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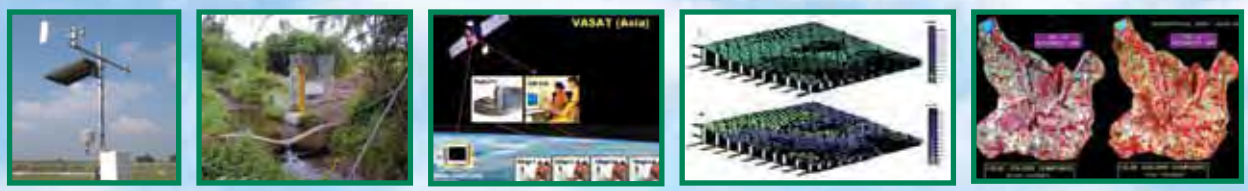

Use of High Science Tools in Integrated Watershed Management

Proceedings of the National Symposium

ICRISAT
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International Crops Research Institute for the Semi-Arid Tropics

A Mission to Enhance Productivity of Rain-fed Crops in Rain-fed Districts of Karnataka, India.

KV Raju[1], M Babu Rao[1], KV Sarvesh[1], NC Muniyappa[1], Abhijit Dasgupta[1] and Suhas P Wani[2]

[1]Government of Karnataka (GoK), Karnataka, India

[2]International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)
Patancheru 502 324, Andhra Pradesh, India

Background

Water shortage is a major constraint for rain-fed crop production and a chief cause of poverty and hunger in the semi-arid tropics of the world. Over 95 per cent of the world's poor and malnourished people live in India, China, the Eastern and Sub-Saharan Africa and parts of Latin America. Rain-fed agriculture is practiced on 80% of the world's farm area, and generates almost 60% of the world's staple foods, providing the livelihoods of 80 per cent of the world's population. In India, 40% of the population depends on rain-fed agriculture, which is cultivated 85 million hectares, and produces 44% of food and fodder requirements for the country. Rain-fed areas in India covering 60% of agriculture produce 75% of pulses and more than 90% of sorghum, millet, and groundnut. These areas are the hot spots of poverty, suffer from water scarcity and droughts, land degradation and low rainwater use efficiency.

Rain-fed agriculture productivity is crucial for food security and economy of even Karnataka state as it has the second largest rain-fed area in India after the state of Rajasthan. Crop yields in the rain-fed areas are from 1 to 1.5 t ha^{-1}, which are two to five times less than those on research farms (Wani et al. 2009). Only 35% to 45% of rainwater is presently used to grow dryland crops in the state. Hence, there is huge scope for improving rainwater harvesting and efficient use of it for rain-fed crops. Scientific technologies including better cultivars could unlock the vast potential of rain-fed agriculture.

A study undertaken by (Singh et al. 2009) at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) reveals that a large gap exists between current farmers' crop yields and potential yields. This is the case with all the major rain-fed crops (finger millet,

groundnut, maize, sorghum and soybean) grown in Karnataka. The good news is that use of modern technologies has increased crop yields by two to three fold.

Science for Agriculture: ICRISAT and Sujala Watershed Project

Watershed Development Department of Karnataka had supported a community-driven watershed project across the six selected districts (Kolar, Tumkur, Madhugiri, Chitradurga, Haveri and Dharwad) in collaboration with ICRISAT. The project known as "Sujala-ICRISAT Productivity Enhancement initiative" covered over 3500 ha in 46 watersheds of the six selected districts during 2005-2008 crop seasons and adopted the consortium approach. Stakeholders, including state government departments, non-governmental organizations, farmers' organizations and women's self-help groups, were brought together to improve understanding on crop, water and soil management skills of farmers.

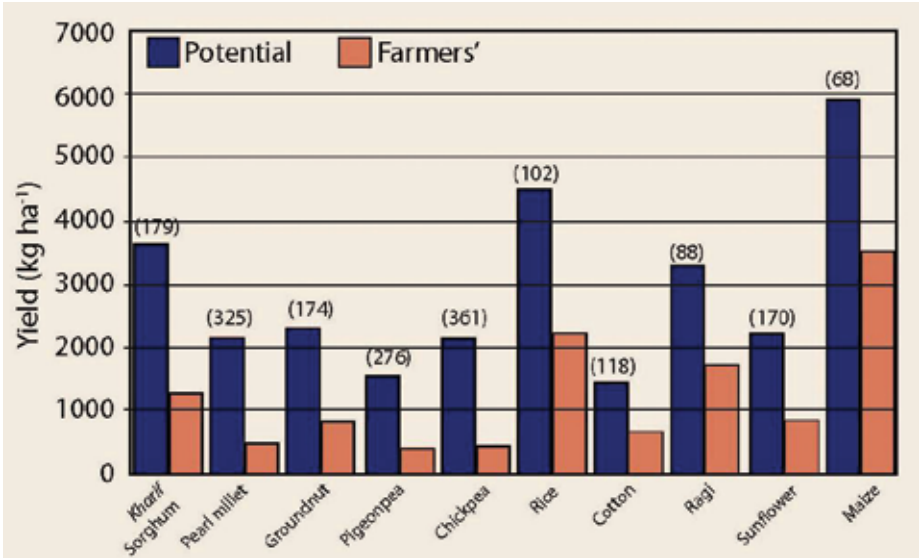


Figure 1. Yield gaps between farmers' field crop yield and potential yield of various dryland crops in Karnataka. (Source: Bhoochetana booklet (2009).

Soil Nutrient Diagnostic Studies

Soil sampling of over 11000 farmers' fields in the Sujala watersheds and their analyses for soil nutrient status revealed that soils in Karnataka desperately need not only water but also vital nutrients (Sahrawat et al. 2007). These soils were deficient in nitrogen, phosphorus, sulfur, zinc and boron, as well as low in organic carbon. Potassium deficiency was not a problem in the six districts. Spatial distribution of nutrients was also assessed using GIS techniques and prepared maps for the benefit of farmers and policy makers.

Bridging the Yield Gap

Through farmers' participatory field evaluation, the Sujala-ICRISAT initiative identified the best management options to increase crop productivity in watersheds of various districts in Karnataka. Better nutrition along with improved cultivars, integrated pest management and land and water management practices increased yields of various crops by 33-58% (Table 1) in spite of the poor rains during 2008 crop season (Progress Report 2008-09 Sujala-ICRISAT project, 2009).

Encouraged by the successes and lessons of the Sujala-ICRISAT initiative, Government of Karnataka (GoK) embarked on the path-breaking project 'Bhoochetana' in mission mode named as Bhoochetana for strengthening rain-fed farming and enhancing crop productivity in many more districts.

Table 1. Crop yield increase in farmers' fields of Karnataka with improved management compared to farmers' management during *kharif* crop season 2008. (Source: Progress report 2008-09, Sujala-ICRISAT project, 2009).

	Grain yield (kg ha^{-1})		
Crop	Farmers' management	Improved management	% yield increase in rain-fed crops
Ragi	1750	2770	58
Groundnut	1300	1940	49
Maize	4760	6490	36
Soybean	1225	1635	33

Goal and Objectives

The goal of Bhoochetana project is to make a difference in the lives of dryland farmers in 24 districts of Karnataka, including the six districts covered under the Sujala-ICRISAT initiative, by increasing average crop productivity by 20% in four years. The objectives of Bhoochetana are:

- to identify and scale-up best bet options (soil, crop and water management) including improved cultivars to enhance productivity by 20% for the selected crops in the selected 24 districts.
- training Department of Agriculture (DoA) staff to perform stratified soil sampling, analyze micronutrients, and prepare GIS-based soil maps. Also, provide guidance to DoA to establish a high-class soil analysis laboratory in Bangalore and Mandya.
- improving skills of farmers and other consortium partners in the sustainable use of natural resources. Stakeholders will also be trained to raise the productivity of dryland farms through best practices.

Strategies

To boost crop yields in rain-fed areas of Karnataka, DoA worked together with partners on a mission-mode, and decided to consolidate the gains of the Sujala-ICRISAT project in the six selected districts during the first year of Bhoochetana project. We adopted Integrated Genetic and Natural Resource Management approach that looks after the entire 'seed to food' chain with participation of Karnataka state Department of Agriculture, Watershed Development Department, Government of Karnataka, International Crops Research Institute for the Semi-arid Tropics (ICRISAT), Patancheru, Andhra Pradesh, India, University of Agricultural sciences, Bengaluru, Dharwad and Raichur, non-governmental organizations, community-based organizations, watershed committees, and farmers, in a consortium approach (Figure 2).

Government of Karnataka constituted a state level coordination committee (SCC) for Bhoochetana program which is headed by the Additional Chief Secretary & Development Commissioner to review the performance of the program at regular intervals. State level committee reviews the progress of project activities and interacts with district level

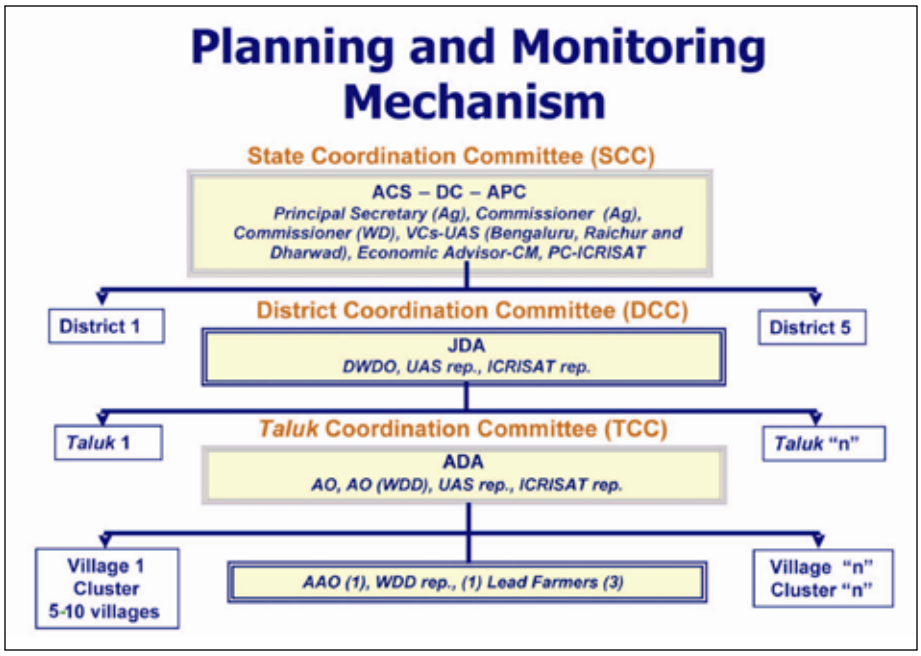


Figure 2. Organogram of project planning and monitoring mechanism set-up for Bhoochetana project, Karnataka.

officials instantaneously through video-conferencing and take stock of solutions to address problems arising in the field and issue directives to each district.

Timelines were defined clearly for encompassing activities of soil sampling and nutrient analysis mapping, capacity building of stakeholders, and productivity enhancements in 24 districts (Map 1) during the project period as shown in Table 2.

In addition to the strength of convergence through consortium, the mission has planning and monitoring mechanism at cluster, *taluk*, district and state levels. The mission has simple principle of accountability and delegation of authority at different levels without diluting the individual accountability in order to meet the mission goal collectively.

Besides, the mission intends to adopt rewarding mechanisms for the best performers i.e., the farmers at cluster, *taluk*, district and state levels with appropriate personal recognitions. Similarly, the mission staff who

Map 1. Selected rain-fed districts for crop productivity enhancement under Bhoochetana project in Karnataka.

Table 2. Timeline for execution of activities in Bhoochetana districts.

		% activity coverage in districts		
Activity	Year	1-6	7-15	16-24
Productivity enhancement	2009	25	-	-
	2010	50	33	-
	2011	75	66	50
	2012	100	100	100
Nutrient status mapping	2009	100	-	-
	2010	-	100	-
	2011	-	-	100
	2012	-	-	-
Capacity-building	2009	100	-	-
	2010	-	100	-
	2011	-	-	100

exhibit outstanding performance will also be recognized by the state government. To fetch complete information from cluster villages, *taluks* to district, weekly reports on progress of the activity were prepared by ICRISAT and ensured that the follow-up weekly reporting synchronized from JDA office and ICRISAT staff.

Rain-fed Agriculture Technologies for Implementation

ICRISAT with 35 years of experience in watershed research, especially after gathering farmers' evaluation locally on science-based methods in the Sujala project, is best suited to support Bhoochetana. Following rain-fed farming technologies have been implemented to increase productivity in the Bhoochetana project:

1. *In-situ* soil moisture conservation techniques

In-situ soil moisture conservation techniques like (a) contour cultivation across slope which is the most common practice for conserving soil moisture. In this method, all field activities including ploughing, planting and intercultivation are done across the slope; (b) contour furrows are a simple and efficient method to conserve moisture. They are laid with the help of country ploughs on a gradient of 0.2-0.4% at the time of sowing. (c) Broad-bed and furrow (BBF) system on Vertisol - a system of broad bed (1m) and furrow (0.5m) cultivation at 0.6% slope - is advocated for draining out excess water as controlled runoff, and furrows act as traffic zone. Raised beds facilitate good aeration for root growth and stores more soil moisture that supports good crop growth for longer period, which suits well for groundnut cultivation on Alfisols.

2 Integrated Nutrient Management

Stratified random soil sampling in farmers' fields and subsequently, results of soil analysis that tell macro and micronutrients status in soil samples of their fields were discussed. Farmers were given soil health cards, which show the nutrient status of their fields along with fertilizer recommendations for different crops. Basal application of micronutrients (sulphur, boron and zinc) on major crops was discussed with farmers in

village meetings in the first year of Bhoochetana. Field facilitators, who were hired by the Department of Agriculture to raise awareness of best agricultural practices, initiated the meetings. Seeds, micronutrients and fertilizers (nitrogen, phosphorus and potash) were supplied to farmers at incentivized rates at the beginning of the season. Biofertilizers which are low-cost, eco-friendly organic agro-inputs, supplementary to the chemical fertilizers like *Rhizobium, Azospirillum*, Azotobacter, which add nitrogen to the soil, and phosphate-solubilizing bacteria were supplied to farmers. Phosphate Solubilizing Bacteria (PSB) and *Trichoderma viride* were applied to soil in Bhoochetana project. Seed treatment along with *Rhizobium* and fungicides were not suggested for groundnut and soybean. *Gliricidia* on field bunds were advised as the plant produces green leaf manure rich in nitrogen and thereby adds organic matter to the soil. It also helps prevent soil erosion. Preparation and application of vermicompost, a natural fertilizer was also advised to improve the health and fertility of soil.

3. Farmers' preferred varieties

High-yielding short duration varieties of major dryland crops, which were evaluated by a large number of farmers in the Sujala-ICRISAT project and found advantageous for the six districts, were recommended for cultivation. Ragi varieties assessed by farmers were GPU 28, MR 1, HR 911 and L 5. Farmers of Kolar, Chikballapur, Tumkur and Chitradurga districts found L 5 and MR 1 suitable for their fields. Short duration varieties of groundnut ICGV 91114, GPBD 4, Kadiri 1375 and Kadiri 6 were evaluated by a large number of farmers. ICGV 91114 met the approval of the farmers in Kolar, Tumkur and Chitradurga while GPBD 4 was found suitable for Haveri and Dharwad districts where it rains better. Soybean cultivars JS 335 and JS 93-05 were evaluated by farmers. JS 93-05 showed good growth and was found to give high yields despite a drought. The variety has been introduced in three districts due to farmers' preference.

4. Integrated pest management technologies

Farmers across districts were trained in pest control using pheromone traps, cultural practices, tolerant cultivars and biological methods. To

check the spread of insect Helicoverpa, the primary pest on pigeonpea, farmers were advised to spray nuclear polyhedrosis virus (NPV) on early instars. This is a cost effective and eco-friendly biological method of controlling pests. Later at the flowering and pod-filling stages, farmers were advised to shake the larvae off the crops.

5. Custom hiring centers for agricultural machinery

Tropicultor is a bullock-drawn, multipurpose field machine, developed by ICRISAT. Cheaper than a tractor, a tropicultor can attach to itself various implements for ploughing, ridging, sowing, harrowing and application of fertilizers. Fast operation, reduction in labour charges and saving in seed and fertilizer costs are other advantages. The machine also ensures the placement of seeds and fertilizer in the fields at proper depth for better crop growth.

Tropicultors and Penugonda ferti-cum seed drill (kurgi) were placed in the control of each ADA to provide them for needy farmers on hiring. This approach helped farmers who can not afford to buy them in the season, but use them based on their operational efficiency and to reduce dependence on labor for timely operations like sowing cum fertilizer application.

6. Income-generating rural livelihoods

Village seed banks were put up in the Sujala-ICRISAT watersheds during the 2005-2008 sowing seasons. Bhoochetana is now setting up many more seed banks in several villages of the six selected districts. This will increase the availability of the preferred varieties of ragi, groundnut and soybean.

Project Activities

Capacity Building of Stakeholders

A team building workshop was conducted in Bengaluru which saw a participation of more than 75 staff of commissionarate of WDD and Department of agriculture along with senior agricultural officers from

six districts on 2nd May 2009. As many as 19 district-level trainings with participation of 1128 officials; sixty eight *taluk* level trainings with participation of 930 field staff and facilitators, and 1806 village level trainings with participation of lead farmers and rural poor were organized in these six districts where government officials, field facilitators and lead farmers learnt about technological advancements in agriculture.

Awareness and Field Publicity Campaigns

The DoA staff ensured wall writings and exhibition of posters in all villages within short period before the on-set of monsoon, indicating the main objective of the program and areas to be covered by the program. Additionally, thousands of brochures and handouts were published in each district on improved management practices, information on nutrients status, nutrients recommended *taluk*-wise and widely distributed in all selected districts. Print media news coverage was extensive to introduce Bhoochetana program to farmers and also on activities during the season in all districts besides field facilitators and lead farmers contacts with individual farmers in selected village.

Awareness Building on Soil Nutrient Status

ICRISAT sampled soils of 25% of fields in each watershed. The method was scaled up by using Geographic Information System (GIS) to produce soil maps of the six districts. Soil sampling and mapping helped farmers diagnose nutrient deficiencies in their fields and turned them into eager partners in this mammoth development project.

Soils samples from around 11000 farmers' fields in several *taluks* of each district were collected in six districts during 2008, and were analyzed for diagnosing macro and micronutrients status of farmers' fields. Based on the established critical limits for each nutrient, fields were categorized as deficient or sufficient. Individual farmers were provided soil health cards in Kannada based on the mean nutrient status in the soils of the village as the soils analyzed were representative of the soils in the village. Soil nutrient status maps were provided for each district using GIS based extrapolation techniques for the benefit of policy makers. In 2009, more than 35460 soil samples were collected from 1773 villages

in nine new districts were analyzed and soil nutrient status maps of the each district were provided by ICRISAT.

Assisted in Setting up Analytical Laboratory

Department of Agriculture, Government of Karnataka, showed interest to upgrade their Soil Testing Laboratories in order to meet the growing demand for soil analysis under Bhoochetana initiative. ICRISAT has commitment in this project, to assist DoA based on its own expertise to set up soil analytical laboratory that can meet the international standards and also to handle large number of samples analyses. ICRISAT scientists evaluated the facilities guided by senior staff of DoA and had discussions with Director of Agriculture. They submitted their assessment and recommendations for upgradation and integration of required facilities with these laboratories.

Scaling-Up Soil, Crop and Water Management Technologies for Boosting Productivity of Selected Crops

Kharif Season Rain-fed Crop Planning 2009

On thorough consultation, Department of Agriculture, University of Agricultural Science, Bengaluru, Dharwad, Raichur and ICRISAT arrived at a consensus on identified major crops in the selected 24 target districts of Karnataka considering the historical annual crop statistics published by Directorate of Economics and Statistics, Government of Karnataka, for enhancing productivity of major dryland crops in each selected district.

In each district, 25% of the cultivated area under two selected crops was identified in clusters of Sujala watershed villages (Table 3) and farmers were motivated about the project and possible benefits for participating in the technology uptake of the project. Technology input kits containing improved seeds, quality organic manure, bio-fertilizers (*Trichoderma, Azospirillum*), borax, gypsum, zinc sulfate, *neem* oil and endosulfan pesticide were made available by DoA at incentivized

Table 3. *Kharif* season cropping planned and actual area sown during 2009 in six districts.

District	Crop	Target area crop-wise (ha)	Total areas sown (ha)	% area sown
Kolar	Groundnut	3500	2800	80
	Ragi	15000	8635	57.6
Chikkballapur	Groundnut	12500	12203	97.6
	Ragi	10000	9350	93.5
Tumkur	Groundnut	35000	18200	52.7
	Contingent crops		13708	39
	Ragi	20000	19830	99
Chitradurga	Groundnut	33000	17308	52
	Ragi	10000	9850	99
	Maize	20000	19883	99
Haveri	Groundnut	6000	6000	100
	Maize	38000	38000	100
Dharwad	Groundnut	10000	10000	100
	Soybean	12000	12000	100
Total		188000	159546	

rates. Coordination with DoA staff for inputs mobilization, especially expediting the procurements or placing inputs at the disposal of field staff for easy distribution to farmers timely was harmonized. ICRISAT facilitated timely procurement of groundnut (ICGV 91114), pigeonpea cultivars, *bajra* hybrids and soybean cultivars by DoA.

Initial monsoon on-set rains and good follow-up rainfall helped farmers in Haveri and Dharwad to take up sowings of 100% target area under major crops in the districts. However, difficult conditions of low rainfall and long break in the months of June, July and August in Kolar, Chikkaballapur, Tumkur and Chitradurga were responsible for a suggestion of contingency crop planning to farmers by ICRISAT and DOA. Further staggered sowing opportunities in these districts were responsible for non-compliance of groundnut sowing in 100% target area. However, farmers turned the short fall in crop areas to good with contingency crops in these districts.

Rabi Cropping Targets 2009

Rain-fed *rabi* crops were successfully sown in Chitradurga, Haveri and Dharwad, covering 77-100% of target areas in the three districts (Table 4).

In Chitradurga, Haveri and Dharwad, vertisol areas provide opportunity for post rainy season rain-fed crops due to stored soil moisture in the profile. Predominant *rabi* season crops in the area are chickpea, *rabi* sorghum and sunflower with life supporting irrigation. The area planned with these crops for production enhancement is given in Table 4. Nutrient recommendations were prepared by ICRISAT based on the nutrient status of soils in each *taluk*. Nutrient recommendations of N, P, and K for different crops were based on DoA data and boron, zinc and sulfur recommendations were based on ICRISAT evaluations in the farmers' fields. DoA and ICRISAT staff coordinated efforts were rendered to support farmers by supplying inputs like seed, fertilizers and insecticides timely in the mission project and were successful in achieving target upto 78% in case of late sown sorghum. However, 90 to 100% targets of sowing was achieved with regard to soybean, chickpea and sunflower.

Table 4. *Rabi* cropping planned and area of sowing completed in different districts during *rabi* season 2009.

District	*Taluk(s)*	Crop(s)	Target area (ha)	Area covered (ha)
Chitradurga	Chitradurga, Hiriyur	Chickpea	5840	5302 (91.5%)
Dharwad	Dharwad, Hubli, Kundagol, Kalghataki, Navalgund	*Rabi* sorghum	18000	13990 (77.72%)
	Dharwad, Hubli, Kundagol, Navalgund	Chickpea	16500	16500 (100%)
Haveri	Haveri, Hirekerur, Savanur	Sunflower	3000	2654 (88.47%)
	Haveri, Hirekerur, Savanur, Shiggao, Ranebennur, Byadagi	*Rabi* sorghum	16000	14550 (90.93%)

(Source: Annual Progress Report 2009-10, 2010)

Field Days

Field days were conducted for groundnut farmers in Kurubaramalluru village on 17th September 2009 and for maize farmers in Kabur village on 12th September 2009 in Haveri district. DoA staff along with C M Udasi, the Hon. Minister of Public Works Department visited the fields of Haveri and observed a clear improvement in crop growth and yield, as a result of technology interventions in the Bhoochetana project.

Kharif Season Crop Planning 2010

During *kharif* 2010, the project was scaled out in nine new districts for production enhancement of rain-fed crops after soil diagnostic studies and awareness campaigns to farmers and other stakeholders about soil health in these additional districts. A target of 11 lakh hectares were almost covered with improved production enhancement technologies as a package in as many as 5038 villages in 16 districts of Karnataka.

Results of Participatory Crop Yield Estimates

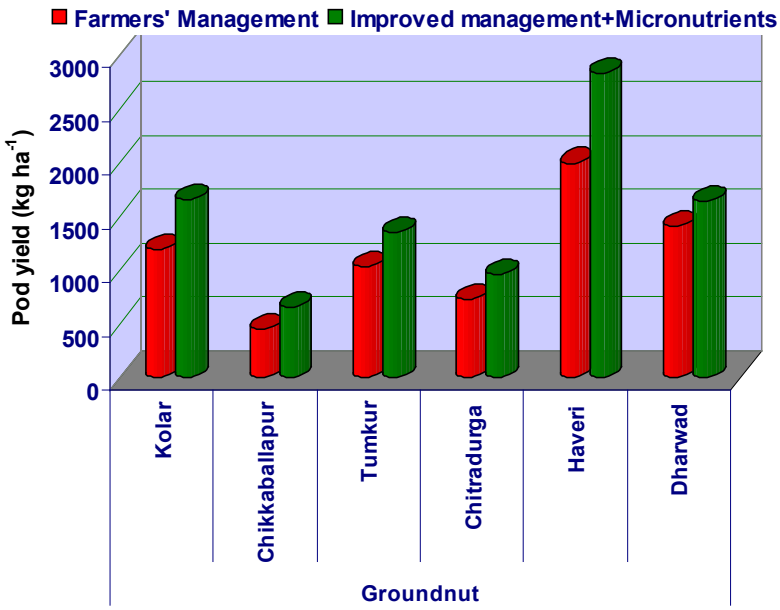
Crop Season 2009

Rainfall in all the six districts was monitored, and it was erratic with early monsoon showers, followed by long dry spell extending up to 52 days in Kolar, Chikballapur, and Tumkur, affecting crop performance. In Haveri and Dharwad, rainfall distribution was normal during the season. However, heavy rainfall at the end of season when the crops were reaching maturity had affected crop harvesting. Participatory crop cutting experiments by a joint team of officials of DoA, UASs and ICRISAT undertook the crop cutting experiments along with participation of farm facilitators, individual farmers and stakeholders recorded observations in the farmers' practice as well as improved management in farmers' fields of five villages in each of all the six districts for yield estimation for selected crops.

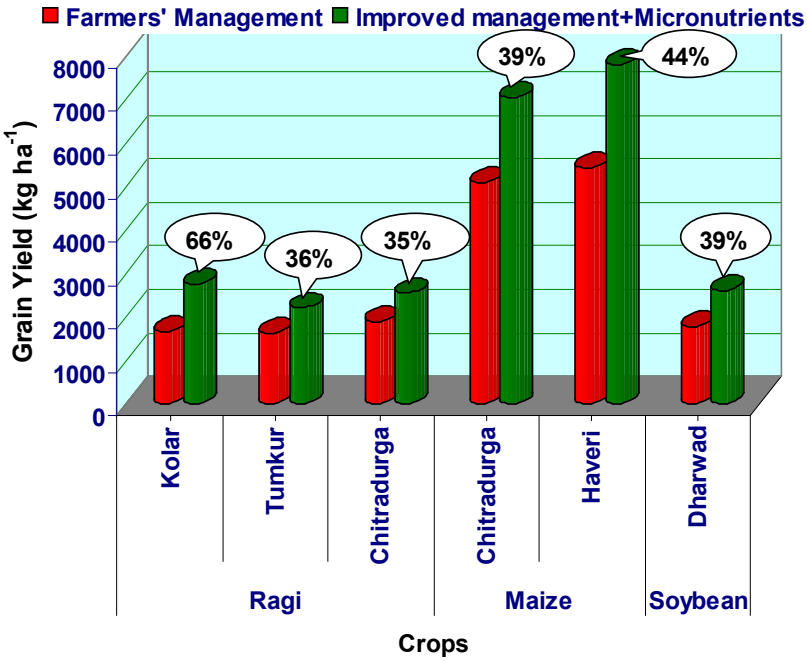
With Bhoochetana initiative, groundnut pod yields increased across all *taluks* of six districts in the range of 32% to 41%, which varied from the lowest increase of 18% in Mulkalmur *taluk* of Chitradurga to the highest

yield increase of 52% in Hubli *taluk* of Dharwad district. Ragi farmers harvested an additional one ton of grain yield and 1.5 t ha^{-1} of fodder by adopting improved management along with balanced nutrition in Kolar. Weighted mean grain yield increase across Kolar, Tumkur and Chitradurga districts varied from 35% to 66%.

Maize grain yield increase in farmers' fields with improved management was between 37-51% in different *taluks* of Haveri and 22% to 45% in different *taluks* of Chitradurga. On an average, farmers harvested grain yield of 1.5 tons and 3 t ha^{-1} of fodder additionally with improved management "balanced nutrition" compared to grain and fodder yields with farmers' management in Haveri. In Dharwad, farmers harvested grain yields in the range of 1480 to 2990 kg ha^{-1} with improved management and the seed yield increase across the district was 39% over farmers' management.



Groundnut pod yield increase (district-wise) with improved management compared to farmers' management in six districts of Karnataka during kharif 2009.(Source. Annual Progress Report 2009-10, 2010)



Grain yield increase in selected crops (district-wise) with improved management compared to farmers' management in five districts of Karnataka during kharif 2009. (Source. Annual Progress Report 2009-10, 2010)

Intense monitoring by state level high-power coordination committee at regular intervals, facilitated by ICRISAT to ensure good coordination of all stake holders to implement technologies in the project, resulted in successful implementation and crop yield increases between 35%-66% for farmers across six districts in the first year.

During *rabi* season 2009, chickpea seed yield increased by 23% in Chitradurga, sorghum grain yield increased by 43% in Haveri and 51% in Dharwad districts with improved management over farmers' management. Sunflower seed yield increased by 38% with improved management compared to farmers' management. Actual yield increase was about 300 kg ha^{-1} with sunflower or chickpea.

Table 5. District-wise crop yield increase in farmers' fields with improved management compared to farmers' management under Bhoochetana project, 2009.

Crop	District	Farmers' management	Improved management + Micronutrients	% yield increase
Groundnut	Kolar	1190	1660	41
	Chickballapur	460	660	43
	Tumkur	1030	1350	32
	Chitradurga	730	960	32
	Haveri	2000	2830	41
	Dharwad	1410	1640	35
Ragi	Kolar	1660	2750	66
	Tumkur	1630	2210	36
	Chitradurga	1890	2550	35
Maize	Chitradurga	5080	7040	39
	Haveri	5420	7800	44
Soybean	Dharwad	1580	2190	39

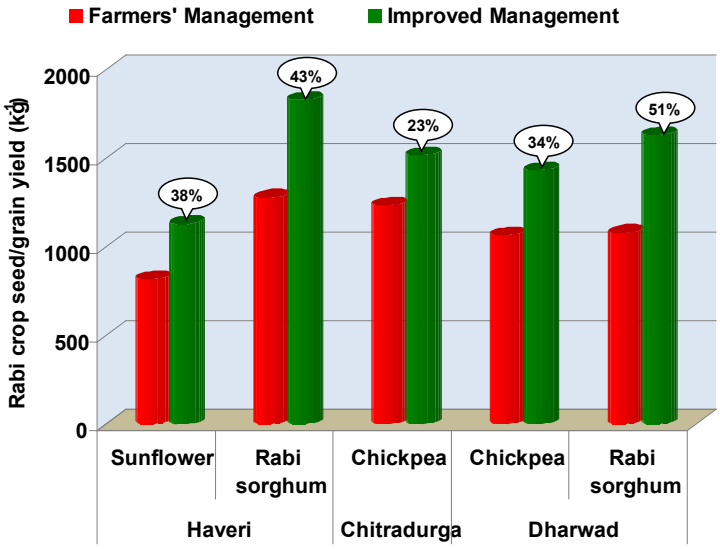
Increased Crop Yields and Economic Gains

We estimated additional economic grains to farmers by investing in application of micronutrients additionally as recommended based on nutrient deficiency diagnosis. Total additional investment made on application of boron, zinc and sulphur was Rs. 1435 per hectare. Total additional income obtained by multiplication of additional grain harvested per hectare with minimum support price per unit of grain (seed) for improved management. We calculated income per additional rupee invested by dividing total additional income with additional investment on micronutrient application. The additional income thus obtained by farmers in different districts was in the range of Rs 2.8 to 11.0 per additional rupee invested with selected rain-fed crops. Income gain to maize farmers on every additional rupee investment was higher in Chitradurga. Groundnut farmers economic gains on additional rupee investment was much lower at Rs.2.8 per rupee invested.

Table 6. Additional income to farmers on additional rupee invested for improved management during 2009 crop season

District	Crop	Crop yield in FM	Additional yield in IM	Additional income Rs.	Income per Rs. additional invested
Kolar	Ragi	1660	2750	9970	6.7
ChikkaBallapura	Groundnut	460	660	4200	2.8
Tumkur	Groundnut	1030	1350	6720	4.5
Chitradurga	Maize	5080	7040	16460	11.0
Dharwad	Soybean	1580	2190	8479	5.7
Haveri	Sunflower (*rabi*)	820	1130	6870	4.6

(Source: ICRISAT, 2010)

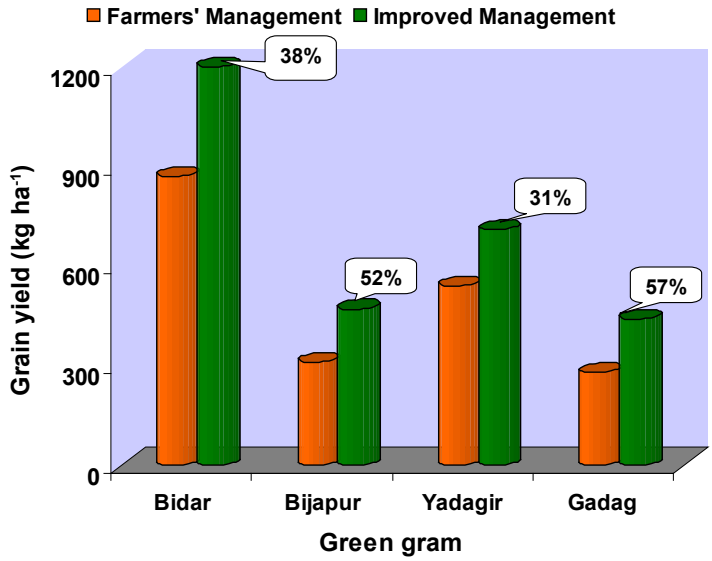


Grain yield increase in selected crops (district-wise) with improved management compared to farmers' management in three districts of Karnataka during kharif 2010. (Source. Annual Progress Report, 2010)

Crop Season 2010

During *kharif* season, rainfall has been above normal in all these districts, and in some districts. Short duration legumes and ragi are affected by incessant rains at harvesting and yield losses also mentioned by farmers. *kharif* crop harvesting and crop cutting experiment for yield estimations have beem completed in all sixteen districts. Early yield estimates for short duration crops like black gram, green gram, groundnut, soybean and ragi available hence presented in this paper to give a glimpse of rain-fed crops response to improved management during rainy season 2010.

According to early estimates available, groundnut pod yields increased by 33% and 35% respectively in Kolar and Haveri with improved management compared to farmers' management. Farmers in Haveri benefited by good crop harvest of nearly 3.5 t ha^{-1} of groundnut pod yield which was higher by 930 kg ha^{-1} in the improved management. Response of ragi crop to improved management in Kolar was very good with 46% grain yield increase and soybean seed yield increase was 25% over farmers' management in Haveri district.



Grain yield increase in green gram (district-wise) with improved management compared to farmers' management in four districts of Karnataka during kharif 2010. (Source. Annual Progress Report, 2010)

Green gram and black gram in North East or North West Karnataka districts were severely affected by terminal incessant rains, and farmers could not harvest the crop in time. Black gram mean grain yield in Bidar district was around 930 kg ha^{-1}under the farmers' management while it was 1230 kg ha-1 with improved management providing a yield advantage of 35% over farmers' management. Green gram crop yield in general this season was low with around 500 kg ha^{-1}. Grain yield difference between farmers' management and improved management ranged from 160 to 330 kg ha^{-1}. Crop response trends with improved management especially by the soil application of deficient micronutrients and introduction of new varieties, land and water management practices helped farmers to obtain significant higher yields and income from rain-fed crops in this project.

Conclusion

Bhoochetana is a unique project of Government of Karnataka in mission mode aimed at increasing crop productivity in 24 rain-fed districts of the state by 20 with the science-led consortium approach by converging all schemes of the government with capacity building and promoting cooperation. Expertise of international organizations like ICRISAT is harnessed for technical backstopping and forming the working consortium to harness the potential of rain-fed agriculture by taking science at the door step of the farmers. The mission mode project aims to increase productivity of selected rain-fed crops in 24 districts by 20 per cent in four years. It takes up the Integrated Genetic and Natural Resource Management approach to take care of the entire 'seed to food' chain by bringing improved agricultural technologies, seeds and other inputs to farmers' doorstep. Analysis of massive scale soil samples collected from farmers' fields in fifteen districts to map nutrient status of soils using GIS was big achievement in the right direction. Public-private partnerships (PPPs) to ensure backward and forward linkages to benefit farmers are envisaged in the mission mode project. A high level SSC to take quick decisions, plan, monitor and evaluate is ensuring that the program is implemented in a mission-mode. Farmer-friendly technologies besides improving soil quality helped farmers increase crop productivity in the range of 32 to 66% in rain-fed groundnut, finger millet, maize and soybean during *kharif* 2009. In *rabi* season

of 2009, chickpea seed yield increased by 23% and sunflower seed yield increased by 38% in Chitradurga, sorghum grain yield increased by 43% in Haveri with improved management compared to farmers' management. During crop season 2010, Bhoochetana project targeted scaling up of productivity enhancement of rain-fed crops in sixteen districts as planned on 11 lakh hectares in 5038 villages. The project created awareness of technologies and facilitated farmers' uptake of improved management inputs. Rainfall was good during the season to obtain higher grain yields in the range of 31-57% with green gram, 46% increase with ragi, 35% pod yield increase with groundnut and 25% seed yield increase with soybean in different districts of Karnataka with early crop yield estimates during 2010. Producing more food with less water is the way forward. Better water management can indeed lead to more food security and help achieve the millennium development goal of halving the number of hungry people by 2015. We have to cross lot of humps to reach the goal and realize the challenge to establish well oiled supply chain and capacity building mechanisms for millions of small farmholder across geographically spread districts. These results clearly demonstrated the power and the success of the science-led approach for unlocking the potential of rain-fed areas in Karnataka to achieve increased food production and increased incomes for millions of small farm holders.

Acknowledgements

We are thankful to Bhoochetana staff of DoA, staff of Watershed Development Department, staff of UAS, Bangalore, Raichur and Dharwad; staff of Rythu Samparka Kendras (RSKs) in each *taluk*, farm facilitators and farmers for their support and working as team for the successful implementation of the project in a consortium mode converging activities of other activities also into this project activity.

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