Annual Report
2015-16

Strengthening Bhoochetana: A Sustainable Agriculture Mission for Improved Livelihoods in Karnataka

Submitted to

Government of Karnataka

ICRISAT

INTERNATIONAL CROPS RESEARCH
INSTITUTE FOR THE SEMI-ARID TROPICS

Contents

ACRONYMS

BCMP	Bhoochetana Mission Program
KSDMC	Karnataka State Disaster Management Center
PR4D	Participatory Research For Development
FF	Farm Facilitator
LF	Lead Farmer
DoA	Department of Agriculture
R4D	Research for Development
SAUs	State Agricultural Universities
UoH	Horticultural University
WDD	Watershed Development Department
SCC	State Coordination Committee
KSSC	Karnataka State Seed Corporation
CBOs	Community Based Organizations
RSKs	Raithu Samparka Kendras
BBMPs	Best-bet Management Practices
SLCC	State Level Coordination Committee
AO	Agriculture Officer
ADA	Assistant Director of Agriculture
JDA	Joint Director of Agriculture
GoK	Government of Karnataka
CCE	Crop Cutting Experiments
AAO	Assistant Agriculture Officer
IP	Improved Practice
FP	Farmers' Practice

Executive Summary

In order to unlock the potential of agriculture in the state of Karnataka through science-led participatory research for development (PR4D), and to increase agricultural productivity and profitability for small farm holders, the Bhoochetana Mission Program (BCMP) was launched by the Government of Karnataka in 2013. During 2009-12, an ICRISAT-led consortium provided technical support to formulate, monitor and demonstrate science-led best management practices through Bhoochetana and crop yields were increased by 20 to 66 per cent by adopting holistic approaches. This was achieved through convergence of schemes, consortium of institutions, capacity building and collective action by all the stakeholders. BCMP covers dryland as well as irrigated crops grown in all 30 districts of Karnataka.

The goal of Bhoochetana is to operationalize an integrated and participatory-knowledge led integrated systems development approach. The objective is to increase agricultural productivity by 20 per cent in five years through convergence and better coordination among different agriculture, research-extension and development sectors in the state to sustainably improve the livelihoods of the farmers. Empowerment and capacity development is done with an approach that is knowledge-based, market-oriented and farmer-centric.

The specific objectives of the second phase of BCMP are:

1. To strengthen the Bhoochetana consortium to increase crop (irrigated and rainfed) yields by 20 per cent over the first phase of Bhoochetana within five years in 30 districts (Figure 1) of Karnataka through science-led development and new innovation systems.
2. To strengthen institutional mechanisms such as seed villages, village seed banks, participatory research for development (PR4D), supply of inputs, agricultural machinery hiring centers, farm extension through farm facilitators (FFs) and communication systems for small and marginal farmers in the state for the Department of Agriculture (DoA) through capacity development, convergence, collective action and partnerships.
3. To assess the impact of climate change in different agro-eco regions of the state in terms of anticipated shifts in the crop growing periods, water availability, major crop yields, and evaluate adaptation strategies for developing climate resilient farming systems.
4. To document the process of consortium functioning, learning, and impact of BCMP in terms of increased crop yields, institutional development and capacity building of different stakeholders in the state.

During the third year of BCMP (2015-16), an ICRISAT-led consortium provided technical support to the DoA of the Government of Karnataka to help it implement a number of improved technologies. During 2015-16, the state received deficit rainfall (-22%) from June to September. Fifteen districts received deficit rainfall of -21 to -41%. However, the week by week data revealed that, 81 taluks received deficit rainfall and two taluks received scanty rainfall. A number of capacity building courses in the area of climate change and adaptation strategies were conducted. In addition, improved management technology courses at the cluster, taluk and district levels were conducted for DoA officials, lead farmers and FFs by the

State Agricultural Universities (SAUs), Krishi Vignan Kendras, DoA staff and ICRISAT scientists. The objective was to train 1,35,413 participants through 3,667 village level, 169 taluk level and 55 district level capacity building courses.

In spite of erratic and scanty rainfall during the rainy season of 2015-16, crop yields increased by 17 to 33 per cent over the farmers' practice, with improved technologies. At the state level, on an average, cotton yield increased by 17 per cent whereas wheat yield increased by 33% over farmers' practice. At the district level, paddy yield increased by 11 to 28% with improved practices as compared to farmers' practice. Similarly, finger millet crop yield increased by 19 to 35%, groundnut crop yield by 18 to 30% and pearl millet crop yield by 21 to 30%. Detailed results of crop yields in various districts during the rainy and *Rabi* seasons of 2014-15 are also presented for all the districts. Overall, a net economic benefit of nearly Rs 146.48 crore was generated through increased crop yield by adopting improved management practices in different crops.

In summary, in spite of a deficit rainfall of 22% in the state, BCMP through science-led development by adopting a holistic approach benefitted the farmers through increased crop yields ranging from 17 to 33 per cent for various crops. Improved management options helped farmers build resilience when it came to variable rainfall. Crop intensification with green gram during the pre-rainy season, growing a new crop like castor in drought prone districts and the use of improved cultivars benefitted farmers immensely in the state.

Background

Karnataka is the second largest state in terms of rainfed area (nearly 70%) next only to Rajasthan. The rainfed areas in the state are characterized by low water availability, degradation of natural resources and frequent climatic aberrations (drought & floods) which ultimately result in low productivity in combination with poor mechanization and traditional farm practices. In order to enhance production and overcome the drudgery that results from the use of traditional farm practices and tools, farmers need to adopt new technologies. But in practice, farmers have limited access to information and knowledge about the wide range of technological alternatives available. They also lack education and credit facilities. Agricultural extension involves offering advice and sharing information. Farmers obtain information from several sources including the mass media, other farmers, extension services, training sessions, etc. Several efforts have been made in the public sector over the past few decades to initiate various reform measures and operational models to improve the organizational performance of the public sector extension system. Yet, the challenge of enhancing the relevance, efficiency and effectiveness of the agricultural extension system in meeting its organizational goals and objectives remains unresolved.

There is an urgent need to develop sustainable agricultural practices during intensification considering the vulnerability of the fragile rainfed agro-ecosystems. The intensification must be sustainable and should be able to build up the resilience of the systems and equip small and marginal farmers to cope with the impacts of climate change. The localized impacts of climate change need to be understood and assessed and the knowledge needs to be shared with the farmers.

It is in this context that BCMP was launched during 2009 and later implemented in all 30 districts of Karnataka. Since its launch, the Bhoochetana program has reached millions of smallholder farmers with new technologies to unlock the potential of rainfed agriculture and has become a huge success in the state.

Based on the success of BCMP, the GoK has decided to extend the science-led productivity enhancement initiative not only to rainfed crops in the 30 districts but also to irrigated crops in the state. This is the ideal time to harness the positive energy generated in the DoA and to adopt and institutionalize the science-led development approach in the state by bringing together knowledge-generating academic institutions like the four SAUs and the Horticultural University (UoH) and knowledge transforming agencies like the DoA to operationalize the Research for Development (R4D) approach in the state for the first time in the country.

Vision of the Bhoochetana Mission Program (BCMP)

The vision of BCMP is to sustainably improve the productivity of small and marginal farmers in the state by developing farmer-centric, science-led, inclusive, market-oriented integrated systems through a participatory development approach.

Mission Goal of BCMP

The goal of BCMP is to operationalize an integrated and participatory-knowledge led integrated systems development approach to increase agricultural productivity by 20 per cent in five years through convergence and better coordination amongst different agriculture, research-extension and development sectors in the state to sustainably improve the livelihoods of the farmers through empowerment and capacity development with a knowledge-based, market-oriented, farmer-centric partnership approach.

Objectives

The specific objectives of the second phase of BCMP are:

1. To strengthen the Bhoochetana consortium and thereby increase crop (irrigated and rainfed) yields by 20 per cent over the first phase of Bhoochetana within five years in 30 districts (Figure 1) of Karnataka through science-led development and new innovation systems.
2. To strengthen the institutional mechanisms such as seed villages, village seed banks, PR4D, supply of inputs, agricultural machinery hiring centers, farm extension through FFs and communication systems for small and marginal farmers in the state for the DoA through capacity development, convergence, collective action and partnerships.
3. To assess the impact of climate change in different agro-eco regions of the state in terms of anticipated shifts in the crop growing periods, water availability, major crop yields, and evaluate adaptation strategies for developing climate-resilient farming systems.
4. To document the process of consortium functioning, learning and impact of BCMP in terms of increased crop yields, institutional development and capacity building of different stakeholders in the state.

Consortium Partners

The consortium comprises the Karnataka State Department of Agriculture, with its Commissioner as the nodal officer for implementing the project. Other partners include:

- Watershed Development Department (WDD) with its Commissioner as the focal person to coordinate activities
- Four Universities of Agricultural Sciences (Bengaluru, Raichur, Dharwad and Shivamogga) in the state of Karnataka with their Vice-Chancellors as State Coordination Committee (SCC) members with supporting technical help from university scientists
- Karnataka State Natural Disaster Monitoring Center
- Karnataka State Seed Corporation (KSSC)
- Department of Economics & Statistics
- Krishi Vignan Kendras in the state
- Community-based Organizations (CBOs)
- Watershed Committees, user groups and watershed associations
- International Crops Research Institute for the Semi-Arid Tropics, (ICRISAT) for facilitation of improved technologies to all stakeholders along with participating farmers
- Private companies

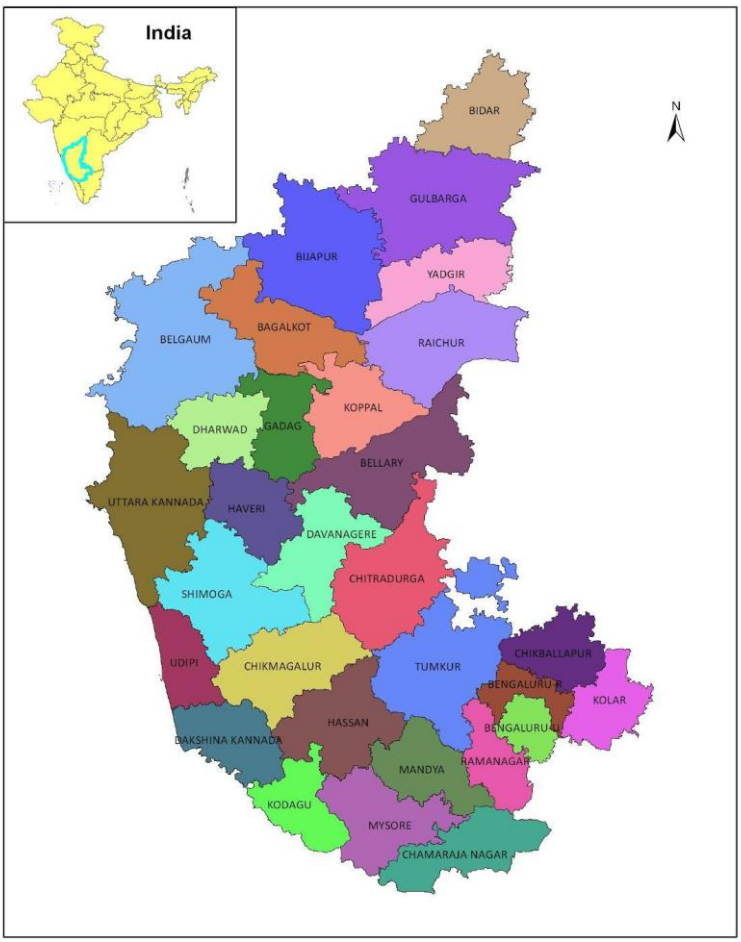

Figure 1. All thirty districts of Karnataka fall under Bhoochetana Phase Two.

Project Strategy

The most important strategy of the project is to expand and strengthen the consortium formed during the implementation of the first phase and to translate the mission mode project into BCMP. The principle of convergence that was tried and found satisfactory during the first phase will be institutionalized for successful implementation of the second phase, viz., the Bhoochetana Mission Project.

The salient strategies for the mission mode program are as follows:

The conversion of the mission project into a mission program will involve the institutionalization of the principle of *convergence* of the agriculture related development programs of different line departments through Bhoochetana. This is a long process as achieving successful convergence in the true sense calls for changing the mindset of different actors for which external drivers and enabling factors will be required.

The mission program adopts the principle of 4 ICEs.
Is: Innovative, Inclusive, Integrated, Intensification;
Cs: Collective, Cooperation, Capacity-Building, Consortium;
Es: Efficiency, Equity, Environment protection, Economic gain.

The consortium comprises knowledge-transforming development agencies such as line departments of the state government viz., DoA, KSSC, WDD, Department of Economics and Statistics (DES) along with knowledge generating academic and research institutions like SAUs, the UoH in the state, Karnataka State Disaster Management Center (KSDMC) and ICRISAT for improving the livelihoods of the rural poor in dryland areas.

ICRISAT leads the consortium and works with experts from the SAUs to address the issues of climate change. During the second phase of BCMP, the SAUs and the UoH need to play a more active role in supporting and institutionalizing the concept of convergence and consortium for capacity development.

The emphasis is strengthened through capacity development which includes not only building the capacity of human resources through training but also building the capacity of the institutions, networking and building partnerships through an enabling environment.

By adopting the principle of four Cs, we address the mission goal through four Es i.e., Efficiency, Economic gain, Equity and Environment protection, which are the important pillars of sustainable intensification and inclusive development in the state. The emphasis is on enhancing the efficiency of land and water resources along with the application of nitrogen fertilizer for sustainable intensification while maintaining the environment.

The approach of the mission is to strengthen backward linkages to meet the four Es through the four Cs by establishing seed villages, village seed banks, customized hire centers for agricultural equipment, ensuring timely supply, availability and access to the necessary vital inputs such as knowledge-based soil nutrient management options, acquiring micronutrients, availability of good quality seed and necessary financial incentives to undertake best-bet

options for increasing agricultural productivity through sustainable intensification. The institutionalization of CBOs and service providers is envisaged for enhancing the impact of BCMP.

The new extension system piloted in the state during the first phase of Bhoochetana using FFs and Lead Farmers (LFs) to share knowledge with farmers is being strengthened through empowered watershed assistants in the state. In addition, efforts will be made to enhance its effectiveness through capacity development and by building partnerships for substantial scaling-up of the improved best-bet management practices.

ICT-tablet based knowledge information sharing systems have been piloted in selected Raithu Samparka Kendras (RSKs) of four districts.

The scientific approach of mapping soil nutrient deficiencies that was initiated during the first phase of Bhoochetana needs to be continued further by monitoring the changes in soil fertility status after adoption of best-bet management practices for five years. This approach will not only increase the productivity of the land, water and applied fertilizers through sustainable intensification but will also reduce the cost of cultivation as farmers will be advised against applying fertilizers, that are not required for their soils.

Along with improving nutrient management, other best-bet practices such as rainwater management, pest management options and organic matter building practices will support long-term sustainability and enhance productivity. The convergence of the activities of WDD and the DoH will ensure increased water availability which is an important driver for sustainable intensification in the state.

The most important constraint in dryland areas is the establishment of good crop stand and availability of good quality seeds of high yielding, improved cultivars. The mission will emphasize integration of KSSC's seed production program under BCMP to ensure production of seeds of improved quality with best-bet management practices (BBMPs). It will also ensure timely supply of good quality seeds to farmers through establishment of seed villages and village seed banks for self-pollinated crops such as groundnut and chickpea as well as cross-pollinated crops such as sorghum and pigeonpea, by training farmers and providing producers with opportunities for value addition in the villages.

Building soil organic matter is a great challenge in tropical countries. Innovative measures undertaken by BCMP will help integrate income-generating activities sponsored under the integrated watershed development program (IWMP). Women and landless members of the SHGs and AGs will produce vermicompost and *Gliricidia* seedlings to increase soil organic matter. This will also increase the income of vulnerable groups in the villages.

The Mission Program will have planning and monitoring mechanisms at the cluster, taluk, district and state levels. The Additional Chief secretary and Development Commissioner (ACS&DC) is the chair of the State-level Coordination Committee (SCC) which includes decision makers from the different consortium partners including line departments to pass on suitable government orders to concerned mission staff. The SCC meets regularly to ensure smooth convergence and Capacity Building through institutionalization of the process and to

strengthen the consortium. Based on the learning from the first phase of Bhoochetana, regular meetings and guidance from the SCC contributed immensely to the success of the innovative approach adopted by the GoK to unlock the potential of rainfed agriculture in the state.

The mission has a simple principle of accountability and delegation of authority at different levels to meet the mission goal collectively without diluting individual accountability.

The mission adopts in addition to the above, rewarding mechanisms for best performers i.e., the farmers at cluster, taluk, district and state level with appropriate personal recognition. Similarly, mission staff with outstanding performance will also be recognized suitably by the state government on the basis of predefined and transparent criteria.

Karnataka: Rainfall situation during the Southwest Monsoon 2015

Karnataka is divided into four regions viz., South Interior Karnataka (SIK), North Interior Karnataka (NIK), Malnad and the Coastal Karnataka region. During 2015, the southwest monsoon advanced over the Andaman Sea on 16th May 2015, four days earlier than normal. However, the monsoon set in over Kerala on 5th June, four days later than its normal date of onset. The monsoon covered the entire state of Karnataka by 13th June 2015.

During the period from 1st June to 30th September, Karnataka state as a whole recorded 652 mm of rainfall as against the normal 839 mm; the percentage departure from normal was -22% and the rainfall was classified under the Deficit category (Tables 1, 2 and Figure 2).

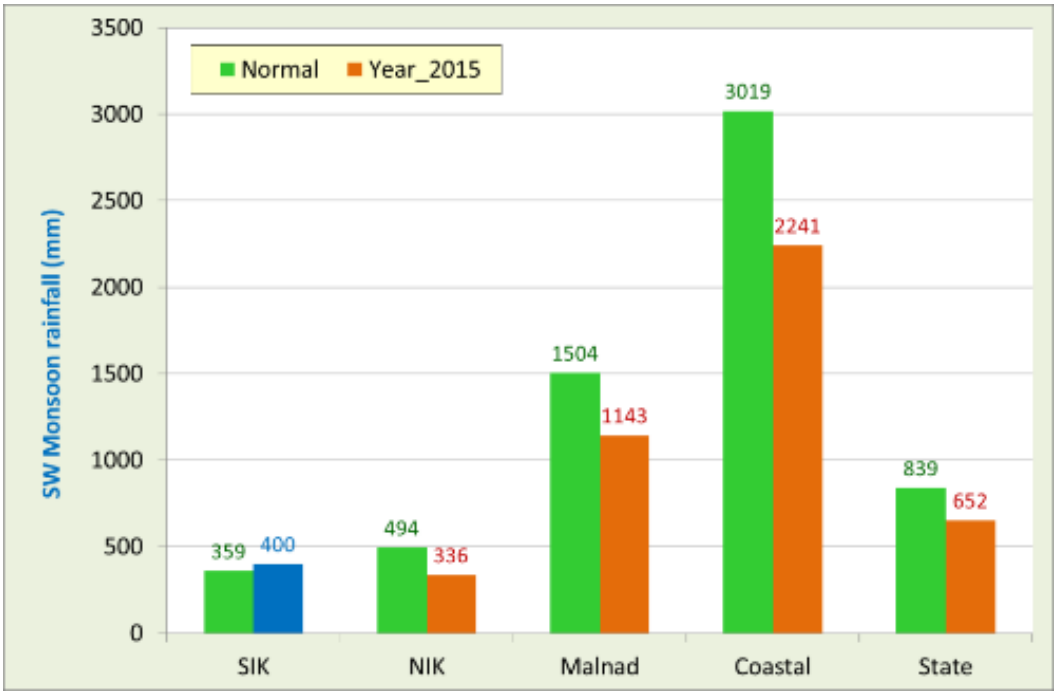

Figure 2. Average rainfall and rainfall received in the period June - September 2015 in four regions of Karnataka and in the state overall *(SIK = South Interior Karnataka; NIK = North Interior Karnataka)*

Table 1. Region-wise rainfall in Karnataka during the Southwest Monsoon of 2015.			
Region	**Jun-Sep**		
	Normal (mm)	**Actual (mm)**	**Departure (%)**
South Interior Karnataka	359	400	+11
North Interior Karnataka	494	336	-32
Malnad	1504	1143	-24
Coastal Karnataka	3019	2241	-26
Whole State	839	652	-22

Table 2. Mean rainfall, actual rainfall during June - September 2015 and % variation from average rainfall in districts of Karnataka.

Sl. No.	District	Rainfall (mm)		Departure (%)
		Normal	Actual	
1	Bengaluru Urban	460	492	7
2	Bengaluru Rural	441	482	9
3	Ramanagara	430	466	8
4	Kolar	387	374	-3
5	Chikkaballapura	399	413	4
6	Tumakuru	361	481	33
7	Chitradurga	276	344	25
8	Davangere	373	378	1
9	Chamarajanagara	305	298	-2
10	Mysuru	395	410	4
11	Mandya	304	332	9
12	Ballari	352	387	10
13	Koppala	376	343	-9
14	Raichur	450	327	-27
15	Kalaburagi	614	367	-40
16	Bidar	684	402	-41
17	Belagavi	612	363	-41
18	Bagalkote	350	278	-21
19	Vijayapura	428	262	-39
20	Gadag	382	272	-29
21	Haveri	485	340	-30
22	Dharwad	498	303	-39
23	Yadgir	592	363	-39
24	Shivamogga	1889	1308	-31
25	Hassan	673	647	-4
26	Chikkamagaluru	1349	1097	-19
27	Kodagu	2345	1700	-28
28	Dakshina Kannada	3441	2498	-27
29	Udupi	4071	3073	-25
30	Uttara Kannada	2457	1832	-25
	State	**839**	**652**	**-22**

Out of the 30 districts, only two districts viz., Tumakuru and Chitradurga received excess rainfall. Fifteen districts viz., Bagalkote, Udupi, Uttara Kannada, Raichur, Dakshina Kannada, Kodagu, Gadag, Haveri, Shivamogga, Vijayapura, Dharwad, Yadgir, Kalaburagi, Bidar and Belagavi received deficit rainfall. The remaining 13 districts received normal rainfall (Table 2).

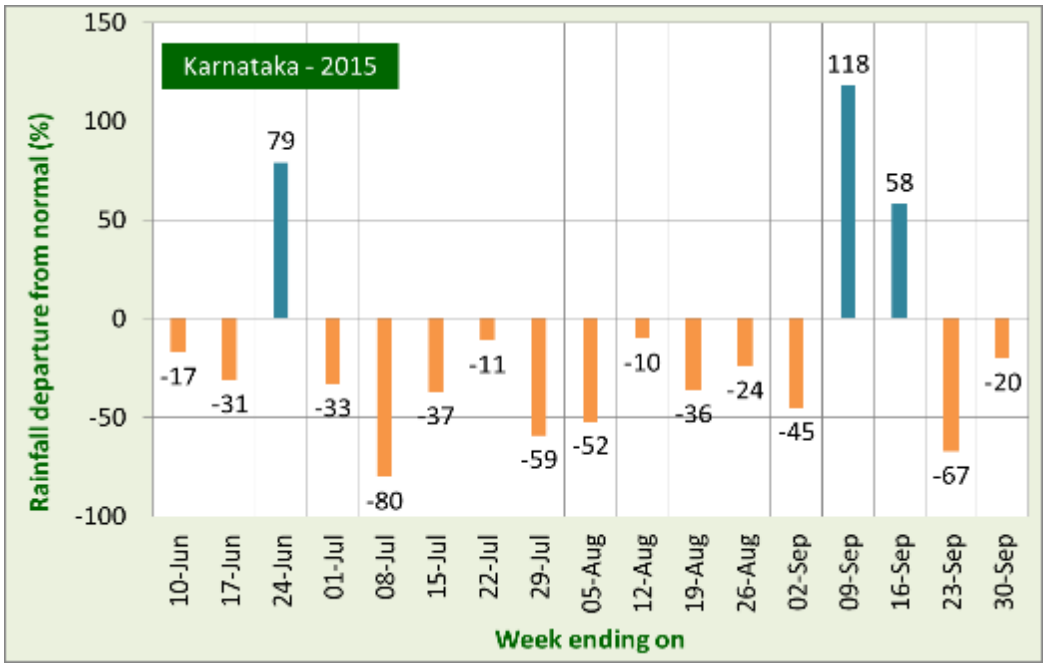

Figure 3. Weekly Rainfall deviation from average rainfall in Karnataka between June and September, 2015.

However, the week-by-week distribution of monsoon rainfall has shown that the state has experienced very dry conditions during July and August (Figure 3). The rainfall situation improved only in September, particularly in North Interior Karnataka and Malnad. Among the 176 taluks in the state, 21 received “Excess” rainfall, 72 taluks received “Normal” rainfall, 81 taluks received “Deficit” rainfall and two taluks received “Scanty” rainfall.

During June, the state as a whole recorded an actual amount of 198 mm of rainfall as against the normal rainfall of 195 mm with percentage departure from normal being (+) 2%. The state as a whole was classified under the “Normal” category. During July, the state as a whole recorded an actual amount of 143 mm of rainfall as against the normal rainfall of 280 mm with (-) 49% departure from normal. The state as a whole was classified under the “Deficit” category. During August, the state as a whole recorded an actual amount of 151 mm of rainfall as against the normal rainfall of 206 mm with (-) 27% departure from normal. The rainfall in the state as a whole was classified under the “Deficit” category.

About 43% of the total geographical area (covering parts of the districts of Kolar, Chikkaballapura, Tumkuru, Chitradurga, Davanagere, Mysuru, Mandya, Ballari, Koppala, Raichur, Kalaburagi, Bidar, Belagavi, Bagalkote, Vijayapura, Gadag, Haveri, Dharwad and Yadgir) experienced moderate to severe moisture stress for agricultural crops (KSNDMC 2015).

Rainfall Variability

Out of the 30 districts, only two districts viz., Tumakuru and Chitradurga districts received excess rainfall. Fifteen districts viz., Bagalkote, Udupi, Uttara Kannada, Raichur, Dakshina Kannada, Kodagu, Gadag, Haveri, Shivamogga, Vijayapura, Dharwad, Yadgir, Kalaburagi, Bidar and Belagavi received deficit rainfall. The remaining 13 districts received normal rainfall (Table 3, Table 4, Figure 4 and Figure 5).

Table 3. District-wise Rainfall during *Kharif* 2015 in Karnataka

District	**Actual (mm)**	**Normal (mm)**	**Departure (%)**	**Classification**
Bangalore Division				
Bengaluru Urban	597	620	-4	Normal
Bengaluru Rural	573	602	-5	Normal
Chitradurga	464	393	18	Normal
Davangere	494	494	0	Normal
Kolar	446	538	-17	Normal
Shivamogga	1410	2035	-31	Deficit
Tumakuru	630	508	24	Excess
Ramanagara	590	599	-2	Normal
Chikkaballapura	519	554	-6	Normal
Mysore Division				
District	Actual (mm)	Normal (mm)	Departure (%)	Classification
Chamarajanagara	433	471	-8	Normal
Chikkamagaluru	1237	1508	-18	Normal
Dakshina Kannada	2756	3702	-26	Deficit
Hassan	735	834	-12	Normal
Kodagu	1845	2546	-28	Deficit
Mandya	428	469	-9	Normal
Mysuru	496	541	-8	Normal
Udupi	3299	4284	-23	Deficit
Kalaburagi Division				
District	Actual (mm)	Normal (mm)	Departure (%)	Classification
Ballari	480	459	5	Normal
Bidar	435	776	-44	Deficit
Kalaburagi	403	716	-44	Deficit
Koppal	383	485	-21	Deficit
Raichur	366	564	-35	Deficit
Yadgir	399	714	-44	Deficit
Belagavi Division				
District	Actual (mm)	Normal (mm)	Departure (%)	Classification
Bagalkote	332	461	-28	Deficit
Belagavi	432	729	-41	Deficit
Vijayapura	308	538	-43	Deficit
Dharwad	399	612	-35	Deficit
Gadag	340	503	-32	Deficit
Haveri	442	603	-27	Deficit
Uttara Kannada	1926	2600	-26	Deficit

Kharif season: June to October *Data source: KSNDMC, Bengaluru*

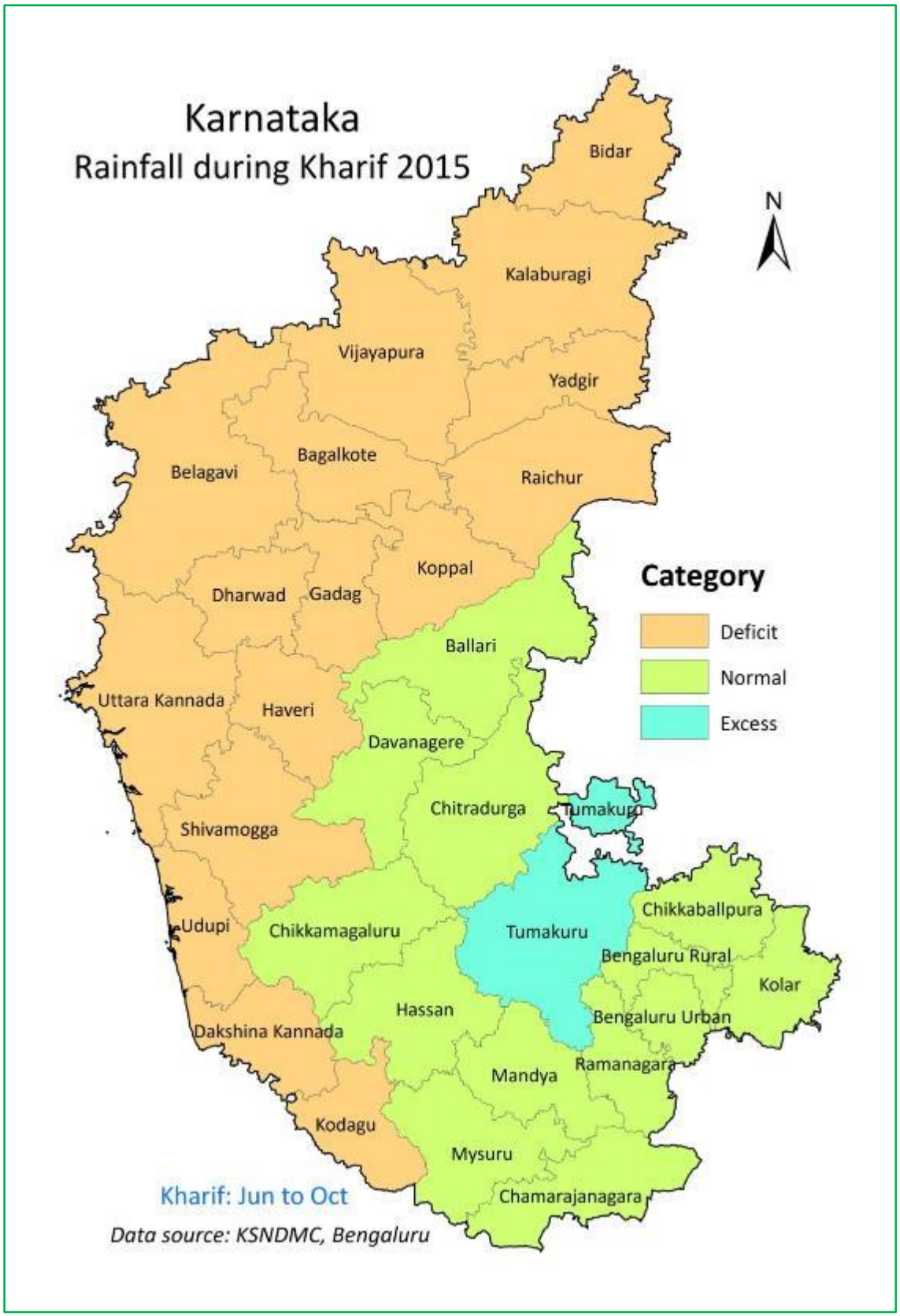

Figure 4. Spatial variability of rainfall received during Kharif 2015

Table 4. District-wise Rainfall during *Rabi* 2015-16 season in Karnataka				
District	**Actual (mm)**	**Normal (mm)**	**Departure (%)**	**Classification**
Bangalore Division				
Bengaluru Urban	230	83	177	Excess
Bengaluru Rural	246	75	228	Excess
Chitradurga	84	45	87	Excess
Davangere	40	54	-26	Deficit
Kolar	378	93	306	Excess
Shivamogga	66	58	14	Normal
Tumakuru	189	62	205	Excess
Ramanagara	191	75	155	Excess
Chikkaballapura	331	75	341	Excess
Mysore Division				
District	Actual (mm)	Normal (mm)	Departure (%)	Classification
Chamarajanagara	231	99	133	Excess
Chikkamagaluru	149	73	104	Excess
Dakshina Kannada	181	109	66	Excess
Hassan	146	71	106	Excess
Kodagu	131	95	38	Excess
Mandya	219	75	192	Excess
Mysuru	143	72	99	Excess
Udupi	177	87	103	Excess
Kalaburagi Division				
District	Actual (mm)	Normal (mm)	Departure (%)	Classification
Ballari	18	45	-60	Scanty
Bidar	3	37	-92	Scanty
Kalaburagi	7	34	-79	Scanty
Koppal	9	37	-76	Scanty
Raichur	10	33	-70	Scanty
Yadgir	4	36	-89	Scanty
Belagavi Division				
District	Actual (mm)	Normal (mm)	Departure (%)	Classification
Bagalkote	8	35	-77	Scanty
Belagavi	8	39	-79	Scanty
Vijayapura	8	37	-78	Scanty
Dharwad	14	50	-72	Scanty
Gadag	6	44	-86	Scanty
Haveri	23	51	-55	Deficit
Uttara Kannada	42	54	-22	Deficit

Rabi season: November to February *Data source: KSNDMC, Bengaluru*

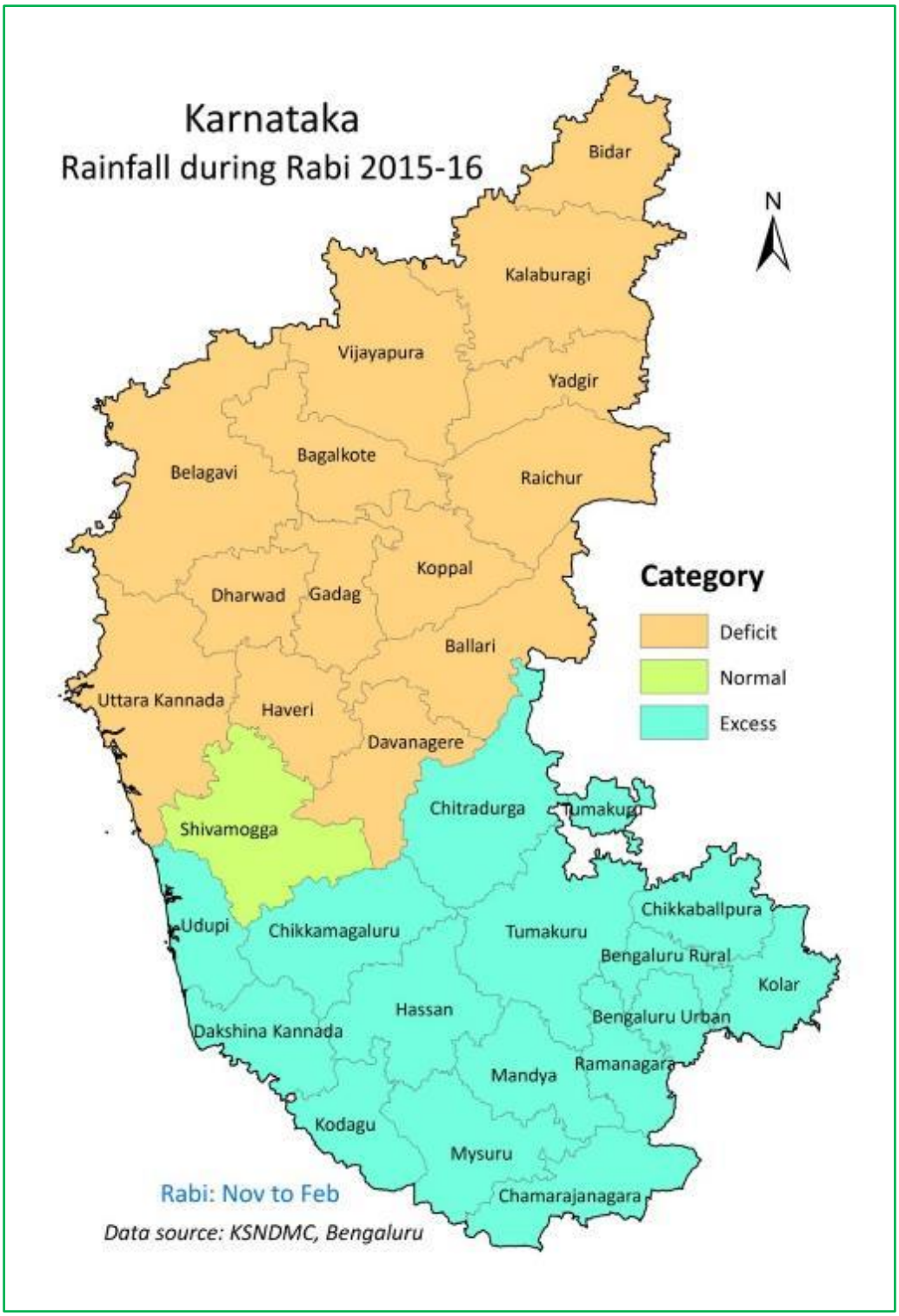

Figure 5. Spatial variability of rainfall received during Rabi 2015-16

Distribution of monsoon rainfall has shown that the state has experienced very dry conditions during July and August. The rainfall situation improved particularly in North Interior Karnataka and Malnad. Among the 176 taluks in the state, 21 received "Excess" rainfall, 72 taluks received "Normal" rainfall, 81 taluks received "Deficit" rainfall and two taluks received "Scanty" rainfall.

Project Activities

District, Taluk and Cluster/Village Level Training Sessions

District level training sessions were organized at different levels to sensitize department staff, FFs and ICRISAT staff located at different districts. The training sessions were attended by officials of the DoA (Joint Director of Agriculture (JDA), Assistant Director of Agriculture (ADA), Agriculture Officer (AO), Assistant Agriculture Officer (AAO), scientists from universities and KVKs as well as scientists, scientific officers and research technicians of ICRISAT. A wide range of topics were covered in these sessions. During 2015-16, 55 training sessions were organized at the district level and 4,845 staff members were trained through these sessions (Table 5).

Figure 6. District level training at DATC, Davangere district

Taluk level training sessions were organized for agricultural assistants, newly appointed FFs and LFs in each taluk during different intervals in all the districts. These training sessions were organized with the objective of providing hands-on training and demonstration of technologies, such as seed treatment, soil sampling, use of tropicultor, crop harvest sampling, and village level record keeping by field facilitators. In all 30 districts, 169 taluk level training sessions were conducted and a total of 13,056 men and women were trained in Bhoochetana technologies (Table 5).

Figure 7. Out-door Training by TKVK Scientist, at Chigateri RSK, Harapanahalli, Davangere district

Cluster/village level training sessions were organized by AOs of the DoA and research technicians of ICRISAT who were assisted by resource persons, i.e. either scientists or scientific officers from ICRISAT. There were also informal gatherings of groups of farmers in a village to discuss the issues of input distribution or specific soil/crop related issues, pest management issues etc. in their villages. These training sessions were conducted in large numbers covering 1,17,512 farm men and women before the start of the season and during crop seasons in all 30 districts. They were generally very effective for communication and proper implementation of technologies.

Table 5. Training sessions conducted in all 30 districts under Bhoochetana during 2015-16

District	Taluks	District-level		Taluk/village-level			
		No. of trainings		No. of trainings			
		District level	Partici-pants	Taluk level	Partici-pants	Village level	Partici-pants
Bagalkote	Badami, Bagalkot, Bilagi, Hungund, Jamakhandi, Mudhol	3	239	12	817	81	2388
Ballari	Ballari, Kudligi, Sandur, Hospet, Siryguppa, H.B. halli, Hadagali	3	210	14	695	278	10000
Bengaluru Rural	Devanahalli, Nelamangala Doddaballapura, Hoskote	1	65	2	296	84	2772

Table 5. Training sessions conducted in all 30 districts under Bhoochetana during 2015-16							
District	**Taluks**	**District-level**		**Taluk/village-level**			
		No. of trainings		**No. of trainings**			
		District level	**Partici-pants**	**Taluk level**	**Partici-pants**	**Village level**	**Partici-pants**
Bengaluru Urban	Anekal, Bengaluru (S), Bengaluru(N), Bengaluru(E)	0	0	0	0	0	0
Belagavi	Athani, Bailhongal, Belgaum, Chikkodi, Gokak, Hukkari, Khanpur, Raibagh, Ramdurg, Savadatti	2	223	15	2369	144	6547
Bidar	Bidar, Bhalki, Basavakalya, Humanabad, Aurad	4	250	10	739	280	5562
Vijayapura	B. Bagewadi, Sindhagi, Bijapur	2	88	2	258	91	4610
Chamarajanagara	Chamarajanagara, Kollegal, Gundalpet, Yelandur	1	60	2	80	89	2740
Chikkaballapur	Chickballapur, Bagepalli, Shidlagatta, Chintamani, Gouribidanur, Gudibandae	3	450	6	368	350	8750
Chikkamagaluru	Chikmagalur, Kadur, Tarikere, Mudigere, N R Pura, Koppa, Sringeri	2	138	10	616	134	3908
Chitradurga	Challakere, Chitradurga, Hiriyur, Holalkere Hosadurga, Molakalmuru	2	285	7	341	387	15529
Davangere	Davanagere, Harihara, Jagaluru, Harapanahalli, Honnali, Channagiri	0	0	0	0	0	0
Dharwad	Dharwad, Hubli, Kalghatgi, Kundgol, Navalgund	3	656	9	465	208	7996
Dakshina Kannada	Mangalore, Bantwal, Belthangady, Puttur, Sulia	3	150	6	448	48	1986
Gadag	Gadag, Ron, Mundargi, Shirahatti, Naragunda	1	21	2	150	15	420
Kalaburagi	Afzalpur, Chincholi, Chitapur, Sedam, Aland, Kalaburgi, Jewargi	2	246	10	833	50	1650
Hassan	Alur, Arklgud, Arsikere, Belur, Chanrayapatna, Hassan, Holenarsipura	3	274	8	914	251	6421
Haveri	Haveri, Hangal, Savanur, Hirekerur, Ranebennur, Byadagi, Shiggaon	1	156	1	86	256	5897
Kolar	Kolar, Mulbagal, Malur, Srinivaspura, Bangarpet,	3	213	6	537	47	2093
Kodugu	Madikeri, Somavarpete, Virajpete	2	133	5	157	45	677
Koppal	Gangaavathi, Koppala. Kustagi, Yalburga	2	77	0	0	20	832

Table 5. Training sessions conducted in all 30 districts under Bhoochetana during 2015-16							
District	**Taluks**	**District-level**		**Taluk/village-level**			
		No. of trainings		**No. of trainings**			
		District level	**Partici-pants**	**Taluk level**	**Partici-pants**	**Village level**	**Partici-pants**
Mandya	Mandya, Maddur, Malavalli, Srirangapatna, Pandavapura, K.R. pete, Nagamangla	2	78	2	87	59	2454
Mysuru	HD Kote, Hunsuru, KR Nagara, Mysore, Nanjanagudu, Periyapattana, T Narasipura	1	85	1	46	30	730
Raichur	Manvi, Lingasugur, Raichur, Sindhanur, Devadurga	0	0	7	840	246	9840
Ramnagara	Channapatna, Magadi, Kanakapura, Ramanagara,	0	0	0	0	0	0
Shivamogga	Shivamogga, Bhadravathi, Shikaripura, Hosnagara, Theerthahalli, Sagar, Soraba	2	100	5	138	99	2425
Tumakuru	Pavagada, Madhugiri, Sira, Koratagere, Tumkur, Gubbi, Chikkanayakanahalli, Tiptur, Turuvekere, Kunigal	1	50	2	125	49	1410
Udupi	Udupi, Kundapura, Karkala	2	60	5	350	40	880
Uttara Kannada	Karwar, Ankola, Kumta, Honnavar, Bhatkal, Sirsi, Siddapur, Mundgod Haliyal, Joida, Yellapur	0	0	2	179	90	1429
Yadgiri	Yadgiri, Shahapur, Shorapur	1	67	1	80	18	592
Total		**55**	**4845**	**169**	**13056**	**3667**	**117512**

Awareness Building

Considering the drought situation in the state, the DoA, along with the concerned line departments, organized a number of awareness building programs at different levels to increase the confidence levels of farmers. These programs were organized at the district, taluk and cluster/village levels in all the districts (Figures 8 & 9). Additionally, thousands of brochures and handouts on improved management practices, information on the status of nutrients, and nutrients recommended taluk-wise were published and distributed widely in each district.

Figure 8. Seed treatment campaign in Maligenahalli village of Honnali taluk.

Figure 9. Bhoochetana awareness Program in Chikkadevarahalli, Chennagiri Taluk.

Rainfed Crop Planning During 2015-16

Target Area Sown with Major Crops during *Kharif* 2015

Under Bhoochetana phase II, in the *Kharif* season of 2015, farmers were motivated to cover a large area under Bhoochetana activities for possible benefits. However, due to lack of rainfall, the area coverage did not reach the expected level. Bhoochetana activities were targeted to cover an area of 52.70 lakh ha with improved management to enhance rainfed as well as irrigated crop productivity in all 30 districts. The project implemented crop productivity enhancement technologies with major cereals, legumes and oilseeds on 44.26 lakh ha in Karnataka which corresponded to 77% of the target area (Table 6).

Figure 10. Field demonstrations with improved varieties of sorghum (CSV 17) and pigeonpea (ICPH 2740) in Mallasettihalli, Chitradurga taluk

Table 6. District-wise target cropping area (hectares) sown with major crops during *Kharif* 2015.

Sl. No	District	Major rainfed crop	Target area	Sown area	% achieved
	Bagalkote	Green gram, maize, bajra	98000	83952	85.7
	Ballari	Jowar, maize, bajra, tur, groundnut, sunflower, cotton	235000	220130	94
	Bengaluru Rural	Ragi, maize	52955	48037	91
	Bengaluru Urban	Ragi	28045	22822	81
	Belagavi	Soyabean, cotton, maize, groundnut, paddy	360000	293590	82
	Bidar	Jowar, rice, pigeonpea, black gram, green gram, soyabean, sugarcane	298000	287253	96
	Chamarajanagara	Ragi, jowar, maize, red gram, green gram, black gram, cowpea hyacinth bean, groundnut, sunflower, cotton	77280	65667	73

Table 6. District-wise target cropping area (hectares) sown with major crops during *Kharif* 2015.

Sl. No	District	Major rainfed crop	Target area	Sown area	% achieved
	Chikkaballapur	Maize, groundnut, ragi, red gram	117500	102363	87
	Chikkamagalur	Paddy, maize, ragi, groundnut, sunflower	139500	121360	79
	Chitradurga	Groundnut, maize, ragi, pigeonpea, cotton, green gram	153000	111952	73
	Davanagere	Sorghum, ragi, maize, pigeonpea, hyacinth bean, sunflower, groundnut, cotton, paddy, sugarcane	268000	266495	99.4
	Dharwad	Soyabean, groundnut, green gram, maize paddy, hybrid cotton	155000	154804	99.7
	Dakshina Kannada	Paddy	15000	14489	96.59
	Gadag	Pigeonpea	177500	177500	100
	Kalaburagi	Bajra, red gram, black gram, green gram, soyabean, cotton, sugarcane	512500	427176	83
	Hassan	Ragi, maize, paddy	197000	151108	77
	Haveri	Soyabean, groundnut maize, paddy, cotton,	275000	265034	96
	Kolar	Ragi, red gram, hyacinth bean, cowpea, groundnut	87000	70245	78
	Kodagu	Paddy	22000	22000	100
	Koppal	Maize, hybrid jowar, bajra, green gram, horse gram, groundnut, sunflower, tur, paddy	183000	156708	85
	Mandya	Ragi, maize, paddy, groundnut, sugarcane, cowpea	115000	74362	65
	Mysuru	Ragi, cotton, maize, hyacinth bean, red gram, sunflower, groundnut	280000	237000	85
	Raichur	Bajra, tur, cotton, paddy	254000	214670	84
	Ramnagara	Ragi, maize, pigeonpea, cowpea, hyacinth bean, groundnut	94000	86480	92
	Shivamogga	Paddy, maize, sugarcane	101000	71250	71
	Tumakuru	Green gram, hybrid maize, ground nut, ragi, hyacinth bean, red gram, cowpea, cotton, paddy	401000	287935	72
	Udipi	Paddy	22000	22000	100
	Uttara Kannada	Paddy, maize, cotton, sugarcane	78000	75986	97.42
	Vijayapura	Pigeonpea	292000	153665	53

Table 6. District-wise target cropping area (hectares) sown with major crops during *Kharif* 2015.					
Sl. No	District	Major rainfed crop	Target area	Sown area	% achieved
	Yadgir	Green gram, black gram, cotton, bajra, paddy, sunflower, sugarcane	182000	140000	77
Total			**5270280**	**4426033**	**84.0**

Target Area Sown with Major Crops during *Rabi* 2015-16

During the 2015-16 *Rabi* season, the Bhoochetana program was targeted to cover about 26.42 lakh ha with improved management to enhance rainfed as well as irrigated crop productivity in all 15 R*abi* districts. The project implemented crop productivity enhancement technologies with major cereals, legumes and oilseeds on 22.59 lakh ha in Karnataka which corresponded to 86% of the target area (Table 7).

Table 7. District-wise target cropping area (hectares) sown with major crops during *Rabi* 2015-16.					
Sl. No	**District**	**Major rainfed crop**	**Target area**	**Sown area**	**% achieved**
1.	Chitradurga	*Rabi* jowar, cowpea	40000	28857	72
2.	Haveri	*Rabi* jowar, chickpea, sunflower	35000	32045	92
3.	Dharwad	*Rabi* jowar, cowpea, wheat, sunflower	122000	116693	96
4.	Davangere	*Rabi* jowar, cowpea, wheat, maize	12500	12275	98
5.	Gadag	*Rabi* Jowar, sunflower, safflower, wheat, cotton	175000	175000	100
6.	Bijapur	*Rabi* jowar, cowpea	472000	431810	91
7.	Raichur	*Rabi* jowar, sunflower, safflower, wheat, cotton, paddy, groundnut	300000	291620	97
8.	Gulbarga	Wheat, chickpea, sorghum, sunflower and sesamum	508000	381461	75
9.	Yadgiri	*Rabi* jowar, sunflower, safflower, wheat, groundnut	120000	91312	76
10.	Bidar	Bengal gram, wheat, sunflower, jowar	108000	110196	102
11.	Bagalkot	*Rabi* jowar, chickpea, sunflower, sugarcane	150000	120000	80
12.	Belgaum	*Rabi* Jowar, maize, wheat, chickpea	225000	194000	86
13.	Ballari	*Rabi* jowar, cowpea, sunflower	170000	123943	73
14.	Chikkamagalur	*Rabi* jowar, cowpea	30000	22255	74
15.	Koppal	*Rabi* Jowar, maize, wheat, bengal gram, sunflower, cotton	175000	128342	73
	Total		**2642500**	**2259809**	**86**

Input Distribution during *Kharif* 2015

Distribution of fertilizers and micronutrients to farmers did not follow any particular pattern in all the districts. Invariably the use of at least one of the nutrients was high as a balanced and recommended usage of nutrients was not achieved. Since Bhoochetana was operationalized in all the 30 districts, when farmers purchased inputs they were aware of the advantage of the inputs as well as their economic ability and the availability of nutrients. Enhanced awareness among farmers about the advantage of correcting nutrient deficiencies in a balanced manner and ensuring timely availability would help in changing farmers' practices in the use of micronutrients to enhance their crop productivity and incomes (Table 8). A total of 44,603 tonnes of gypsum was distributed across 30 districts. In addition, 4,598 tonnes of Zinc sulphate and 1,272 tonnes of borax was distributed during the *Kharif* season of 2015.

Table 8. Actual district-wise distribution of micronutrients to farmers during *Kharif* 2015.

Sl. No.	District	Crops covered	Nutrients distributed (tons)		
			Gypsum	Zinc sulphate	Borax
1	Bagalkote	Green gram, maize, bajra	1148	114	33
2	Ballari	Jowar, maize, bajra, pigeonpea, groundnut, sunflower, cotton	3092	420.6	64.4
3	Bengaluru (R)	Ragi, maize	482	18.7	5.95
4	Bengaluru (U)	Ragi	106	3.39	3.52
5	Belagavi	Soyabean, cotton, maize, groundnut, paddy	2026	298	31
6	Bidar	Jowar, rice, pigeonpea, black gram, green gram, soyabean, sugarcane	2050	240	120
7	Chamarajanagara	Paddy, ragi, jowar, maize, pigeonpea, green gram, black gram, cowpea, hyacinth bean, groundnut, sunflower, sugarcane, cotton	1022	55	24
8	Chikkaballapur	Maize, groundnut, ragi, pigeonpea	950	98	15
9	Chikkamagalur	Paddy, maize, ragi, groundnut	1024	189	59
10	Chitradurga	Groundnut, maize, ragi, pigeonpea, cotton, green gram	2548	313	161
11	Davangere	Sorghum, ragi, maize, pigeonpea, hyacinth bean, sunflower, groundnut, cotton, paddy, sugarcane	2975	259	84

Table 8. Actual district-wise distribution of micronutrients to farmers during *Kharif* 2015.					
Sl. No.	**District**	**Crops covered**	**Nutrients distributed (tons)**		
			Gypsum	**Zinc sulphate**	**Borax**
12	Dharwad	Soyabean, groundnut, green gram, maize, paddy, hybrid cotton	2277	310	58
13	Dakshina Kannada	Paddy	465	0	3
14	Gadag	Maize, groundnut, green gram, sunflower, cotton, pigeonpea	900	200	64
15	Kalaburagi	Bajra, pigeonpea, black gram, green gram, soyabean, cotton, sugarcane	3619	287	97
16	Hassan	Ragi, maize, paddy	3432.7	155.85	65.355
17	Haveri	Soyabean, groundnut, maize, paddy, cotton	1375	304	58
18	Kolar	Ragi, red gram, hyacinth bean, cowpea, groundnut	958	26	14
19	Kodagu	Paddy, maize	947	15	8
20	Koppal	Maize, hybrid Jowar, bajra, green gram, horse gram, groundnut, sunflower, pigeonpea, paddy	886	136	109
21	Mandya	Ragi, maize, paddy, groundnut, sugarcane, cowpea	438	45	12
22	Mysuru	Ragi, maize, cotton, cowpea, hyacinth bean, pigeonpea, sunflower, groundnut, paddy, sugarcane	2650	245	21
23	Raichur	Bajra, pigeonpea, cotton, paddy	950	710	66
24	Ramnagara	Ragi, maize, pigeonpea, cowpea, hyacinth bean, groundnut	670	75	25
25	Shivamogga	Paddy, maize, sugarcane, green gram, cotton, groundnut	4260	110	35
26	Tumakuru	Green gram, hybrid maize, groundnut, ragi, hyacinth bean, red gram, cowpea, cotton, paddy	1819	110	34

Table 8. Actual district-wise distribution of micronutrients to farmers during *Kharif* 2015.					
Sl. No.	**District**	**Crops covered**	**Nutrients distributed (tons)**		
			Gypsum	**Zinc sulphate**	**Borax**
27	Udupi	Paddy	444	21	2
28	Uttara Kannada	Paddy, maize, cotton, sugarcane	875	22	7
29	Vijayapura	Maize, bajra, pigeonpea, sunflower, groundnut, sugarcane	764	172.4	47.1
30	Yadgir	Green gram, black gram, cotton, bajra, paddy, sunflower, sugarcane	350	5	10

Note: Based on data from the Department of Agriculture, GoK, Bengaluru.

Input Distribution during *Rabi* 2015-16

During *Rabi* 2015-16, 11,275 tonnes of gypsum, 3,308 tonnes of Zinc sulphate and 632 tonnes of borax was distributed to the farmers (Table 9).

Table 9. Actual district-wise distribution of micronutrients to farmers during *Rabi* 2015-16.					
Sl. No.	**District**	**Crops covered**	**Nutrients distributed (tons)**		
			Gypsum	**Zinc sulphate**	**Borax**
1	Chitradurga	*Rabi* jowar, cowpea	1196	105	51
2	Haveri	*Rabi* jowar, chickpea, sunflower	55	30	3
3	Dharwad	*Rabi* jowar, cowpea, wheat, sunflower	791	192	73
4	Davangere	*Rabi* jowar, cowpea, wheat, maize	290	8	7
5	Gadag	*Rabi* jowar, sunflower, safflower, wheat, cotton	5100	489	135
6	Bijapur	*Rabi* jowar, cowpea	0	0	0
7	Raichur	*Rabi* jowar, sunflower, safflower, wheat, cotton, paddy, groundnut	350	375	10
8	Gulbarga	Wheat, chickpea, sorghum, sunflower, sesamum	821	124	81
9	Yadgiri	*Rabi* jowar, sunflower, safflower, wheat, groundnut	728	66	32
10	Bidar	Bengal gram, wheat, sunflower, jowar	750	180	120
11	Bagalkot	*Rabi* jowar, bengal gram, sunflower, sugarcane	0	0	0
12	Belgaum	*Rabi* jowar, maize, wheat bengal gram	225	78	21

Table 9. Actual district-wise distribution of micronutrients to farmers during *Rabi* 2015-16.					
Sl. No.	**District**	**Crops covered**	**Nutrients distributed (tons)**		
			Gypsum	**Zinc sulphate**	**Borax**
13	Ballari	*Rabi* jowar, cowpea, sunflower, sunflower	123	1480	47
14	Chikkamagalur	*Rabi* jowar, cowpea	359	84	32
15	Koppal	*Rabi* jowar, maize, wheat, bengal gram, sunflower, cotton	487	98	21
	Total		**11275**	**3308**	**632**

Uniform Sampling Procedure for Crop Yield Estimations

For maintaining uniformity across all districts, the State Level Coordination Committee has approved the following committee and a uniform sampling procedure for undertaking Crop Cutting Experiments (CCE) under Bhoochetana.

CCE Committee at the district level:

1. In each district the responsibility for undertaking the CCEs for Bhoochetana plots rests with the concerned JDA as the data needs to be integrated in the state statistics for agricultural production. The CCE Committee in the district is chaired by the JDA and it comprises the following representatives to ensure ownership for the data.

   Chair : The District JDA
   Members : DoA representative
   DoE&S staff
   WDD representative
   UAS representative
   ICRISAT Research Technician
   Farm Facilitator
   Farmer

2. For CCEs in each taluk two major crops will be identified based on the planning undertaken by the DoA while preparing the BC plans. The ADAs and AOs along with the ICRISAT Research Technician will be responsible for identifying the crops in their districts and ensuring that the selected crops are the major crops in terms of area coverage under BC.

3. Based on the registration and the knowledge of the officials and the technician for each of the two identified crops, 10 farmers in each taluk need to be selected. Three to four villages covering different zones in terms of soil, rainfall pattern during the season and area coverage under BC need to be selected. From each of the selected villages, three to four farmers need to be selected randomly based on the registrations. *For each taluk it is essential to maintain a minimum number of 10 farmers per crop.*

4. Each farmer will be provided a Unique Identification Number (UIN) by ICRISAT and before the CCE starts it is the responsibility of the ICRISAT Research Technician and the concerned scientist in-charge/Scientific Officer to ensure timely provisioning of

harvest bags (Muslin cloth bags for stalk sub-samples and *Kora* cloth bags for pod/head sub-samples), unique identification number and necessary data sheets for the CCEs in the district.

5. The Improved Practice (IP) and Farmers' Practice (FP) samples should be taken from the same field.
6. In each of the selected Bhoochetana farmers' fields, for improved practice (IP), a randomly selected representative area of 5 m X 5 m (total area of 25 m^2) at one spot needs to be identified for undertaking the CCE.
7. Similarly, in each of the selected Bhoochetana farmers' field for farmers' practice (FP), a randomly selected representative area of 5 m X 5 m (total area of 25 m^2) at one spot needs to be identified for undertaking the CCE.
8. From the demarcated areas all the plants should be cut at ground level from each plot separately. The pod/head must then be separated from the stalk and the total fresh weight should be recorded separately for the pod/head and stalk (25 m^2) after checking the provided balance properly each time (care must be taken to ensure that the needle is at the zero level). The total fresh weight of both parts of the plant in the field must be recorded (Appendix 2).
9. From each harvested sample a representative sub-sample of a minimum of two kg must be collected separately for earheads/pod and stalk. The fresh weight should be recorded and the samples must be put in sampling bags that have been properly labeled with the unique identification number of the farmer.
10. The fresh weight of the pod/head and stalk sub-sample should be recorded immediately after the sub-sample is drawn. It is necessary to ensure that this weight is a minimum of two kg for each sub-sample.
11. From the field of each of the selected farmers two samples need to be collected - one IP and one FP.
12. Care should be taken to record the weights in the given format and the signatures of all the representatives of the CCE Committee present in the field must be taken.
13. The sub-samples should be dried and sent to ICRISAT for calculating yield (kg ha^{-1}) on a dry weight basis.
14. All the identified team members should participate in CCEs and the concerned JDA should assign responsibilities to the ADAs and AOs for undertaking CCEs in their respective taluks.
15. GPS enabled photographs of CCEs must be collected and these should be available with the JDA office.

Analysis of Crop Cutting Experiment data

Altogether, 4,532 (2,266 in *Kharif* + 2,266 in *Rabi*) CCEs were conducted across 30 districts. The CCE results showed that with soil test-based application of micro and secondary nutrients along with other improved practices in different districts of Karnataka during *Kharif* 2015, the increase in grain yields of major crops varied between 17 and 24%. The difference in crop yield among treated and control fields for different crops was as follows: finger millet (24%),

pearl millet (23%), sorghum (23%), maize (23%), soybean (18%), pigeonpea (24%), groundnut (22%) and paddy (21%) (Figure 11 & Annexure 1).

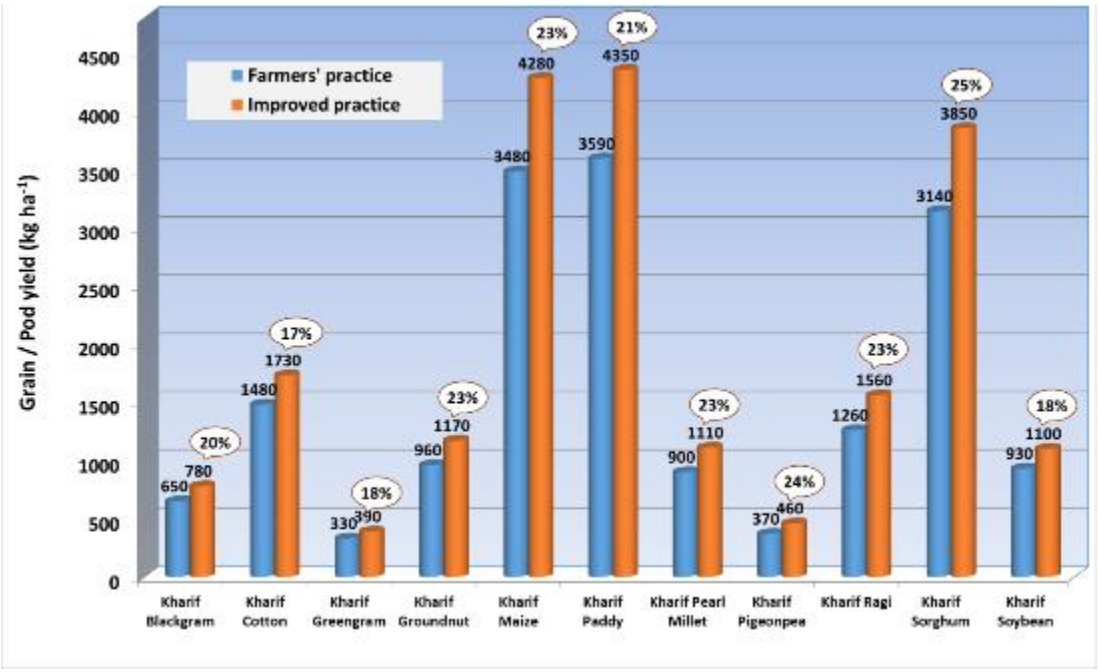

Figure 11. Comparison of yield of major crops during Kharif 2015

Similarly, during *Rabi* 2015-16, the difference in crop yield among treated and control fields for crops such as sorghum, chickpea and wheat was 24%, 32%, and 33% respectively (Figure 12).

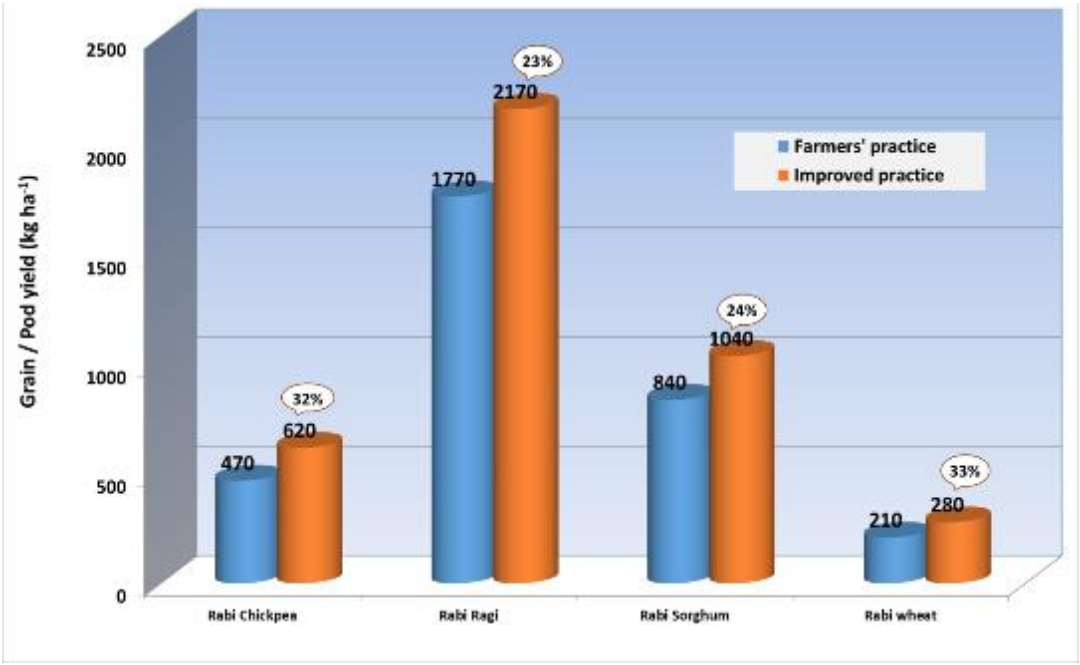

Figure 12. Comparison of yield of major crops during Rabi 2015-16

Impact of Bhoochetana Program on Crop Yields: District-wise Analysis

Ballari

Crop yield in different crops recorded an increase ranging from 12-30% during 2015-16 (Figure 13). The yield response was found to be high in crops like chickpea, groundnut, pearl millet, maize and sorghum (up to 33% increase).

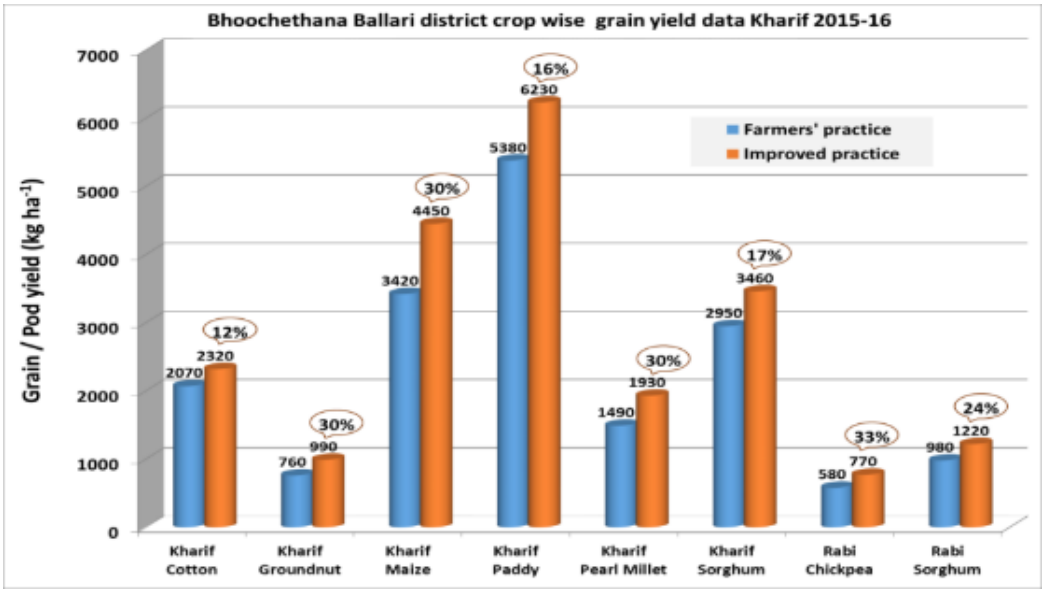

Figure 13. Comparison of yield of major crops during Kharif and Rabi 2015-16

Bagalkot

The grain yield for chickpea was 520 kg/ha with improved practice while it was 380 kg/ha with farmers' practice. This shows that there was an increase of 37% in crop yield by adopting improved management practices over farmers' practice. Similarly, *Rabi* sorghum grain yield with improved practice was 990 kg/ha whereas it was 770 kg/ha in farmers' control fields, an increase of 29% with improved practice over farmers' practice (Figure 14).

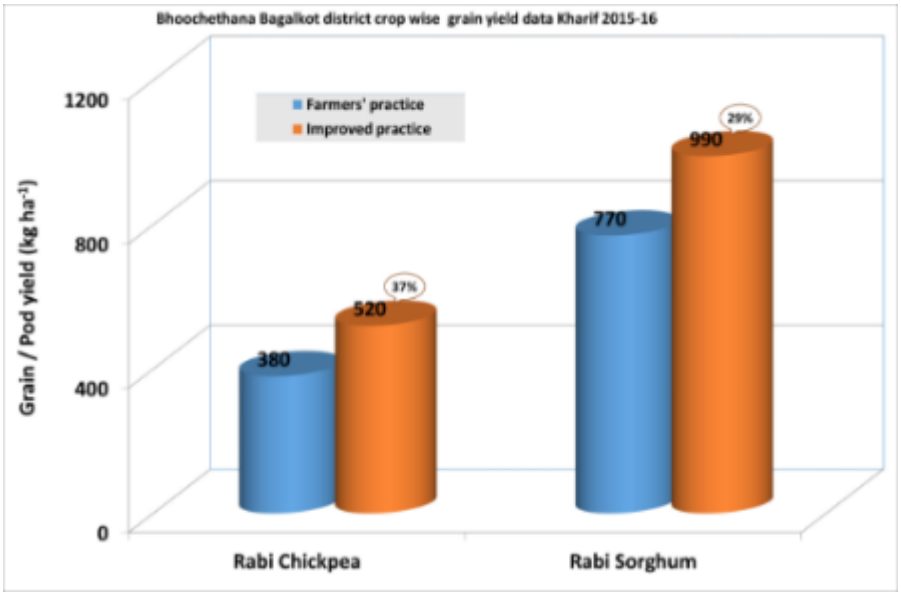

Figure 14. Comparison of yield of major crops during Rabi 2015-16

Belagavi

Sorghum yield recorded in Belagavi district was 350 kg/ha with improved practice compared to 280 kg/ha with farmers' practice, an average increase of 25% (Figure 15).

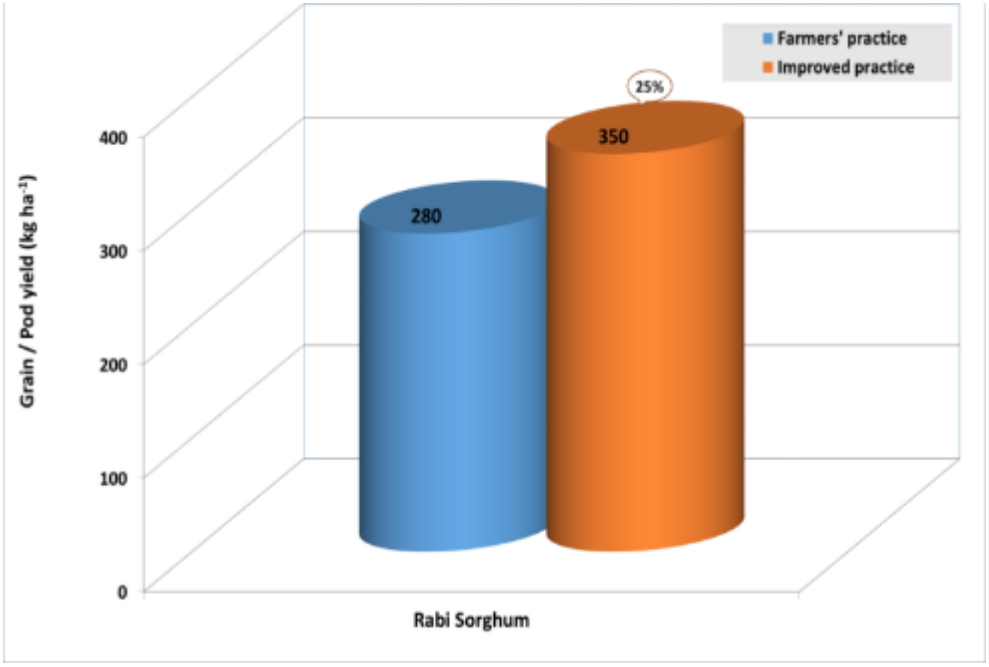

Figure 15. Comparison of yield of major crops during Rabi 2015-16

Bengaluru Rural

Maize yield with improved practice was 2,850 kg/ha compared to 2,180 kg/ha with farmers' practice, an average increase of 31%. In case of sorghum, grain yield increased by 35% with improved practice compared to farmers' practice (1,780 kg/ha with improved Vs 1,320 kg/ha with farmers' practice) (Figure 16).

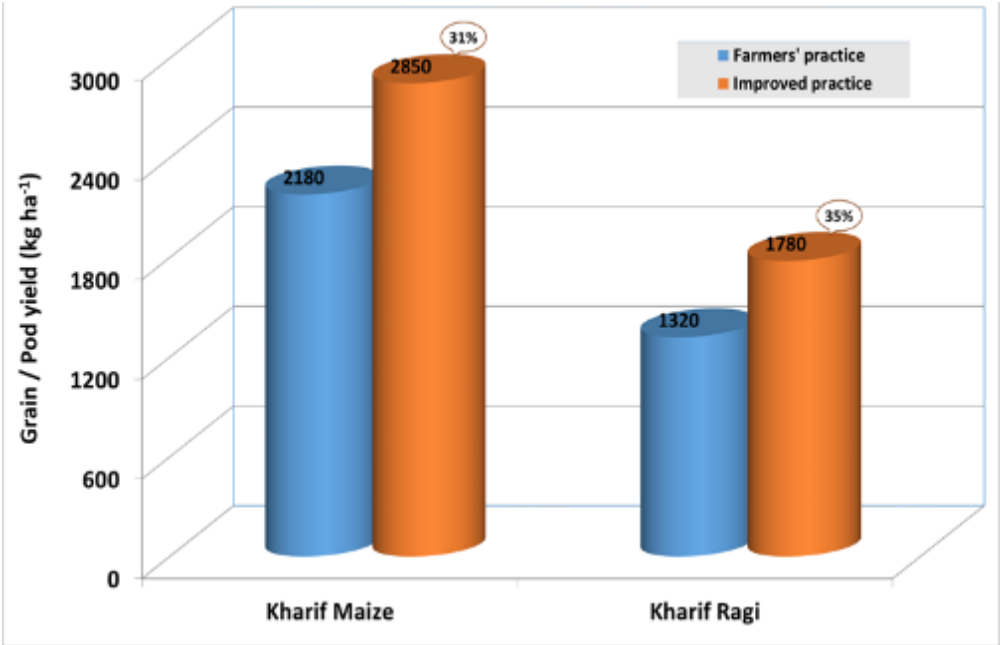

Figure 16. Comparison of yield of major crops during Rabi 2015-16

Bengaluru Urban

Crop yield of finger millet with improved practice with application of micronutrients was 2,030 kg/ha and grain yield was 1,670 kg/ha in the farmers' control field. An average increase of 22% was observed (Figure 17).

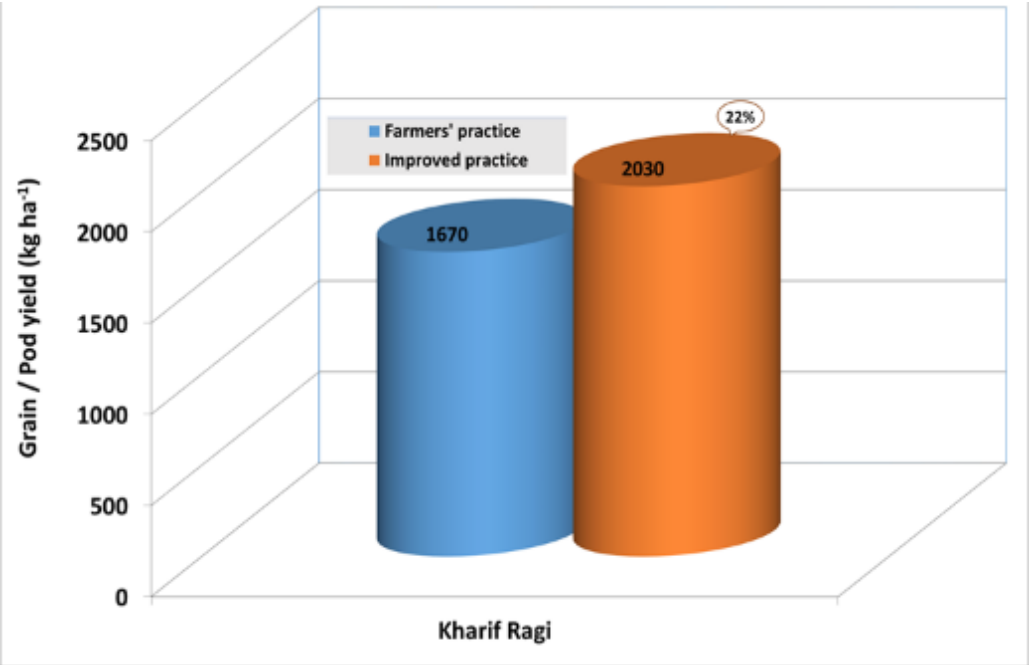

Figure 17. Comparison of yield of major crops during Rabi 2015-16

Bidar

The grain yield in black gram recorded an increase of 20% and in pigeonpea, 18% with improved management practice compared to farmers' practice (Figure 18).

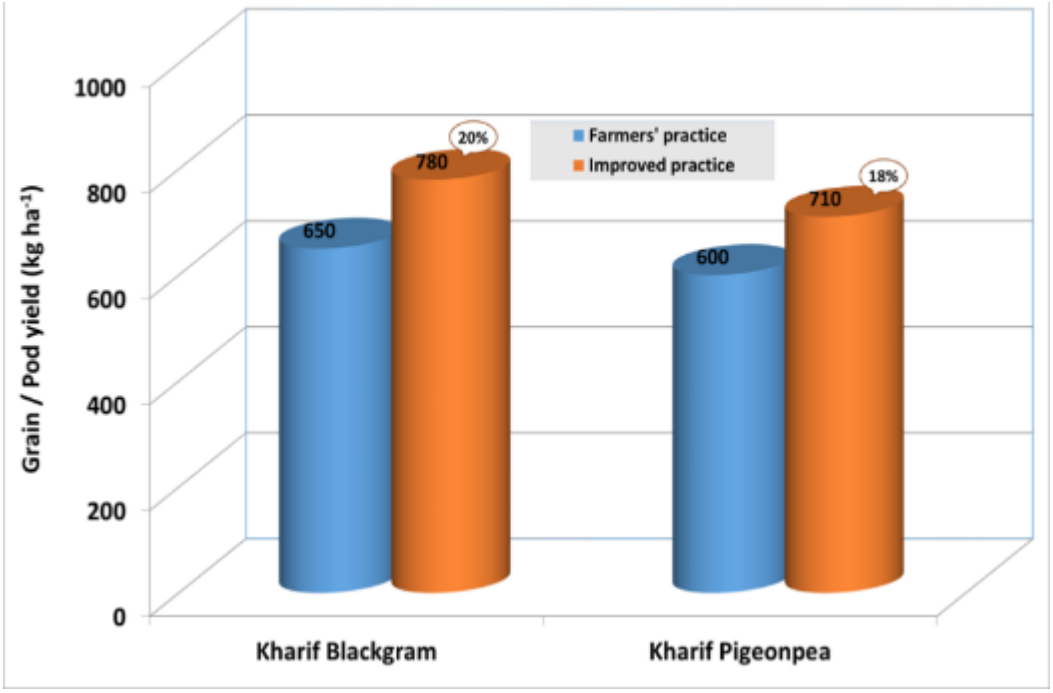

Figure 18. Comparison of yield of major crops during Rabi 2015-16

Chamarajanagar

Crop yield of groundnut, maize and finger millet showed an increase of 28, 19 and 24% respectively with improved management practices over farmers' practice (Figure 19).

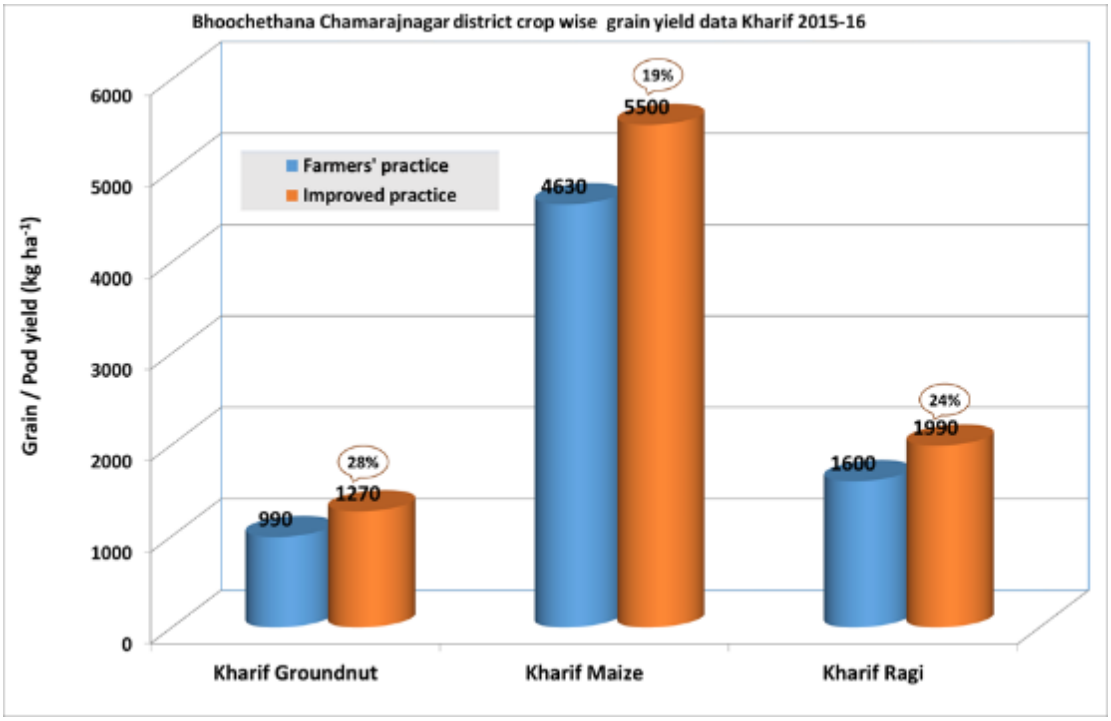

Figure 19. Comparison of yield of major crops during Rabi 2015-16

Chikkaballapur

Crop yield of groundnut, maize and finger millet showed an increase of 22, 22 and 29% respectively with improved management practices over farmers' practice (Figure 20).

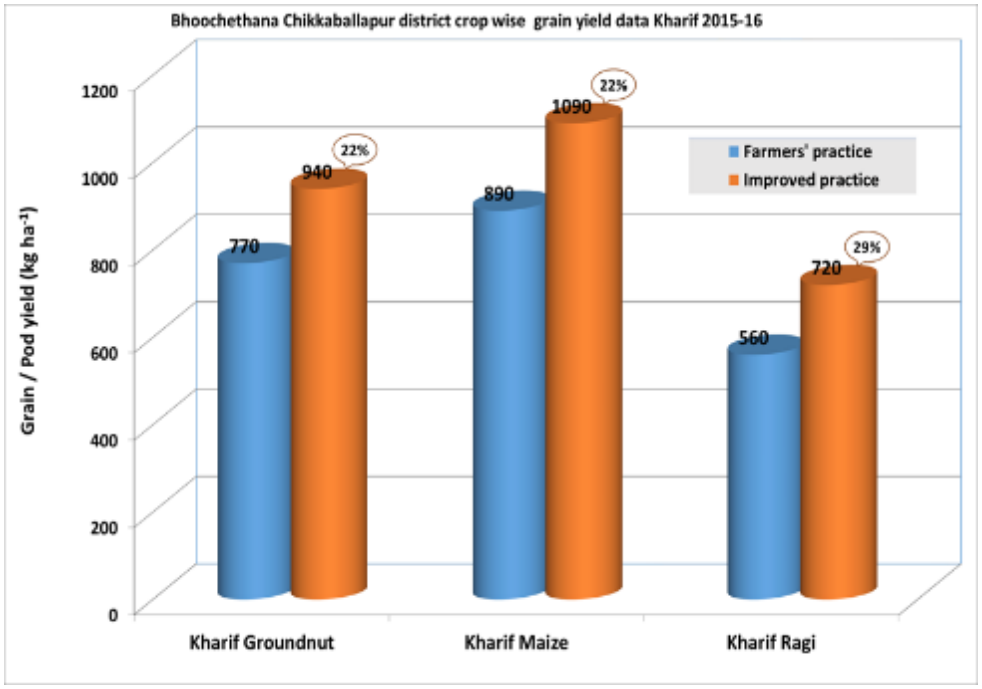

Figure 20. Comparison of yield of major crops during Rabi 2015-16

Chikkamagaluru

With improved management practices, paddy and finger millet grain yields showed an increase of 23 and 29% over farmers' practice (Figure 21).

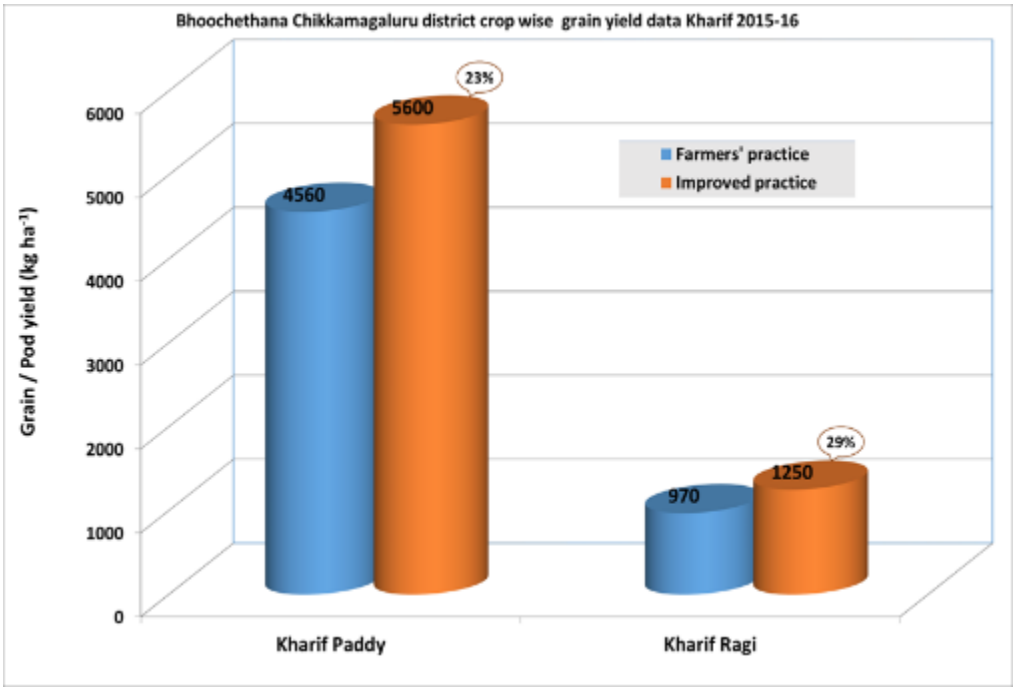

Figure 21. Comparison of yield of major crops during Rabi 2015-16

Chitradurga

CCEs were conducted in crops like sorghum, maize, finger millet, groundnut, green gram, pigeonpea and cotton. The increase in crop yield in different crops ranged from 15% in cotton to 33% in chickpea (Figure 22).

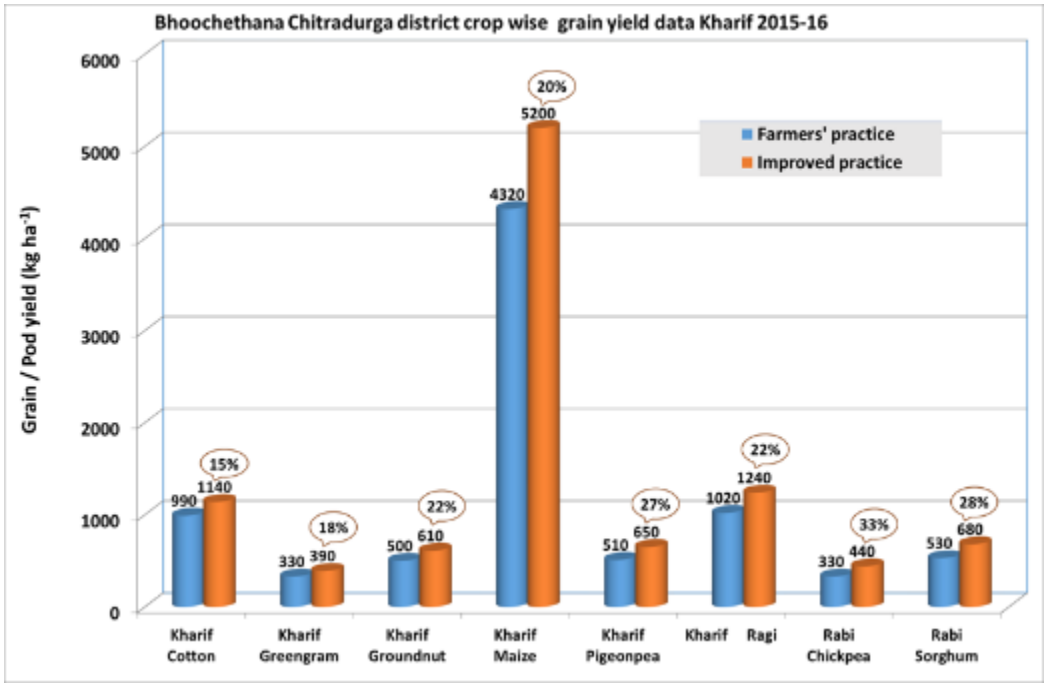

Figure 22. Comparison of yield of major crops during Kharif and Rabi 2015-16

Dakshina Kannada

The major crop grown in the district is paddy. The paddy grain yield recorded with improved practice was 3,870 kg/ha while in farmers' practice it was 3,090 kg/ha. A 25% higher yield was observed over farmers' practice (Figure 23).

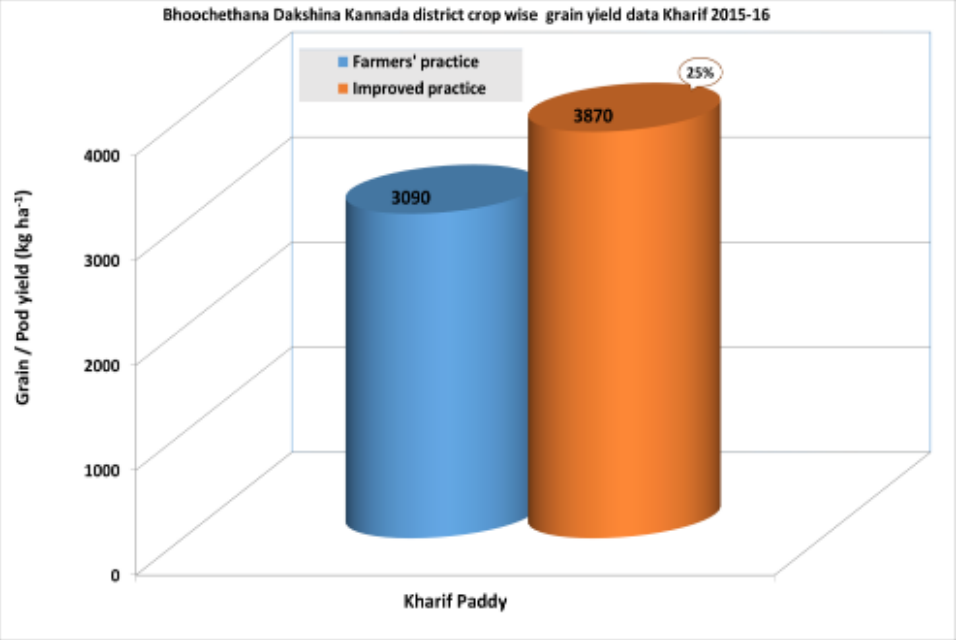

Figure 23. Comparison of yield of major crops during Kharif 2015

Davangere

Crop cutting was conducted in various crops like finger millet, sorghum, maize, pigeonpea, groundnut, paddy and cotton. The crop yield for the various crops with improved practice has shown an increase ranging from 18% in maize to 31% in chickpea over farmers' practice (Figure 24).

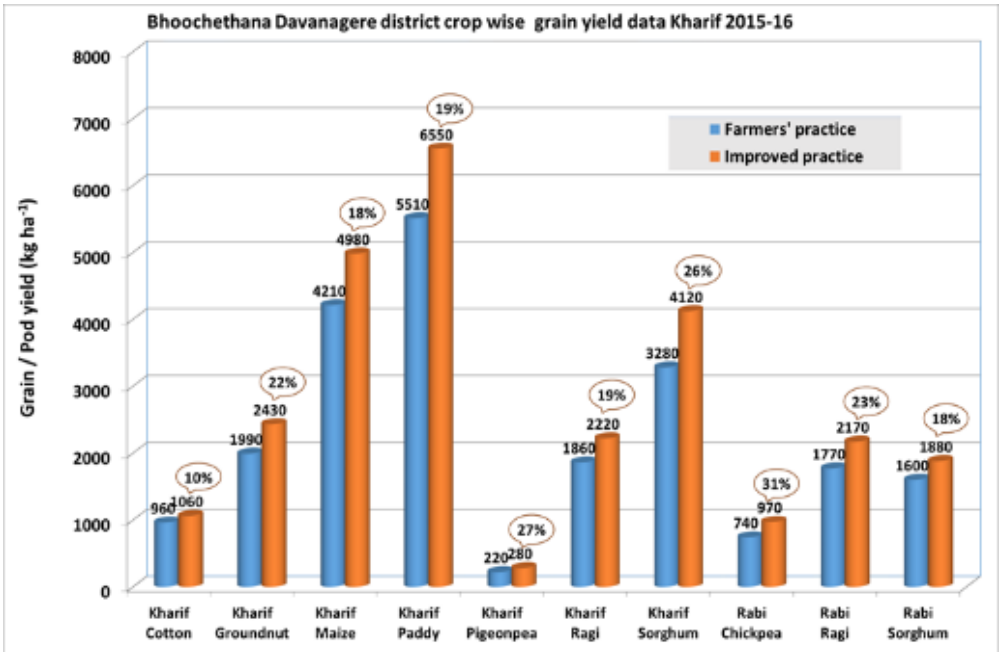

Figure 24. Comparison of yield of major crops during Kharif and Rabi 2015-16

Dharwad

In Dharwad district, the increase in crop yield for sorghum, soybean and wheat was 25, 29 and 29% respectively over farmers' practice (Figure 25).

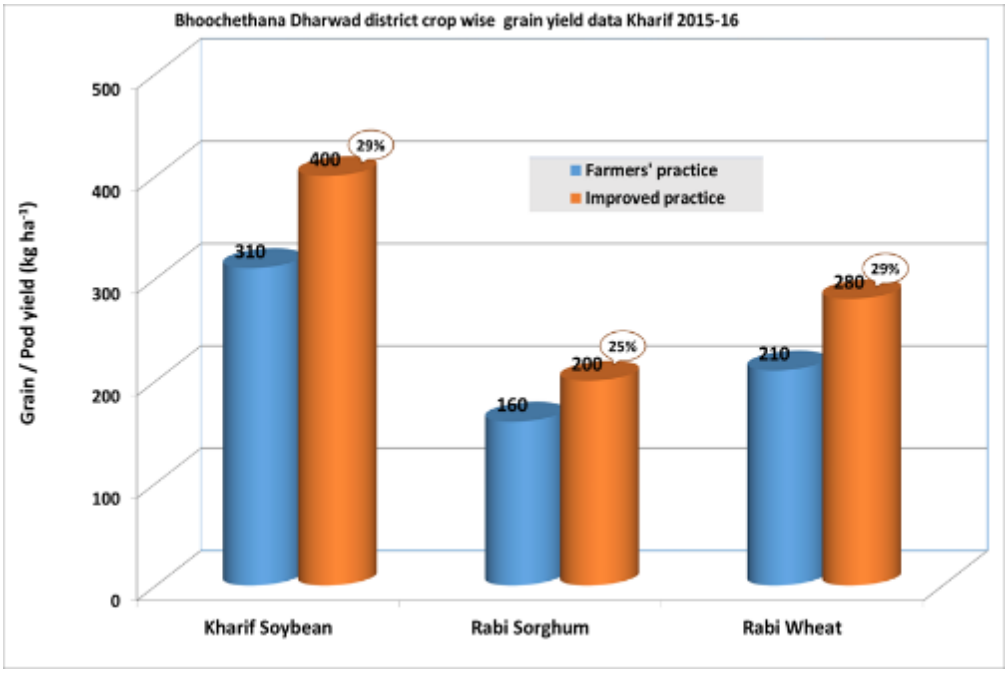

Figure 25. Comparison of yield of major crops during Kharif and Rabi 2015-16

Gadag

The CCE data shows that the groundnut yield was 24% higher with improved management practices in Gadag district (Figure 26).

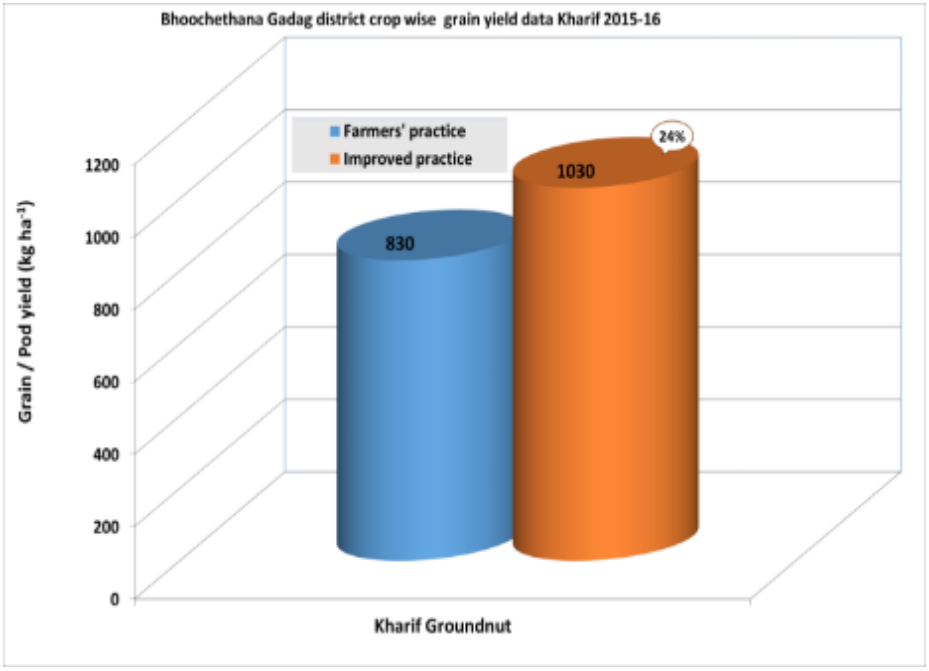

Figure 26. Comparison of the yield of major crops during Kharif and Rabi 2015-16

Hassan

The CCEs were conducted in crops like maize, paddy and finger millet. The increase in crop yield for maize, finger millet and paddy was 22, 29 and 22% respectively over farmers' practice (Figure 27).

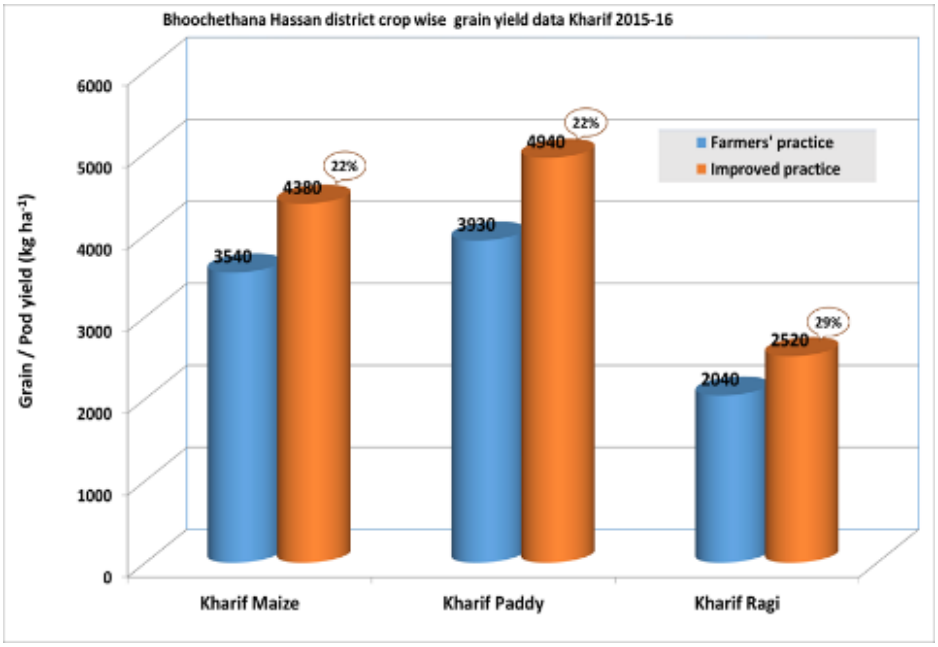

Figure 27. Comparison of yield of major crops during Kharif and Rabi 2015-16

Haveri

With improved management practices, the increase in crop yield recorded for soybean, sorghum, paddy, maize, groundnut, chickpea and cotton was 17, 19, 28, 18, 19, 28 and 10% respectively compared to farmers' practice (Figure 28).

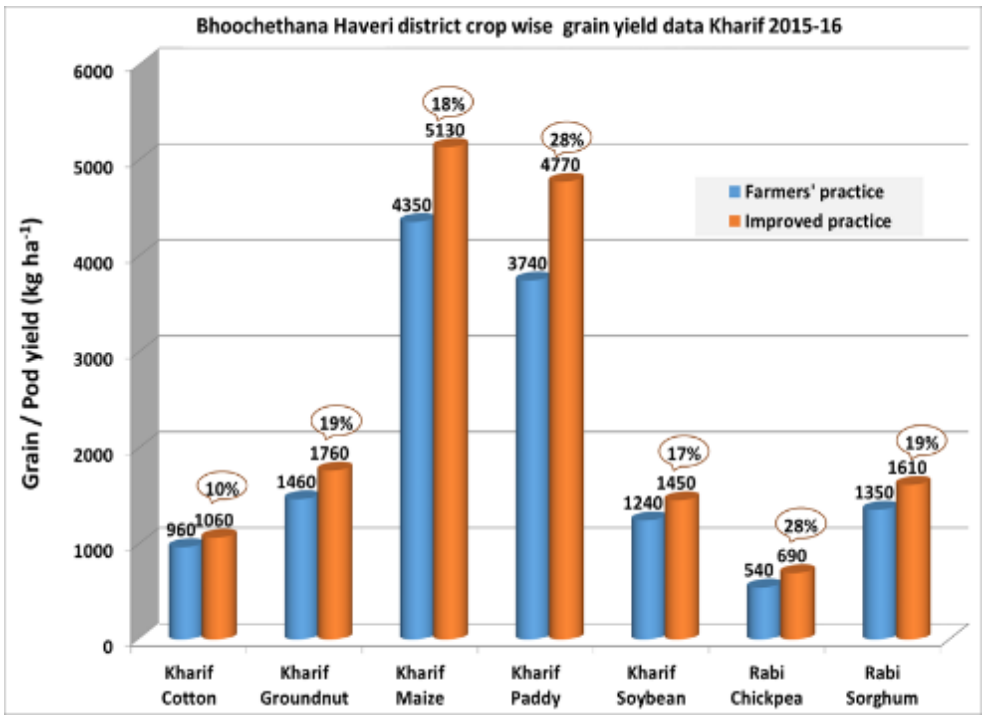

Figure 28. Comparison of yield of major crops during Kharif and Rabi 2015-16

Kalaburagi

With improved management practices, the pigeonpea yield was 22% higher compared to farmers' practice in Kalaburagi district (Figure 29).

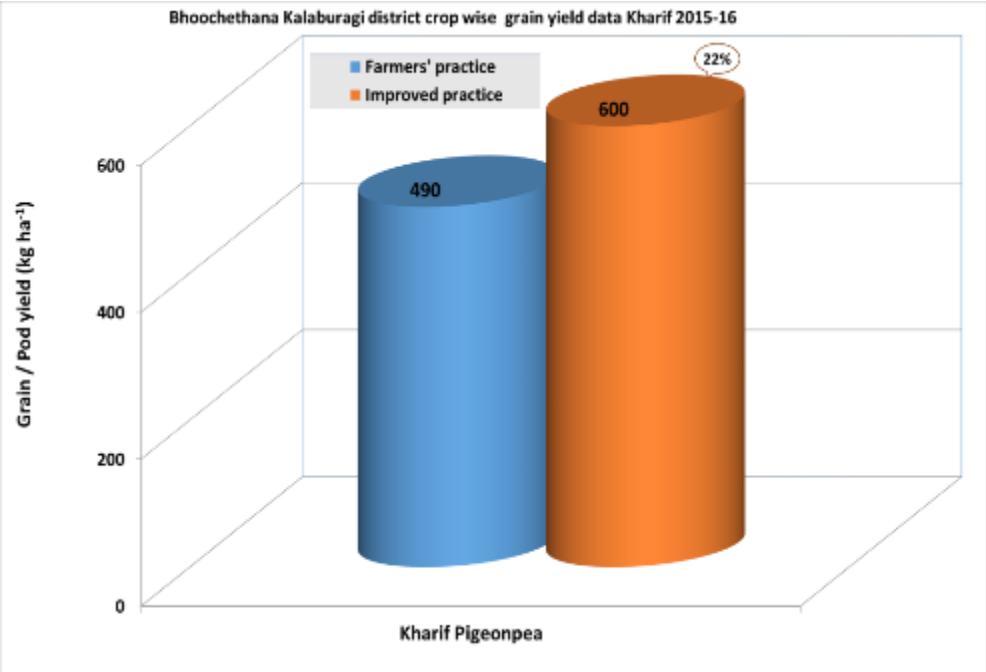

Figure 29. Comparison of yield of major crops during Kharif 2015

Kodagu

CCE data in Kodagu district showed that crop yield of maize and paddy was higher by 20 and 24% over farmers' practice (Figure 30).

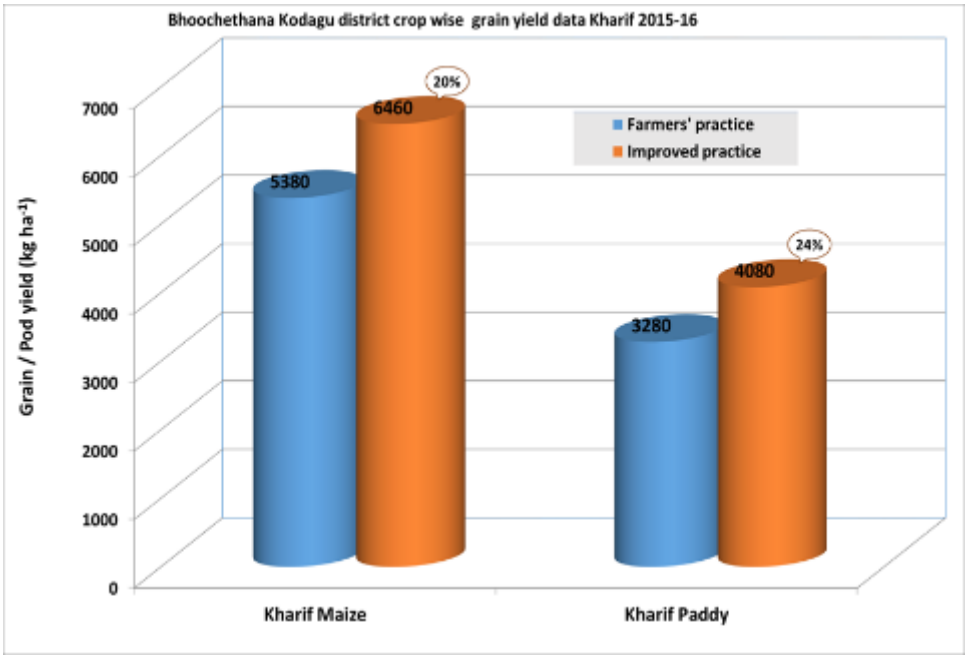

Figure 30. Comparison of yield of major crops during Kharif and Rabi 2015-16

Kolar

In Kolar district, with improved management practices finger millet yield was 27% higher compared to farmers' practice (Figure 31).

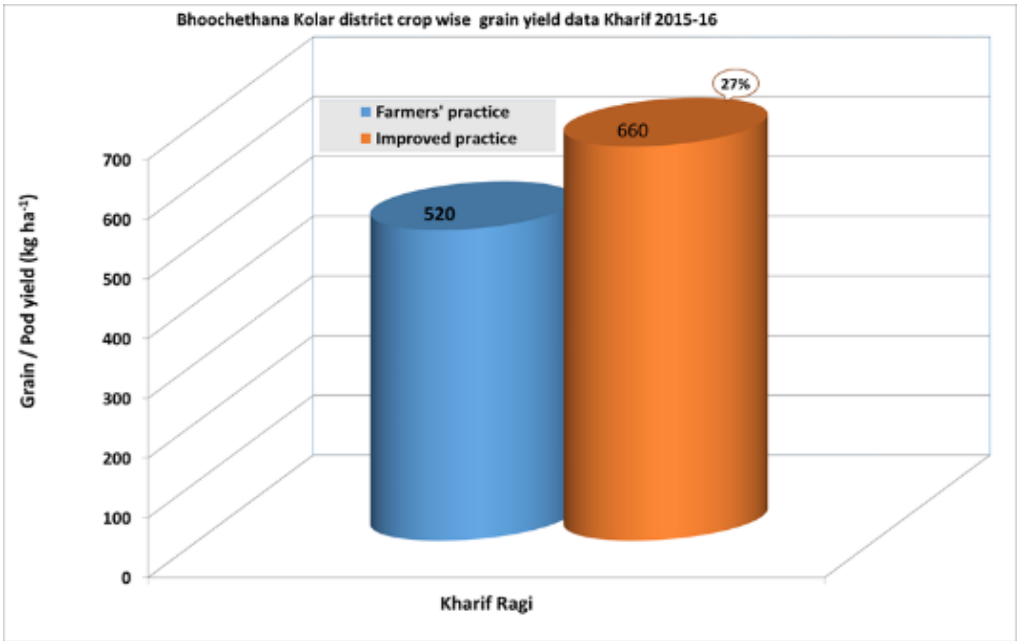

Figure 31. Comparison of yield of major crops during Kharif 2015

Koppal

CCEs conducted for crops such as maize, paddy, groundnut, pearl millet, sorghum and chickpea. Crop yield of maize, paddy, groundnut, pearl millet, sorghum and chickpea was higher by 25, 20, 26, 21, 26 and 26% respectively with improved management practice over farmers' practice (Figure 32).

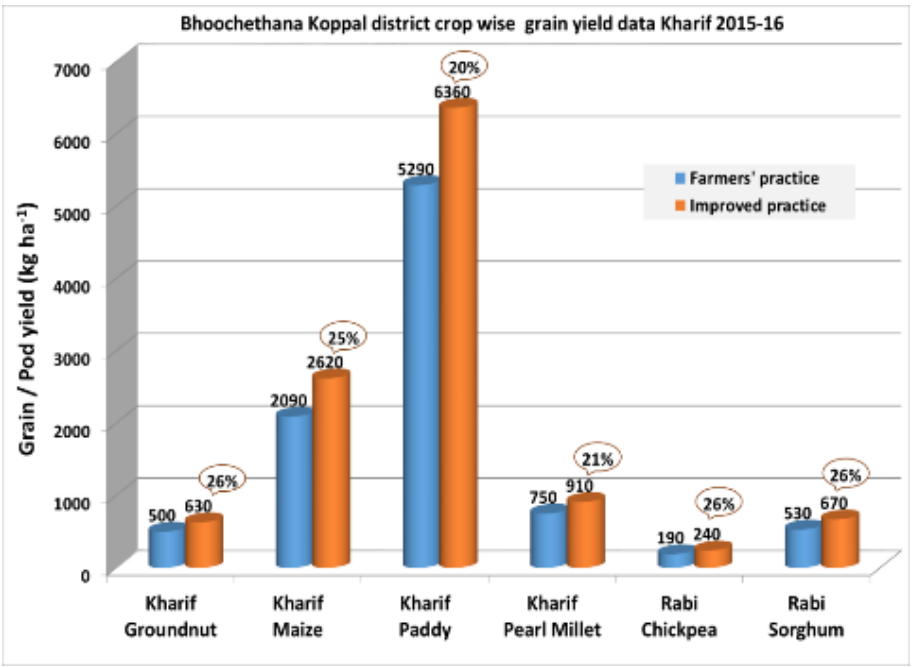

Figure 32. Comparison of yield of major crops during Kharif and Rabi 2015-16

Mandya

Crop yield of paddy and finger millet increased by 15 and 25% respectively with improved practice (Figure 33).

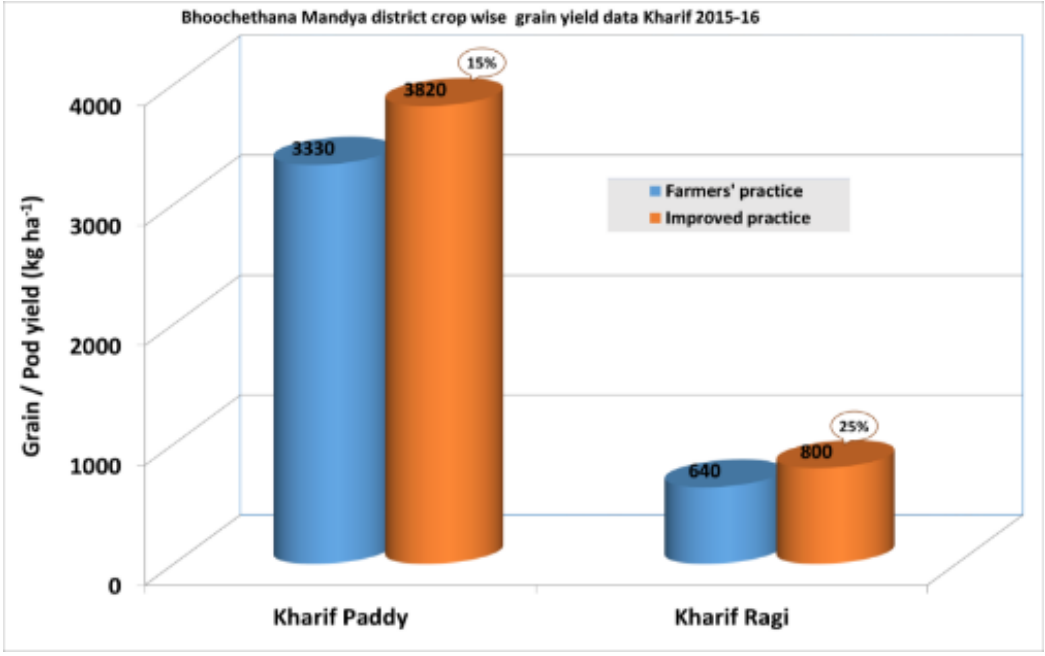

Figure 33. Comparison of yield of major crops during Kharif 2015

Mysuru

In Mysuru district, with improved management practices, crop yield recorded for crops like maize, paddy, finger millet and cotton was higher by 23, 27, 29 and 31% respectively over farmers' practice (Figure 34).

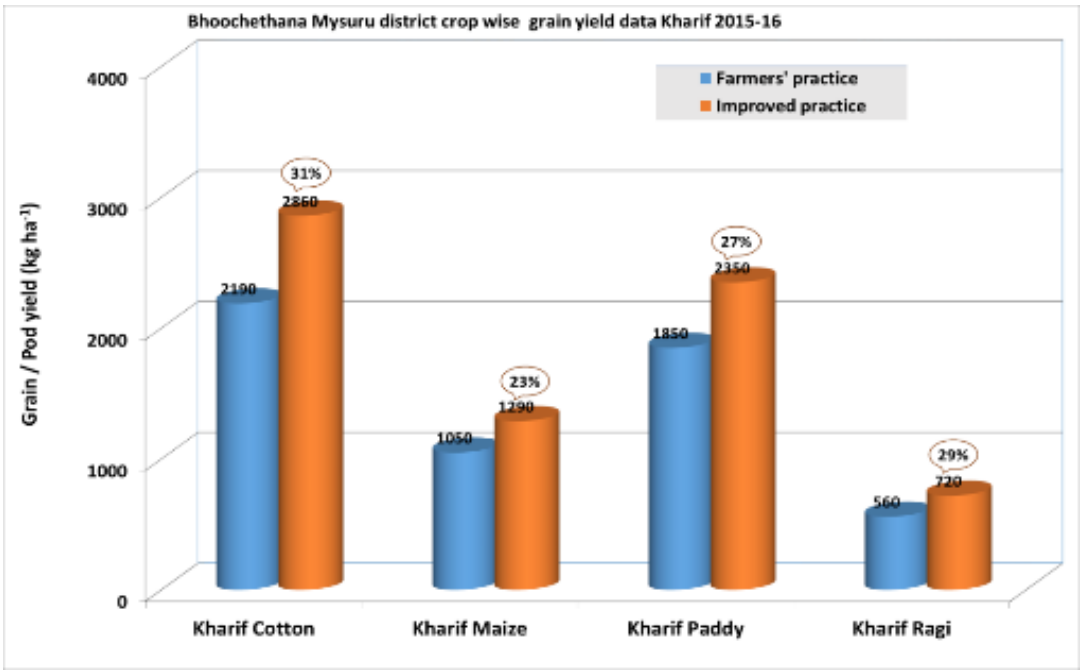

Figure 34. Comparison of yield of major crops during Kharif 2015

Raichur

Paddy, pigeonpea and cotton yield obtained under improved management practices were found to be 14, 27 and 10% higher than farmer managed control fields in Raichur district. An additional 570 kg paddy, 100 kg cotton and 110 kg pigeon pea grains were harvested by adopting improved practices over the control condition during *Kharif* 2015 (Figure 35).

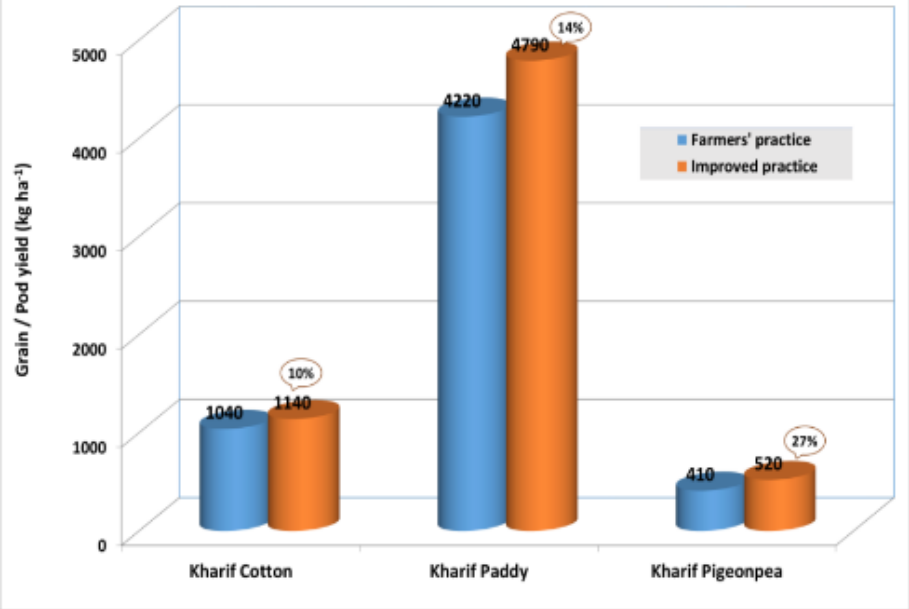

Figure 35. Comparison of yield of major crops during kharif 2015

Ramnagara

Crop yields of maize, pigeonpea, finger millet and groundnut were found to be higher by 30, 26, 24 and 30% respectively by adopting improved management practice compared to farmers' practice fields under control conditions. Crop response with application of balanced fertilizer was seen as an additional grain yield of nearly 80 to 1,100 kg (Figure 36).

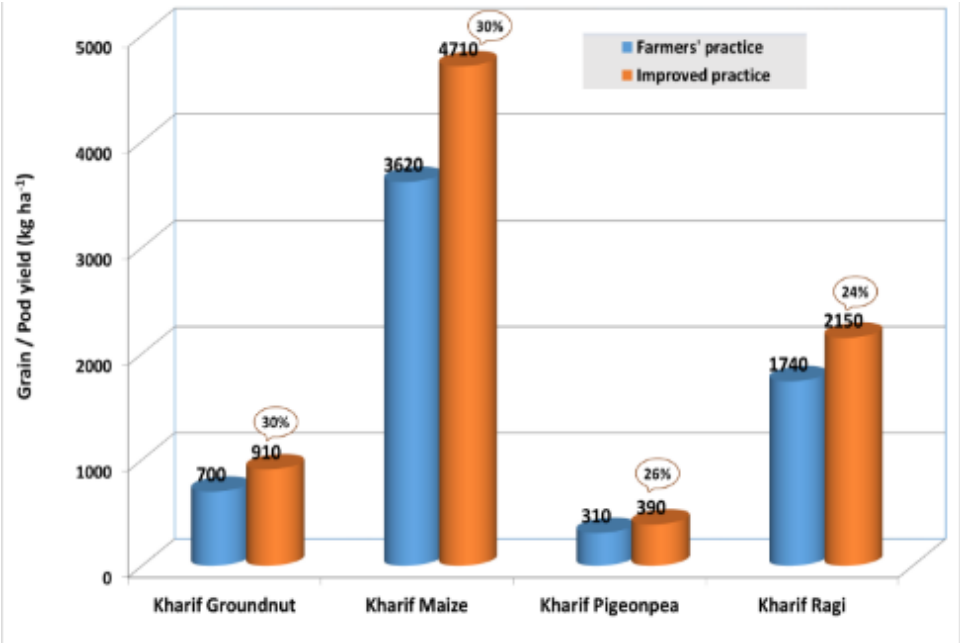

Figure 36. Comparison of yield of major crops during Kharif 2015

Shivamogga

Maize and paddy yields were found to be 22 and 23% higher respectively under improved management condition compared to farmers' practice fields under control conditions in Shivamogga. Farmers benefited by harvesting 700-850 kg of additional grain yield by adopting improved management practices compared to the control condition (Figure 37).

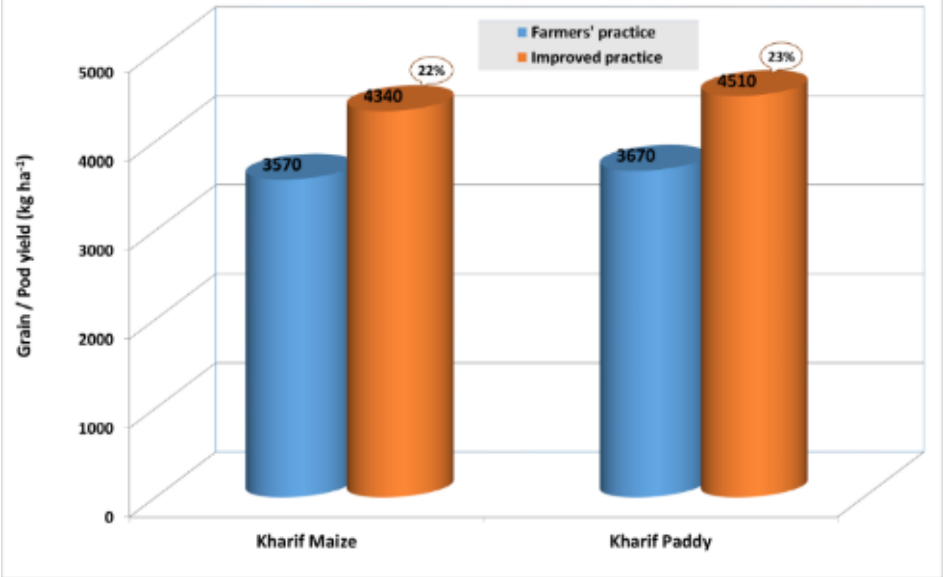

Figure 37. Comparison of yield of major crops during Kharif 2015

Tumakuru

Finger millet, groundnut, maize and paddy are the predominating cropping systems in Tumkur. The crop yield with the improved management condition was found to be higher by 11-24 % compared to that from farmers' practice control fields. Balanced fertilizer application along with seed treatment and improved cultivars helped in enhancing crop yield both in rainfed and irrigated areas. An additional 20% higher yield of finger millet and groundnut crops was harvested by adopting improved management techniques even in rainfed areas (Figure 38).

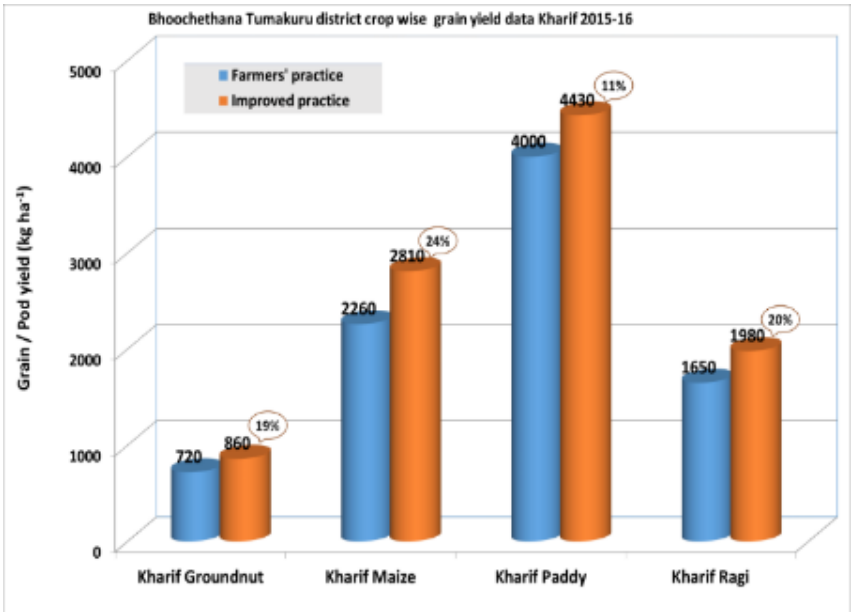

Figure 38. Comparison of yield of major crops during Kharif 2015

Udupi

Paddy is the predominating cropping system in Udupi. Crop yield with improved management practices in paddy was found to be higher by 20% compared to farmers' practice control fields. Farmers harvested an additional 500-650 kg grains by adopting improved management practices (Figure 39).

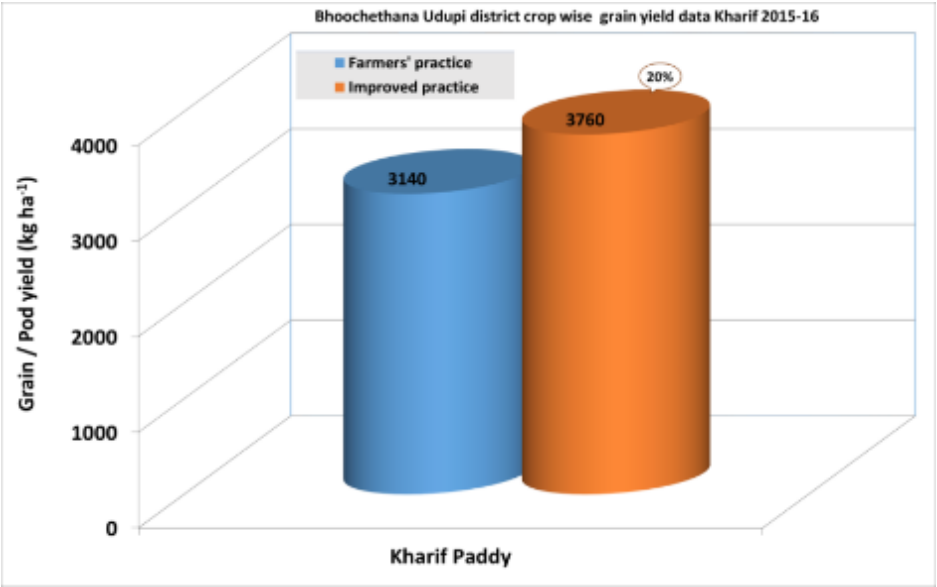

Figure 39. Comparison of yield of major crops during Kharif 2015

Uttara Kannada

Crop yield of maize and paddy was found to be higher by 29 and 24% respectively in improved practice compared to farmer managed control fields (Figure 40).

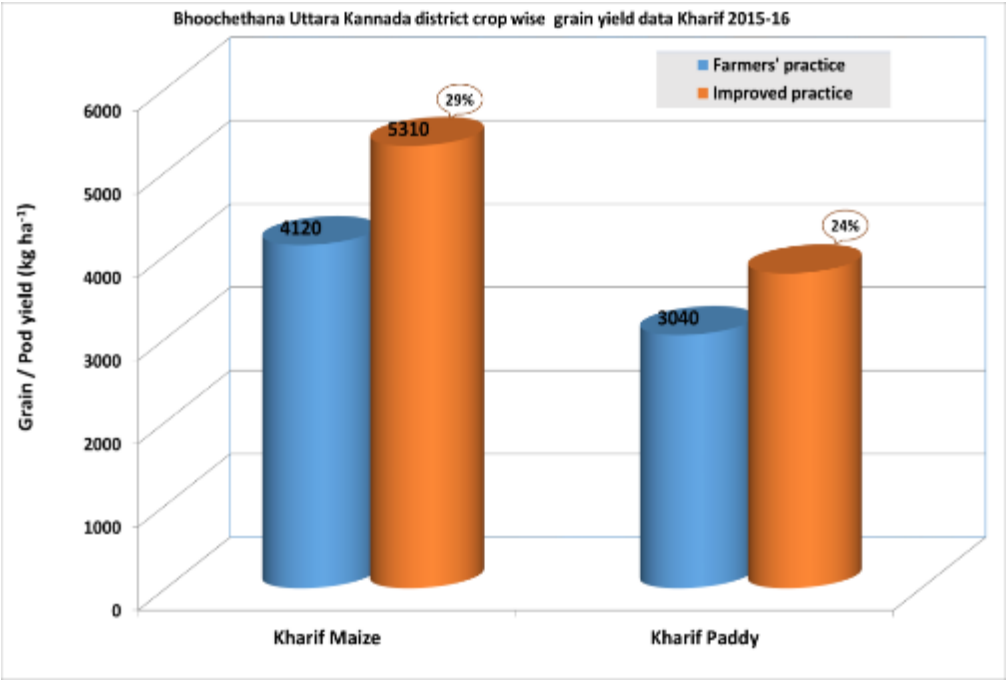

Figure 40. Comparison of yield of major crops during Kharif 2015

Vijayapura

Vijayapur was one of the districts worst hit by drought in 2015. Pigeonpea yield recorded under the improved management condition was 330 kg/ha compared to 260 kg/ha in control fields. Similarly sorghum yield under improved and control conditions was recorded as 790 and 610 kg/ha, respectively. Due to drought, crop yield in general was found to be relatively less; however the improved management condition alleviated the effect of drought to some extent (Figure 41).

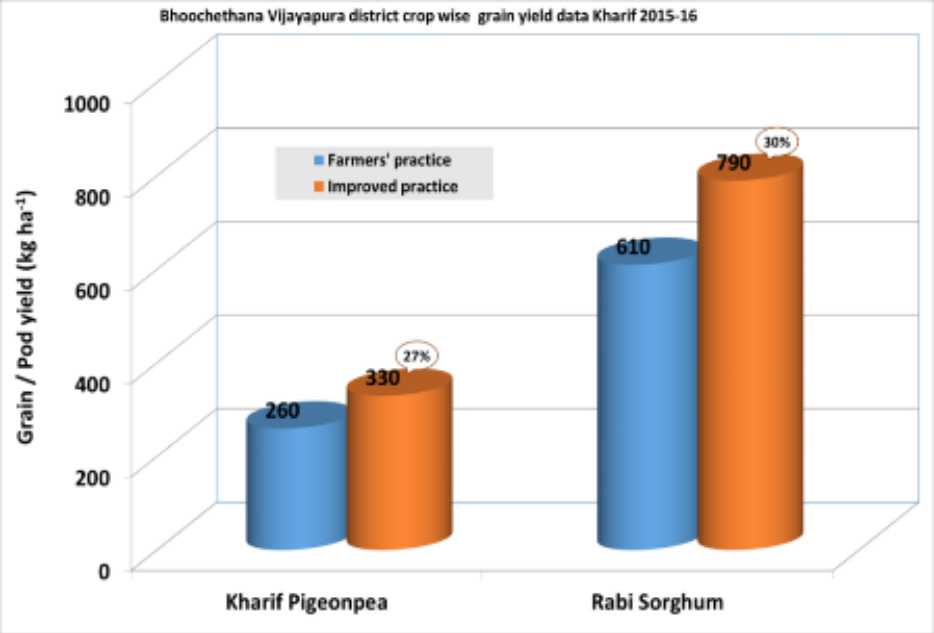

Figure 41. Comparison of yield of major crops during Kharif 2015

Yadagir

Crop yield of pigeonpea was found to be higher by 21% under improved management practice compared to farmers' control fields (Figure 42).

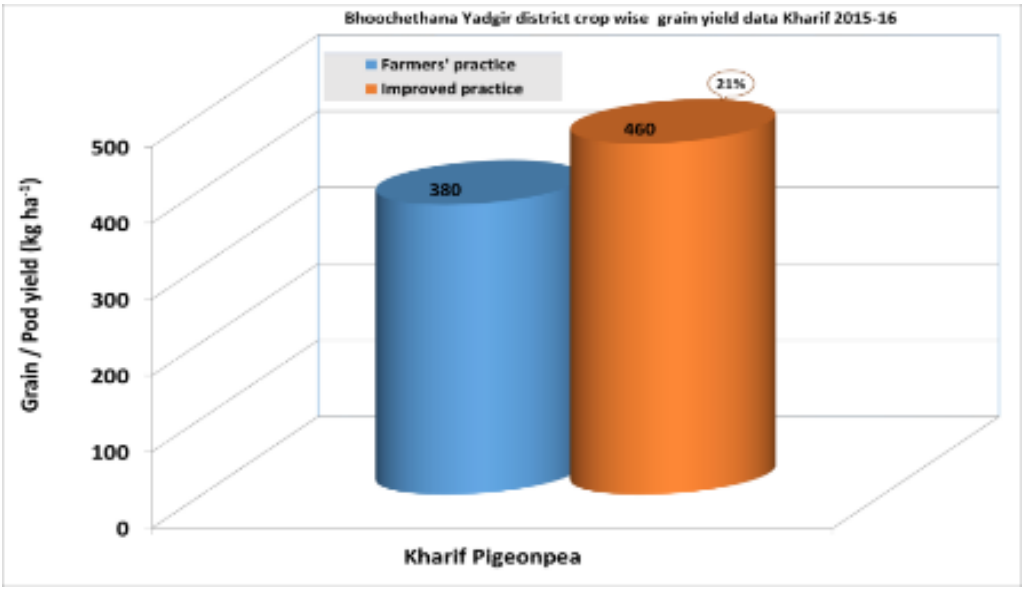

Figure 42. Comparison of yield of major crops during Kharif 2015

Economic Benefits of Bhoochetana during 2015-16

The Bhoochetana mission program was implemented over 66.85 lakh ha during the 2015-16 crop season with 44.26 lakh ha during *Kharif* and 22.59 lakh ha during the *Rabi* season. Nearly 87 per cent of the target area of 79.12 lakh ha was sown. Although, 2015-16 was declared as a drought year, the crop yield increased between 17 and 33 per cent over farmers' practice. Similarly, additional yield benefit recorded during the 2015-16 season showed that the additional yield benefit was observed in crops like paddy, maize, ragi, pearl millet and sorghum (Table 10). The increased yield resulted in increased net economic benefits to the state. Overall, a net economic benefit of nearly Rs 14,648 crores was generated through increased crop yield by adopting improved management practices (Table 10).

Table 10. Economic benefits of Bhoochetana during 2015-16 for major crops in Karnataka

Crops	Grain yield with Farmers' Practice (Kg/ha)	Grain yield with Improved Practice (Kg/ha)	Additional yield benefit (kg/ha)	Net Economic Benefit (Rs crores)
Black gram	650	780	130	0.39
Chickpea	460	605	145	6.15
Cotton	1368	1597	228	8.24
Green gram	330	390	60	0.05
Groundnut	1016	1252	236	10.87
Maize	3309	4075	766	41.27
Paddy	3869	4656	787	58.21
Pearl Millet	1120	1420	300	0.55
Pigeonpea	398	493	95	4.47
Ragi	1280	1588	308	11.87
Sorghum	1316	1615	299	3.54
Soybean	775	925	150	0.79
Wheat	210	280	70	0.08
All crops	**1841**	**2248**	**407**	**146.48**

Improving Rural Livelihoods through Integrated Watershed Management in Ballari district in Karnataka

In convergence with Bhoochetana, different watershed programs have been implemented in collaboration with the Department of Agriculture, WDD, SAUs and NGOs in selected districts of Karnataka. In the public-private partnership mode, a project for improving rural livelihoods through integrated watershed management was implemented at Ballari district with support from the Jindal South West foundation. The overall goal of this initiative is to sustainably increase agricultural productivity and improve the livelihoods of the rural poor in vulnerable rainfed areas through integrated watershed management. The specific goal of this initiative is to increase agricultural productivity, improve rural livelihoods and achieve sustainable rural development in selected villages.

The specific objectives are:

1. To establish a "Model Site of Learning" in the low-rainfall zone (<700 mm rainfall per annum) in Karnataka for demonstrating the potential of rainfed areas by adopting the integrated water resource management approach.
2. To enhance water availability and its (green and blue water) use efficiency to diversify the livelihood systems in the target villages by adopting the integrated water resource management approach.
3. To build the capacity of the farmers in the region for improving rural livelihoods through knowledge sharing and dissemination strategy.

Strategy

The proposed strategy is based on the learnings from the experiences over the last 40 years and more recently from the upscaling of the innovative farmers' participatory consortium model for integrated watershed management in India and four other Asian countries. The salient features of the strategy are:

- Identifying target villages in Ballari district and forming the consortium of critical partners to converge project activities with the GoK's Department of Agriculture (DoA) and WDD activities
- Adopting a collective participatory approach to implement R4D
- Adopting a holistic and integrated approach for sustainable development of rainfed areas through conservation, enhancement, and efficient use of natural resources by using watershed management as an entry point for improving rural livelihoods
- Developing innovative and effective mechanisms to share the knowledge with different stakeholders and building community-based institutions for sustainable development
- Diversifying the sources of livelihood for the families to build their resilience against the impacts of climate change
- Targeting convergence of activities of the Department of Agriculture of the GoK as well as of other Rural Development departments
- Establishing a 5,000 ha site of learning encompassing a holistic community watershed management approach
- Establishing rain gauges and hydrological monitoring stations at sites of learning in the watersheds which will provide strategic data on hydrological parameters for planning watershed interventions in specific agro-eco-regions with varying soil types
- Developing Natural Resource Management (NRM) based income-generating activities for improving livelihoods of vulnerable groups
- Demonstrating improved management options for enhancing productivity on a sustainable basis.
- Training lead farmers to serve as trainers in the district
- Establishing field laboratories for students to undertake strategic research in target agro-eco-regions in the area of community watershed management
- Harnessing public-private partnerships for backward and forward linkages, to improve the incomes of the farming community
- Initiating waste water treatment and its reuse in agriculture to address the issue of water scarcity

Partners

- Department of Agriculture (DoA), Government of Karnataka
- WDD, Government of Karnataka
- University of Agricultural Sciences (UAS), Raichur
- JSW Foundation
- Farmers' Association

Target Area

Target area for the proposed study is Sandur taluk of Ballari district in Karnataka state. The district is endowed with iron ore and is famous for mining and related industrial activities which have provided employment opportunities for the young population. Owing to the availability of industrial employment opportunities, the lack of a labor force and falling returns due to low crop yields and price constraints agriculture has been left for elders and women folk. Furthermore, degradation of soil and water resources in the district largely due to improper water management along with crop management practices have led to the current problems of neglected agriculture, non-inclusive and imbalanced development in the area that have resulted in food insecurity and poor nutrition of human beings and cattle in the region.

Ballari District Profile

The district Ballari is located in the eastern part of Karnataka state and lies between the latitudes 140 30'N - 150 47'N and longitudes 750 40' E - 77011'E. The geographical area of the district is 8,420 sq. kms. The topography of the district is hilly and undulated in the central part with plains in the east and west (Figure 43).

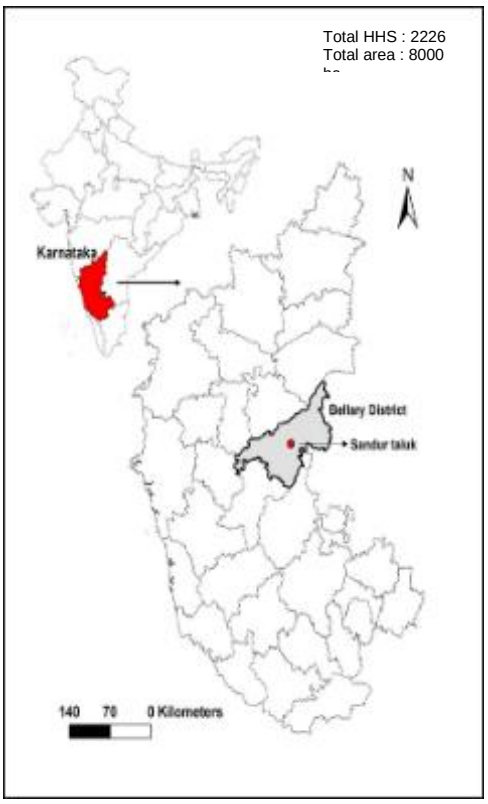

Figure 43. Sandur taluk in Ballari district, Karnataka

Activities Undertaken

- Soil and Water Conservation measures
- Productivity Enhancement
- Monitoring and Evaluation
- Avenue Plantation
- Income generating Activities
- Livestock development
- Capacity Building and Dissemination

Soil and Water Conservation Measures

During the year various soil and water conservation structures viz. farm ponds, check dams and field bunding were built, and silt removal from check dams was undertaken (Table 11 & Figure 44). The five farm ponds that were constructed have created the effective storage capacity to harvest about 1,500 m^3 of rainwater which can be used for groundwater recharging and supplementary irrigation. Two check dams were constructed with about 1,000 m^3 net storage capacity. About 4,020 m of field bunding has been done in farmers' fields to conserve rain water as well as to reduce soil erosion. Desilting of old check dams was done to increase the storage capacity (300 m^3) of the structures. Runoff water was diverted into dry open wells to rejuvenate them as well to increase rain water use efficiency.

Table 11. Soil and water conservation and water harvesting structures constructed in JSW watershed villages, 2013- 2016.

Sl. No.	Particulars	2013-14	2014-15	2015-16	Total Achievement	Total Beneficiary farmers
1	Gully plugs	90	0	0	**90**	**41**
2	Farm Pond (FP)	9	3	5	**17**	**17**
3	Mini Percolation Tank (MPT)	2	1	0	**3**	**4**
4	Borewell Recharge Pit	15	1	0	**16**	**16**
5	Nala bund (NB)	1	0	0	**1**	**10**
6	Check Wall	1	0	0	**1**	**1**
7	Check Dam (CD)	3	7	2	**12**	**53**
8	Waste water treatment tank	1	0	0	**1**	**5**
9	Field Bunding (Running meters)	17137	2967	4020	**24214**	**126**
10	Silt removed from old check dams (m^3)	360 (1 CD)	819 (2 CDs)	165 (1 CD)	**1344**	**12**
11	Open well recharging	0	4	0	**4**	**4**

Total water impounded: Soil and water conservation and water harvesting structures constructed in the watersheds have created a net storage capacity of about 18,500 $m.^3$ The gross water conserved is about 45,000 m^3 due to refilling in the rainy season (Figure 44).

Figure 44. Different soil and water conservation structures constructed in the JSW ICRISAT watershed, Ballari.

Productivity Enhancement Initiatives

Farmers' participatory varietal evaluation trials with pearl millet (2), pigeonpea (11), groundnut (2), maize (2) and foxtail millet (2) were conducted in farmers' fields to show them the advantages of using improved cultivars to enhance crop productivity (Figure 45 and Table 12). ICRISAT pearl millet variety ICTP8203 has given a 12% increase in grain yield over the farmers' variety. The ICRISAT pigeonpea variety ICPL 87119 showed an average enhanced grain yield of 26%, over local varieties. The ICRISAT groundnut variety ICGV 91114 enhanced grain yield by 24% over the local variety. In case of maize and foxtail millet grain yield with the improved variety increased by 25 and 13% compared to local varieties.

Figure 45. Improved crop varieties of pigeonpea, groundnut and foxtail millet at JSW watershed villages

Table 12. Farmers' participatory evaluation trials of pearl millet, pigeonpea, groundnut, maize and foxtail millet crops during 2015.

Farmer Name	Village	Crop	Improved variety	Grain yield (Kg ha^{-1})	Local variety	Grain yield (Kg ha^{-1})	% increase in grain yield
Venkappa	Kodalu	Pearl millet	ICTP-8203	1212	Pioneer	1040	16
Revanna	Kodalu	Pearl millet	ICTP-8203	1119	Pioneer	1040	7.5
Mean				**1165**		**1040**	**12**

Farmer Name	Village	Crop	Improved variety	Grain yield (Kg ha^{-1})	Local variety	Grain yield (Kg ha^{-1})	% increase in grain yield
Hanumanthappa	D. Anthapur	Pigeonpea	ICPL 87119	1044	ICP 8863	810	28
Kardibasappa	D. Anthapur	Pigeonpea	ICPL 87119	1081	ICP 8863	780	38
Basavaraj	D. Anthapur	Pigeonpea	ICPL 87119	1025	ICP 8863	750	36
Mean				**1050**		**780**	**34**
Sanmukappa	Joga	Pigeonpea	ICPL 87119	1025	ICP 8863	825	24
Mean				**1025**		**825**	**24**

Ganganna	Kodalu	Pigeonpea	ICPL 87119	857	ICP 8863	700	22
Komari	Kodalu	Pigeonpea	ICPL 87119	932	ICP 8863	730	27
Mallayya	Kodalu	Pigeonpea	ICPL 87119	969	ICP 8863	720	34
Mareppa	Kodalu	Pigeonpea	ICPL 87119	783	ICP 8863	670	16
Mean				**885**		**705**	**25**
Shanmukayya	Chikkanthapur	Pigeonpea	ICPL 87119	913	ICP 8863	750	22
Shivagangamma	Chikkanthapur	Pigeonpea	ICPL 2740	932	ICP 8863	720	29
K. Basappa	Chikkanthapur	Pigeonpea	ICPL 87119	839	ICP 8863	720	16
mean				**894**		**730**	**22**

Farmer Name	**Village**	**Crop**	**Improved variety**	**Yield (Kg ha-1)**	**Local variety**	**Grain yield (Kg ha-1)**	**% increase in grain yield**
Gangadhar	D Anthapur	groundnut	ICGV 91114	1566	TMV-2	1250	25
Kumbar Hemanna	Kodalu	groundnut	ICGV 91114	1510	TMV-2	1220	23
Mean				**1538**		**1235**	**24**

Farmer Name	**Village**	**Crop**	**Improved variety**	**Grain yield (Kg ha^{-1})**	**Local variety**	**Grain yield (Kg ha^{-1})**	**% increase in grain yield**
G. Basdeppa	Chikkantapur	Maize	High-tech seeds	2331	NK-6240	1850	26
Basavanagowda	Kodalu	Maize	High-tech seeds	2275	NK6240	1830	24
Mean				**2303**		**1840**	**25**

Farmer Name	**Village**	**Crop**	**Improved variety**	**Grain yield (Kg ha^{-1})**	**Local variety**	**Grain yield (Kg ha^{-1})**	**% increase in grain yield**
Nigamma	Doddantapura	Foxtail millet	HMT-100-1	951	local	825	15
Jambanna	Chikkantapur	Foxtail millet	HMT-100-1	895	local	810	10.5
Mean				**923**		**817.5**	**13**

Micronutrient Trials

Soil test-based balanced fertilizers trials were conducted in 61 famers' fields in four villages to demonstrate the advantage of application of S, Zn and B nutrients in addition to the application of NPK fertilizers. Farmers applied 200 kg gypsum, 12.5 kg Zinc sulphate and 2.5 kg borax per hectare in improved practice and compared the results with those of farmers' practice. Results from farmers' field trials indicated that crop yield can be increased with improved agronomic practices. Table 13 indicates an increase of 19% in groundnut yield and 27% in maize yield as compared to farmers' practice (Figure 46).

Table 13. Average grain yields of major crops under farmers' practice (NPK only) and improved practice (NPK+Zn+S+B) during the rainy season of 2015				
Crop	**Village**	**Yield (kg/ha)**		**% increase in yield**
		FP	**IP**	
Groundnut	Kodalu	1305	1510	15.7
Groundnut	Doddanthapur	1250	1566	25
Mean		**1277**	**1530**	**19**
Maize	Chikkantapur	1775	2331	31
Maize	Kodalu	1850	2275	23
Mean		**1812**	**2303**	**27**

Monitoring and Evaluation

Automatic weather station

An automatic weather station has been established to collect climatic data on rainfall, air and soil temperature, solar radiation and wind velocity and direction (Figure 47). Additional rainfall data will also be collected from different parts of the watershed through four rain gauges installed across the watershed. Most of the rainfall in Ballari district is received in the three month period Aug-Oct; Year-to-year variability in rainfall is very high and the coefficient of variation (CV) of rainfall in these three months ranges from 53 to 66%. Seasonally, the southwest monsoon period (Jun-Sep) receives a rainfall of about 352 mm with a CV of 28% and the post-monsoon period (Oct-Dec) receives a rainfall of 144 mm with a CV of 56%. There is also considerable spatial variability in rainfall in the Ballari district. The above clearly shows the importance of rainfall measurements at watersheds to help quantify the amount of moisture availability in different phenophases of crop growth and to relate this with the water requirements of the crop. Rainfall monitoring is therefore also necessary to assess runoff, soil loss and groundwater recharge. Most importantly it helps the community understand crop water usage and irrigation scheduling. The annual amount of rainfall in D. Anthapur was 328 mm, Chikkanthapur 347 mm, Kodalu 327 mm and Joga 286 mm during 2015 (Figure 48).

Figure 46. Micronutrient trails conducted on farmers' fields at JSW watershed villages during 2015

Figure 47. Automatic weather station installed in Chikkanthapur and one of the raingauges installed in Doddanthapur.

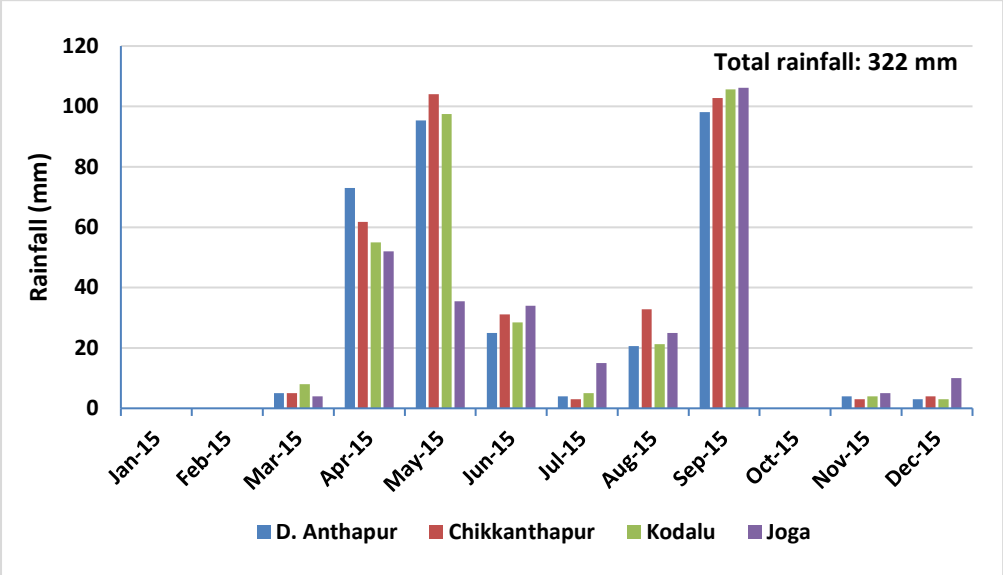

Figure 48. Monthly rainfall received in the JSW watershed villages during 2015.

Hydrological gauging station

A hydrological gauging station invariably requires continuous recording by means of an automatic runoff recorder and automatic micro-processor based sediment samplers, which monitor the temporal changes in the suspended sediment concentration during the runoff event.

A hydrological gauging station consisting of an automatic runoff recorder and a microprocessor-based sediment sampler along with an appropriate masonry hydraulic measuring structure (viz. broad-crested rectangular weir or notch) was installed (Figure 49) to monitor runoff, peak runoff rate and soil loss from the watershed. Runoff during 2015 from the D. Anthapur village was about 4.90 mm.

Figure 49. Installation of Hydrological gauging station at JSW villages

Groundwater level monitoring

There are 220 bore wells in the watershed. Groundwater levels are monitored using a groundwater level meter in the watershed at 52 selected wells on topo-sequence at a fortnightly interval through farmers' participatory mode to assess the impact of various watershed interventions in improving groundwater levels. Necessary training has been given to the local community members in recording groundwater levels using this equipment. The groundwater level during the first year serves as a baseline value to assess the impact of various watershed interventions in improving groundwater levels (Figure 50).

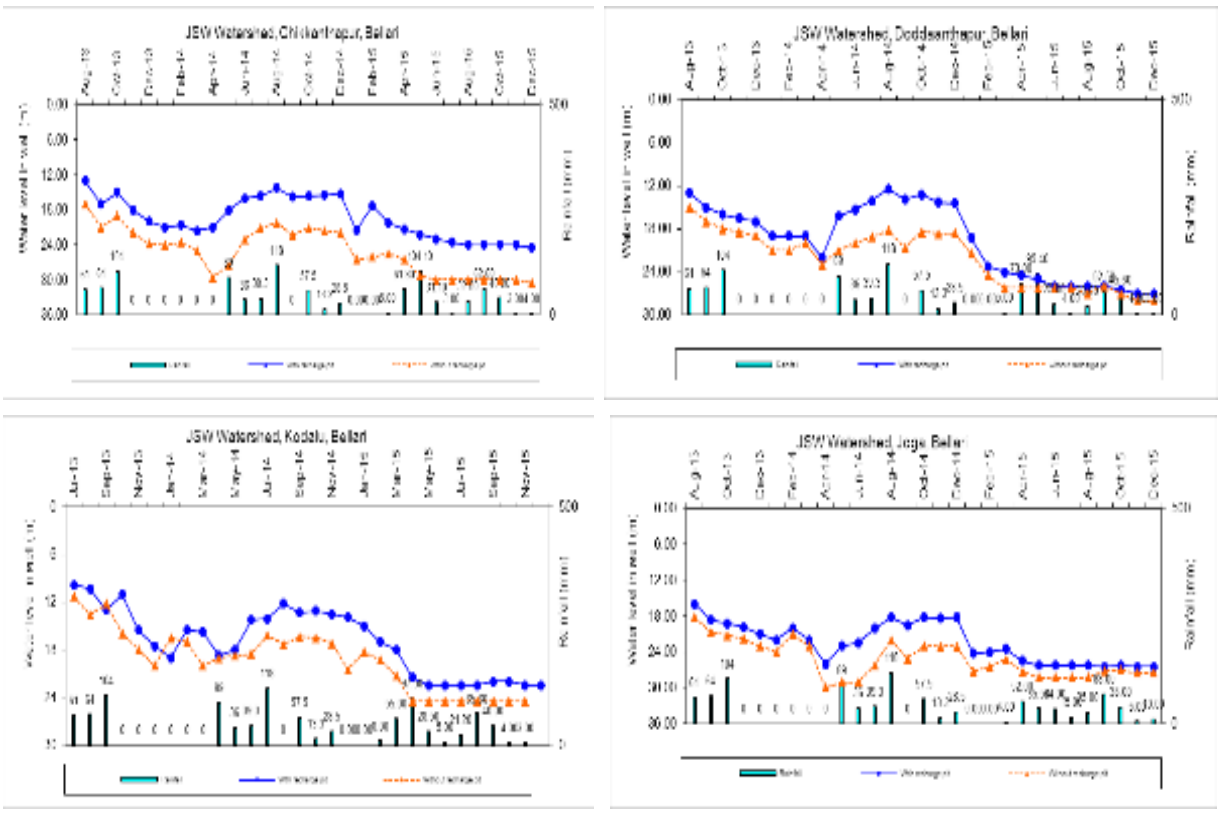

Figure 50. Groundwater levels (near and away from water harvesting structures) in the JSW Watershed, Ballari district.

Avenue Plantation

In order to increase the greenery as well as to prevent the dust problem, avenue plantation has been taken up (Figure 51). Various tree species including horticulture plants (18,100) were planted in the project villages.

Figure 51. Avenue plantation activities at JSW watershed villages

Income generating activities

To promote income generating activities and improve livelihoods, necessary training sessions were conducted on Agarbathi making for 25 women at Chikkanthapur village during 2015 (Figure 52).

Figure 52. Income generating activity on Agarbathi making program at Chikkanthapur village

Livestock development

Various animal health developmental programs and activities were being taken up in all the watershed villages (Joga, D. Anthapur, Chikkanthapur and Kodalu) for improvement of livestock. In Kodalu village three farmers have been growing *Azolla* as nutritional feed for cattle (Figure 53).

Figure 53. Conducting animal health camps (left) at D. Anthapur village; cultivation of Azolla (right) for cattle feed in Kodalu village

Capacity Building Programs to Improve Livelihoods

Various capacity building programs were conducted for farmers and women SHGs to train and build their capacity for sustainable management and effective utilization of resources for enhancing crop productivities and improving livelihoods (Table 14 and Fig 54-56).

Table 14. Capacity Building/Training/Awareness programs conducted in watershed villages

S No	Details	Particulars	2014-15	2015-16	Total Achievement	Total beneficiary farmers
1	Farmers' Training	65 (2 times)	112 (1 time)	30 (1 time)	**4**	**207**
2	- Institutional Training sessions at DATC, Kampli, Dept. of Agriculture attended by women (3days)	109 (6 times)	15 (1 time)	30 (1 time)	**8**	**139**
3	SHG's Capacity Building Training sessions	203 (4 times)	181 (3 times)	0	**7**	**384**
4	International women's Day Celebration	55	60	0	**2**	**115**
5	Farmers' Day	1 (1300 farmers)	1 (58 farmers)	1 (76 farmers)	**3**	**1434**
6	World environmental Day	55	0	0	**1**	**55**
7	User group training sessions and farmers' meeting	0	310 (2 times)	0	**2**	**310**
8	Wall writing (Watershed Objectives and fertility status of the village)	3	0	18	**21**	**21**
9	Revolving fund check distribution program	0	95 (SHG women)	0	**1**	**95**
H.	**Exposure visits**					
1	Dharwad Krishimela Visit	10	0	0	**10**	**10**
2	Raichur Krishimela Visit	4	0	0	**4**	**4**
3	Exposure visit	15 (ICRISAT)	0	54 (JSW)	**69**	**69**
4	Exposure visit to Shivamogga for Agriculture study purpose under Atma Project	4	0	2	**6**	**6**
5	Visit to ARS Hagari Krishimela	27	22	0	**49**	**49**
6	NWFD at ICRISAT attended by JSW village women farmers	0	13	0	**13**	**13**
I	**Field Day**					
	Groundnut	0	0	1	**1**	**48**
	Pigeonpea	0	1	1	**2**	**121**
	Maize			1	**1**	**60**

Figure 54. Exposure visits to Jindal foundation (right), BG kere village (left).

Figure 55. Visits of JSW delegates (right) and IIT students (left) to watershed villages

Figure 56. Field days conducted in watershed villages (left) and awareness on watershed activities through wall writing (right).

International Women's Day

"International Women's Day" was celebrated at Chikkanthapur village in JSW watershed, Bellary on 8th March 2015. During the celebration there was a discussion on the social and economic aspects of womens' rights as well as on the cultural and political achievements made by women over the year. They also spoke on how women are changing the face of power and wielding influence to positively impact all aspects of our globally connected world. The watershed concept, soil and moisture conservation practices and other components of watershed management were explained to the participants. Subsequently the Bhoochetana scheme and soil fertility information and the importance of micronutrient application for enhancing crop productivity were also explained. Some games were conducted for SHG's in which they had to guess the performance of participating members. There were prizes for the winners during this celebration.

During the celebration of "International Women's Day" the participants included the District IWRMP training Officer **Mr. Umesh Naganavar**, the JSW foundation School teacher **Miss. Shivalingamma**, a Health department doctor **Dr. Venkatesh**, and a Gram Panchayat member **Miss. Hampamma,** SHG women and ICRISAT staff. There were about 60 members who participated in the event (Fig 57-58).

Figure 57. Inaugural session (left) and active participation of SHG women (right) in Chikkanthapur village

Figure 58. Explanation of the watershed concept by Mr. Umesh Naganavar (left) and womens' rights in the world by Miss. Shivalingamma (right) in Chikkanthapur village

Figure 59. SHG's women have participated in a game to make pyramids through tea cups (left) and in musical chairs (right) in chikkanthapur village.

Figure 60. Distribution of prizes to winners during "International Women's Day" celebration occasion at Chikkanthapur village

Integrated Water Resource Management in Kolar District of Karnataka for Increasing Agricultural Productivity and Improved Livelihoods

The Kolar watershed "Markandeya Samgra Jala Sampnmula Niravahane Samithi" that is supported by the Coca-Cola India Foundation for Rural Water Infrastructure and the ICRISAT led consortium along with MYRADA, farmers and the Government of Karnataka identified a

meso-watershed in Kolar taluk of the district that is spread over a 1,333 ha area, has 1,411 households and covers eight villages. The eight villages of Vakkaleri Hobli are in the vicinity of Kolar town that is at a distance of about 6-16 km. The selected villages in the watershed have a dry climate and an average rainfall of about 710 mm. This was a pilot site for improving water use efficiency and groundwater recharge and strengthening ecosystem services through a community watershed management program.

Kolar district is situated in the Eastern Dry Zone of Karnataka state. Groundwater depletion is a major concern for agriculture in Kolar district. Groundwater is being used for irrigating cash crops such as tomato, chili and mulberry. However, wide spread plantation of *Eucalyptus* has been the main reason for depletion in groundwater recharge. The present status of the groundwater level is greater than 300 m.

During the period the various activities that were undertaken were: soil and water conservation which included - farm ponds, gully plugs and sunken pits as well as *in situ* moisture conservation systems; productivity enhancement initiatives like - soil test-based fertilizer application, improved crop varieties' selection; crop diversification - floriculture and vegetable cultivation; afforestation with *silver oak, neem* and *gliricidia*; livelihood activities like supporting women SHGs in dairying, keeping back yard gardens, tailoring, keeping petty shops, etc.

Soil and Water Conservation

The various soil and water conservation and groundwater recharge structures constructed were: farm ponds (9 nos. size 15 m x 10 m x 3 m and 10 m x 10 m x 3 m), field bunding (2,500 cum covering 65 ha), gully plugs (11 nos.) and ponds "*go katte*" for cattle (1 nos.) (Figure 61). As the watershed has low potential for runoff in waterways, a major focus of farm pond construction has been to harvest the runoff from individual farmers' fields. These farm ponds have been very beneficial in terms of storage of water after percolation. All the water harvesting structures constructed so far, ie, a total of 28 farm ponds and 75 stone checks, were constructed to store excess runoff water from farmers' fields. Taken together these structures had 13,500 m^3 of net storage capacity. As a result the total rainwater harvested was 33,750 m^3 with two or three fillings in a season depending on the rainfall received during the year. Each wastewater treatment unit once constructed, is used by two farmers for vegetable cultivation in three acres of land.

Productivity Enhancement

The crop demonstration during 2015-16 involved 55 farmers over 25 ha (Table 15). This year, 2015 is a very poor and erratic rainfall year with about 567 mm of rainfall (Figure 62). This has severely affected sowing and the crop stand in the district and in the watershed. The results showed productivity improvement by 26% in ragi with improved management (Table 16 and Figure 63). Water harvesting structures were helpful in sustaining the bore wells to provide at least one or two irrigations, in spite of a sharp decline in the water table in the wells, especially those located away from farm ponds.

Farm pond, Mudavatti

Farm pond, Shattiganahalli

Trench cum bund, Mudavatti

Gliricidia and silveroak bund plantation

Figure 61. Water harvesting and groundwater recharge structures in the Coca Cola-ICRISAT watershed, Kolar.

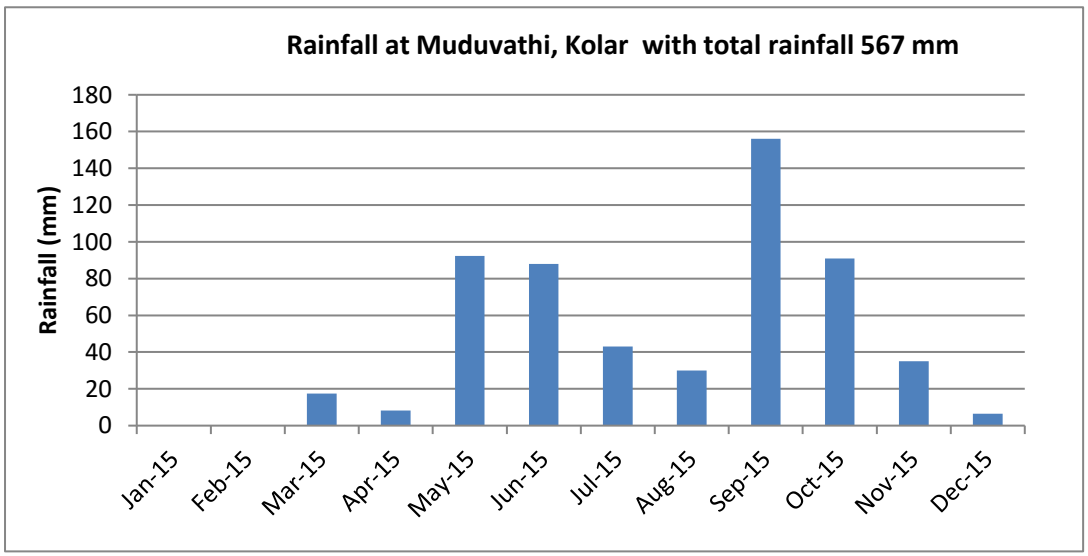

Figure 62. Rainfall during 2015 at Muduvathi village, Kolar.

Figure 63. A farmer showing his ragi crop grown with improved Practice, 2014-15.

Table 15. Crop demonstration during 2015.		
Crop	**Area (ha)**	**No. of Farmers**
Groundnut	6	15
Finger millet	12	25
Pigeonpea	6	12
Castor	1	3

Table 16. Impact of balanced micronutrient application with improved variety on ragi during *Kharif* - 2015.		
Crop	**Treatment**	**Pod yield kg/ha**
Ragi (GPU 28) with two irrigations	Improved practice (RDF * + Agribor+ Zinc sulphate)	737 (26)
	Farmers practice (RDF)	583

* RDF: Recommended Dose of Fertilizers; crop variety: local; * figures in parenthesis are % increase over control.

Other Activities

Bund plantation with horticultural plants (636 plants) covering 8 ha and benefitting 30 farmers as well as with forestry species (2,000 plants of silver oak, *Gliricidia* and neem) covering 10 ha and benefitting 15 farmers has been done. Vermicomposting has been done with nine farmers with a vermi bed size of 3 m x 1 m x 1 m, which can prepare 10-12 tons of manure in 8-10 weeks. In addition to this, with the convergence of department schemes, vermi beds have been provided to farmers. A domestic wastewater treatment and safe reuse system was introduced last year and benefitted two farmers who were able to grow vegetables even during extended dry spells this year. Training was provided in tailoring for unemployed women. Figure 64 shows the various livelihood activities in the watershed.

Figure 64. Various livelihood activities in the Coca Cola-ICRISAT watershed, Kolar

Several SHG activities have been adopted to improve livelihoods with convergence and linkage of banks to SHG members for financial support. The watershed project coordinated training of thirteen SHG members in tailoring by the Community Management Resource Center of MYRADA and linked SHGs to banks for financial support to buy sewing machines to improve their livelihood. Similarly the Watershed project has facilitated farmers (four groups, each consisting of 15 members) to avail of a loan from NABARD for the purchase of mulching animals. To encourage women farmers to improve home nutrition and additional income, 300 fruit plants (sapota, jamun and lemon) were distributed on the occasion of International women's day celebration.

Awareness, Capacity Building and Convergence Activities

Capacity building activities play a very critical role in effective participation and implementation of the watershed program. Several awareness and capacity building activities have been taken up in the watershed for effective dissemination and wider implementation of watershed interventions. Various activities in this direction include need based training on different topics, tailoring, environment day, farm pond krishi bhagya yojana, field day, information through display of wall writings and video screenings using pico projectors (Table 17 and Figure 65). An innovative digital extension system was introduced to reach a large number of farmers using a hand held pico projector to show farmers videos of improved practices as an effective tool. Twenty one video disseminations have been done covering 150 farmers.

Digital extension system; During the field day, officials address farmers after the field visit

International women's day celebration and training to SHGs

Figure 65. Various capacity building activities conducted

Table 17. Capacity building and convergence activities in watershed, Kolar.			
Sl No.	**Details of Training**	**No. of Training sessions**	**Number of beneficiaries**
1	Training on tailoring	2	30
2	SHG Linkages/ Nafini/PKGB	6	90
3	Digital extension for watershed staff and lead farmers (video production)	13	13
4	Video dissemination and adoption	21	150
5	Farm pond krishi bhagya yojane	11	11
6	Biodigester	5	5
7	PG Menstural Hygine	7	40
8	Training program through USHA	1	30

ANNEXURE I

Crop-wise state mean yields of major crops in 2015-16

Crop	Grain FP	Fodder FP	TDM FP	Grain IP	Fodder IP	TDM IP	% Increase over FP			No of samples	
							Grain	Fodder	TDM	Grain FP	Grain IP
Kharif											
Black gram	650	480	1120	780	640	1410	20	33	26	5	5
Cotton	1480	6810		1730	7770		17	14		115	115
Green gram	330	740	1060	390	900	1290	18	22	22	10	10
Groundnut	970	1280	2250	1180	1470	2620	22	15	16	184	184
Maize	3480	3990	8380	4280	4810	10170	23	21	21	388	388
Paddy	3590	4080	7670	4350	4930	9280	21	21	21	490	490
Pearl Millet	900	1990	3260	1110	2460	4090	23	24	25	50	50
Pigeonpea	370	860	1460	460	1070	1840	24	24	26	147	147
Ragi	1260	2710	4530	1560	3330	5560	24	23	23	425	425
Sorghum	3140	4580	8530	3850	5670	10540	23	24	24	17	17
Soybean	930	1240	2180	1100	1450	2550	18	17	17	30	30
										1861	1861
Rabi											
Rabi Chickpea	470	680	1150	620	830	1440	32	22	25	161	161
Rabi Ragi	1770	3470	6350	2170	4290	7850	23	24	24	20	20
Rabi Sorghum	840	1700	2900	1040	2060	3530	24	21	22	214	214
Rabi wheat	210	630	840	280	770	1050	33	22	25	10	10
										405	405
										2266	2266

Note: For groundnut pod is considered instead of grain

District-wise mean yields of major crops during *kharif* 2015-16

District	Crop	Grain FP	Fodder FP	TDM FP	Grain IP	Fodder IP	TDM IP	% Increase over FP			No of samples	
								Grain	Fodder	TDM	Grain FP	Grain IP
Ballari	Cotton	2070	6810		2320	7770		12	14		30	30
Ballari	Groundnut	760	1000	1760	990	1300	2290	30	30	30	10	10
Ballari	Maize	3420	3230	7390	4450	4210	9590	30	30	30	50	50
Ballari	Paddy	5380	6560	11940	6230	7750	13980	16	18	17	30	30
Ballari	Pearl Millet	1490	2400	4630	1930	3190	6190	30	33	34	10	10
Ballari	Sorghum	2950	4450	8170	3460	5380	9820	17	21	20	7	7
Ballari Total											137	137
Bengaluru Rural	Maize	2180	4470	7050	2850	5350	8690	31	20	23	20	20
Bengaluru Rural	Ragi	1320	2200	4130	1780	2970	5570	35	35	35	31	31
Bengaluru Rural Total											51	51
Bengaluru Urban	Ragi	1670	2590	4840	2030	3210	5970	22	24	23	16	16
Bengaluru Urban Total											16	16
Bidar	Blackgram	650	480	1120	780	640	1410	20	33	26	5	5
Bidar	Pigeonpea	600	1470	2430	710	1700	2830	18	16	16	15	15
Bidar Total											20	20
Chamarajanagar	Groundnut	990		990	1270		1270	28		28	4	4
Chamarajanagar	Maize	4630	12130	18440	5500	14160	21420	19	17	16	34	34
Chamarajanagar	Ragi	1600	4380	6570	1990	5400	8100	24	23	23	42	42
Chamarajanagar Total											76	76
Chikkaballapur	Groundnut	770	1490	2250	940	1770	2710	22	19	20	16	16
Chikkaballapur	Maize	890	910	2430	1090	1160	3070	22	27	26	10	10
Chikkaballapur	Ragi	560	1730	2620	720	2170	3310	29	25	26	9	9
Chikkaballapur Total											35	35
Chikkamagaluru	Paddy	4560	5750	10310	5600	7240	12840	23	26	25	40	40
Chikkamagaluru	Ragi	970	3630	5070	1250	4510	6330	29	24	25	30	30
Chikkamagaluru Total											70	70
Chitradurga	Cotton	990			1140			15			20	20
Chitradurga	Greengram	330	740	1060	390	900	1290	18	22	22	10	10
Chitradurga	Groundnut	500	390	890	610	500	1110	22	28	25	30	30
Chitradurga	Maize	4320	2500	8090	5200	2880	9490	20	15	17	20	20
Chitradurga	Pigeonpea	510	750	1660	650	970	2150	27	29	30	19	19
Chitradurga	Ragi	1020	2050	3520	1240	2460	4240	22	20	20	20	20
Chitradurga Total											119	119
Dakshina Kannada	Paddy	3090	4040	7130	3870	5120	8990	25	27	26	35	35
Dakshina Kannada Total											35	35
Davanagere	Cotton	960			1060			10			10	10
Davanagere	Groundnut	1990	3470	5470	2430	4120	6550	22	19	20	10	10

District	Crop	Grain FP	Fodder FP	TDM FP	Grain IP	Fodder IP	TDM IP	% Increase over FP			No of samples	
								Grain	Fodder	TDM	Grain FP	Grain IP
Davanagere	Maize	4210	2830	8280	4980	3470	9890	18	23	19	20	20
Davanagere	Paddy	5510	4690	10190	6550	5510	12060	19	17	18	20	20
Davanagere	Pigeonpea	220	740	1090	280	980	1440	27	32	32	20	20
Davanagere	Ragi	1860	2730	5310	2220	3380	6500	19	24	22	20	20
Davanagere	Sorghum	3280	4660	8780	4120	5880	11050	26	26	26	10	10
Davanagere Total											110	110
Dharwad	Soybean	310	550	860	400	700	1100	29	27	28	10	10
Dharwad Total											10	10
Gadag	Groundnut	830	470	1270	1030	550	1550	24	17	22	50	50
Gadag Total											50	50
Hassan	Maize	3540	3540	7770	4380	4210	9420	24	19	21	49	49
Hassan	Paddy	3930	5700	9630	4940	6650	11600	26	17	20	10	10
Hassan	Ragi	2040	3090	6180	2520	3850	7640	24	25	24	20	20
Hassan Total											79	79
Haveri	Cotton	960			1060			10			15	15
Haveri	Groundnut	2400	2610	5040	2850	3160	6040	19	21	20	20	20
Haveri	Maize	4350	3620	8780	5130	4430	10460	18	22	19	50	50
Haveri	Paddy	3740	5480	9220	4770	6770	11540	28	24	25	20	20
Haveri	Soybean	1240	1590	2830	1450	1830	3280	17	15	16	20	20
Haveri Total											125	125
Kalaburagi	Pigeonpea	490	1310	1810	600	1570	2190	22	20	21	12	12
Kalaburagi Total											12	12
Kodagu	Maize	5380	4720	10920	6460	5640	13140	20	19	20	10	10
Kodagu	Paddy	3280	4560	7840	4080	5310	9390	24	16	20	20	20
Kodagu Total											30	30
Kolar	Ragi	520	2980	3870	660	3530	4650	27	18	20	38	38
Kolar Total											38	38
Koppal	Groundnut	500	1870	2400	630	2230	2890	26	19	20	7	7
Koppal	Maize	2090	5220	7860	2620	6550	9930	25	25	26	19	19
Koppal	Paddy	5290	4680	9970	6360	5330	11690	20	14	17	9	9
Koppal	Pearl Millet	750	1890	2910	910	2260	3490	21	20	20	40	40
Koppal Total											75	75
Mandya	Paddy	3330	3430	6760	3820	4080	7900	15	19	17	40	40
Mandya	Ragi	640	2190	3070	800	2590	3650	25	18	19	39	39
Mandya Total											79	79
Mysuru	Cotton	2190			2860			31			20	20
Mysuru	Maize	1050	1860	3770	1290	2290	4600	23	23	22	19	19
Mysuru	Paddy	1850	4270	6130	2350	5100	7450	27	19	22	39	39
Mysuru	Ragi	560	1310	2230	720	1630	2790	29	24	25	40	40
Mysuru Total											118	118
Raichur	Cotton	1040			1140			10			20	20

District	Crop	Grain FP	Fodder FP	TDM FP	Grain IP	Fodder IP	TDM IP	% Increase over FP			No of samples	
								Grain	Fodder	TDM	Grain FP	Grain IP
Raichur	Paddy	4220	4390	8600	4790	4980	9770	14	13	14	20	20
Raichur	Pigeonpea	410	1500	2180	520	1860	2760	27	24	27	20	20
Raichur Total											60	60
Ramanagara	Groundnut	700	940	1640	910	1270	2180	30	35	33	7	7
Ramanagara	Maize	3620	2050	6600	4710	2530	8400	30	23	27	10	10
Ramanagara	Pigeonpea	310	1580	2280	390	2120	3030	26	34	33	4	4
Ramanagara	Ragi	1740	2470	4870	2150	3000	5990	24	21	23	40	40
Ramanagara Total											61	61
Shivamogga	Maize	3570	1970	6350	4340	2390	7810	22	21	23	37	37
Shivamogga	Paddy	3670	2790	6460	4510	3420	7930	23	23	23	65	65
Shivamogga Total											102	102
Tumakuru	Groundnut	720	1280	2000	860	1540	2410	19	20	21	30	30
Tumakuru	Maize	2260	4580	7210	2810	5290	8560	24	16	19	20	20
Tumakuru	Paddy	4000	3470	7470	4430	4170	8600	11	20	15	4	4
Tumakuru	Ragi	1650	2830	5210	1980	3450	6200	20	22	19	80	80
Tumakuru Total											134	134
Udupi	Paddy	3140	2360	5510	3760	2790	6540	20	18	19	58	58
Udupi Total											58	58
Uttara Kannada	Maize	4120	2740	8150	5310	3500	10390	29	28	27	20	20
Uttara Kannada	Paddy	3040	3930	6970	3780	4810	8590	24	22	23	80	80
Uttara Kannada Total											100	100
Vijayapura	Pigeonpea	260	300	700	330	390	920	27	30	31	49	49
Vijayapura Total											49	49
Yadgir	Pigeonpea	380	1350	2130	460	1630	2530	21	21	19	8	8
Yadgir Total											8	8
Grand Total											1857	1857

District-wise mean yields of major crops during *Rabi* 2015-16

District	Crop	Grain FP	Fodder FP	TDM FP	Grain IP	Fodder IP	TDM IP	% Increase over FP			No of samples	
								Grain	Fodder	TDM	Grain FP	Grain IP
Bagalkot	Rabi Chickpea	380	630	1010	520	800	1320	37	27	31	42	42
Bagalkot	Rabi Sorghum	770	1340	2340	990	1660	2920	29	24	25	39	39
Bagalko Total											81	81
Ballari	Rabi Chickpea	580	790	1370	770	960	1730	33	22	26	40	40
Ballari	Rabi Sorghum	980	5230	6800	1220	6260	8210	24	20	21	10	10
Ballari Total											50	50
Belgavi	Rabi Sorghum	280			350			25			13	13
Belgavi Total											13	13
Chitradurga	Rabi Chickpea	330	420	750	440	480	920	33	14	23	30	30
Chitradurga	Rabi Sorghum	530	1180	1900	680	1570	2510	28	33	32	30	30
Chitradurga Total											60	60
Davanagere	Rabi Chickpea	740	1040	1780	970	1210	2180	31	16	22	20	20
Davanagere	Rabi Ragi	1770	3470	6350	2170	4290	7850	23	24	24	20	20
Davanagere	Rabi Sorghum	1600	2810	4980	1880	3370	5940	18	20	19	20	20
Davanagere Total											60	60
Dharwad	Rabi Sorghum	160	190	410	200	240	500	25	26	22	5	5
Dharwad	Rabi wheat	210	630	840	280	770	1050	33	22	25	10	10
Dharwad Total											15	15
Haveri	Rabi Chickpea	540	870	1410	690	1040	1730	28	20	23	16	16
Haveri	Rabi Sorghum	1350	2930	4830	1610	3470	5700	19	18	18	40	40
Haveri Total											56	56
Koppal	Rabi Chickpea	190	350	540	240	450	680	26	29	26	13	13
Koppal	Rabi Sorghum	530	1530	2260	670	1810	2690	26	18	19	10	10
Koppal Total											23	23
Vijayapura	Rabi Sorghum	610	240	1040	790	300	1330	30	25	28	47	47
Vijayapura Total											47	47
											405	405

ANNEXURE II

Coca Cola-ICRISAT Watershed, Kolar

Details of various activities in the watershed - Feb 2016.

Sl. No		Activities	Total Achieved	Beneficiaries (nos.)
A		**Soil and Water conservation structures**		
	1	Farm pond (FP)	28	28
	2	Gully checks	75	150
	3	Water pond for cattle ("*Go Katte*")	2	150
	4	Water used from wastewater treatment unit	2	2
	5	Field bunding (m^3)	9000	100
B		**Income generating activities**		
	1	Vermi composting	19	19
	2	Fruit plant distribution to SHG women for kitchen gardening	300	300
	3	Bund plantation with horticultural plants provided to farmers	4173 (18 ha)	132
	4	Forestry species to plant on bunds	4565 (12 ha)	40
C	1	**Livestock Improvement**		
	1	Animal health camp	2	138 (716 cattle vaccinated)
D		**Productivity Enhancement conducted trails**		
	1	Crop demonstration (variety and balanced fertilization)	40 ha	100
	2	Integrated nutrient management (Bhoo Chetana)	600 ha	450
E		**Capacity building /training/awareness**		
	1	Training sessions for farmers	11	366
	2	International Women's day	01	350
	3	Field day	01	22
	4	World environment day	02	210
	5	Video production and dissemination	13	401
	6	National women's day at ICRISAT	1	13
	7	Training sessions for SHGs	10	200
F		**Exposure visits**		
	1	Krishi Mela, Kamasamudra watershed, milk federation	05	42
	2	Exposure visit to ICRISAT	01	14