	RSK benefits to farmers in Chikkamagaluru
2		Seed germination test of green gram using paper.
3		Application of Trichoderma in tomato field
4		Bhoochetana scheme: farmers experience in Chikkamagaluru
5		How to take a soil test sample
6		Finger millet seed treatment using azospirillum
7		Potato seed treatment using Trichoderma
8		Importance of micronutrients for field crops
9		Seed availability in RSK
10		Demonstration of Tropicultor
11	**Raichur**	Neem oil application in paddy field
12		Pheromone trapping in pigeonpea crop
13		RSK benefits to farmers in Raichur
14		Installation of yellow trap in cotton field
15		Sorghum seed hardening method
16		Groundnut seed treatment
17		Sorghum seed treatment
18		Precautions before handling pesticides
19		Bhoochetana Scheme in Raichur
20		Bhoochetana Scheme: Farmers' & Farm Facilitators' experience
21		Benefits of vermicompost
22		Germination test for paddy and red gram _ Raichur
23	**Bijapur**	Fertilizer quality testing
24		Importance of micronutrients
25		Plastic mulching in brinjal crop
26		Soil test
27		Summer plowing
28		Integrated Farming System
29		Seed germination test of green gram using paper
30		Raitha Samparka Kendra benefits to farmers
31		Seetani (Sihitene) preparation
32		Sulakai cultivation
33		Guava cultivation
34		Pigeonpea seed treatment
35		Groundnut seed treatment
36		Maize seed treatment
37	**Tumkur**	Banana bunch feeding for high yield in Tumkur
38		Sorghum seed treatment
39		Red gram seed treatment
40		Bhoochetana impact on field crops
41		Raitha Samparka Kendra benefits in Tiptur
42		Importance of fertigation in Coconut plantation
43		Coconut planting method
44		Integrated Disease Management
45		Banana Special Spray
46		Application of Trichoderma
47		Importance of soil sampling
48		Intercropping in coconut plantation

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CGIAR

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

ICRISAT works in agricultural research for development across the drylands of Africa and Asia, making farming profitable for smallholder farmers while reducing malnutrition and environmental degradation.

We work across the entire value chain from developing new varieties to agri-business and linking farmers to markets.

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