Annual Report
2015-16

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

ICRISAT
Science with a human face

International Crops Research Institute for the Semi-Arid Tropics

Table of Contents

Executive Summary 01
Background 02
Objectives 02
Strategy 03
Operational Details 04
Consortium Partners 04
Rainfall situation 06
District wise progress of Bhoosamrudhi 06
- Chickmangaluru 06
- Raichur 32
- Tumkur 59
- Vijayapura 81

Executive Summary

Bhoosamridhi 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. The consortium approach is adopted to harness the synergies of international research institutes (ICRISAT, IWMI, ILRI, IRRI, CIMMYT, IFPRI, ICARDA, AVRDC, IIHR), 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).

During the year 2015, forty thousand hectare area is covered with various innovative technologies at each pilot site in the state which have shown good responses in terms of increased yield as well as protecting the environment. The Direct Seeded Rice (DSR) technology has been scaled-out in 8000 ha (by 10000 farmer) in Raichur and piloted in Chikmagalur and Tumkur sites. 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. For in-situ soil and water conservation, improved land management i.e. Broad Bed and Furrow is piloted in 450 ha in Raichur site and 125 ha in Vijayapura. The water impact calculator, a generic decision support tool for efficient irrigation scheduling is demostrated at Chikmagalur, Raichur and Vijayapura. Surface and sub-surface drip irrigation in paddy is being evaluated at Raichur. Magnetic water conditioner is piloted in Vijayapura to evaluate the beneficial effects on salt content of irrigation water. With target to enhance productivity and adaptation to climate change scenarios, improved varieties of crops like groundnut, sorghum, castor, finger millet, pearl millet, pigeonpea, green gram, blackgram are being evaluated – about 400 farmers in Chikmagalur, 500 farmers in Raichur, 300 farmers in Tumkur, and 120 farmers in Vijayapura district. The crop cutting experiments completed showed increased yields with improved varieties - 30 to 40% in castor, 10 to 40% in groundnut. The greeng ram has proved to be a bet option to cultivate rice- fallows with yield levels of 225 to 400 kg ha^{-1} in Raichur, Tumkur resulting net returns of Rs 7000 to Rs 28000 ha^{-1}. With objective to enhance soil organic C and reduce dependence on chemical fertilizers, the recycling of on-farm wastes through accelerated decomposition by microbial consortia is promoted with 200 farmers in Raichur, 33 in Chikamagalur, 40 farmers in tumkur and 20 in Vijayapura. To address fodder scarcity and enhance livestock based enterprises, high yielding fodder varieties like (Sorghum - CSH24MF, CSH14; Maize – NK6240) are promoted with 30 farmers in Chikmagaluru, 60 farmers in Raichur, 30 farmers in Tumkur and 20 farmers in Vijayapura. As cattle fodder, multipurpose thornless Cactus is also being evaluated. Other crop/site-specific important technologies piloted and showing benefits across the pilots are – aquasap (sea weed extract, a source of nutrients and growth hormones) spray, laser leveling, zero tillage (along with machinery development), weed management through inter-cultivation and power weeder, relay planting (on maize in cotton), insect-monitoring through pheromone traps, shredding machines for biomass chopping – as fodder use and composting (particularly in pigeonpea and cotton), good practices in vegetable cultivation, biomass generation through Gliricidia plantations. For wastewater recycling, site is selected across all four sites. Tablet-based extension system, Krishi Gyan Sagar, farmer-farmer videos in addition to capacity building programs like trainings, fields' days including by CG centers has enabled effective dissemination and adoption of technologies by the farmers in the pilots.

Considering the limitations of deficit and poorly distributed rainfall, reasonably good progress is achieved at the four benchmark sites under Bhoosamridhi. 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.

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, 60% is rainfed. Karnataka has the second largest area under rainfed agriculture only after Rajasthan in the country. Farmers' crop yields in dryland areas are quite low (1-1.5 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 Bhoochetana Plus in the second year.

Objectives

The specific objectives of this GoK-CGIAR 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)

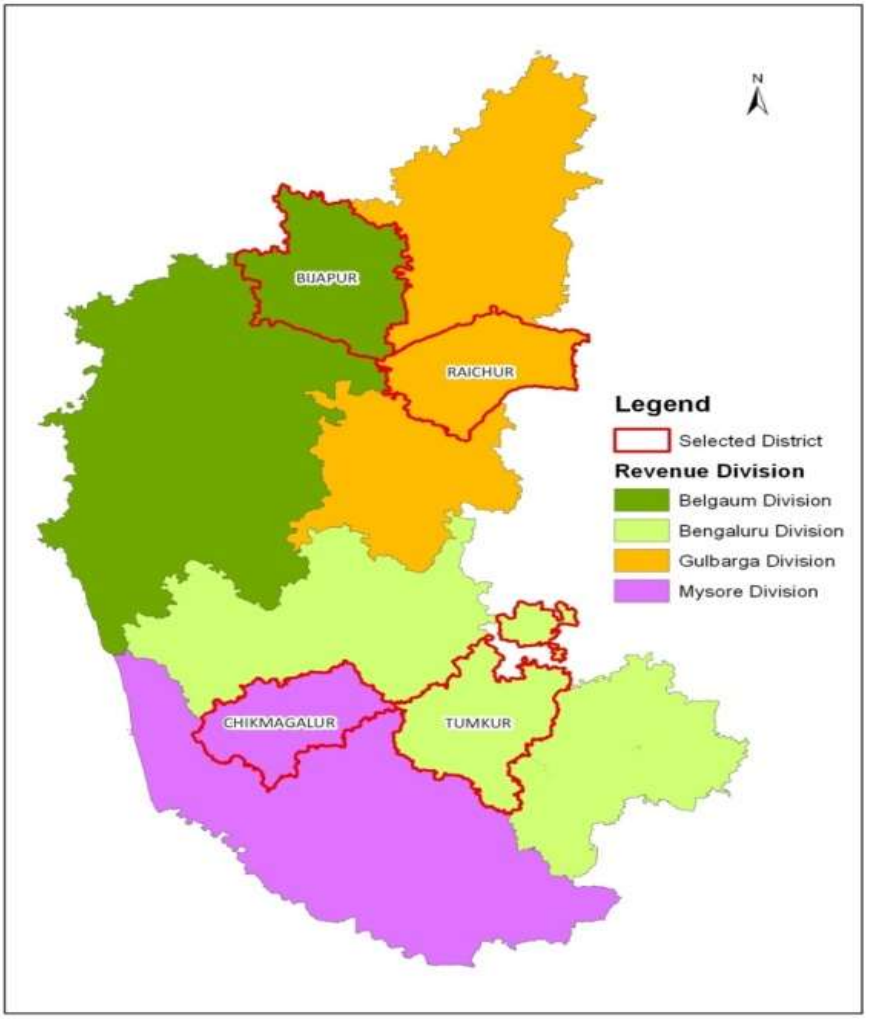
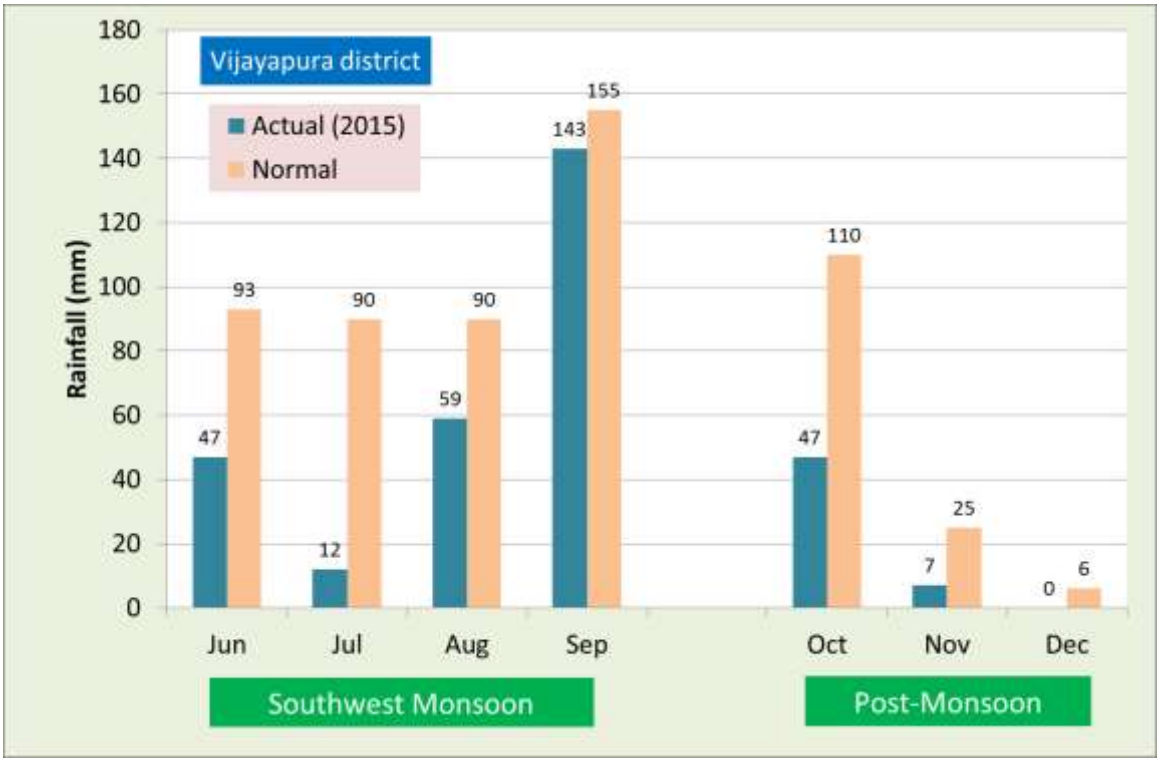


Figure 1. Map of four benchmark districts from four revenue divisions of Karnataka.

Status of rainfall in selected districts in 2015-16

Vijayapura:

- During Southwest Monsoon 2015, Vijayapura district received a rainfall of 262 mm as against a normal of 428 mm; percentage departure from normal is -39% and is classified under **Deficit** category. During June and July the rainfall was scanty or deficit in all the Hoblis while in September the rainfall was normal.
- In the SWM season, out of 18 Hoblis 16 received deficit rainfall and 2 Hoblis received normal rainfall.

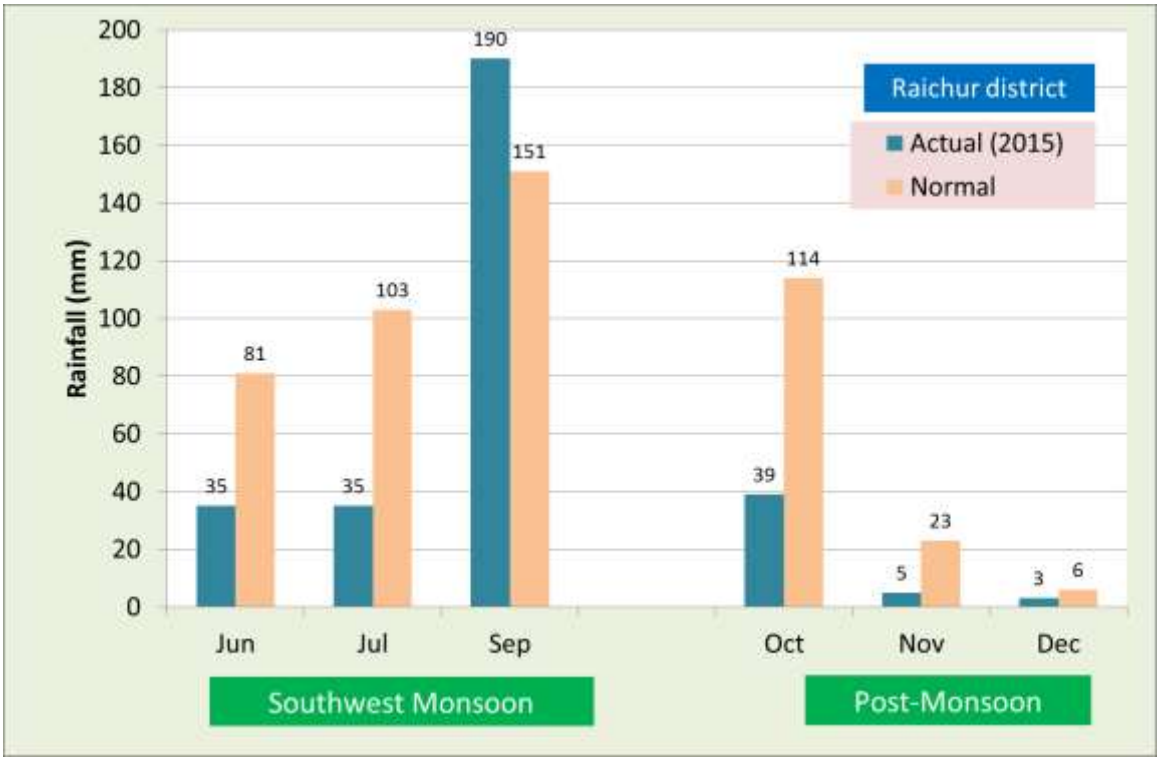


- In the Post-Monsoon season (Oct-Dec), the district recorded an actual rainfall of 54 mm as against its normal of 141 mm with percentage departure from normal being (-) 61% and the district is classified under **Scanty** category.
- Out of 18 hoblis, 13 received scanty and 5 received deficit rainfall.
- During Rabi 2015-16, 575564 ha was sown which constitutes106% of the normal area.

Raichur:

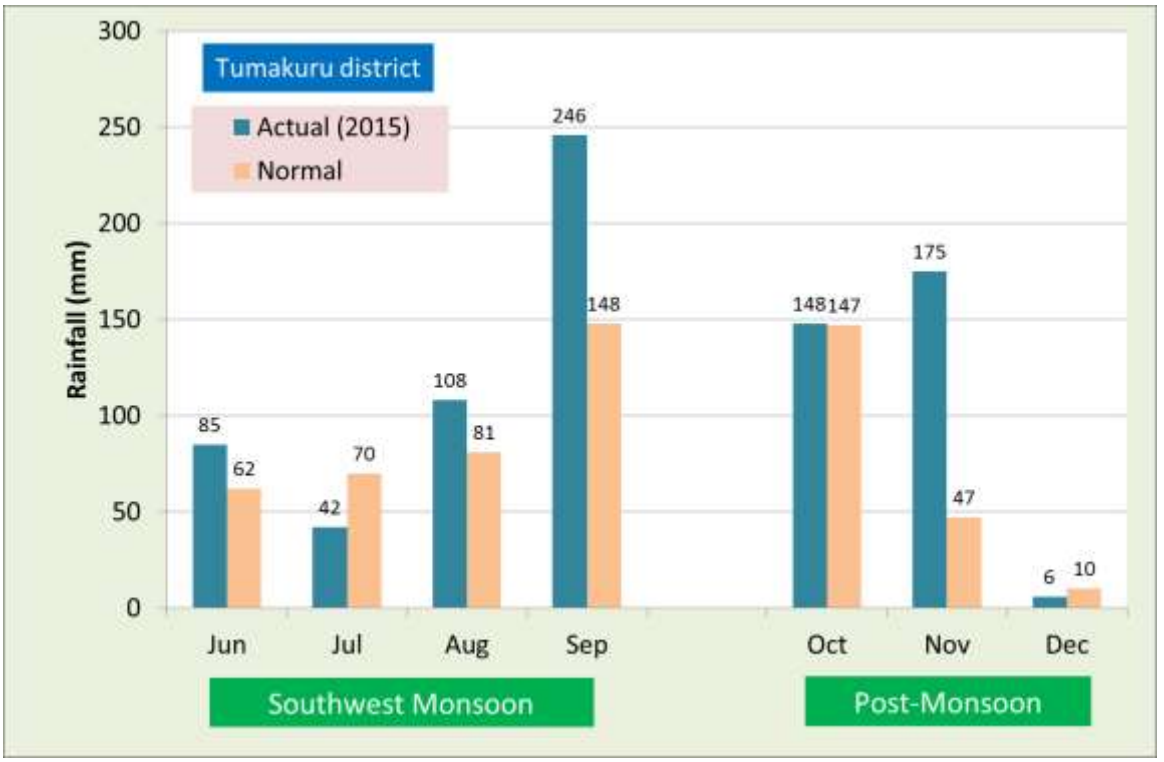
- During Southwest Monsoon period 2015, Raichur district received a rainfall of 327 mm as against the normal of 450 mm; Percentage departure from normal was -27% and the district is classified under **Deficit** category.

- In June, July and August the district received either scanty or deficit rainfall in all Hoblis which lead to sever water stress while in September the rainfall was normal
- Overall during SWM season, out of 37 hoblis 27 received deficit and 10 received normal rainfall.
- In the Post-Monsoon 2015, the district recorded an actual rainfall of 48 mm against its normal of 143 mm with a percentage departure from normal as -67% and the district is classified under **Scanty** category.
- Out of 37 Hoblis, 29 received scanty and 8 received deficit rainfall.



Tumakuru:

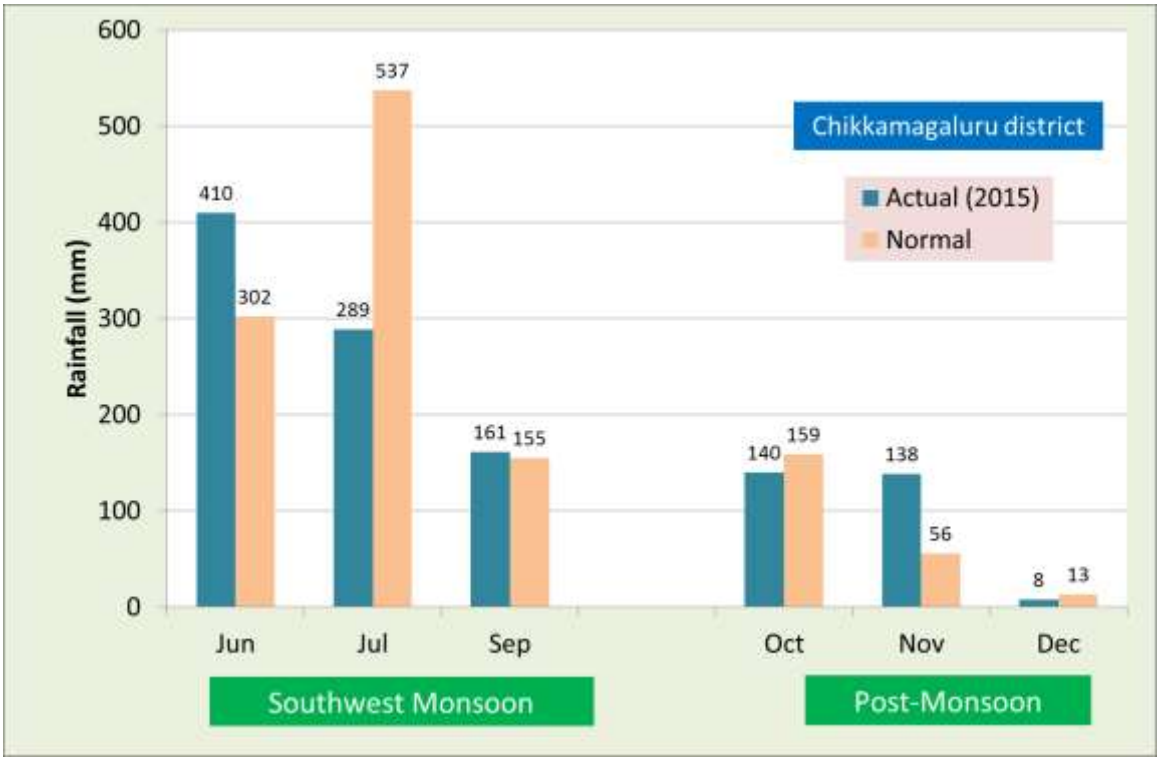
- During Southwest Monsoon 2015, Tumakuru district received a rainfall of 481 mm and the normal was 361 mm. The percentage departure from normal was +33% and the district was classified under **Excess** category.
- Rainfall in June, August and September was Normal while in July rainfall was Deficit in most of the Hoblis.
- In the total SW Monsoon period, out of 50 Hoblis in the Tumakuru district, rainfall was excess in 34 Hoblis, normal in 15 Hoblis and deficit in one Hobli.



- Tumakuru district received a rainfall of 329 mm in the Post-Monsoon period as against its normal value of 204 mm. The percentage departure from normal is +61% and the district is classified under **Excess** category. Out of 50 Hoblis, rainfall was excess in 46 hoblis and normal in 4 Hoblis.

Chikkamagaluru:

- During Southwest monsoon 2015, Chikkamagaluru district received a rainfall of about 1097 mm against the normal of 1349 mm with a percentage departure from normal being -19%. Thus, the district is classified under **Normal** category.
- During June, August and September, rainfall was normal or excess in many parts of the district while in July it was drier.
- Out of 34 Hoblis in the Chikkamagalur district, rainfall was excess in 11 Hoblis, normal in 11 Hoblis and deficit in 12 Hoblis.
- The district recorded a rainfall of 286 mm in Post-Monsoon 2015 as against its normal value of 228 mm with percentage departure from normal being +26% and the district is classified under **Excess** category. Rainfall was excess in 20 Hoblis, normal in 13 Hoblis and deficient in one Hobli.



District-wise Progress of Bhoosamrudhi

Chikmangaluru

During the year 2015, a detailed process was followed to identify pilot sites for further scaling up of Bhoosamrudhi activities in Chikkamagaluru district. Accordingly, the work plan was prepared collectively by all partner organisations including line departments and deliberated in various meetings Chaired by Additional Chief Secretary and Development Commissioner. The total project area of the district is 96,198 ha and the cultivable area is 37,969 ha in four taluks. The total number of families benefiting from this initiative is 25,049 of which about 16,976 are small and medium farmers. For demonstrating the cumulative effect of interventions, two villages from each taluk have been selected as pilot villages where innovative technologies have been demonstrated at large scale. The selected pilot villages are listed in Table 1.

Table 1. Pilot villages selected for 2015-16 in Chikkamagaluru district.

Taluk	Hoblis	Pilot villages	Total geographical area (ha)	Cultivable area (ha)	Total Farm Families	Small & marginal Farmers
Chikmagaluru	Lakya	Sadarahally	634.20	432.50	172	158
		Ganadhalu	272.03	204.02	32	30
Kadur	Birur	Kannenahally	153.5	128	76	60
		Chikkangala	762	586.6	483	423
Koppa	Jayapura	Kuluru	1044.1	159.75	224	31
		Sannakere	1224	654	382	78
Tarikere	Lingadahalli	Udeva	1776	495	60	128
		Mallenahalli	1083.2	330	61	108

The major activities implemented were described as below:

Land and Water Management

For better soil and water management, appropriate land and water management technologies have been implemented in the pilot villages. The major interventions include *in-situ* soil moisture conservation practices and drip irrigation system for enhancing water use efficiency (Figure 5).

AVRDC and ICRISAT in collaboration with IWMI gave training to Agriculture and horticulture officials regarding water impact calculator which estimates the impact of farmers' current practices on water conservation, and explores ways to use water more efficiently by running the water balance model. The WIC is a generic decision support tool that can be useful for irrigation scheduling for any crop as well as to decide the timing and quantity of water as supplemental irrigation during a drought situation while growing rain-fed crops. The WIC compiles key information such as soil and climate maps, water needs per crop according to growth stage, and prevalent weather conditions. The farmer only needs to provide some simple information (sowing date and type of crops, name of village/district and, if possible, a description of the soil) and the calculator helps to decide when and how much water he/she should apply on the plots. This tool is particularly adapted for small and marginal farmers in the Chikkamagaluru where water availability is increasingly unpredictable.

Figure 5. In-line drip system laid out in Chilli crop in Chikamgaluru district.

Nutrient Management

Aerobic composting

The conventional agro waste disposal is a traditional and oldest method of waste disposal in which agriculture wastes are dumped as it is to degrade in a particular place for decomposing. As the wastes are dumped as such, it takes more time to degrade and it causes environmental pollution. The mechanical shredder machine aims to reduce the agro waste by chaffing and enhance the process of decomposition So, this year we are plan to introduce 8 mechanical shredder in 4 taluks of chikkmagaluru distinct for demonstration purpose.

A Consortium of micro-organisms developed as inosulant for accelerated aerobic composting of organic waste. Waste to which this product is added becomes organically richer and can be used in the farmer's fields. The recommended dose is 1kg for 1mt of organic waste. If the waste is dry, prepare slurry using 30 ltr of water per 1 kg of Madhyam and then spray onto the waste. Turn over the compost heap every week for proper aeration. Under normal conditions, the composting process should be complete within 4-6 weeks.

Earlier, the farmers practicing organic farming were not adopting proper methodologies. They were using raw cow dung as compost which led to infestation as also problems with weeds. To obviate these difficulties, this year ICRISAT advise and demonstrate them to adopt the 'Madhyam' inoculants. So now the farmers are mixing the cow dung and agriculture biomass with their product and this is adding to soil fertility (Figure 2).


Figure 6. Aerobic compost preparation using microbial culture.

Table 2. Madhyam culture supplied and quantity of compost generated in Bhoosamrudhi villages in Chikkamagaluru

Sl. No	Village	Quantity of culture supplied (kgs)	Aprx. quantity of compost generated (kgs)
1	Chikkanagala	10	9950
2	Kannenahalli	10	8300
3	Kuruchikanahalli	3	3300
4	Ganadhal	2	1500
5	Sadarahalli	2	1150
6	Ganadhal	2	1700
7	Narsipura	1	650
8	Gulladamane	1	1200
9	Hulithimmapur	1	900
10	Nandi	4	2450
11	Kenchapura	1	850
	Total	**37**	**31950**

Sea weed extract organic fertilizer as foliar spray for crops

Aquasap 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 (Figure 7).

- Dosage: 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 1litre 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.

Figure 7. Aquasap foliar spray on vegetable crops.

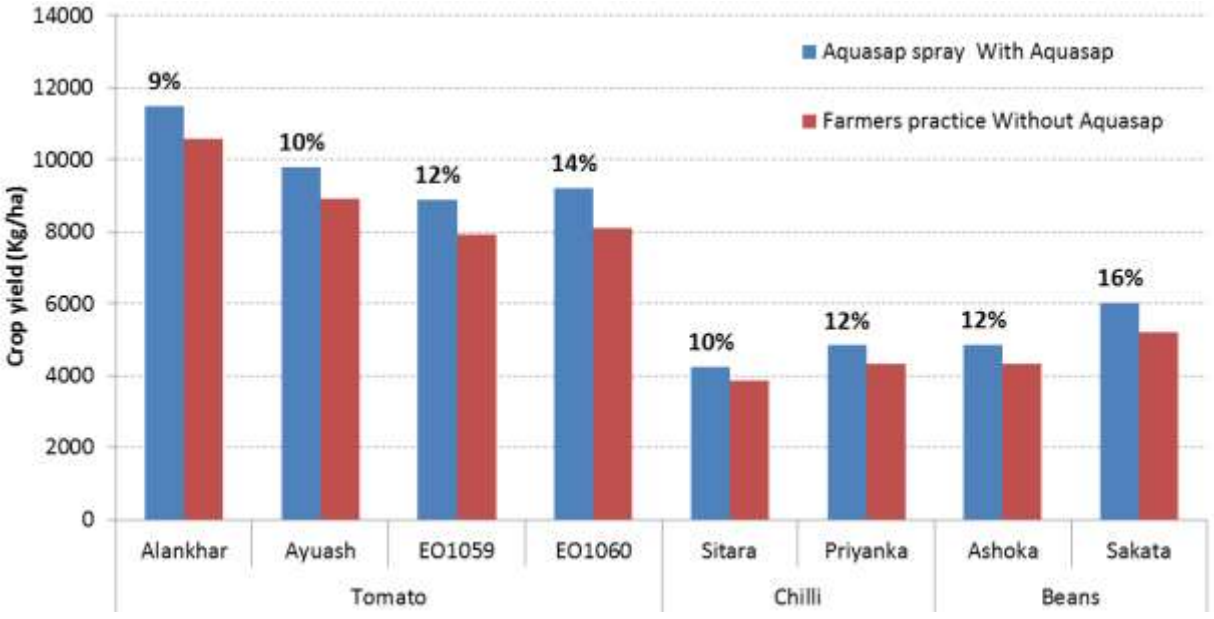


Figure 7a. Yield increase due to Aquasap foliar spray on vergetable crops

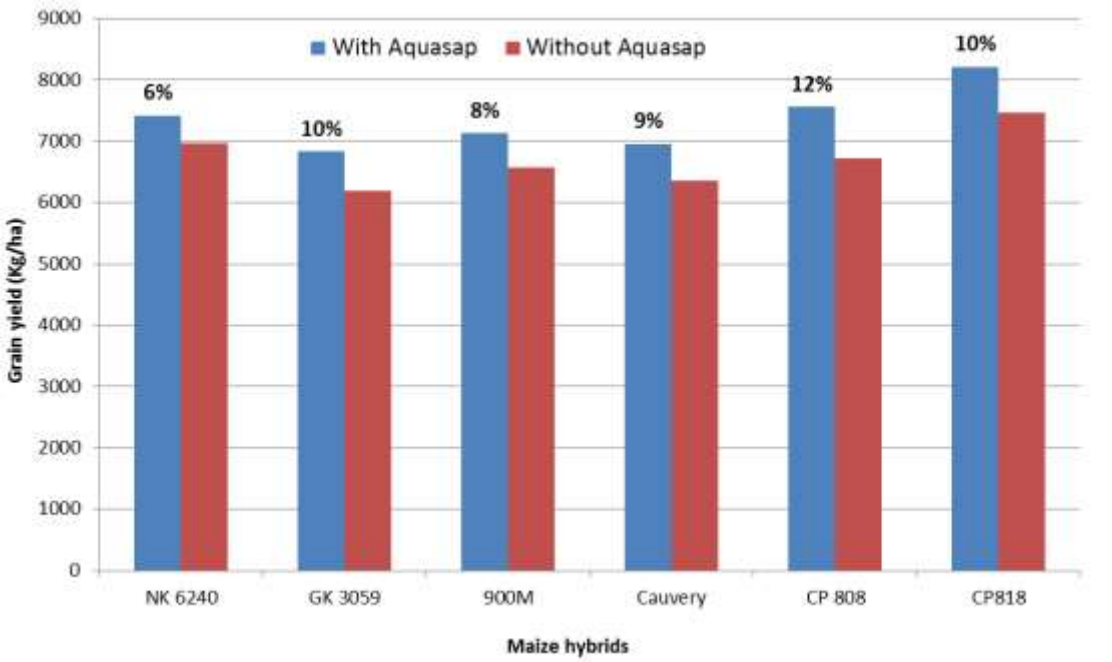


Figure 7b. Maize yield increase due to aquasap foliar spray

Crop Intensification and Diversification

Farmers' Participatory Varietal promotion during *Khraif* 2015

Productivity enhancement as well as adapting to climate change scenarios are the twin objectives of introducing improved varieties of different crops in Bhoosamrudhi pilot districts. Already tested and evaluated good performing improved verities were scaled up in all the eight Bhoosamrudhi pilot districts during *khraif* 2015. Good varieties supplied are Groundnut (ICGV 91114, 0350, 0351), Finger millet (MR 1), Soybean (JS 9560), Sorghum (CSV 15 and CSV 23), Pearl Millet (ICTP 8203 and HHB 67), Castor (DCH 177 and Jyothi) and Sunflower (DRSH 1) (Figure 8 and 9). The characteristics of these cultivars are presented in Annexure 1. The scaling-up of these varieties is done with farmers' participation with close monitoring by ICRISAT staff in each district supported by Scientific Officers and Scientists (Table 3 & 4).

Figure 8. Castor crop as intercrop with groundnut crop in Kadur taluk, Chikkamagaluru.

Figure 9. Performance of Improval Groundnut variety in Birur hobli, Kadur taluk.

Table 3. Castor production potential in the pilot villages of Chikkamagluru district		
Castor cultivar	Grain vield (kg/ha)	% increase over RC 8
Jwala	685	36.9
Jvothi	598	27.7
RC-8	432	-

Table 4. Performance of different cultivars of groundnut in Birur hobli. Kadur taluk.		
Cultivars	Pod vield (Kg/ha)	% increase over TMV 2
ICGV 91114	2342	39.1
ICGV 350	2004	28.8
ICGV 0351	1650	13.5
K 9	1532	6.9
TMV 2	1427	

Promotion of Improved Rice Varieties

Farmer participatory introduction, evaluation, demonstration and popularization of improved varieties of rice

The improved rice varieties viz: KHP 12, KHP 2, KHP 9 ; Sharavathi; IET 7192; IET 21478; IET 21749 and Swarna sub 1 are being demonstrated in a farmer participatory mode in 33 farmers' fields in Kasaba, Megunda, Hariharapura Hoblis of Koppa Taluq in Chikmagaluru district (Figure 10 to 15). In two farmers' fields the Swarna sub 1 and IET 21479 were established by direct seeding and in the rest of the fields transplanting method of rice establishment was adopted. Best management practices are suggested to farmers for adoption in the demonstration fields.

Figure 10. KHP 2 variety of rice demonstration of BhooSamrudhi in the field of the farmer, Mr. Ramesh, Kullur village, Chikmagaluru district (at two stages).

Figure 11. IET 21478 variety rice (at two stages of crop growth) demonstration conducted as a part of BhooSamrudhi activities in the field of the farmer, Mr. Manjunatha Hegde in Kullur village of Chikmagaluru district.

Figure 12. Sharavati rice variety demonstration field of the farmer Mr. Narayana Shetty in Nagalapura village of Chikmagaluru district.

Figure 13. KHP 9 variety of rice demonstration of BhooSamrudhi. (At two growth stages).

Popularizing best management practices (BMP) for transplanted rice (machine/manual)

The best management practices are being demonstrated in seven farmers' fields where rice was transplanted by using transplanting machine. In six other farmers' fields, best management practices are being demonstrated in the farmers' fields where line transplanting of rice cultivars IET 21478 and IET local varieties was done. In the farmer participatory demonstration of rice varieties also the BMP are being demonstrated.

Figure 14. Farmer participatory demonstration of Swarna sub 1 variety demonstration in: i) farmer, Mr. Karunakar's field Gunavante village of Chikmagaluru district. (Greener rice is Swarna sub 1 and lighter rice on right corner is local rice) (Left); i) farmer, Mr. Mariappa field in Nagalamara village of Chikmagaluru district - transplanted in rows, (Right). (Early tillering stage).

Figure 15. Rice variety KHP 12 field of farmer, Mr. Nagaraj at Parandur village of Koppa Taluk, Chikmagalur district. The crop is excellent and the farmer is happy with seed of rice variety being demonstrated in his field.

Introduction of dry-seeding method of rice establishment with the onset of monsoon

In collaboration with the Zonal agriculture Research Station, one acre demonstration on direct seeded rice (DSR) was conducted and it was harvested (Figure 16). The crop was harvested. In farmers' fields the DSR was restricted to two fields, as the requested hand tractor driven seeder is yet to be procured. Advises on Best management practices were given to farmers who established rice by direct-seeding (Figure 16). The DSR is possible in Chikmagaluru district, only if the rice seeding is done prior to the onset of the monsoon.

Figure 16. The direct-seeded rice field established in the ZARS, Mudigere. It is possible to grow the dry-direct seeded rice in Chikmagaluru district (L);
Advises on Best Management Practices are being given in the discussions with the farmers growing direct-seeded rice at Chikmagaluru district (R).

Best Management Practices in Paddy

Technological Inputs:

Variety: Improved varieties use viz., KHP10 (6.0 t/ha)/KHP 2 (6.0-6.5 t/ha)/ KHP 5 (6.5 t/ha); Sharavathi (5.5 t/ha) Tunga (5.5-6.0 (t/ha); IET 21214 (7.0 t/ha); IET 21478 (6.5-7.0 t/ha); IET21749 (7.0 t/ha)

Establishment method: Mechanical transplanting or direct-seeding of rice

Nutrient management:

1. Incorporation of green manure (Sunhemp)
2. Split application of fertilizer: Apply N and K in four equal splits viz., Basal, Tillering, Panicle initiation and Heading stages
3. Nitrogen management through leaf colour chart (LCC)

Weed management: Pre emergence application of

1. Bensulfuron at 0.6 % + Pretilachlor at 0.6%or Butachlor 1.25 kg/ha
2. Post-emergence herbicide - Bispyrispac-40 ml/ha and Allmix (8 g/ha).

Yield analysis of paddy

Farmer participatory demonstrations of improved rice varieties Swarna sub-1, KHP-9, IET 7191, IET 21478, IET 21479, KHP-12, and Sharavati were undertaken in the Koppa Taluk of Chikmagaluru district. The rice grain yield greater than 6.5 t/ha was obtained with IET 21478, IET 21479 and IET 7191 varieties (Fig 17). The average rice productivity in the district is around 3 t/ha. A comparision of different varieties with Swarna Sub-1 showed non-suitability of Swarna Sub-1 to the district.

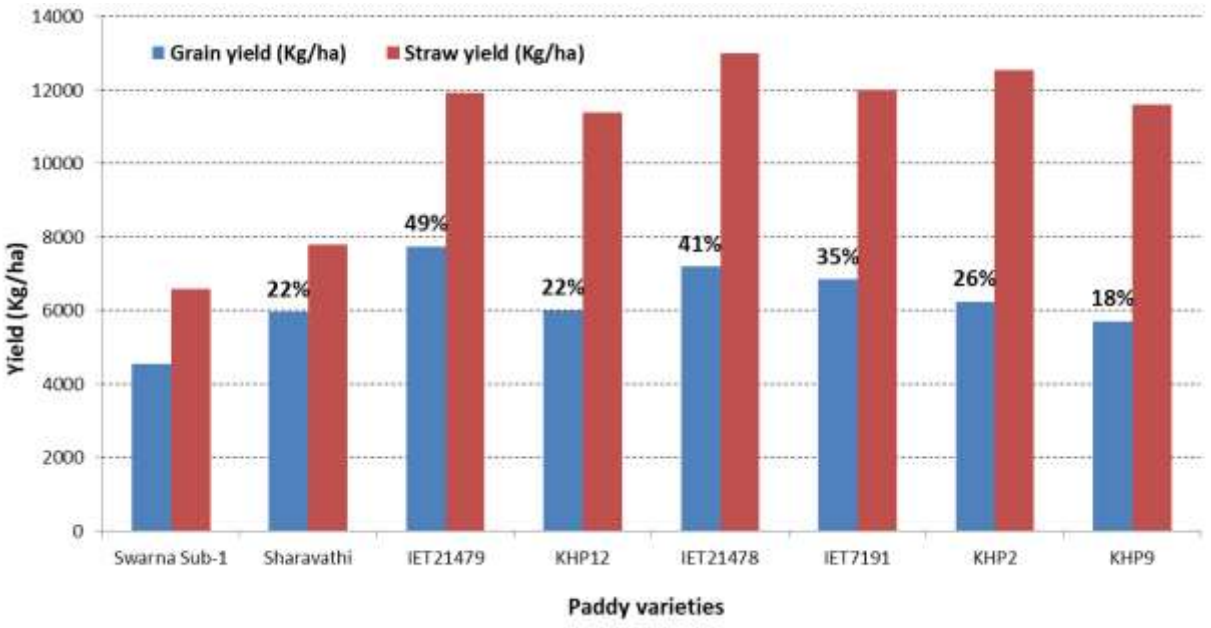


Figure 17. Rice grain yield as recorded in the farmer participatory demonstration of improved rice varieties in Chikmagaluru district

Site specific nutrient management in Maize

Maize is the important crop of Karnataka with highest acreage in the country and remained as focus crop for Chikkamagaluru. In the pilot site/ domains, 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 trials were conducted in GoK- CGIAR prioritized districts during the report period. Suitable hybrids for each of these districts were identified out of large number of hybrids and sold to Raita Samparka Kendras (RSKs). However, farmers were also educated on the large inter hybrid variability to reduce the variability amongst the hybrids for improving yield performance. During 2015-16, 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). These maize trials were conducted in Chikkamagaluru. Nine hybrids based on the sale statistics and also preference by farmer were selected for the SSNM with targeted yields. The basic objective of this study was to introduce farmer to the SSNM not only to achieve targeted high yields but also supply nutrients based on the history of previous crop, nutrient management practices and potential yields at those situations. In Chikkamaguluru, as indicated above six hybrids were demonstrated in 32 locations in said taluka. The hybrids such as NK6240, GK3059, GK3049, 900M, CP818, CP808, Pioneer30V92, Kauvery222 and Rajkumar remained focused hybrids. In general all hybrids responded well to SSNM based nutrient management. Grain yield in all the hybrids were significantly inferior in the plots where farmers followed traditional nutrient management package. In SSNM based fertilizer application, we targeted 8 tones/ha yield. Results of these demonstrations indicated a significant variation between the hybrids (Fig. 18). Hybrids such as Pioneer 30V93, CP-808, NK-6240, and 900M in that order recorded higher yield closer to targeted yield. Other hybrids included in the demonstrations were of no match to these responsive hybrids. The failure of these hybrids in not meeting the targeted yield was due to aforesaid reasons of very unfavorable climatic conditions that prevailed in the piloted sites of the state.

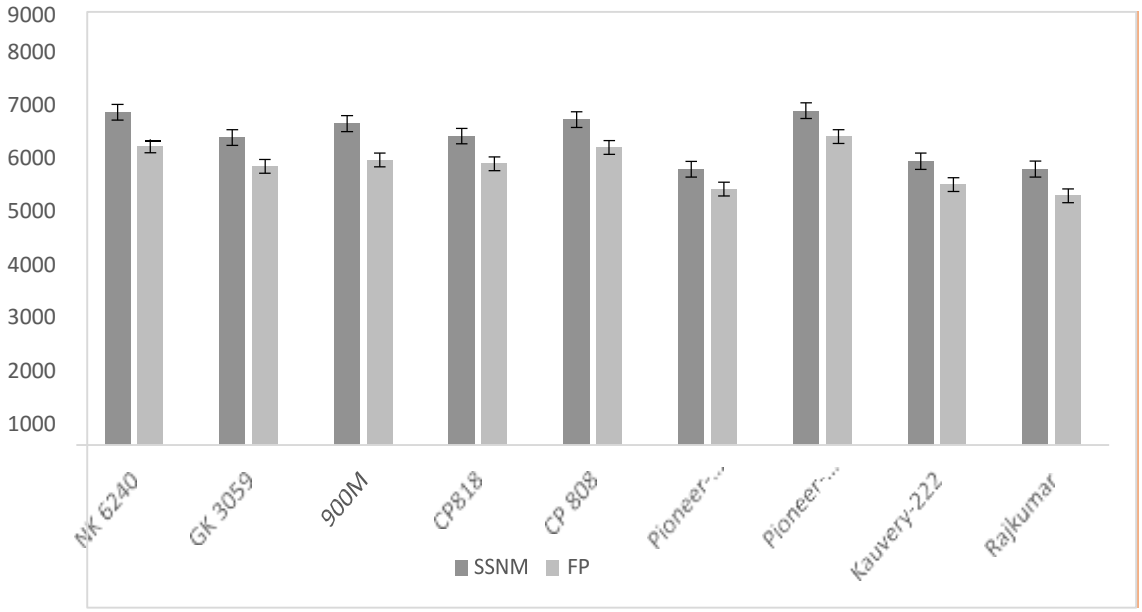


Figure 18: Performance of common hybrids to site specific nutrient management (SSNM) in Chikkmagaluru

Fallow management

Introduction of vegetable cowpea and vegetable mungbean

In Chikkamagaluru district most of the farmers are practicing Rice-fallow system after the harvest of *khraif* rice, climatic conditions of rice fallow lands in many areas are suitable for growing vegetable cowpea and mungbean. The residual moisture left in the soil at the time of rice harvest is often sufficient to raise short-season crops. Further, by use of short-duration and high-yielding varieties of rice allowing vacating fields in October, the traditional rice fallows can be converted into productive lands. Introduction of cowpea and mungbean in rice fallows can increase the productivity as well as sustainability of rice. During the year 2015, efforts were made by AVRDC to introduce vegetable cowpea and mungbean in 25 ha in order to intensify the rice cropping system in Chikkamagaluru district. The yields obtained from these fields are encouraging and efforts are on to scale out the area under these crops in this region. The improved varieties such as Pragathi and KM 5 performed better compared with local variety i.e., C 152. The yield data showed that nearly 35% higher yield was achieved in case of Pragathi and 18.4% in the case of KM 5 compared to C 152 variety (Table 5).

Table 5. Vegetable cowpea yield in Koppa taluk, Chikkamagaluru district

Cultivars	Yield (kg/ha)	% increase over local variety
Pragathi	930	34.7
KM 5	690	18.4
C-152	580	-

Promotion of Green gram

Improved varieties of green gram seeds have been supplied and encouraged farmers to cultivate the fallow land during pre-*khraif* season to maximize the land utilization as well as earn additional income with available soil moisture. Greengram is the third most important pulse crop cultivated in India covering an area of 3.43 m ha, with production of 1.71 m t and an average productivity of 498 Kg ha^{-1} (Anon, 2012), Important greengram growing states in India are Rajasthan, Odisha, Andhra Pradesh, Maharashtra, Karnataka and Bihar among which Rajasthan occupies larger area and production. Uttar Pradesh leads first in productivity with an average yield of 686 Kg ha^{-1}. In Karnataka, it occupies an area of 293 thousand ha with a total production of 73 thousand tonnes and an average productivity of only 249 Kg ha^{-1} (Anon., 2012). This accounts for less than half of the national productivity thereby indicating the scope to improve its productivity. The production and productivity of mung bean is reported to be low in Karnataka due to non-availability of suitable mung bean varieties. The yield ability of mung bean is mainly dependent on date of sowing. Hence new varieties *viz.,* Pusa vishal, KKM 2, DGGV2 and BGS 9 were adopted in three districts during pre-*Khraif* situation 2015.

Greengram cultivars identified by researchers and farmers for higher seed yields. Varieties with specific and general adaptation identified and recommended for specific growing sites. Seeds of selected varieties are safely stored. During pre-*khraif* 2015, ICARDA introduced new varieties of greengram in selected Bhoosamrudhi taluks/villages in 12 acres. Field interactions on soil health, soil profiling, selection were done in collaboration with Department of Agriculture. In these areas, soil health information was shared by ICRISAT and that has been utilized for soil fertility status, and based on that needed fertilizers was recommended and applied.

Technology intervention

Timely transfer important technological interventions to the farmers doing mung bean cultivation followed by close supervision according to the physiological stages of the crop. The details of these technological interventions are as given below.

Sowing Time:

1st fortnight of May to 1st fortnight of June

Seed Rate and Spacing:

12 kg/ha (4.8 kg/acre)

Spacing maintained at 30cm x 7.5 - 10cm

Seed Treatment

1. Seeds soaked at 1 hour in 2% Calcium chloride and then 7-8 hour dried in the shade before sowing.
2. Seeds treatment with Carbendazim (1g a.i./kg seed) + Thiram (2g / kg seed) after seed priming followed by Rhizobium inoculation (40-45 gm/kg seed).
3. Treated seed are not exposed to direct sunlight.

Fertilizer Dose:

1. Straight fertilizer planned to be applied for mung bean cultivation in following dose N:P:K @ 25-50-20 kg/ha and Gypsum @ 100 kg/ha
   (FYM @2- 5 t/ha to maintain soil health)

2. Fertilizer applied in furrows just before sowing during last ploughing followed by planking

Foliage Spray:
2% urea sprayed at pre-flowering stage i.e. 25-30 days after sowing for normal sowing and one another spray.

Weed Management:
Two time inter cultivation at 40 days before sowing
For mung bean production, 12 farmers were selected from two villages in one taluk and 12 acres of land selected. The improved varieties and improved package of practices provided, on an average yield 345 Kg/ha. The state average productivity of mung bean during 2010-11 was 266 Kg/ha. Pusa Vishal variety yield potential is 1200-1400 Kg/ha as per the research studies, due to prolonged dry spell during cropping period the average yield 345 Kg/ha in pilot villages. Mung bean yield in demonstration plots ranged between 197 Kg/ha and 437 Kg/ha with an average 345 Kg/ha in the district (Figure 19 and 20).

Figure 19. Improved variety of Greengram cultivation in Kadur taluk, Chikkamagaluru district.

Figure 20. Greengram crop after spraying 2% urea (L) Comparison of local Vs early maturing Pusa Vishal Variety (R).

Table 6. Economics of Green gram variety in Kadur taluk, Chikkamagalur district						
Farmer's Name	Variety	Area sown (m2)	Grain Yield (Kgs) in sown area	Net income from sown area (Rs/acre)	Grain Yield (Kg/ha)	Net income (Rs/ha)

Jiganihalli village						
T. Mariyappa S/o Timmayya	Pusa Vishal	2000	158	10220	395	25550
Nagarajappa S/o Cidappa	Pusa Vishal	2000	161	10490	402	26180
Kariyappa S/o Giddamallayya	Pusa Vishal	2000	136	8240	340	20600
Mallappa S/o Kumaranna	Pusa Vishal	2000	112	6080	280	15200
Timmayya S/o Manjunath	LGG 460	2000	151	9590	377	23930
Chandrappa S/o Maruti	KKM 2	2000	162	10580	405	26450
Yaradankala village						
Krishnappa S/o Basappa	Pusa Vishal	2000	156	10040	390	25100
Shekarappa S/o Nanjappa	Pusa Vishal	2000	90	4100	225	10250
Pandurangappa S/o Chandrappa	Pusa Vishal	2000	79	3110	197	7730
Jagadesh S/o Papayya	Pusa Vishal	2000	175	11750	437	29330
Average yield (Kg/ha)					345	21050

Capacity development in green gram production

Pre-sowing training discussing the final farmers list, mung bean production practices and seed selection methods were elaborately discussed in training programs. These capacity development programmes were highly successful in reaching out to the farming community at grass root level. These interventions have successfully motivated to expand mung bean cultivation in the area during pre-*Khraif season*.

Feed and Fodder Management

Thorn less cactus

In order to create awareness to farmer regarding importance of edible cactus as a fodder during offseason ICARDA with the help of ICRISAT and DoA established one edible cactus nursery comprising of 1500 cladodes in Lingadalli village (Figure 19).

Figure 21. Cactus nursery raising in DoA farm at Lingadahalli in Chikkamagaluru district.

Fodder varieties

ILRI has demonstrated number of technologies to improve fodder productivity and management (Figure 20). During 2015, ILRI introduced multi-cut fodder sorghum (CSH 24MF) in 30 farmers' fields covering about 7 ha area. Similarly, dual purpose sorghum (CSH 14 and maize (NK 6240) were introduced in nearly 50 farmers' fields covering about 25 ha area.

Figure 22. Fodder crop promotion in Chikkamagaluru district.

Vegetable production technologies

Vegetable cowpea taken in 10 farmers in paddy fallow in Koppa and as a inter cultivation in coconut garden in Kadur Taluk (Figure 23).

Figure 23. Veg cow pea in Paddy fallow (L); Veg cow pea in coconut garden (R).

Implemented protected cultivation with improved practices like mulching, Inline drip, fertigation, and introduced grafted capsicum which are tolerance to bacterial wilt in Shade net / poly house in 10 farmer's field. Capsicum variety / hybrid used are indra of Syngenta company (Figure 24 to 27).

Figure 24. Healthy Capsicum plants in Poly house / Shade net.
Figure 23. DDH Chikmagalore Visited polyhouse in farmer field on 26th May 15.

Figure 25. Capsicum crop established in shade nets in Chikkamagaluru.

Figure 26. AVRDC staff installing pheromone traps in farmers Field.

Figure 27. Farmer collecting capsicum crop grown under shadenet.

Yield analysis of vegetable production

In Chikkamagaluru, demonstrations were conducted on tomato both in open field and shadenets. The grafted tomato seedlings were tried for ensuring less incidence of wilt particularly during early crop growth stage. The results clearly revealed that in case of tomato in shadenet, the yield of grafted tomato was 35 per cent higher viz, 53 t/ha as against 42.1 t/ha with normal planting. Similarly, in case of open field condition, the IPM practices in tomato resulted in 26 per cent increase in yield viz, 46.5 t/ha as against 34.37 t/ha in control situation (Fig 2). The grafted capsicum in shadenets resulted into 14 per cent higher yield (52.3 t/ha) compared to non-grafted (46t/ha). Similarly, grafted capsicum plated I open field (32.5 t/ha) resulted in 33 per cent higher yield compared to normal planted seedlings (24.5 t/ha).

Table 7: Vegetables productivity with different management practices in Chickkmagaluru

			Yield t/ha		
Crop	**Interventions**	**Situation**	**IP**	**FP**	**% increase in yield**
Tomato	IPM (open field)	Open field	46.48	34.37	35
Tomato	Grafted (shadenet)	Shadenet	53.04	42.1	26
Capsicum	Grafted (shadenet)	Shadenet	52.3	46	14
Capsicum	Grafted (Openfield)	Open field	32.5	24.5	33
Mungbean	Vegetable type (paddy fallow)	Open field	0.5	Paddy fallow	-
Cowpea	Vegetable type (paddy fallow)	Open field	1.25	Paddy fallow	-

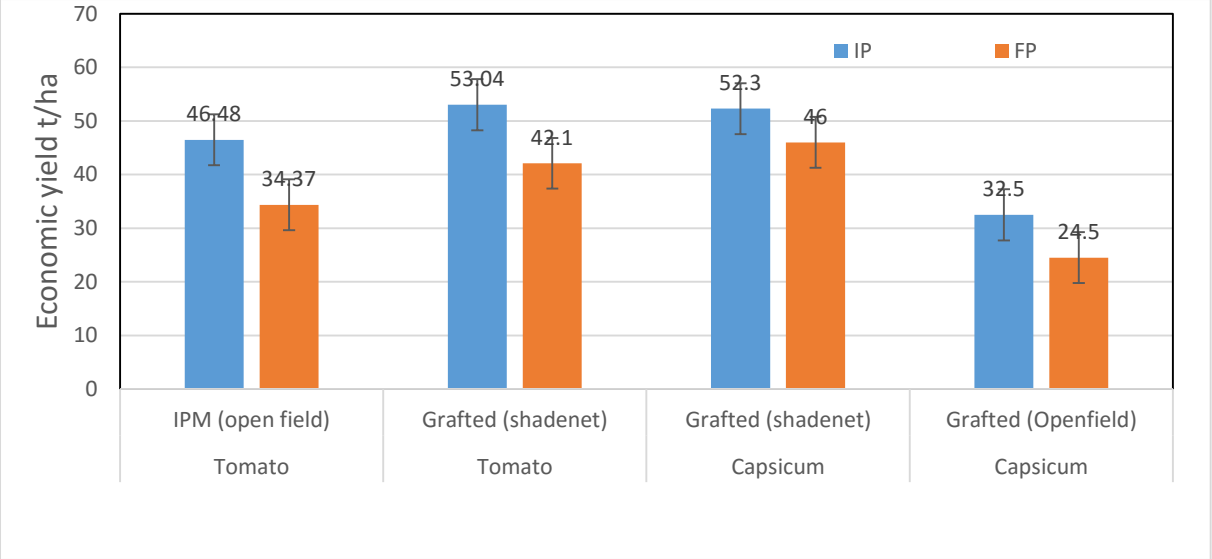


Fig. 28 Vegetable crops productivity with differnt management practices

The efforts done on crop intensification in rice fallows resulted in additional yield of vegetable mungbean (0.5 t/ha) and Vegetable cowpea (1.25 t/ha) thereby increasing farmers net income (by Rs 10000-15000 per ha) (Fig 2).

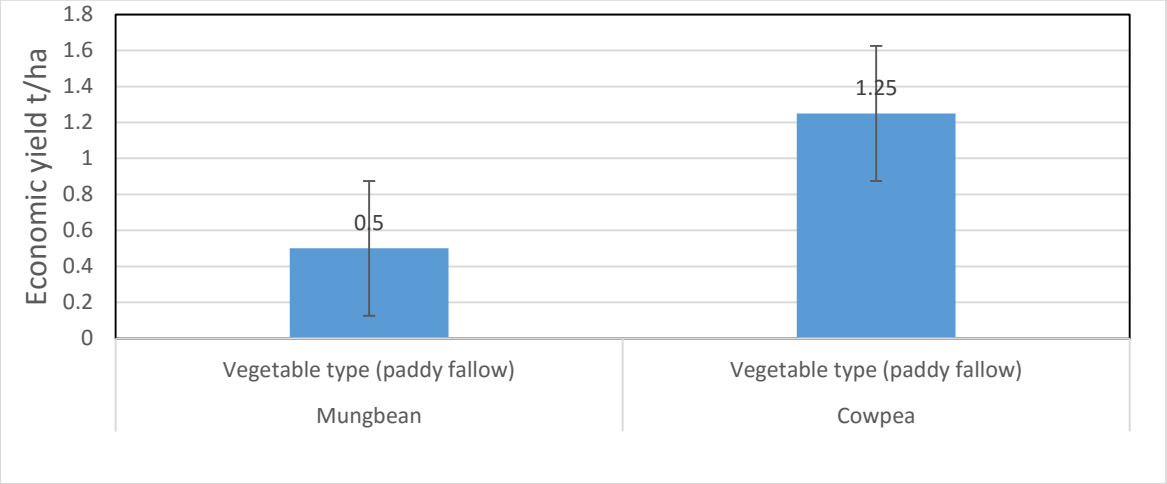


Fig. 29 Vegetable crops productivity with differnt management practices

Wastewater recycling and reuse in agriculture

Site selected for commissioning of a constructed wetland (CW) as well as treated water storage tank in Sadarahalli village. The exact location of the suitable site is **Latitude:** 13.358661°N and **Longitude:** 75.892760°E. The site is a existing wastewater drain which carries wastewater from nearby 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 if leaches to groundwater on the way. The farmers nearby experience foul smell

as they pump water for irrigation from the bore wells which are along the path of this wastewater drain. Presently, farmers are not using this wastewater for irrigation purpose. The name of the farmer whose field is adjacent to this wastewater drain in Mr. Ranganatha (mobile: 9108743900) has a total cultivated land of 5 acres. Local agricultural officer Mr. Mallikarjuna stressed the need of cleaning and covering of the approach drains to ensure effective drainage of the wastewater to the constructed wetland. The wastewater samples from the selected site was previously sampled in January 2015 and the wastewater analysis data is given in Table 12.The suitable design with inner dimensions for the constructed wetland as well as treated water storage tank is given in Figure 27. Required government land is available at the proposed site. The depth and size of different sand and gravel layers of both the CW as well as the gravel filter is shown in Figure 28.

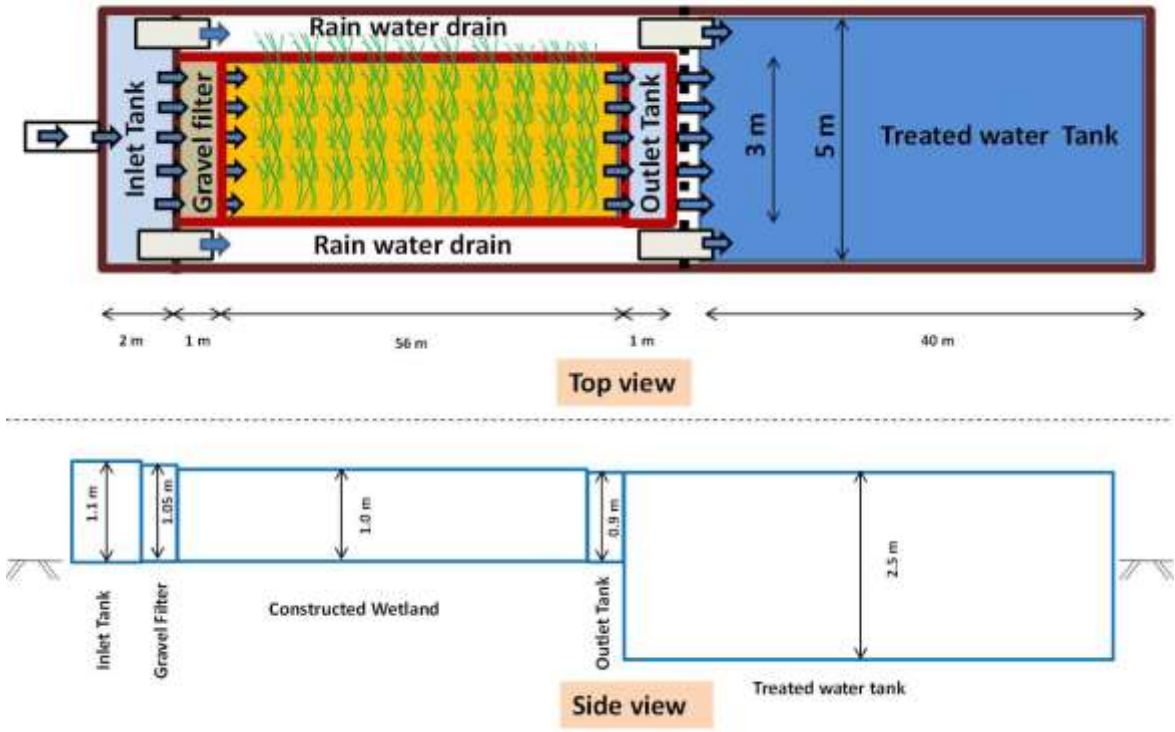


Figure 27. Design with inner dimensions for the constructed wetland as well as treated water storage tank for Sadarahalli, Chikmagalur (RCC base for the area bordered with red colour).

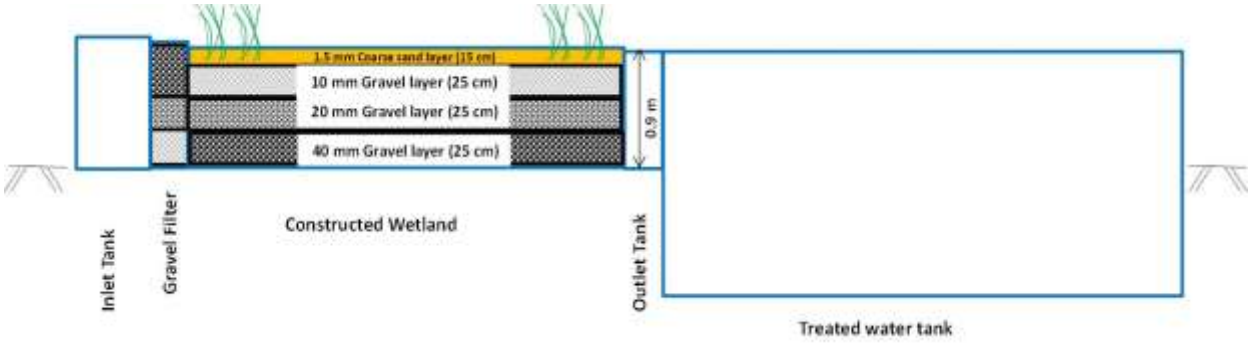


Figure 30. Different gravel and sand layers of the constructed wetland and gravel filter

Figure 31. Interaction with the farmer during the visit at the site selected

Table 8. Wastewater characteristics for the samples collected from Sadarahalli, Chikmagalur.

Sl No	Chikmagalur water sample analysis data	Unit	Concentrations (mg/L)
1	Alkalinity (Total)	(mg/L as CaCO3)	462
2	Arsenic	(mg/L)	BDL
3	Boron	(mg/L)	0.11
4	Biochemical Oxygen Demand (3 day at 27oC)	(mg/L)	379.00
5	Cadmium	(mg/L)	BDL
6	Calcium	(mg/L)	124
7	Chlorides	(mg/L)	631.47
8	Chromium	(mg/L)	BDL
9	Cobalt	(mg/L)	BDL
10	Chemical Oxygen Demand	(mg/L)	477
11	Copper	(mg/L)	BDL
12	Electrical Conductivity	mS/cm	1.93
13	Fluorides	(mg/L)	2.19
14	Hardness (Total)	(mg/L as CaCO3)	674.20
15	Lead	(mg/L)	BDL
16	Magnesium	(mg/L)	79.00
17	Manganese	(mg/L)	BDL
18	Nickel	(mg/L)	BDL
19	Nitrogen-Ammoniacal	(mg/L)	52.93
20	Nitrogen-Nitrate	(mg/L)	7.40
21	pH at 25 oC		7.51
22	Phosphates	(mg/L)	45.33
23	Potassium	(mg/L)	45.33
24	Sodium	(mg/L)	78.10
25	Sulfate	(mg/L)	118.10
26	Total Dissolved Solids	(mg/L)	1155
27	Total iron	(mg/L)	0.15

28	Total Suspended Solids	(mg/L)	39.10
29	Zinc	(mg/L)	0.06
Sodium Adsorption Ratio (SAR)			1.90

BDL: Below Detection Limit

Expected Outcome:

1. Proper wastewater management for the 200 households living in the village
2. Abatement of groundwater pollution
3. The treated water will be able to irrigate 2 ha of land even in peak summer
4. The treated water can provide water for flushing toilets in public toilets

Description of the local objection for the work at the selected site: 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). However it seems that the construction of a marriage hall for the minority community has been sanctioned adjacent (Fig 32) to the site (in the area the plantation area). Particular emphasis was given during the visits for listening to the views of all the stakeholders without any prejudice.

The alternative site at a distance of 60 meter proposed by the local leaders (next to the graveyard) is not fit for the activity because of the following specific reasons:

1. The proposed site is in an existing drainage ephemeral channel. Such channels experience high flow during monsoon and are not suitable for constructed wetlands.
2. Cost of pipeline will significantly escalate the cost of activity significantly.
3. Lack of reuse scope for the treated water.

It must be noted that the issue has cropped up after the 45 days of construction activity. The contractor engineer has claimed that he has already completed 80 % of the assigned work (though the quality of the work executed is evident of inferior quality). It is not possible 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 my discussion with officials and village leaders (Fig 33).

Fig 32: Discussing the poor quality of construction work as well as the land dispute with local leaders and officials at Lingadahalli (Tarikere, Chikmagalur) site.

Fig 33: Site was selected in the vicinity of fields with vegetation

Extension system

Farmer to Farmer videos

In addition for the effective dissemination of good management practices a farmer to farmer (F2F) dissemination route is explored through a farmer-centric video documentation. Digital Green (http://www.digitalgreen.org/) is the technology partner for this innovative dissemination route. Digital Green has initiated the participatory video and mediated instruction for agricultural extension. The advantage of F2F system is the fact that farmers trust fellow farmers to adopt improved management practices. Farmers can easily

understand these farming practices as they explain in their languages. This system has two processes video production and video screening.

The entire process of video production to screening and the various personnel involved in this process are analogous to movie industry. In this process the Producer is research and development agencies or scientist from ICRISAT. The Producer decides the subjects of the videos based on location, crops, and stage on the crop. Since these videos are the real life stories, producer's field staff identifies the progressive farmer who has adopted the improved agricultural practices with respect to topics. The video usually contains two character's conversation about the improved technology and demonstration. Farmer shares his/her experience about the technology on camera, whereas farmer facilitator plays supporting role as an interviewer. The interviews were scripted such a way that the length of video remains short. However, message from video is very clear so that other farmer can easily adopt the demonstrated technology. The director, camera person, and editor for these video are ICRISAT's ground staff. Digital Green has trained the ICRISAT's staff for video production process.

The processed videos are given to the farmer facilitators for screening in the villages. The battery operator portable projectors (PICO projector) along with necessary accessories were provided to farmer facilitators. Farmer facilitator screens the video to small gathering (20 – 30 farmers) in villages. At the end of the video, farmer facilitator collects feedback from farmers regarding previous videos. The feedback system also captures the adoption rate of screened technologies. Digital Green has developed online/offline data management framework (COCO) that captures data related to the key processes of the Digital Green approach – video production, dissemination and adoption of practices. Total 48 videos were produced by ICRISAT staff and were screened in target villages by farmer facilitator. Based on the feedback from the farmers, one in seven farmers has adopted the screened technology (Figure 34, table 9).

Table 9. Farmer to farmer videos production, dissemination and adoption

Particulars	Chikkamagaluru
Training to SOs, RT & FFs	3
Short video produced	02
No. Of video disseminated	13
Video screenings	27
Viewers	418
Viewer adoptions	108

Figure 34. Video production on the importance of Gypsum in Potato and video screening

Tablet-based Extension System

New innovative extension system is piloted with Samsung Galaxy Tab 2. However, tablet with similar specification including seven inch touch screen, 3G and wi-fi connectivity, voice calling facility, good resolution primary and secondary camera, GPS, bluetooth, expandable memory, and 1 GB RAM is also suitable for tablet based extension system. Since this tablet will be used in farmers' fields, ruggedness of the tablet is also the most preferable feature. The proposed tablet runs on android operating system. The price range for an android tablet is from USD 65 to 450. However, low-cost tablet devices may not be suitable for outdoor condition.

Krishi Gyan Sagar

Tablet-based extension system 'Krishi Gyan Sagar' (KGS) is developed by ICRISAT. KGS is a generic framework for digital extension system that can be deploy in any part of world. The KGS app in Bhoochetana is available in English as well as Kannada. Krishi Gyan Sagar is design to help in knowledge sharing from laboratory to farmers as well as information collection from farmers to laboratory. The KGS has two platforms for two different user groups. The first part is an android app, which is designed as an information dissemination as well as data collection tool. Farmer facilitators are the primary users for android app in tablet. Each FF has jurisdiction of about 500 ha area, which covers one or two villages. Once logged-in FFs can access information available in KGS app and give advice to farmers. In addition, they can capture details of on-going farming activity using various option available in the app. Availability of information in app is restricted based on jurisdiction of logged in user. The other platform of KGS is the web application. Both, the android app and web app are backed with common database server. The server receives data from remote users as well as database administrator. This web app is more useful for policy maker and development agents for monitoring and report generation. Web app users can generate query-based reports from data captured by FFs at field level.

Capacity building

Training programme on Grafting Techniques in tomato and chilli conducted on 5th May 2015 at Sakarayapatna village Chikmagalore District (Figure 35). About 25 nursery owners and rural youths participated in Training. Dr Narayana kutty Professor of KAU participated in training as a Chief resource person and trained the rural youths and nursery owners on Grafting Techniques in Tomato and chilli. Smt Vijaya lakshmi Associate Professor, Agriculture Collage Mandya, UAS Bangalore also participated in training and delivered note on nutritive value of vegetables and value addition.

Table 10. Capacity building programme organized under Bhoosamrudhi.

CG Institutes	Capacity building program	Farmers/Line depts	No. of persons
ICRISAT	Water impact calculator for irrigation scheduling	Line dept (DoA, DoH, DoS)	32
ICRISAT	Tablet based extension system	Farm Facilitators	10
ICRISAT	Farmer-to-farmer videos	Farm Facilitators	18
IRRI	INM and leaf colour chart for efficient N management	Farmers/ATMA	25
CIMMYT	Target based yield achievement thru site specific nutrient management	Farmers	45
ICARDA	Mung bean –best management practices	Farmers	40
IWMI	Irrigation and fertigation scheduling	Farmers	60

Table 11. Number of field days organized in different RSKs in Chikkamagaluru district

Name of the RSK	Name of the village	No. of participants
Lakva	Hale lakva	45
Birur	Chikkangala	62
Lingadahalli	Udeva	38

Figure 35. Training on Grafted techniques in Sakarayapatna.

Orientation Programme to Shade net (Capsicum) farmers jointly organized by AVRDC and IWMI on 26th May 2015 at Sadharahally, Lakya hobli, Chikmagaluru District (Figure 36).

Figure 36. Training programme on protected cultivation in Chikkamagaluru district.

Raichur

In Raichur, four taluks (Raichur, Deodurga, Manavi and Lingasugur) were selected representing North dry Zone, North eastern dry Zone, respectively (Figure 37 and 38). 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. The criteria included accessibility of the sites representativeness, 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. 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 etc.

Figure 37: Raichur district in Karnataka

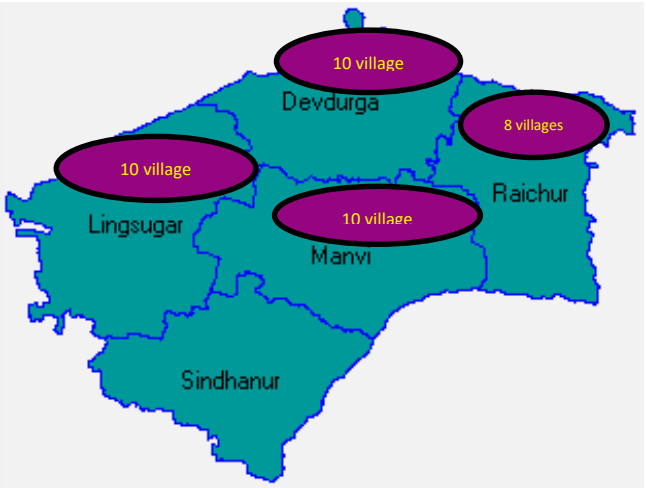


Figure 38: Study sites in Raichur district

In order to assess the ground reality of newly added area during 2015-16, it was decided to thoroughly study and analyze the constraints and opportunities in all pilot sites. Criteria adopted for identification of pilot site for 2015-16 was based on process of Stakeholders' consultations and Consultation with all line Departments.

- Representative site for the district
- Good potential for impact to bridge the gaps
- Accessibility
- Willingness to adopt new
- Presence of suitable institutions
- Predisposition for change

Accordingly, the CGIAR team conducted village level meetings with all the stakeholders with support from all line departments headed by Agriculture department (Figure 39). The interaction with these stakeholders basically involving farmers was taken as basis of designing and piloting the interventions during 2015.

Through the Stakeholders Consultations during group discussions (Figure 40), team has identified following Constraints across all the villages Based on Stakeholders Consultations,

- Mono-cropping system (Cotton/Paddy)
- Poor Weed and pest management
- Low resource use efficiency (ex., Paddy-Fallow)
- Water scarcity
- Labor scarcity
- Lack of access to market
- High cost of cultivation – Low resource use efficiency
- Fodder scarcity
- Poor mechanization
- Low milk yielders

Figure 39. CGIAR scientists during Group discussion in Pilot sites for constraints identification and Benchmark Characterization

Figure 40. CEO, CGIAR scientists and all line departments during Action plan finalization meeting.

Sector-wise Progress Report

A. Nutrient Management

1. Soil testing

ICRISAT initiated intensive soil samplings from additional 20,000 ha area covering 18 villages with latitude and longitude (GPS). ICRISAT along with DoA staff collected soil samples in selected villages by adopting stratified soil sampling method (Figure 41). The Soil analysis results revealed wide spread deficiency of organic carbon (13-100%), phosphorous (0-85%), zinc (0-98%) and boron (0-73%) 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 12). The details of soil samples collected from farmers field.

The trials conducted on kharif paddy, pigeonpea clearly revealed that balanced nutrient management has resulted in increase in grain yield compared to farmers management practice. In case of paddy, the results showed that yield is ranging from 43-50 q/ha as compared to 37-44 q/ha in farmers managed field. The per cent increase in grain yield was ranging from 12-16 per cent with average of 14 per cent.

Table 12. Soil health status of pilot sites in Raichur.

Taluk	Village	OC	Av P	Av K	Av S	Av Zn	Av B
		% deficiency					
2013							
Raichur	Pucchaldinni	100	15	35	35	80	85
Raichur	Idapnur	98	32	1	1	96	49
Raichur	Midgaldinni	75	0	10	10	75	50
Manvi	Govindoddi	30	10	0	0	50	0
Manvi	Haravi	82	12	2	2	75	37
Manvi	Kurukunda	82	27	0	0	97	73
Manvi	Patakamdoddi	93	48	0	0	98	55
Manvi	Sangapur	65	5	0	0	50	5
Manvi	Wadavatti	79	26	0	0	74	30
2014							
Lingsugur	Ankushdoddi	52	48	0	0	74	30
Lingsugur	Buddinni	40	60	10	10	90	60
Lingsugur	Katagal	70	55	0	0	80	20
Lingsugur	Mittekalluru	54	46	4	4	79	42
Lingsugur	Mudabhal	95	80	0	0	90	20
Devadurga	Banddegudda	85	25	0	0	85	30
Devadurga	Malkamdinni	93	85	0	0	93	11
Devadurga	Malledevaragudda	73	45	0	0	68	18
Devadurga	Rekalmaraddi	84	68	0	0	88	28
2015							
Deodurga	Karigudda	93	10	3	37	100	67
Deodurga	Galag	43	30	0	63	67	47
Deodurga	Ganadal	38	5	25	20	35	38
Deodurga	Jalahalli	70	22	15	18	70	25
Deodurga	Somanamaraddi	75	38	3	20	80	10
Manvi	Husenapur	67	20	0	43	97	40
Raichur	Palkamdoddi	63	8	8	33	65	48
Raichur	J.Venkatapura	75	85	0	65	100	5
Raichur	Kasbe Camp	63	37	3	17	50	7
Raichur	Vijayanagar Camp	13	0	0	0	0	0
Raichur District Total		60	23	7	29	65	29

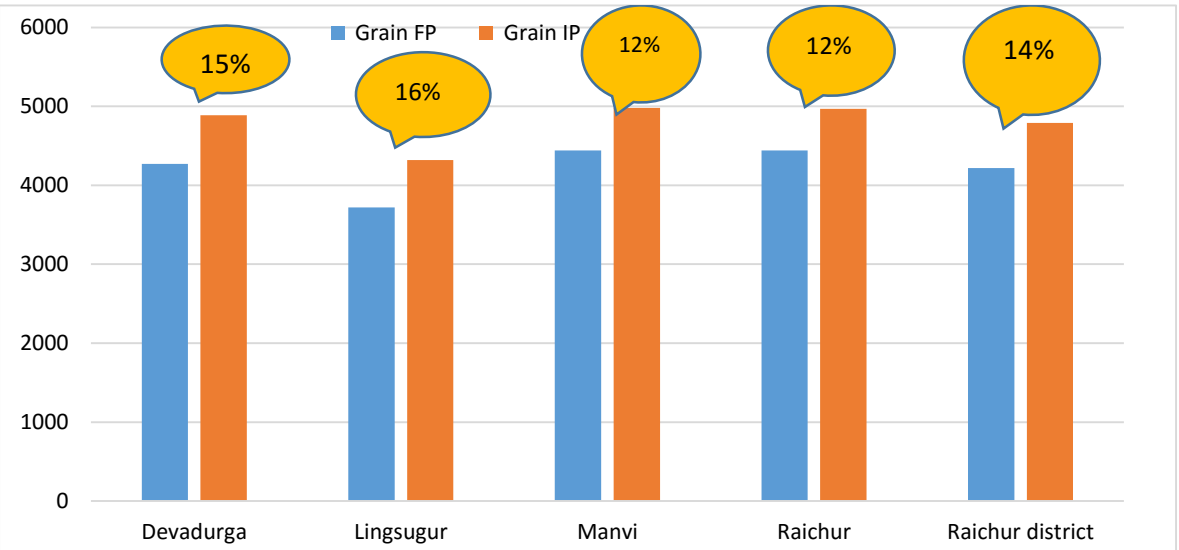


Fig. 41 Yield improvement in Paddy with best management practices incluiding BN, new variety etc

2. 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 revealed that there is significant yield improvement with aquasap application on Bt Cotton. The per cent increase in Kapas yield with aquasap is ranging from 7-11 per cent with an average of 10 per cent.

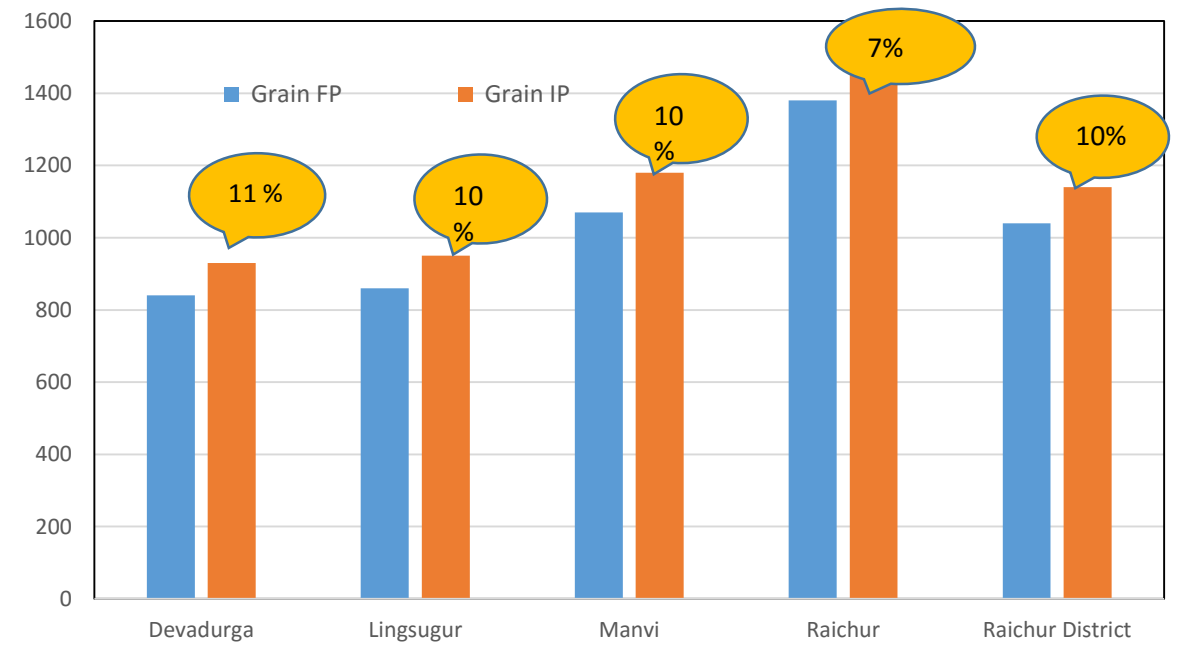


Fig. 42 Yield improvement in Bt. Cotton with best management practices incluiding aquasap

Figure 43. ***A healthy Cotton field of Mr Hendad Basav at Vijayanagara Camp, Raichur***

Figure 44. A healthy maize field after aquasap spray in Raichur

3. 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. The ex CEO of Raichur Mrs. Jyotsana inaugurated this shredder machine and the aerobic composting activities in Idapnur. We have also provided 200 packets of Microbial culture 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 50 tons of compost is produced by different farmers and used in their own fields.

B. Land and Water Management (BBF, Zero till, Drip, WIC)

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), 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).

Altogether, around 450 ha of area is covered during *khraif* and 20 ha area during *rabi* season covering pigeonpea, maize, groundnut and chickpea crops.

Specification: The BBF consists of a relatively flat bed or ridge approximately 105 cm wide and shallow furrow about 45cm wide and 15 cm deep. The BBF system is laid out on a grade of 0.4 – 0.8% for optimum performance.

Area of applicability and scope: 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.

Method of implementation: The BBF system is most effectively implemented in several operations or passes. After the direction of cultivation have been set out based on the topographic survey, furrow making is done by an implement attached with two ridgers with a chain tied to ridgers or a multipurpose tool developed from "ICRISATs Tropicultor" called as BBF maker to which two ridgers are attached, is used for this operation. It is important to have the ridgers operate at shallow depth to attain straight lines; sharp curves must be avoided. A bed former is used to further shape up the broadbeds. 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 disappearing in deep cracks in black soils. In Raichur taluk, more than 400 ha area is covered with BBF maker whereas in Puchaldinni and Idapnur, on 30 ha BBF was prepared and crops viz, pigeonpea, maize were sown. The crops grown on BBF have receded good crop vigor.

Expected Benefits:

1. 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.
2. The BBF design is quite flexible for accommodating crops and cropping systems with widely differing row spacing requirements.
3. 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.
4. Reduces runoff and soil loss and improves soil properties over the years.
5. Facilitates double cropping
6. Improves crop yield

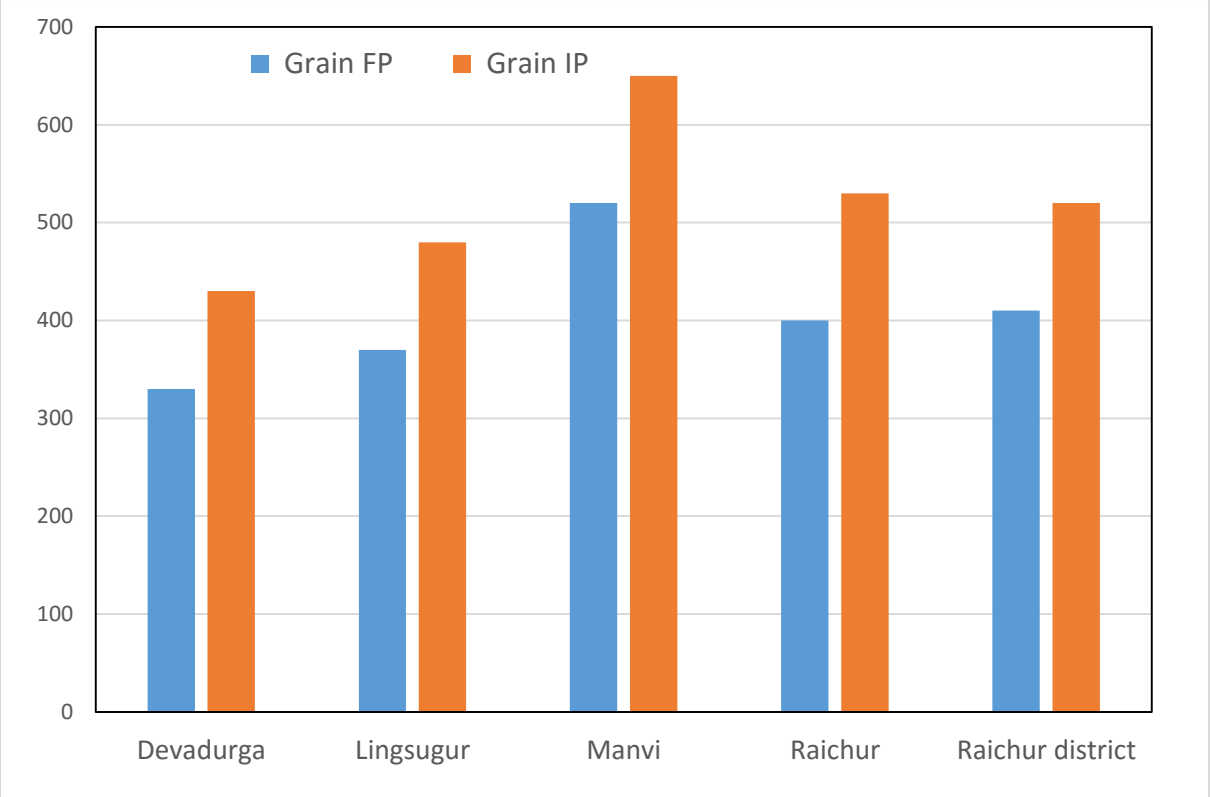


Fig. 45. Performance of pigeonpea under landform management (BBF)

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 2013. 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, chick pea, maize, sorghum etc. and got success in chick pea and sorghum. Intensifying cotton is rewarding, especially when relayed with short duration crops under proper residual soil moisture. During the year 2015-16, kapas yield of cotton remained low when planted alone and became less profitable as yields were lower (1.0 to1.3 t/ha) than normal (4-5 t/ha).

The prevailing dry conditions and delayed canal releases led to lower yields and farm income. The cotton yield was not much affected by relayed chickpea and sorghum. When crop was relayed with chick pea in the latter stages, cotton-chick pea system became more stabilized as the farm income increased from Rs. 42,750 to 68,375, as cotton equivalent yield increased from 1.13 to1.76 t/ha. An improvement of system productivity (Cotton equivalent yield; CEY) by 56 % was observed in cotton-chick pea and 43% in cotton+ sorghum system over cotton alone. Our efforts of intensifying cotton especially with chickpea were more successful with potential multiplication in other areas where cotton is cultivated in more than one lac acres. This can transform further for the livelihoods security of cotton growing farmers in the region. Introduction of mechanization in cotton along with relay technology has gained momentum in the area.

Chick pea as a relay crop in cotton

Sorghum as a relay crop in cotton

Relay Planter

Chickpea relayed with cotton

Table 13. P*rofitability of cotton in relay cropping*

System	Cotton yield (t/ha)	Chickpea/sorghum yield (t/ha)	Cotton equivalent yield(t/ha)	Cost of cultivation (Rs/ha)	Gross Return cotton (Rs/ha)	Gross return of relay crop (Rs/ha	Total Returns (Rs/ha)	Net returns (Rs/ha)
Cotton	1.1	-	1.125	24125	42750	-	42750	18625
Cotton+ chick pea	1.0	0.7	1.762	31625	38000	30375	68375	36750
Cotton+ Sorghum	1.0	0.6	1.624	32250	38000	23750	61750	29500

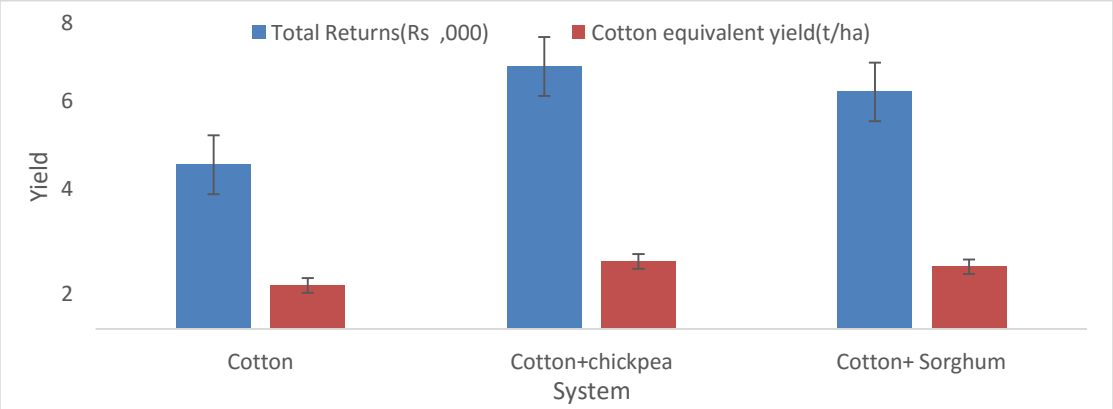


Figure 46: Comparison of cotton based crop diversification in Raichur

Direct dry seeded rice (DSR)

With the joint efforts of CIMMYT, IRRI, ICRISAT, DoA and UAS- Raichur, development and validation of DSR technology had shown 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. In addition to increase in net income of farmers, the other benefits recorded in the DSR are; timely sowing, reduced seed rate by half, reduced fuel consumption by 40-50 lit/ha, reduced water use by 25-35% facilitating an additional area under irrigation with other associated benefits of reduced water logging/salinity & reduced GHGs, increased NUE sue to placement. Altogether 10000 farmers have adopted the DSR in Raichur, Manvai taluks clusters of GoK-CGIAR pilot sites.

Similarly, ICRISAT in partnership CIMMYT, IRRI, DoA, UAS Raichur and other partners have undertaken activities in rice-based systems. Particularly, research activities are aiming to enhance water productivity and profitability of resilient cropping systems. The three types of research trails are undertaken viz., transplanted rice; wet seeded rice and dry seeded rice. The interventions viz, agronomic management particularly pre-emergence application of herbicides, weeding, and hoeing are targeted in pilot demonstrations to keep fields weed free.

IRRI has participated in the Raichur district level workshops and created awareness among the department staff on the best management technological options available with IRRI. Effort was made to incorporate the available technological options in the proposed demonstrations particularly encouraging farmers in direct-seeding method of rice establishment and adoptoping best management practices (Figure 47).

Similarly, efforts were made to providing technological inputs to department officials during the cropping season on best management practices. Despite large inputs (fertilizers and water inputs), farmers yields are not reaching to potential level or declining. Number of improved practices/technologies are identified and demonstrated at pilot villages.

Farmer participatory evaluation and demonstrations of improved direct-seeded rice varieties:

In Raichur district the farmer participatory varietal demonstrations were conducted in 250 ha. The cultivars: RNR 15048 (Telangana Sona), JGL 11470 (Jagityal Mashuri) , JGL 11118 (Anjana), JGL 18047 Bathukamma), WGL 32100 (Warangal Sannalu), Gangavati Sona were demonstrated, in a farmers participatory mode, in the farmers' fields of Raichur district as per the action plan. Among the varieties the RNR 15048, Jagityal Mashuri were observed to perform exceptionally good.

Similarly, the demonstrations on Integrated Weed Management (managing weeds during the critical period of crop weed competition using herbicides such as pendimethalin, oxadiagril as pre-emergence application and byspiribac sodium, pyrazosulfuron, azimsulfuron as post emergence application combined with the use of cycle weeder or manual weeding) were conducted in 400 ha, where the use of proper use of herbicides was demonstrated. In these demonstrations the weeds were controlled effectively. The recommendation of the herbicides in these demonstrations was done based on the weed flora present.

Fig. 47. The rice variety RNR 15048 being given to the farmer in Raichur district and is being sown (direct dry-seeding) by the farmer

Table 14. Area coverage under best management practices of rice.				
Sl No	Components	Total Tar. (Ha/No/qts/ Tons)	Total Ach. (Ha/No/qts/ Tons)	Remarks - impact
1	Farmer participatory demonstrations of paddy	150 ha	250 ha	Among varieties demonstrated the RNR 15048 (Telangana Sona) became very popular in the district due to BhooSamrudhi activities
2	Mechanical transplanting of paddy	100 ha	100 ha	Machine transplanting requires considerably less time and labor than manual transplantation
3	Adopting the best management practices in DSR	100 ha	500 ha	INM, Leaf color chart /IPM/safe use of herbicide resulted in rice yield increase
4	Distribution of leaf colour chart	1000 Nos	1000 Nos	Leaf color chart is useful for optimizing the nitrogen use and attain optimal rice productivity
5	Integrated weed management in DSR/transplanted rice	200 ha	400 ha	Capacity building and continuous monitoring

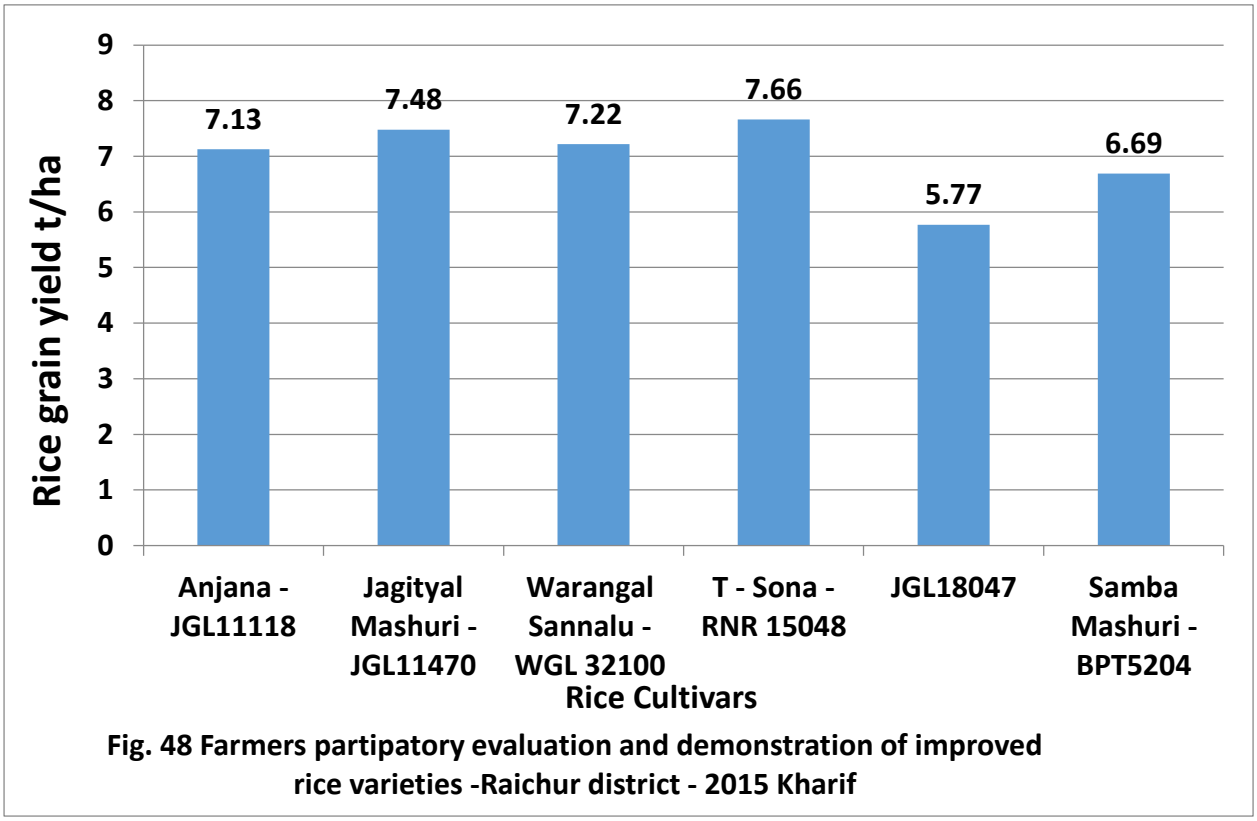


Fig. 48 Farmers partipatory evaluation and demonstration of improved rice varieties -Raichur district - 2015 Kharif

Figure 49. Participatory evaluation of promising paddy varieties thru direct seeding method in Raichur district

Evaluation trials 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 2015.
During the year under report, 4 participatory strategic research trials were laid-out 16 involving surface and subsurface irrigation in DSR. This is a completely new innovation in the state of Karnataka.

Table 15. 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	Anandgowda ,	Govindoddi	Rice 1.5 acre

Figure 50: Surface drip irrigation with laterals placed at 60 cm and 80 cm apart

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).

Table 16: Effect of water regimes on growth parameters in rice (site 1)

S. No	Treatments	Plant height (cm)	No of tillers/hill	No of tillers /m^2	SPAD	Leaf Area (cm^2)
1	TPR	88.00 ±2.78	11.66±0.81	504±14.53	40.22±0.92	32.60±2.95
2	DSR (as per farmers practice)	98.40±3.30	12.66±0.92	580±15.29	42.12±1.37	31.80±3.90
3	DSR-surface irrigation (60 cm)	92.80±2.36	13.00±0.92	679±18.54	39.04±1.66	34.73±2.57
4	DSR- surface irrigation (80cm)	82.20±3.12	12.66±0.80	600±13.83	37.66±1.37	29.95±1.95
5	DSR- subsurface irrigation (60 cm)	103.60±2.38	13.33±0.97	590±8.03	41.44±1.25	40.88±3.78
6	DSR- subsurface irrigation(80 cm)	106.28±1.56	12.33±0.92	655±15.91	41.60±1.71	36.08±2.90

Results of the trail at site 1 revealed that the growth parameters viz. plant height, number of tillers, SPAD and leaf area were inferior in transplanted rice (Table 16) compared to DSR. On the other side, sub-surface drip irrigation in DSR followed by surface drip irrigation with laterals spaced at 60 cm apart recorded better growth parameters. Data on yield and related yield parameter are provided in Table 11. In general, higher grain yield was recorded in s DSR with micro irrigation. The lowest (7.40 t/ha) grain yield was observed where rice was transplanted followed by direct seeding (7.60 t/ha) with farmers practice of water management. A highest grain yield (10.10 t/ha) was observed in direct seeded rice receiving irrigation through surface drip irrigation with laterals placed 80 cm apart followed by same system with 60 cm laterals (9.00 t/ha). The yield performance under sub-surface drip irrigation was also identical to that of surface.

Figure 51: Layout and establishment of surface and sub-surface drip and Hon. Agril Minister (GoK) interacting farmers on Drip DSR

Table 17: Effect of water regimes on yield parameters in rice (Site 1)

S.No	Treatment	Panicle length (cm)	Seed/panicle (No)	Chaffy seeds (%)	Test weight (gm)	Straw yield (t/ha)	Grain Yield (t/ha)
1	TPR	23.22 ± 1.11	188.60 ±10.09	12.83 ±2.52	19.03 ±.0.12	6.00 ±0.02	7.40 ±0.05
2	DSR (as per Farmers)	22.24 ± 0.44	188.00 ±7.09	4.89 ±1.71	20.00 ±0.26	7.60 ±0.05	7.60 ±0.03
3	DSR- surface irrigation (60 cm)	22.32 ±0.20	224.60 ±15.95	3.76 ±2.29	20.57 ±0.57	8.90 ±0.09	9.00 ±0.05
4	DSR- surface irrigation (80 cm)	22.42 ±1.35	181.20 ±10.58	1.76 ±0.86	19.87 ±0.40	9.20 ±0.09	10.10 ±0.11
5	DSR- sub surface irrigation (60 cm)	22.36 ±1.05	22.36 ±1.05	2.81 ±1.30	20.73 ±0.60	8.03 ±0.06	8.30 ±0.03

All values are of 5 replicates except grain and straw which represents 3 replicates 18

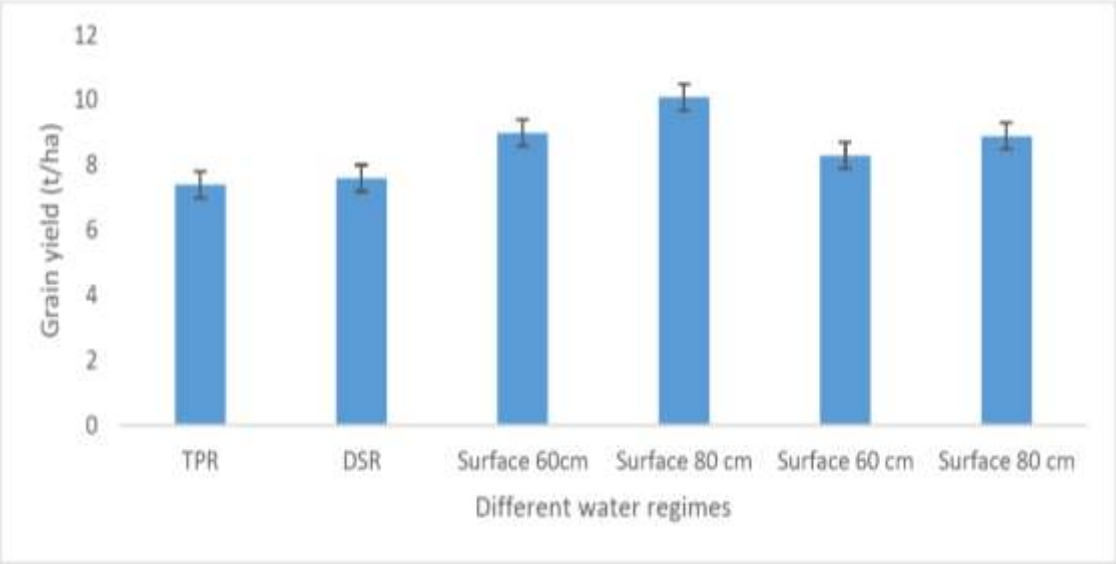


Figure 52: Effect of different water regimes on rice yield (Site 1)

Transplanted rice received largest volumes of water (2025mm) followed by direct seeded rice (1425 mm) where water management was still at the level practiced by farmers. Despite of water management as per the farmers practice, there was a net saving of over 30% of water in DSR compared to transplanted rice practiced by the farmers (Table 18). Looking to the low water requirement of DSR in both surface and sub surface micro irrigation systems, this practice showed the distinct possibility and could become very potential water saving technology in the rain fed ecosystems of Karnataka. Water productivity is a best indicator of water used by the crop with response to crop yield in any production system. Lowest water productivity was observed in transplanted rice (0.36 kg grain m-3 water) which remarkably improved under direct seeding (0.53 kg grain m-3 water). However, with surface and sub surface drip irrigation, the water productivity (WP) was recorded almost three times more than the conventional flood irrigated in TPR. Layering micro-irrigation with DSR led to significant increase in WP recorded at 1.52 and 1.40 kg grain m-3 water under surface and sub surface micro irrigation, respectively. However, these results are of first season and preliminary which will get confirmed for succeeding seasons/years under diverse condition.
Many farmers have already convinced and started realizing the importance of this innovation.

Table 18: Water Budgeting as influenced by various cultures of Rice (Site 1)

Treatments	Irrigation water (mm)	Rainfall during season (mm)	Total water applied (mm)	Water productivity (kg grain m^{-3})	Grain yield (t/ha)	Water saving (%)
TPR	1600	425	2025	0.36	7.4	
DSR	1000	425	1425	0.53	7.6	30
DSR, Surface drip 60 cm lateral	183	425	608	1.48	9.0	70
DSR, Surface drip 80 cm lateral	217	425	642	1.57	10.1	69
DSR, Subsurface drip 60 cm lateral	178	425	603	1.37	8.3	71
DSR, Subsurface drip 80 cm lateral	194	425	620	1.43	8.9	70

2.2.3.2 Micro irrigation results of site 2

At site 2, three scenarios (transplanted rice, DSR with surface micro irrigation with lateral spaced at 60 and 80 cm) were compared. The data of this site are presented in Table 19. Transplanted rice recorded lower plant height (97 cm), number of tillers (13), SPAD (43.4), leaf area (31.3 cm2) etc. compared to all other two scenarions. A highest plant height (105.4 cm), number of tillers (21.6), SPAD (40.2), leaf area (49.5 cm2) etc. were observed with DSR which received irrigation through surface micro irrigation where laterals spaced at 80 cm.
Rice grain yield and yield parameters as influenced by surface micro irrigation compared to transplanted rice are presented Table14 and Fig 10. All the yield attributes were recorded higher with surface drip irrigation at 60 cm laterals followed by surface drip irrigation at 80

cm and the lowest with TPR. The panicle length (25.2 cm), seeds/panicle (315) etc. were found to be numerically superior in direct seeded rice which received irrigation through surface micro irrigation with laterals laid at 60 cm apart. Number of seeds/ panicle (262), chaffyness (5.25%), test weight (19.8 gm), straw yield (6.6 t/ha) etc. were numerically lower with TPR compared to micro irrigation system in DSR.

Table 19: Effect of water regimes on growth parameters in Rice (Site 2)

Treatment	Plant height (cm)	No of tillers/hills	No of tillers/m^2	SPAD	Leaf area (cm^2)
TPR	97±1.64	13.66±2.7	490±98.0	43.44±1.13	31.32±2.80
DSR, Surface drip 60 cm lateral	103±3.16	18.00±3.6	652±130.4	43.54±1.66	46.58±2.40
DSR, Surface drip 80 cm lateral	105±1.33	21.60±4.3	738±147.6	40.28±0.85	49.54±0.92

All values replicates of 5 data points

Highest grain yield was recorded with DSR having drip irrigation at 80 cm laterals (9.40 t/ha) followed by DSR with drip irrigation with 60 cm laterals (8.0 t/ha). DSR with surface micro irrigation system at 80 cm laterals recorded the 18 and 200% more grain yield and straw yield, respectively compared to TPR. Despite high panicle length seed/panicle then DSR irrigated surface irrigation with lateral space 80 cm apart recorded high grain and straw yield due to marginally high test weight.

Table 20: Effect of water regimes on yield parameters in rice (Site 2)

S.No	Treatment	Panicle Length (cm)	Seeds/Panicle	Chaffy seeds (%)	Test weight(gm)	Straw yield (t/ha)	Grain yield (t/ha)
1	TPR	24.40±0.69	262.00±6.64	5.25±2.42	19.80±0.17	6.60±0.66	8.00±0.92
2	DSR, Surface drip 60 cm lateral	25.26±0.46	315.00±20.73	2.09±1.07	20.90±0.12	9.90±0.99	8.00±0.91
3	DSR, Surface drip 80 cm lateral	24.60±0.92	292.90±17.16	2.36±1.39	21.07±0.43	12.0±1.20	9.40±1.07

All values are of 5 replicates except grain and straw which represents 3 replicates

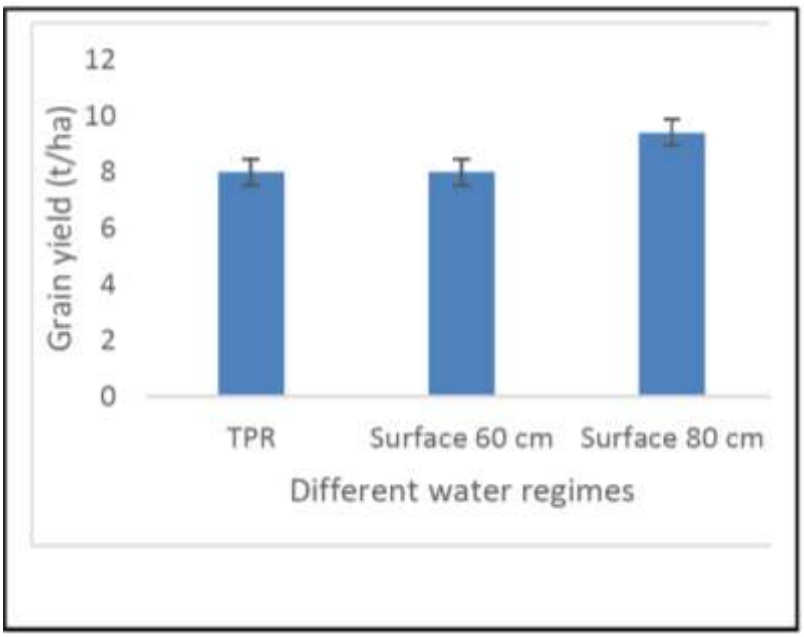


Figure 53: Effect of surface micro irrigation on rice grain yield

Table 21: Effect of water regimes on yield parameters in rice (Site No: 2)

Treatments	Irrigation water (mm)	Rainfall during season (mm)	Total water applied (mm)	Water productivity (kg grain m^{-3})	Grain yield (kg/ha)	Water saving (%)
TPR	1100	425.2	1525.2	0.52	8000	
DSR, Surface drip 60 cm lateral	177.2	425.2	602.2	1.32	8000	61
DSR, Surface drip 80 cm lateral	215.4	425.2	640.2	1.46	9400	59

Surface irrigation systems resulted in saving of water to the tune of around 60 % with no significant difference between the lateral spacing's of 60 and 80 cm. More years of study is required on various micro irrigation regimes (both surface and sub subsurface) in DSR to understand the pattern of growth parameters and grain yield.

C. Mechanization

(Zero till multi-planter Lazer leveler Shredder Relay planter Power weeder)

CIMMYT prioritized interventions are designed and implemented to address issues mainly regarding water labour and energy storage, poor mechanization, mono-cropping with subsistence with low diversity, high-cost of production and low-resource use efficiency. Number of interventions, technologies are demonstrated, details are given below:

1) Introduction and local adaptation of CA machinery relevant to farmers of target domains

Timeliness of planting and precise crop establishment is the key for successful crop production in general but for rainfed ecologies for capturing moisture and establishing crops, suitable planting machinery is very critical. In the project domain, a range of crops are being grown by the farmers and hence for planting all crops, adapted multi-crop planters are required. The traditional drill being used by the farmers are not efficient and can be used for limited crops and under certain situations. We introduced and evaluated multi-crop, multi- purpose planters in the project domain which showed lot of potential for use of these planters. Introduction of these planters in the project area have created awareness among the farmers and many farmers purchased and provide services to other farmers. However, as these planters are to be imported from North India, the cost of transport is huge and many farmers cannot afford these.

2) Design and development of CA machinery locally through capacity enhancement of local manufacturers

Designing, development and fine-tuning of CA machineries required meeting the needs of the local farmers, soils and crops /cropping systems and accelerated adoption of the technology. As of now, a major impediment in promotion of CA-based technologies is non availability of suitable CA machineries locally. As well as higher transport and maintenance costs which have been major constraints experienced by the farmers and promoters of the CA-based technologies. Efforts are being made to replace the traditional planters / machines developed and/or those purchased from various companies located in north India (Ludhiana, Punjab) with locally fabricated planter incorporating local requirements based on the participatory learning. Through capacity development and networking of local manufacturers with advance manufacturers in other parts of the country, efforts were made to create local expertise and save transport cost and time. This was made possible by sending some local potential fabricators and designers to a established fabricators to design and fabricate them locally.

Figure 54. Zero till planter.

M/s VERSA agencies, Chitradurga was one such fabricator who was identified as potential local manufacturer and linked him with National Agro industry Ludhiana to fabricate Zero-Till multi-crop planters with technical support from CIMMYT and UAS Raichur. These efforts bore fruits as he not only fabricated them locally but also started supplying units to the farmers throughout the state. The CA machines developed by him meet all technical specifications design needs of the region and has a wider acceptability among the farmers. Now with this development and availability of locally designed machines GoK and farmers are placing their orders here instead of placing orders to the manufacturers based in Punjab.

3) Identified CA machinery for introduction in the project domain

As CIMMYT has been working on Conservation Agriculture in different ecologies and have been involved in design, development and fine-tuning of range of CA machinery. Therefore, in addition to multi-crop zero till planter, the other potential CA machinery relevant to the need of the farmers of the study area have been identified and will be introduced through Department of Agriculture, Govt of Karnataka (Figure 55). The potential machinery to be introduced for different farm typologies are listed as under:

- Multi-crop turbo seeder for residue management and eliminate burning
- Straw management system (SMS) attachment to combine harvesters to eliminate residue burning
- 2-WT (power tiller) operated multi-crop planter attachment for small farmers
- High clearance planter for 4-WT for relay planting of crops and sustainable intensification
- 2-WT relay seeder
- Animal drawn multi-crop zero till planter
- Multi-crop zero till planter for small tractors
- Multi-crop raised bed planter for crop diversification

Figure 55. Demonstration of machinery

4. Encouraging machine transplanting and providing technical inputs:
In collaboration with department of agriculture, emphasis is being given on transplanting using transplanting machines. It is planned to take improved varieties and best management practices to farmers in the coming season.

Understanding farmers' concept of direct-seeding of rice:
A survey is being undertaken in collaboration with University of Agricultural Sciences, Raichur, and Department of Agriculture, to understand the farmers concept of direct-seeded rice, which would enable to understand the farmers cultural practices and identify areas where IRRI technological interventions are needed so as to popularize those technologies in the coming season. Technical support for popularising machine transplanting and taking best management practices to farmers is being undertaken in collaboration with staff of department of Agriculture.

Direct-seeded rice is becoming popular method of establishment due to water, labour, energy and time saving. Direct-seeded rice predominated by broadleaved weeds. Technological inputs were made available to manage weeds depending on the weed flora.

5. Introduction of shredder for enhancing organic matter availability
ICRISAT has introduced one tractor operated shredder machine for chopping the hard stems which are difficult to decompose easily because of hard lignin content. This machine break them in to finer pieces and then can be easily used for faster decomposition. Through this initiative, six machines are being procured for spreading this technology to all the stakeholders at affordable rate through taluka RSKs.

Case study on Recycling of Cotton/ Pigeonpea Waste through Aerobic Composting Method

Cotton is the major commercial crop in Raichur district which most of the time is intercropped with pigeonpea. Due to continuous mono cropping of cotton and its exhaustive nature, over the years, soil nutrient status has been declined leading to imbalance in the soil fertility and thereby reduction in cotton yield as well. Conventionally farmer's burn the cotton/pigeonpea stalks after harvesting which is a really be the huge loss of nutrients and valuable carbon in addition to causing environmental pollution. Compost making by using crop stalk is natural way of recycling organic materials back into the soil. Billions of living organisms in healthy soil transform dead plants into vital nutrients for new plant growth. Since healthy plants come from healthy soil, one of the best ways you can build healthy soil in farmer field is by using compost. Therefore, ICRISAT staff and DOA staff created awareness regarding the technology of production of compost from cotton/pigeonpea stalk by arranging the demonstration of tractor operated shredder for making stalks into finer pieces and then using Madhyam culture for preparing the compost unit (Figure 56).

Key Requirements for Compost Making

1. Any organic waste of plant or animal origin (Crop waste, cattle and domestic animal wastes, poultry waste, vegetable waste, kitchen waste, food and fruit processing

plants' waste, sugar factory waste including press-mud, municipal organic waste and all sorts of wastes that are of organic nature).

2. Composting microbial culture (Madhyam®, Bioculum® etc.). 1.0-1.5 kg is required for a ton of material is provided by ICRISAT staff for evaluation.
3. Water.
4. A shredder cum chipper machine when waste is dry plant waste. A machine was provided by ICRISAT for demonstration purpose
5. Material mixing machine when operation is to be done on a larger scale. A tractor with a rotator or cultivator attachment is ideal.
6. Urea, nitrogen source when dry plant material is the major waste.
7. Compost nutrient enrichers (Rock phosphate, Phosphate solublizers, Nitrogen fixers etc.), if required

Dharmareddy S/o Kalmesh reddy residence of Idapanur village was keenly interested in adopting this technology and chaffed 1 acre cotton/pigeonpea field and practice what ICRISAT staff advised regarding compost making. Within 65-75 days, he got nearly 1.5 tonnes of compost costing ` 4500. Prior to this he use to purchase compost from outside @ ` 3000 tonnes. Experience for last year's showed that there is vast potentiality of utilizing cotton stalk for production of compost. The compost produced from crop stalk has contain relatively higher amount of plant nutrients including micro and secondary nutrients. Further the time taken for production is very less i.e. 2-2.5 months as compared to other methods which takes 6-9 months. Besides more than 100 farmers have adopted this method of composting in Idapanur village.

Advantages

1. Compost was done in the field itself
2. No transportation charges
3. No pit construction
4. Compost is equal to vermicompost with respect to nutrient status

Figure 56. Demonstration of Shredder machine as a part of Aerobic composting in Idapnur village of Raichur district.

D. Crop intensification and diversification (Promotion of improved varieties Fallow Management Mung bean)

1. Participatory varietal evaluation

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.

In pilot site, farmers chose improved varieties of preferred dryland crops from the list of varieties provided to farmers' groups. ICRISAT, SAUs released improved cultivars and proprietary hybrids of crops were evaluated with an objective to select cultivars having suitable traits for better adaptation to biotic and abiotic stresses to enhance or sustain productivity and further scaling up the spread of these varieties to satellite taluks. Each demonstration was laid-out approximately on half to one acre of farmers' field. Best-bet management include application of 70 kg DAP, 100 kg Urea fertilizers, 5 kg Borax, 50 kg Zinc Sulphate and 200 kg Gypsum ha^{-1} for cereal crops and for legumes a reduction in urea application from 100 kg to 40 kg ha^{-1} was done. The layout of varietal trial was designed to assess the performance of local variety with traditional way of input management. In this trial, there were two treatments with (FP) local/traditional cultivar+ farmers' inputs, (T1) and Improved cultivar + and best-bet inputs (T2) as shown in layout 1.

Layout 1. Participatory varietal selection cum yield maximization trial during 2013-14	
Traditional/local cultivars + Farmers' Inputs (FP)	HY Cultivar + Best-bet management (IP)

With these trials, farmers were exposed to several improved varieties of each crop grown in their watershed and had the option of evaluating the performance of each variety more or less in the same climatic and soil conditions with different levels of input management. Participatory Varietal selection trials were confined to two or three main rainfed cropping systems of the district/region during this crop season. During 2015-16, crops evaluated include cereals and millets (sorghum, Pearl millet), pulses (pigeonpea, chickpea) and oilseed crops (groundnut, soybean, and castor).

The activity is promoted through the program with active involvement of agriculture department and ICRISAT staffs. The program collects and delivers the data which, not only assists farmers with their choice of suitable varieties, but also facilitates the registration and commercialization of new cultivars by plant breeders. The experimental protocol, has been established to evaluate the performance of improved varieties under balanced nutrition against a common set of traditional varieties to characterize their yield, quality, disease resistances/tolerances and agronomic characteristics. The information on yield performance of the improved cultivars was collected through crop cutting experiments by ICRISAT staff and FFs in presence of agriculture department staff/officials.

Varietal evaluation of cereals and oilseeds (viz, sorghum, pearl millet, fodder maize and castor)

With the help of line department staff and farmers, we identified farmers for undertaking the participatory varietal evaluation in pilot sites. The seeds for the demonstration were supplied to the farmers by ICRSIAT at the beginning of season through department of agriculture Table 19. The crop is in good condition and will be ready to harvest at the end of October.

As regards to pulses and oilseeds, the improved cultivars were introduced in order to overcome the issue of pest and diseases particularly sterility and mosaic in pulses and wilting in oilseeds. In case of pigeonpea, the first in the crop (first in world in any legume) commercial cytoplasmic-nuclear male-sterility- (CMS) based hybrid, which is the results of the crop improvements efforts by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) based in Hyderabad, were evaluated. Two CMS-based medium-duration pigeonpea hybrids viz, ICPH2671 and ICPH-2740 were developed by ICRISAT, ICAR, and partners under a project supported by ISOPOM, Ministry of Agriculture, Government of India. These hybrids are found most promising with respect to yield, stability and disease resistance and are resistant to shattering and have more root biomass compared to other existing varieties. The special characteristic of the hybrids is the good dal quality and by most (80%) respondents it was rated as "better than the market sample" in flavor, taste, and cooking time. Last year farmers recorded yield advantage of 79 per cent in groundnut; 801 to 115 per cent in pigeonpea.

Table 22. Details of seeds supplied to farmers for participatory varietal evaluation

Crops (variety)	Seeds provided (Kg)	Area covered (Ac)	No of farmers	Average Yield (q/ha)
Sorghum CSV 27, PVK 801	70	25	50	14-17
Pearl Millet (ICTP8203 Fe)	50	25	35	12-16
Pigeonpea (Maruthi, TS3R, ICPH2740, ICPH 2671)	100	50	40	4.3-6.5
Maize (Fodder)	100	20	40	48-52
Groundnut (ICGV91114, ICGV0350, ICGV0351, ICGV2266)	1300	22	40	20-22

6. Promotion of Mungbean through crop intensification

ICARDA was involved in identification of appropriate mung bean cultivars and development of improved agronomic practices and capacity development of farmers and Extension agents in production agronomy, seed processing and storage.

In Raichur, 11 trials were conducted with the support from Agricultural department in Raichur taluk. The results are clearly shows importance of the study as farmer has obtained on an average Rs 15000 to Rs 26000 and having benefit cost ratio ranging from 2.53 to 4.48, Table 23.

Table 23. Results of evaluation study on greengram							
Taluk/ Block	Village	Farmer's Name	Variety	Area sown (Acre)	Grain Yield (Kg/ha)	net returns	B:C ratio
Raichur	SriRamnagar camp	Honnappa S/o Subhaiah	Pusa Vishal	1	365	24850	4.11
		Hooligappa S/o Hanumappa	Pusa Vishal	1	398	27820	4.48
		Mallekarjunna S/o Somanna	Pusa Vishal	1	345	23050	3.88
		Muduranganna S/o Goudappa	Pusa Vishal	1	340	22600	3.83
		Ramanna S/o Basanna	Pusa Vishal	1	280	17200	3.15
		Subhanna S/o Ramanna	Pusa Vishal	1	377	25930	4.24
		Srinivas S/o kallappa	Pusa Vishal	1	335	22150	3.77
		Veerabahdra rao S/o mallappa	Pusa Vishal	1	390	27100	4.39
		Addanna S/o Doddappa	Pusa Vishal	1	225	12250	2.53
		Amarappa S/o Hanumantha	DGGV2	1	253	14770	2.85
		Amarappa S/o Monappa	BGS 9	1	303	19270	3.41

Figure 57. Introduction of Greengram for crop intensification

Cropping system diversification and intensification

Direct seeded rice is the dominant system in the tail end commands of Tungabhadra in Raichur district where no crops were raised in fallows during winter/rabi season due to shortage of irrigation water. Till recently a double rice–rice cultivation was practiced, many of those areas now been converted to single crop of rice due to prevailing poor monsoon/

climate/droughts and insufficient irrigation water for winter rice crop. Attempts have been made to identify short duration high value crop and varieties which could be raised on residual soil moisture after rice during winter/rabi. During the year, zero till green gram, mustard, black gram, chick pea were promoted in rice/DSR fallows. Amongst all the catch crop, green gram and mustard remained superior over other crops. Data on DSR and DSR-mustard and DSR-green gram are presented in the Table 8 for their comparison.

Table 58 Green gram and mustard based DSR intensification in Raichur district

Similarly, AVRDC is also promoting rice fallow management through introduction of greengram and cowpea. They have covered around 25 farmers for this initiative. The crop is in early stage and the past record is clearly encouraging for these demonstrations Figure 47.

System	Rice yield (t/ha)	Mustard/ GG yield (t/ha)	Rice equivalent yield (t/ha)	cost of cultivation (Rs/ha)	Gross Return DSR (Rs/ha)	Gross return relay crop (Rs/ha	Net Returns (Rs/ha)
DSR	5.57	-	-	51555	117000	-	65479
DSR-mustard	5.57	0.325	6.370	59051	-	141440	82423
DSR-Green gram	5.57	0.560	6.30	63538	-	144500	80995

Yield analysis of vegetable crops

In Raichur, demonstrations were conducted on tomato in open field conditions. The grafted tomato seedlings demonstrated for ensuring less incidence of wilt particularly during early crop growth stage. The results clearly revealed that the yield of grafted tomato was 33 per cent higher (viz, 32.5 t/ha) as against 24.5 t/ha with normal seedling planting. Similarly, in case of grafted capsicum in shadenet, the best management practices resulted in 24 per cent increase in yield (viz, 26 t/ha) as against 21 t/ha in control situation (Fig 59). The grafted capsicum in open field (20 t/ha) resulted in 25 per cent higher yield compared to normal planted seedlings (16 t/ha).

Table 24: Vegetables productivity with different management practices in Raichur

Crop	Interventions	Situation	Yield t/ha		% increase in yield
			IP	FP	
Tomato	Grafted (open field)	Open field	32.5	24.5	33
Capsicum	Grafted (shadenet)	Shadenet	26	21	24
Capsicum	Grafted (Open field)	Open field	20	16	25
Mungbean	Vegetable type (Paddy fallow)	Open field	0.68	Paddy fallow	-
Cowpea	Vegetable type (Paddy fallow)	Open field	1.42	Paddy fallow	-

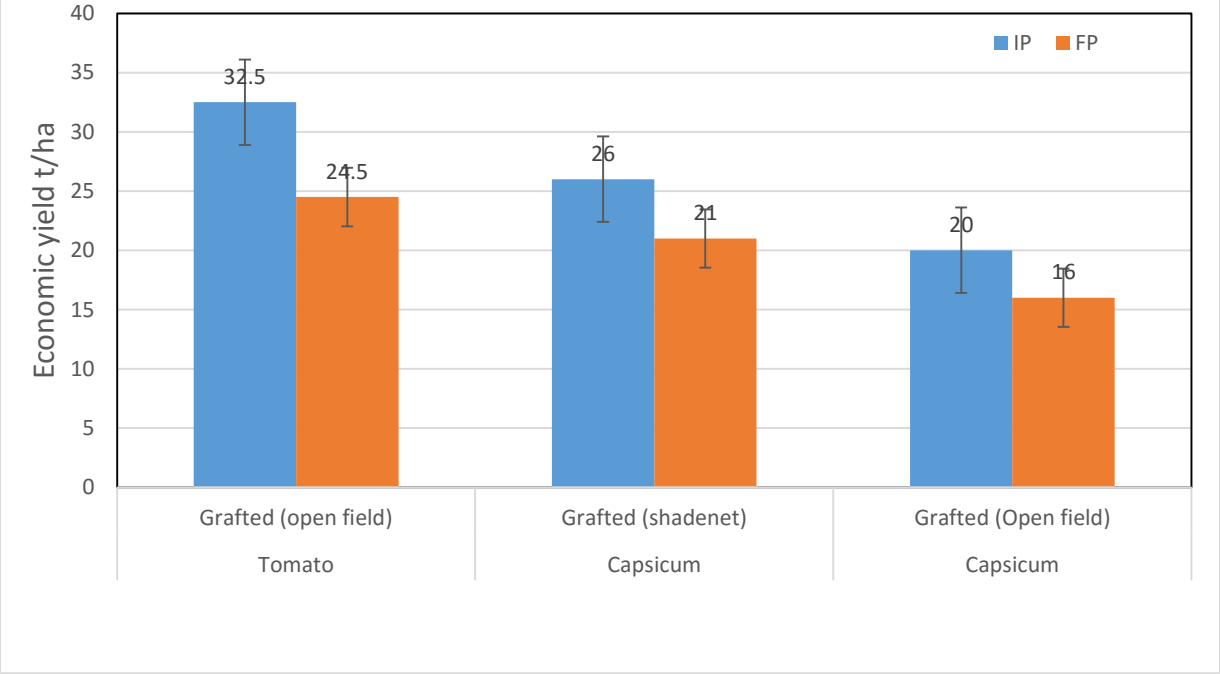


Fig. 59 Vegetable crops productivity with differnt management practices

As regards to rice fallows, the efforts were made to introduce vegetable mungbean and cowpea for increasing cropping intensity and thereby produce additional income to the farmers. The vegetable mungbean grown in rice fallows recorded 0.68 t/ha grain yield

whereas vegetable cowpea recorded 1.42 t/ha green pod yield. Thus the farmers under study have obtained additional RS 12000 to 15000 net income with this interventions.

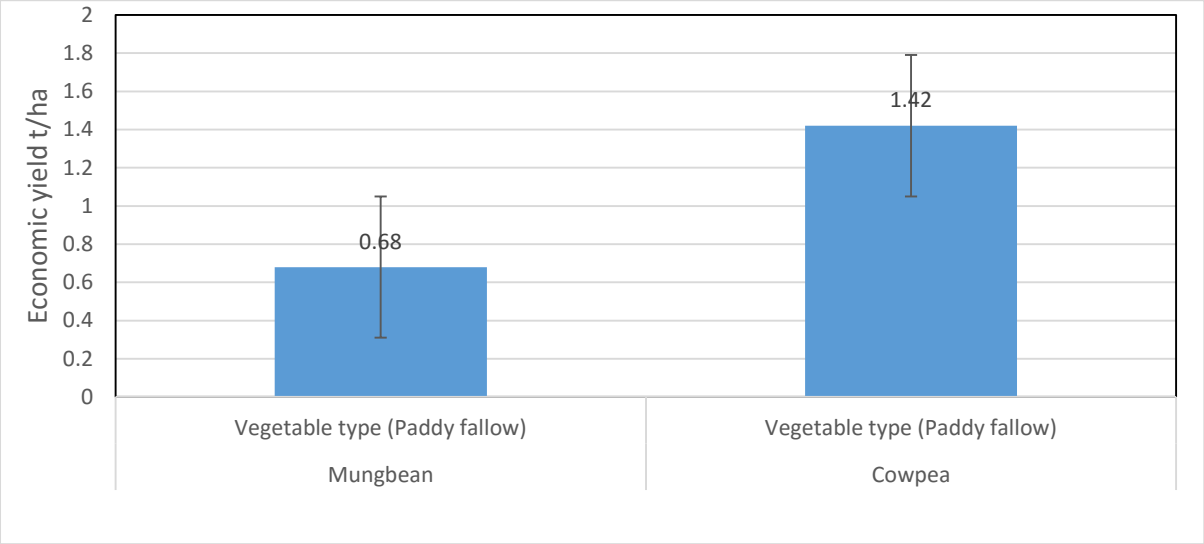


Fig. 60 Vegetable crops productivity with differnt management practices

E. Feed and Fodder Management

International Livestock Research Institute conducted field trials on dual purpose maize and forage sorghum on 60 farmers' field. At Mittekallur village, Lingsugur taluka dairy feeding trial with NK 6240 maize stover is under progress. Similarly, CSH 24 MF forage sorghum samples from the field of Sri Ram Nagar camp village are collected and send to ILRI for its nutrient analysis and further recommendations Figure 61.

In order to increase fodder availability, ICARDA has introduced multipurpose thorn-less cactus (*Opuntia spp*.) in Raichur for its evaluation and subsequent value addition. Cactus *(Opuntia ficus-indica)*, commonly known as prickly pear, belongs to the family Cactaceae. Family Cactaceae is reported to contain about 130 genera and nearly 1500 species. Generally, these species are used as live fences to protect agricultural fields from human and animal encroachments. It is suited to water-scarce dry zone of the world as an alternate source of food and fodder. Different parts of the cactus can be used as fruit and vegetable for human consumption, fodder for cattle, and raw material for various industries to prepare plywood, soap, dyes, adhesives and glue, pharmaceutical products for treating blood sugar and various other disorders, and cosmetics such as shampoo, cream, and body lotion, etc. The present program is undertaken to introduce the thorn-less cactus through improved germplasm, frontline demonstration, and value addition of the spp. in establishment of cacti species in degraded and wastelands of Karnataka. In Raichur district, eleven farmers are selected from 5 villages and 1800 cladodes are planted covering three promising varieties viz, Cactus 1270, 1271 and 1280.

Figure 61. ILRI Institute Fodder demonstrations on field of Mr Hanumagouda Patil And Kumarguoda Patil on dual Maize, fodder Sorghum and Bajara crops

Figure 62. Cactus nursery at mittekallur village.

G. Capacity Building

Tablet-based extension system: With the aim to reach large number of farmers with innovative technologies, ICRISAT along with Department of Agriculture and all other line departments has established an innovative extension system called Tablet-based extension system to cater the needs of farmers. Initial level trainings have been provided to Farm facilitators and local level extension officers of DoA, ICRISAT and others. Green SIM cards have been distributed along with Tablets to facilitate FFs to register farmers and to provide needed information.

Farmer-to-Farmer videography: In partnership with Digital Green, Department of Agriculture and ICRISAT introduced Farmer-to-Farmer videography to record and disseminate innovative technologies, practices, methods, etc to fellow farmers. Initial level trainings and orientation programs were organized with the help of DoA and ICRISAT.

Digital green staff provided three days production training to ICRISAT staff, Farm facilitator and Agriculture staff regarding handling of camera and story writing about contents for film production was organized. The focus of training was on basics of camera handling, training on different shots and camera angles, writing a story board, basics to keep in mind while developing a video, video editing and final video development

Also training regarding handling of Pico projector and dissemination of films based on their requirement to farmers/self-help groups in selected villages (Figure 50). To test the technology visit was made to Vjayanaga Camp village and told farm facilitator to show one film regarding seed treatment to pigeonpeaand 20 farmers attended the programme and appreciate the method of disseminating the technology.

The main aim of the training programme is to train the participants to produce the video independently and in that we identified 10 content for video production viz., (1) DSR method of paddy cultivation; (2) BBF maker for soil and water conservation; (3) Seed treatment in sorghum; (4) Rhizobium treatment in chickpea; (5) Use of pheromone trap in cotton; (6) Use of power weeder in paddy 7) Integrated farming system approach (8) Vermicomposting; (9). Aerobic composting; (10). Use of shredder in cotton.

Figure 50. Raichur Training Session, Dated, 12-15 July 2015

Training program

A training program was organized (in collaboration with UAS, Raichur; DOA, Raichur, ICRISAT) at UAS-R wherein all the CGIAR institutes has given training to agril. Department staffs and 60 farmers on best management practices in agriculture and allied sectors. Both oral presentations and practical training were given to a participants on safe use of herbicides.

Field day: One district level field day was organized on "Surface and sub surface drip for rice and Direct-seeded rice" at Govindoddi village, Manvi taluk on 1 December 2015 with the active support from CIMMYT and DoA. Mr.R.V.D'Souza, IAS, Chief Executive Office, Zilla Panchayat, Raichur; Dr.P.M. Salimath, Vice Chancellor, University of Agriculture Sciences, Raichur were the Chief guests at the farmers day cum training meeting organized at Govindoddi village (Figure 63). Prior to the field day the Chief Guests visited the direct-seeded rice fields of Mr. Suresh and Mr. Gouda in whose fields the BhooSamrudhi team is conducting the demonstration on the drip irrigation system. The CEO has interacted with the farmers and got acquainted with the farmers' experiences. The CEO, in his address, stressed the need for producing more crops with less water and asked farmers to utilize the services of scientists and organizations involved in BhooSamrudhi. The Vice Chancellor also stressed the need for adopting the technologies developed by scientists and get benefitted. Farmers asked a few questions and the JDA and the scientists answered those questions. Dr.Yogesh, CIMMYT, Mr.Ashoka, ADA, Manvi Taluk.

Figure 63. TheCEO, Raichur during 'Field day' organized at Govindoddi village, Manvi Tq.

iii) Extension agents, service providers and farmers

As a part of capacity development and empowering farmers and other stakeholders with latest CA machineries and related technologies, four training programmes were organized All together nearly 300 stakeholders were trained on various aspects of Conservation Agriculture. In addition large number of farmers and other stakeholders were exposed to these technologies through field days and in-field interaction meetings.

iv) Extension agents, service providers and farmers

All together nearly 300 stakeholders were trained on various aspects of Conservation Agriculture. In addition large number of farmers and other stakeholders were exposed to these technologies through field days and in-field interaction meetings.

6. Vegetable production technologies

AVRDC has undertaken capacity building training programs on vegetable cultivation, value addition and market linkages. They have identified and selected farmers for vegetable growing in 500 acre area in Ligasugur, Raichur and Deodurga taluks. Field scale capacity building programs were organized on grafting and nursery raising of mango, tomato, improved management of vegetables, staking in vegetables etc. The further details of interventions are as below,

1) Vegetable cowpea and mungbean taken in 4 ha each (10 farmers) in paddy fallow in Raichur, district (Figure 64) and Vegetable cowpea field days conducted on 04-04-2015 at Manavi taluk Raichur District and on 25th April 2015 at Village Gunavanthe / Manipura of Koppa Taluk Chikmagalore district.

Figure 64. Field day of vegetable Cowpea in Raichur District.

2) Implemented protected cultivation with improved practices like mulching, Inline drip, fertigation, and introduced grafted capsicum which are tolerance to bacterial wilt in Shade net in four farmer's field in Raichur District (Figure 65, Table 25). Capsicum variety / hybrid used are indra of Syngenta company.

Figure 65. Capsicumum with improved Practices

Table 25. List of farmers.						
Sl no	Farmer Name	Taluka	Village	Mobile number	Survey no	Sources of water
1	Raffiuddin	Raichur	Puchaldinni	09743236787	436	Burwell
2	Amaresh gouda	Manvi	Kurkunda	0966333870	200/2	Burwell
3	Basavaraj	Lingasuguru	Mittekelluru	09900881277	6	Burwell
4	Saleem	Raichur	Idapnur	07036406113	23	Burwell

3) On July 2015 Kitchen gardening training conducted in Devadurga taluk of raichur district in collaboration with DOH and 100 Kitchen gardening kits issued Figure 66.

Figure 66. Kitchen gardening training programme.

4) AVRDC introduced grafted Tomato which is tolerant to Bacterial wilt in farmer's field in kurkunda village of Manvi taluk and on 27th August field training conducted (Figure 67 to 69).

Figure 67. Farmers in grafted tomato plot during field training.

Figure 68. UAS Raichur Scintist Visit to Grafted tomato plot.

Figure 69. JDA Raichur in Vegetable field with AVRDC technician during field visit.

Wastewater treatment unit for safe use of drainage water

The sites are identified for decentralized wastewater treatment system at Raichur. ICRISAT team has visited two sites in Bhoosamrudhi pilot area: Kurkunda and Hirehannagi villages.

Site 1: Kurkunda Village (16^0 10' 29.32" N, 76^0 53' 32.60") Table 23

This village has nearly 200 households; however the drains from each house not properly collected to common disposal point. Shallow earthen drains are used to convey domestic wastewater to disposal point (Figure 70). One farmer is using this wastewater for cultivating 1.5 to 2 acre land. As per the farmers' experience wastewater flow is good during morning for three hours. As per requirement farmers diverts wastewater into his field. Otherwise wastewater is disposed into a small pond.

Recommendations

- Farmer is using raw wastewater for growing crop which is unsafe.
- A small low cost structure may be constructed to treat the wastewater as the wastewater generation and drain connectivity is poor in this village.

Table 26. Design parameters for wastewater treatment system at Kurkunda village (Cost may change as per location).	
Number of households connected to common drainage	200
Domestic water consumption (m^3/d)	40
Wastewater generation (m^3/d)	4
Initial design hydraulic retention time (days)	5
Required volume of wetland considering 5 day HRT and 0.5 porosity (m^3)	40
Depth of wetland (m)	0.8
Width of wetland (m)	5
Length (m)	10
Component of Constructed wetland	
Sedimentation tank	Not required
Filter bed - Quantity of gravel and sand required for filter bed	
Sand (top 0.2 m layer) (m^3)	10
10 mm gravel (0.2 m layer below sand layer) (m^3)	10
20 mm gravel (0.2 m layer below 10 mm gravel layer) (m^3)	10
40 mm gravel (0.2 m layer below 40 mm gravel layer) (m^3)	10
Storage tank - capacity (m^3)	Not required
Cost	
Excavation (@150 per m^3) Total volume = 44 m^3	Rs 6,600.00
Lining of the wetland (@500 per m^2) Total area = 70 m^2	Rs 35,000.00
Sand and gravel (@ Rs 850 per m^3) Total quantity = 40 m^3	Rs 34,000.00
Labor cost	Rs 10,000.00
Approximate cost	Rs 85,600.00

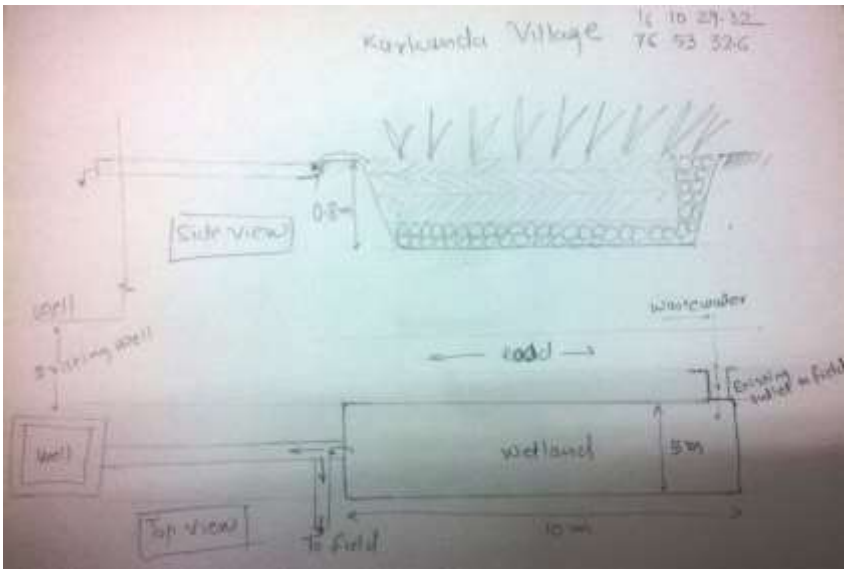


Figure 70. Schematic of constructed wetland for wastewater treatment (All dimensions in meter).

Site 2: Hirehanagi village (16^0 10' 23.70" N, 76^0 51' 7.92")

This village has nearly 300 households. Most of the households are connected to cemented drain that carries wastewater to a common point outside the village. Presently, wastewater is disposed in open field (Figure 71) and forms a natural drain. This natural drain also has some wetland plant species like Typha that help to treat the wastewater. Further this drain connects to newly constructed field channel.

We recommend converting existing natural drain into constructed wetland (Figure 72) to improve the treatment efficiency. Treated water coming out of constructed wetland may be connected to field channel drain or stored irrigation.

Figure 71. Wastewater disposed in to field.

Figure 72. Location of village, proposed constructed wetland, and existing field water channel.

Table 27. Design parameters for wastewater treatment system at Hirehanagi village in Manvi taluk (Cost may change as per location).	
Number of households connected to common drainage	200
Domestic water consumption (m^3/d)	40
Wastewater generation (m^3/d)	20
Initial design hydraulic retention time (days)	5
Required volume of wetland considering 5 day HRT and 0.5 porosity (m^3)	200
Depth of wetland (m)	0.8
Width of wetland (m)	4
Length (m) (divided into 15 m compartments)	63
Component of Constructed wetland	
Sedimentation tank	Length = 1 m Width = 5 m Depth = 1.5 m
Filter bed - Quantity of gravel and sand required for filter bed	
Sand (top 0.2 m layer) (m^3)	50.4
10 mm gravel (0.2 m layer below sand layer) (m^3)	50.4
20 mm gravel (0.2 m layer below 10 mm gravel layer) (m^3)	50.4
40 mm gravel (0.2 m layer below 40 mm gravel layer) (m^3)	50.4
Storage tank - capacity (m^3)	600
Cost	
Excavation (@150 per m^3) Total volume = 880 m^3	Rs 132,000.00
Lining of the wetland (@500 per m^2) Total area = 378 m^2	Rs 189,000.00
Sand and gravel (@ Rs 850 per m^3) Total quantity = 201.6 m^3	Rs 171,360.00
Labor cost	Rs 100,000.00
Approximate cost	Rs 592,360.00

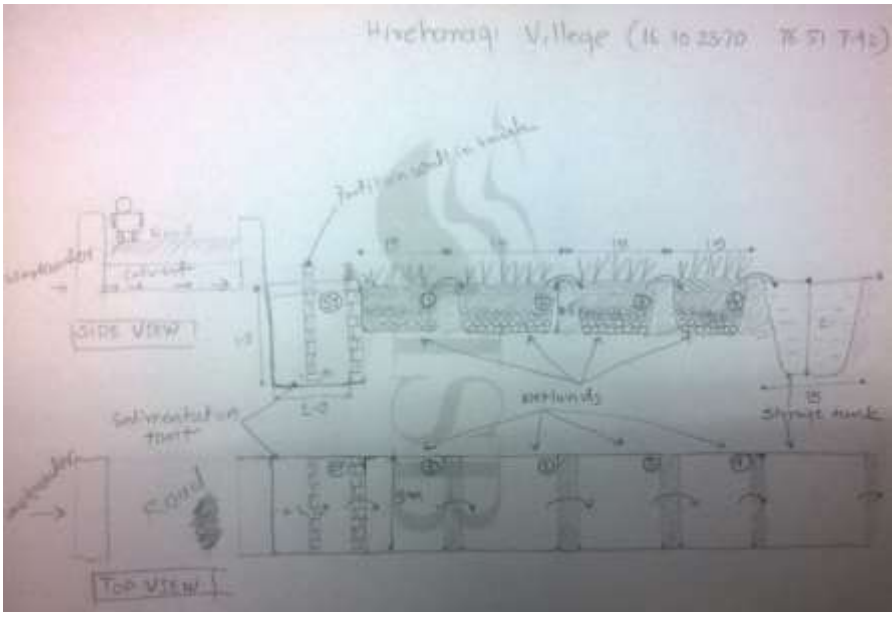


Figure 73. Schematic of constructed wetland for wastewater treatment (All dimensions in meter).

Tumkur

Tumkur, a southeastern district of Karnataka borders with southern Andhra Pradesh. With 10 taluks in the district, it has one taluk, Pavagada, which is totally delinked from the district, and surrounded by a strip of Anantapur district of Andhra Pradesh. It 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.

Targeted area of Bhoosumrudhi program in 2015-16: Bhoosumrudhi program in 2015-16 targeted to cover nearly 50,000 Ha area from eleven hoblis of five taluks (Table 28). Tumkur, Tiptur and Madhugiri taluks were selected in 2013-14; and two new taluks Pavaguda and Sira is also included this year under the BhooSumruddi program. Total 41 Gram Panchayats which covers 172 villages and approximate 40,000 households will be benefited from this program in 2015-16.

Table 28. Target villages of Bhoosumrudhi program in 2015-16.

Sl No	Taluk	Hobli Nos	Gram Panchayats	Area (Ha)	Villages (No's)	No of House holds
1	Pavagada	1	7	10176	21	10697
2	Madhugiri	3	13	12614	57	13066
3	Tumkur	2	7	7458	37	6051
4	Tiptur	3	9	9866	41	6057
5	Sira	2	5	10000	16	4101
Total		11	41	50114	172	39972

Sector-wise progress

Number of technology demonstrations were made in selected pilot sites with help of consortium partners and line departments. This document reports the work progress of all these interventions and its impact. As Tumkur experienced drought situation in beginning of the monsoon and crop sowing was delayed. We are in process to do crop cutting experiments for understanding the clear impact of various interventions on crop yield and income. All the interventions are largely classified into seven-major activities as listed below:

Land and Water Management

***In-situ* soil moisture conservation techniques:**

A large percentage of rural families in Tumkur is largely dependent on rainfed agriculture. Tumkur receives on an average 700 mm rainfall which is uncertain both in terms of its quantity and distribution. There are number of challenges such as fragmentation of farm lands, low crop yields, water scarcity, land degradation and inability to access credit and markets. Research institutes and university has developed various land management techniques so that more amount of soil moisture is harvested in field. Field demonstrations for enhancing *in-situ* soil moisture is planned in selected model villages. Land form methods

such as Broad-Bed and Furrow will be demonstrated during *Khraif* 2015 which enhances soil moisture 10-15% compare to traditionally cultivated field, and also this methods helps in disposing-off excess runoff safely during heavy down-pour. Increased soil moisture in BBF field helps crop to protect from water stress situation especially during dry-spells. Moreover, other soil conservation practices, such as use of zero-till facilitate use to sow seed without doing tillage operation and therefore huge amount of soil moisture especially from top 15 cm soil depths are saved.

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

Due to fragmented and small land holdings and variable farmer typology, it is not affordable to purchase many machines for the planting of different crops by the same farmer. 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
- Zero-till demonstration made in Paddy-Fallow lands of Hiregundagal and Kallushethalli villages (5 Acres)

Figure 74. With limited water availability, chickpea yield was recorded at Hiregundegal village 600 -800 kg/ha without applying any supplemental irrigation and fertilizer amount. Framer benefited with an additional income of nearly Rs. 25000/ha.

Observing benefits of multi-planter zero-till machine in *Rabi* 2014 (Figure 74), nearly 20 farmers in *Khraif* 2015 adopted this technology along with weed management and sown cereal crops like paddy, maize and finger millet in nearly 50 acres land of Hiregundegal

villages. This has saved their cultivation cost ranging between 2000 and 5000/acre. Crop cutting experiment will be done in Dec 2015.

Introduced Direct seeded rice in Hiregundegal village (CIMMYT, ICRISAT)

With increasing water scarcity, it is important to promote water saving technology such as DSR. Cropping system in Tumkur however is largely predominated by Finger Millet, groundnut and Maize based cropping system but Paddy is also cultivated in various places where water availability is good (e.g., near water tanks etc). Farmers in Tumkur are in practices to cultivate paddy under the puddled transplanted situation with flood irrigation. Despite huge water scarcity, paddy farmers pump incredible amount of water. We demonstrated Direct Seeded Rice technology in one of the pilot village (hiregundegal village). Paddy is directly sown using zero-till machine and limited amount of irrigation provided (Figure 75).

Paddy requires large amount of water as it is being cultivated in submerged puddled condition. It is estimated that nearly 5000 Liters of water is required to produce 1 kg of rice. With increasing water scarcity, it is not sustainable to grow paddy under flooded situation therefore improved method of cultivation is required. Direct seeded Rice has been proven technique which has number of advantages compared to transplanted rice.

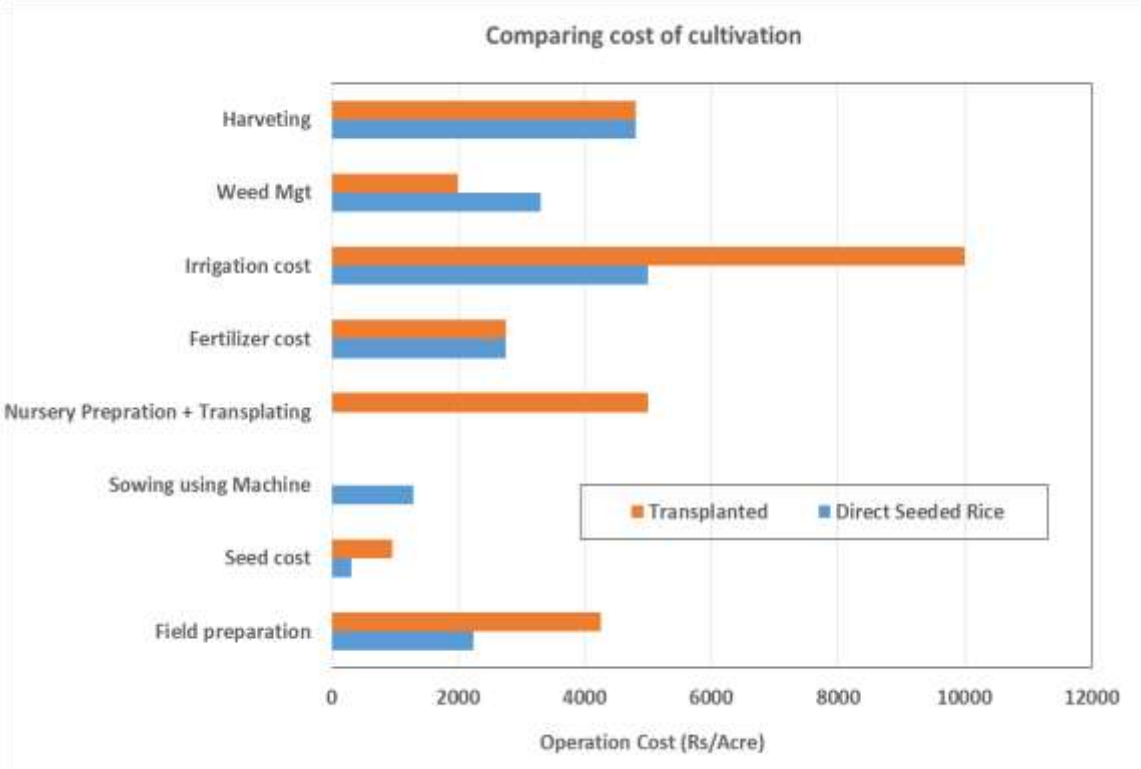
I) It saves nearly 40-50% water;
II) It does not require field preparation and puddling operations therefore reduces cost of cultivation;
III) Crop yields obtained under DSR is comparable with transplanted rice.

Figure 75. Direct Seeded Rice demonstration in Hiregundegal villages, Tumkur taluk.

In Bhoosumruddi program, we have demonstrated DSR technique in Hiregundagal village, Kora RSK, Tumkur taluk, Tumkur districts with help of CIMMYT and DoA. Field experiment with Mr. Dayananad Sagar, s/o Murgyappa and other neighboring farmers was undertaken nearly in 5 acres land. IR64 was which 120 days crop was chosen for cultivation. This experiment was undertaken between 29th July 2015 and 9th Dec 2012.

Paddy seeds were sown using zero-till multi-planter. Zero-till multi-planter facilitated to sow seeds without any seed bed preparation, without puddling which reduced significant amount of fuel and cultivation cost. Zero-till machine makes a 4-5 cm sharp cut on surface soil, place seed and fertilizer appropriately and cover it with soil. As surface soil layer did not disturbed, available moisture in top soil was also protected from non-productive evaporation losses. Recommended dose of pre-emergent weedicide (Pandi Methylene) was applied to control the weeds. Fields were irrigated once in a week or 10 days interval as per need. Recommended dose of fertilizers were applied as per defined protocol. Moreover a nearby field was cultivated as per traditional manner (transplanted paddy method with flooded field condition).

Crop yield obtained from DSR was found to be 30 Q/Acres compared to 24 Q/Acres with transplantation method. Figure xx compared the cost of different operation in both of the methods. DSR costed nearly Rs.19700/acre compared to Rs. 29700/acre in case of transplantation. Saving of nearly Rs 10,000/acer was obtained mainly by avoiding puddling and minimizing irrigation. As a result, net income from DSR is found to be 22,000/acre compared to mere 3800/acre in transplanted condition.



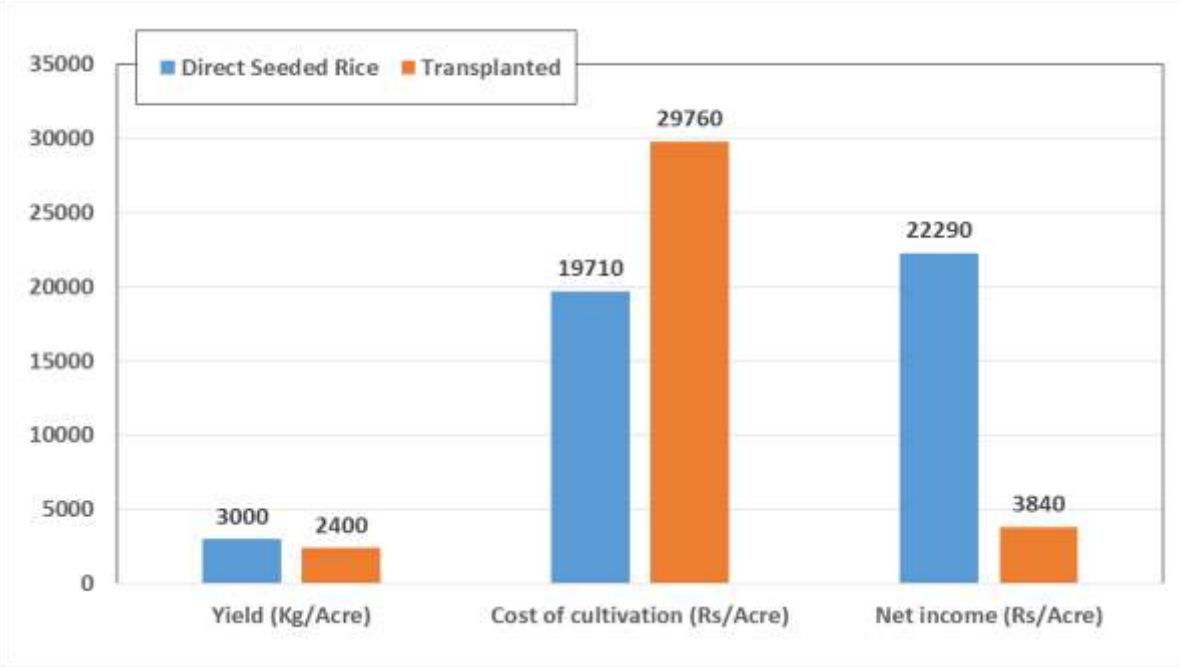


Figure 76 (a): Comparing cost of field operations among DSR method and transplanted paddy; b) comparing economic of the DSR method with transplanted paddy (Data collected from Herigundegal village of Tumkur taluk, Tumkur district in year 2015-16, Farmer: Mr. Dayanand Sagar)

Nutrient Management

Soil sampling and analysis

Soil samples from new BhooSumrudhi villages were collected in year 2015 (Figure 77). Total 1000 samples from 100 villages were collected and analyzed at ICRISAT laboratory for important micro, secondary nutrients. Soil test based fertilizer recommendation were developed for pilot villages and soil health card also will be made available for the sampled farmers.

Figure 77. Collection of soil samples with help of farmers in BhooSamruddi villages of Tumkur.

Foliar spray of micro-nutrients

Foliar spray of Aquasap- 5X

Aquasap-5X 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. The liquid is an organic produce and hazard free and can be handled with bare hands for mixing with water for preparation of solution. Aquasap-5x was provided to 60 farmers covering 50 acres land and applied in different crops such as for maize, groundnut, paddy (Figure 78).

Figure 78. Promoted foliar spray of micro-nutrient (Aquasap and Bio20).

Foliar spray of micro-nutrient

Bio-20 is a 20-20-20 NPK concentrated water soluble suspension containing a unique package of nutrients, bio-stimulants and micronutrients. It is ideal as a stand alone fertiliser, Bio 20 also offers a proven track record of superior stress relief and plant health promotion chemical. It is recommended as a general foliar feed and plant growth stimulant, particularly in times of stress, or in a regular nutrient management to boost a wide range of nutrient levels. Bio-20 was supplied to 20 farmers having total area 37 acres mainly for Maize crop in pilot villages (Table 29; Figure 79).

Table 29. Bio20 chemical evaluation as foliar spray during *Khraif* 2015.

Name of the farmer	Hobli	Village	Soil type	Variety	Area of sowing (Acres)
Madhugiri Taluk					
Puttarangappa S/o Rangappa	Puravara	Raghuvanahalli	Red	NK - 6240	1.0
Veerabhadraiah S/o Rudraiah	Puravara	Halethimmanahalli	Red	NK - 6240	1.0
Devaraju S/o Hanumanthappa	Puravara	Halethimmanahalli	Red	Ganga Kaveri	1.0
Govindappa S/o Govindappa	Puravara	Gondihalli	Red	Ganga Kaveri	1.0
Gangappa S/o Venkataramanappa	Puravara	Aralapura	Red	NK - 6240	1.0
Subbarayappa S/o Kavalappa	Puravara	Aralapura	Red	NK - 6240	1.0
Nagaraju S/o Dase Gowda	Puravara	Doddahosalli	Red	NK - 6240	2.0
N.Jayaramaiah S/o P.N.Nagappa	Puravara	Doddahosalli	Black	NK - 6240	1.0
Muntalappa S/o Muni	Puravara	Kondavadi	Red	NK - 6240	1.0

Lakshmaiah					
Hanumantharayappa S/o Obalappa	Kodigenahalli	Jogihalli	Red	NK - 6240	1.0
Tumkur Taluk					
Janardhana S/o H.V. Gopalakrishna	Kora	Bommanahalli	Red	NK - 6240	5.0
Ravi Kumar S/o Gangappa	Kora	Bommanahalli	Red	NK - 6240	3.0
Nataraju S/o Shankara Char	Kora	Bommanahalli	Red	NK - 6240	1.0
Siddagangaiah S/o Narasiyappa	Kora	Bommanahalli	Red	NK - 6240	3.0
Tiptur Taluk					
Siddamallappa S/o Ganganna	Honnavalli	Rudrapura	Red	NK - 6240	2.0
Chandrashekhara S/o Channappa	Honnavalli	Rudrapura	Red	NK - 6240	3.0
Jaya Kumar S/o Mahadevappa	Honnavalli	Rudrapura	Red	Pionear	3.0
Marulappa S/o Chikka ramaiah	Honnavalli	Karikere	Red	NK - 6240	2.0
Mahalingappa S/o Siddegowda	Honnavalli	Karikere	Red	NK - 6240	3.0
Shadaksharaiah S/o Rudraiah	Honnavalli	Karikere	Red	NK - 6240	1.0
Total					37

Figure 79. farmers' participatory demonstrations on foliar spray.

A total of 30 participatory trials were conducted in Tumkur district of which 21, 7 and 8 were conducted in Madhugiri, Tumkur and Tiptur talukas, respectively. In this district, as mentioned above NK6240 was the only hybrid of remained choice of the farmers because of its multipurpose use both as grain and fodder. Response of this hybrid to SSNM based on target yield is presented in Figure 3. As the district is much drier than Chikkamguluru, a lower target of 6 ton/ha maize yields was aimed in the district and it remained lower (3-4 tone/ha). The scattered diagram on the performance of this hybrid across region indicated the marginal improvement in the crop performance over the recorded yield levels for the district. Normally, farmers did not apply potassium and they focused on nitrogen and phosphorous. Application of nitrogen and phosphorous remained fairly adequate but withholding potassium application appeared a key in deciding maize yield. The SSNM based application including potassium and micro nutrients provided more balanced nutrients to the crop resulting in higher grain yield. A higher grain yield was observed in SSNM based

applications and recorded nearly 8-9% more grain yield over farmer based application (Table 30 and Fig 80).

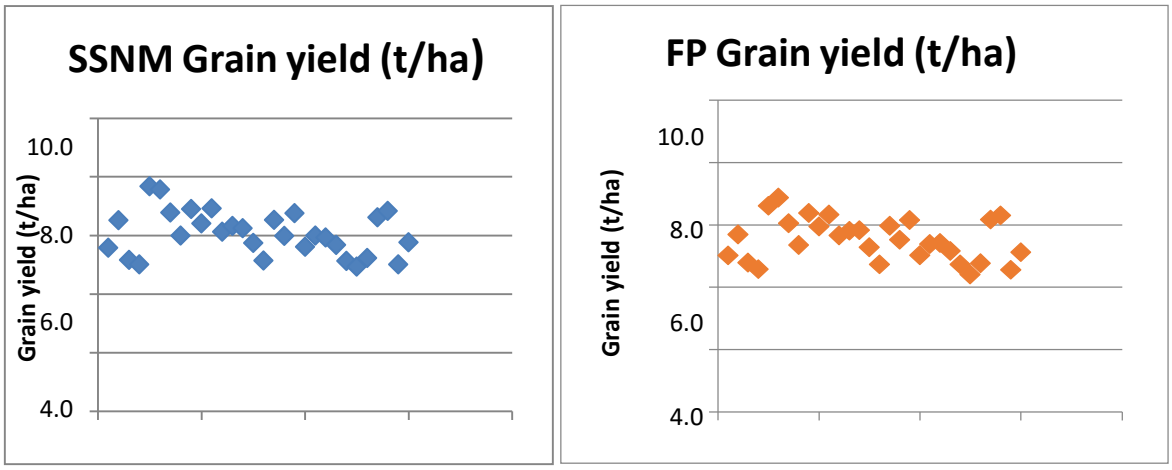


Figure 80: Response of NK6240 for the nutrient management in Tumkur

Table 30: Mean yield of (30 farmers) NK6240 under site-specific nutrient management practices

Treatment		Seed rate (Kg/ha)	N (Kg/ha)	P (Kg/ha)	K (Kg/ha)	Straw yield (t/ha)	Biological Yield (t/ha)	Gross return (INR/ha)
SSNM	Mean	10	140	65.14	70	7.18	4.60	83755.31
	SEm±	0	0	0.14	0	0.15	0	1792.12
FP	Mean	10	131.33	50	-	6.54	4.60	76087.38
	SE m±	0	0.84	0	-	0.14	0	1580.66

Note: Mean of 30 farmers

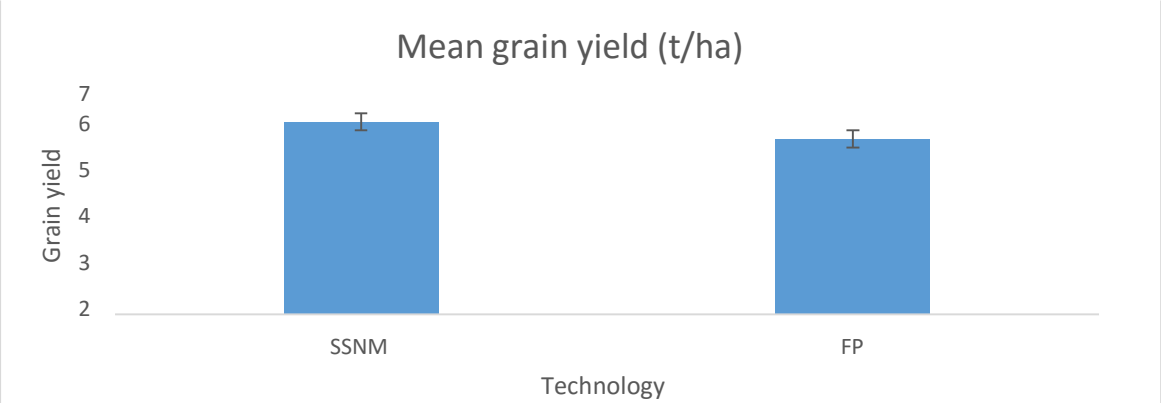


Figure 81: Response of NK6240 to the site specific nutrient management and farmer's practice

Aerobic composting using Madhyam culture

Madhyam culture is a consoltium of micro organisms specifically developed for accelerated aerobic composting of organic waste. It contains cultures of Bacteria & fungi along with enzymes, which facilitate bio conversion of organic waste into a bio stabilized compost speedily. It is free from any toxic or hazardous material. Soil results showed that organic carbon is below 0.5% in most of the fields. We promoted aerobic composting by providing training and live-demonstration in selected pilot villages (Figure 82).

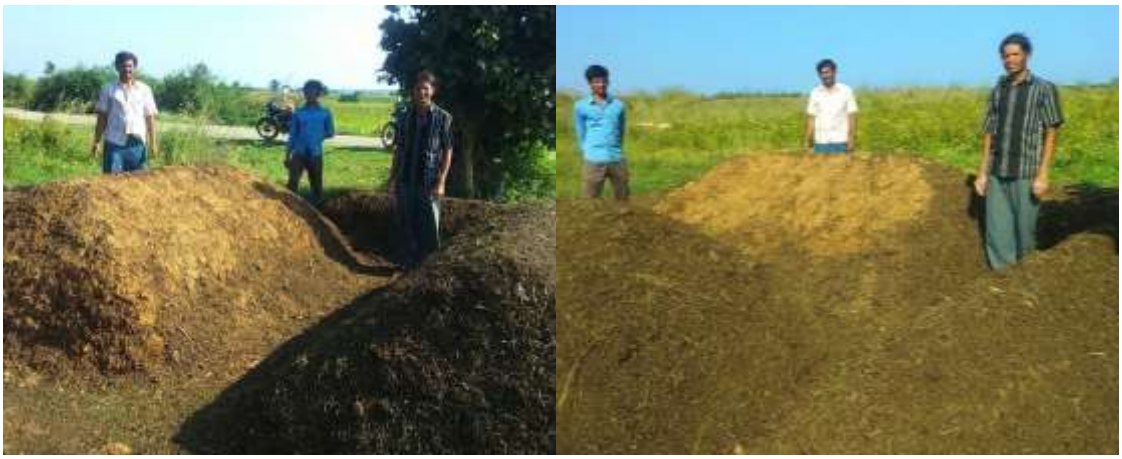


Figure 82. Aerobic composting promoted in pilot villages to enhance organic matter (Tiptur taluk).

Crop intensification and Diversification

Promoting improved crop varieties through farmers participatory field trials (ICRISAT)

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 cultivates are identified and is planned for scaling up in Bhoo-Sumriddi village (Figure 83). Nearly 5500 Kg of improved variety seeds of different crops (Pigeonpea, groundnut, castor, pearl millet, fodder variety) were supplied in district. Table 31A-Table 31E shows the details of seed supplied in selected five taluks.

Table 31A. Improved seeds supplied for varietal promotion at Tumkur taluk during *Khraif* 2015											
SN No	Seeds	Variety	Duration days	Spacing cm	Seed Rate (Kg/ac)	Quantity kg	Cost Rs/Kg	Total cost Rs	Distribution Details (Kg)		Total
									Bellavi	Kora	
1	Castor	DCH 177	90-100	150X30	2	30	250	7500	0	30	30
2	Castor	DCH 519	105-110	150X31	2	50	250	12500	50	0	50
3	Castor	48-1 (Jwala)	100	75X30	2	10	250	2500	10	0	10
4	Pearl millet	ICTP8203 Dhanshakti	75-80	45X 10	2	24	50	1200	10	14	24
5	Sorghum Fodder variety	CSH24 MF	Multiple cut	40X 10	5	15	100	1500	15	0	15
6	Pigeonpea	ICPH2740	170-180	150X30	sole 5 inter crop 2kg	10	250	2500	10	0	10
7	Pigeonpea	ICPL85063 (Laxmi)	150-160	150X30	sole 5 inter crop 2kg	14	150	2100	0	16	16
8	Pigeonpea	ICPL7035	200-210	150X30	sole 5 inter crop 2kg	10	250	2500			0
9	Compost	Madyam culture				10	90	900	5	5	10
10	Glyricidia	Green manure	Perinial	0.5m	8000 seedlings per kg	2	600	1200	1	1	2
						175		34400	101	66	167

Table 31B. Improved seeds supplied for varietal promotion at Tiptur taluk during *Khraif* 2015												
SN	Seeds	Varities	Duration	Spacing (cm)	Seed rate (kg/ac)	Quantity (Kg)	Cost (Rs/kg)	Total cost (Rs)	Seed distributed (kg)			Total Seed (kg)
									Biligere	Kasaba	Honnavalli	
1	Castor	DCH 177	90-100	150X30	2	30	250	7500	10	10	10	30
2	Castor	DCH 519	105-110	150X31	2	50	250	12500	16	16	18	50
3	Castor	48-1 (Jwala)	100	75X30	2	10	250	2500	2	4	4	10
4	Pearl millet	ICTP8203 Dhanshakti	75-80	45X 10	2	24	50	1200	8	8	8	24

5	Sorghum Fodder variety	CSH24 MF	Multiple cut	40X 10	5	10	100	1000	0	5	5	10
6	Pigeonpea	ICPH2740	170-180	150X30	sole 5 inter crop 2kg	10	250	2500	4	2	4	10
7	Pigeonpea	ICPL85063 (Laxmi)	150-160	150X30	sole 5 inter crop 2kg	16	150	2400	4	8	4	16
8	Pigeonpea	ICPL7035	200-210	150X30	sole 5 inter crop 2kg	10	250	2500	*4*	*2*	*4*	10
9	Compost	Madyam culture				10	90	900	3	3	4	10
10	Glyricidia	Green manure	Perinial	0.5m	8000 seedlings per kg	2	600	1200	1	0.5	0.5	2
						172		34200	52	59	62	172

Table 31C. Improved seeds supplied for varietal promotion at Madhugiri taluk during *Khraif* 2015

SN	Seeds	Varities	Duration	Spacing (cm)	Seed rate (kg/ac)	Quantity (Kg)	Cost (Rs/kg)	Total cost (Rs)	Seed distributed (kg)		Total Seed (kg)
									Puravara	Kodigenahalli	
1	Groundnut	ICGV91114	95-100	30 X10	60	1000	150	150000	600	400	###
2	Groundnut	ICGV0350	110-115	31 X10	60	150	150	22500	100	50	150
3	Groundnut	ICGV0351	110-120	30 X10	60	50	150	7500	0	50	50
4	Groundnut	ICGV2266	110-120	30 X10	60	50	150	7500	50	0	50
5	Sorghum	CSV17	85-90	30 X10	3	12	100	1200	0	12	12
6	Sorghum	CSV27	100	45 X 15	3	15	100	1500	0	15	15
7	Sorghum	CSV-23	100	45X15	3	15	100	1500	0	15	15
8	Sorghum	PVK801	100	45X15	3	30	100	3000	30		30
9	Pigeonpea	ICPH2740	170-180	150X30	sole 5 inter crop 2kg	10	250	2500	4	6	10
10	Pigeonpea	ICPL85063 (Laxmi)	150-160	150X30	sole 5 inter crop 2kg	16	150	2400	8	8	16
11	Pigeonpea	ICPL7035	200-210	150X30	sole 5 inter	10	250	2500	6	4	10

					crop 2kg						
12	Pigeonpea	ICPL161	135-140	60X30	sole 5 inter crop 2kg	10	150	1500	4	6	10
13	Castor	DCH177	90-100	150X30	2	30	250	7500	20	10	30
14	Castor	DCH519	105-110	150X31	2	50	250	12500	20	30	50
15	Castor	48-1 (Jwala)	100	75X30	2	10	250	2500	0	10	10
16	Compost	Madyam culture				10	90	900	5	5	10
17	Glyricidia	Green manure	Perinial	0.5m	8000 seedlings per kg	2	600	1200	0	2	2
						1470		228200	847	623	1470

Table 31D. Improved seeds supplied for varietal promotion at Pavaguda taluk during *Khraif* 2015

SN	Seeds	Varities	Duration	Spacing (cm)	Seed rate (kg/ac)	Quantity (Kg)	Cost (Rs/kg)	Total cost (Rs)	Seed distributed in Y.N.Hoskote
1	Groundnut	ICGV91114	95-100	30 X10	60	1550	150	232500	1550
2	Groundnut	ICGV0350	110-115	31 X10	60	450	150	67500	450
3	Groundnut	ICGV0351	110-120	30 X10	60	100	150	15000	100
4	Groundnut	ICGV2266	110-120	30 X10	60	100	150	15000	100
5	Groundnut	K-9	110-120	30 X 10	60	400	150	60000	400
6	Sorghum	CSV17	85-90	30 X10	3	12	100	1200	12
7	Sorghum	CSV27	100	45 X 15	3	15	100	1500	15
8	Sorghum	CSV-23	100	45X15	3	15	100	1500	15
9	Sorghum	PVK801	100	45X15	3	30	100	3000	30
10	Pigeonpea	ICPH2740	170-180	150X30	sole 5 inter crop 2kg	10	250	2500	10
11	Pigeonpea	ICPL85063 (Laxmi)	150-160	150X30	sole 5 inter crop 2kg	16	150	2400	16
12	Pigeonpea	ICPL7035	200-210	150X30	sole 5 inter crop 2kg	10	250	2500	10
13	Pigeonpea	ICPL161	135-140	60X30	sole 5 inter crop 2kg	10	150	1500	10
14	Castor	DCH177	90-100	150X30	2	30	250	7500	30
15	Castor	DCH519	105-110	150X31	2	50	250	12500	50

16	Castor	48-1 (Jwala)	100	75X30	2	10	250	2500	10
17	Compost	Madyam culture				10	90	900	10
18	Glyricidia	Green manure	Perinial	0.5m	8000 seedlings per kg	2	600	1200	2
						2820		430700	2820

Table 31E. Improved seeds supplied for varietal promotion at Sira taluk during *Khraif* 2015

SN	Seeds	Varities	Duration	Spacing (cm)	Seed rate (kg/ac)	Quantity (Kg)	Cost (Rs/kg)	Total cost (Rs)
1	Groundnut	ICGV91114	95-100	30 X10	60	300	75	22500
2	Groundnut	ICGV0350	110-115	30 X10	60	150	75	11250
3	Groundnut	TAG37A	100-110	30 X 0	60	150	75	11250
3	Sorghum	PVK801	100	45X15	3	30	100	3000
4	Sorghum Fodder variety	CSH24 MF	Multiple cut	40X 10	5	20	100	1500
5	Pearl millet	ICMH1201Fe	70-75	45 X 10	2	40	50	2000
6	Pearl millet	ICTP8203Fe	70-75	45 X 10	2	30	50	1500
7	Castor	GCH-4	105-110	150X30	2	12	250	3000
8	Glyricidia	Green manure	Perennial	0.5m	8000 seedlings per kg	3	600	1800
9	Tropicultor Tractor drawn	Complete set with seed and fertilizer unit				500	85000	85000
						1235		1,42,800

Figure 83. Farmers' participatory field trials conducted in one of the BhooSumruddi pilot village (Hiregundegal village, Tumkur taluk) demonstrating improved seed variety and crop management interventions.

Enhancing land and water use efficiency through fallow management

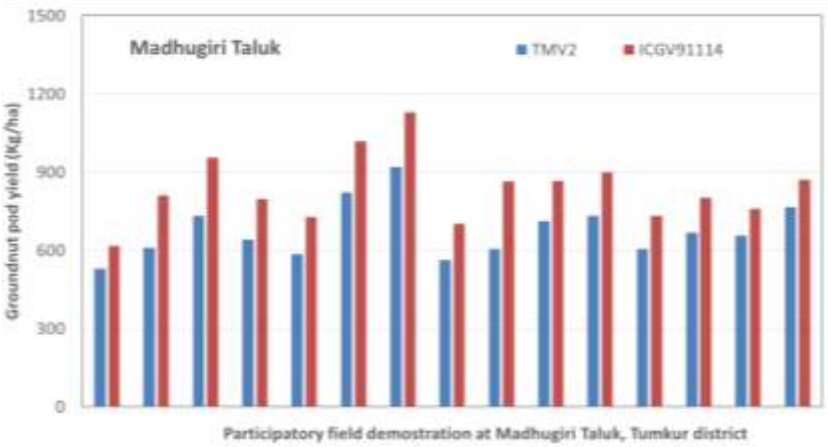
Mung bean is a major pulse crop in Karnataka. It occupies an area of 293 thousand ha with a total production of 73 thousand tonnes with an average productivity of 239 Kg ha^{-1}. The production and productivity of mung bean is reported to be low in Karnataka due to non-availability of suitable mung bean varieties. Present program is taken up to promote high yielding, early maturing, and disease resistant mung bean varieties along with matching production technologies, production of quality seed during pre-*Khraif* season to enhance land and water use efficiency.

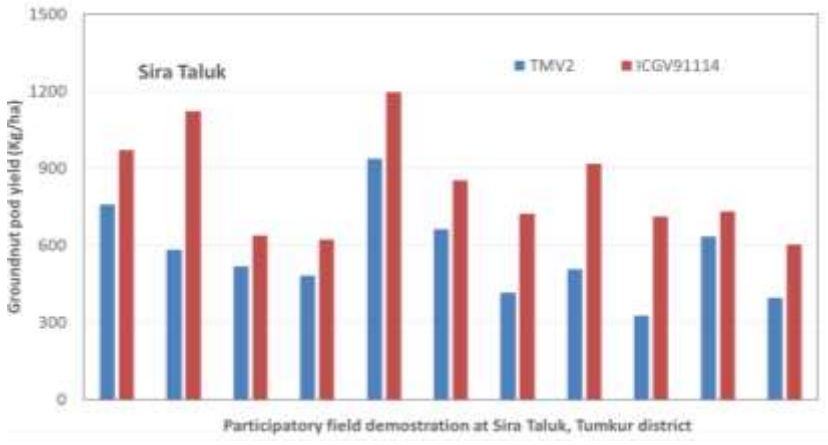
Table 32. Mung bean seed yield and net income obtained from farmers participatory field trials during pre-*khraif* 2015.

Farmer name	Mung bean (variety)	Area sown (m2)	Yield (kg)	Net income (from sown area)	Yield (kg/ha)	Net Income (INR/ha)
Karikere village, Tiptur taluk						
Marulasidda swamy S/o Shanthaiah	Pusa Vishal	2000	85	5650	425	28250
K.S.Ramesh S/o Shiva ramaiah	Pusa Vishal	2000	72	4480	360	22400
Lakshmamma W/o Siddappa	Pusa Vishal	2000	69	4210	345	21050
Shadaksharaiah S/o Rudraiah	Pusa Vishal	2000	83	5470	415	27350
Kumara swamy S/o Siddappa	Pusa Vishal	2000	74	4660	370	23300
Chikkaramaiah S/o Rame gowda	Pusa Vishal	2000	65	3850	325	19250
Ramanna S/o Rame gowda	Pusa Vishal	2000	38	1420	190	7100
K.G.Neelakantaiah S/o Gubbiyappa	Pusa Vishal	2000	63	3670	315	18350
K.C.Siddamari S/o Chikka veeraiah	Pusa Vishal	2000	82	5380	410	26900
Channaiah S/o Shivaiah	LGG 460	4000	168	11120	420	27800
Palakshamurthy S/o SadaShivaiah	KKM 2	4000	143	8870	357	22130
chanamma w/O chikkanna	Pusa Vishal	4000	162	10580	405	26450
Hiregundagal village, Tumkur taluk						
krishnaiah s/o Hanumanthaiah	Pusa Vishal		183	12470	457	31130
puttaiah s/o Hanumanthaiah	Pusa Vishal	4000	148	9320	370	23300
Baalaiah s/o Bheemaiah	Pusa Vishal	4000	167	11030	417	27530
Baalaiah s / o Baalaiah	Pusa Vishal	2000	71	4390	355	21950
Raamaiah s/o Raamaiah	Pusa Vishal	2000	82	5380	410	26900
					353	21770

Table 32 showed crop cutting experiment results from pilot villages of Tiptur and Tumkur taluks. Improved variety mung-bean seeds were made available to 20 farmers covering total 10 acre land during pre-*khraif* season. Tumkur receives pre-*Khraif* rainfall which could be utilized effectively by introducing short duration (60-70 days) pulse such as mung-bean (Figure 84). Farmers benefited by harvesting mung-bean seeds in range between 190 kg and 460 kg/ha with average of 350 kg/ha resulted into additional income of Rs 21,770/ha before monsoon itself. It also addresses the nutritional security of the individual household.

Figure 84. Introduced mung-bean as pre-khraif crop at Hiregundegal village, Tumkur taluk.





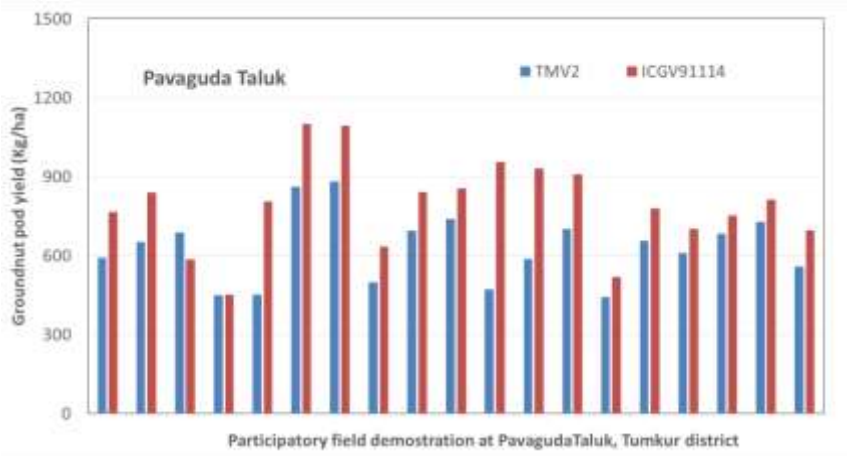


Figure 85: Comparison of improved groundnut cultivar (ICGV91114) with traditionally grown cultivar (TMV2) in different farmers' field of Madhugiri, Sira and Pavaguda taluks of Tumkur district

Farmers' participatory field trials were conducted in different taluks of Tumkur district. 10-20 number of farmers from each of the groundnut predominating taluks (Madhugiri, Sira and Pavaguda) were selected for undertaking farmers' participatory field trials. High yielding groundnut cultivar (ICGV91114) was sown in one part of the field and traditionally grown cultivar (TMV2) in another half for comparison purpose. Crop cutting experiments were conducted and results are presented in Figure xx. Results showed that groundnut pod yield of ICGV91114 was found 30% higher than TMV2 on an average. Groundnut pod yield of ICGV91114 was found 837 kg/ha compared to 677 kg/ha in TMV2 at Madhugiri taluk showed 160 kg net difference. Similarly the yield difference obtained at Sira and Pavaguda was 260 and 160 kg/ha, respectively (Figure 85). Maximum pod yield of ICGV91114 was recorded as 1136 kg/ha compared to 936 kg/ha of TMV2 at Sira Taluk.

Feed and Fodder Management

Promoted dual purpose maize and multi-cut sorghum (ILRI, ICRISAT)

The purpose of this intervention was to promote food security and also generate good quality fodder through promoting dual purpose maize cultivars that provide both food and feed. It was investigated the potential of dual-purpose maize in enhancing the livelihoods of resource poor crop- livestock farmers of Tumkur. Nearly 200 kg of dual purpose maize seed and 100 kg multi-cut sorghum was provided to 30 farmers in Bhoosumrudhi pilot villages (Figure 86).

Introduction of multipurpose thorn-less cactus (Opuntia spp.) for enrichment of animal fodder

Cactus *(Opuntia ficus-indica)*, commonly known as prickly pear, belongs to the family Cactaceae. It is suited to water-scarce dry zone of the world as an alternate source of food and fodder. Different parts of the cactus can be used as fruit and vegetable for human consumption, fodder for cattle, and raw material for various industries to prepare plywood, soap, dyes, adhesives and glue, pharmaceutical products for treating blood sugar and various other disorders, and cosmetics such as shampoo, cream, and body lotion, etc. The present program is undertaken to introduce the thorn-less cactus through improved

germplasm, frontline demonstration, and value addition of the spp. in establishment of cacti species in degraded and wastelands of Tumkur district (Table 33; Figure 87).

Figure 86. Multi-cut sorghum and dual purpose maize (NK-6240) promoted in Tiptur taluk.

Figure 87. Cladades/pads planted in BhooSumrudhi pilot village.

Table 33. Details showing number of cladades/pads planted in BhooSumruddi pilot villages			
Village name	Farmer name	Varieties given	No. of cladodes/ pads planted
Bellavi	Chandrappa S/o Lakkanna	Cactus-1270	50
Bellavi	Narasimha murthy S/o Bhagavanthaiah	Cactus-1271	75
Dodderi	Rajanna S/o Raamaiah	Cactus-1280	80
Devarajanahalli	Ranganathappa S/o Thimmappaiah	Cactus-1270	40
Haralakatte	EERanna S/o Mallaraiah	Cactus-1271	60
Haralakatte	Kumaramma S/o Chikkanna	Cactus-1280	50
Haralakatte	Lingappa S/o Chikkamallaiah	Cactus-1270	75
Haralakatte	Thimappa S/o Moodalagiriyappa	Cactus-1271	80
Haralakatte	Bhagyamma S/o Umapathi	Cactus-1280	50
Haralakatte	Narayanappa S/o Rangappa	Cactus-1270	60
Bellavi	Ramesh S/oDevarumar	Cactus-1271	80
Ayarahalli	Basavaraju S/o Shivanna	Cactus-1280	120
Ayarahalli	Kumaraiah S/o Shivanna	Cactus-1270	100
Byrapura	B.R. Ashok Kumar S/o Rangappa	Cactus-1271	60
Rudrapura	R.C.Mallikarjuna S/o Channappa	Cactus-1280	120
Rudrapura	Basavaraju S/o Siddappa	Cactus-1270	60
Rudrapura	Channabasappa S/o Virbhadrappa	Cactus-1271	60
Rudrapura	Siddamallappa S/o Ganganna	Cactus-1280	110
Rudrapura	Paramesh S/o Siddamallappa	Cactus-1271	90
Rattenahalli	Prasanna Kumar S/o Basappa	Cactus-1280	80

Promoting vegetable production technologies

Grafted Chilli with improved management practices including mulching

It is generally known that roses, and also fruit such as apples and plums, are usually grafted. In recent years this technique has been applied to vegetables with great success. We have promoted grafted technology in BhooSumrudhi villages on chilli and also tomato. Total five farmers were chosen for technology demonstration in Tumkur (Figure 88).

Grafted tomato with improved management technique including staking

Grafted tomato with improved management was promoted in Hiregundgal village with IPM practices to control Leaf minor. Total 10 farmers from Tumkur and Pavaguda was chosen for technology demonstration (Figure 89; Table 34).

- Grafted seedlings are found tolerance against bacterial wilt / blight and nematodes.
- Grafted tomato Success rate / survival rate is 98 % in field after transplanting
- No incident of bacterial wilt
- Expecting 30-50% increased yield (70 ton/ha in Grafted tomato compared to 35 ton/ha in non grafted tomato)

Figure 88. Grafted Chilli with improved management practices including mulching.

Table 34. Beneficiaries list of Hiregundagal village cultivated grafted tomato (1000 seedlings each farmer).			
Farmer	Survey Number	Village	Hobli
Dayanandsagar; s/o Murugappa	123/4A	Hiregundagal	Kora
Krishnaiah s/o Hanumanthaih	6/8	Hiregundagal	Kora
Puttaiah	41	Hiregundagal	Kora
Ramachandraiah; s/o lakshmaiah	63/4	Hiregundagal	Kora
H.N.govindaiah; s/o narasimhayya	1/1	Hiregundagal	Kora

Figure 89. Grafted tomato with improved management technique including staking.

Integrated Pest management technique

Insect pests and diseases are among the major constraints to enhancing production and productivity of vegetable crops. In recent years, farmer incomes have been declining particularly due to the rising costs of inputs for plant protection. In the past five decades the use of chemical pesticides steadily increased from 2.2 g/ha of active ingredient (a.i.) in 1950 to the current level of 650 g/ha (which is a 300 fold increase). Plant protection in the present day is mainly oriented towards chemical control. Pheromone traps (using yellow sticky and water traps) installed in tomato fields to address tomato leaf miner challenge. Technology is demonstrated with 10 farmers' field (5 in pavaguda and 5 in Tumkur taluk, Figure 90; Table 35).

Table 35. Beneficiaries list where IPM technique demonstrated in Pavaguda taluk.

Farmers name	Village	Hobli	Taluk
Anjana Reddy S/o Hanumanthappa	Ponnasamudra	YN Hoskote	Pavagada
Ramalingappa S/o Bommaiah	Yarrammanahally	YN Hoskote	Pavagada
Thimmareddy So Sathyanarayana Reddy	Yarrammanahally	YN Hoskote	Pavagada
Doddanna S/o Bommaiah	Yarrammanahally	YN Hoskote	Pavagada
Chandrashekara Reddy S/o kondareddy	Yetthinahally	YN Hoskote	Pavagada

Figure 90. IPM technology promoted in grafted tomato at Tumkur and Pavaguda taluk.

Yield analysis of vegetable crops

In Tumkuru, demonstrations were conducted on tomato in open field conditions (Fig 91). The IPM practices in tomato resulted in 28 per cent increase in yield (45.1 t/ha) as compared to farmers practice of cultivation (35.1 t/ha). The grafted tomato seedlings demonstrated resulted in increased yield by 22 per cent (51.1 t/ha) over farmers practice (41.75 t/ha).

Table 5: Vegetables productivity with different management practices in Tumkuru

Crop	Interventions	Situation	Yield t/ha		% increase in yield
			IP	FP	
Tomato	IPM (open field)	Open field	45.1	35.1	28
Tomato	Grafted (shadenet)	Shadenet	51.1	41.75	22
Mungbean	Vegetable type (fallow)	Open field	0.58	Kh fallow	-
Cowpea	Vegetable type (fallow)	Open field	1.49	Kh fallow	-

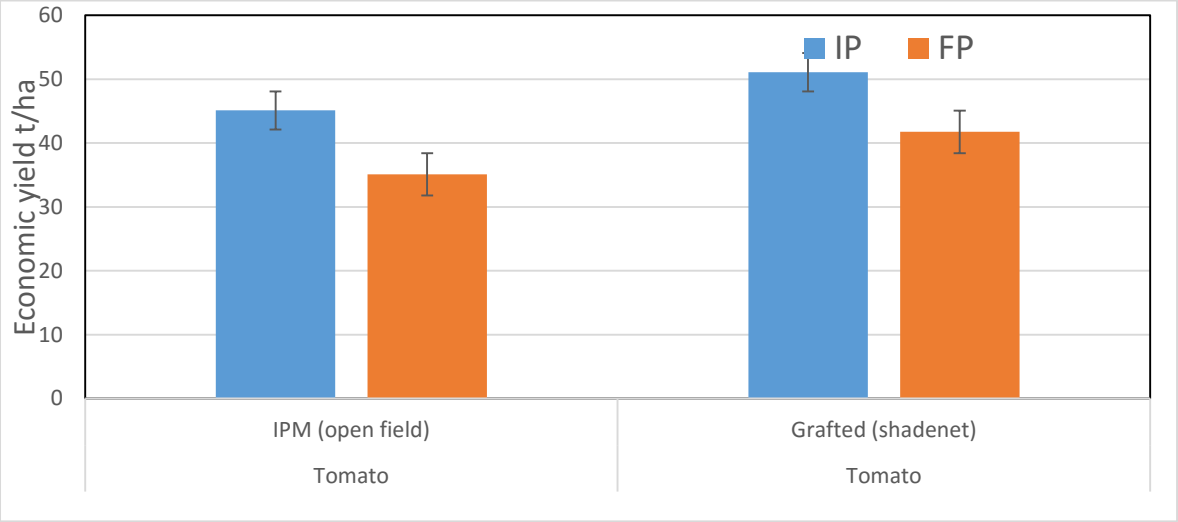


Fig. 91. Vegetable crops productivity with differnt management practices

As regards to fallows management during rabi, the vegetable mungbean grown in fallows recorded 0.58 t/ha yield whereas vegetable cowpea recorded 1.49 t/ha green pod yield (Fig 92). Thus the farmers under study have obtained additional RS 8000 to 12000 net income with this interventions.

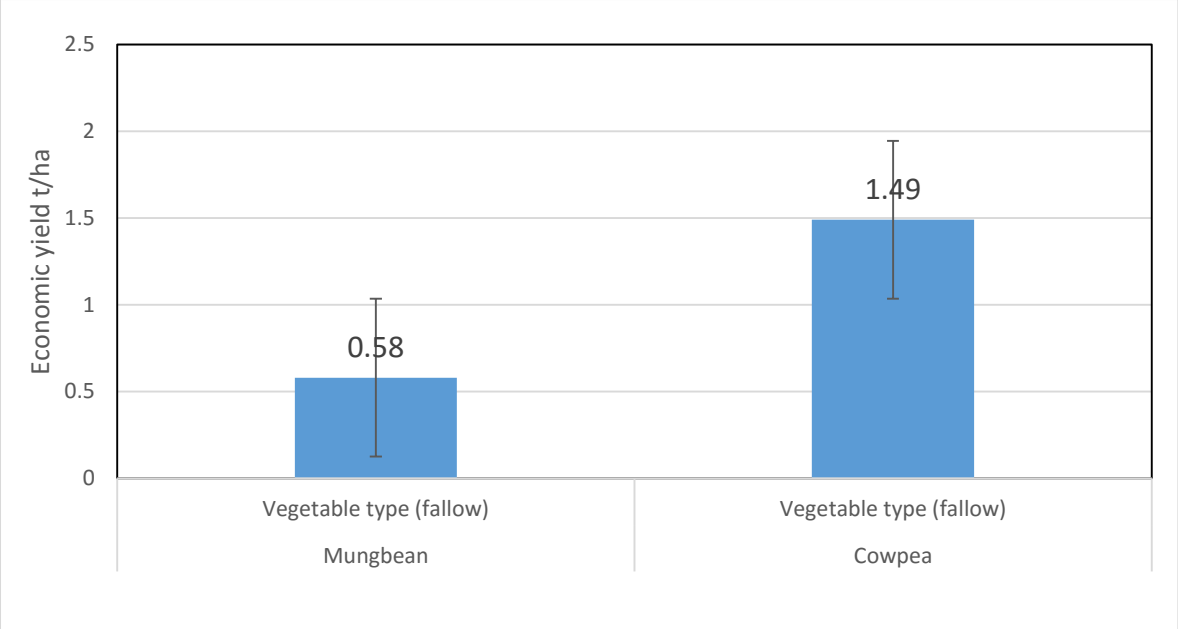


Fig. 92 Vegetable crops productivity with differnt management practices

Decentralized Wastewater Management

Identified wastewater treatment site: Gondihalli village Madhugiri taluk

BhooSamrudhi team has proposed safe reuse of domestic wastewater in agriculture in pilot villages. The main objective this activity is to improve water productivity by reuse of domestic wastewater through establishing low cost decentralized wastewater treatment (DWT) plant at village level. The rationale behind developing DWT is water scarcity, direct use of wastewater in agriculture is not good for farmers and consumers, disposal of untreated wastewater pollutes environment, and all localities do not have sewage treatment plants. Safe reuse of wastewater as a part of Integrated Water Resources Management is not only helpful in enhancing crop production and income of small holder farmers but also in improving water quality of groundwater wells and downstream water bodies. Suitable Sites were identified for constructing wastewater treatment system in selected pilot villages (Figure 93). Parameters measured from wastewater sample collected at Gondihalli village, Madhugiri taluk, Tumkur is shown in Table 36.

Figure 93. Site identified for constructing wastewater treatment system in Gondihalli village, Madhugiri taluk, Tumkur.

Criteria for site identification

- Good drainage network to allow wastewater to get collected at a common sumps
- Connectivity between household wastewater and the wastewater drain
- Land availability: Constructed Wetlands as well as the treated water tank

Potential benefit

- Treatment capacity: 20,000 L/day
- Additional area under irrigation: 4 Ha in *Khraif*; 2 Ha in *Rabi*/Summar

Table 36. Parameters measured from domestic wastewater at Gondihalli village, Madhugiri taluk, Tumkur.

Parameters	Units	Concentrations
Alkalinity (Total)	mg/L as $CaCO_3$	360
Boron	mg/L	2.3
Calcium	mg/L	13.4
Chemical Oxygen Demand	mg/L	480
Chloride	mg/L	86.3
Electrical Conductivity	ms/cm	1.925
Fluorides	mg/L	2.192
Hardness (Total)	mg/L as $CaCO_3$	680
Magnesium	mg/L	3.72
Nitrogen-Ammoniacal	mg/L	52.932
Nitrogen-Nitrate	mg/L	7.404
pH at 25° C	-	7.51
Phosphates	mg/L	2.31

Potassium	mg/L	8.25
Sodium	mg/L	67.5
Sulfates	mg/L	78.1
Total Suspended Solids	mg/L	34
Total Dissolved Solids	mg/L	1155

Innovative Extension System

For the effective dissemination of good management practices a farmer to farmer (F2F) dissemination route will be explored through a farmer-centric video documentation. Digital Green has initiated the participatory video and mediated instruction for agricultural extension. The advantage of F2F system is the fact that farmers trust fellow farmers to adopt improved management practices. Farmers can easily understand these farming practices as they explain in their languages. This system has two processes video production and video screening.

The director, camera person, and editor for these video are ICRISAT's ground staff. Digital Green Has trained the ICRISAT's staff for video production process (Figure 94). All together 14 videos were produced for technology for farmer to farmer dissemination (Table 37).

Table 37. Short video produced for farmer to farmer dissemination.

SN	Video produced
1	Banana Bunch
2	Seed treatment in pigeon-pea
3	Benefits of RSK
4	Bhoochetana
5	Banana Special spray
6	Fertigation in coconut
7	IDM in coconut
8	Seed treatment with tricoderma
9	Planting method in coconut
10	Seed treatment in Sorghum
11	Sirohi Buck
12	Nari Suvarna
13	Seed treatment in groudnut
14	Improved groundnut variety ICGV91114

Figure 94. Video production training to ICRISAT field staff based at Karnataka

Vijayapura

The Bhoosamrudhi project in Vijayapura district covers in all the 5 taluka with a geographical area of 48995 ha with cultivable area of 46760 ha in 16 villages. The details of area are shown in Table 38 and 39.

Table 38. Basic information (villages and area in ha) of Bhoo Samvruddhi villages.

Sl No	Taluk	Hobli	Gram Panchayat	Villages	Geographical area (ha)	Cultivable area (ha)	Non agri area (ha)
1	B.Bagewadi	kolhar	Beeraladinni	Beeraladinni	534	488	46
			Beeraladinni	Angadageri	1284	1188	96
			Beeraladinni	Hunsyal PC	1192	1133	60
		Total			3010	2808	202
2	Indi	Chadchan	Hattalli	Havinal	3983	3704	279
			Chadchan	Chadchan	3846	3582	264
			Devar Nimbaragi	Devar Nimbaragi	2902	2653	249
				Jeeraankalagi	1937	1842	96
			Baradol	Baradol	4571	4454	117
			Jigajivanagi	Jigajivanagi	5902	5692	210
			Inchageri	Inchageri	3290	3268	22
		Total			26431	25194	1237
3	Bijapur	Babaleshwar	Kumate	Kumate	1888	1809	79
			Nidoni	Nidoni	6234	5958	276
			Sarwad	Sarwad	5770	5519	251
		Total			13892	13286	606
4	Sindagi	D.Hipparagi	Mulsavalgi	Mulsavalgi	4320	4169	151
			Mulsavalgi	Nivalkhed	784	759	25
		Total			5104	4928	176
5	Muddebihal	Dhavalagi	Dhavalagi	Agasbal	558	543	14
		District Total			48995	46760	2235

Table 39. Basic information (villages and area in ha) of Bhoo Samvruddhi villages.

Sl No	Taluk	Hobli	GP	Name of Villages	No. of farmers						
					SF	MF	Other	Total	SC	ST	Women
1	B.Bagewadi	kolhar	Beeraladinni	Beeraladinni	100	81	13	194	13	0	2
			Beeraladinni	Angadageri	144	64	185	393	85	49	25
			Beeraladinni	Hunsyal PC	198	110	91	399	47	0	1
		Total- 3			442	255	289	986	145	49	28
2	Indi	Chadchan	Hattalli	Havinal	250	275	72	597	75	0	18
			Chadchan	Chadchan	408	223	60	691	36	0	12
			Devar Nimbaragi	Devar Nimbaragi	502	250	258	1010	220	2	193
				Jeeraan kalagi	302	152	276	730	52	0	45

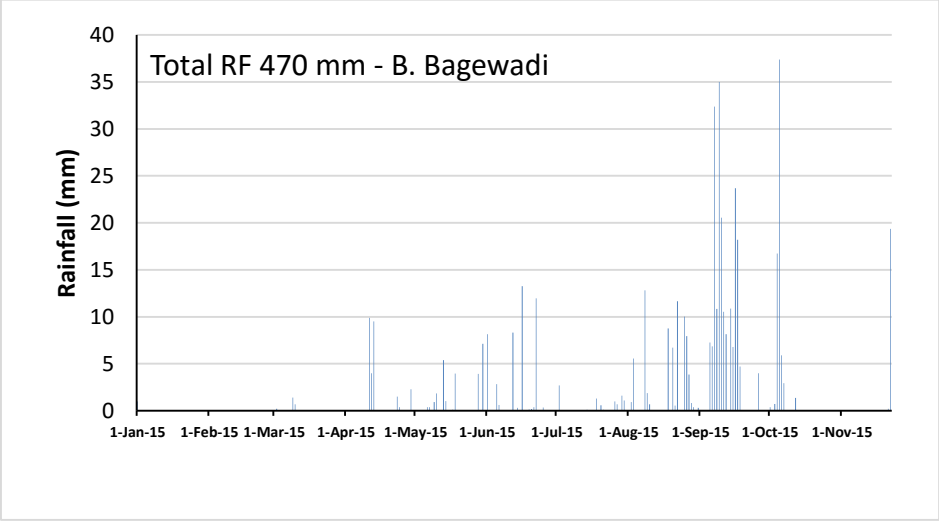
			Baradol	Baradol	415	128	207	750	77	0	32
			Jigajivanagi	Jigajivanagi	818	373	829	2020	358	0	35
			Inchageri	Inchageri	472	271	171	914	312	0	32
		Total-7			3167	1672	1873	6712	1130	2	367
3	Bijapur	Babalesh-war	Kumate	Kumate	200	120	380	700	25	0	20
			Nidoni	Nidoni	410	280	550	1240	30	0	35
			Sarwad	Sarwad	1047	200	449	1696	31	4	224
		Total-3			1657	600	1379	3636	86	4	279
4	Sindagi	D.Hipparagi	Mulsavalgi	Mulsavalgi	568	144	712	1424	150	0	70
			Mulsavalgi	Nivalkhed	150	31	125	306	15	0	10
		Total-2			718	175	837	1730	165	0	80
5	Muddebihal	Dhavalagi	Dhavalagi	Agasbal	65	42	93	200	23		28
		District Total-16			6049	2744	4471	13264	1549	55	782

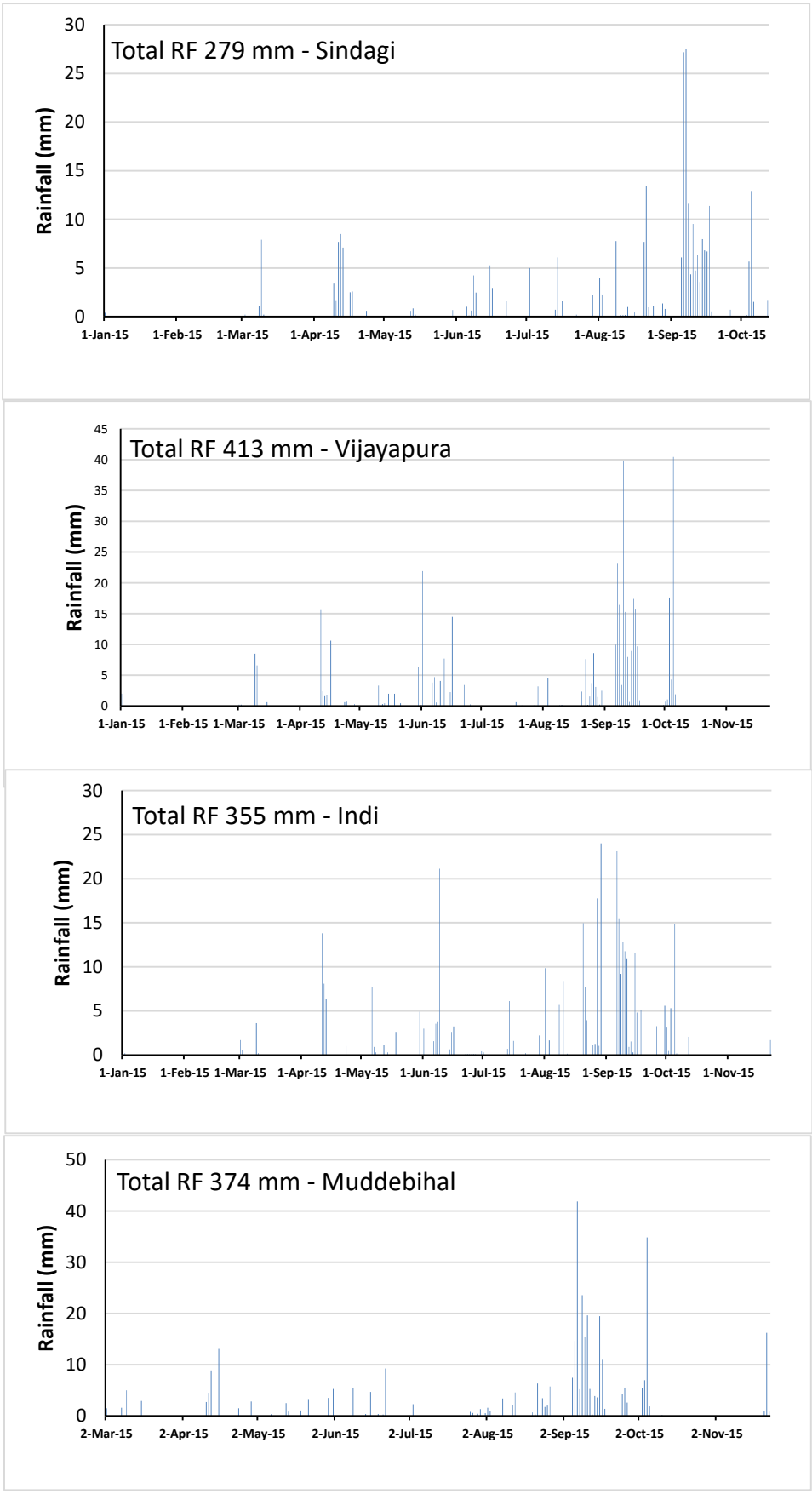
Rainfall

During 2015, against normal rainfall of the district 615 mm, five taluks received deficit rainfall of 24 - 54 % (Figure 95A and Table 40). Decadal water balance during SW Monsoon (Jun-Sep) 2015 of Vijayapur is shown in Figure 80B.

Table 40. Rainfall received in five taluks of Vijayapura during 2015.

Taluk	Rainfall received up to Nov 2015	% Deficit
Vijayapura	413	-33
Basavana Bagewadi	470	-24
Sindagi	279	-54
Indi	355	-42
Muddebihal	374	-39





95A. Rainfall in five taluks of Vijayapura district up to Nov 2015.

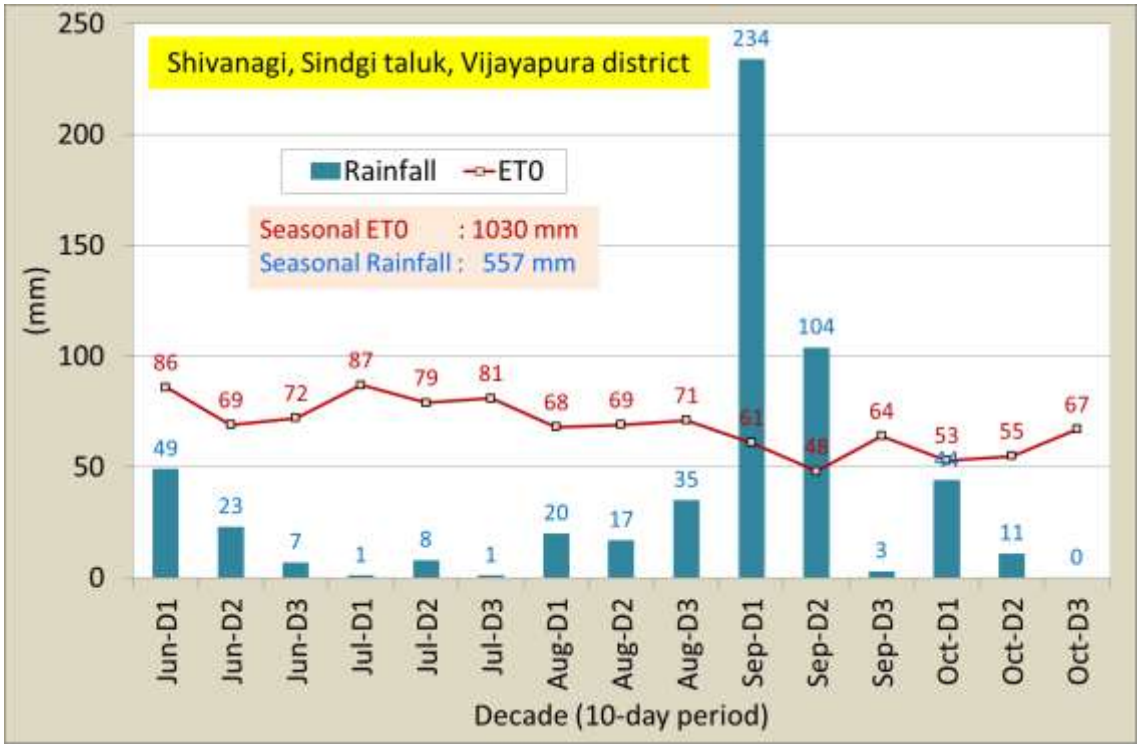


Figure 95B. Decadal water balance during SW Monsoon (Jun-Sep) 2015.

Technologies implemented

During 2015-16, various activities/ technologies demonstrated in Bhoosamrudhi project in Vijayapura are improved land and water management for in-situ moisture conservation, integrated balanced nutrient management and productivity enhancement initiatives and capacity building programs.

Land and Water Management

Broadbed and furrow land management:

Broadbed and furrow system (BBF) of land management system to enhance the green water storage and use efficiency was adopted in an area of 125 ha in 3 villages (Inchageri, Angadageri and Beeraldinni) during late *khraif* and *rabi* with pigeonpea, sorghum, chickpea and safflower in Vijayapura district (Figure 96 and Table 41). 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 crops during *khraif* were badly affected due to long dry spell during June and July months. The crops are yet to be harvested. A BBF maker cum seed drill was constructed through a private workshop in Dharwad, which will be procured now to use during 2016 *khraif* season.

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:

- 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
- Improve crop yields

Figure 96. JDA along with his staff visiting Broadbed and furrow system of land form in Angadager (left) and Berraladinni (right).

Table 41. Broadbed and furrow system of land form with improved management in Bhoosamrudhi project in Vijayapura during 2015-16.

Village	Area Covered (ha)	No. of Beneficiary
Beeraldinni	17	12
Angadageri	65	45
Inchageri	43	30
Total	125	87

Table 42. Crop yield Report of BBF landform under Bhoosamruddhi Programme in Vijayapur, 2015

Crop	Variety	Grain yield in (Q/ha)		% increase in BBF landform over flat cultivation
		BBF landform	Flat landform	
Sorghum	M-35-1	7.65	6.43	19
Safflower	PBNS-12	11.39	9.21	24

Table 43. Crop yields in local and improved cultivars under Bhoosamruddhi Program in Vijayapur, 2015

Crop	Grain yield in (Q/ha)		% increase in improved cultivar over local cultivar
	Local	Improved	
Pearl millet	18.22 (Hi-Tech 500)	19.5 (Dhanashakati)	7
Pigeon pea	8.43 (Red- Gulyal)	9.31 (ICPL-88039)	11
Chickpea	6.99 (JG-130)	7.42 (JAKI -9218)	6

Table 44. Yield Report of Aquasap demonstrations under Bhoosamruddhi Programme in Vijayapur

Crop	Variety	Crop yield (Q/ha)		% increase in aquasap sprayed field over no-spray field
		No Aquasap spayed	Aquasap sprayed	
Pigeon pea	Red-Gulyal	7.84	9.03	15
	ICPL-88039	8.27	10.71	30
Pearl Millet	JK-249 Hybrid	13.41	18.22	36
	ICTP-8203	17.51	20.03	14

Magnetic water conditioner

The bore well 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 97). 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 (Figure 98).

Figure 97. Magnetic water conditioner installed for testing in field, jumanal village.

Figure 98. Impact of Magnetic water conditioner in field.

Magnetic water treatment devices (MTDs) or magnetic water (MW) conditioners are simple environment-friendly equipment with low installation costs and no energy requirements. MW can be used to increase crop yield, induce seed germination and benefit the health of livestock. MW treatment is currently used in several other countries. MW has been found to be effective in preventing and removing scale deposits in pipes and water containing structures. Magnetized water also can increase the levels of CO_2 and H+ in soils comparable to the addition of fertilizers. Magnetic water treatment works on the principle that as water passes through a magnetic water conditioner, a Lorentz force is exerted on each ion which is in the opposite direction of each other. The redirection of the particles increases the frequency of collisions between ions of opposite sides, combining to form a mineral precipitate or insoluble compound. Calcium carbonate precipitates out of solution as a sludge and can be easily removed from the system since it will not adhere to pipe walls.

Micro irrigation and water impact calculator

International Water Management Institute along with ICRISAT have conducted three trainings for 180 farmers in three villages on efficient management of drip and fertigation system and the maintenance for enhanced efficiency of equipment (Table 45). These farmers were monitored and advised with appropriate irrigation schedule depending on the crop water requirement using water impact calculator.

Table 45. Training on micro irrigation seheduling to farmers in Bhoosamrudhi villages.

Sl. No.	Village	Crop	No. of Participants
1	Nidoni	Grapes, Sugarcane and Lemon	108
2	Mulsavlgi	Grapes, Lemon and Mulberry	39
3	Chadchan	Grapes, Onion, Sugarcane and Lemon	33
		Total	180

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 (Table 46 and Figure 99).

Table 46. Beneficiaries and area covered with land smoothening using laser leveler, 2015.

Sl. No	Village	Area covered (ha)	No. of Beneficiary
1	Inchageri	1.2	1
2	Sarwad	4	4
3	Angadageri	1	1
	Total	6.2	6

Figure 99. Laser land leveler in operation in Inchageri village.

Integrated Nutrient Management

Soil health mapping and soil test based fertilizer management:

Geo referenced soil samples were collected using stratified randomized soil sampling method in all the 16 villages by ICRISAT along with DoA staff. Soil samples were analyzed and recommendations were provided. Soil analysis revealed wide spread deficiency of organic carbon (42-92%), phosphorous (54-88%), sulfur (43-91%), zinc (67-99%) and boron (0-80%) (Table 47).

Soil test-based fertilizer recommendation that includes micro, secondary and major nutrients were provided to address the nutrient deficiency of soil to enhance the productivity.

Table 47. Percent farmers field deficient in nutrients, Vijayapura.

Taluk	Village	OC	Av P	Av K	Av S	Av Zn	Av B	Av Fe	Av Cu	Av Mn
Sindgi	Mulasavalagi	72	64	0	56	96	36			
Sindgi	Nivalkhed	92	88	0	68	92	80			
Vijayapura	Kumathe	92	75	0	75	92	42			
Vijayapura	Nidoni	79	58	0	58	67	29			
Vijayapura	Sarwad	89	80	0	91	93	0	1	0	0
B. Bagewadi	Angaddageri	58	78	4	82	84	14	2	0	0
B. Bagewadi	Beeraladinni	67	73	0	43	83	10	3	0	0
B. Bagewadi	Hunsyal PC	42	54	0	50	88	10	0	0	0
Indi	Chadachan	54	74	0	56	88	27	3	0	0
Indi	Havinal	52	85	1	65	91	5	0	0	0
Indi	Jigajeevanagi	53	63	5	47	83	16	8	0	0
Indi	Inchageri	77	72	4	60	93	33	2	0	0

Indi	Baradol	55	69	3	66	92	31	4	1	0
Indi	Devara	76	71	4	66	93	31	1	0	0
Indi	Jeerankalagi	74	74	5	57	99	22	0	0	0
Muddebihal	Agasbal	74	74	4	56	96	7	15	0	0

Table 48. Details of soil samples drawn from villages covered under third year, Vijayapura.

Sl.No	Taluka	Hobli	Village	No. of samples
1	Bijapur	Babaleshwar	Sarwad	244
2	Muddebihal	Dhavalagi	Agasbal	27
3	Indi	Chadachan	Inchageri	137
4			Jigajeevani	228
5			Devarnimbaragi	106
6			Jeerankalagi	80
7			Bardol	178
			Total	1000

Aquasap 5X – organic nutrient liquid:

Aquasap 5X is a 100% sea weed extract organic liquid which is used as foliar spray for commercial crops. Aquasap- 5X: It contains macro and 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. Spray preparation of 1% is used for foliar application for 3 times during crop season at after establishment stage, pre-flowering and post flowering stage of crop. It can also be used for vegetable crops. The seedlings roots have to be dipped in 0.3% solution. The solution is available in 1 litre pack and that is sufficient for one acre. As the liquid is an organic product, it is hazard free and can be handled with bare hands for mixing with water for preparation of solution.

Demonstrations were conducted in pigeonpea crop (Figure 100 and Table 49). The crop stand is quite good. The crop is yet to be harvested.

Figure 100. Aquasap organic fertilizer spray used in pigeonpea crop in Agasabala.

Table 49. Aquasap (sea weed extract organic nutrient liquid) evaluation, 2015.		
Taluka	Area (ha)	No. of Beneficiary
Indi	8	15
Sindagi	1	2
Vijayapura	8	6
Muddebihal	1	1
B.Bagewadi	10	15
Total	28	39

Aerobic composting

Manure contains most elements required for plant growth including N, P, potassium, and micronutrients. However, it is manure's organic carbon that provides its potential environmental value. Soil organic matter is considered nature's signature of a productive soil. Organic carbon from manure provides the energy source for the active, healthy soil microbial environment that both stabilizes nutrient sources and makes those nutrients available to crops. Manure organic matter contributes to improved soil structure, resulting in improved water infiltration and greater water-holding capacity leading to decreased crop water stress, soil erosion, and increased nutrient retention. But unfortunately availability of manure is declining over time due to reduced animal population.

Aerobic composting takes place in the presence of ample oxygen. In this process, aerobic microorganisms break down organic matter and produce carbon dioxide (CO_2), ammonia, water, heat and humus, the relatively stable organic end product. Although aerobic composting may produce intermediate compounds such as organic acids, aerobic micro-organisms decompose them further. The resultant compost, with its relatively unstable form of organic matter, has little risk of phytotoxicity. The heat generated accelerates the breakdown of proteins, fats and complex carbohydrates such as cellulose and hemi-cellulose. Hence, the processing time is shorter.

To improve the soil health aerobic composting was introduced in 7 villages involving 17 farmers during 2015. Microbial culture "Madhyam" was provided to farmers and conducted the trainings on compost preparation. In a period of 2-3 months quality manure can be produced. The farmers' response was very good and they are happy. About 25 tons of compost prepared by farmers.

Promotion of planting Gliricidia on field bunds:

Promotion of N-rich Glricidia on field was taken up as incorporation of Gliricidia leaves as green manuring also it strengthens field bunds in the watershed area where bunding has been done (Figure 101).

Figure 101. Planting Gliricidia on field bund, Beerladinni, Vijayapura.

Crop Intensification and Diversification

Three promising pigeonpea cultivars of ICRISAT were taken up for varietals evaluation (Table 50) and two pearl millet varieties suffered severe drought (immediately after sowing 60 days dry spell occurred) and failed. In addition to this, evaluation of promising released varieties from universities/ private seed companies (viz. maize, castor, sorghum, safflower and chickpea) were conducted (Table 51 & 52 and Figure 102 & 103).

Table 50. Pigeonpea varietial evaluation conducted in Vijayapura, 2015.

Variety	Varietal characteristics	Village	Area (ha)	No. of Beneficiary
ICPL 88034	• Short duration (135-140 days) • Suitable for drought prone areas and also • for intercropping with groundnut • yields 1.8 to 2.0 t ha^{-1}	Nivalkhed	0.4	1
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}	Angadageri	0.4	1
		Jeerankalagi	0.8	2
		Agasbal	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	1.50	1
		Total	3.5	6

Figure 102. Pigeonpea improved variety ICPL 88039 and local Gulyal evaluation, Agasabala village.

Figure 103. Pigeonpea ICPL 88034 intercropped with lemon at pod bearing stage in Nivalkhed, Vijayapur, 2015.

Table 51. Other promising cultivars evaluation conducted during *khraif* (late sown, not yet harvested) 2015.

Crop	Variety	Varietal characteristics	Village	Area (ha)	No. of Beneficiary
Maize	Syngenta NK 6240 hybrid	• Mid duration (95-100 days) • Sweet corn and dual purpose • Yield 1.0 t ha-1	Angadageri	2.0	1
			Inchageri	0.4	1
			chadachan	1.6	3
			Bardol	0.4	1
			Jeerankalagi	0.8	1
			Nivalkhed	1.6	4
			Mulsavalagi	2.8	7
Castor	DCH 177	• Short duration (90-100 days) • Resistance for fusarium wilt, whitefly insect. • Considered for bund planting and intercropping with pigeonpea • Yield 1.6 to 2.2 t ha-1	Inchageri	0.4	2
			Jeerankalagi	0.4	1
			Bardol	0.4	1
			Chadachan	0.4	1
			Total	10.0	23

Table 52. Other promising cultivars evaluation conducted during *rabi* 2015.

Crop	Variety	Varietal characteristics	Village	Area (ha)	No. of Beneficiary
Sorghum	BJV 44	• Duration is 130-135 days, spiny, bold seeded • Drought tolerant and resistant to shoot fly • Yields 2.0 t ha-1 and about4.5 t ha-1 fodder under rainfed	Angadageri	1.0	2
			Beeraladinni	0.2	1
			Inchageri	22.0	13
	M 35-1	• Local ruling variety, duration is 125-130 days • Drought tolerant • Yields 1.5 t ha-1 and about 3.5 t ha-1 fodder under rainfed	Beeraladinni	1.0	1
			Angadageri	16.0	10
			Inchageri	1.6	4
Safflower	PBNS 12	• Duration is 135-137 days, spiny, bold seeded • Moderately tolerant to aphid • Yields 1.5 t ha-1 under rainfed and about 2.0 t ha-1 under irrigated conditions.	Beeraladinni	0.8	1
			Angadageri	0.4	1
			Inchageri	0.4	2
Chickpea	KAK 2	• Short duration (95-100 days) extra-large seeded variety of kabuli chickpea. • Semi spreading. Resistance to fusarium wilt. • Yields 1.5 t ha-1 under rainfed and about 2.5 t ha-1 under irrigated conditions.	Inchageri	1.2	3

Table 52. Other promising cultivars evaluation conducted during *rabi* 2015.					
Crop	Variety	Varietal characteristics	Village	Area (ha)	No. of Beneficiary
	JG 130	• Plant height 46.5cm; semi spreading plants with profuse branching, Suitable for machine harvest. • Resistant to fusarium wilt, moderately resistant to dry root rot and tolerant to Helicoveropa. • Duration is100-110 days, • Yield potential of 1.8-2.0 t/ha.	Angadageri	0.8	1
			Inchageri	1.2	3
	JAKI 9218	• Short to medium duration (95 -105 days), bold-seeded • Resistant to fusarium wilt • Average yields 1.8-2.0 t ha-1.	Angadageri	0.8	1
			Inchageri	0.4	1
	JG 11	• Duration is 95-105 days • Average yield 1.8-2.0 t ha-1 under rainfed. • Resistant to fusarium wilt and moderately resistant to dry root rot diseases.	Angadageri	24.0	12
			Beeraldinni	4.0	2
			Total	88.1	85

Eco-friendly pest management system:

An eco-friendly pest control system was piloted using solar light pest trap equipment in Vijayapura during 2015.Two units were brought to evaluate this season and their performance shown satisfactory in term of pest control (Figure 104 & 105). Two solar traps have been installed one in pigeonpea in Agasabala and other one in capsicum in Jumnal crops.

Figure 104. CEO and DoA officials visit the solar light trap installed in Capsicum crop.

Figure 105. Solar trap in pigeonpea field (L) and pests trapped (R), Agasabala, Vijayapura, 2015.

Table 53. Crop yield Report of BBF landform under Bhoosamruddhi Programme in Vijayapur, 2015

Crop	Variety	Grain yield in (Q/ha)		% increase in BBF landform over flat cultivation
		BBF landform	Flat landform	
Sorghum	M-35-1	7.65	6.43	19
Safflower	PBNS-12	11.39	9.21	24

Table 54. Crop yields in local and improved cultivars under Bhoosamruddhi Program in Vijayapur, 2015

Crop	Grain yield in (Q/ha)		% increase in improved cultivar over local cultivar
	Local	Improved	
Pearl millet	18.22 (Hi-Tech 500)	19.5 (Dhanashakati)	7
Pigeon pea	8.43 (Red- Gulyal)	9.31 (ICPL-88039)	11
Chickpea	6.99 (JG-130)	7.42 (JAKI -9218)	6

Table 55. Yield Report of Aquasap demonstrations under Bhoosamruddhi Programme in Vijayapur

Crop	Variety	Crop yield (Q/ha)		% increase in aquasap sprayed field over no-spray field
		No Aquasap spayed	Aquasap sprayed	
Pigeon pea	Red-Gulyal	7.84	9.03	15
	ICPL-88039	8.27	10.71	30
Pearl Millet	JK-249 Hybrid	13.41	18.22	36
	ICTP-8203	17.51	20.03	14

The crop yield in various interventions introduced have revealed an encouraging results even during the poor rainfall during the year. The crop yield in improved in-situ moisture conservation system with broadbed and furrow (BBF) increased by 19-24% over flat cultivation traditionally practiced by farmers (Table 53). The yield gain in improved cultivar of pearl millet (Dhashakati) and pigeonpea (ICPL 88039) was 6-11%, while aquasap sprayed on pigeonpea and pearl millet was 14-36% (Table 54). Aquasap apray with other improved practices like seed treatment, soil test based fertilizer application and moisture conservation has given a good yield gain (Table 55).

Feed and Fodder Management

Multipurpose thorn less cactus:

Multipurpose thorn less was introduced in Vijayapura district. During 2014, a Cactus nursery was raised in KVK Vijayapura. Three species of cactus (Cactus-1270; 1271; 1280) were planted in four villages (Inchageri, Jigjeevani, Beeraldinni and Angadageri) covering 12 farmers on bund which provides notorious source of fodder to animals and also it has medicinal properties (Figure 106).

Figure 106. Cactus nursery in KVK (L) and cactus planted along the bund (R), Vijayapura.

Cactus *(Opuntia ficus-indica)*, commonly known as prickly pear, belongs to the family Cactaceae. Family Cactaceae is reported to contain about 130 genera and nearly 1500 species. Generally, these species are used as live fences to protect agricultural fields from

human and animal encroachments. It is suited to water-scarce dry zone of the world as an alternate source of food and fodder. Different parts of the cactus can be used as fruit and vegetable for human consumption, fodder for cattle, and raw material for various industries to prepare plywood, soap, dyes, adhesives and glue, pharmaceutical products for treating blood sugar and various other disorders, and cosmetics such as shampoo, cream, and body lotion, etc. The present program is undertaken to introduce the thorn-less cactus through improved germplasm, frontline demonstration, and value addition of the spp. in establishment of cacti species in degraded and wastelands of Karnataka.

Fodder crop production: Fodder scarcity is one of major constraint faced by farmers. To enhance the fodder availability, measures like dual purpose maize and multi-cut sorghum have been introduced by International Livestock Research Institute (ILRI). Field demonstrations were conducted on dual purpose maize (NK 6240) and multi cut forage sorghum (CSH 20 MF and CSH 24 MF) on 23 farmers' field in seven village (Inchageri, Jeerankalagi, Chadachan, Angadageri, Mulsavalagi, Nivalkhed, Bardol). The crop is yet to be harvested. ILRI has imparted training to technicians on feed quality assessment tool and feed management.

Livestock development:
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 107). 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.

Figure 107. Beneficiary farmers with Sirohi bucks in Beeraldinni village, Vijayapura.

Vegetable production technologies
Vegetable production technologies like protected cultivation with improved practices like mulching, inline drip, fertigation, with grafted capsicum which are tolerance to bacterial wilt in shade net in 3 farmer and indeterminate tomato with improved practices in shade net with 5 farmer's field in five villages were taken up (Figure 108 and Table 56). Capsicum cultivar used is *Indra* and tomato varieties are (IIHR PH 6321, IIHR PH 1025 IIHR PH 1021 and Arka Rakshak/Samrat).

Watershed department has taken up Cucurbits on field bunds in Nidoni (Figure 109) which gives additional income to the farmers and strengthens bund.

Figure 108. AVRDC field Staff with farmer in grafted capsicum and indeterminate tomato plot in shade net and open with improved practices, Nidoni, Vijayapura.

Table 56. Vegetable production systems taken with farmers during 2015.				
Sl	Village	Vegetable	No. of seed	No. of
1	Nidoni	Grafted Tomato	800	2
2	Jumnal	Grafted Capsicum	300	1
3	DevarNimbaragi	Capsicum	300	1
4	Jigjeevani	Capsicum	200	1
5	Angadageri	Indeterminate tomato	5500	2
		Total	7100	7

Figure 109. Watershed department has taken up Cucurbits on field bunds in Nidoni.

Wastewater management re-use system

Mulasavagi is a village identified for decentralized wastewater treatment system in Vijayapura district (Figure 110). The village has two drainage canals; the one which has been identified for the construction is a major drain and has about 900 households, the characteristics of water samples are shown in Table 57. With the approval of CEO this activity is carried by the Panchayat Raj department. The design and estimation work is in process (Figure 111, 112 & 113).

Figure 110. Google-Earth image of the location selected for the activity (Lat: 16^{O}53'19.6" N; Long: 76^{O}01'26.5")

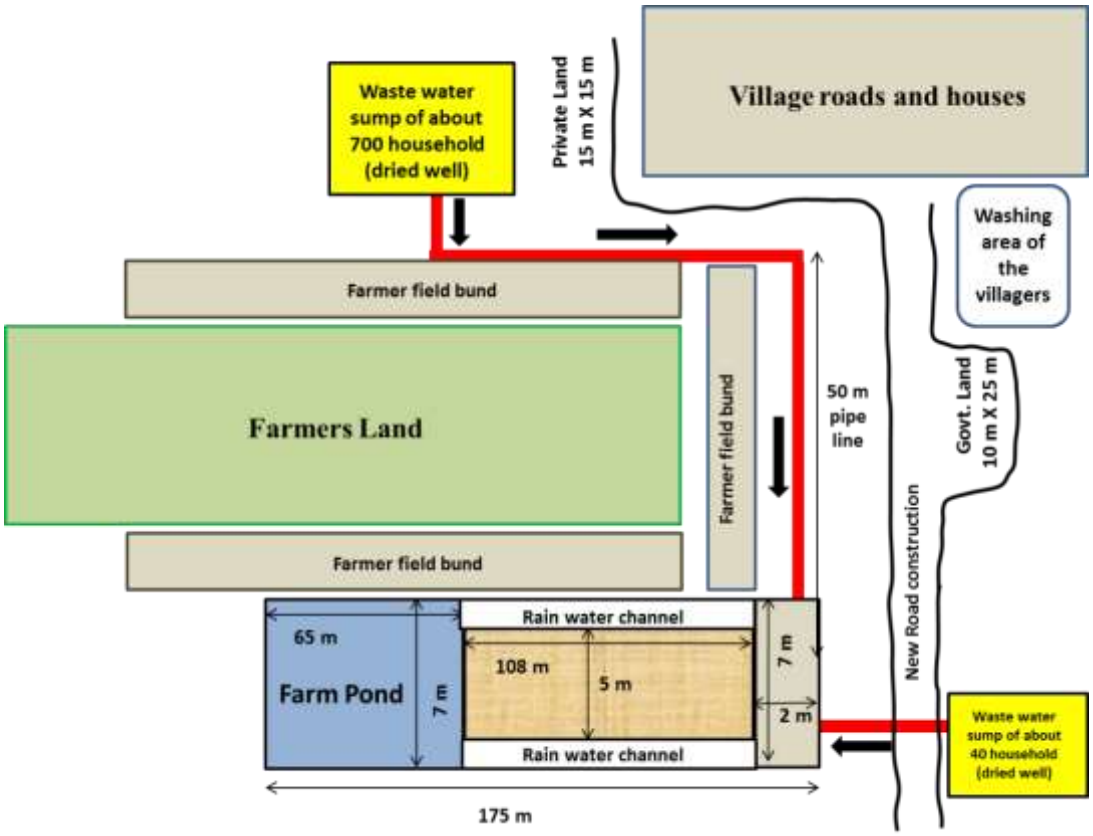


Figure 111. A lay-out of the village and the proposed site for the activity.

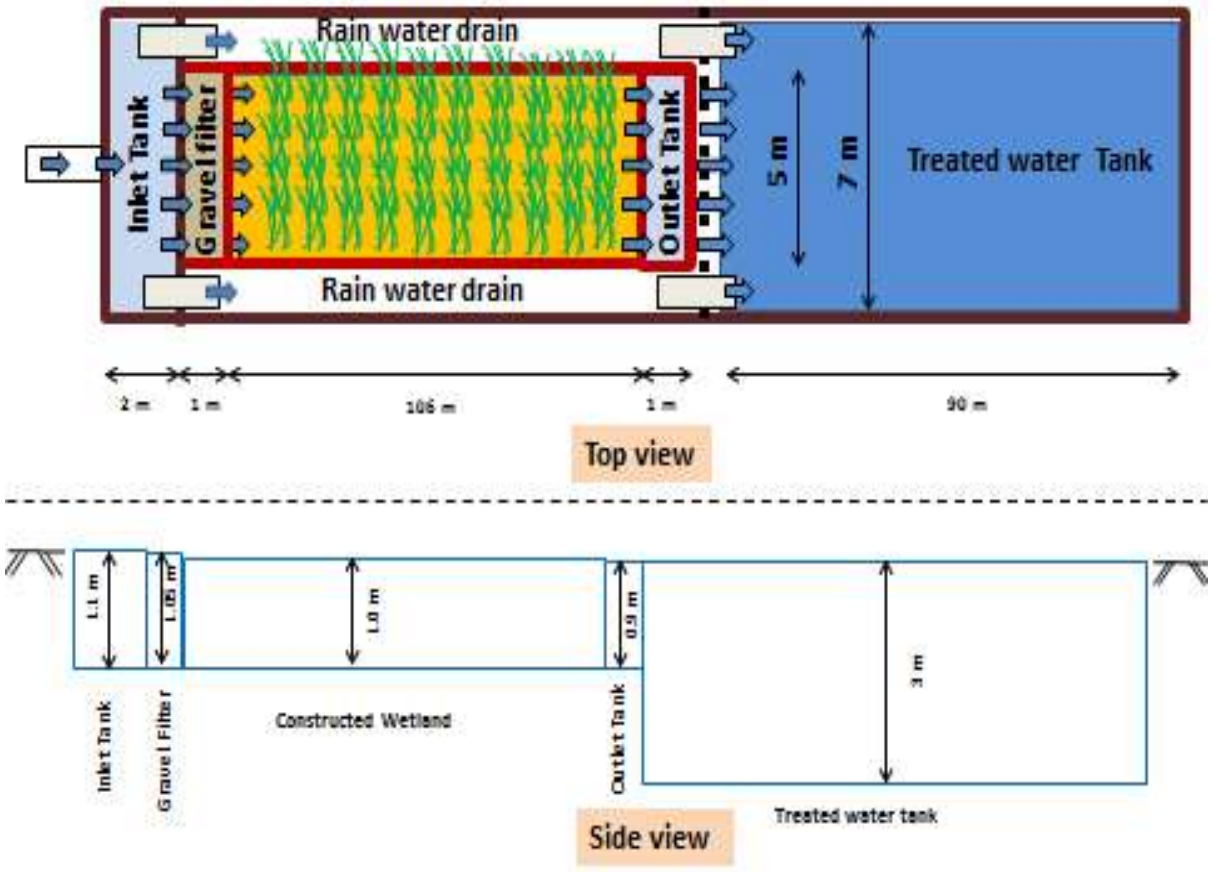


Figure 112. Line Design of the dimensions of the whole wastewater treatment system.

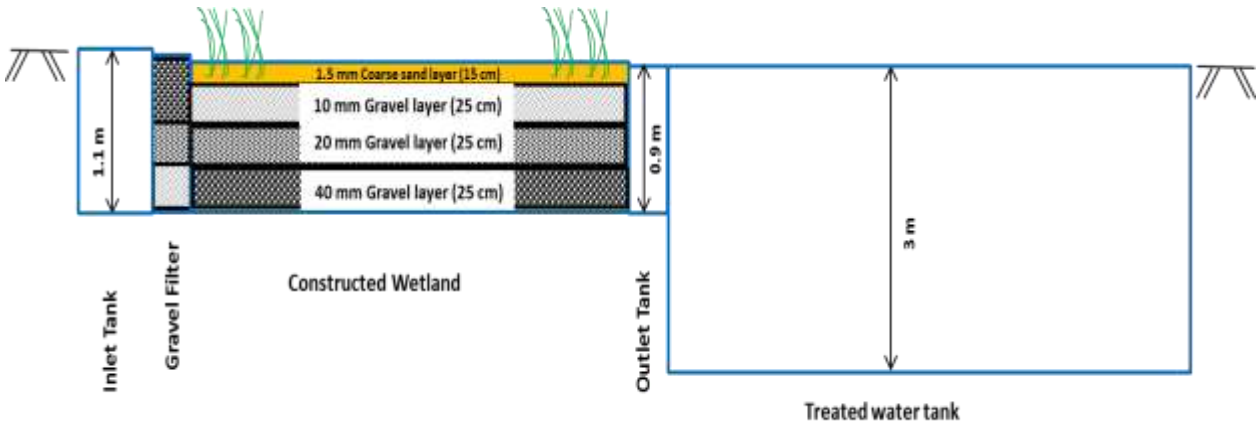


Figure 113. Depth of different sections and the different layers of constructed wetland
Point of contact: S.R.Naikodi.

Table 57. Wastewater characteristics for the samples collected from Mulasavalagi, Vijayapura			
Sl No.	Bijapur-1 water sample analysis data	Unit	Concentrations (mg/L)
1	Alkalinity (Total)	(mg/L as CaCO3)	213
2	Arsenic	(mg/L)	Below Detection Limit
3	Boron	(mg/L)	0.25
4	Cadmium	(mg/L)	Below Detection Limit
5	Calcium	(mg/L)	78
6	Chlorides	(mg/L)	307.50
7	Chromium	(mg/L)	Below Detection Limit
8	Cobalt	(mg/L)	Below Detection Limit
9	Chemical Oxygen Demand	(mg/L)	640
10	Copper	(mg/L)	Below Detection Limit
11	Electrical Conductivity	mS/cm	1.33
12	Fluorides	(mg/L)	2.13
13	Hardness (Total)	(mg/L as CaCO3)	360.00
14	Lead	(mg/L)	Below Detection Limit
15	Magnesium	(mg/L)	36.00
16	Manganese	(mg/L)	Below Detection Limit
17	Nickel	(mg/L)	Below Detection Limit
18	Nitrogen-Ammoniacal	(mg/L)	60.07
19	Nitrogen-Nitrate	(mg/L)	2.47
20	pH at 25 oC		7.67
21	Phosphates	(mg/L)	2.72
22	Potassium	(mg/L)	10.20
23	Sodium	(mg/L)	67.10
24	Sulfate	(mg/L)	92.90
25	Sulfur	(mg/L)	27.00
26	Total Dissolved Solids	(mg/L)	798
27	Total iron	(mg/L)	0.04
28	Total Suspended Solids	(mg/L)	34.00
29	Zinc	(mg/L)	0.06
Sodium Adsorption Ratio (SAR)			2.22

Digital Extension System

Dissemination of information from farmer to farmer through videos:

For the effective dissemination of good management practices a farmer to farmer (F2F) dissemination route has been explored through a farmer-centric video documentation (Figure 114).

Figure 114. Video production and screening in Bhoo Samruddhi villages, Vijayapura.

Table 58. Farmer to farmer dissemination through video production and screening activities.

Particulars	Nos.
Training on farmer to farmer videos	4
Video produced	18
Video screenings	200
Viewers	1150
Viewer adoptions	240

An innovative Tablet-mediated extension system: Krishi Gyan Sagar

The KGS app is available in English as well as Kannada. Krishi Gyan Sagar is designed to help in knowledge sharing from laboratory to farmers as well as information collection from farmers to laboratory. The KGS has two platforms for two different user groups. The first part is an android app, which is designed as an information dissemination as well as data collection tool. Farmer facilitators are the primary users for android app in tablet. Each FF has jurisdiction of about 500 ha area, which covers one or two villages. Once logged-in FFs can access information available in KGS app and give advice to farmers. In addition, they can capture details of on-going farming activity using various option available in the app. Availability of information in app is restricted based on jurisdiction of logged in user. The other platform of KGS is the web application. Both, the android app and web app are backed with common database server. The server receives data from remote users as well as database administrator. This web app is more useful for policy maker and development agents for monitoring and report generation. Web app users can generate query based reports from data captured by FFs at field level.

Soil test based fertilizer recommendation:

One of the important outputs from Bhoochetana project is the soil fertility atlas of Karnataka state of India. This data is adopted in KGS app in two forms: 1) district wise soil

fertility maps including status of organic carbon, phosphorous, potassium, sulphur, boron, and zinc are embedded in the app and 2) site specific fertilizer recommendation. Based on the user's district, the soil maps will be displayed in the app. KGS app is backed by geo-referenced soil fertility data and location information recorded while farmers' registration. The queried data pre-processed on the basis of on location, farm area, and crop specific nutrient requirements to provide customized fertilizer recommendation. This dynamic customization is not possible with soil health cards or information written on walls.

Farmers' registration:

Farmer database is the base of agricultural extension system. Farmers' details include their basic information and farm information. The basic information is one time entry, though it can be edited at any time. All this information is captured by FFs while interacting with farmers. Earlier, these information was collected through paper form when farmers used to come for taking inputs at local extension centers. The location information of each farmer is linked with the geo-referenced soil fertility data, which is used for providing site specific fertilizer recommendations.

Table 59. Tablet based extension system activities.

Particulars	Nos.
Training on Tablet applications	3
Farmer registration on KGS	1200
Training for Krishi Vani	1
Green Sim Cards	100

Package of Agronomic Practices:

This part of app provides updated information about good agricultural practices with respect to crop. It contains information from soil and climate requirement, land preparation, available cultivars, seed treatment, sowing/planting, fertilizer and water management, plant protection practices, harvesting and post-harvest practices, etc. The updated information is provided by National Agricultural Research and Extension Systems and ICRISAT. This information is translated into local language and supported with picture so the FFs could easily understand it.

Krishi Vani:

Krishi Vani platform initiated in collaboration with IKSL and Bharti Airtel. Krishi Vani is a mobile phone/phablet based application. Through this application generic advisories are delivered to groups of farmers in a location through the mobile phone enabled by Green SIM. IKSL has pioneered the voice message based agro-advisory. To subscribe Krishi Vani, user has to buy Green SIM from Airtel. These SIM card specially configured for receiving voice messages and other agro advisory services. Every day, four free voice messages are delivered to the subscribers. The contents of voice messages is advised by subject matter specialist and cover diverse areas like soil management, crop management, dairy and animal husbandry management, horticulture and vegetable management, plant protection, market rates, weather forecasts information, human & cattle health, employment opportunities, government schemes, etc.

Capacity Building

Twenty two trainings were conducted involving 1697 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 and digital video screening and awareness about Bhoosamrudhi program, etc. (Figure 115). Details of trainings are shown in Table 60.

Table 60. Capacity building activities carried out in Vijayapura, 2015.

Date	Training	Village	No. of Participants	Stakeholders
09-06-2015	BBF land management	Sarwad	25	ICRISAT
19-06-2015	Soil sample training	Selected villages in 2015-16 (BS)	25	ICRISAT-DoA
26-06-2015	BBF Land management	Angadageri	25	ICRISAT
30-06-2015	BBF and Soil sampling training	Beeraldinni	33	ICRISAT-DoA
10-07-2015	Bhoochetana village level action plan implementation, FFs and Climate change	DATC, Hittinahalli Farm, Vijayapur	88	ICRISAT-DoA, RARS, KVK, AC-VIJAYAPUR CAMPUS
13-07-2015 to 15-07-2015	Video Dissemination and Data Management training	DATC, Hittinahalli Farm, Vijayapur	75	DIGITAL GREEN-ICRISAT
24-07-2015 to 01-08-2015	Bhoosamruddhi Awareness and Capacity Building Program to Farmers	All BhooSamruddhi Villages	900	ICRISAT-DoA, LINE Depts , IWMI, AVRDC
20/08/2015 and 21/08/2015	Aerobic compost preparation	Inchigeri, JigjeevanI, Mulsavlgi and Nivalkaed villages.	68	ICRISAT
24/08/2015	Aerobic compost preparation	Agasbala village.	21	ICRISAT
24/08/2015	Integrated pest management; Integrated nutrient management	Agasbala village.	15	ICRISAT
22/09/2015	Integrated pest management; Integrated nutrient management	Mulsavalagi, Nivalkhed	18	ICRISAT
06/10/2015	IPM and INM in Red gram and Pearl Millet	Agasbal	8	ICRISAT
06/10/2015	IPM and INM in Red gram and Maize	Inchageri and Jigjeevani	12	ICRISAT
23/11/2015	Seed treatment training program	Jeerakalgi , Angadageri, Beeraldinni and Hunshyal pc	15	ICRISAT-DoA
25/11/2015	Compost preparation	Mulsavlgi	6	ICRISAT
02/12/2015	Capacity building on “Spineless Cactus as Feed”	Angadageri, Beeraldinni and Hunshyal pc and Inchageri and Jigjeevani	123	ICRISAT-DoA, ICARDA
August- October	Efficient management of Drip system and efficient water application	All BhooSamruddhi Villages (25 trainings)	240	IWMI/ICRISAT

Figure 115. Various capacity building programs conducted in Vijayapura district.

Annexure 1. Characteristics of crop cultivars provided for varietal promotion in BhooSumruddi villages

Crop	Variety	Seed rate (kg/ha)	Duration (Days)	Major characteristics	what agronomic practices need to be considered
Groundnut	ICGV 91114	150 pod	95-100	This is a short-duration Spanish variety, matures in 95 – 100 days in the rainy season. This variety is released in Andhra Pradesh, Orissa and Karnataka and also Gujarat. 52% oil content, 17% protein. Resistance for intermitent and terminal droughts. Shelling percentage 70%. 100 seed weight 41g, Pod yield 2 tons ha^{-1}. Fodder quality is very good.	Seed treatment with Traichoderma, BBF planting. Fungicide treatment with Baviston and carbandisom
Groundnut	ICGV 0350	150 pod	110-115	This is a drought tolerant Spanish variety matures in 110 – 115 days in the rainy season. The average yield recorded in FPVS trials under stress is 2.0 t ha–1. It performs well in post rainy also. This variety is released in Tamil Nadu and Andhra Pradesh.	Seed treatment with Traichoderma, BBF planting. Fungicide treatment with Baviston and carbandisom
Groundnut	ICGV 0351	150 pod	100-115	This is a drought tolerant Spanish variety matures in 110 – 115 days in the rainy season. The average yield recorded in multi-location yield trials is 2.5 t ha^{-1}. Released as Co7 in Tamil Nadu and performing well also in Karnataka.	Seed treatment with Traichoderma,BBF planting.Fungicide treatment with Baviston and carbandisom
Groundnut	ICGV 2266	150 pod	110-115	This is drought tolerant Spanish variety matures in 110 – 115 in rainy season. It has resistance to foliar diseases and has high haulm yield. It is performing well in all India trails and will be released shortly.	Seed treatment with Traichoderma,BBF planting.Fungicide treatment with Baviston and carbandisom
Groundnut	Kadiri 9	150 pod	115-125	Medium tall plant with green obtuse leathery leaves suitable for drought prone groundnut growing area. Remains green till harvest, Medium tall plant with dark green foliage with plant height of 30-35cm. Spanish bunch with 4-6 primaries and 0-2 secondary. Pod character is medium size 2 seeded reticulation moderate construction. Kernel character testa color rose.	Seed treatment with Traichoderma,BBF planting.Fungicide treatment with Baviston and carbandisom
Pigeonpea	ICPH 2740	4-5 kg as inter crop and for sole crop8-10kg ha-1	180-190	Medium-duration, wilt and sterility mosaic resistant, cytoplasmic male–sterility based hybrid. It is indeterminate type and its height is around 230-260 cm. It flowers in 120-125 days and matures in 160-180 days. . This hybrid yields around 2.7-3.0 t ha^{-1} and exhibits about 30% superiority over Asha check. Released for cultivation in AP.	Inter cropping with cotton ,castor and maize and bund planting of rice fields.
Pigeonpea	ICP 8863 (Maruthi)	4-5 kg as inter crop and for sole crop8-10kg	150-160	Fusarium wilt resistant variety released for cultivation in southern states of India.High yielding,Medium duration(150-160 days), Semi-spreading and indeterminate, Suitable for peninsular India,Suitable for sole cropping and intercropping, Medium-sized brown seeds	Inter cropping with, Ragi,castor and maize .

Crop	Variety	Seed rate (kg/ha)	Duration (Days)	Major characteristics	what agronomic practices need to be considered
		ha-2			
Pigeonpea	ICPL 87119	4-5 kg as inter crop and for sole crop8-10kg ha-1	150-170	Medium-duration, wilt and sterility mosaic resistant, cytoplasmic male–sterility based hybrid. It is indeterminate type and its height is around 230-260 cm. It flowers in 100-115 days and matures in 150-170 days. The seeds are dark brown and bold seed. This hybrid yields around 3.0-3.5 t ha^{-1} it is about to release for cultivation.	Inter cropping and bund planting
Pigeonpea	ICPL 7035	sole 5 inter crop 2kg	200-210	Long-duration, high-yielding, flowering 140-150 days, maturity200-210 days, immature seeds are sweet and preferred as vegetable. Bold dark brown seeds with weight of 22 g 100 seeds-1 and yields 1.5 t ha-1. Cultivation for both green and dry seed production.An important source of wilt and sterility mosaic resistance. It is popular in sterility mosaic prone areas of Karnataka state.	Grown on bunds of paddy fields. Wider spacing rows of 1.5m as sole crop.
Pigeonpea	ICPL 88034	sole 5 inter crop 2kg	135-140	It is a short duration, indeterminate line, flowers in 75-80 days and matures in 135 – 140 days. Flower color is yellow and it is semi-spreading. Seed color is brown with 100-seed mass of 10 –10.5 g. On an average it produces about 1.8 – 2.0 t ha^{-1}. It is suitable for drought prone areas and also for intercropping with groundnut and Ragi	Suitable as inter crop with groundnut 1:8 and Ragi crop 1:8
Pigeonpea	ICPL 161	sole 5 inter crop 2kg	125-135	Promising short duration indeterminate variety with plant height of 160-180 cm. The variety will be flowering 50% around 75-85 days and 75% maturity at 115-125 days. Each pod contains 3-4 seeds and weight of 100seed is 9-9.8g and seed color is brown and yields potential is 2000-2300kg ha^{-1}	Suitable as inter crop with groundnut 1:8 and Ragi crop 1:8
Pigeonpea	ICPL 88039	sole 5 inter crop 2kg	120-125	This is an extra short-duration line. It is best suited for double cropping. After harvesting of this pigeon pea line chickpea crop can be taken. This is a non-determinate (NDT) line which flowers in 50-60 days and matures in 100-105 days at ICRISAT, Patancheru. It is tolerant to drought and due to earliness it escapes insect damage. Its seeds are brown and oval with a 100-seed mass ranging from 9.0-9.5 g. Yields around 1.7-1.8 t ha-1. .Extra short duration grown as sole or inter cropped with Ragi and groundnut	Suitable as inter crop with groundnut 1:8 and Ragi crop 1:8

Crop	Variety	Seed rate (kg/ha)	Duration (Days)	Major characteristics	what agronomic practices need to be considered
Sorghum	CSV 17	8-10kg	85-90	Low rain fall and drought prone sorghum growing regions of the country. Plant height 133-140cm with tan pigmentation, leaves dark green with white dull midrib , well exsefted, cylindrical, semi compact panicle, creamy seed, early maturing variety moderately resistant to shoofly, stem borer, rust, anthracnose ,leaf spot diseases, sugary disease and charcoal rot' ,Yield potential 25-30 q ha-1 ,Free threshing.	Rainy season crop planted as inter-crop on ridge and furrow confugration
Sorghum	PVK 801	8-10kg	115-120	It is a grain mold resistant variety and matures in 115 to 120 days, grows to a height of 1.9 to 2.1 m, produces 3.0 to 3.5 t ha^{-1} grain with grain size of 3.2 to 3.5 g 100^{-1} grains and 13.0-14.0 t ha^{-1} fodder. It is resistant to leaf diseases and remains green at maturity. It has high grain Fe (40 ppm) and Zn (21 ppm) in the grain. It remains green at maturity, so its fodder quality is excellent.	Rainy season crop planted as inter-crop on ridge and furrow confugration
Sorghum	CSV 27	8-10kg	110-115	It is a high yielding medium duration variety and matures in 110 to 115days, grows to a height of 2.10 to 2.30 m, produces 3.0 to 3.5 t ha-1 grain with tan pigmentation grains and 13.0-14.0 t ha^{-1} fodder. It is tolerant to shootfly, resistant to leaf diseases and remains green at maturity. It is dual purpose non lodging type variety.	Rainy season crop planted as inter-crop on ridge and furrow confugration
Sorghum	CSV 23	8-10kg	110-115	It is a high yielding medium duration variety and matures in 110 to 115days, grows to a height of 2.0 to 2.15 m, produces 2.8 to 3.3 t ha^{-1} grain with tan pigmentation grains and 13.0-15.50 t ha-1 fodder. It istolerant to shootfly, resistant to leaf diseases and remains green at maturity. It is dual purpose non lodging type variety.	Rainy season crop planted as inter-crop on ridge and furrow confugration
Sorghum	CVH 24MF	10-2kg ha^{-1}		Early maturing multi cut hybrid of 105- 110 days with average yield of green fodder of 913 q ha^{-1} . The plant height is 200-210cm tan color light green foliage with green midrib, resistance to foliar diseases. Medium thick juicy stem with basal tillering. Medium long and broad semi-erect leaves with senescence only up to 3-4 lower leaves. Narrow cylindrical semi-compact panicles erect tillering, fast growing, regeneration (rationing) ability to give 3-4 cuttings for green fodder with leaf stem ratio of 0.42. 50% flowering at 62-65 days after sowing. Juicy stalks with semi sweet with 5-6% T.S.S. at 60 days of growth.	Fodder hybrid grown during all season with high density planting.
Greengram	LGG 460	10-12 kg ha	65-70	Short duration high yielding and resistance to wilt and sterility mosaic disease. Released variety of LAM farm Guntur AP.	Rainy season planting planted before paddy crop.
Greengram	SML 668	10-12 kg ha	60-65	Plant is erect, medium tall and profusely branched. The variety matures in 60-65 days and yields on an average 1000 to 1200 kg of grain per hectare. It has a fair degree of tolerance to yellow mosaic disease.Short duration variety high	Rainy season planting in paddy crop. Good harvest with early sowing.

Crop	Variety	Seed rate (kg/ha)	Duration (Days)	Major characteristics	what agronomic practices need to be considered
				yielding and grows 45-71cm height grows erect, foliage colour is green, long pods in bunches with 10-12 dull green bold seeds;	
Green gram	IPM 02-14	10-12 kg ha	62-66	Released for cultivation from IIP Kanpur in the states of Tamilnadu, Andhra Pradesh, Karnataka and Orissa in summer. THe palnt height: 36-39 cm; Erect-upright, Determinate, Synchronous maturity, mediumleaf size, shiny green seed. Resistant to mungbean yellow mosaic virus and leaf crackle.yield potential 700-740kh ha^{-1}	Rainy & Summer planting in paddy crop. Good harvest with early sowing.
Castor	DCH 177	5-6 kg ha	90-100	This hybrid is high yielding (1550-2130kg ha^{-1}) and early maturing, 90-100 days and oil content is about 49% and suitable for growing in Karnataka, Tamilnadu, Maharashtra and Orissa. This has got resistance for fusarium wilt, Whitefly insect	bund planting and inter cropping with red gram
Castor	DCH 519	5-6 kg ha	105-110	Days to maturity – 105-110, Resistant to Fusarium wilt, leaf hoppers Oil content (%) – 50, Yield (kg/ha) – 1740-2130	bund planting and inter cropping with red gram
Castor	Jwala 48-1	5-6 kg ha	100-110	Resistant to wilt, capsule borer and tolerant to jassid and *Botrytis, Yield potential is 1100-2000 kg ha-1 oil content is 48%.*	bund planting and inter cropping with red gram
Castor	Jyothi	5-6kg	90-95	Resistance to fusarium wilt and jassids and leaf hoppers, Yield (kg/ha) – 1030-2000, Days to maturity – 90-95,Oil content (%) – 48	bund planting and inter cropping with red gram
Ragi	MR 1	10-12kg ha^{-1}	120-130 days	ENTIRE RAINFED *KHRAIF* RAGI GROWING AREAS OF SOUTH KARNATAKA GRAIN: 3406 KG/HA.;STRAW : 13193 KG/HA.	Pigeonpea crop inter cropped1:8
Ragi	GPU 28	10-12kg ha^{-1}	110-115	Medium duration-*Khraif* July Sowing, all ragi growing area of Karnataka *Khraif* Rainfed /Irrigated and Summer conditions. Grain color copper brown; shape round,surface smooth grains 5-7, grain covering intermediate glume length 0.4cm, resistant to fungal infestations,About 2.5 tonnes of grains per hectare	Pigeonpea inter crop along with Ragi 1:8
Pearl Millet	ICTP 8203 Fe (Dhanashakti)		75-80	High iron content improved version of ICTP8203 (early maturing open pollinated variety).The plant and seed characteristics are similar to original ICTP8203, Dhanashakti had 71ppm Fe density (9% more than ICTP8203), 38 ppm Zn density (comparable to ICTP 8203). Grain yield potential of 2.2 t ha^{-1} (11% more than ICTP8203) and medium tall (1.8-2.0m). It flowers in 38-55 days and matures in 75-80 days. Anther color is mixed, heads are medium-long (2-28 cm), semi-compact to compact, cylindrical to lanceolate with slight tapering towards the tip. Resistance to downy mildew and tolerance to drought	Inter cropped with groundnut 2:6, inter cropped with pigeonpea 2:1