Progress Report
(2016-17)

Bhoosamrudhi
Improving Rural Livelihoods through Innovative Scaling-up of Science-led Participatory Research for Development

ICRISAT DEVELOPMENT CENTER

ICRISAT INTERNATIONAL CROPS RESEARCH INSTITUTE FOR THE SEMI-ARID TROPICS

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Submitted to

Government of Karnataka

ICRISAT DEVELOPMENT CENTER

INTERNATIONAL CROPS RESEARCH INSTITUTE FOR THE SEMI-ARID TROPICS

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Executive Summary

After the success of Bhoochetana, Government of Karnataka launched a new program "Bhoosamridhi" that is a flagship initiative of establishing learning sites of scaling-up integrated and participatory research for development to benefit small and marginal farmers across four districts of Tumkur, Chikkamagalur, Raichur and Bijapur. As in Bhoochetana, the consortium approach is adopted to harness the synergies of international research institutes (ICRISAT, IWMI, ILRI, IRRI, CIMMYT, IFPRI, ICARDA, AVRDC), state agricultural universities (Bengaluru, Dharwad, Raichur, Shimoga), state horticulture university (Bagalkote), state university of Animal Husbandry & Fisheries (Bidar) and line-departments (DoA, WDD, DoAH, DoH, DoWR, DRD & PR, KSSC). The aim of this initiative is to adopt holistic approach to find solutions to improve rural livelihood in the selected districts at pilot sites.

The program is in its fourth year and covered eighty thousand hectare area with scaling-up of various innovative technologies at each pilot site in the state. Many innovative technologies have been scaled out with a focus on increasing the yield and income. The Direct Seeded Rice (DSR) technology has been scaled-out in Raichur and Tumkur districts covering about 21,000 ha and showed increased yield ranging between 6.8 and 9.6 t ha^{-1} and on average net income of Rs. 50,000 ha^{-1} as against to Rs. 20,000 ha^{-1} with transplanted method. The DSR technology has shown on par or increased paddy yields with significantly reduced water usage as well as saving in time which has enabled timely sowing of 2^{nd} crop. More than 2000 ha area has been treated with weed management through inter-cultivation and power weeder to protect the crop and increase the yield. For *in-situ* soil and water conservation, improved land management i.e. Broad Bed and Furrow (BBF) is piloted in 150 ha in Raichur and 160 ha in Vijayapura. The yield increment was about 14% with greengram varieties such as DGGV 2 and 17% in IPM 2-14 with BBF method over farmers practice. With target to enhance productivity and adaptation to climate change scenarios, improved varieties of crops like groundnut, sorghum, castor, finger millet, pearl millet, pigeonpea, greengram, blackgram are being evaluated in about 500 ha across four districts. Although the season experienced deficit rainfall in all the districts, the crop cutting experiments completed showed increased yields with improved cultivars and management practices. The yield increase of groundnut ICGV 91114 was ranging from 25-42% in Chikkamagaluru; 14-32% in Tumkur and 4-6% in Raichur districts. More than 5000 ha area has been covered with improved cultivars of pigeonpea viz., ICPH 2740, Maruti, Asha and TS3R. Pigeonpea yield was higher by 12.8%, 13% and 15.4% with ICPL 88039, ICPL 161 and ICPL 85063 respectively over farmers'practice. Fodder varieties of sorghum (CSH24MF) and maize (NK 6240) as well as multi-purpose thornless cactus are being evaluated in all pilot sites with a view to ensure fodder security to livelstock population. Surface and sub-surface drip irrigation in paddy is being evaluated at Raichur and Tumkur district for crop intensification. Magnetic water conditioner is piloted in Vijayapura covering about 15 acres to evaluate the beneficial effects on salt content of irrigation water. As a breed improvement program, Sirohi bucks were supplied to all pilot districts and the results are encouraging. In Vijayapura, more than 50 progenies are expected from two sirohi bucks. To promote mechanization, about 3600 ha has been cultivated with different machines viz., multi-crop planter, easy planter for vegetable transplanting, BBF maker, mechanical shredder, shadenets, etc. across four districts pilot sites. Two solar dryers with a drying capacity of 35-40 kg were evaluated by farmers in Chikkamagaluru and Raichur districts for minimizing post harvest losses. Other crop/site-specific important technologies piloted and showing benefits across the pilots are –laser leveling, zero tillage (along with machinery development), mulch laying machine, relay planting (maize and chickpea in cotton), insect-monitoring through pheromone traps, shredding machines for biomass chopping, aerobic composting using bioculture, grafting technology in vegetable cultivation, easy planter for vegetable transplanting, biomass generation through Gliricidia plantations. Wastewater recycling is one of the important activitiy across all four sites. For information dissemination and awareness creation, about 100 training programs were organized covering nearly 6400 farmers/officers and trained on different technologies covering agriculture and allied sectors.

Although the year 2016 experienced a deficit and poorly distributed rainfall, reasonably good progress is achieved at the four benchmark sites under Bhoosamridhi. A number of farmers both men and women from these districts were brought to ICRISAT to participate in the National Farmers' Day which provided them the opportunity to interact with women farmers from different states as well as be exposed to new technologies. Field Days were also conducted for dissemination of improved technologies.A significantly better crop response is recorded with various innovative technologies and system level productivity is improved by adopting science-led integrated approach for development. Number of technologies are also being scaled-out during rabi season 2016-17 for increasing yield and income for which results are awaited.

Background

Across the world, rainfed areas are hotspots of poverty, malnutrition and degradation of natural resources. In India, of 142 million ha of arable lands, 56% is rainfed. Karnataka has the second largest area under rainfed agriculture only after Rajasthan in the country. Farmers' crop yields in dryland areas are quite low (1-1.5 t/ha), which is two to five times below potential yield. Recently, findings from the 'Comprehensive Assessment of Water for Food and Water for Life' revealed that the millennium development goal of reducing the number of poor people by half can be met only through efficient use of scarce water resources for agriculture. Food production can be increased substantially in rainfed areas through enhanced water use efficiency measures, improving soil health status and other new technologies in an integrated approach. It is evident that the vast potential of rainfed agriculture could be unlocked by using available scientific technologies including improved cultivars.

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

Realizing high impacts in terms of increased agricultural productivity, increased gross value of agriculture production and improved livelihoods, the state government has requested ICRISAT to lead a consortium of CGIAR institutions working in India, and to operationalize impact oriented research for development with the aim of improving rural livelihoods. The ICRISAT-led consortium of CG institutions took up this challenge and established a "proof of concept" for translating strategic research knowledge into improving livelihoods through scaling-up of the participatory research for development (PR4D) model. Constraints and problem of all four pilot locations were identified by conducting a number of meetings and stakeholder consultations, and project started in 2013-14. This document reports the progress of Bhoosamrudhi in the fourth year.

Objectives

The specific objectives of this initiative are:

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

Strategy

The main strategy for this initiative is to achieve Convergence of the CGIAR research institutions with the GoK's line departments and the state agricultural universities (SAUs) and other academic institutions in the state to undertake the Participatory Research for Development (PR4D) to improve the livelihoods of small and marginal farmers in Karnataka.

The salient strategies for the program are as follows:

- The main strategy will be to build partnerships and harness the synergy to benefit farmers through science-led development strategy built on the experiences gathered during the implementation of Bhoochetana in the state. Strengthening the consortium of CGIAR centers and development agencies with the SAUs is a challenging task as it calls for *changing the mindset calling for a systemic change.* The principle of convergence tried and found good during implementation of Bhoochetana will be institutionalized for successful implementation.
- To link knowledge-generating institutions such as the CGIAR institutions and SAUs with development-oriented line departments and extension systems to benefit farmers.
- This will be a long process as successful convergence in the true sense calls for changing the mindset of different actors.
- Internalize the "*must win"* mindset among the consortium partners.
- A *missionary approach* to harness the benefits of scientific developments and convert them into increased investments and impacts through scaling-up for improving livelihoods.
- The *science-led systems approach* will ensure that we build the capacity of farmers as well as other stakeholders to minimize the impacts of frequently occurring droughts as well as impacts of climate change to which small farmers particularly rainfed farmers are more vulnerable.
- The pilot sites will become the "*Sites of Learning*" and the consortium will adopt the principle of "*Seeing is Believing".* Through *networking* farmers as well as farmer facilitators will be empowered to achieve the desired results.
- ICRISAT will lead the consortium and strive hard to *develop the capacity* of all the partners to achieve the systemic change. The strategy will be targeting *"scaling up"* the innovations with the help of the concerned line departments in the state.
- The emphasis will be on strengthening c*apacity building* of human resources through training via networking of the institutions and building partnerships through enabling environments.
- By adopting the principle of *4Cs* (Convergence, Consortium, capacity building and collective action) we will address the consortium goal through *4 Es ie, Efficiency, Economic gain, Equity and Environmental protection,* which are the important pillars of the sustainable intensification and inclusive development. The emphasis will be on enhancing

the efficiency of land and water resources along with applied fertilizer nitrogen for sustainable intensification while maintaining the environment.

- The approach of the mission will be to strengthen backward and forward linkages to meet the 4 Es through 4 Cs by establishing seed villages, custom hire centers, small scale business development to undertake best-bet options for increasing agricultural productivity through sustainable intensification. The institutionalization of CBOs and service providers is envisaged for enhancing impact.
- 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 the systems' productivity. The convergence of activities of the Department of Agriculture (DoA), Watershed Development Department (WDD) and Department of Horticulture (DoH) will ensure increased water availability and increased efficiency which are the important drivers for sustainable intensification.
- The most important constraint in dryland areas is the establishment of a good crop stand and availability of good quality seeds of high yielding, improved cultivars. The consortium will help in identifying farmer-preferred improved cultivars and hybrids of major crops such as sorghum, maize, rice, pigeonpea, chickpea and other crops. Training farmers and providing opportunities add value to their practices will be an objective.
- The Additional Chief Secretary and Development Commissioner (ACS&DC) will be the chair of the State Coordination Committee (SCC) which will include decision makers from various consortium partners including line departments. The SCC will meet regularly to ensure smooth convergence through the institutionalization process and to strengthen the consortium.
- The SCC will play a more active role in supporting and institutionalizing the concept of convergence and consortium for capacity development.
- The mission will have a *simple principle of accountability* and *delegation of authority* at different levels without diluting individual accountability to meet the mission goal collectively.

Operational Details

Four learning sites were established in the four selected pilot districts (Tumkur, Chikkamagaluru, Raichur and Bijapur) representing four revenue divisions (Bengaluru, Mysore, Raichur and Belgaum) (Figure 1) since 2012 to demonstrate improved technologies by converging different programs and schemes of line departments.

In the selected districts, representative sites were identified using the multiple criteria worked out by the multi-disciplinary team of scientists and on-site visits undertaken by CGIAR and line department representatives. The criteria included accessibility, good potential for impact to bridge the gaps, willingness of the partners to adopt new technologies, presence of suitable institutions and pre-disposition of actors for change.

Consortium Partners

The consortium includes international research organizations, national agricultural research system and line departments. The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is leading the consortium. The consortium partners are:

National and International Research Organizations

- International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)
- International Water Management Institute (IWMI)
- International Livestock Research Institute (ILRI)
- International Rice Research Institute (IRRI)
- International Maize and Wheat Improvement Center (CIMMYT)
- International Food Policy Research Institute (IFPRI)
- International Center for Agricultural Research in the Dry Areas (ICARDA)
- The World Vegetable Center (AVRDC)
- Indian Institute of Horticulture Research (IIHR)

State Agricultural Universities

- University of Agricultural Sciences, Bengaluru, Dharwad, Raichur and Shimoga
- University of Horticultural Sciences, Bagalkot
- Karnataka Veterinary, Animal and Fisheries Sciences University, Bidar

Line Departments

- Department of Agriculture (DoA)
- Watershed Development Department (WDD)
- Department of Animal Husbandry and Veterinary Services (DoAH)
- Department of Horticulture (DoH)
- Department of Water Resources
- Department of Rural Development and Panchayat Raj
- Karnataka State Seeds Corporation (KSSC)

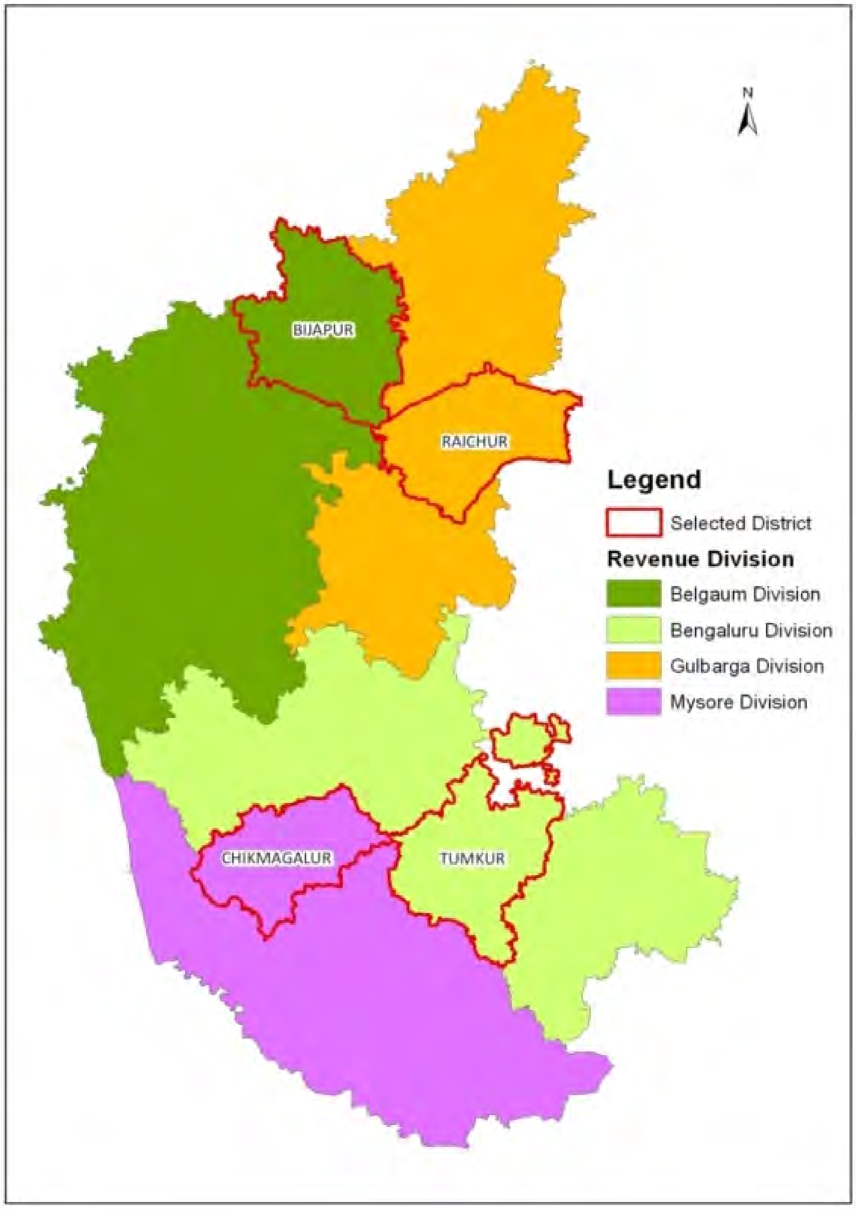

Figure 1. Map of four benchmark districts from four revenue divisions of Karnataka.

Rainfall Situation in Selected Districts

Karnataka is divided in to four regions viz., South Interior Karnataka (SIK), North Interior Karnataka (NIK), Malnad and Coastal Karnataka region. Southwest monsoon (SWM) advanced into south Andaman Sea and Nicobar Islands on 18th May 2016 (2 days ahead of its normal date). However, further advance was sluggish. It set in over Kerala on 8th June (7 days behind the normal schedule of 1st June) and covered the entire country by 13th July (against the normal date of 15th July). Southwest monsoon entered Karnataka on 9th June 2016. After witnessing good rains over the State during the first two days since the onset of monsoon, SWM subdued and further advancement was not observed initially, however, monsoon covered the entire Karnataka State by19 June, 2016.

During the period from 01 June to 30 September 2016, Karnataka State as a whole recorded an actual amount of 690 mm of rainfall as against the normal rainfall of 839 mm; the percentage departure from normal was -18% and was classified under Normal category. Rainfall received in different regions indicates that all regions have received lesser rainfall compared to their normals with coastal Karnataka showing largest deviation.

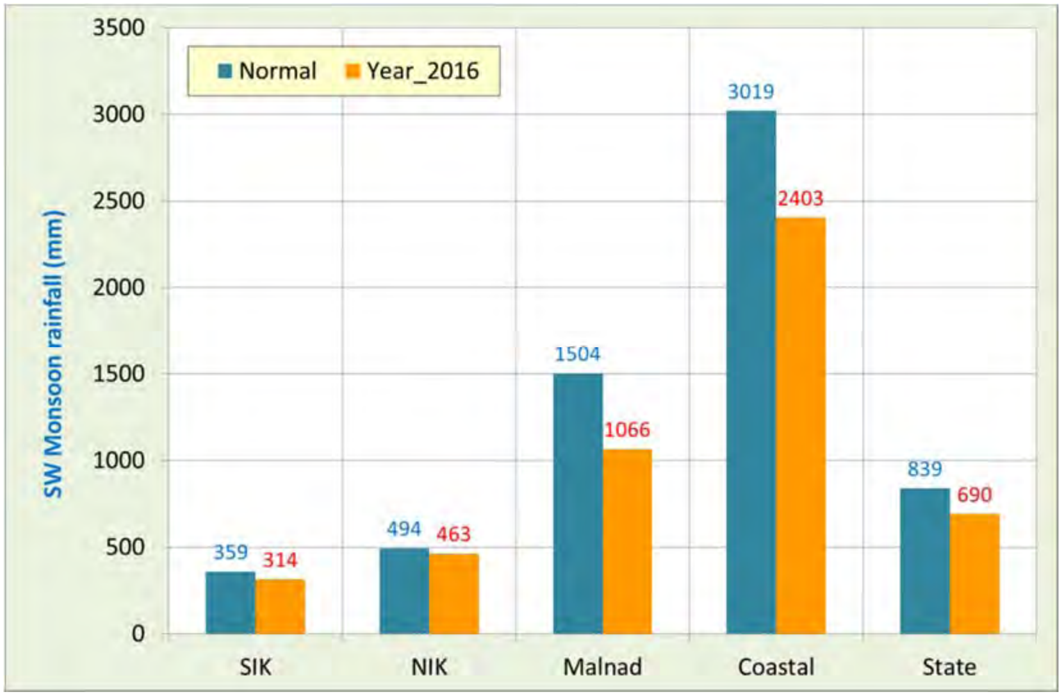

Figure 2. Region-wise rainfall in Karnataka during Southwest Monsoon 2016

Table 1. Rainfall during southwest monsoon 2016 in pilot Bhoosamrudhi districts									
District	Actual Rainfall (mm)				Southwest monsoon				Class
	Jun	Jul	Aug	Sep	Actual	Normal	Deviation		
					mm	mm	mm	%	
Chikkamagaluru	311	356	222	107	996	1349	-353	-26	Deficit
Raichur	111	106	53	134	404	450	-46	-10	Normal
Tumakuru	124	152	32	37	345	361	-16	-4	Normal
Vijayapura	100	115	43	125	383	428	-45	-11	Normal
Data source: KSNDMC, Karnataka									

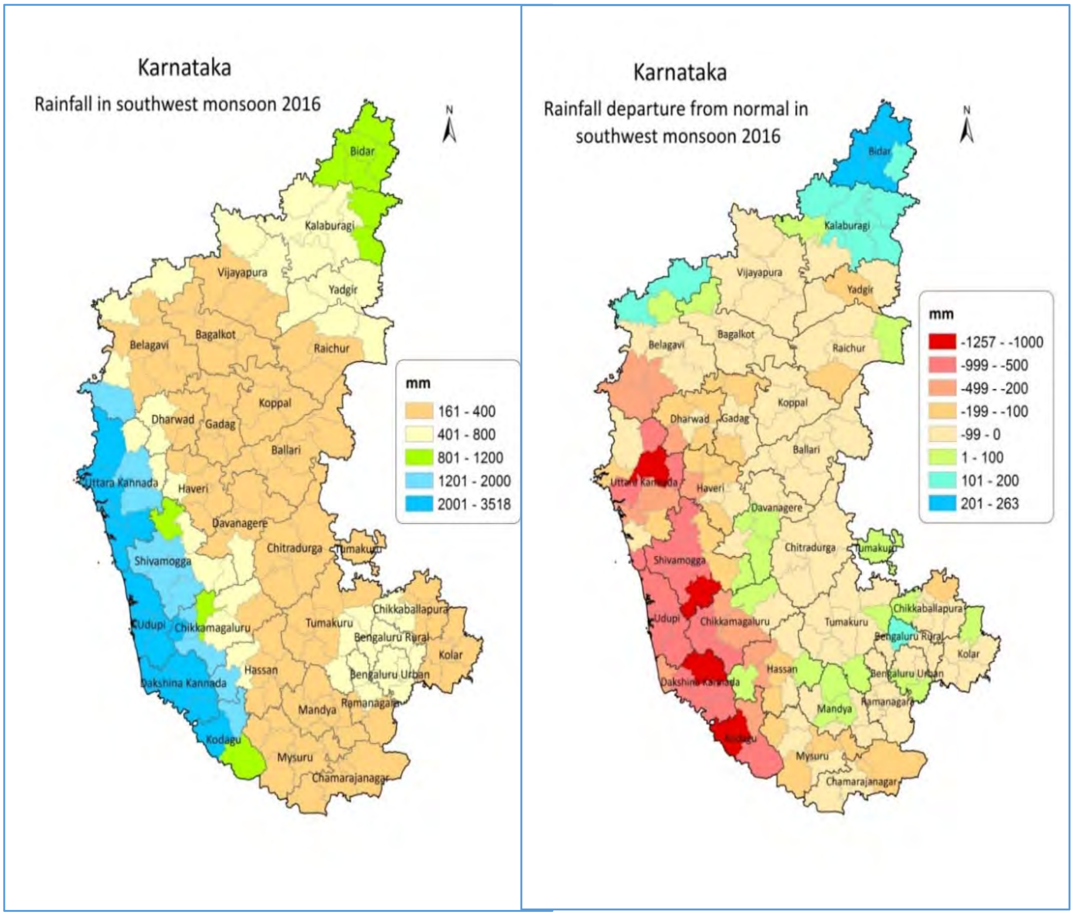

Figure 3. Status of rainfall departure from normal in southwest monsoon 2016

[If the departure of actual rainfall from normal is more than 20%, then rainfall is classified as "Excess"; if it is between –19% and +19% it is classified as "Normal"; if it is between –20% and –59% it is classified as "Deficit"; and if it is between –60% and –99% then it is classified as "Scanty"].

Out of the four pilot districts, Chikkamagaluru received "Deficit" rainfall; while the other three districts viz., Raichur, Tumakuru and Vijayapura received "Normal" rainfall during southwest monsoon 2016.

Out of the 25 pilot taluks in the four districts, seven taluks viz., Chikkamagaluru, Kadur, Koppa and Mudigere in Chikkamagaluru district, Lingsugur and Sindhanur in Raichur district and Muddebihal in Vijayapura district received "Deficit" rainfall. Remaining 18 taluks received "Normal" rainfall. It is noted that all the ten taluks of Tumakuru district received "Normal" rainfall during the southwest monsoon 2016.

Week-by-week distribution of monsoon rainfall has shown that throughout the season, both Raichur and Vijayapura districts received more or less normal rainfall. Chikkamagaluru district received low rainfall from the last week of July onwards, while Tumakuru district received more than normal rainfall (Figure 4). Details rainfall analysis is provided in Annexure I.

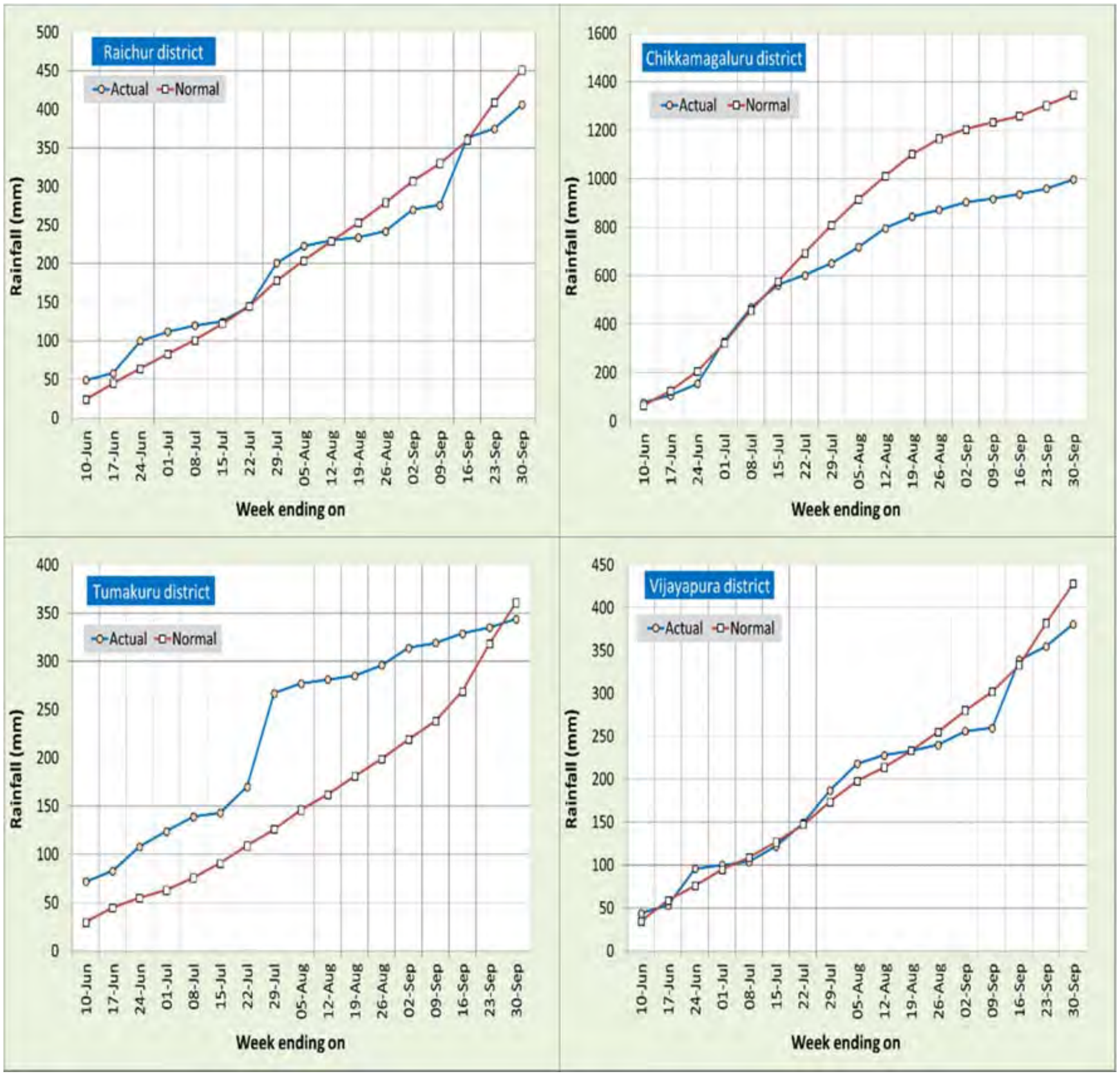

Figure 4. Week-wise rainfall during Southwest monsoon 2016

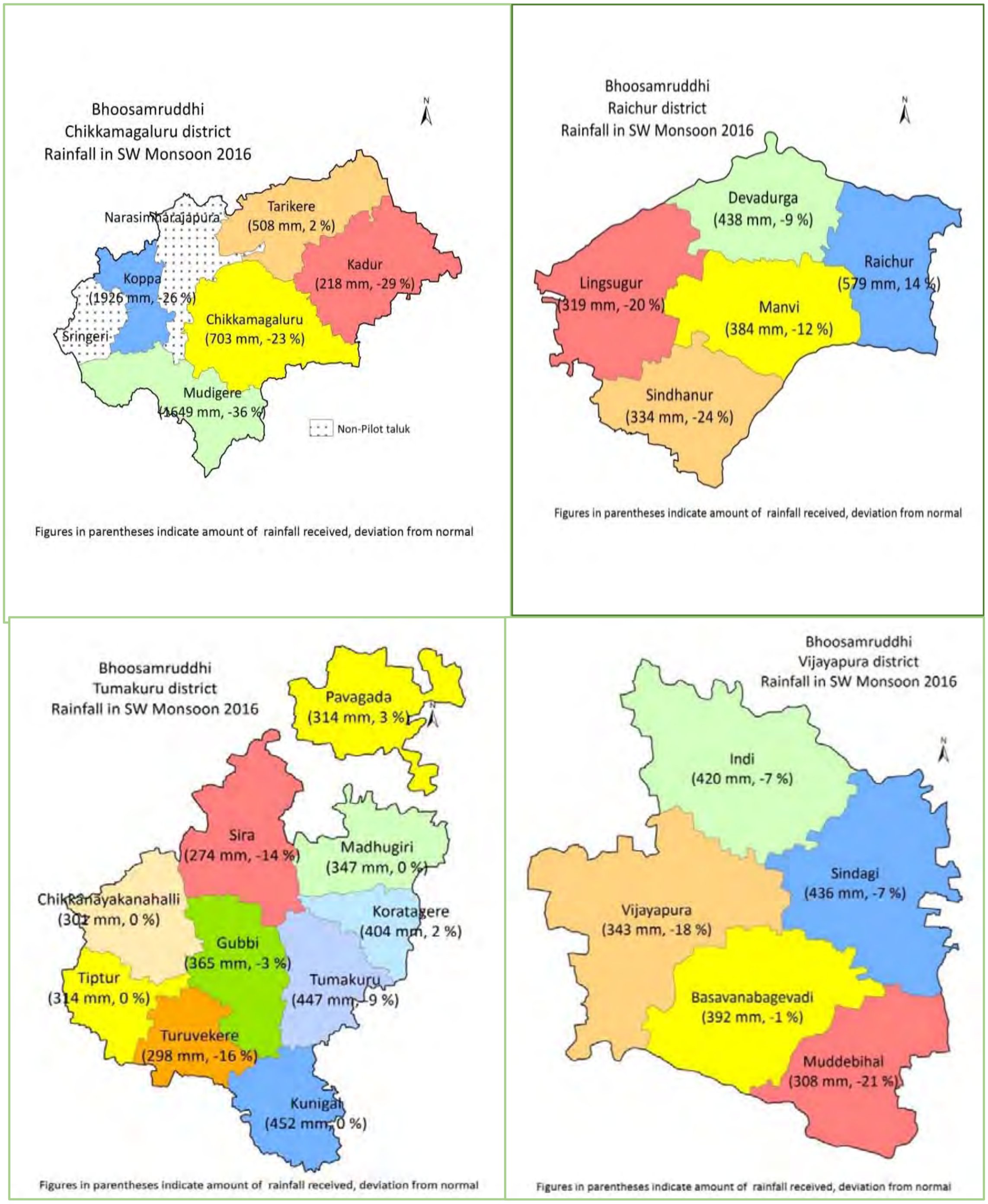

Figure 5. Taluk-wise rainfall status during southwest monsoon 2016

Demonstration of Technologies in Pilot Districts

During 2016, number of innovative technologies have been demonstrated with farmers' participation to test and validate its suitability for scaling up in large areas. Location specific technologies have been demonstrated in all the four districts. Table 2 describes that the area under improved crop cultivars and direct seeded rice was nearly 26,638 ha across all four districts. In Chikkamagaluru, during 2016 kharif season, about 130 ha area has been demonstrated with improved cultivars of groundnut, castor, pigeonpea, mungbean, pearlmillet, sorghum, maize, rice and chickpea crops. Similarly, Tumkur, Raichur and Vijayapura covered 172 ha, 26,182 ha and 154 ha respectively. Importantly, direct seeded rice (DSR) is progressively increasing in Raichur district where farmers prefer DSR over transplanted rice due to reduced cost of cultivation as well as increased profit. This technology is being promoted in Tumkur and farmers are receptive towards this technology due to its advantage over transplanted method of rice cultivation.

Table 2. Area under improved cultivars (ha) and Direct Seeded Rice in selected districts under Bhoosamrudhi, Karnataka

Crops	Chikkamagaluru	Tumkur	Raichur	Vijayapura
Groundnut	15.2	37.2	200	2
Castor	5.6	80	0	0
Pigeonpea	Intercrop	0	5000	10
Mungbean	14.8	6	0	33
Pearlmillet	0	8	0	5
Multi cut sorghum	13.6	10	10	28
Dual purpose Maize	16	10	20	16
Rice	50	0	0	0
DSR paddy	0	21.2	20952	0
Chickpea	15	0	0	60
Total	**130.2**	**172.4**	**26182**	**154**

Similarly, Bhoosamrudhi program has put emphasis on mechanization to overcome labour shortage and increasing wage rate. During 2016 kharif season, number of technologies have been promoted in all four districts. The major machines promoted are zero till multi crop planter, machine transplanter, laser leveler, leaf color charts, BBF maker, easy planter, pigeonpea nipping machine, etc. These machines have covered about 2000 ha in Chikkamagaluru, 27 ha in Tumkur, 1309 ha in Raichur and 240 ha in Vijayapura districts (Table 3). These machinaries will be tested for their cost effectiveness as well as for their efficiency so that these can be linked to custom hiring centers for wider accessibility and benefits to more number of farmers in the state. Mechanization has an added advantage in completing timely field operations as well as cost effectiveness. Therefore, the efforts are being made to popularize best performing and cost effective machines with required capacity building under Bhoosamrudhi program in all the four districts.

Table 3. Area under mechanization (ha) in selected districts under Bhoosamrudhi in Karnataka

Technologies	**Chikkamagaluru**	**Tumkur**	**Raichur**	**Vijayapura**
Zero-till multi planter	0	20	40	0
Machine transplanting	50		10	0
Laser levelling	0	2	40	5
Leaf color charts	100		0	0
BBF	0	0	5	160
Herbicides	1800		200	20
Easy planter	10	4	10	5
Nipping	0	0	1000	50
Surface and sub-surface drip irrigation	0	1.2	4	0
Total	**1960**	**27.2**	**1309**	**240**

For effective information dissemination as well as technology transfer to farmers and other stakeholders, number of capacity building programs were organized. About 100 training programs covering nearly 6400 participants organized during kharif 2016 (Table 4). The major focus of these capacity building programs are educating farmers to adopt different technologies for achieving better results in agriculture and allied sectors. Resource persons were drawn from CGIAR centers, line departments and KVK scientists. Participants are both men and women representing wide array of education and social background with varied age group.

Table 4. Capacity building programmes organised during 2016-17 under Bhoosamrudhi

Particulars	Chikkamagaluru	Tumkur	Raichur	Vijayapura
No. of trainings	12	7	30	50
No. of participants	590	555	905	4394

The below section provides district specific activity-wise details.

Chikkamangaluru

The major activities implemented were described as below:

Land and Water Management

In Chikmagaluru, with the help of line departments and CG institutes, several innovative land and water management practices were implemented in the pilot villages. AVRDC in collaboration with ICRISAT, IWMI along with line departments established shade nets for vegetable cultivation (Figure 6). These shadenet houses demonstrated an effective integration of these technologies as critical components of protected cultivation package. Improved practices like plastic mulching, in-line drip with fertigation, staking and IPM approaches were adopted in these shadenet houses. Seedlings of the indeterminate tomato Arka Samrat were transplanted in July 2016 in three polynet houses, and capsicum seedlings in two poly nethouses. Common bean and white cucumber were sown in each shade nethouse during this period (Table 5-8).

Table 5. Tomato cultivation in shadenet houses in Lakya hobli, Chikmagaluru taluk		
Name of the farmer	**Location**	**Up to Sep 2016**
Bhommegowda	Ganadaalu	5-picking, 440 kg
Biregowda	Sadarahalli, Lakya Hobli	4-picking, 356 kg
Murthy	Ganadaalu	5-picking, 310 kg

Note: On an average, farmers obtained INR 13-14 per kg. Further harvesting is underway (we may expect another 3-5 pickings).

Example: Tomato hybrid that cultivated in open field: Duration: 2.5 to 3.5 months with 8-10 pickings, yields 14-15 t/ac; Under PC: Crop can be maintained up to 6 months, with 13-14 pickings, yields 19-22 t/ac

Table 6. Tomato cultivation in shadenet houses in Lakya hobli, Chikmagaluru taluk		
Name of the farmer	**Location**	**Up to Sep 2016**
Renukacharya	Sadarahalli	3-picking, 410 kg
Eshwarappa	Sadarahalli	Planted in end of Sep.

Note: On an average, farmer obtained INR 15-17 per kg. Further harvesting is underway (we may expect another 3-4 pickings).

Example: Capsicum hybrid that cultivated in open field: Duration: 5-6 months with 5-6 pickings, yields 35-40 t/ac; Under PC: Crop can be maintained up to 9 months, with 9-10 pickings, yields 90-110 t/ac

Table 7. Common bean cultivation in shadenet houses in Lakya hobli, Chikmagaluru taluk		
Name of the farmer	**Location**	**Up to Sep 2016**
Muniyanayaka	Birur Hobli, Kadur Tq	560 kg

Note: On an average, farmer obtained INR 15-17 per kg.

Example: Beans hybrid that cultivated in open field: Duration: 45-48 days with 5-6 pickings, yields 4.2 to 5.0 t/ac Under PC: Crop can be maintained up to 65-70 days, with 9-10 pickings, yields 13-14 t/ac

Table 8. White-cucumber cultivation in shadenet houses in Lakya hobli, Chikmagaluru taluk		
Name of the farmer	**Location**	**Up to Sep 2016**
Ganghadhara	Rangenahalli, Birur Hobli	660 kg

Note: On an average, farmer obtained INR 20-22 per kg. No crop has been grown in open field for comparison.

Protected vegetable cultivation has received a good response from the farmers due to many advantages over open field cultivation. This technology is useful to identify which crop is suitable under protected cultivation. However, at this juncture, it is hard to pin down which crops are suitable and which aren’t to be grown under protected cultivation. Farmers’ own experiences suggested each individual was happy with the crop he/she cultivated and would like to continue with the same crop for another two or three seasons before shifting to other alternative higher-value crops. The main challenge was to assist farmers in moving into using protected cultivation, often for the first time, and to grow healthy and safer vegetables using improved cultivation methods. Farmers are learning the technical know-how of handling this method of cultivation, and introducing this has been a significant contribution towards improving yield and income levels of vegetable growers and encouraging wider adoption of these practices. With growing vegetables under protected cultivation farmers are experiencing less insect incidence, reduced pesticides sprays, a prolonged crop cycle (additional pickings), good yield with quality and better income.

Along with the land and water management, introduction of IPM practices under protected cultivation for Leaf miner in tomato were effective in controlling the pest. This involved the use of yellow sticky traps and water (lure) traps at the rate of 50 such traps per hectare (stand alone trap and in combination was examined). After seeing this good and effective result in the fields of 15 farmers during their routine field visits, the Department of Horticulture officials have recommended to the Karnataka government to scale up this intervention, and this is expected to cover 200–240 ha in the 2016 *rabi* season.

Figure 6. Capsicum and grafted tomato cultivation under shadenet under Bhoosamrudhi in Chikamagalur district

Crop Intensification and Diversification

Farmers' Participatory Varietal promotion during *Khraif* 2016

The main objective of farmers'participatory varietal promotion is to adapt to climate change scenarios as well as increasing the productivity to meet the food security of increasing population. With this objective, improved crop cultivars have been introduced under Bhoosamrudhi in pilot districts. Already tested and evaluated good performing improved verities were scaled up during *khraif* 2016. In Chikmagaluru, crop varieties supplied includes Groundnut (ICGV 91114), Finger millet (MR 1), Sorghum (CSH 24MF), Castor (DCH 177 and Jyothi), Pigeonpea, and maize (NK6247) (Table 9). The scaling-up of these varieties is done with farmers' participation with close monitoring by ICRISAT staff in each district supported by line department staff especially Department of Agriculture. Most of these seeds were treated with appropriate chemicals to ensure proper germination as well as disease free crop growth (Figure 7). The yields are higher than the farmers practice (Figure 10).

Table 9. Details of Farmers'participatory varietal promotion under Bhoosamrudhi in Chikmagaluru during 2016-17			
Name of the Crop	Name of the Cultivar	Extent of area (acre)	No. of beneficiaries
Groundnut	ICGV 91114	38	37
Castor	DCH 177, 48-1	14	15
Pigeonpea	Asha 87119, ICPL 8863	Intercrop	15
Mungbean	IPM 2-14, DGGV-2	37	32
Fodder sorghum	CSH24MF	34	34
Maize	NK6247	40	40
Total		**163**	**143**

Figure 7. Groundnut seed treatment with DM 45 and Biophos at Balenahalli, Chikmagaluru

Figure 8. Crop cutting experiment on Groundnut crop variety ICGV 91114, at Balenahalli

Figure 9. Greengram (IPM 2-14) at Yaradankala, Lingadalli, Chikmagaluru district

Yield analysis of groundnut

During kharif 2016, improved variety of groundnut (ICGV 91114) was evaluated in nearly 15 ha area in Lakya, Birur and Lingadahalli hoblis of Chikkamagaluru district under Bhoosamrudhi program. The possibility for scaling up of improved varieties is assessed by evaluating the performance of new high yielding varieties in different rainfall zones within the district. The yield of ICGV 91114 is ranging between 2000 and 1700 kg ha^{-1} with variation in rainfall and soil types. The increased yield translates to about 25 - 49% increased productivity compared to farmers' practice in the district (Figure 10). The crop cutting results revealed that there is a potential in the district to harness the cultivation of improved varieties of groundnut such as ICGV 91114 to a larger extent to benefit large number of groundnut growing farmers. Since the inception of Bhoosamrudhi, large number of farmers have evaluated improved variety of groundnut ICGV 91114 and found beneficial in terms of yield despite low rainfall.

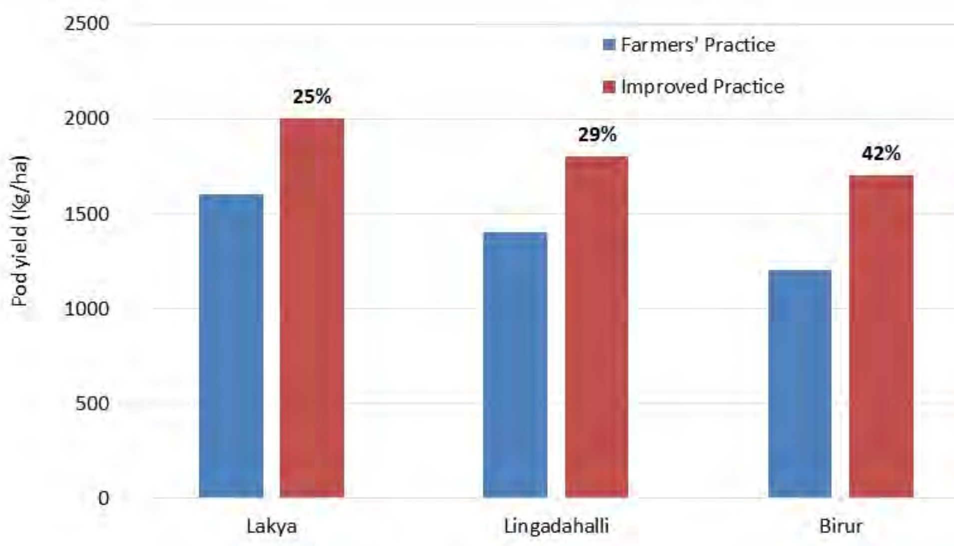

Figure 10. Groundnut pod yield in different taluks under Bhoosamrudhi in Chikkamagaluru district

Yield analysis of finger millet

Finger millet is one of the major staple food in some parts of the district. Under Bhoosamrudhi, efforts were also made to evaluate improved variety of finger millet (MR1) to enhance the area under improved cultivars. During 2016 kharif season, about 30 ha in kadur district was demonstrated and the yield was ranging between 690 and 1270 kg ha^{-1} compared to 500 and 1170 kg ha^{-1} with farmers' practice (Figure 11). This reveals that the district has the potential of increasing area under improved varities to benefit farmers.

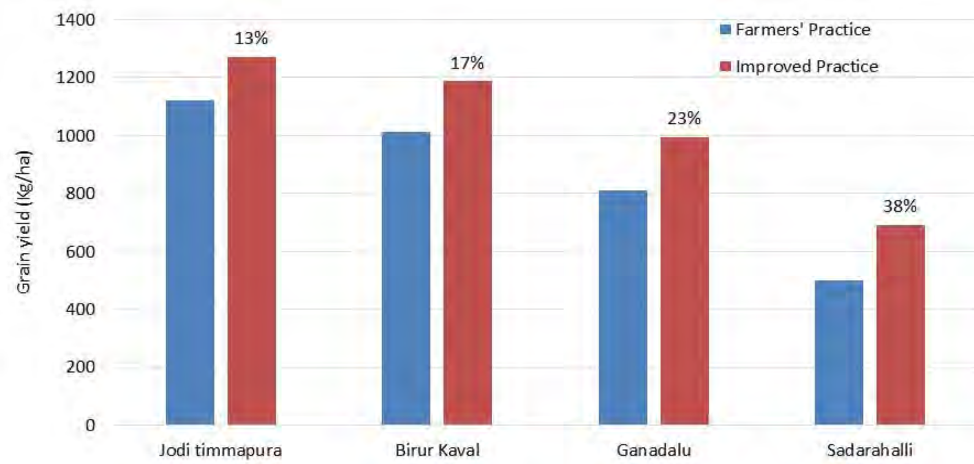

Figure 11. Finger millet yield in different villages under Bhoosamrudhi in Chikkamagaluru district

Promotion of Improved Rice Varieties

The improved rice varieties of IET 21478 and IET 21749 were promoted as these crop varieties were yielded comparatively good yield during the last year (Table 10). Apart from this, KPR1 also being promoted from DoA for large scale adoption. Nearly 100 acres are being cultivated with IET 21478 and IET 21479 varieties in Koppa and Mudigere taluks under Bhoosamrudhi. Best management practices are suggested to farmers for adoption in the demonstration fields. Apart from this, mechanization is given importance as labour shortage is severe and also a unique effort is being made to restore germplasm of 17 varieties with the help of ZA&HRS, KVK and DoA in Mudigere.

Table 10. Farmer participatory promotion of improved rice cultivars in Chikmagaluru district under Bhoosamrudhi

Technology	**Target (ha)**	**Achieved (ha)**	**Beneficiary (Nos)**
Farmer participator demonstration of improved rice cultivars (IET21478, IET21479)	50	50	50
Farmer participatory demonstration of establishing rice with transplanting machine	50	50	50
Integrated nutrient management using leaf color chart	100	100	100
Integrated weed management using herbicides as component	1800	1800	1800

At Mudigere, with combined participation of the farmers; Department of Agriculture; CGIAR institutions (IRRI and ICRISAT); ZA&HRS, Mudigere and KVK, Mudigere, the Bhoosamrudhi program is undertaking the seed to seed mechanisation program in around 40 acres of land in Gonibidu village. Improved high yielding rice culltivars: IET 21478, IET 21479, KHP 9, KPR (Karnataka Ponnampet Rice) (selection from IET-21214 variety; blast and BPH resistant; 110 to 115 cm height and 145 days duration) are being demonstrated in these fields along with cultivar: Tunga. The nurseries were raised and farmer participatory demonstration of the rice establishment by transplanting machine is being undertaken (Figure 12).

The herbicide recommendations

Pre-emergence application of Londax power @ 4kg granules per acre
Saathi [Pyrazosulfuron ethyl] @ 80 grams per acre etc).

These were given to farmers for application within two days of transplanting.

At Koppa, rice varietal seed was distributed to farmers for undertaking nearly fifty farmer participatory demonstrations of the improved varieties including IET 21479, KHP12, IET 21478. Suggestions were given on nurseraies including the fertiliser application, irrigation without seedling submergence and herbicide (Byspiribac sodium @ 100 ml per acre) application at 15 Days after seeding.

Herbicides were introduced as component of Integrated Weed Management (IWM). Mechanisation at each stem of rice production including planting by transplanting machine, weeding by cono-power weeder, harvesting by reaper and threshing by thresher were emphasised. High-yielding varieties like IET 21478 and IET 21479 became popular among farmers and based on the advice of the Hon. Minister of Agriculture, the process of releasing these varieties was initiated by the State Agricultural University.

In Chikkamagaluru, a farmer participatory demonstration on the machine transplanted rice (MTU 1001) was transplanted on 24 August 2016. Based on the mats used for machine transplanting, adviseries were given to farmers, for adoption in future, on the proper nursery preparation on the need for use of fine soil and compost mixture during mat rice seedling nursery preparation for machine transplanting (Figure 13).

The farmer participatory demonstrations of IET 21479 and IET 21478 were transplanted (Figure 14&15). The fertilser application and the herbicide application were recommended. The IET 21478 performance is also tested in a farmers’ participatory demonstration (Figure 16). The farmer applied only organic manure (Cow dung and urine - 2 to three tractor loads per acre). The farmer was traditionally growing the rice variety Valya.

Figure 12. The process of machine transplanting in a farmer participatory demonstration field at Chikmagaluru district.

Figure 13. The farmer participatory machine transplanted rice (MTU 1001) field

Figure 14. Farmer participatory demonstration of IET 21478 in Holundur Village, Koppa Taluk, Chikmagaluru district

Figure 15. Farmer participatory demonstration of IET 21479 (left) and IET 21478 in Koppa Taluk, Chikkamagaluru district

Figure 16. Machine transplanted paddy plot variety IET-21478 at Gonibidu, Mudigere

An effort is also being made in conservation of several traditional varieties by multiplying the seed and maintaining it at the Zonal Agriculture and Horticulture Research Station, Mudigere, as a convergent activity of Bhoosamrudhi (Figure 17). Nearly 17 different rice varieties are multiplying with the help of ZA&HRS, KVK and DoA in Mudigere to restore traditional germplasm.

Figure 17. The traditional varieties of Malnadu area are being preserved at the ZA&HRS, Mudigere, as a part of Bhoosamrudhi activities.

Yield analysis of rice cultivars

In Chikkamagaluru, rice is the major crops grown in hilly (Malnad) region of the district. Under Bhoosamrudhi, IRRI, ICRISAT, DoA, ZA&HRS and KVK evaluated different varieties which are suitable to heavy rainfall regions. The major rice cultivars tested were IET 21478 and IET 21479 in Koppa district and 17 other varieties in Mudigere under Adarsha Sansad Gram Yojane which is converged with Bhoosamrudhi since 2016 (Figure 18 & 19).

The crop cutting studies are conducted to estimate the yield in different farmers' field. The fresh yield data revealed that there is a good response from varieties such as IET 21478 and 21479 in Koppa taluk which are suitable to local conditions and farmers are adopting in a large scale due to yield benefit. Similarly, in Mudigere, all the varieties which are evaluated are performing better compared to local varieties (Figure 19).

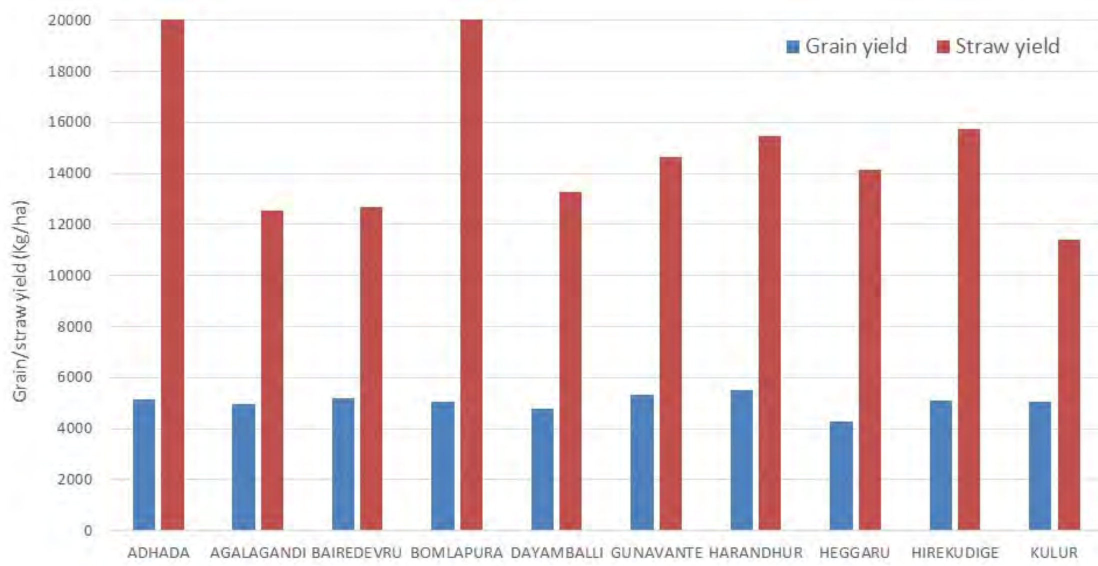

Figure 18. Fresh yield of IET 21478 in different villages of Koppa taluk under Bhoosamrudhi during kharif 2016

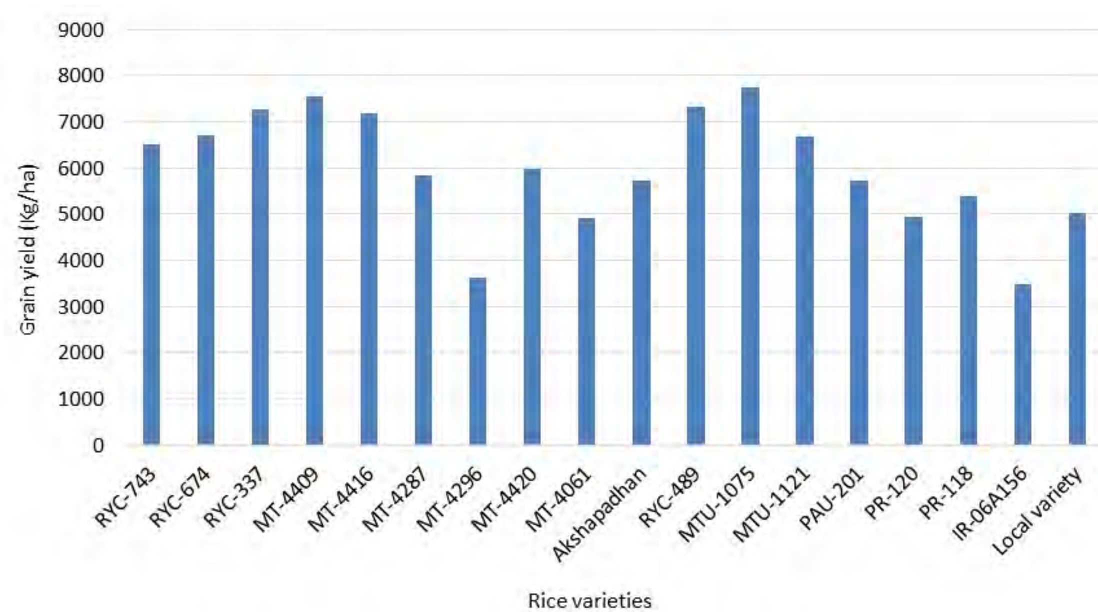

Figure 19. Fresh yield of 17 different rice varieties in Mudigere taluk under Bhoosamrudhi during kharif 2016

Site specific nutrient management in Maize

Maize is the important crop in Chikkamagaluru district as most of the farmers cultivate using hybrids for higher yields. There are several niches for sustainable intensification of dominant cropping systems through inclusion of maize as it provides an opportunity for the second crop in the winter season. However, information on high yielding hybrids of maize adapted to different management practices in different farm typologies is not readily available to developmental agencies, stakeholders and farmers. Therefore, participatory validation demonstrations were conducted under Bhoosamrudhi. During 2015-16, suitable hybrids for the district were prioritized out of large number of hybrids which are sold in Raita Samparka Kendras. However, farmers were also educated on the large inter hybrid variability to reduce the variability amongst the hybrids for improving yield performance. During 2016-17, in consultation with officials of Department of Agriculture, selected hybrids were tested for their yield potential with Nutrient Expert (NE) decision support system based Site-Specific Nutrient Management (SSNM) (Figure 20). However, due to poor rainfall in the district, the crop has been failed.

Figure 20. Hybrid Maize (GK 3059, NK6240) plot at Halelakya, Chikmagaluru taluk

Feed and Fodder Management

Feed and fodder management is also given importance as most of the time farmers face fodder scarcity to feed animal population in the district. With the help of ILRI and DoA, fodder varieties of sorghum and maize were promoted in nearly 75 acre benefiting nearly 75 farmers (Figure 21). Since Chikmagaluru is the main market for milk and meat, animal husbandry is gaining importance. Therefore, ensuring fodder security for the increasing livestock population is the need of the hour in the district.

Figure 21. Fodder maize (NK 6240) plot in Chikmagaluru

Thorn less cactus

ICARDA with the help of DoA and ICRISAT established a thornless cactus nursery comprising of 1500 cladodes in Lingadahalli to create awareness to farmer regarding importance of edible cactus as a fodder during off season (Figure 22). These cladodes are being planted in farmers field bunds for larger adoption by farmers as animal feed in the district.

Figure 22. Thornless cactus nursery in DoA seed farm at Lingadahalli, Tarikere

Post Harvest Technologies in Vegetable Production

Installing a commercial solar dryer facility in Chikmagalur

One of the activities being pursued by the Department of Horticulture, GoK, jointly with the CGIAR centers is the establishment of improved facilities for vegetable drying through the provision of solar dryers. Two solar dryers with a drying capacity of 35-40 kg were distributed to farmers in Chikkamagaluru and Raichur districts.

Farmers in Kadur taluk in Chikamagaluru district have requested a large commercial sized dryer with a capacity to dry 1.5 tonnes to be installed locally. The farmers have shown great enthusiasm to have a community- owned commercial scale `Solar Dryer' to speed drying of their vegetable produce and to protect the quality. They in fact have come forward to partially financially support this initiative.

The underlying strategy is to encourage improved quality produce which can fetch a better price for farmers from processors who pay a premium for such quality. So far we have worked with the Kadur chili farmers to link them up with Paprika Oleos, an oleoresin producer, who have been buying dried chili from these farmers for over a year. Farmers who previously sold chili to traders at Rs 70-80/kg now secure Rs 130-150/kg from the firm because of the chili they produce has met rigid quality standards including low pesticide residues. The consortium worked with 40 farmers to improve the quality of their chili so as to meet company standards. The farmers are organized into a society and thus collaborate effectively in disseminating learning and experience as well as in sharing resources.

The provision of a 1.5 tonne solar dryer to these farmers will have a significant positive impact on their incomes and open up further opportunities for value chain enhancement. Currently, farmers dry chili in the open which results in both contamination and crop loss during the extended drying period. In tests conducted on this larger dryer, it was found that the drying period for chili can be reduced from 7 days (open drying) to about 2-3 days.

Farmers have lost the first harvest in the field over the past two seasons due to unseasonal rains. The reduced drying period can enable quicker harvesting and drying cycles, thus limiting crop loss. The unit can also be used to dry other horticulture produce like onions and arecanut during the off season when the drier is not being used for chili. This could possibly be organized on user pay basis so that some funds are available for maintenance of the unit.

Wastewater recycling and reuse in agriculture

The activity is an attempt to improve the rural wastewater management while increasing the reuse potential of domestic wastewater. The activity is a scale-up attempt of the proven capability of sub-surface constructed wetland to facilitate low-cost wastewater treatment without the involvement of chemical or electro-mechanical processes.

Constructed wetland (CW) is a proven age old wastewater treatment system. Such systems devoid of chemicals or moving mechanical parts, inculcate low operating and maintenance cost. As common gardening skills are sufficient to take care of such a wastewater treatment system, CWs presents a feasible solution to the wastewater menace for small rural communities with limited resources and power supply as recommended by ICRISAT. At present of the 62,000 MLD (million liter per day) the total wastewater generated in major Indian cities only 23,277 MLD gets treated (CPCB). The proper rural wastewater management remains a challenge in India. Constructed wetlands are built for specific purposes such as urban storm water treatment, water storage or as a wildlife habitat. The various types of constructed wetlands used over the last four decades can be grouped into two broad categories viz., free water surface (FWS) wetlands or sub-surface flow (SSF) wetlands. In a nutshell the former involves a pond whereas the latter involves a dry surface (as their names suggest). One major advantage of SSF CWs (though being slightly expensive than FWS CWs owing to the filtering media cost) is the better control of mosquito menace. Despite their apparent simplicity of CWs these are complex ecosystems driven by many physical, chemical and biological processes. The CWs involve basic biogeochemical processes such as filtration, sedimentation, plant uptake or phytoremediation and microbial degradation in removing contaminants from wastewater CWs may also provide additional income source for the villagers during the construction, operation as well as maintenance activities. The revenue generated through treated wastewater as well the biomass aid the economic sustainability of these engineered ecosystems.

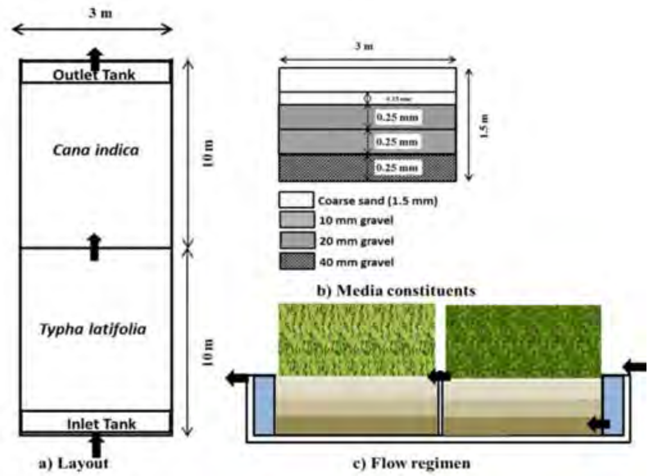

Figure 23. General design of SSF CW: a) general layout; b) media constituents and c) flow regimen

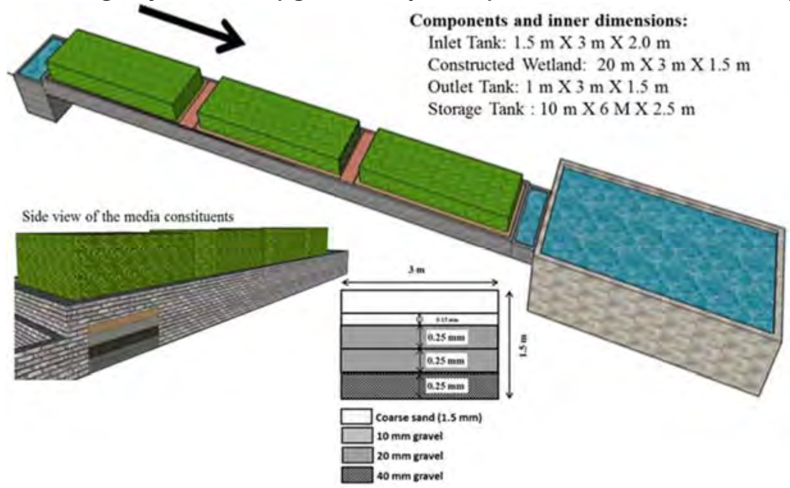

Figure 24. A typical DWAT system with its components and media constituents

A typical DWAT consists of four components, an inlet tank which acts as flow equalization tank as well; a horizontal flow subs-surface constructed wetland where specific plants such as *Cana indica; Typha latifolia* are grown on a sand gravel media to facilitate phytoremediation of the wastewater. Once the plants gets established bulk of the pollutant removal takes place in the root-zone. The third component is an outlet tank downstream of the constructed wetland. The inlet tank and outlet tank help to maintain the subsurface flow regimen by suitably placing the inlet and outlet pipes while utilizing the gravity flow. The final component is a storage tank for the treated water. For sites where scope of reuse is restricted or the flow wastewater is not expected to irrigate one acre of land this component may be omitted. The cost of the DWAT system varies from site to site based on the geometry which in turn depends on the wastewater flow. A minimum of three day hydraulic retention time is required to treat the wastewater effectively in DWAT system. Cost of filter media constituents, such as sand and aggregates, differ from place to place thus affecting the cost. A typical DWAT system treating wastewater generated from rural communities costs between Rs.7-10 lakh. The basic structure and media of a sub-surface flow horizontal CW for the treatment of wastewater generated by rural households is given Figure 23 and Figure 24.

Site selection criteria for decentralized wastewater treatment (DWAT) units

1. Good drainage infrastructure i.e. cemented or lined drains with proper cleaning frequency. The cemented drains reduce the percolation loss and thereby ground water pollution. Clean drains reduce the stagnation time and thereby reduce evaporation loss.
2. Wastewater sump which receives wastewater from approximately hundred households.
3. Slope availability to enable gravity flow.
4. An ideal site should be close to agricultural land to enable the reuse for irrigation.
5. There is no set limit for inlet wastewater volume. However the structure should be able to deal with peak flow.
6. Government land availability dictates the geometry of the unit while keeping the foot print same in square meter.
7. The purpose of DWAT units to reduce groundwater and freshwater contamination improving rural hygiene.

Based on the above criteria, about eight sites were identified. However, after a scoping study conducted by the experts including local PRED officials, four sites were found suitable and finalized for construction of wastewater treatment unit (Table 11). Major problems in other four identified locations were lack of suitable public land availability, in most of these places, road widening prospects restricted the scope of the activity. For example, a site selected in Birur was suitable as the wastewater was contaminating fresh water reservoir. However, the land available was belong to Railway authorities.

Table 11. Details of the sites explored for construction of wetland in Chikkamagaluru district

Sl. No.	Village Name	Latitude	Longitude
1	Sadarahalli	13.21’26.37’’N	75.53’34.1’’E
2	Kunnalu	13 ° 22’44.38’’ N	75 ° 54’46.1’’E
3	Udeva	13 ° 33’14.89’’ N	75 ° 50’3.24’’E
4	Lingdahalli	13 ° 35’42.42’’ N	75 ° 50’20.22’’E
5	Birur	Not suitable due to unavailability of public land	
6	Belawadi		
7	Vagarehalli		
8	Kalasapura		

Details of the sites selected in Chikkamagaluru for this activity are given below:

Table 12. Details of selected sites for construction of wetland in Chikkamagaluru district

Sl. No.	Village Name	Latitude	Longitude
1	Sadarahalli	13.21’26.37’’N	75.53’34.1’’E
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4	Lingdahalli	13 ° 35’42.42’’ N	75 ° 50’20.22’’E

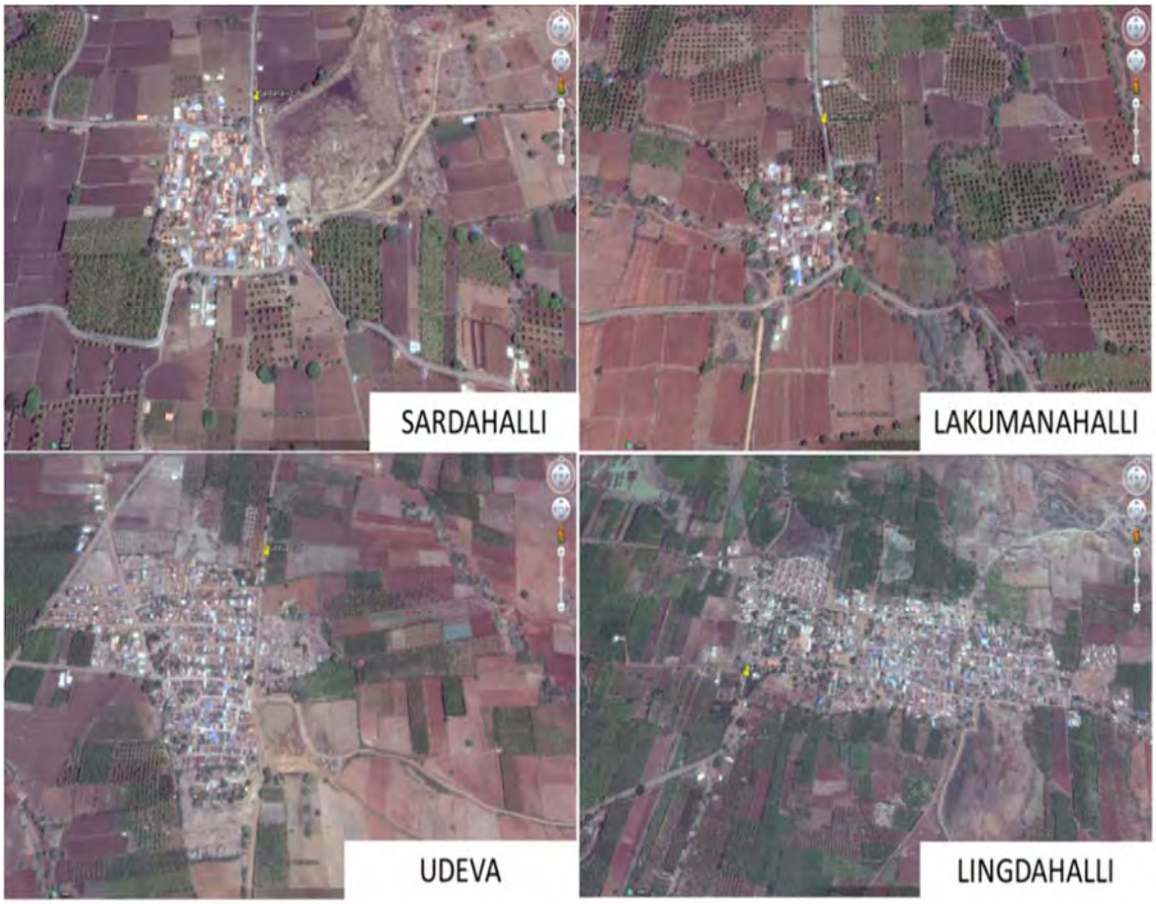

Figure 25. Land-use pattern of the four locations selected

Decentralized wastewater treatment unit in Sardahalli

The site was selected after consultation with the local engineering department as well as adjacent farmers. The site is an existing wastewater drain which carries wastewater from nearly 200 households. The wastewater flow though is low as well as intermittent. The peak flow hours lie between 7.00 am to 9.00 am during which the village receives water supply. Presently the drain carries the wastewater to long distances and most of it leaches to groundwater on the way. The farmers nearby experience foul smell as they pump water for irrigation from the borewells which are along the path of this wastewater drain. Presently, farmers are not using this wastewater for irrigation purpose. The farmer has a total cultivated land of 5 acres. The wastewater samples from the selected site was previously sampled in January 2015 and the wastewater analysis data is given in Table 13.

Table 13. Wastewater analysis report for Sadarahalli, Chikmagalur (Sampling: 4th Dec 2015)		
Sl. No.	**Parameters**	**Sadarahalli**
1	Arsenic (mg/L)	BDL
2	Boron (mg/L)	0.09
3	Biochemical Oxygen Demand or BOD(mg/L)	75.20
4	Cadmium (mg/L)	BDL
5	Calcium (mg/L)	113.00
6	Chlorides (mg/L)	317.50
7	Chromium (mg/L)	BDL
8	Cobalt (mg/L)	BDL
9	Chemical Oxygen Demand or COD (mg/L)	96.00
10	Copper (mg/L)	BDL
11	Electrical Conductivity or EC (ms/cm or ds/m)	1.60
12	Fluorides (mg/L)	1.18
13	Lead (mg/L)	BDL
14	Magnesium (mg/L)	61.00
15	Manganese (mg/L)	BDL
16	Ammoniacal-Nitrogen (mg/L)	33.90
17	Nickel (mg/L)	BDL
18	Nitrate-nitrogen (mg/L)	0.73
19	pH	7.26
20	Phosphates (mg/L)	1.86
21	Potassium (mg/L)	5.00
22	Sodium (mg/L)	95.00
23	Sulfate (mg/L)	79.10
24	Sulfur (mg/L)	17.94
25	Total Alkalinity (mg/L as CaCO3)	192.00
26	Total Dissolved Solids or TDS (mg/L)	1492
27	Total Hardness (mg/L as CaCO3)	720
28	Iron (Fe3+ and Fe2+) (mg/L)	BDL
29	Total Suspended Solids (mg/L)	44
30	Zinc (mg/L)	BDL

Figure 26. a) Interaction with the farmer during the visit at the site selected (1st December 2015); b) the site selected for constructed wetland (left side of the road); c) Site inspection alongside engineering officials; d) Contaminated ground water well.

Figure 27. Detail discussion about the design for the constructed wetland at Sadarahalli

The current status at Sadarahalli

Despite repeated requests and enquiries the construction has remained a "work in progress". The work such as preparation of the bed with gravel and sand media is yet to complete (Figure 28). As per the plan, this unit must have started functioning way earlier and would serve as a first hand know-how gathering place for the engineers who are executing the work in the other three locations in the district. However, the situation is different and no adequate answer from the concerned authorities.

Figure 28. The constructed wetland structures at Sadarahalli a) Situation in June 2016; b) Situation in October 2016

Decentralized wastewater treatment unit in Udeva

The ICRISAT team did this site inspection along with local engineering department officials once the activity got approved under Bhoosamrudhi. The Udeva structure was made as per the given design, however the structural stability remains doubtful. In our recent site inspection in October 2016, we could see portions of side wall breaking down even before the unit has been commissioned. The success of these type of low-cost and low maintenance technologies depend a lot on the quality of construction at the start. The local engineering authorities must give some sort of assurance about the structural stability of the construction work undertaken. In this site though the fabrication of the brick-masonry structure has been completed. However, the gravel-sand filter bed preparation work, plantation work and fencing work is yet to be completed (Figure 29). These works need to be completed as soon as possible and the constructed wetland is covered with weeds and bushes which needs to be cleared for functioning with appropriate side wall construction.

Figure 29. The Udeva constructed wetland: a) Situation in June 2016; b) Situation in October 2016

Figure 30. Site inspection and design discussions with local engineering department officials in Tarikere

Decentralized wastewater treatment unit in Lakumanahalli

The site identification and initial work happened at a brisk pace. However, as is the case in other locations the work remains "in progress" after enough time was allocated for the construction of the unit. The quality of construction at this location seems to be good.

Figure 31. ICRISAT team discussing about the activity with the locals at Lakumanahalli

Figure 32. The Lakumanahalli constructed wetland site: a) Situation in June 2016; b) Situation in October 2016

Decentralized wastewater treatment unit in Lingdahalli

Poor quality construction work was evident at the site selected at **Lingdahalli**. The structure must withstand rainfall event and that cannot be compromised as it is the major structure for storing and treating the water. The suitability for the site for the activity has come under some dispute due to some recent local development. The site was selected based on the drainage line, public land availability as well as it being not in the immediate proximity of households (the site was opposite to a graveyard). The plan was discussed with villagers. However, it seems that the construction of a marriage hall for the minority community has been sanctioned adjacent to the site (in the of plantation area). The alternative site at a distance of

60 meter proposed by the local leaders (next to the graveyard) is not fit for the activity. It must be noted that the issue has cropped up after 45 days of construction. The contractor engineer has claimed that 80 % of the assigned work was completed. It is not advisable to commission constructed wetlands at such proximity to a marriage hall as even temporary nuances of any wastewater treatment unit such as bad smell or temporary water logging (immediately after a heavy shower) may become reasons of severe public grievances. As it stands now the site is no longer fit for the activity after considering all the options which came out during our discussion with officials and village panchayat leaders and it is not possible to know future plans or projects in the pipeline.

Figure 33. The Lingdahalli constructed wetland site: a) Situation in June 2016; b) Situation in October 2016

Capacity building on micro irrigation management

Nearly 10 training programs were organized on different aspects of agriculture and horticulture in Chikkamagaluru under Bhoosamrudhi program. About 300 farmers trained on different aspects covering best management practices in rice cultivation, integrated weed management, site specific nutrient management in maize, drip irrigation in horticulture crops, grafting techniques in vegetables, etc (Table 14).

Table 14. Capacity building programs in Chikmagaluru

Sl. No	Training	No. of trainings	No. of participants	Institute
1	Micro irrigation in horticulture crops	3	300	IWMI/ICRISAT/DoH/DoA
2	Best management practices in rice cultivation	2	100	IRRI/ICRISAT/DoA
3	Site specific nutrient Management	1	30	CIMMYT/ICRISAT/DoA
4	Seed treatment, aerobic composting	4	120	ICRISAT/DoA
5	Grafted techniques in tomato, chilli	2	60	AVRDC/IWMI/DoH/ICRISAT

IWMI along with ICRISAT and line departments (DoA, DoH) organized a training program on creating awareness about drip irrigation in horticulture crops in Chikmagaluru district during 2016-17 crop season (Figure 34). There were about 30 farmers participated in the training.

Figure 34. Training to farmers on micro irrigation management under Bhoosamrudhi in Chikmagaluru

Raichur

In Raichur, four taluks (Raichur, Deodurga, Manavi and Lingasugur) were selected representing Northern dry Zone, North eastern dry Zone, respectively. These sites were identified using the multiple criteria worked out by the multi-disciplinary team of scientists and on-site visits undertaken by CGIAR and line department representatives. Looking at the diversity in rural livelihood system in the district, different CG institutions have proposed various interventions targeting different sectors viz., agriculture, horticulture, animal husbandry, sericulture and social forestry.

Nutrient Management

Soil testing

ICRISAT initiated intensive soil samplings from additional 40,000 ha area covering 45 villages with latitude and longitude. ICRISAT along with DoA staff collected soil samples in selected villages by adopting stratified soil sampling method. The Soil analysis results revealed wide spread deficiency of organic carbon, phosphorous, zinc and boron which are the major stumbling blocks for low productivity. Therefore, the focus was given to promote use of deficient secondary and micro nutrients along with major nutrients to address this issue. The results of soil samples collected from farmers' fields were analyzed and results are shared with all the stakeholders (Table 15). The details of soil samples collected from farmers' field.

Table 15. Soil Sample collection under BS 2016-17 in Raichur			
Raichur	**Manvi**	**Devdurga**	**Total**
100	100	134	334

Land and water management

Several in-situ soil and water conservation practices have been adopted to ensure sustainable management of resources (Table 16). The major *in-situ* soil and water conservation practices adopted were conservation furrow system (1500 ha), cultivation across the slope (12000 ha) and broad-bed and furrow system (150 ha). Similarly, integrated nutrient management techniques such as balanced nutrient application (22500 ha), bio-fertilizers (19890 ha), vermicomposting (25000 Nos), gliricidia planting on bunds (100 ha) and Azolla fern (10 Nos).

The above practices have been converged with Bhoochetana and ensured larger impacts on the farmers' field. These practices have gained importance among farmers as they obtained increased yield as well as reduced cost of cultivation which is the objective of Bhoosamruidhi in ensuring sustainable livelihood.

Similarly, several improved crop production practices such as transplanting pigeonpea (5 ha) and paired row planting of pigeonpea (100 ha) have been adopted by the farmers for increasing the yield and income (Table 16). These practices have coupled with pest and disease management methods such as pest monitoring using pheromone traps (2500 ha), cultural control method in cotton (1000 ha), bio-rational pesticides (2500 ha) and bio-fungicide (500 ha).

Table 16. *In-situ* soil and water conservation techniques and INM practices under Bhoosamrudhi in Raichur district	
***In-situ* Soil and Water Conservation Techniques**	Extent of area (Ha)/Nos
1. Conservation furrow system	1500
2. Cultivation across slope	12000
3. Broad-bed and furrow (BBF)	150
Integrated Nutrient Management Techniques	
1. Balanced nutrient application	22500
2. Bio fertilizers	19890
3. Vermicomposting	25000
4. *Gliricidia* planting on field bunds	100
5. *Azolla* Fern	10 (nos)
Rainfed technologies	**Extent of area (ha)**
Transplanting in Pigeonpea	5
Paired row planting of Pigeon pea	100
Pest and disease management	
Pest monitoring by using pheromone traps	2500
Cultural control method in cotton	1000
Bio-rational pesticides	2500
Bio-fungicide	500

Direct seeded rice (DSR) and other technologies

CIMMYT along with IRRI, ICRISAT, DoA and UAS- Raichur, have demonstrated DSR technology and it showed promise for its out-scaling through innovative strategies in the areas where water supplies are limited and farmers do not get sufficient water at right time and constrained with ON-OFF canal water supply. During 2016 crop season, about 20,000 ha has been covered under DSR in Raichur (Table 14). Similarly, efforts were made to promote other technologies with the help and cooperation of line departments (Table 17).

Table 17. Improved technologies demonstrated under Bhoosamrudhi in Raichur

Technologies under paddy cultivation	Area (ha)
Direct seeded rice (DSR)	20952
Drum seeded rice plantation	50
Machine transplanting	50
Other technologies	
Pigeonpea Nipping	200
Green manure Diancha/green gram/paddy transplanting	1500
Inter crop system in pigeonpea/pearlmillet/pigeonpea/soybean	2000
Total area (ha)	**25993**

Crop Intensification and Diversification

Farmers'participatory evaluation of improved varieties

The participatory varietal Evaluation program works towards increasing farm productivity by facilitating the delivery of high yielding, profitable varieties that are well adapted to a wide range of soil types, environments and farming systems. This is achieved by providing accredited, unbiased information to farmers on better adapted crop varieties, or new and better cultivars, at the earliest opportunity. During crop season 2016-17, number of new crop varieties were promoted with farmers'participation under Bhoosamrudhi in Raichur district (Table 18). Nearly 45000 ha has been brought under improved crop cultivars which include Pigeonpea (ICPH 2740, TS3R, Asha), DSR paddy (BPT 5204, Rpbio 226) (Figure 35) and groundnut (ICGV 91114) (Figure 36).

Table 18. Promotion of improved cultivars during kharif 2016

Crop	**Name of the technology**	**Area (ha)**
Groundnut (ICGV 91114)	Seed cum drill sowing, BBF maker	200
Pigeon pea (ICPH 2740, TS3R, ASHA)	Dibbling, Transplanting, seed cum drill sowing	17500
Others (specify)	DSR paddy (BPT 5204, Rpbio226)	25000
Total area (ha)		44500

Table 19. Groundnut demonstrations undertaken during 2016 in Deodurga taluk, Raichur district							
Name of the farmer	**Survey numb er**	**Village**	**Hobli**	**Crop details**	**Area (acre)**	**Yield of local variety (q/acre)**	**Yield of ICGV 91114 (q/acre)**
Hussain sab s/o Raja Sab	189	Kyadigera	Arkera	Intercro p	1	2.96	3.12
Ranggayya s/o Shivaraya	73	H Siddapur	Jalahalli	Sole	1	3.38	3.52
Timmanayak s/oShivaraya	170	Jalahalli	Jalahalli	Sole	1	3.24	3.40
Tirupatihi s/o Sugganna	14/1	Karigudda	Deodurg a	Sole	1	Flowering stage	Flowering stage
Dhanraj s/o Bibban gouda	50/1	Khanapur	Gabbur	Sole	1	Flowering stage	Flowering stage

Figure 35. Pigeonpea ICPH 2740 with broad bed and furrow system under Bhoosamrudhi in Raichur

Figure 36. Ground nut variety ICGV9114 grown at Devdurga, Raichur District

The crop cutting studies revealed that the groundnut yield in pilot sites is marginally increasing compared with farmers' practice. The performance of ICGV 91114 is affected with rainfall fluctuation in the district and the yield benefit was ranging between 4.1% and 5.4% compared to farmers' practice (Figure 37). However, it is necessary that farmers are encouraged to adopt high yielding improved varitiy seeds by supplying seeds well in advance to undertake sowing operations in the district.

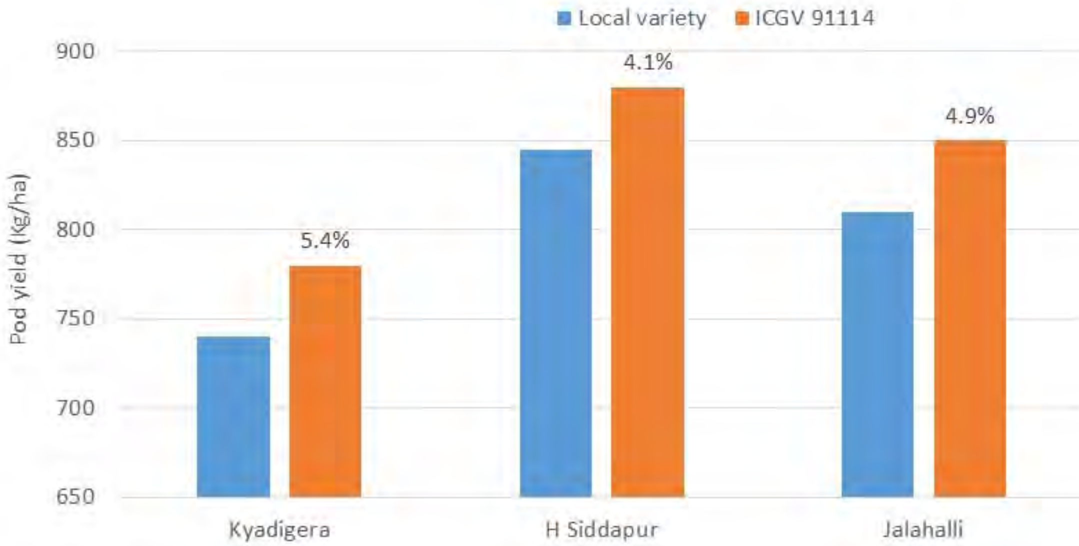

Figure 37. Performance of groundnut variety ICGV 91114 over local varieties in Raichur during 2016 kharif season

Promotion of Improved Paddy Varities

Raichur is one of major district for cultivation of paddy concerned deriving its irrigation source from TB reservoir, every year tail end farmers will face water deficit for irrigation purpose, by keeping all this in a view we have introduced many improved paddy varieties like RpBio 226, JGL3855, JGL11470, RNR15048, JGL17002. These varieties have good yield potential and one variety JGL 17002 was a short duration (100 days) which is highly suitable for the tail end farmers (Figure 38).

Figure 38. Promotion of improved paddy seeds like JGL 3855, RNR15048 and JGL11470, Rp bio 226 field visit and JGL17002 (short duration variety) nursery

Organic rice cultivation

Organic rice cultivation is being demonstrated in Raichur and Sindanoor taluks of Raichur District (Figure 39). In organic rice cultivation, the farmers are using neem cake (2.5 t/ha), farmyard manure (5 t/ha), and vermicompost (5 t/ha) instead of inorganic fertilizers. Rice varieties Karimnagar Samba (JGL 3855) and Telangana Sona (RNR 15048) are tested in Raichur and Improved Samba Mahsuri (RP Bio 226) is included in the Sindhanur taluk demonstration. Neem oil and jeeva amrutham application are being used for insect management. The crop is in the vegetative stage at Raichur as it was transplanted late in Raichur and it is in the flowering stage at Sindanoor taluque.

Figure 39. Farmer participatory demonstration of Improved Samba Mahsuri (RP Bio 226) under organic (left) and inorganic (right) methods of rice cultivation in Sindanoor.

Performance evaluation of rice cultivars

In Raichur, during kharif 2016, number of improved varieties of rice were evaluated with an objective to scale up good performing location specific varities to benefit large number of farmers. The crop cutting studies revealed that farmers harvested about 9.2 t ha^{-1} by cultivating RP Bio 226. Similarly, WGL 32100 (7.5 t ha^{-1}), RNR 15048 (7.4 t ha^{-1}) and JGL11470 (7.4 t ha^{-1}) performed better than other varieties (Figure 40). These varietis have harnessing the potential of higher yields to bridge large yield gap exists in the region.

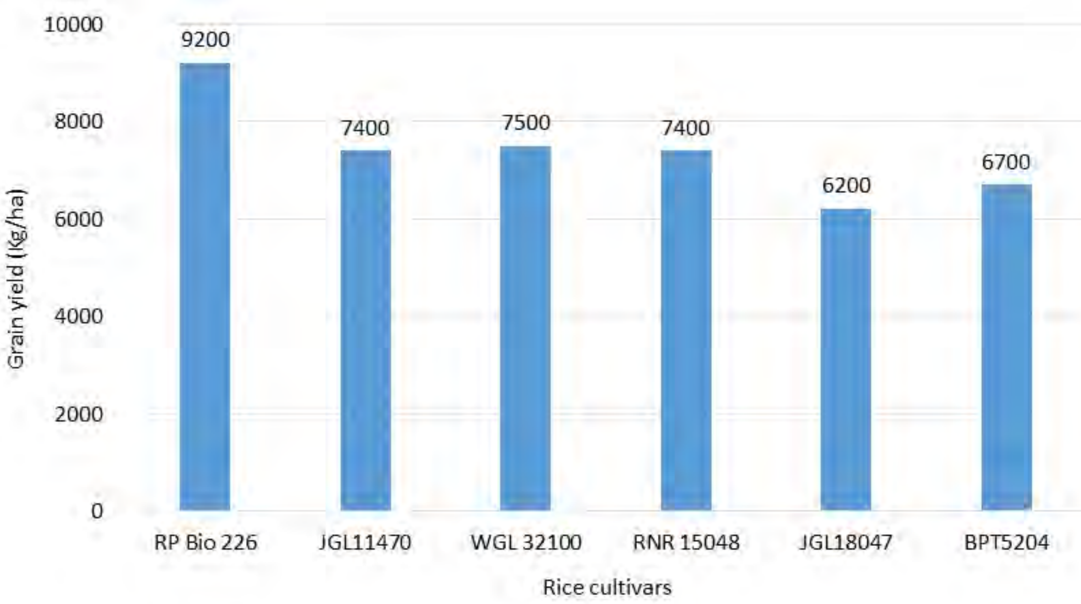

Figure 40. Performance of different rice cultivars under Bhoosamrudhi program in Raichur district during kharif 2016

Promotion of Green gram

The mungbean was sown in Kasbe camp and other Bhoosamrudhi villages as a farmer participatory demonstration for increasing the income of farmers by proper land use. The mungbean was sown by some using irrigation and by others with the summer rains that occurred in mid-May. Mungbean variety BGS9 was sown by most of the Bhoosamrudhi demonstration farmers (Figure 41). Looking at the demonstrations, other farmers also raised mungbean but the variety they used was Sipai. A few farmers have raised variety Pusa 3. BGS9 mungbean was found to be more vigorous than Sipai. Some farmers hand-weeded the mungbean fields and left the weeds in the field or placed the hand-weeded weeds on the bunds. The need for collecting the weeds from the fields and proper disposal of the weeds was explained to the farmers as the predominant weeds such as *Trianthema portulacastrum* have the capacity to regenerate, if left in the field. In some mungbean fields, volunteer rice seedlings were observed to be abundant. The application of post-emergence herbicide quizalofop (Turga super) at 300 mL/acre at 20–25 days after seeding was advised to farmers for properly and effectively managing weeds with less cost. Mungbean yield varied among the farmers and the varieties grown. On average, Sipai, BGS-9, and Pusa 3 yielded 3.3, 3.6, and 4 quintals per acre (Table 20). The farmers gained a net income of INR 21,750 to 29,400 because of growing mungbean prior to rice in the kharif season. The crop was harvested in mid-June and the rice was sown by some using zero tillage and by others after minimum tillage as advocated by Bhoosamrudhi.

Table 20. The yield and economics of mungbean grown before direct-seeded/transplanted rice in Raichur District.

Variety	Yield (q/ha)	Gross income* (INR/ha)	Cost of cultivation (INR/ha)	Net income (INR/ha)
Sipai†	8.1	36,450	14,700	21,750
Pusa 3 ‡	9.8	44,100	17,150	29,400
BGS-9¥	8.8	39,600	13,230	26,125

Note: Values are average of † and ‡ = 3 farmers; ¥ = 8 farmers; * at INR 4,500 per quintal mungbean

Figure 41. The possibility of growing a mungbean (variety BGS9) crop was demonstrated in a farmer participatory manner by sowing mungbean with the onset of monsoon as a part of crop intensification in Raichur District.

Bhusamruddhi project 2016-17 gave special importance to promote green gram in parts of Raichur district, as a part of PET, we have introduced Green gram varieties like BGS 9 and IPM 2-14 which are good in yield and suitable for machine harvest. Farmers got yield around an average of 4-5 quintals/acre and this income to farmer was additional with least irrigation and inputs (Figure 42). We also tried introducing mechanical harvestor to save labour cost and time and it was a success (Figure 43).

Figure 42. Green Gram (BGS 9) grown as a pre-khariff crop to get additional income to farmers

Figure 43. Green gram variety BGS 9 grown at Kasbe camp (L), green gram mechanical harvesting (R)

The yield of BGS 9 in Kasabe camp and Srirampura Camp shows the potential of greengram cultivation in these areas as additional income source for farmers. The yield benefit is ranging between 718 kg ha^{-1} in Kasabe camp and 880 kg ha^{-1} in Srirampura camp (Figure 44).

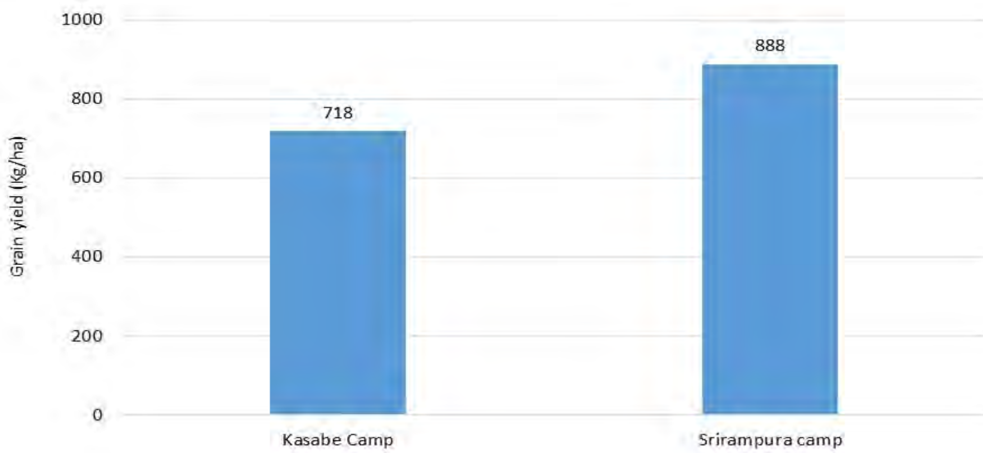

Figure 44. Greengram production during pre-kharif 2016 in Kasabe camp and Srirampura Camp in Raichur

Demonstration of Aquasap benefits

Aquasap is a Sea weed extract organic fertilizer which is used as foliar spray for commercial crops. Aquasap- 5X: This is a 100% organic extract from sea plants. It contains macro & micro nutrients, essential amino acids and plant growth hormones that provide major boost to crop yield by accelerating metabolic function and enhancing its nutrition uptake capacity. Spraying preparation 1% for foliar application for 3 times during crop season. After establishment stage, pre-flowering and post flowering stage of crop. It can also be used for vegetable crop the seedlings roots need to be dipped in 0.3% solution. The solution is available in 1 litre pack and sufficient for one acre area. The liquid is an organic produce and hazard free and can be handled with bare hands for mixing with water for preparation of solution. The requirement for one acre trial 3 times sprays need 3 liter. The demonstrations are being conducted on Bt Cotton, Chilli, Paddy, maize, chickpea etc which has resulted in good crop growth and vigour. The yield data are expected for assessing the impact of aqausap foliar spray in rabi season.

Aerobic composting

In order to increase availability of compost at field level, we have introduced shredder machine which is tractor operated and can be used to chop all agricultural residues into finer parts which can be easily used for compost preparations. We have also provided 2500 packets of Microbial culture to interested farmers and conducted the capacity building programs to educate them on the complete procedure for adopting this process. The farmers' response was very good and they are happy with the fast decomposition of crop residues with this initiatives. Altogether around 100 tons of compost is produced by different farmers and used in their own fields.

Land and Water Management

Major land and water management interventions include:

- Growing of Green manuring crops like Dhaincha, Glyrsidia to restore soil nitrogen (Figure 45)
- Broad bed furrow and wider spacing in Pigeon pea (ICPH 2740) for moisture conservation as well as to provide good drainage under excess rainfall circumstances.
- Organic Paddy cultivation also initiated to create awareness about soil health and land management.
- Zero tillage in Maize fallow Paddy with drip irrigation for both land and water management.
- Introduction of Green gram as a beneficial crop in pre khariff which will fetch an additional income with residual moisture and also fix atmospheric nitrogen as a legume crop.

Figure 45. Green manure crop at kasbe camp developed under Bhoosamrudhi, Raichur

In Raichur, the sites selected are in water scarce region. There is a need for an improved *in-situ* soil and water conservation that can protect the soil from erosion throughout the season and provide control at the place where the rain falls. ICRSIAT introduced Broad bed maker (BBF maker) on 10 ha area, a multi facilitated machine for wider implementation, particularly for sowing of all rainfed crops in black soils. The hands-on training to farmers on familiarization of the system was given with support from department of agriculture. The benefits of this machine is in two way, one it can be used to drain out the excess moisture during heavy rainfall scenario and second it is used for in-situ rainfall harvesting. Broad bed and furrow (BBF) system has been found to satisfactorily attain these goals not only in black soils but also in Alfisols (red soils).

Sustainable intensification of cotton systems through relay planting of maize in standing cotton (after 2/3rd picking)

Cotton is an important commercial crop of Raichur district in Northern Karnataka. Cotton is raised under irrigated as well as rainfed conditions especially in the tail end command areas where limited irrigations prevailed. In conventional practice, farmers generally raise single crop and yields dependent mainly on assured irrigation and availability of timely adequate rainfall. But cotton yield is subjected uncertainties as both of the above situations are not in control. To stabilize the income opportunities of the cotton farmers, we explored the possibility of sustainable intensification of cotton through introduction of a relay crop which can be raised under residual moisture without any competition with the main crop using a novel technology (relay planter). For the success of relay crop in cotton, timing of introducing relay crop in cotton is very crucial. For successful relay crop in cotton, sowing relay crop either at early stages preferably sowing along with cotton or at the latter stages such as after second picking to enhance the farm gate income. We explored the possibility of inclusion of second crop through relay seeding of maize and other crops in standing cotton to capture the residual moisture for crop establishment and advancing planting to escape the heat stress at pollination. During current winter season, 10 participatory validation trials have been established on relay planting of maize in standing cotton using the best performing as well as some new maize hybrids identified during khraif 2016. The maize was planted in standing cotton after 3rd picking. This is one of the important strategies for sustainable intensification in these resource constraint areas to increase productivity, profitability and livelihoods of resource poor farmers. We also choose crops such as green gram, chickpea, maize, sorghum etc. and got success in chickpea and sorghum.

Validation study on Surface and sub-surface drip irrigation

The state of Karnataka faced an unprecedented drought in succession and demand for dwindling resources, especially water is increasing. In canal commands, rice-rice system is ending-up to only single rice system due to non-availability of water for irrigation. Farmers in the tail end are facing difficulty of raising even single crop of rice. In this region, DSR which became popular is now faced with shortage of water even for kharif crop. To address these growing challenges of water shortage, we initiated participatory innovative research-cum-validation trials integrating DSR with micro irrigation during kharif 2016.

During 2016-17 also 4 participatory strategic research trials are continuing involving surface and subsurface irrigation in DSR (Table 21). This is a completely new innovation in the state of Karnataka.

Table 21. Details of demonstrations on surface and sub surface drip.

SNo	Name of the Farmer	Name of the village	Crop/Area
1	Hari Babu	Vijayanagar Camp	Rice 2Acres
2	Satyanarayan	Vijayanagar camp	Rice 1acre
3	Suresh	Govindoddi	Rice 1.5 acre
4	Anand Gowda	Govindoddi	Rice 1.5 acre

The details of irrigation regimes followed at different sites are:
Site 1 : Transplanted rice (8 cm standing, allowed to recede to saturation before flooding again), DSR (as practiced by farmers, 5 cm standing, allowed to recede to saturation before flooding again), surface irrigation (60 and 80 cm lateral spacing), subsurface irrigation (60 and 80 cm lateral spacing placed at 10 cm depth).

Site 2: Transplanted rice (5 cm standing, allowed to recede to saturation before flooding again), surface irrigation (60 and 80 cm lateral spacing).

Site 3: Transplanted rice (8 cm standing, allowed to recede to saturation before flooding again), DSR (as practiced by farmers, 5 cm standing, allowed to recede to saturation before flooding again), surface drip irrigation (60 and 80 cm lateral spacing), subsurface irrigation (60 and 80 cm lateral spacing placed at 10 and 15 cm depth).

Site 4: Transplanted rice (8 cm standing, allowed to recede to saturation before flooding again), DSR (as practiced by farmers, 5 cm standing, allowed to recede to saturation before flooding again), surface drip irrigation (60 and 80 cm lateral spacing), subsurface irrigation (60 and 80 cm lateral spacing placed at 10 cm depth).

Figure 46. Zero Till Paddy grown under drip Irrigation at Govindoddi, Neermanvi, Manvi Taluk

Yield benefit of zero till paddy with drip irrigation is varying with variation in soil types and varieties. Four farmers have adopted drip irrigation in paddy and the results are encouraging and can be a scalable model if implemented in a large scale. The yield in these demonstrations field varied between 6000 kg ha^{-1} to 8400 kg ha^{-1} (Figure 47).

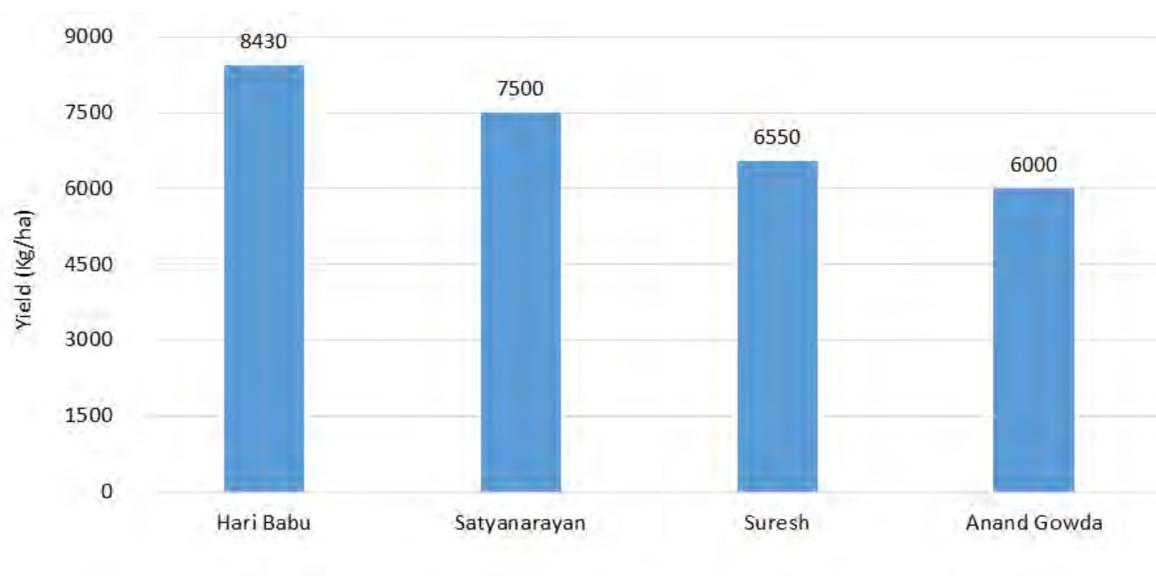

Figure 47. Performance of DSR under drip irrigation in Raichur district during Kharif 2016

Vegetable production technologies

In Raichur district, capsicum (in two shadenets), and tomato and French bean crops in two shadenets were grown with improved practices. Mungbean was introduced as a pre *kharif* crop in the rice fallow during May 2016 in ten farmers' fields in Raichur district (Figure 48). Mungbean introduction in paddy fallow has helped the farmers to get additional income, and being a legume crop, mungbean aids in improving soil texture, structure and fertility of the soil. The SML 668 variety (i.e., NM 94), that WorldVeg has been promoting, is tolerant to mungbean yellow mosaic virus (MYMV).

Farmers have obtained an average yield of 700-800 kg ha^{-1} and the present market price has been between Rs. 80 to 110 kg^{-1}. The addition of mungbeans in the rice fallow has been reported by farmers to be associated with increasing paddy yield up to 3 to 4 % following mungbean harvest.

The mungbean area has been steadily increasing as farmers have seen the results. For instance, WorldVeg ran a 0.6 ha demonstration trial during the 2014 Rabi season on the farm of Mr. Subbarao, a progressive farmer from Neer manvi village in Raichur district. The average yield harvested was 600 kg and it was sold at a cost of Rs. 80 kg^{-1}. In the second year (2015, Rabi), the same farmer grew mungbean in 4.4 ha of paddy and harvested an average yield of approximately 1.0 t ha^{-1} (as a lack of water during pod setting stage reduced the yield), and selling it for INR 90 kg^{-1}.

Figure 48. Tomato cultivation under shadenet cultivation (L); Visit of GoK department staff to mungbeans field

Grafted tomatoes with improved practices were demonstrated in twelve farmers' fields in Manvi, Devadurga and Lingasugur taluks of Raichur District. Now the crop is at the flowering and early fruit set stage. Information on disease incidence and control, the effect on yield patterns and cost-benefit ratios, and the acceptance of improved cultivation practice by farmers will be provided in the subsequent report.

Drying of Chili, Tomato and Onion using a Solar Dryer facility in Raichur

An assessment of drying needs was undertaken during the visit of the Worldveg postharvest specialist, Dr Arshad Pal to Raichur during July-August 2016. Following consultations with farmers and departmental officials, two Worldveg small-scale solar drying units with a drying capacity of 40-50 kg each were fabricated and installed (Figure 49) for use by farmers through a community-owned arrangement. Test drying of samples was demonstrated. The units will be used for chili and onion drying as well as to produce sun-dried tomatoes in the district. Required training provided to farmers on different technologies (Figure 50 & Table 22).

Figure 49. WorldVeg designed Solar Dryers

Figure 50. Training on kitchen gardening conducted in Manvi Taluk of Raichur District

Table 22. Capacity building programs in Raichur district during 2016-17

Training	Village	No. of Participants	Stakeholders
Bhoosamruddhi Awareness and Capacity Building Program to Farmers	Vijayanagaracamp,	250	ICRISAT-DoA, CIMMYT, IRRI, LINE Depts, IWMI, AVRDC
Bhoosamruddhi action plan and proposed activities	All DoA and line department staffs	75	All CGIAR centers
Participatory varietal evaluation of Paddy	Vijaynagarcamp, Kasbe camp, Sitaram Camp, SIndhnur	25	IRRI, ICRISAT
Landform management: Tropicultor use, BBF making, irrigation management	Idapnur, Mittekallur, Sitaram camp, SIndhnur	120	ICRISAT, IRRI, DoA, CIMMYT
Integrated pest management	Lingasugur, Deodurga and Raichur taluk farmers	150	ICRISAT, IRRI, CIMMYT, UAS-Raichur, DoA
Irrigation water management to Paddy	Sindhnur, Manavi, Vijaynagar Camp	40	IRRI, ICRISAT
Nipping in Chickpea	Idapnur, Sitaram camp, Kasbe camp	45	ICRISAT, IRRI
Training program on micro irrigation	Deodurga, Manavi,	200	IWMI

Vijayapura

The Bhoosamrudhi project in Vijayapura district covers in all 5 talukas with a geographical area of 48,995 ha with cultivable area of 46,760 ha in 16 villages.

The details of interventions adopted during 2016-17 are given below.

Land and water management

Broadbed and furrow system

Broadbed and furrow system (BBF) of land management system to enhance the green water storage and use efficiency was adopted in an area of 160 ha during kharif and rabi season with greengram, pearlmillet and pigeonpea (Table 23 and Figure 51). Along with improved land management of BBF improved crop management such as pre- emergence herbicide was used to control weeds and recommended dose of micro nutrients were used. The crop yields during khraif was low due to less moisture and in some regions due to water logging because of erratic rainfall.

The BBF system consists of a relatively flat bed or ridge approximately 105 cm wide and shallow furrow about 45 cm wide and 15 cm deep. The BBF system is laid out on a grade of 0.4 – 0.8% for optimum performance. The BBF system of land management can be adopted in semiarid tropics with deep black soils and for groundnut crop in red soils with a reduced gradient along the BBF (0.2-0.3%) with an average rainfall of 600-800 mm. The BBF system is most effectively implemented in several operations or passes. After the direction of cultivation have been set out, furrow making is done by an implement attached with two ridgers with a chain tied to ridgers or a multipurpose tool carrier called “Tropicultor” to which two ridgers are attached or any other suitable implement. If opportunity arise (after showers) before the actual begging of the rainy season, another cultivation is done to control weeds and improve the shape of the BBF. Thus, at the begging of the growing season this seed is receptive to rainfall and, importantly, moisture from early rains is stored in the surface layers without loosing in deep cracks in black soils.

Benefits of BBF system are as below:

- The raised bed portion acts as an *in-situ* ‘bund’ to conserve more moisture and ensures soil stability; the shallow furrows provides good surface drainage to promote aeration in the seed and root zone; prevents water logging of crops growing on the bed.
- The BBF design is quite flexible for accommodating crops and cropping systems with widely differing row spacing requirements.
- Precision operations such as seed and fertilizer placement and mechanical weeding are facilitated by the defined traffic zone (furrows), which saves energy, time, cost operation and inputs.
- Reduces runoff and soil loss and improves soil properties over the years.
- Facilitates double cropping

Table 23. Yield of major crops under Broad-bed and Furrow system under Bhoosamruddhi in Vijayapur 2016-17

Sl.No	Crop	Variety	Yield in BBF plot qt/ha	Yield in Non BBF plot qt/ha
1	Green gram	DGGV-2	2.5	2.2
2	Greengram	IPM-02-14	2.1	1.8
3	Pearl Millet	Dhanashakthi	10.21	9.21
4.	Pigeonpea	ICPL - 88039	3.0	2.66
		ICPL - 161	5.2	4.6
		ICPL - 85063	15	13

Yield benefits of Broad-Bed and furrow system

The broad-bed and Furrow system is an effective method of soil and water conservation in different rainfall regions. Under Bhoosamrudhi, BBF method of cultivation has been promoted in Vijayapura in a large scale. The impact of this method on the crop yield is encouraging. During kharif 2016, greengram was cultivated in BBF and the yield increment was about 14% in DGGV 2 and 17% in IPM 2-14 over farmers practice (Figure 52). This shows that the improved method of soil and water conservation plays an important role in increasing crop yield and there is a scope to converge different schemes to promote this method to benefit more number of farmers.

Figure 51. Crops sown with Broad-Bed and Furrow system under Bhoosamrudhi in Vijayapura district

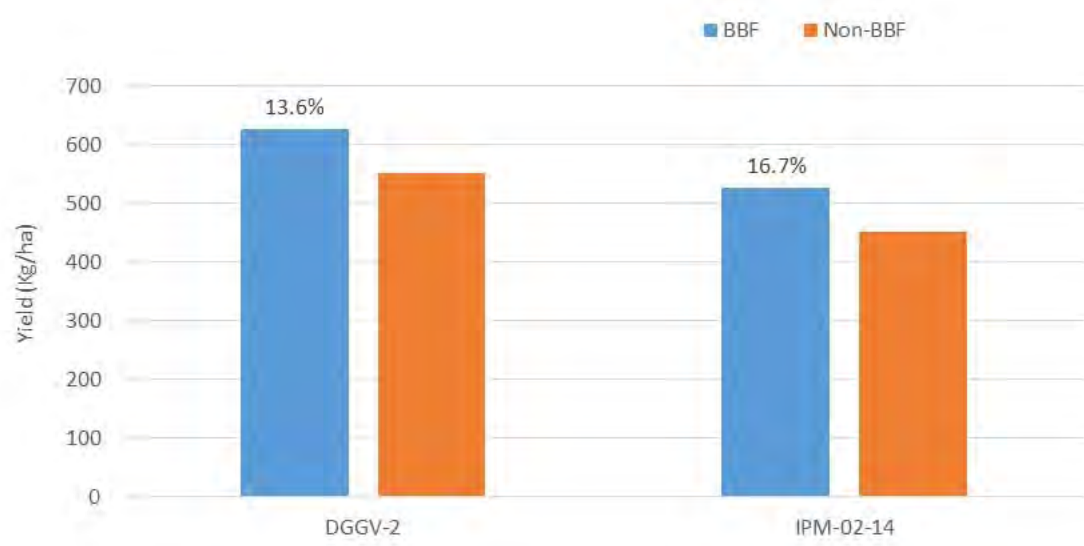

Figure 52. Greengram production with broad-bed and furrow (BBF) method in Vijayapura district

Pigeonpea is one of the major crops in Vijayapura district. During kharif 2016, pigeonpea was cultivated with BBF method and the yield benefit was about 12.8%, 13% and 15.4% with ICPL88039, ICPL161 and ICPL85063 respectively over farmers practice (Figure 53).

Figure 53. Performance of pigeonpea with BBF method in Vijayapura district

Laser leveler

Land smoothening or leveling plays a critical role in avoiding the uneven distribution of moisture on surface due to small depressions resulting uneven growth of crop. Land smoothening using laser land leveler was introduced by CIMMYT and ICRISAT. One laser land leveler has been procured and used in three villages. During 2016-17 crop season, about 5 ha area in Inchageri village has been levelled using land leveler (Figure 54).

Figure 54. Laser land leveler in operation in Inchageri village

Magnetic Water Conditioner

The borewell water that is used for irrigation in the district has high salt content that leads to salinity formation of soil. To overcome the problem a Magnetic water conditioner has been installed in the water line to treat the water to reduce the salinity of water and pH in Jumanal village (Figure 55). The Magnetic water conditioner is installed in a water pipeline, the water pass through the magnetic field for pilot test. During the flow it controls and stabilizes the pH results in desalinization of soil. It also scales formation in pipeline. It was observed by a team of department and ICRISAT officials that the field irrigated using water conditioner has shown clearly reduced the salt formation on soil surface after irrigation compared to the field irrigated without water conditioner. About 10 Magnetic water conditioner was demonstrated covering 15 acres. Magnetic treated and untreated water drip irrigation in alternate lines of brinjal crops at Inchageri village was evaluated for its scaling up. The Fruit size of Brinjal was bigger in treated line than in untreated line. In treated line farmer harvested around 9Kg of Brinjal Where as in untreated line he harvested 7.5 to 8 Kg. The other crops covered are onion, sugarcane, grapes, capscicum and tomato. This activitiy was also converged to cultivate capscicum and tomato under shade net condition developed by AVRDC.

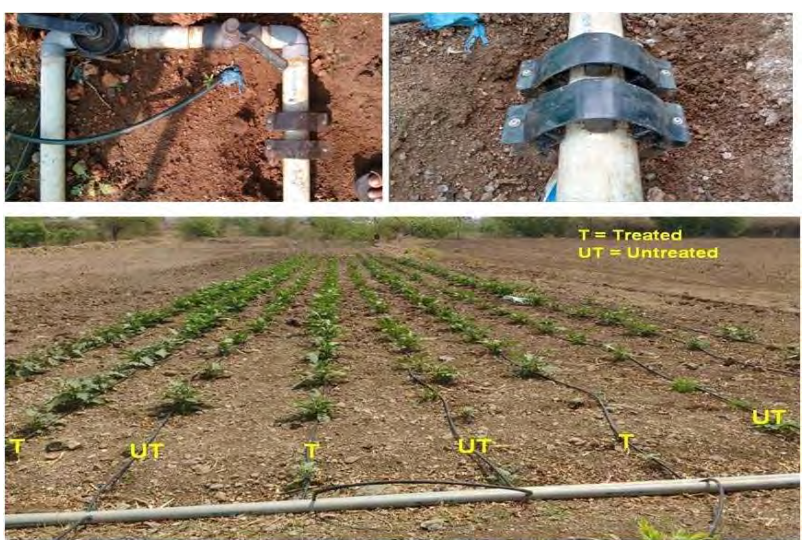

Figure 55. Magnet treated and untreated water drip irrigation in alternate lines of brinjal crops at Inchageri village, Vijayapura

Crop Intensification and Diversification

Vijayapura district has the most dry areas although many rivers flow through the district. To find suitable crop cultivars for adjusting to varying rainfall and climate related risks, promising pigeonpea cultivars of ICRISAT were taken up for varietals evaluation (Table 24). These cultivars have different charactristics which are suitable to this region and yielding comparatively good yield. In addition to this, evaluation of promising released varieties from universities/ private seed companies (viz. maize (NK-6240), safflower (PBNS-12) and foxtail millet (Surayanandhi) were also conducted (Table 25 & Figure 56). Maize (NK 6240) is being promoted with the help of ILRI for meeting fodder requirement for animals. To control, weeds, weedicides are also applied on the BBF (Figure 57).

Table 24. Pigeonpea varietial evaluation under Bhoosamrudhi in Vijayapura, 2016

Variety	Varietal characteristics	Village	Area (ha)	No. of Beneficiary
ICPL 85063	• Long duration (170-175 days) • Suitable for irrigated condition • Resistant to Fusarium wilt • for intercropping with groundnut • yields 1.8 to 2.0 t ha^{-1}		4	7
ICPL 88039	• Extra short duration (120-125 days) • drought tolerant and escape insect damage due to earliness • yields 1.7 to 1.8 t ha^{-1}	Hallur	0.4	1
		Tamba	0.4	1
		Beeraldinni	0.4	1
		Angadageri	0.4	1
		Thidagundi	0.4	1
ICPL 161	• short duration indeterminate variety (125-135 days) • drought tolerant and escape insect damage due to earliness • yields 2.0 to 2.3 t ha^{-1}	Beeraldinni	0.8	1
		Tamba	0.2	1
		Total	3.5	6

Table 25. Foxtail millet, Maize and Safflower promotion under Bhoosamrudhi in Vijayapura, 2016

SL.No	Village	Crop	Variety	Yield qt/acre	Local Variety Yield qt/acre
1	Aareshankara	Foxtail Millet	Surayanandhi	3.2	1.68
2	Hattali	Maize	NK-6240		
3	Inchageri	Safflower	PBNS-12	1.6	1.23

Figure 56. Promotion of different crops in Bhoosamrudhi, Vijayapura

Figure 57. Use of weedicide (Pendimethalin) in BBF

Kitchen Gardens in Vijayapura District

To ensure nutritional availability in the foods farmers consume, kitchen garden kits were distributed to farmers under Bhoosamrudhi program. Around 12 families have beneficted from this interventions in Vijayapura (Table 26). The observations and experiences of farmers are awaited (Figure 58).

Table 26. Promotion of kitchen garden kits under Bhoosamrudhi in Vijayapura

Kitchen Gardens in Vijayapura District			
Sl. No.	**Village**	**No. of Beneficiary**	**No. of Gardens**
1	Angadageri	1	1
2	Inchageri	3	3
3	Muddebihal	1	1
4	Jumnal	1	1
5	Sarwad	1	1
6	Aliyabad	1	1
7	Atharga	1	1
8	Mulsavalagi	1	1
9	Mulwad	1	1
10	Beeraldinni	1	1
	Total	**12**	**12**

Figure 58. Kitchen garden promoted under Bhoosamrudhi in Vijayapura

Solar Insect Light Trap

An eco-friendly pest control system was piloted using solar light pest trap equipment in Vijayapura during 2015 and that is being continued during 2016. About 9 farmers have benefited this technique covering crops such as pigeonpea, Chickpea, pigeonpea and grapes, Pigeonpea and lemon and pigeonpea and Capsicum (Table 27 & Figure 59).

Table 27. Solar insect pest traps installed under Bhoosamrudhi in Vijayapura, 2016-17

	Solar Insect Light Traps 2016-17			
Sl. No.	Village	No. of Beneficiary	Crop	No. of Gardens
1	Angadageri	1	Redgram	1
2	Beeraldinni	1	Redgram	1
3	Shivanigi	1	Redgram & Grapes	1
4	Mulsavalgi	1	Redgram & Lemon	1
5	Nivalkhed	1	Redgram	1
6	Mannur	2	Redgram and Capsicum	2
7	Hallur	1	Chickpea	1
8	Agasbal	1	Chickpea	1
	Total	9		9

Figure 59. Solar trap in pigeonpea field and and capscicum field, Vijayapura, 2016

Nipping in Redgram

Nipping in pigeonpea is a good practice but recently got popularity after realizing the benefits of increased yield. Nipping should be done at 50 days after sowing at 5-6 cm from the top which helps in branching and higher pod yield. In Vijayapura, during 2016-17, about 50 ha area under pigeonpea was done with nipping (Figure 60). The yields under nipped plot shows higher yield compared to control plots where nipping was not done (Table 28).

Table 28. Nipping in pigeonpea in Sarwad and Hallur village, Vijayapura district

Nipping in Redgram					
Sl.No.	**Crop**	**Variety**	**Village**	**Yield in Nipped plot Q/ha**	**Yield in Control plot Q/Acre**
1	Redgram	TS3R	Sarwad	3.1	2.9
2	Redgram	TS3R	Hallur	2.9	2.7

Figure 60. Nipping in pigeonpea in Vijayapura and Muddebihal taluk, Vijayapura district

Shirohi Goat for breed improvement

The Adaptation of Shirohi goat in earlier days of introduction was very critical, after lot of efforts and feed mangagement the goats which are introduced in Beeraldinni and Havinal villages are adapted well to the locality. Sirohi bucks (male goats) have been introduced to improve meat production of local breed of goats. Three Sirohi bucks (two in Beeraladinni and one in Havinal villages) were provided for natural insemination with local breeds of goats (Figure 61). Sirohi goats are adoptable for various agro-climatic conditions ranging from hot to cool climate. The breed is preferred mainly for increased meat production as it is fast growing. It has lower mortality in kids. For natural insemination for herds of 25 goats, one Sirohi buck was kept and three kids born. The details is given in Table 29.

Table 29. Introduction of Sirohi bucks and beneficiaries

Sl.No.	Village	No. of bucks given	Beneficiary	No. of progenies	Outbreeding	Outbreed Progenies
1	Beeraldinni	1	1	28	20	37
2	Havinal	1	1	24	16	26

Figure 61. Beneficiary farmers with Sirohi bucks in Beeraldinni and Havinal village, Vijayapura

Feed and fodder production and analysis

ILRI along with ICRISAT undertaook demonstrations on promoting fodder varieties of maize in Vijayapura district. A total of 20 farmers were benefited from these interventions. About 60 cattle feed samples have been sent to ILRI for further analysis and recommendations (Table 30 & Figure 62).

Table 30. Feed and fodder analysis to increase milk yield					
Sl.No.	Village	Maize Crop	No. CCE	Benificiery	No. of cattle feed samples sent to ILRI for analysis
1	Hattalli	NK-6240	6	10	30
2	Havinal	NK-6240	6	10	30

Figure 62. Awareness about cattle feeding and CCE of maize fodder variety for analysis

Vegetable production technologies

In Vijayapura district, capsicum, ridge gourd, tomato and bitter gourd cultivation were grown under shade nets with improved practices on five farmers' fields. Though the initial growth rates were good (with 1-2 irrigation through drip), long dry spells and a lack of water in May-June, 2016 affected yields. The demonstration of capsicum and chili cultivation with improved practices in open fields in July-Aug, 2016 in farmers' fields is now at the post flowering and fruit setting stage (Figure 63). The results on the yield and impact of improved practices will be reported subsequently.

Figure 63. Capscicum cultivation under Shadenet houses in Vijayapura

Figure 64. Vegetable cowpea and interterminate tomato demonstration in Vijayapura

Table 31. Yield of vegetable cowpea and indeterminate tomato in Vijayapura				
Sl.No.	**Village**	**Crop**	**Benificiery**	**Yield Q/Acre**
1	Angadgeri	Vegetable Cowpea	1	15.5
2	Jumnal	Vegetable Cowpea	1	12
3	Kannal	Indeterminate Tomato	1	17.5

Wastewater treatment Unit

Mulasavagi village was identified for decentralized wastewater treatment system in Vijayapura district (Figure 65). The village has two drainage canals; the one which has been identified for the construction is a major drain and has about 900 households. With the approval of CEO this activity is carried by the Panchayat Raj department. The excavation work is in progress (Figure 66).

Figure 65. Google-Earth image of the location selected for the activity (Lat: 16^{O}53'19.6" N; Long: 76^{O}01'26.5")

Figure 66. Wet land construction work is in progress in Mulasavagi village

Capacity Building

Twenty one trainings were conducted involving nearly 4000 participants to impart the training and building the capacity of farmers on improved land and water management, participatory soil sampling and integrated nutrient management, compost preparation, climate change adaptation, improved crop management with integrated pest management, etc. (Table 32). Apart from these, IWMI has organized training programs on drip irrigation and efficiency of drip in different cropping system benefiting nearly 400 farmers (Table 32b and Figure 67).

Table 32a. Capacity building activities carried out in Vijayapura, 2016.

Date	Training	Village	No. of Participants	Stakeholders
22-05-2016 to 05-06-2016	Bhoosamruddhi Awareness and Capacity Building Program to Farmers	All BhooSamruddhi Villages	1452	ICRISAT-DoA, LINE Depts, IWMI, AVRDC
07-06-2016	BBF land management	Inchageri	25	ICRISAT
08-06-2016	Bhoosamruddhi Awareness and Field day and training on Inter cropping of Vegetable cowpea in Sugarcane	Angadageri	56	ICRISAT, AVRDC, ILRI and IWMI
14-06-2016	BBF Land management	Angadageri	25	ICRISAT
27-06-2016	Video production on Seed treatment of Redgram	Sarwad	10	ICRISAT
13-07-2016	ILRI Training on Animal feed for livestock.	Hattalli and Havinal	60	ICRISAT, ILRI and AHVS officers.
15-07-2016	INM, IPM and Use if PPC in Redgram and other crops Trainings to farmers.	Angadgeri, Beeraldinni, Hunshyal PC.	224	ICRISAT
18-07-2016	INM, IPM and Use if PPC in Redgram and other crops Trainings to farmers.	Inchageri, Athrga, Aliyabad	224	ICRISAT
21-07-2016 to 26-07-2016	Aerobic compost preparation	Angadgeri, Beeraldinni, Hunshyal PC, Tamba, Jeerankalgi, Inchigeri, JigjeevanI, Mulsavlgi and Nivalkaed villages.	468	ICRISAT
10-08-2016	Capacity building on "Spineless Cactus as Feed"	Inchageri and Jigjeevani	12	ICRISAT & ICARDA
02/09/2016 to 05-09-2016	Nipping Machine Demonstration and training on PPC and crop Management	Sarwad, Bableshwar, Hallur, Agasbala and Angadageri village.	587	ICRISAT and Agri. Dept
08-11-2016 & 11-11 -2016	Solar Insect light trap Demonstration and training on pest control	Mulsavalgi, Nivalkhed, Mannur, Hlluru, B.Bagewadi, and Shivangi.	456	ICRISAT and Agri Dept

Table 32a. Capacity building activities carried out in Vijayapura, 2016.				
Date	**Training**	**Village**	**No. of Participants**	**Stakeholders**
24-11-2016	Training on POP of Chickpea, seed treatment, INM, IPM and use of Plant protection chemicals and crop management.	Angadgeri	30	ICRISAT
06-12-2016	Training on Cultivation of Vegetable cowpea	Jumnal	10	ICRISAT and AVRDC
06-12-2016	Video Production on Sugarcane trash cutter	Sarwad	12	ICRISAT and Dept
08-12-2016	Training on Cultivation of Indeterminate tomato	Kannal	23	ICRISAT and AVRDC
09-12-2016 to 11-12-2016	ILRI Training " Awareness training on water utilization and management and Capacity building training to farmers on Micro irrigation, Irrigation Scheduling to crops and drip use and its management.	Aliyabad, Jumnal, Inchageri and Mannur Villages	380	ICRISAT and ILRI
21-09-2016	Farmers Day at ICRISAT	ICRISAT	15	ICRISAT
06/10/2016	IPM and INM in Red gram and Pearl Millet	Agasbal	8	ICRISAT
06/10/2016	IPM and INM in Red gram and Maize	Inchageri and Jigjeevani	12	ICRISAT
23/11/2016	Seed treatment training program	Jeerakalgi , Angadageri, Beeraldinni and Hunshyal pc	15	ICRISAT-DoA

Table 32b. Capacity building programs on irrigation management in Vijayapura				
Sl.No.	**Training**	**Event**	**Subject**	**Benificiery**
1	Jumnal	Training	Drip irrigation	37
2	Aaliyabad	Demonstration	Efficiency of Drip in Plastic mulched tomato with control	1
3	Inchageri	Training	Drip irrigation and water management	45
4	Mannur	Demonstration of drip irrigation	Capsicum and Tomato	2
5	Mannur	Training	Drip irrigation and water management	160
6	Inchageri	Training	Drip irrigation and water management	135

Figure 67. Training on micro irrigation and efficient water use and management in Vijayapura

ICARDA provided training to farmers on Cultivation of Spineless Cactus and using it as feed during summer (Figure 68).

Figure 68. Training on cultivation of spine less cactus for feed purposes

Tumkur

Geographically, Tumkur district covers major agroecologies such as dryland, irrigated area and plantation crops which is the main source of livelihood for majority of the farmers. The district has an annual average rainfall of 687 mm with 50% of it received in the southwest monsoon period and the rest in later months. It also has three important rivers Shimsa, Jayamangali, Suvarnamukhi passing through it and many streams join these at different points in the district. Bhoosumrudhi program in 2016-17 targeted to cover all 10 taluks in the district. The major interventions covered during 2016-17 under Bhoosamrudhi are described below.

Land and water management

Use of Zero-till multi-planter (CIMMYT, ICRISAT)

The multi-crop planter can plant different crops with variable seed size, seed rate, depth, spacing etc., providing simple solution to this. In addition to adjustments for row spacing, depth, gears for power transition to seed and fertilizer metering systems, the multi-crop planters have precise seed metering system using inclined rotary plates with variable grove number and size for different seed size and spacing for various crops. This provides flexibility for use of these planters for direct drilling of different crops with precise rate and spacing using the same planter which does not exist in flutted roller metering drills. Hence, the same multi-crop planter can be used for planting different crops by simply changing the inclined plates. The planter can also be used to make the beds and simultaneously sowing the crop just by mounting the shovels and shapers which can be easily accomplished due to the given provision in the machine. Moreover Farmers generally keeps their land fallow in *Rabi* despite huge soil moisture after Paddy harvesting. This machine provides opportunity to sow seeds without ploughing operation.

- Zero-till machine helps in timely sowing after harvesting first crop
- Nearly 50 acres of land was sown using zero-till multiplanter at Tumkur and Kunigal taluks during 2016-17 crop season benefiting nearly 53 farmers (Figure 69).

Figure 69. Direct seeded rice sowing using zero till multi-planter machine at Bhoosamruddhi villages in Tumkur and Kunigal taluk

Lazer leveller

Uneven soil surface has a major impact on the germination, stand, and yield of crops due to inhomogeneous water distribution and soil moisture. Therefore, land levelling is a precursor to good agronomic, soil, and crop management practices. Traditionally farmers level their fields using animal drawn or tractor-drawn levelers. These levelers are implements consisting of a blade acting as a small bucket for shifting the soil from higher to the low-lying positions. It is seen that even the best leveled fields using traditional land leveling practices are not precisely leveled and this leads to uneven distribution of irrigation water. Laser leveling of agricultural land is a recent resource-conservation technology. It has the potential to change the way food is produced by enhancing resource-use efficiency of critical inputs without any disturbing and harmful effects on the productive resilience of the ecosystem. During 2016-17 crop season, 2 ha area has been levelled on pilot basis in Mayasandra village of Turuvekere taluk, Tumkur district (Figure 70).

Benefits of laser land leveling over conventional land leveling:

- Reduction in time and water for irrigation
- Uniform distribution of water
- Less water consumption in land preparation
- Precise level and smoother soil surface
- Uniform moisture environment for crops
- Lesser weeds in the field
- Good germination and growth of crop
- Uniformity in crop maturity
- Reduced seed rate, fertilizers, chemicals and fuel requirements

Figure 70. Laser leveller followed by DSR demonstration taken at Mayasandra, Turuvekere taluk

Direct Seeded Rice (DSR)

Seasonal scarcity of agricultural labour is one of the biggest challenges to the viability and profitability of agriculture. This is especially true for rice farmers whose primary method of crop establishment is transplanting rice seedlings into fields that have been repeatedly tilled. Labour constraints mean sowing and transplanting are often delayed, resulting in yield losses.

Generally manual transplanting of Rice after 2–3 paddling operations with 21 – 35 days old rice seedling is common in the District. This age-old method of planting is used to reduce water percolation and also help in weed control. However, this system is labour intensive, requires huge tractor usage which often delays transplanting of paddy up to second week of August, it ultimately lead is poor tillering, poor grain formation and low yields of rice.

Machine-sown dry direct seeded rice (DSR) on the other hand is a modern agricultural technology that allows rice seeds to be sown directly into non- puddled fields, foregoing the need to raise rice nurseries and transplant seedlings. DSR generally requires one or two passes of the machine and can also be practiced under zero-tillage, offering considerable time, costs and energy savings for farmers.

- Reduces cost of cultivation (9000-10000/acre) by avoiding plouging, puddling, transplanting operations
- Facilitates timely establishment of rice that would provide opportunity to cultivate second crop in Rabi
- Saves water by 50-70 % (Irrigation frequency in DSR = once in a week; Irrigation frequency in transplanted paddy = Alternate day)
- Saves energy, labor, fuel, and seed requirement
- More yield(28-30 qtls/ac) compared to transplanted paddy(22-24qtls/ac)

Introduction of New rice varities
Under Bhoosamrudhi, new rice varieties viz., DRR Dhan 42 (IR 64 Drt I) and DRR Dhan 43 (released 2014-15) were evaluated for suitability and yield benefits and scaling up to a larger areas in Tumkur district. The major characteristics of these varities are given below.

DRR Dhan 42(IR 64 Drt I):
- Long slender grain type. (Released: 2014-15)
- Days to flower: 88 days; Day to maturity: 120 days
- Moderately resistant to bacterial leaf blight

DRR Dhan 43 (Released: 2014-15)
- Days to flower: 88 days; Day to maturity: 120 days
- Resistant to blast; Moderately resistant to bacterial blight, bacterial leaf blight, neck blast, brown spot, sheath rot, BPH, WBPH

About 50 acres has been covered benefiting 53 farmers in the district with new rice varieties of DRR Dhan 42 (IR 64) and DRR Dhan 43 (Figure 71 & 72).

Figure 71. Scientists interacting with farmer at DSR demonstration plots at Hiregundagal village, Tumkur taluk

Figure 72. DSR crop at the time of harvest at Hiregundagal village, Tumkur taluk: Variety – DRR Dhan 42

A comparision of different method of rice cultivation revealed that yield in DSR method of cultivation is higher than Transplanted method due to increased cost of cultivation. The data obtained from six farmers in Hiregundgal village, Tumkur clearly showed that nearly 9600 kg ha^{-1} is possible with DSR method under rainfed condition (Figure 73). In addition, DSR generally requires one or two passes of the machine and can also be practiced under zero-tillage, offering considerable time, costs and energy savings for farmers.

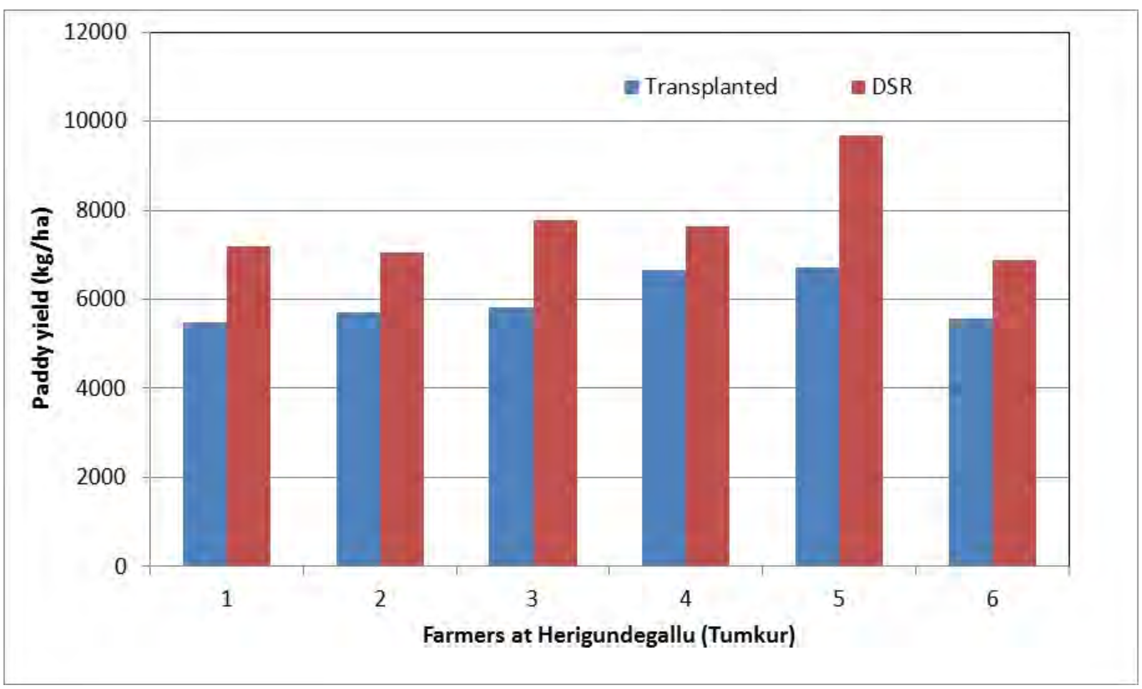

Figure 73. Comparision of DSR and transplanted method of rice cultivation in Tumkur

Case Study of Mr. Chikkahanumaiah, Hiregundagal village, Tumkur

Mr. Chiikahanumaiah of hiregundgal village in Tumkur taluk adopted DSR paddy. The demonstration was compared with transplanted paddy. The results obtained are very encouraging providing opportunities to scale up this technology to a larger areas with suitable support from department of agriculture. The DSR paddy was economically beneficial compared to transplanted paddy as the net income obtained from DSR paddy was almost three times higher than the transplanted paddy although yield was almost equal in both the system (Table 33). Similarly, irrigation cost was for transaplanted paddy was double than the DSR paddy which indicates that water scarcity issues can be effectively addressed by adopting DSR system. The information has been shared by organizing the field days which saw huge participation from the farmers (Figure 74).

Table 33. Economics of DSR paddy cultivation in Hiregundgal village, Tumkur

Agricultural operations	**DSR**	**Transplanted**
Field preparation (Rs/acre)	2000	5400
Sowing cost (Rs/acre)	800	0
Seed cost	380	900
Nursery preparation (Rs/acre)	0	1000
Transplantation (Rs/acre)	0	3150
Fertilizer and manure (Rs/acre)	2250	2500
Total irrigation cost(Rs/acre)	5000	10000
Plant protection charges (Rs/acre)	1500	-
Harvesting,Threshing, Transportation (Rs/acre)	5300	5300
Total cost of cultivation (Rs/acre)	17230	28250
Total yield (qtl/ac)	24	22
Market price (INR/Kg)	1650	1650
Net income (INR/Acre)	22370	8050

Figure 74. DSR paddy field day organized by Department of Agriculture

Surface and sub surface drip irrigation for crop intensification

Water scarcity is an issue in district like Tumkur where the rainfall is uncertain in its quantity as well as distribution. In such situiations, innovative technologies such as surface and sub-surface irrigation plays an imposrtant role to minimize the pressure on freshwater availability. In Hiregundgal village of Tumkur taluk, the surface and sub-surface drip irrigation system was demonstrated in about 3 acres with farmers'participation for crop intensification (Figure 75). The major advantages of this system are given below:

- In subsurface drip irrigation evaporation is minimised and water is used more efficiently.
- In this method, water is transported through laterals that are buried in soil near the root zone.
- High degree of control over water application is obtained and risk of direct contact with crop and labours is reduced.
- Increased water and fertilizer efficiency
- Less incidence of diseases and pests as plant foliage remains dry

The cropping pattern followed

- Green gram-Paddy-Vegetable
- Green gram- Ragi- Vegetable

Figure 75. Surface and sub surface drip irrigation at Hiregundagal village, Tumkur (Variety: Dhan 42)

Farmers' Participatory Varietal promotion during *Khraif* 2016

For enhancing the crop productivity and reduce the yield gaps, pest incidence besides providing crop security crop diversification is suggested. With previous experiences based on field demostartions, the promising cultivars are identified and scaled up in Bhoosamrudhi villages (Table 31). More than 300 acres of area has been covered with improved variety seeds of different crops (Groundnut, castor, pearl millet, paddy, green gram variety) were promoted in the district. Table 34 shows the details of promotion of improved crop vartieies in selected taluks.

Table 34. Area and beneficiaries of improved crop varieties promotion under Bhoosamrudhi							
Name of Taluk	**Area under crops (acre)**					**No. of beneficiaries**	**Total area (acre)**
	Groundnut	**Castor**	**Pearl millet**	**DSR paddy**	**Green gram**		
CN halli	0	10	0	0	0	10	10
Gubbi	5	20	0	0	1	26	26
Koratagere	5	10	0	0	0	20	15
Kunigal	0	30	0	20	0	45	50
Madhugiri	38	30	0	0	0	38	30
Pavagada	25	20	0	0	0	25	25
Sira	20	20	20	0	0	40	40
Turuvekere	0	10	0	3	0	13	13
Tumkur	0	20	0	30	0	50	50
Tiptur	0	30	0	0	14	44	44
TOTAL	**93**	**200**	**20**	**53**	**15**	**311**	**303**

Promoting improved crop varietiey (Groundnut- ICGV91114)

Groundnut is the major cash crop grown since 25 – 30 years. In the past, farmers were growing local spreading varieties. As the number of rainy days decreased over a period of time, farmers gradually switched over to bunch varieties, the most popular being TMV-2. Though many bunch varieties like Kadiri and TMV2 were released, TMV-2 prevailed for a long period, as seeds were readily available. Over a period of time, the yields of TMV-2 have been gradually decreasing owing to various reasons - non-availability of pure seed; loss of genetic vigour in the available seed; small size of pods and kernels and increased susceptibility to pests and diseases owing to continuous cultivation.

A drought-tolerant groundnut variety- ICGV series were introduced through farmer-participatory varietal selection. Farmers evaluated the varieties, considering the different traits like plant stand, resistance to drought, rejuvenation of crop after receipt of rains and with parameters of yield of pods and haulms. Farmers observed that ICGV 91114 variety performed well and was therefore the preferred variety (Table 34 & Figure 76).

Farmers' observations on ICGV 91114 groundnut variety

- The crop can withstand prolonged drought up to 43 to 47 days.
- Pod yield and haulm yield is more than the local variety.
- Medium sized pods and kernels
- The variety has uniform maturity

Figure 76. ICGV 91114 evaluation plot at Kodigenahalli, Madhugiri taluk (L) Bukkapatna, Sira taluk (R)

Tumkur is one of the major districts which grows groundnut in a large scale. Under Bhoosamrudhi during kharif 2016, improved variety of groundnut ICGV 91114 was promoted in Pavagada, Madhugiri and Gubbi taluks based on the earlier results. The ICGV 91114 was compared with local variety TMV 2 and the results are encouraging. The yield is ranging between 440 kg ha^{-1} and 870 kg ha^{-1} with ICGV 91114 and 340 kg ha^{-1} and 760 kg ha^{-1} with TMV 2 in Pavagada taluk. Similarly, 430 kg ha^{-1} and 790 kg ha^{-1} and 330 kg ha^{-1} and 640 kg ha^{-1} with ICGV 9114 and TMV 2 respectively in Madhugiri taluk. In Guibbi taluk, the yield was ranging between 550 and 650 kg ha^{-1} with ICGV 91114 and 420 kg ha^{-1} and 490 kg ha^{-1} with TMV 2 variety (Figure 77). Based on the earlier results, ICGV 91114 was promoted in all the taluks where groundnut is grown and during 2017, DoA is planning to scale up this variety in a larger areas to benefit more farmers in the district.

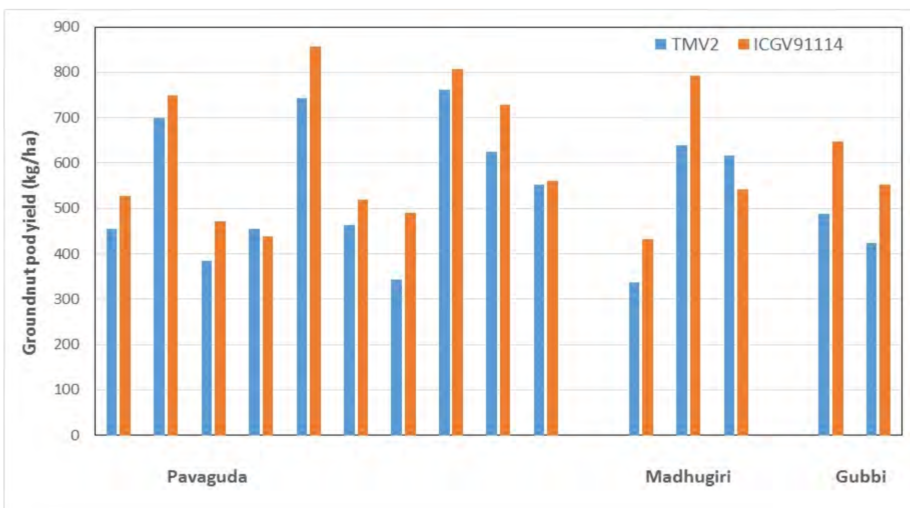

Figure 77. Performance of ICGV 91114 in comparision with TMV 2 under Bhoosamrudhi in Tumkur district

Impact of integrated management practices on groundnut yield

During kharif 2016, an effort was made to analyse the impact of integrated management of practices on groundnut yield in Tumkur. The study revealed that where farmers combined improved variety, in-situ soil and water conservation, micro nutrient and irrigation resulted in higher yield compared to farmers' practice (Figure 78). Similarly, other practices also resulted in increased yield compared to farmers' practice but integrated management approach was more beneficial.

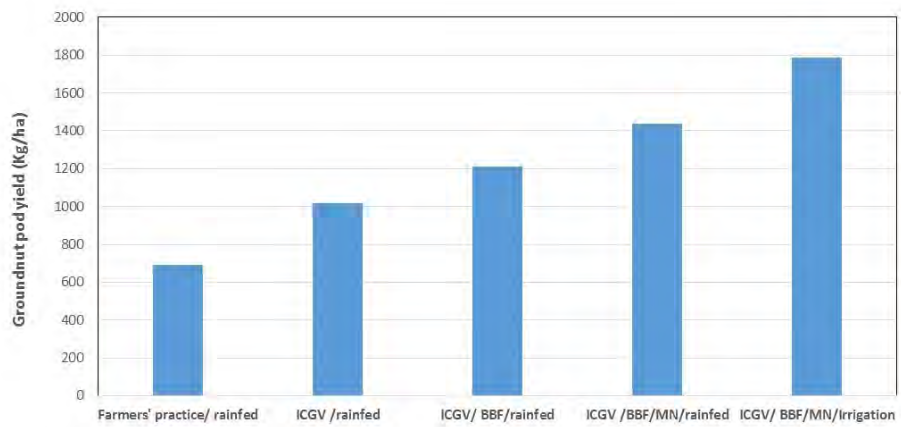

Figure 78. Impact of integrated management practices on groundnut yield under Bhoosamrudhi in Tumkur district

Castor for crop diversification- DCH177; DCH512; Jwala; Jyoti

Castor is an important alternate crop. Under the degraded soils, shallow soils and poor water holding capacity, castor may generate remunerative return (Figure 79). Participatory field evaluation was made in selected fields of Bhoosamruddhi villages during Kharif 2016-17 covering 200 acres.

Figure 79. ICGV 91114 intercropping with redgram (L) and Castor crop DCH177

Vegetable production at Tumkuru

In Tumkur district, tomato cultivation with improved practices (such as drip irrigation, water soluble fertilizers, proper stalking and timely prophylactic measures) were demonstrated in ten farmers' fields. Using these improved practices promoted by WorldVeg, farmers were able to harvest on an average 52 tonnes/ha with 7-8 pickings.

The World Vegetable Center also promoted the cultivation of vegetable cowpea as an intercrop in sugarcane (Vijayapura, Chikamagulur) and in coconut gardens (Tumkur). After the sugarcane was harvested between December and January, vegetable cowpea with a maturity of 60-65 days was introduced as an intercrop. Fresh green cowpea yields of 2.2-3.0 t/ha were harvested, which gave an additional income of INR 65- 70,000/- to farmers and as a legume, also helped in enriching the soil fertility (Figure 80).

Figure 80. Open cultivation of tomato and Vegetable cowpea in a coconut garden in Tumkur

Easy planter for transplanting Red gram seedlings

Easy planter for transplanting redgram was promoted in 10 acres covering 13 farmers. Twenty days old BRG-4 red gram seedlings were transplanted using easy planter in Bhoosamruddhi villages of Tumkur Taluk (Figure 81). Easy planter reduces labour cost as it requires only 3 persons to plant in an area of 1ha. It reduces soil pollution caused by mulch sheet when done traditionally. It also controls weed growth as there will be no exposure of soil even around the plant seedling. AVRDC and ICRISAT organised training programs to create awareness among farmers about new innovations in vegetable cultivation (Figure 82).

Figure 81. JDA Tumkur demonstrating transplanting of red gram seedlings using easy planter at hiregundagal village, Tumkur taluk

Table 35. Capacity building programs in Tumkur district

Sl. No	Training topics	No. of trainings	No. of participants	Institute
1	Training program on micro irrigation in plantation crops	5	500	IWMI/ICRISAT/DoH/DoA
2	Training on direct seeded rice	1	25	IRRI/CIMMYT/ICRISAT/DoA
3	New practices in vegetable cultivation	1	30	AVRDC/ICRISAT/DoH

Figure 82. Training on Vegetable cultivation carried out in Gubbi and Sira taluks of Tumkur District

Rainfall during Southwest monsoon 2016 in pilot taluks of Bhoosamruddhi project									
Chikkamagaluru district									
Pilot taluk	Actual Rainfall (mm)				Southwest monsoon				Class
	Jun	Jul	Aug	Sep	Actual	Normal	Deviation		
					mm	mm	mm	%	
Chikkamagaluru	230	242	140	91	703	908	-205	-23	Deficit
Kadur	103	71	12	32	218	306	-88	-29	Deficit
Koppa	515	689	522	200	1926	2605	-679	-26	Deficit
Mudigere	518	648	330	153	1649	2560	-911	-36	Deficit
Tarikere	180	165	78	85	508	497	11	2	Normal
Raichur district									
Pilot taluk	Actual Rainfall (mm)				Southwest monsoon				Class
	Jun	Jul	Aug	Sep	Actual	Normal	Deviation		
					mm	mm	mm	%	
Deodurga	82	116	60	180	438	479	-41	-9	Normal
Lingsugur	92	77	42	108	319	400	-81	-20	Deficit
Manvi	112	99	42	131	384	437	-53	-12	Normal
Raichur	151	185	73	170	579	509	70	14	Normal
Sindhanur	123	66	55	90	334	440	-106	-24	Deficit
Tumakuru district									
Pilot taluk	Actual Rainfall (mm)				Southwest monsoon				Class
	Jun	Jul	Aug	Sep	Actual	Normal	Deviation		
					mm	mm	mm	%	
CN Halli	127	132	20	22	301	301	0	0	Normal
Gubbi	137	157	35	36	365	375	-10	-3	Normal
Koratagere	149	204	18	33	404	397	7	2	Normal
Kunigal	116	194	93	49	452	450	2	0	Normal
Madhugiri	135	151	5	56	347	348	-1	0	Normal
Pavagada	104	153	16	41	314	305	9	3	Normal
Sira	126	101	10	37	274	319	-45	-14	Normal
Tiptur	110	118	55	31	314	315	-1	0	Normal
Tumakuru	144	219	41	43	447	492	-45	-9	Normal
Turuvekere	91	126	56	25	298	353	-55	-16	Normal
Vijayapura district									
Pilot taluk	Actual Rainfall (mm)				Southwest monsoon				Class
	Jun	Jul	Aug	Sep	Actual	Normal	Deviation		
					mm	mm	mm	%	
B Bagevadi	101	135	60	96	392	397	-5	-1	Normal
Indi	126	107	34	153	420	452	-32	-7	Normal
Vijayapura	75	110	34	124	343	420	-77	-18	Normal
Sindagi	112	128	48	148	436	471	-35	-7	Normal
Muddebihal	86	91	43	88	308	389	-81	-21	Deficit