# Progress Report (2016-17)

# Scaling-up of Bhoosamrudhi Program in Additional Four New Districts

ICRISAT DEVELOPMENT CENTER

ICRISAT INTERNATIONAL CROPS RESEARCH INSTITUTE FOR THE SEMI-ARID TROPICS

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# Scaling-up of Bhoosamrudhi Program in Additional Four New Districts

*Submitted to*

*Government of Karnataka*

IDC ICRISAT DEVELOPMENT CENTER

ICRISAT INTERNATIONAL CROPS RESEARCH INSTITUTE FOR THE SEMI-ARID TROPICS

## Table of Contents

## Executive Summary

The Hon'ble Chief Minister, Govt. of Karnataka, in his 2015-16 budget speech, has announced that "Bhoosamrudhi initiative will be scaled-up in a phased manner to all the districts and from 2015 additional four districts will be implementing the project to benefit large number of farmers". Further, during Review and Planning meeting of Bhoosamrudhi and Bhoochetana held at ICRISAT from 23 to 25 Feb 2015, Hon'ble Minister of Agriculture indicated that ICRISAT should provide technical backstopping for scaling-up Bhoosamrudhi in eight districts namely Tumkur, Chikkamagaluru, Raichur and Vijayapura; Bidar, Dharwad, Chikkaballapur and Udupi.

As in first phase, the consortium approach is adopted to harness the synergies of international research institutes (ICRISAT, IWMI, ILRI, IRRI, CIMMYT, IFPRI, ICARDA), state agricultural universities (Bengaluru, Dharwad, Raichur, Shimoga), state horticulture university (Bagalkote), state university of Animal Husbandry & Fisheries (Bidar) and line-departments (DoA, WDD, DoAH, DoH, DoWR, DRD & PR, KSSC). The aim of this initiative is to adopt holistic approach to find solutions to improve rural livelihood in the selected districts at pilot sites.

The specific objectives of this initiative are:

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

The Bhoosamrudhi program in additional four districts is in 2$^{nd}$ year and covered 20,000 ha area in each of the districts with improved technologies. Soil health mapping was done and converged with Bhoochetana program and micronutrients were made available in a large scale. Based on earlier experience, number of improved cultivars were evaluated through farmers' participatory evaluation. During 2016, farmers' participatory evaluation of climate resilient crop cultivars were evaluated in nearly 560 ha. This helped to identify farmers' preferences among improved cultivars while establishing their yield potentials. In Bidar, greengram variety IPM 2-14 produced 10% higher yield (600 kg ha$^{-1}$) with improved management compared to farmers' practice (550 kg ha$^{-1}$). Similarly, blackgram variety IPM 2-43 and T9 also shown increased yield over farmers' practice. Two pearlmillet varieties viz., HHB67 and ICTP 8203 were evaluated and HHB67 produced 1400 kg ha$^{-1}$ against the average yield of 400 kg ha$^{-1}$ from ICTP 8203 in Chikkaballapur. In Udupi, farmer participatory salinity tolerant rice variety Kagga was introduced procuring from Kerala Agricultural University and produced average grain yield of 4.45 t ha$^{-1}$ as against to district average of 2.27 t ha$^{-1}$ and 1 t ha$^{-1}$ in coastal saline area. Nearly 750 ha of paddy has been machine transplanted which helped to overcome labour scarcity.

Direct seeded rice (DSR) is being promoted using multi-crop planter in Dharwad and Udupi districts for addressing labour scarcity, reducing energy consumption and enhancing water use efficiency. Mechanization was given importance in these districts and number of machineries have been promoted with the help of CGIAR institutions, Universities, KVKs, and line departments. During 2016-17, nearly 3000 ha area has been demonstrated with mechanization such as zero-till multi crop planter, machine transplanting, lazer leveler, leaf color charts, BBF maker, easy planter, surface and sub-surface drip irrigation techniques, etc. Among four additional districts, Bidar and Udupi have achieved the distinction as these districts have cultivated more than 1500 ha using different machineries. Weed management was done in more than 1000 ha using herbicides and leaf color charts were used by 425 farmers in Udupi for determining the N deficiency in rice crop. In Dharwad, land and water management practice such as broadbed and furrow (BBF) system was implemented in about 140 ha. An innovative method called nipping in pigeonpea was promoted to ensure good crop vegetation as well as yield which was a success in Bidar as most of the pigeonpea farmers adopted this techniques. The new varieties of cowpea have been demonstrated in Udupi in rice fallow areas for crop intensification. Improved variety of sorghum viz., CSV 17 and PVK 801 with an aim to improve animal fodder and have shown yield increase of 15% and 12% respectively over farmers' practice in Bidar. The multi cut forage sorghum yield on average 913 q/ha green fodder, it grows in all seasons with high density planting and fast growing generation ability to give 3-4 cuttings. Multi-purpose thornless cactus are being evaluated in Bidar and Chikkaballapur for its evaluation and subsequent value addition. In all the sites, aerobic composting was done using shredder machines for chopping on-farm wastes for composting and chopping fodder biomass. Gliricidia nurseries are being raised and transplanted on field bunds to generate N-rich organic soil on-site.

In addition, 45 training courses were held covering 2420 stakeholders including department officials, farm facilitators and farmers. A number of farmers both men and women from these districts were brought to ICRISAT to participate in the National Farmers' Day which provided them the opportunity to interact with women farmers from different states as well as be exposed to new technologies. Field Days were also conducted for dissemination of improved technologies. Considering the limitations of deficit rainfall, good progress has been achieved at the four additional districts.

## Background

Karnataka is primarily an agrarian state with more than 56% population depending on agriculture as major livelihood source. As per the population census in the year 2011, agriculture supports 13.74 million workers, of which 23.61 per cent are cultivators and 25.67 per cent agricultural workers. A total of 12.2 million ha of land is cultivated in Karnataka constituting 64.6% of the total geographical area of the state. The agricultural sector of Karnataka is characterized by vast steppes of drought- prone region and sporadic patches of irrigated area. Thus, a large portion of agricultural land in the state is exposed to the vagaries of monsoon with severe agro-climatic and resource constraints. A large number of workers depend on agriculture relative to the output it generates, resulting in lower labour productivity compared to non-agricultural sectors. Less than one-fifth of the state domestic product comes from more than 50% of the workforce in the state. This has serious implications for improving the welfare of rural population and poverty alleviation.

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.

The Hon'ble Chief Minister, Govt. of Karnataka, in his 2015-16 budget speech, has announced that "Bhoosamrudhi initiative will be scaled-up in a phased manner to all the districts and from 2015 additional four districts will be implementing the project to benefit large number of farmers". Further, during Review and Planning meeting of Bhoosamrudhi and Bhoochetana held at ICRISAT from 23 to 25 Feb 2015, Hon'ble Minister of Agriculture indicated that ICRISAT should provide technical backstopping for scaling-up Bhoosamrudhi in eight district namely Tumkur, Chikkamagaluru, Raichur and Vijayapura; Bidar, Dharwad, Chikkabalapur and Udupi. Now, Government of Karnataka has decided to scale it up in a phased manner to cover all the districts.

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 2015-16. This document reports the progress of Bhoosamrudhi in additional new four districts during 2016 crop season.

## Objectives

The specific objectives of this initiative are:

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

## Strategy

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

The salient strategies for the program are as follows:

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

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

## 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)
- Indian Institute of Horticulture Research (IIHR)

**State Agricultural Universities**

- University of Agricultural Sciences, Bengaluru, Dharwad, Raichur and Shivamogga
- 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)
- Department of Forestry

## Operational Details

Four additional new districts (Bidar, Chikkaballapur, Dharwad and Udupi) were selected for scaling-up of Bhoosamrudhi activities representing four revenue divisions (Bengaluru, Mysore, Raichur and Belgaum) since 2015 by converging different programs and schemes of line departments as depicted in Figure 1.

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.

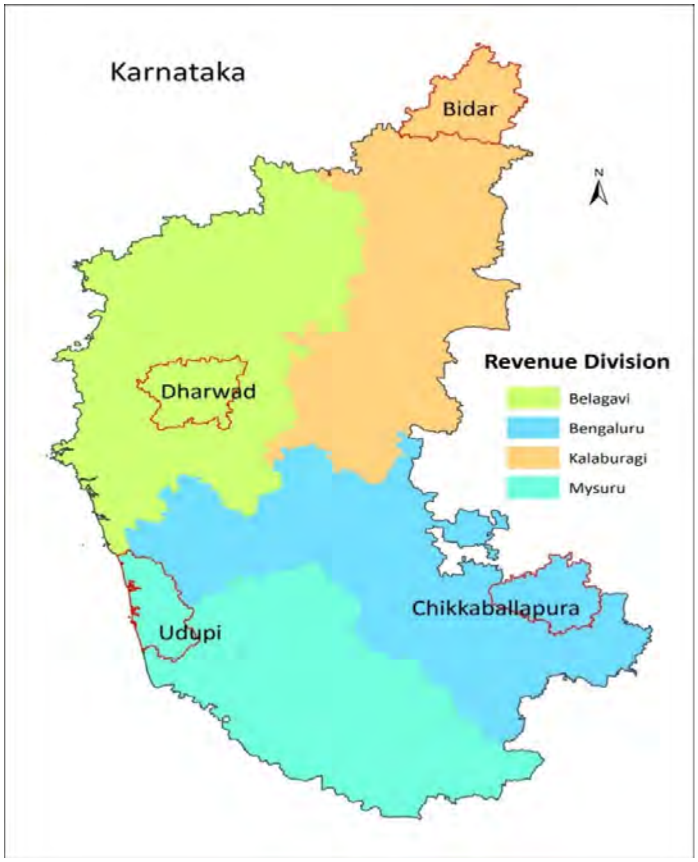



***Figure 1. Map of additional new districts from four revenue divisions of Karnataka.***

## Rainfall Situation in Southwest Monsoon 2016

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

During the period from 01 June to 30 September 2016, Karnataka State as a whole recorded an actual amount of 690 mm of rainfall as against the normal rainfall of 839 mm; the percentage departure from normal was -18% and was classified under Normal category. Rainfall received in different regions indicates that all regions have received lesser rainfall compared to their normals with coastal Karnataka showing largest deviation (Figure 2).

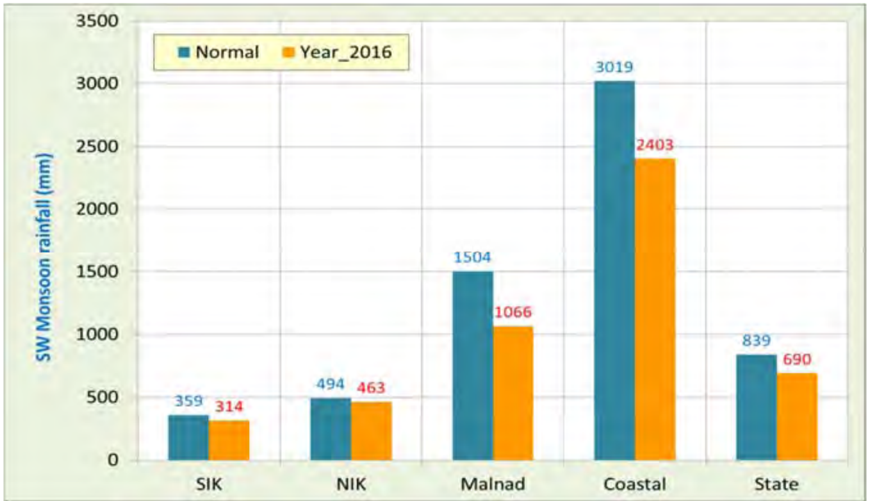



***Figure 2. Region-wise rainfall in Karnataka during Southwest Monsoon 2016***

| Table 1. Rainfall during southwest monsoon 2016 in pilot districts | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| District | Actual Rainfall (mm) | | | | Southwest monsoon | | | | Class |
| | Jun | Jul | Aug | Sep | Actual | Normal | Deviation | | |
| | | | | | mm | mm | mm | % | |
| Bidar | 176 | 212 | 84 | 429 | 901 | 685 | 216 | 32 | Excess |
| Chikkaballapura | 105 | 184 | 17 | 40 | 346 | 399 | -53 | -13 | Normal |
| Dharwad | 129 | 115 | 74 | 51 | 369 | 498 | -129 | -26 | Deficit |
| Udupi | 1225 | 990 | 663 | 283 | 3161 | 4071 | -910 | -22 | Deficit |

Data source: KSNDMC, Karnataka

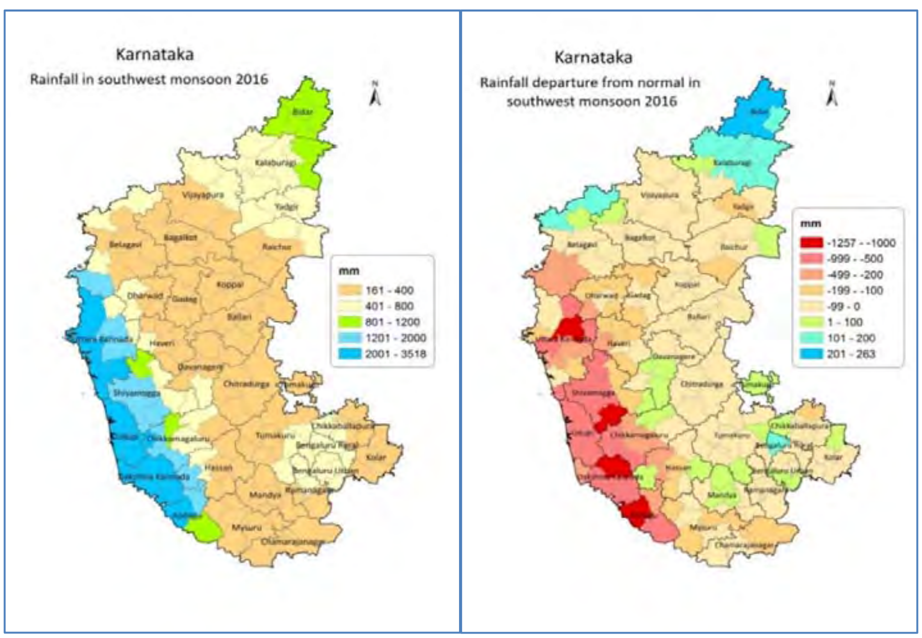



***Figure 3. Status of rainfall departure from normal during southwest monsoon 2016***

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

Out of the 4 districts, Bidar received "Excess" rainfall; Chikkaballapura received "Normal", while Dharwad and Udupi districts received "Deficit" rainfall during southwest monsoon 2016.

Out of the 9 pilot taluks in the four districts, only one taluk (Basavakalyan) received "Excess" rainfall and Bidar, Gowribidanur and Sidlaghatta taluks received "Normal" rainfall in the SW Monsoon period. Remaining five pilot taluks viz., Dharwad, Kalghatgi, Karkala, Navalgund and Kundapur received "Deficit" rainfall during the southwest monsoon 2016.

Week-by-week distribution of monsoon rainfall has shown that Bidar district has received more or less normal rainfall till middle of September and in the second fortnight of September received a very good rainfall of about 398 mm. Chikkaballapura district received good rainfall during the second fortnight of July and first week of August, later on rainfall was never above normal. Dharwad and Udupi districts experienced deficit rainfall from last week of July and continued till end of September.

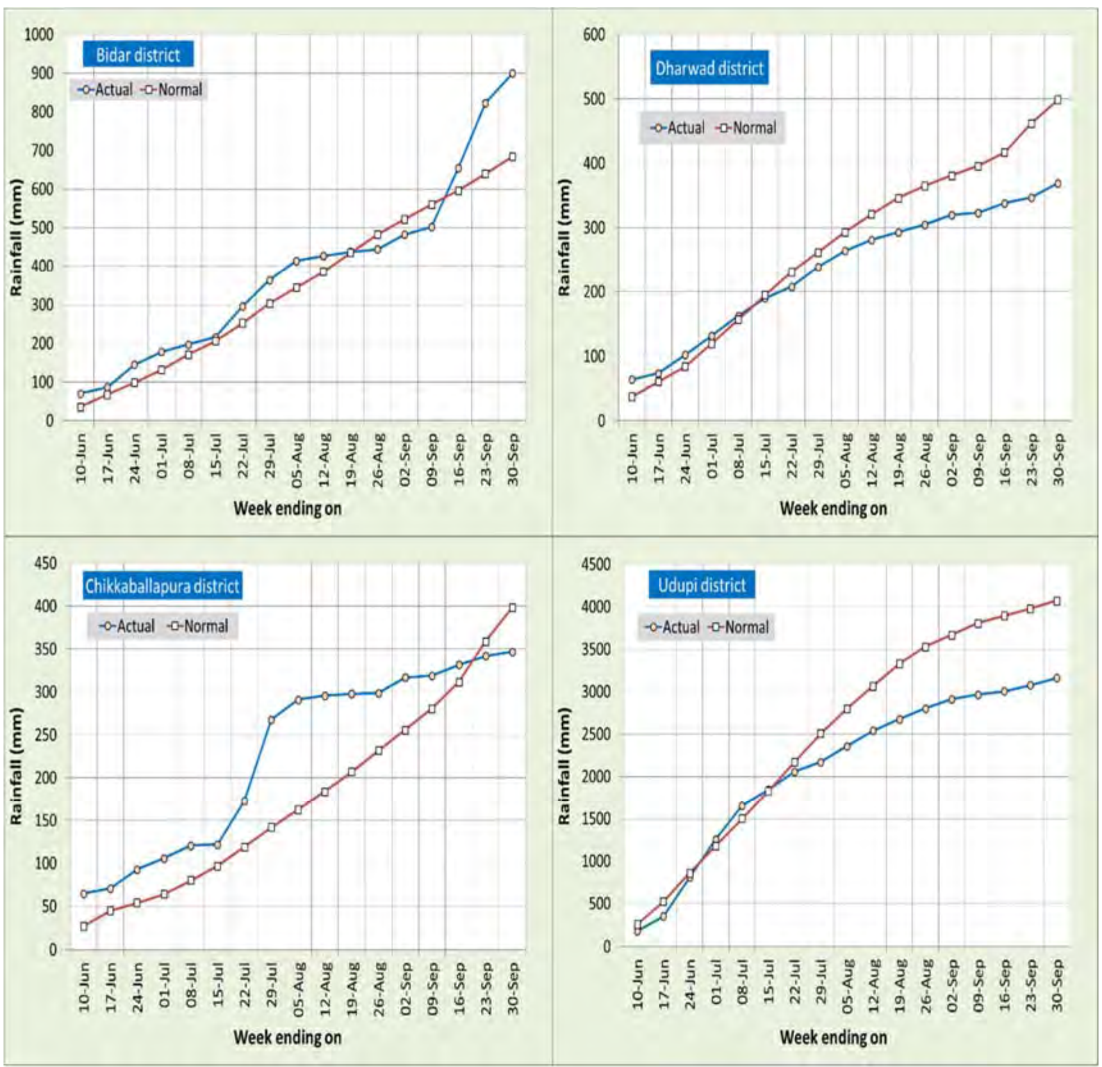



*Figure 4. Week-wise rainfall during Southwest monsoon 2016*

| Table 2. Rainfall during Southwest monsoon 2016 in pilot taluks of Bidar district | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Pilot taluk | Actual Rainfall (mm) | | | | Southwest monsoon | | | | Class |
| | Jun | Jul | Aug | Sep | Actual | Normal | Deviation | | |
| | | | | | mm | mm | mm | % | |
| Basavakalyan | 175 | 222 | 84 | 430 | 911 | 648 | 263 | 41 | Excess |
| Bidar | 183 | 231 | 82 | 390 | 886 | 747 | 139 | 19 | Normal |

| Table 3. Rainfall during Southwest monsoon 2016 in pilot taluks of Chikkaballapura district | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Pilot taluk | Actual Rainfall (mm) | | | | Southwest monsoon | | | | Class |
| | Jun | Jul | Aug | Sep | Actual | Normal | Deviation | | |
| | | | | | mm | mm | mm | % | |
| Gowribidanur | 140 | 223 | 10 | 61 | 434 | 384 | 50 | 13 | Normal |
| Sidlaghatta | 101 | 189 | 26 | 36 | 352 | 409 | -57 | -14 | Normal |

| Table 4. Rainfall during Southwest monsoon 2016 in pilot taluks of Dharwad district | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Pilot taluk | Actual Rainfall (mm) | | | | Southwest monsoon | | | | Class |
| | Jun | Jul | Aug | Sep | Actual | Normal | Deviation | | |
| | | | | | mm | mm | mm | % | |
| Dharwad | 142 | 152 | 108 | 62 | 464 | 593 | -129 | -22 | Deficit |
| Kalaghatagi | 176 | 146 | 99 | 40 | 461 | 719 | -258 | -36 | Deficit |
| Navalgund | 90 | 72 | 33 | 47 | 242 | 355 | -113 | -32 | Deficit |

| Table 5. Rainfall during Southwest monsoon 2016 in pilot taluks of Udupi district | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Pilot taluk | Actual Rainfall (mm) | | | | Southwest monsoon | | | | Class |
| | Jun | Jul | Aug | Sep | Actual | Normal | Deviation | | |
| | | | | | mm | mm | mm | % | |
| Kundapur | 1198 | 944 | 628 | 282 | 3052 | 4015 | -963 | -24 | Deficit |
| Karkala | 1196 | 1127 | 820 | 375 | 3518 | 4417 | -899 | -20 | Deficit |

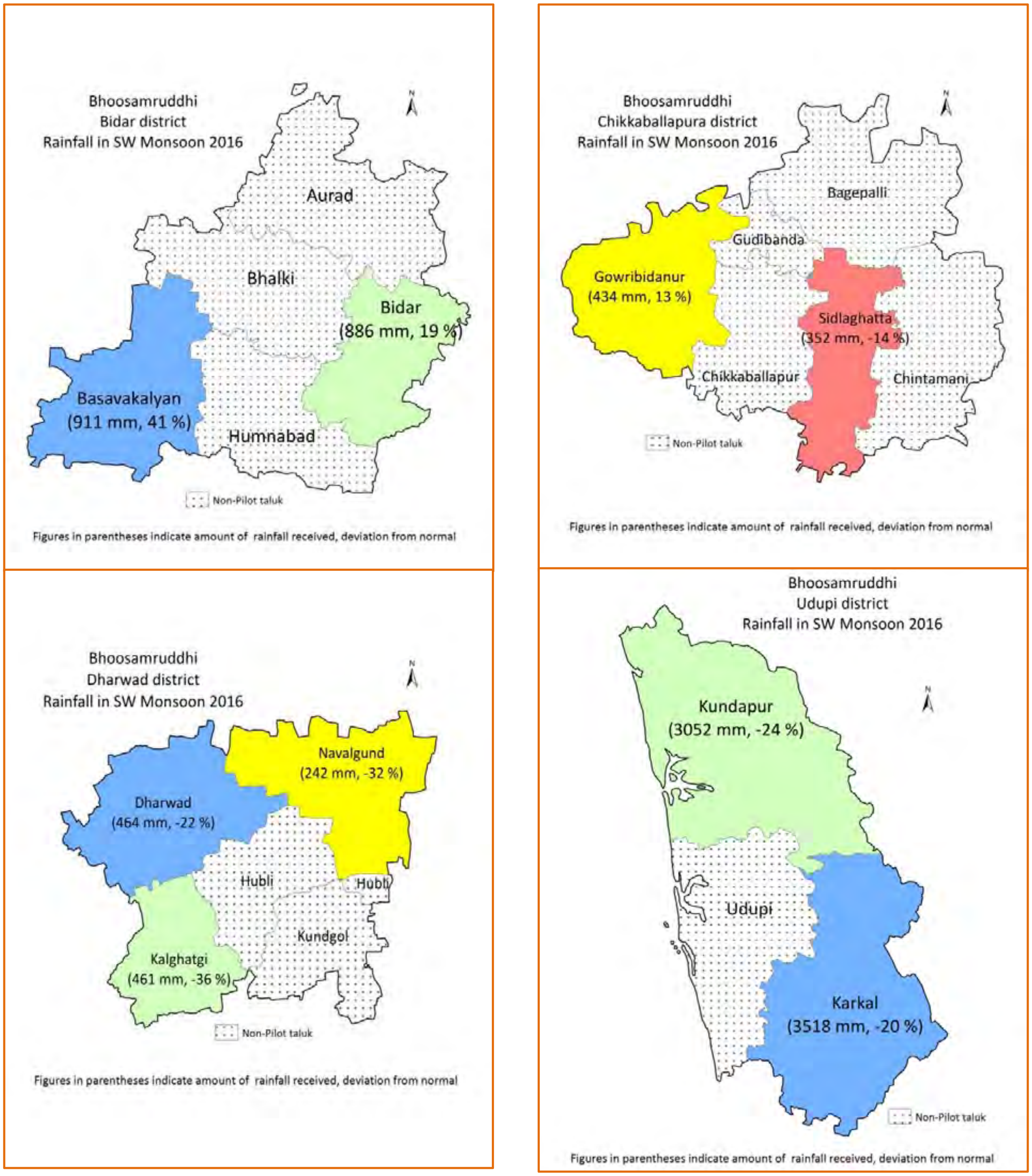



***Figure 5. Taluk-wise rainfall status during southwest monsoon 2016***

## Demonstration of Technologies in Pilot Districts

During 2016 crop season, number of improved cultivars have been demonstrated with farmers' participation across additional four districts. Number of improved crop cultivars such as groundnut, castor, pigeonpea, mungbean, blackgram, pearlmillet and chickpea along with rice were demonstrated to test and validate for up-scaling (Table 6). Districts like Bidar, Chikkaballapur and Dharwad, multi cut sorghum and dual purpose maize also demonstrated as fodder crops. Nearly 560 ha has been covered with above crops across four districts.

**Table 6. Area under improved cultivars (ha) and Direct Seeded Rice in selected districts under Bhoosamrudhi, Karnataka**

| **Crops** | **Bidar** | **Chikkaballapur** | **Dharwad** | **Udupi** |
|---|---|---|---|---|
| Groundnut | 0 | 20 | 5 | 0 |
| Castor | 0 | 10 | 0 | 0 |
| Pigeonpea | 100 | 10 | 20 | 0 |
| Mungbean | 30 | 0 | 25 | 20 |
| Blackgram | 30 | 0 | 0 | 25 |
| Pearlmillet | 0 | 10 | 0 | 0 |
| Multi cut sorghum | 40 | 10 | 10 | 0 |
| Dual purpose Maize | 0 | 10 | 5 | 0 |
| Rice | 0 | 0 | 0 | 100 |
| Direct Seeded Rice | 0 | 0 | 10 | 10 |
| Chickpea | 60 | 0 | 2 | 0 |
| **Total** | **260** | **70** | **77** | **155** |

Similarly, as in first phase districts, the focus is on mechanization to overcome labour scarcity as well as high wage rate. During the crop season, nearly 3000 ha demonstrated with mechanization such as zero-till multi crop planter, machine transplanting, lazer leveler, leaf color charts, BBF maker, easy planter, surface and sub-surface drip irrigation techniques. Among four additional districts, Bidar and Udupi have achieved the distinction as these districts have cultivated more than 1000 ha using different machineries (Table 7). Weed management was done using herbicides and leaf color charts were used mainly in Udupi for determining the N deficiency in rice crop. Such innovative technologies have been demonstrated and farmers have been educated to realize the benefits.

**Table 7. Area under mechanization (ha) in selected districts under Bhoosamrudhi in Karnataka**

| **Technologies** | Bidar | Chikkaballapur | Dharwad | Udupi |
|---|---|---|---|---|
| Zero-till multi planter | 10 | 0 | 6 | 0 |
| Machine transplanting | 0 | 0 | 0 | 740 |
| Laser levelling | 0 | 1 | 1 | 0 |
| Leaf color charts | 0 | 0 | 0 | 425 |
| BBF | 5 | 10 | 142 | 0 |
| Herbicides | 940 | 2 | 75 | 0 |
| Easy planter | 10 | 0 | 2 | 100 |
| Nipping | 500 | 5 | 0 | 0 |
| Surface and sub-surface drip irrigation | 0 | 0 | 5 | 0 |
| **Total** | **1465** | **18** | **231** | **1265** |

Information dissemination is an important activity in Bhoosamrudhi. During 2016 crop season, about 45 trainings organized covering about 2420 participants (Table 8). The major focus of these capacity building programs are educating farmers to adopt different technologies for achieving better results in agriculture and allied sectors. Resource persons were drawn from CGIAR centers, line departmenst and KVK scientists. Participants are both men and women representing wide array of education and social background with varied age group. In addition, number of field days were organized and benefited farmers.

**Table 8. Capacity building programes organised during 2016-17 under Bhoosamrudhi**

| Particulars | Bidar | Chikkaballapur | Dharwad | Udupi | |
|---|---|---|---|---|---|
| No. of trainings | 7 | 23 | 10 | 5 | |
| No. of participants | 931 | 955 | 455 | 81 | |

## District-wise Progress of Activities

### Bidar

In Bidar, five hoblis are selected covering around 40,000 ha area. 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.

**Balanced Nutrient Management**

***Soil test based fertilizer recommendation***

Based on ICRISAT initiatives adopted, ICRISAT along with DoA staff promoted soil test based balanced nutrient management on large scale. The Soil analysis results revealed wide spread deficiency of organic carbon, phosphorous, zinc and boron which are the major stumbling blocks for low productivity. Therefore, the focus was given to promote use of deficient secondary and micro nutrients along with major nutrients to address this issue. Altogether, ~28000 ha area.

***Land and water management***

As per the agro-economic situation, 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. To harness the full potential of soil moisture availability, broadbed and furrow system was introduced which is a multi-facilitated machine for wider implementation, particularly for sowing of all rainfed crops in black soils. During 2016-17, altogether, 100 ha area was covered under pigeonpea, green gram, blackgram and soybean crops (Figure 6).

***Figure 6. Improved crop cultivation method under Bhoosamrudhi in Bidar district***

The performance of prominent varieties of greengram and blackgram was evaluated by comparing with farmers' practice. The crop cutting studies revelead that the yield of greengram IPM 2-14 was about 10.3% higher compared to farmers' practice (Figure). Similarly, blackgram variety IPM 2-43 and T 9 have also shown increased yield over farmers' practice (Figure 7). The yield increment was about 9% and 16% for T 9 and IPM 2-14 varieties respectively.

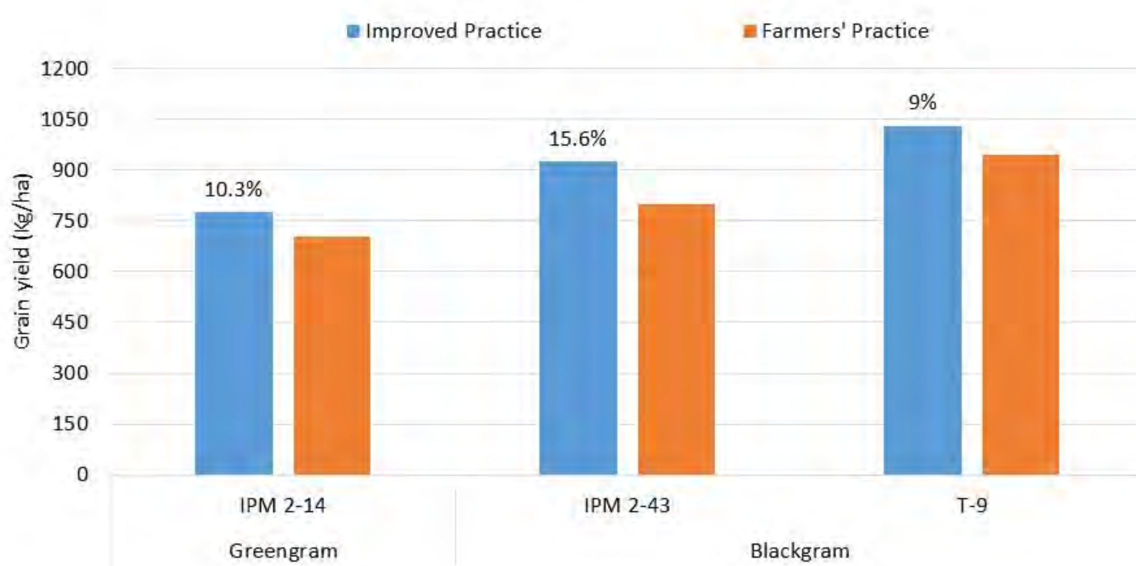



***Figure 7. Performance of greengram and blackgram in Bidar during kharif 2016***

**Mechanization**

During 2016-17, number of interventions are implemented to address water and labour scarcity, and energy. Since, number of crops grown in the district, during peak season, demand for labour is high. To overcome labour scarcity, number of interventions implemented with a focus on demonstrating mechanization under Bhoosamrudhi. The traditional drill being used by the farmers are not efficient and can be used for limited crops and under certain situations. 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 order to address the issue, introduced and evaluated multi-crop, planters which has the potential address the labour scarcity issue. Based on 2015-16 experience of 100 ha rea covering 150 farmers, this year extensive plan was developed to promote trash shredder machine for easy and sound establishment of sugarcane seedlings (Figure 8).

***Figure 8. Trash shredder demonstration under Bhoosamrudhi in Bidar***

**Crop Intensification and Diversification**

***Farmers' Participatory varietal evaluation***

Number of farmers' participatory demonstrations were evaluated for validating and ensuring selection of suitable cultivars for scaling up. Both pre-kharif, kharif and post kharif crops such as greengram, blackgram, groundnut, pigeonpea, sorghum, maize were demonstrated. 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.

Through farmers'participatory varietal evaluation, farmers were exposed to several improved varieties of crop 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. During 2016-17, crops evaluated include cereals and millets (sorghum, Pearl millet), pulses (pigeonpea, chickpea) and oilseed crops (groundnut, soybean) (Figure 9). An innovative method called nipping in pigeonpea was promoted to ensure good crop vegetation as well as yield which was a success in Bidar as most of the pigeonpea farmers adopted this techniques (Figure 10).

***Figure 9. Varietal evaluation of improved crop cultivars under Bhoosamrudhi in Bidar***

***Figure 10. Nipping machine demonstration in pigeonpea crop at Hokarana K Village, Bidar district***

The yield performance of groundnut is assessed using crop cutting studies and the result revealed that the ICGV 91114 with improved management practices shown yield increment of 13% compared to farmers' practice (Figure 11).


***Figure 11. Performance of groundnut (ICGV 91114) during kharif 2016 in Bidar district***

**Feed and Fodder Management**

During 2016-17, ILRI demonstrated dual purpose maize and forage sorghum covering 50 farmers. Similarly, ICARDA has introduced multipurpose thorn-less cactus (*Opuntia spp*.) in Bidar for its evaluation and subsequent value addition. During the crop season, about 600 cladodes are planted covering promising variety Cactus 1270 in Manhalli village in Manhalli taluk.

Sorghum was used as fodder for feeding animal in the district and ILRI along with ICRISAT and DoA promoted improved variety of sorghum CSV 17 and PVK 801. These varieties have shown yield increase of 14.8% and 12.4% respectively over farmers' practice (Figure 12).


***Figure 12. Performance of different varieties of sorghum in Bidar district during kharif 2016***

**Capacity Building**

All together nearly 500 stakeholders were trained on various aspects of agriculture and allied sectors. In addition, large number of farmers were exposed to number of technologies through field days and interaction meetings. The training on best management practices in sugarcane, soybean, chickpea particularly targeting integrated crop management (ICM) practices received good attention (Table 9 & Figure 13).

**Table 9. Capacity building programs in Bidar district during 2016-17**

| Training | Village | No. of Participants | Stakeholders |
|---|---|---|---|
| Bhoosamruddhi Awareness and Capacity Building Program to Farmers | All DoA and line department staffs and farmers | 75 | ICRISAT-DoA, CIMMYT, IRRI, LINE Depts |
| Use of trash shredder in sugarcane, Aerobic composting | Manahalli, Yakhatpur, | 276 | ICRISAT-DoA, CIMMYT, IRRI, LINE Depts |
| Participatory varietal evaluation | Manahalli, Budhera, Mirzapur | 25 | IRRI, ICRISAT |
| Landform management | Chintalgera, Manahalli, Ghouspur, Baroor | 120 | ICRISAT, IRRI, DoA, CIMMYT |
| Integrated pest management | Manahalli, Yakhatpur, Satoli, Baroor, Ghouspur | 150 | ICRISAT, IRRI, CIMMYT, DoA |
| Irrigation water management | Manahalli, Yakhatpur, Satoli, Baroor, Ghouspur | 40 | IRRI, ICRISAT |
| Nipping in Chickpea | All pilot site villages | 245 | ICRISAT, IRRI |

***Figure 13. Training on IPM in Manahalli Village under Bhoosamrudhi in Bidar district***

## Chikaballapur

For the bhoosamrudhi, two taluks viz., Siddlaghatta and Gowribidanur have been selected during 2016-17. Total geographical area of selected area is about 45,509 ha, with total cultivable area of 25,414 ha. The total number of farmers includes 21292. The area under agriculture component includes 15746 ha, horticulture 6090ha, sericulture 1782 ha and 1796 ha area under other allied departments (Table 10a). During 2016-17, fourteen model villages have been selected for technology interventions (Table 10b).

During 2016-17, several innovative interventions were undertaken with the help of consortium partners including line departments in the district. The major interventions are discussed below.

**Table 10a. Basic Information of the area selected for Bhoosamrudhi 2016-17**

| Name of Taluk | Name of the Hobli | Name of the Panchayath | No of villages | Geographical Area (ha) | Total Cultivable area (ha) | Total farmers | Name of model village |
|---|---|---|---|---|---|---|---|
| Gowribidanur | D Palya | B Bommasandra | 9 | 3163 | 1808 | 1860 | B Bommasandra |
| | | Namagondlu | 10 | 3487 | 2237 | 2075 | Namagondlu |
| | Kasaba | Gangasandra | 4 | 2371 | 1756 | 1026 | Kengenahalli |
| | | Hirebidanur | 7 | 2167 | 1443 | 1266 | Cheegatagere |
| | Manchenahalli | Gowdagere | 6 | 2061 | 1341 | 1260 | Gowdagere |
| | | Pura | 12 | 2589 | 1644 | 1252 | Arkunda |
| Sidlaghatta | Bashettihalli | TN halli | 5 | 3199 | 1009 | 1078 | G Kurabarahalli |
| | | Ganjigunte | 13 | 4112 | 2051 | 2416 | Ganjigunte |
| | Sadali | E Thimmasandra | 5 | 3837 | 1383 | 1059 | Kariyappanahalli |
| | | Talakayalabetta | 16 | 8550 | 5843 | 2896 | Autagollahalli |
| | Jangamkote | Hospete | 10 | 1914 | 1006 | 1320 | Hospete |
| | | J Venkatapura | 7 | 2889 | 1214 | 1314 | Baluvanahalli |
| | Kasaba | Y Hunasenahalli | 12 | 2981 | 1863 | 1614 | Chikkadasenahalli |
| | | Kundalagurki | 6 | 2189 | 816 | 856 | Kundagurki |
| **Total** | | | **122** | **45509** | **25414** | **21292** | |

**Table 10b. Basic Information of the Area selected for Bhoosamrudhi 2016-17**

| Name of Taluk | Name of the Hobli | Name of the Panchayath | Total Cultivable | Area Covered in (in ha) | | | | Total livestock population |
|---|---|---|---|---|---|---|---|---|
| | | | | Agri | Horti | Seri | Others | |
| Gowribidanur | D Palya | B Bommasandra | 1808 | 1200 | 553 | 20 | 35 | 6825 |
| | | Namagondlu | 2237 | 1137 | 966 | 19 | 114 | 8900 |
| | Kasaba | Gangasandra | 1756 | 904 | 565 | 16 | 271 | 7395 |
| | | Hirebidanur | 1443 | 1146 | 265 | 15 | 17 | 4793 |
| | Manchenahalli | Gowdagere | 1341 | 825 | 470 | 35 | 11 | 5725 |
| | | Pura | 1644 | 1125 | 432 | 57 | 30 | 6631 |
| Sidlaghatta | Bashettihalli | Ganjigunte | 2051 | 1851 | 80 | 80 | 40 | 4984 |
| | | Thimmanayakanahalli | 1009 | 365 | 263 | 96 | 285 | 13952 |
| | Sadali | E Thimmasandra | 1383 | 812 | 56 | 17 | 498 | 14683 |
| | | Talakayalabetta | 5843 | 3506 | 1461 | 584 | 292 | 4725 |
| | Jangamkote | Hospete | 1214 | 910 | 164 | 100 | 40 | 2068 |
| | | J Venkatapura | 1006 | 250 | 229 | 482 | 46 | 7270 |
| | Kasaba | Y Hunasenahalli | 1863 | 1256 | 300 | 200 | 107 | 2926 |
| | | Kundalagurki | 816 | 459 | 286 | 61 | 10 | 5287 |
| **Total** | | | **25414** | **15746** | **6090** | **1782** | **1796** | **96164** |

**Farmer's Participatory Varietal evaluation Demonstrations**

***Promotion of Pearl Millet: DhanShakti: ICTP8203-Fe/HHB67***

For addressing malnourishment, ICRISAT's high-Iron pearl millet variety ICTP 8203Fe was released as Dhanshakti. It is the first mineral biofortified crop cultivar. This variety was found to have the highest level of iron density among a diverse range of populations. HHB 67, released in 1990 by CCS Haryana Agricultural University, is one such single-cross pearl millet hybrid. It is highly popular because of its extra-early maturity (it needs less than 65 days from sowing to grain maturity). Under Bhoosamrudhi, pearl millet is promoted with the idea of crop diversification as Pearl Millet (Pennisetumglaucum) is grown for grain and stover in the hottest and driest areas where dryland crop production is possible. Nearly 30 ha has been covered with pearl millet majorly in Gauribidnur and Chikkaballapur taluks (Figure 14).

***Figure 14. Pearlmillet (ICTP 8203-Fe/HHB67) in Gouribidanur taluk, Chikkaballapur district***

**Groundnut - ICGV91114/02266/K9**

Groundnut is a major crop in both Siddlaghtta and Gouribidnur taluks. Generally farmer prefer local varietuy – TMV-2 in the district. But from past three years improved varieties which are drought tolerant and high yielding have been promoted and about 70 ha was planned to cultivate improved varieties of groundnut during 2016-17 crop season. However, about only 37 ha has been cultivated in both taluks due to rainfall variation (Figure 15).

***Figure 15. Groundnut – ICGV 91114 in Siddlaghtta and Gouribidnur taluks, Chikkaballapur district***

**Evaluation of castor**

As India is the leading producer of the castor, it has wide commercial usage and importance it has insecticidal and acaricidal properties. It is good trap and border crop. An unintended but important advantage to a castor bean project is that the plants absorb carbon dioxide, thereby reducing greenhouse gas accumulations in the atmosphere. The estimated carbon dioxide absorption level of castor bean plants is 34.6 tonnes per hectare, with two growing cycles per year, which offers another avenue for revenue in the form of carbon tax credits.

Some experiments shown that farmers has good yields in castor as border crop along bunds and on farm ponds for the last year 2015-16 .In the current season, many improved varieties like DCH 177, DCH519, JWALA, DCS 107 has been promoted in two taluks viz., Siddlaghatta and Gauribidanur the cumulative area covered is about 75.28 ha mostly as border crop and 2.4 ha under sole cropping (Figure 16). The crop is at harvesting stage with dried capsules and leaves in some fields and at maturity phase with capsules in some fields.

***Figure 16. Castor demonstration under Bhoosamrudhi in Chikkaballapur district***

**Diversification of cropping system**

To maintain sustainability in agriculture, diversification of maize with redgram was given importance, as maize is the exhaustive crops and redgram adds nutrients to the soil. About 130 ha target has reached in both Gouribidnur and Siddlaghatta taluks (Figure 17).

***Figure 17. Pigeonpea (BRG 1&2) intercrop with Maize under Bhoosamrudhi in Chikkaballapur district***

Under Bhoosamrudhi, the performance of pearl millet and maize were evaluated using different practices. Nearly 30 ha area has been covered with improved variety of pearl millet (HHB67) and compared with ICTP8203. The data revealed that improved variety of pearl millet was recorded about 1400 kg $ha^{-1}$ compared to 400 kg $ha^{-1}$ with ICTP 8203 (Table 11). Similarly, maize crop was cultivated using different land form treatments viz., broad-bed and furrow, lazer leveler and combination of BBF and lazer leveler. Farmers obtained higher yields where both lazer leveler and BBF was adopted – 3000 kg $ha^{-1}$ compared to normal practice (2440 kg $ha^{-1}$).

**Table 11. Performance of pearl millet and maize in Chikkaballapur district**

| Crop | Technology | Treatment | Yield (kg/ha) |
|---|---|---|---|
| Pearl Millet | Variety | HHB67 | 1400 |
| | | ICTP8203 | 400 |
| Maize | Land form treatment | Normal + BBF | 2440 |
| | | Lazer level | 2600 |
| | | Lazer Level + BBF | 3000 |

**Establishment of waste water treatment plants**

The main objective of this activity is to improve overall 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.

**Treatment technology: constructed wetlands**

Constructed wetlands are human-made wetlands built to remove various types of pollutants (sulfate, phosphate, nitrogen load, pathogens, etc) present in wastewater that flows through these systems (Figure 15).

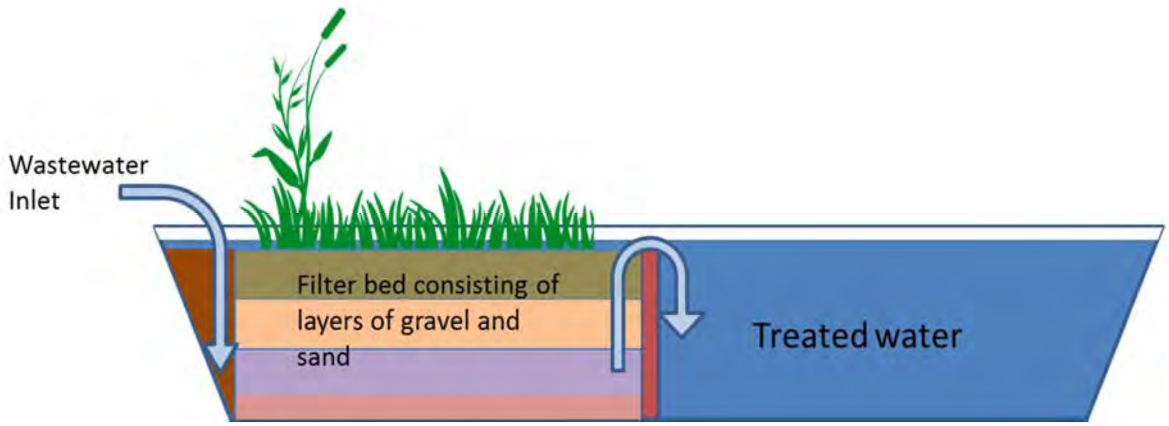



***Figure 25. Schematics of Constructed Wetland***

**Filter media**

- Layers of gravel and sand

**Vegetation**

- Local wetland vegetation such as Cat-tails, *Cana Indica*, water hyacinth, water lettace, etc

**Reuse of treated water**

- Non-edible crops such as lemongrass
- Fodder crop

**Site selection in Chickkballapur district**

Eight sites were visited in two taluks (Shidlaghatta and Gauribidanur) of Chikkballapur district (Figure 16). Five villages (M Kurubrehalli, Hotagolahalli, E Timmasundara, Kariyappanhalli, Gollahalli, and Hosapet) in Shidalgatta taluk and five villages (Namagondlu, Chigatagere, Veeralagollahalli, Gangasandra, and Arkunda) in Gowribidnur taluk were visited for site assessments.


***Figure 16. Sites visited in Chikkballapur district for assessment of suitability for wastewater treatment and reuse activity.***

**Site selection criteria:**

1. Number of households: 100-500
2. Good drainage facility for wastewater
3. Common land/Panchayat land availability for construction of DWT
4. Wastewater is being used for irrigation

**Table 12. Sites visited in Chikkballapur district for assessment of suitability for wastewater treatment and reuse activity**

| No | Location | Households contributing to wastewater | Good drainage facility | Government land availability | Wastewater reused | Suitabi-lity |
|---|---|---|---|---|---|---|
| 1 | Hotgolhalli, Shidlaghatta | <75 | Yes | No | Yes | No |
| 2 | E Timmasandra, Shidlaghatta | >200 | Yes | Yes | No | Yes |
| 3 | Kariappanhalli, Shidlaghatta | ~100 | Yes | No | No | No |
| 4 | M Kukubrehalli, Shidlaghatta | ~200 | Yes | No | No | No |
| 5 | Hosapet, Shidlaghatta | >150 | Yes | Yes | No | Yes |
| 6 | Gollahallil, Shidlaghatta | >100 | No | No | No | No |
| 7 | Chigatagere, Gauribidnur | >100 | Yes | Yes | No | Yes |
| 8 | Gangasandra, Gauribidnur | >150 | Yes | Yes | No | Yes |
| 9 | Namagondlu, Gauribidnur | >100 | Yes | Yes | No | Yes |
| 10 | Veeralagollahalli, Gauribidnur | >100 | Yes | No | No | No |
| 11 | Akrunda, Gauribidnur | >100 | Yes | No | Yes | No |

Note: Dark blue colored sites are potential sites to develop Wastewater treatment units

**Site 1 (Hotgolhalli village, Shidalgatta):**

- The number of families in this village is less (~50).
- Cemented channels available for wastewater disposal.
- Common land is not available for construction purpose
- Farmers are presently using the wastewater for irrigation, but very small area
- **Thus, this site may not be suitable**


***Figure 17. Location of Site 1 (Hotgolhalli village, Shidalgatta)***

**Site 2 (E Timmasandra village, Shidalgatta)**

- Households in this village are more than 200.
- Earlier site identified in this village was on the edge of water storage tank. Currently this water tank is over flowing due to recent heavy rain. Thus, we have identified new site.
- Cemented channels available for wastewater disposal.
- Common land is available for construction purpose
- Farmers are not using the wastewater for irrigation, but the wastewater is disposed into large water harvesting structure
- **This site is suitable**


***Figure 18. Location of Site 2 (E Timmasundara village, Shidalgatta)***

**Design of DWT**

- Table  show the design parameters and approximately cost of DWT.
- Drains need to be diverted to collect wastewater from two side of village
- Assumptions for designing the DWT
    - Number of household connected to wastewater drains = 300
    - Average size of house hold = 5
    - Average daily use of water per person = 40 liters
    - Wastewater generation (percentage of water use) = 80%
    - Hydraulic retention time = 3 days
    - Width of wetland = 6 m
    - Depth of wetland = 0.8 m
    - Root stock of *Canna Indica/ typha/ paragrass* to be planted in wetland at 0.5 m spacing

**Table 13. Decentralized wastewater treatment system for Site 2 (E Timmasundara)**

| Sr No | Item | Quantity | Unit |
|---|---|---|---|
| 1 | Number of households connected to common drainage | 300 | Numbers |
| 2 | Domestic water consumption | 60 | m3/d |
| 3 | Wastewater generation | 48 | m3/d |
| 4 | Initial design hydraulic retention time (days) | 3 | days |
| 5 | Required volume of wetland considering 3 day HRT and 0.5 porosity | 288 | m3 |
| 6 | Depth of wetland | 0.8 | m |
| 7 | Width of wetland | 6 | m |
| 8 | Length | 60 | m |
| 9 | Sedimentation tank | | |
| 9.1 | Length | 1 | m |
| 9.2 | Width | 5 | m |
| 9.3 | Depth | 1.5 | m |
| 10 | Filter bed – Quantity of gravel and sand required for filter bed | | |
| 10.1 | Sand (top 0.2 m layer) | 72 | m3 |
| 10.2 | 10 mm gravel (0.2 m layer below sand layer) | 72 | m3 |
| 10.3 | 20 mm gravel (0.2 m layer below 10 mm gravel layer) | 72 | m3 |
| 10.5 | 40 mm gravel (0.2 m layer below 40 mm gravel layer) | 72 | m3 |
| 11 | Storage tank – minimum capacity | 480 | m3 |
| 12 | Cost (this may change location wise) | | |
| 12.1 | Excavation (@80 per m3) | 61,440.00 | Rs |
| 12.2 | Sand and gravel (@ Rs 850 per m3) | 244,800.00 | Rs |
| 12.3 | Labor cost (Rs 350 per m3) | 100,800.00 | Rs |
| 12.4 | Cost of vegetation plantation | 50,000.00 | Rs |
| 13 | Approximate cost | 457,040.00 | Rs |

### Schematics of DWT

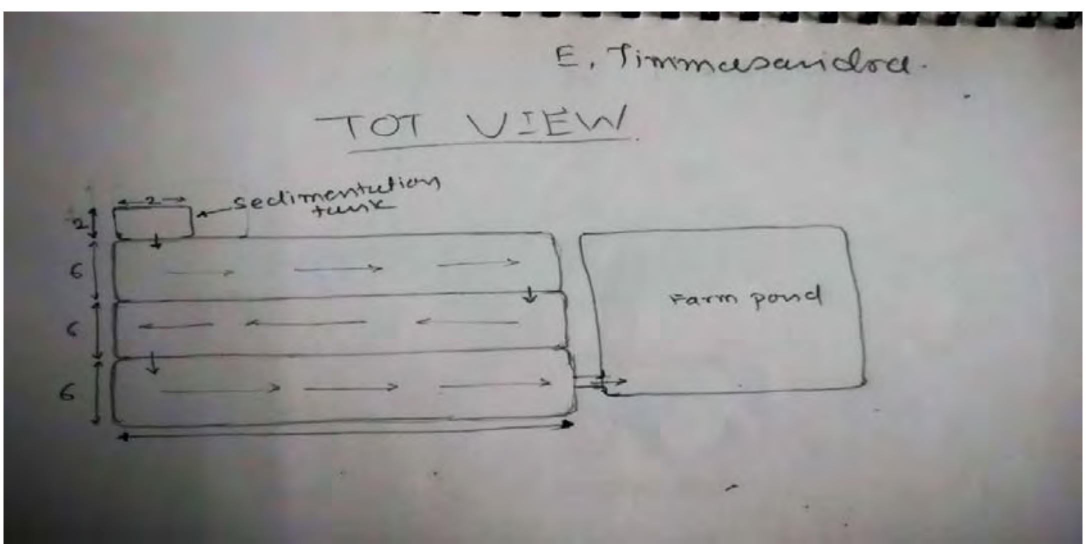



***Figure 19. Top view of the DWT showing three constructed wetlands, storage water tank, road, open well, and wastewater drain (E Timmasundara)***

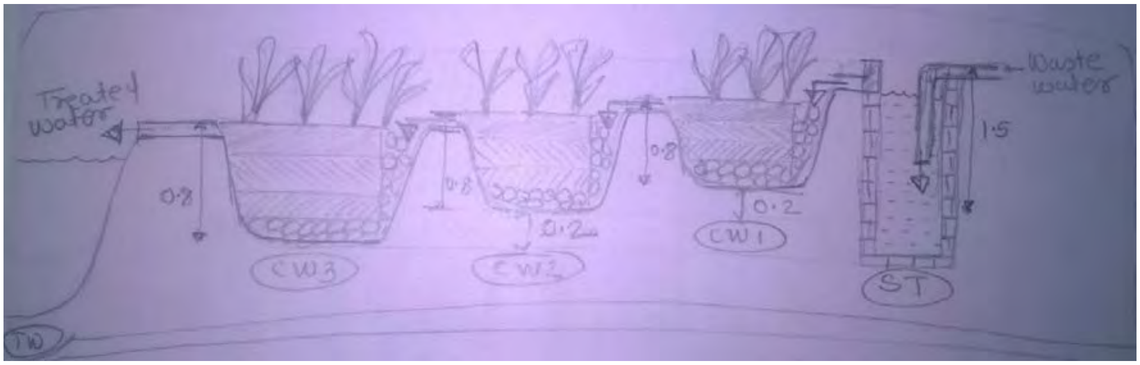


*Figure 20. Side view of the interconnected three constructed wetlands, sedimentaion tank , and storage water tank (E Timmasundara)*

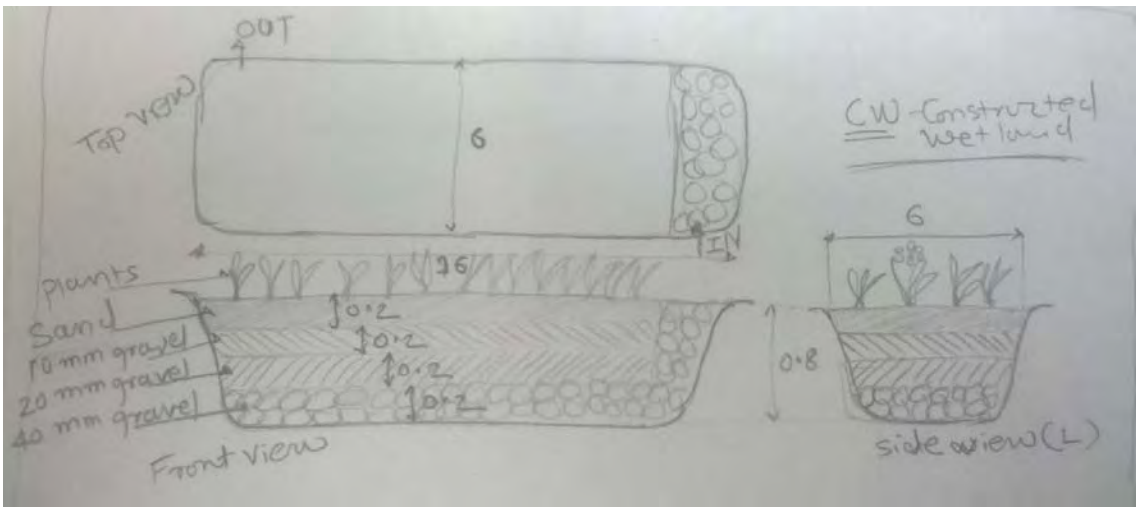


*Figure 21. Top, front, and side view of constructed wetland showing configuration of sand and gravel layers (E Timmasundara)*

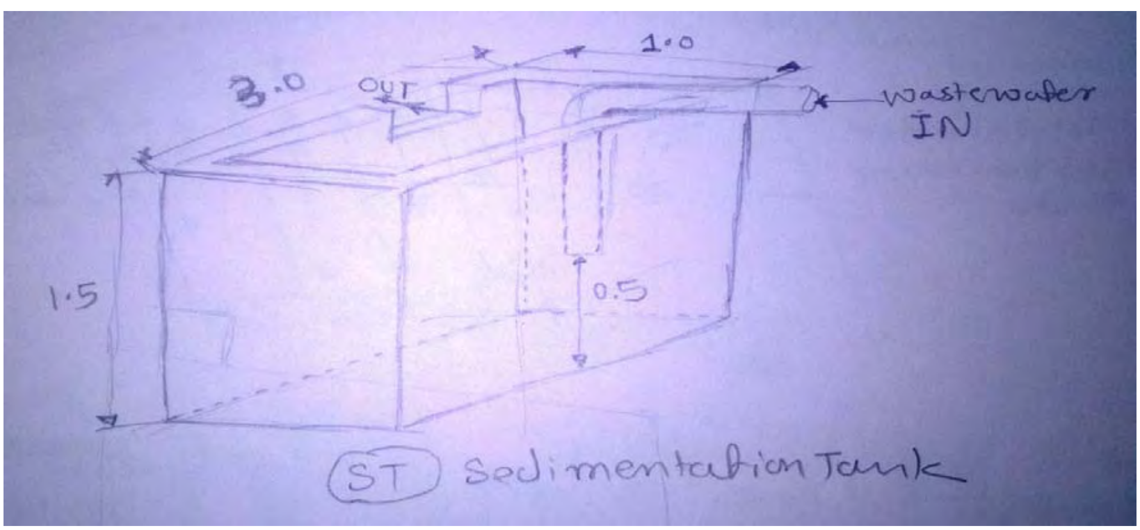


*Figure 22. Isometric view of sedimentation tank showing inlet pipe (E Timmasundara)*

**Site 3 (Kariayappanhalli, Shidalgatta):**

- Households in this village are around 100.
- Cemented channels available for wastewater disposal.
- Common land is available for construction purpose, but 150 meters away from the end of the cemented drain.
- Farmers are not using the wastewater for irrigation,
- **This site is suitable, if the wastewater drain extended to the common land**


***Figure 23. Location of Site 3 (Kariyappanhalli)***

**Design of DWT**

- Root stock of *Canna Indica/ typha/ paragrass* to be planted in wetland at 0.5 m spacing
- show the design parameters and approximately cost of DWT.
- The cemented drain for carrying the wastewater is constructed till the end of the village. After this, wastewater flows through unstructured earthen drain. Thus, cemented drain needs to be extended (~150 m) to site of DWT.
- Assumptions for designing the DWT
  - Number of household connected to wastewater drains = 100
  - Average size of house hold = 5
  - Average daily use of water per person = 40 liters
  - Wastewater generation (percentage of water use) = 80%
  - Hydraulic retention time = 3 days
  - Width of wetland = 6 m
  - Depth of wetland = 0.8 m
  - Root stock of *Canna Indica/ typha/ paragrass* to be planted in wetland at 0.5 m spacing

| Table 14. Decentralized wastewater treatment system for Site 3 (Kariyappanhalli) | | | |
|---|---|---|---|
| **Sr No** | **Item** | **Quantity** | **Unit** |
| 1 | Number of households connected to common drainage | 100 | Numbers |
| 2 | Domestic water consumption | 20 | m3/d |
| 3 | Wastewater generation | 16 | m3/d |
| 4 | Initial design hydraulic retention time (days) | 3 | days |
| 5 | Required volume of wetland considering 3 day HRT and 0.5 porosity | 96 | m3 |
| 6 | Depth of wetland | 0.8 | m |
| 7 | Width of wetland | 6 | m |
| 8 | Length | 20 | m |
| 9 | Sedimentation tank | | |
| 9.1 | Length | 1 | m |
| 9.2 | Width | 5 | m |
| 9.3 | Depth | 1.5 | m |
| 10 | Filter bed – Quantity of gravel and sand required for filter bed | | |
| 10.1 | Sand (top 0.2 m layer) | 24 | m3 |
| 10.2 | 10 mm gravel (0.2 m layer below sand layer) | 24 | m3 |
| 10.3 | 20 mm gravel (0.2 m layer below 10 mm gravel layer) | 24 | m3 |
| 10.5 | 40 mm gravel (0.2 m layer below 40 mm gravel layer) | 24 | m3 |
| 11 | Storage tank – minimum capacity | 160 | m3 |
| 12 | Cost (this may change location wise) | | |
| 12.1 | Excavation (@80 per $m^3$) | 20,480.00 | Rs |
| 12.2 | Sand and gravel (@ Rs 850 per $m^3$) | 81,600.00 | Rs |
| 12.3 | Labor cost (Rs 350 per m3) | 33,600.00 | Rs |
| 12.4 | Cost of vegetation plantation | 50,000.00 | Rs |
| 13 | Approximate cost | 185,680.00 | Rs |

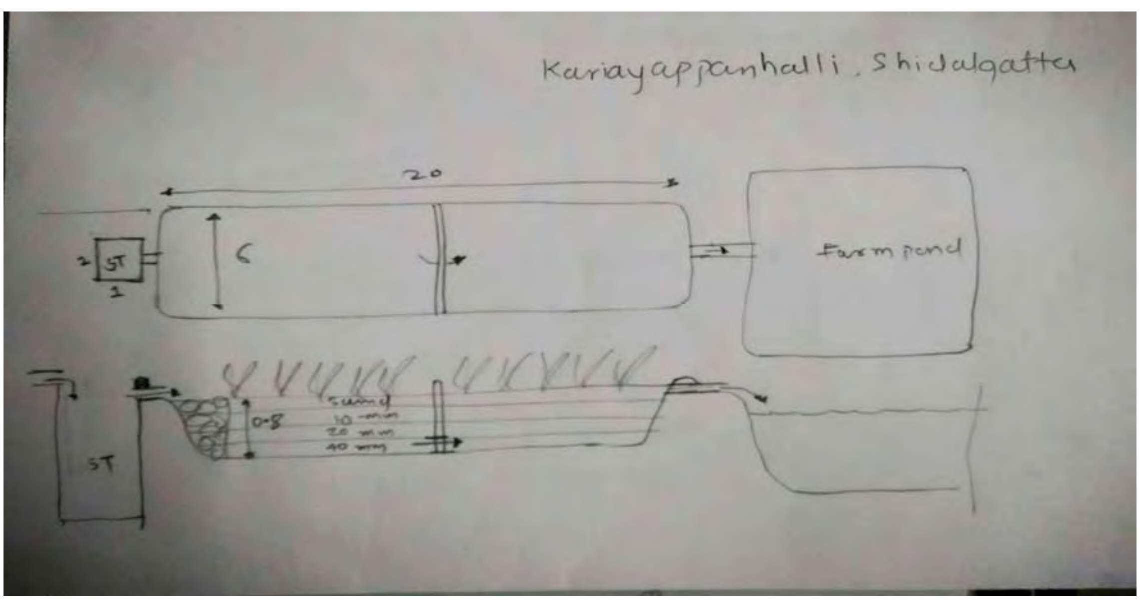



*Figure 24. Schematics of constructed wetland*

**Site 4 (M Kurubrehalli):**

- Households in this village are around 200.
- Cemented channels available for wastewater disposal.
- Common land is not available for construction purpose.
- **Site may be suitable, but common land is not available for construction**


***Figure 25. Locaiton of Site 4 (M Kurubrehalli)***

**Site 5 (Hosapet, Shidlaghatta)**

- Households contributing wastewater to this location are more than 150.
- Cemented channels available for wastewater disposal, but government land is not available at the end of drainage
- As per the villagers, small patch of government land is available at about 150 m away from this point. (presently wastewater is flowing on the road after the end point of drainage)
- This location may be suitable, if enough land is available for treatment plan (need to be discussed with grampanchayat) as vegetation need to be cleared from the site of construction.

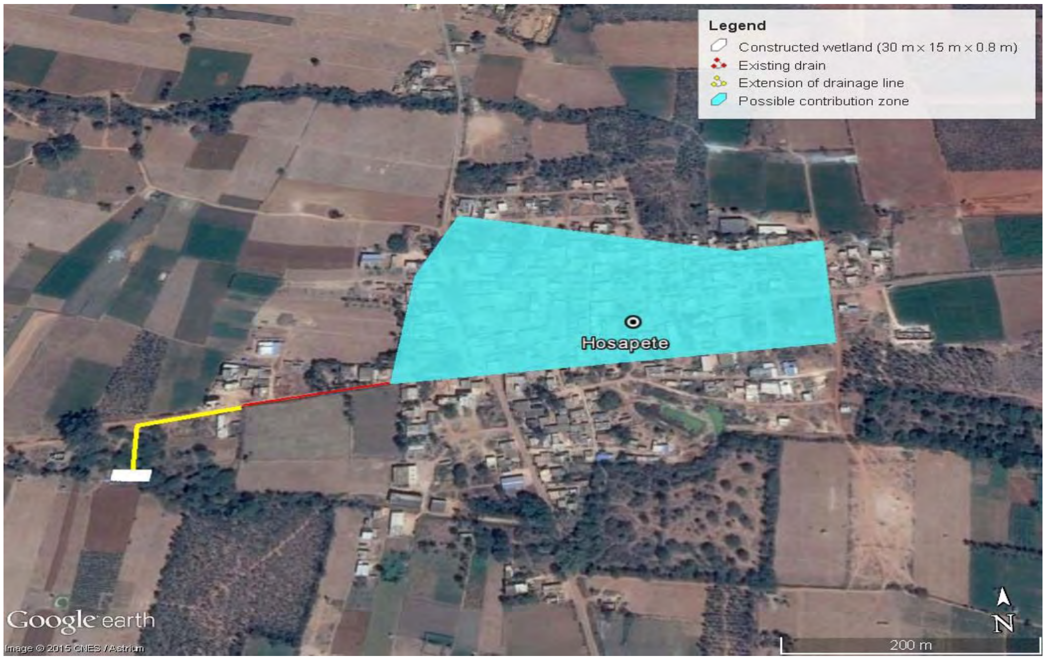



***Figure 26. Identified site in Hosapete village of Shidalagatta taluk***

***Figure 27. Wastewater flowing on the road after enf of cemented drain (left) and existing vegetation at identified location.***

**Design of DWT**

- Table  show the design parameters and approximately cost of DWT.
- The cemented drain for carrying the wastewater is constructed till the end of the village. After this, wastewater flows on the road. Thus, cemented drain needs to be extended (~150 m) to site of DWT.
- Vegetation is required to be cleared for construction of wetland.
- Assumptions for designing the DWT
    - Number of household connected to wastewater drains = 150
    - Average size of house hold = 5
    - Average daily use of water per person = 40 liters
    - Wastewater generation (percentage of water use) = 80%
    - Hydraulic retention time = 3 days
    - Width of wetland = 6 m
    - Depth of wetland = 0.8 m
    - Root stock of *Canna Indica/ typha/ paragrass* to be planted in wetland at 0.5 m spacing

| Table 15. Decentralized wastewater treatment system for Site 3 (Hosapete) | | | |
|---|---|---|---|
| **S No** | Item | Quantity | Unit |
| 1 | Number of households connected to common drainage | 150 | Numbers |
| 2 | Domestic water consumption | 30 | m3/d |
| 3 | Wastewater generation | 24 | m3/d |
| 4 | Initial design hydraulic retention time (days) | 3 | days |
| 5 | Required volume of wetland considering 3 day HRT and 0.5 porosity | 144 | m3 |
| 6 | Depth of wetland | 0.8 | m |
| 7 | Width of wetland | 6 | m |
| 8 | Length | 5 | m |
| 9 | Sedimentation tank | | |
| 9.1 | Length | 1 | m |
| 9.2 | Width | 5 | m |
| 9.3 | Depth | 1.5 | m |
| 10 | Filter bed – Quantity of gravel and sand required for filter bed | | |
| 10.1 | Sand (top 0.2 m layer) | 36 | m3 |
| 10.2 | 10 mm gravel (0.2 m layer below sand layer) | 36 | m3 |
| 10.3 | 20 mm gravel (0.2 m layer below 10 mm gravel layer) | 36 | m3 |
| 10.5 | 40 mm gravel (0.2 m layer below 40 mm gravel layer) | 36 | m3 |
| 11 | Storage tank – minimum capacity | 240 | m3 |
| 12 | Cost (this may change location wise) | | |
| 12.1 | Excavation (@80 per $m^3$) | 30,720.00 | Rs |
| 12.2 | Sand and gravel (@ Rs 850 per $m^3$) | 122,400.00 | Rs |
| 12.3 | Labor cost (Rs 350 per m3) | 50,400.00 | Rs |
| 12.4 | Cost of vegetation plantation | 50,000.00 | Rs |
| 13 | Approximate cost | 253,520.00 | Rs |

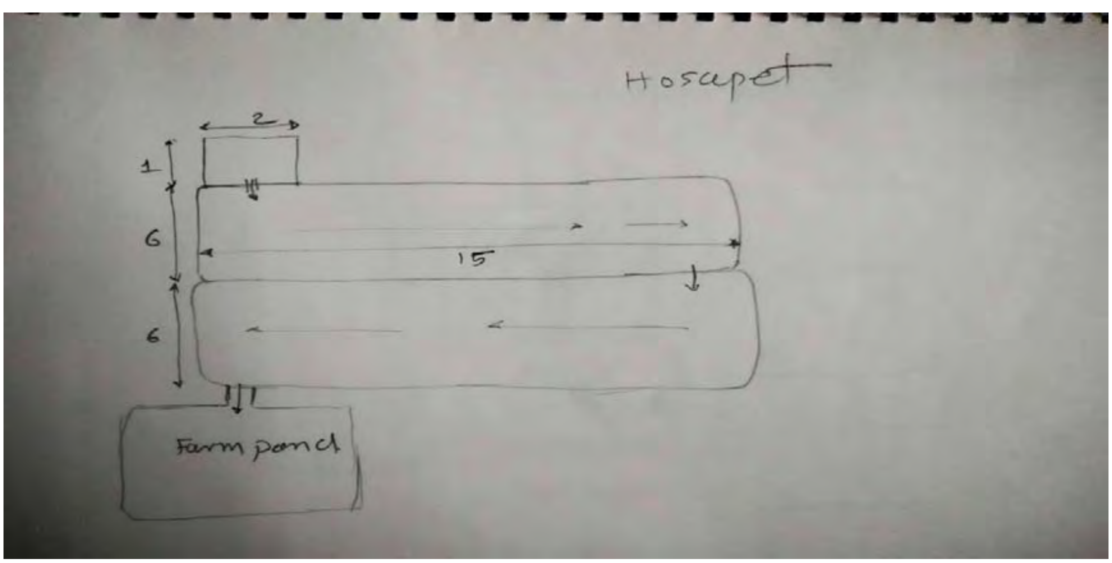



***Figure 28. Schematics of constructed wetland***

**Site 6 (Gollahalli, Shidlaghatta)**

- Households contributing wastewater to this location are more than 100.
- Cemented channels is available for wastewater disposal, but government land is not available at the end of drainage
- **This location may not be suitable**

**Site 7 (Chigatagere village, Gauribidanur)**

- Households contributing to this end of the drainage line are more than 100.
- Cemented channels available till end of the wastewater disposal point. Wastewater is being disposed into big tank. This tank is currently empty.
- The land of this tank belong to government.
- **This site is suitable as as constructed wetland may be prepared along the boundary of the tank.**


***Figure 29. Identified location for constructed wetland in Chigatagere village of Gauribidnur taluk***

**Design of DWT**

- Table show the design parameters and approximately cost of DWT.
- The wetland need to be constructed along the boundary of tank.
- Wall of the wetland should the high enough to avoid entry of water from tank.
- Assumptions for designing the DWT
  - Number of household connected to wastewater drains = 150
  - Average size of house hold = 5
  - Average daily use of water per person = 40 liters
  - Wastewater generation (percentage of water use) = 80%
  - Hydraulic retention time = 3 days
  - Width of wetland = 6 m
  - Depth of wetland = 0.8 m
  - Root stock of *Canna Indica/ typha/ paragrass* to be planted in wetland at 0.5 m spacing

| Table 16. Decentralized wastewater treatment system for Site 3 (Chigatagere) | | | |
|---|---|---|---|
| Sr No | Item | Quantity | Unit |
| 1 | Number of households connected to common drainage | 150 | Numbers |
| 2 | Domestic water consumption | 30 | m3/d |
| 3 | Wastewater generation | 24 | m3/d |
| 4 | Initial design hydraulic retention time (days) | 3 | days |
| 5 | Required volume of wetland considering 3 day HRT and 0.5 porosity | 144 | m3 |
| 6 | Depth of wetland | 0.8 | m |
| 7 | Width of wetland | 6 | m |
| 8 | Length | 30 | m |
| 9 | Sedimentation tank | | |
| 9.1 | Length | 1 | m |
| 9.2 | Width | 5 | m |
| 9.3 | Depth | 1.5 | m |
| 10 | Filter bed – Quantity of gravel and sand required for filter bed | | |
| 10.1 | Sand (top 0.2 m layer) | 36 | m3 |
| 10.2 | 10 mm gravel (0.2 m layer below sand layer) | 36 | m3 |
| 10.3 | 20 mm gravel (0.2 m layer below 10 mm gravel layer) | 36 | m3 |
| 10.5 | 40 mm gravel (0.2 m layer below 40 mm gravel layer) | 36 | m3 |
| 11 | Storage tank – minimum capacity | 240 | m3 |
| 12 | Cost (this may change location wise) | | |
| 12.1 | Excavation (@80 per $m^3$) | 30,720.00 | Rs |
| 12.2 | Sand and gravel (@ Rs 850 per $m^3$) | 122,400.00 | Rs |
| 12.3 | Labor cost (Rs 350 per m3) | 50,400.00 | Rs |
| 12.4 | Cost of vegetation plantation | 50,000.00 | Rs |
| 13 | Approximate cost | 253,520.00 | Rs |

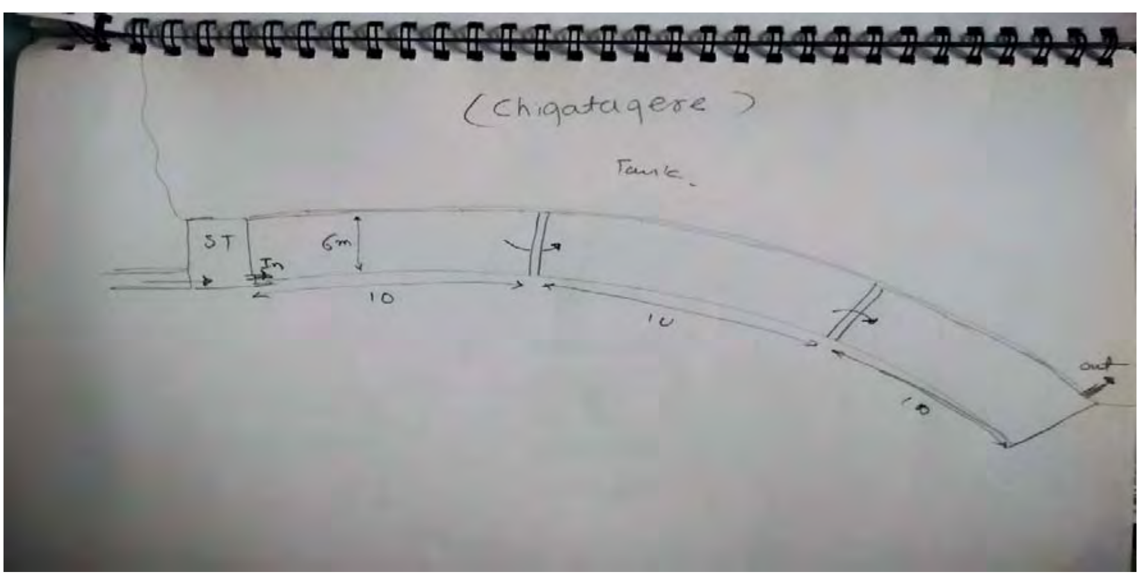



***Figure 30. Schematics of constructed wetland***

***Figure 31. Wastewater treatment units constructed at Chhagattegere in Chikkaballapur district***

**Site 8 (Gangasandra village, Gauribidanur)**

- Households contributing to this end of the drainage line are more than 200.
- Cemented channel is available for carrying wastewater, but need to be extended till end of the wastewater disposal point. Wastewater is being disposed into natural depression.
- There is small patch of land at higher elevation that the natural depression, which may be used for construction of wetland

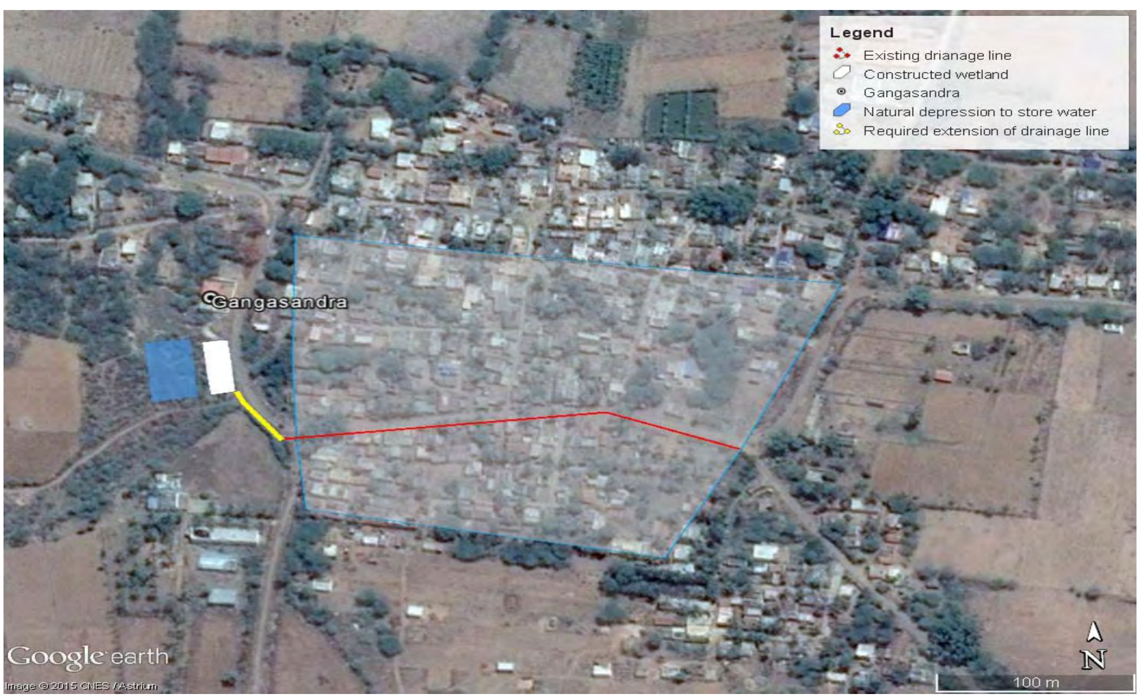



***Figure 32. Identified location for constructed wetland in Gangasandra village of Gauribidnur taluk***

**Design of DWT**

- Table show the design parameters and approximately cost of DWT.
- Assumptions for designing the DWT
  - Number of household connected to wastewater drains = 150
  - Average size of house hold = 5
  - Average daily use of water per person = 40 liters
  - Wastewater generation (percentage of water use) = 80%
  - Hydraulic retention time = 3 days
  - Width of wetland = 6 m
  - Depth of wetland = 0.8 m
  - Root stock of *Canna Indica/ typha/ paragrass* to be planted in wetland at 0.5 m spacing

**Table 17. Decentralized wastewater treatment system for Site 3 (Gangasandra)**

| **Sr No** | Item | Quantity | Unit |
|---|---|---|---|
| 1 | Number of households connected to common drainage | 150 | Numbers |
| 2 | Domestic water consumption | 30 | m3/d |
| 3 | Wastewater generation | 24 | m3/d |
| 4 | Initial design hydraulic retention time (days) | 3 | days |
| 5 | Required volume of wetland considering 3 day HRT and 0.5 porosity | 144 | m3 |
| 6 | Depth of wetland | 0.8 | m |
| 7 | Width of wetland | 6 | m |
| 8 | Length | 30 | m |
| 9 | Sedimentation tank | | |
| 9.1 | Length | 1 | m |
| 9.2 | Width | 5 | m |
| 9.3 | Depth | 1.5 | m |
| 10 | Filter bed – Quantity of gravel and sand required for filter bed | | |
| 10.1 | Sand (top 0.2 m layer) | 36 | m3 |
| 10.2 | 10 mm gravel (0.2 m layer below sand layer) | 36 | m3 |
| 10.3 | 20 mm gravel (0.2 m layer below 10 mm gravel layer) | 36 | m3 |
| 10.5 | 40 mm gravel (0.2 m layer below 40 mm gravel layer) | 36 | m3 |
| 11 | Storage tank – minimum capacity | 240 | m3 |
| 12 | Cost (this may change location wise) | | |
| 12.1 | Excavation (@80 per $m^3$) | 30,720.00 | Rs |
| 12.2 | Sand and gravel (@ Rs 850 per $m^3$) | 122,400.00 | Rs |
| 12.3 | Labor cost (Rs 350 per m3) | 50,400.00 | Rs |
| 12.4 | Cost of vegetation plantation | 50,000.00 | Rs |
| 13 | Approximate cost | 253,520.00 | Rs |

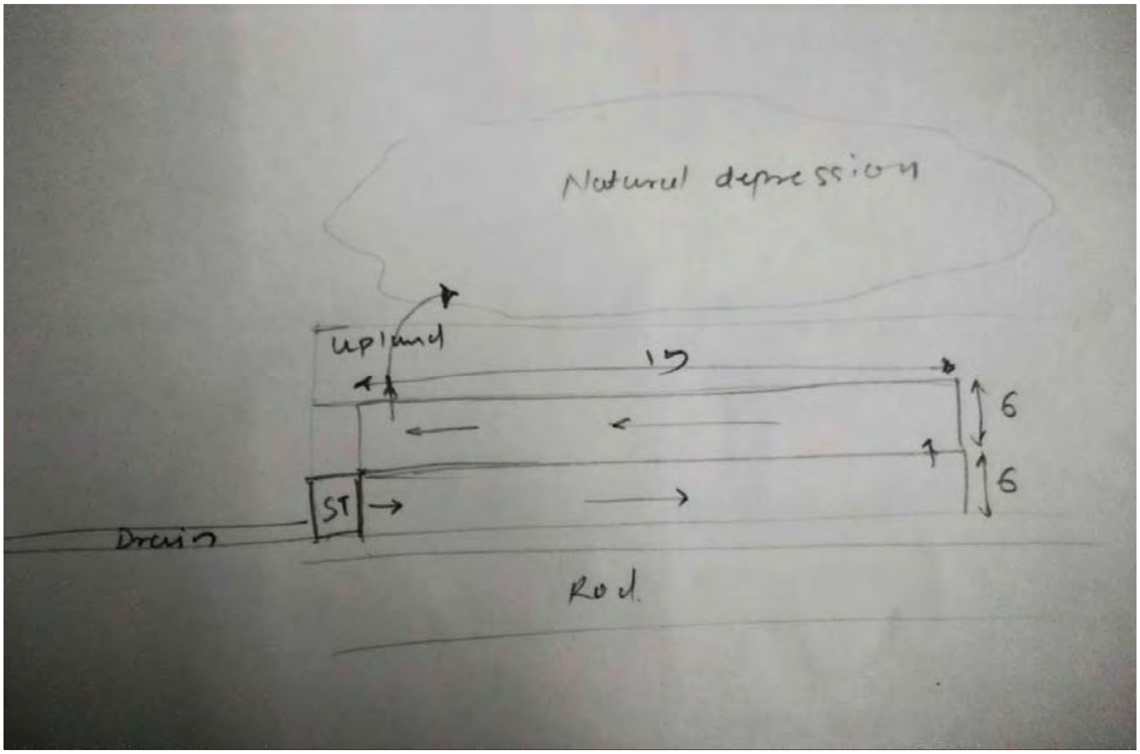



***Figure 33. Schematics of constructed wetland***

**Site 9 (Namagondlu village, Gauribidanur)**

- Households contributing to this end of the drainage line are more than 150.
- Cemented channel is available in some part of village for carrying wastewater, but need to be extended till end of the wastewater disposal point. Wastewater is being disposed into a pond that has been eutrophicated.
- Half portion of this pond may be used for construction of wetland and other half of the pond for water storage.

**Design of DWT**

- Table show the design parameters and approximately cost of DWT.
- Assumptions for designing the DWT
  - Number of household connected to wastewater drains = 200
  - Average size of house hold = 5
  - Average daily use of water per person = 40 liters
  - Wastewater generation (percentage of water use) = 80%
  - Hydraulic retention time = 3 days
  - Width of wetland = 6 m
  - Depth of wetland = 0.8 m
  - Root stock of *Canna Indica/ typha/ paragrass* to be planted in wetland at 0.5 m spacing

| Table 18. Decentralized wastewater treatment system for Site 3 (Namagondlu) | | | |
|---|---|---|---|
| **Sr No** | Item | Quantity | Unit |
| 1 | Number of households connected to common drainage | 200 | Numbers |
| 2 | Domestic water consumption | 40 | m3/d |
| 3 | Wastewater generation | 32 | m3/d |
| 4 | Initial design hydraulic retention time (days) | 3 | days |
| 5 | Required volume of wetland considering 3 day HRT and 0.5 porosity | 192 | m3 |
| 6 | Depth of wetland | 0.8 | m |
| 7 | Width of wetland | 6 | m |
| 8 | Length | 40 | m |
| 9 | Sedimentation tank | | |
| 9.1 | Length | 1 | m |
| 9.2 | Width | 5 | m |
| 9.3 | Depth | 1.5 | m |
| 10 | Filter bed – Quantity of gravel and sand required for filter bed | | |
| 10.1 | Sand (top 0.2 m layer) | 48 | m3 |
| 10.2 | 10 mm gravel (0.2 m layer below sand layer) | 48 | m3 |
| 10.3 | 20 mm gravel (0.2 m layer below 10 mm gravel layer) | 48 | m3 |
| 10.5 | 40 mm gravel (0.2 m layer below 40 mm gravel layer) | 48 | m3 |
| 11 | Storage tank – minimum capacity | 320 | m3 |
| 12 | Cost (this may change location wise) | | |
| 12.1 | Excavation (@80 per $m^3$) | 40,960.00 | Rs |
| 12.2 | Sand and gravel (@ Rs 850 per $m^3$) | 163,200.00 | Rs |
| 12.3 | Labor cost (Rs 350 per m3) | 67,200.00 | Rs |
| 12.4 | Cost of vegetation plantation | 50,000.00 | Rs |
| 13 | Approximate cost | 321,360.00 | Rs |

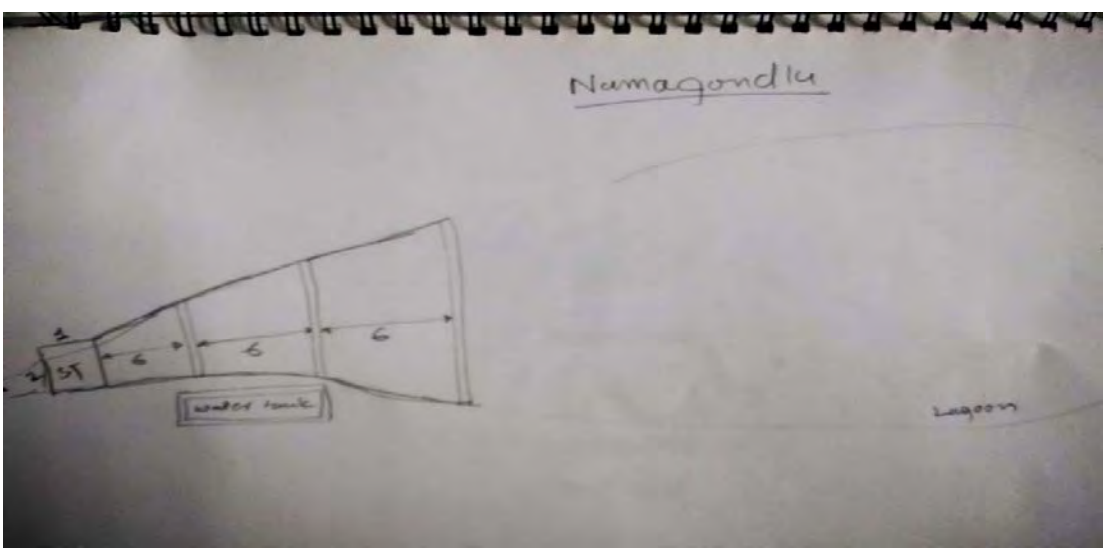



*Figure 34. Schematics of constructed wetland*

**Site 10 (Veeralagollahalli village, Gauribidanur)**

- Households contributing to this end of the drainage line are more than 100.
- Cemented channel is available for carrying wastewater, but government land is not enough for construction.

**Site 11 (Arkunda village, Gauribidanur)**

- Households contributing to this end of the drainage line are more than 100.
- Cemented channel is available for carrying wastewater, but government land is about 150 m away from the end of drainage and is at more or less same elevation.

**Aerobic composting**

To reuse, recycle the domestic wastes as manure, aerobic composting has been promoted in Bhoosamrudhi villages and converged with Suvarna Krishi Gram Yojana (SKGY). Nearly 20 demonstrations were established in Gangasandra village of Gauribidnur, Jangamkote village of Siddlaghatta. The target for 1000 units planned this year in both taluks.

***Figure 35. Aerobic composting using madhyam culture in Bhoosamrudhi pilot villages in Chikkaballapur district***

**Lazer Land Leveler to enhance water use efficiency and crop productivity**

Uneven soil surface has a major impact on the germination, stand, and yield of crops due to inhomogeneous water distribution and soil moisture. Therefore, land levelling is a precursor to good agronomic, soil, and crop management practices. Traditionally farmers level their fields using animal drawn or tractor-drawn levelers. These levelers are implements consisting of a blade acting as a small bucket for shifting the soil from higher to the low-lying positions. It is seen that even the best leveled fields using traditional land leveling practices are not precisely leveled and this leads to uneven distribution of irrigation water. Laser leveling of agricultural land is a recent resource-conservation technology. It has the potential to change the way food is produced by enhancing resource-use efficiency of critical inputs without any disturbing and harmful effects on the productive resilience of the ecosystem. During 2016-17 crop season, 1 acre area has been levelled on pilot basis in SKGY village (Figure 36).

**Benefits of laser land leveling over conventional land leveling:**

- Reduction in time and water for irrigation

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

***Figure 36. Laser leveler demonstration at SKGY village in Chikkaballapur district***

**Establishment of cactus nursery**

Cactus nursery was established at Madanaykhalli of Gouribidnur, cactus cladodes of 2 years age well established with drought tolerance. Some cactus strains are also planted in SKGY villages of Gauribidnur on borders (Figure 37).

***Figure 37. Thornless cactus nursery in Madanayakanahalli, Gouribidanur, Chikkaballapur district***

**Capacity building**

The capacity building on fodder production and livestock production has completed (Figure 38). Nearly 955 farmers/officers including women participated in the training (Table 19).

***Figure 38. Capacity building programs on fodder production***

**Table 19. Capacity building programs in Chikkaballapur during 2016-17**

| Training topics | No. of trainings | No. of beneficiaries | Institution |
|---|---|---|---|
| Training on cactus production and value addition | 7 | 315 | ICARDA |
| Tablet based extension system, video production | 2 | 67 | KVK/DOA |
| Training on surface and subsurface irrigation | 6 | 184 | IWMI/DoA |
| Training on water impact calculator for irrigation and fertigation | 8 | 389 | ICRISAT/DoA |

## Dharwad

Dharwad district is situated in the Western sector of the northern half of Karnataka State. The District encompasses an area of 4263 sq. kms lying between the latitudinal parallels of $15^0$02’ and $15^0$51’ North and longitudes of $73^0$43’ and $75^0$35’ East (Table 20a). The district is bounded on the North by the District of Belgaum, on the East by the district of Gadag, on the South Haveri and on the West by Uttara Kannada district of Karnataka. The District lies about 800 mts above the sea level ranging from 534 msl (Kalaghatagi Taluk) to 715 msl (Dharwad Taluk), which is why it enjoys a moderate climate. Dharwad district after trifurcation in 1997, now has 5 taluks namely Dharwad, Hubli, Kalaghatagi, Kungol and Navalgund. Thre are 372 inhabited, 18 uninhabited and 6 towns existing in the district.The District may be divided into 3 natural regions, viz., the Malnad, Semi-Malnad and Maidan. These regions, on an average, receive moderate to heavy rainfall and have dense vegetation. Kalghatagi and Alnavar area in Dharwad district in particular receive more rainfall than other taluks of the District. Broadly, the work force statistics of the district indicates that cultivators 26%, 28% agricultural laborers, 3% industries and 43% other workers. Agricultural production of the districts has substantial share in the state domestic production. The average rainfall of the district is 787 mm ranging from lowest 432 mm in Navalgund taluk to 947 mm in Dharwad taluk. The black and red soils are predominant soil types in the district. The presence of black soils help in raising crops like Cotton, Wheat, Jowar, soybean, onion, chilli and Oil seeds, while red soils are suitable for groundnut, maize, vegetables, horticultural crops and paddy.

**Table 20a. General information of Dharwad district.**

| Parameter | Details |
|---|---|
| Geographic Location | 15 02' and 15 51' N; 73 43' and 75 35' E |
| Temperature | 22 $C^{0}$ Min 40 $C^{0}$ Max |
| Rainfall | 787 mm |
| Rivers/ Streams | Bedthi & Shalmala (west flowing rivers) |
| Average Elevation. msl | 2580 ft |
| Geographical Area: | 427329 ha |
| Horticulture Area | 74282 ha |
| Irrigated Area | 55885 ha |
| Soil type | Deep black cotton, Red sandy, Shallow black Sandy loam |
| Agro-climatic Zones | III North Arid Zone . |

**Table 20b. Bhoosamruddhi project villages information, Dharwad district**

| Name of village | Area (ha) | No. of household |
|---|---|---|
| Dharwad Taluk, Garag Hobli | | |
| Tadakod | 1138 | 677 |
| Timmapur | 256 | 137 |
| Hangaraki | 717 | 448 |
| Jiragawad | 193 | 109 |
| Garag, | 1661 | 882 |
| Agasihalli | 323 | 204 |
| Kotur | 1071 | 510 |
| Shinganahalli | 323 | 192 |
| Gungarakatti | 160 | 139 |
| Belur, | 341 | 230 |
| Neeralgatti | 269 | 365 |
| Kalaghatagi Taluk, Dummavad Hobli | | |
| G.Basavankoppa | 340 | 167 |
| Neersagar | 442 | 237 |
| Hirehonahalli | 1396 | 917 |
| Devalingekoppa | 284 | 161 |
| Dasnur | 69 | 41 |
| Jambyal | 183 | 89 |

| | | |
|---|---|---|
| Dummawad | 834 | 367 |
| Total no. of Villages: 18 | 10000 | 6706 |

**Table 20c. New villages Selected in Bhoosamruddi Scheme 2016-17 (Dharwad Taluk)**

| Gram Panchayat | Name of village | No of Households | Area |
|---|---|---|---|
| Amminabavi | Amminabavi | 561 | 1000 |
| | Marewad | 321 | 300 |
| | Navalur | 456 | 522 |
| Kanaknur | Kanaknur | 201 | 306 |
| | Chandanamatti | 153 | 200 |
| | Talavayi | 306 | 320 |
| | Benakanamatti | 366 | 300 |
| | Kavalgeri | 165 | 200 |
| Hebballi | Hebballi | 564 | 800 |
| | Shivalli | 421 | 421 |
| Maradagi | Maradagi | 350 | 700 |
| | Somapur | 162 | 279 |
| | Gongadikopp | 154 | 250 |
| | Gopanakopp | 347 | 700 |
| | Dandikopp | 124 | 200 |

**Table 20d. New villages Selected in Bhoosamruddi Scheme 2016-17 (Navalgund Taluk)**

| **Gram Panchayat** | Name of village | No of Households | Area |
|---|---|---|---|
| **Naiknur** | Bogganur | 109 | 700 |
| | Kannur | 380 | 550 |
| | Datanal | 607 | 652 |
| | Naiknur | 221 | 350 |
| **Shalavadi** | Shalavadi | 456 | 700 |
| | Navalli | 77 | 548 |

**Technologies implemented**

During 2016-17, technologies demonstrated in Bhoosamrudhi project in Dharwad 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 86 ha in 20 villages during *khraif* and *rabi* 2016-17 with groundnut, soybean, pigeonpea, green gram in *khraif* and *rabi* sorghum, and chickpea in *rabi* in Dharwad district (Table 21 & Figure 39). 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 BBF landform is a raised bed system consists of a relatively flat bed or ridge approximately 100 cm wide and shallow furrow about 50 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
- Improves crop yields

**Table 21. Broadbed and furrow system of land form with improved management in Bhoosamrudhi project, Dharwad during 2016-17.**

| Crop | Villages | Area covered ( ha) | No. of beneficiary |
|---|---|---|---|
| Groundnut | Garag, Kotabagi, Belur, Niralakatti, Amminabavi, Marewad | 10 | 20 |
| Soybean | Garag, Shinganalli, Kotor, Niralakatti, Dummawad, G.Basavankopp Amminabavi, Marewad | 40 | 60 |
| Chickpea | Bogganur, Kannur, Naiknur, Shalavadi | 36 | 52 |
| | Total | 86 | 132 |

*Figure 39. Sowing of improved crop varieties with Broad-bed and Furrow system*

**Participatory evaluation of improved varieties**

Improved cultivars of pigeonpea, groundnut, soybean, green gram, maize, sorghum and chickpea released by ICRISAT and SAU were introduced (Figure 40). New soybean variety (DSB-21) was introduced in 100 ha benefiting around 110 farmers in the Bhoosamrudhi pilot sites. Similarly, groundnut G2-52 variety was introduced for higher yield in the pilot sites benefiting 20 farmers covering 15 ha (Figure 41 & 42).

*Figure 40. Participatory evaluation of soybean (DSB-21) variety in Bhoosamrudhi project sites in Dharwad district*

***Figure 41. Improved variety of groundnut (G2-52) demonstration under Bhoosamrudhi in Dharwad district***

***Figure 42. Crop cutting for yield estimation in soybean (DSB-21) in Dharwad district***

Pulses also form important part of cropping system in Dharwad district. During 2016-17, greengram variety DGGV-2 and Nirmal seeds was promoted in 30 ha benefiting about 15 farmers. The crop cutting experiments revealed that the yield in the improved management practice is higher than the normal farmers practice (Figure 43).

***Figure 43. Greengram crop cutting experiments under Bhoosamrudhi in Dharwad district***

Similarly, chickpea was promoted in about 75 ha with different varieties such as JG11, J-130 and JAKI benefiting around 100 farmers (Figure 44). Pigeonpea was cultivated as an intercrop with maize (ICPL88039, ICPL161, ICPL88084) in about 20 ha area (Figure 45).

***Figure 44. Chickpea sowing with BBF machine in pilot sites, Dharwad***

***Figure 45. Pigeonpea intercrop with maize in Bhoosamrudhi pilot sites in Dharwad***

**Crop Intensification and Diversification**

Improved cultivars of pigeonpea, groundnut, soybean, green gram, maize, sorghum and chickpea released by ICRISAT and SAU were introduced (Table 22 &Figure 46).

***Figure 46. Improved cultivars of groundnut and chickpea crops demonstration in Dharwad district***

| Table 22. Promising cultivars introduced during *khraif* 2016. | | | | |
|---|---|---|---|---|
| **Crop (variety)** | **Varietal characteristics** | **Village** | **Area Covered ( ha)** | **No. of Beneficiary** |
| Pigeonpea (ICPL 88034) | • Short duration (135-140 days)<br>• Suitable for drought prone areas and also for intercropping with groundnut<br>• Yields 1.8 to 2.0 t $ha^{-1}$ | Garag, Shinganalli, Kotor, Niralakatti | 5 | 8 |
| Pigeonpea (ICPL 88039) | • Extra short duration (120-125 days)<br>• Drought tolerant and escape insect damage due to earliness<br>• Yields 1.7 to 1.8 t $ha^{-1}$ | Jammihal, Hirehonnalli, Dummawad, G.Basavankopp | 5 | 7 |
| Groundnut (G2-52) | • New realized variety<br>• High in olic:linolic acid<br>• Uniform flowering<br>• Less no of immature pods | Garag, Kotabagi, Belur, Niralakatti | 15 | 20 |
| Groundnut (ICGV-9114, ICGV-0350) | • Resistance to intermittent and terminal drought tolerant<br>• Short duration, *Spanish* variety<br>• Pod yield 2tons per hectare<br>• Fodder quality is good | Garag, Kotabagi, Belur, Niralakatti | 5 | 10 |
| Soybean (DSV-21) | • Rust resistant<br>• High yielding | Garag, Shinganalli, Kotor, Niralakatti Dummawad, G.Basavankopp | 100 | 110 |
| Green gram (DGGV2) | • Comes to mechanical harvest<br>• Shiny and bold seeded<br>• High yielding | Garag, Amminabavi, Marewad | 10 | 14 |
| Green gram (Nirmal seeds) | • Comes to mechanical harvest<br>• Shiny and bold seeded<br>• High yielding | Garag, Amminabavi, Marewad | 5 | 10 |
| | Total | | 80 | 88 |

**Fodder improvement**

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 24 MF) in about 15 ha area in Bhoosamrudhi villages in Dharwad (Figure 47). The multi cut forage sorghum yield on average 913 q/ha green fodder, it grows in all seasons with high density planting and fast growing generation ability to give 3-4 cuttings.

***Figure 47. Dual purpose maize and multi-cut forage sorghum cultivation in Dharwad***

**Direct Seeded Rice (DSR)**

With increasing water scarcity, it is important to promote water saving technology such as DSR. In Dharwad district, the cropping pattern mainly pulses along with cash crops such as cotton, chilly and other vegetable crops. Paddy is also grown in some places as a dryland crops where water availability is good. CIMMYT along with ICRISAT and DoA demonstrated Direct Seeded Rice technology in one of the pilot village (hullakoppa village). Paddy is directly sown using zero-till machine and limited amount of irrigation provided (Figure 48).

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.

The DSR cultivation was done with zero till multi-crop planter machine which 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.

***Figure 48. DSR paddy sowing with zero till multi-planter in Bhoosamrudhi sites, Dharwad***

## DSR Field day at Hullakoppa village

A field day was organized to create awareness among farmers about the DSR technology and its benefits. Large number of farmers, (53 participants) both men and women participated in the event and interacted with scientists (Figure 49).

***Figure 49. DSR field day at Hullakoppa village, Dharwad district***

**Capacity building programs**

Nearly 6 capacity building programs were organized on different topics (Table 23). The training programs were attended by large number of farmers and scientists from different research organizations were also attended and imparted the required knowledge to farmers. These training programs were organized by the line departments mainly to disseminate new knowledge and information to farming community and make them aware about the technologies.

| Table 23. Capacity building programs on different topics in Dharwad | | | |
|---|---|---|---|
| **Date** | **Training** | **Place** | **No of participants.** |
| 15/04/16 | Training on finalizing the components in Action plan of BhoosamruddiprogrammeIn new villages based on constraints at village level. | Amminabavi RSK, Navalgund RSK. | 100 |
| 30/6/16 | Demonstration of BBF Implement in new villages selected | Shalavadi, Boggannur villages | 25 |
| 03/07/16 | FFs in Soybean | Garag,Amminabavi | 30 |
| 10/07/16 | Seed treatment training and programme | Dummawad | 15 |
| 15/07/16 | Seed treatment training and programme | Garag | 15 |
| 07/07/16 | Training on DSR Method in Rice | Hulakoppa | 30 |

***Figure 50. Training program on seed treatment in Dharwad district under Bhoosamrudhi***

## Udupi

Udupi district is essentially an agriculture district with more than 80% of population depends on agriculture for their livelihood whereas only 40% of the available land is used for agriculture. Rest is either forest land or land unsuitable for agriculture. Agriculture is confined mainly to the valley area and is by and large confined to the traditional *kharif* cultivations depending on the monsoon. Paddy is the main crop raised by 75% of the cultivated area in *kharif* season. The other crops are chillies, sweet potato, ginger and vegetables. In *rabi* season, paddy, chilies, black gram and green gram are raised. Pulses are raised during dry season. The crops raised during summer are limited with chief crop being sugarcane, groundnut, paddy and sweet potato. Plantation crops include coconut, cashew nut, areca nut and pepper. Cardamom is also grown in valley areas.

**Production system constraints**

Udupi district is one of the developed districts in the state of Karnataka in terms of its contribution to state domestic product. However, agriculture is suffering due to outmigration and farmers practice agriculture as a hobby rather than livelihood source. In this situation, developing agriculture is a challenge. Moreover, the district face many challenges such as i) high rainfall, ii) poor mechanization, iii) sea inundation, iv) salinity and water logging, v) low crop productivity, and vi) low nutrient use efficiency. To address these constraints, two taluks covering about 20,000 ha area were selected for implementing innovative technologies to improve the productivity and income of farmers.

**Nutrient management**

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. During 2016-17, mechanical shredder are being used to chaff agro-wastes and used for composting in Kundapura and Udupi taluks of Udupi district 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. Now farmers are mixing the cow dung and agriculture biomass with their product and this is adding to soil fertility (Figure 51). During 2016-17, about 250 kgs of bioculture supplied targeting to produce more than 2000 kgs of compost which is useful for plantation as well as field crops.

**Cropping system diversification and intensification**

Low cropping intensity is continued to remain as one of the major issues and has become concern due to falling income as is restricted to single crop. To augment the concern of the farmers and improve socio- economics of the farmers, crop diversification and intensification of the present system could increase productivity and farm profitability in the area. In the years of low rainfall and prevailing arid conditions rising a short duration crop holds a key. During the year short duration crops such as greengram, blackgram, cowpea. etc are promoted during rabi season (Table 24).

***Figure 51. Demo conducted on aerobic composting at KVK Brahmavara, District minister, ADR, JDA were present***

<table>
<tr><th colspan="3">Table 24. Sustainable intensification options & strategies in Bhoosamrudhi pilot sites</th></tr>
<tr><th>Current cropping system</th><th>Alternate system with sustainable intensification option</th><th>Area covered (ha)</th></tr>
<tr><td rowspan="3">Paddy-Fallow</td><td>Paddy-blackgram</td><td>25</td></tr>
<tr><td>Paddy-greengram</td><td>20</td></tr>
<tr><td>Paddy-cowpea</td><td>10</td></tr>
</table>

**Farmer's participatory varietal promotion during *Kharif* 2016**

During *kharif* season, rice varieties of MO-13, and kagga (saline tolerant variety) were demonstrated with farmers' participation in about 32 ha in Kundapur and Udupi taluks (Table 25 & Figure 52).

| Table 25. Varietal demonstrations on farmers field during *Kharif*, 2016 | | | |
|---|---|---|---|
| **Sl. No** | **Name of the Crop** | **Name of the Variety** | **Area covered (ha)** |
| 1 | Paddy | MO-13 | 30 |
| 2 | Paddy | Kagga (Saline tolerant) | 2 |

***Figure 52. MO-13 variety of paddy in the farmers field***

***Figure 53. Kagga variety of paddy in the farmers' field***

During 2016-17, farmers are encouraged to grow short duration legume crops in rice fallow areas (Table 26). This will be an opportunity for validating suitability of legumes for the region. This season, short duration legumes such as greengram, blackgram, cowpea and field bean were demonstrated covering about 75 ha area.

| Table 26. Varietal demonstrations on farmers field during *rabi*, 2016-17 | | | |
|---|---|---|---|
| **Sl. No** | **Name of the Crop** | **Name of the Variety** | **Area covered (ha)** |
| 1 | Paddy | MO-13 | 73 |
| | | MO-21 | 10 |
| 2 | Black gram | LBG-752 | 25 |
| 3 | Green gram | LGG-460 | 10 |
| | | SML-668 | 10 |
| 4 | Cowpea | Arka mangala | 10 |
| 5 | Field bean | HA-4 | 10 |
| 6 | White sesamum | DS-5 | 10 |

**Promotion of improved rice varieties**

Earlier in Udupi district farmers are growing Mo-4 variety but compared to varietal characterization and yield attributes MO-13 variety of paddy introduced to this region in the *kharif* season, 2016. In addition, we identified that soil is affected with salinity, therefore, introduced Kagga variety of paddy suitable to saline soils. During *rabi* season we plan to introduce a new variety i.e., MO-21. This variety is well suited for this region during *rabi* season.

**Farmers' participatory demonstrations on wet-seeding of rice:** Rice establishment by wet-seeding is being demonstrated in a farmer participatory mode in Udupi District. Herbicides were recommended for managing weeds, whose control is critical in attaining optimal yields with the wet-seeding method of rice establishment (Figure 54). Farmers were observed using the cono-weeder. Field staff advised popularizing the power weeders in row-seeded machine-transplanted and wet-seeded rice fields.

***Figure 54. The wet-seeded rice (drum-seeded) demonstration field in Udupi district. A farmer operating the cono-weeder in a WSR field.***

**Farmer participatory demonstrations of improved varieties in transplanted rice:** In Udupi District, along with MO4, MO13 was also included among the varieties in the demonstrations on best management practices (Figure 55). At all the demonstrations, Bhoosamrudhi staff interacted with the farmers and made clarifications on best management of rice.

**Figure 55. Farmer participatory demonstrations of machine-transplanted MO4 (farmer: Mr. Tristin) and MO13 (Farmer: Mr. Eeswar Sherwega).**

**Farmer participatory demonstrations of a salinity-tolerant rice variety:** Kagga (landrace: KareKagga; local variety: Ankola) is being demonstrated in two farmers' fields, which were visited by many farmers. Interactions were held with the farmers and necessary suggestions were given on best management practices of rice (Figure 56). The growth parameters were recorded. This is a tall variety, prone to lodging. Hence, seed of improved saline-tolerant rice varieties was procured and will be demonstrated in the next season.

***Figure 56. The salinity-tolerant local cultivar Kagga was included in one of the demonstrations, which was visited by several farmers, and Bhoosamrudhi staff have interacted with the farmers.***

**Case study: Salinity tolerant, traditional rice variety Kagga for better yield and income**

Rice is the main cereal crop grown in the wetlands of coastal Karnataka. The rice varieties popular among the farmers include: Mahaveera, KCP1, M04, Champaka, Phalguna (in Kharif); Jyothi, Mukthi (in rabi) and Jaya (in summer), which are not salinity tolerant. Hence they yield around 1 to2 t/ha when grown in salinity affected areas of Udupi district. The traditional varieties are distinct in morphology, taste, aroma, quality and other special features and hence farmers prefer to grow them for their household consumption. Among the traditional varieties the Kagga variety is known for salt tolerance. Its grains are black in color, good in taste, believed to contain high protein and nutrient rich and used only as boiled rice. Hence, to assess its yield and economic return potential under best management practices, farmer participatory demonstration of salt tolerant Kagga rice variety was under taken in two farmers' fields.

The seed of Kagga variety was collected and given to two promising farmers in Hemmadi and Katbeltur villages. Half acre each was selected in the farmers' fields. The seed sowing in nursery was done on 28/06/2016 and 02/06/2016 at Hemmadi and Katbeltur villages respectively. 30 day seedlings were transplanted in the selected fields. The best management practices recommended for transplanted rice were followed for Kagga cultivation in both the farmers' fields. The crop was harvested at maturity in November 2016.

Average yield in costal saline area is about 1 t/ ha as against the 2.27 t/ha, the average productivity of rice in Udupi district, Karnataka (Rajanna, 2010). Last year the selected farmers got on an average 3 t/ha with MO4. In the current demonstrations, the average productivity of Kagga variety was 4.45 t/ha. Thus 48.3% increase in yield was recorded with the Kagga variety over the average productivity of rice in the district (Table 27).

**Table 27. The growth parameters of variety Kagga in participatory demonstrations in**

| Name of farmer | Plant height (cm) | No. of tillers/hill | No. of panicles/hill | Panicle length (cm) | No. of seeds/ panicle | Grain yield (t/ha) |
|---|---|---|---|---|---|---|
| Mr. Ganappa @ Hemmadi | 129.76 | 7 | 5.8 | 25.62 | 107.4 | 4.6 |
| Mr. Dinesh S/o Narasimha | 130.18 | 7 | 5.6 | 25.48 | 94.4 | 4.3 |
| **Average** | **129.97** | **7** | **5.7** | **25.55** | **100.9** | **4.45** |

As the expenditure was same as the other variety, the additional yield of 1.45 t/ha, over the previous years farmers rice yield, fetched the farmer an additional income of Rs. 20,445 (Rs. 1410/quintal of rice as per MSP fixed by GoI for 2015-16).

The variety is tall (130 cm) and lodging is a problem at harvest. Hence dwarf salt tolerant varieties will be screened in coming years. The farmers faced the problem of marketing the produce as the higher rice produced was more than what they need for house consumption. Therefore, it is necessary that arrangements should be made to procure and market specific varieties such as Kagga.

Technological improvements, including the use of new salt-tolerant varieties of rice along with organic soil amendments, proved to be relatively inexpensive for farmers to adopt.

Several salt tolerant high yielding rice varieties are available such as: Vyttila 3, Vyttila 4, Vyttila 5, Vyttila 6, CSR 22, CSR 36 and CSR 43, which need to be evaluated and demonstrated on a large scale, in saline affected areas of Udupi district and other coastal districts of Karnataka for increasing rice production in Karnataka and increase income of farmers of costal districts. After screening the identified salt tolerant varieties need to be popularized among farming community through farmer participatory manner as adopted in BhooSamrudhi.

Karnataka state has many saline tolerant traditional rice varieties (Sanna vadlu, Picha neelu, Beli picha neelu, Thokapichaneelu, Choluchangi, Kasarnellu, Bilitokavdlu, Kari tokavdlu, Bilipichanellu, Pichanellu, Jowguri, Mullubatha, Chintapolavodlu, Karichannangi, Bilichannangi, and Cholu channangi), that are high in nutritional value and have medicinal properties, and most are resistant to extreme drought conditions, diseases and pests and are popular for their taste. These are valuable genetic resources and their conservation is crucial for food security, hence should be preserved in the State Agriculture Universities and popularized where ever farmers prefer and used in breeding programs for developing sat tolerant high yielding rice varieties.

The University of Agriculture Sciences, Shimoga and Zonal Agriculture and Horticulture Research Station, Bramhavar should have the facilities for breeding and screening salinity tolerant rice varieties. They need to work actively with collaborating partners in BhooSamrudhi to popularize and scale up the adoption of identified salinity tolerant rice varieties among the farming community of salinity affected regions of the state. Guaranteed access to seeds becomes necessary, which can be ensured by supporting the local farmers' seed multiplication efforts.

**Machine transplanting of rice**

Demonstrations were conducted in the Chilkensal area of Kundapura taluk (Figure 57) on rice establishment through machine transplanting. Around 100 acres were transplanted with a machine under Bhoosamrudhi in and around Hakadi panchayat, Nujadi Village (Figure 58). The best management practices of raising a mat nursery and rice after transplanting were explained to the farmers and demonstrated with farmer participation.

***Figure 57. Farmer participatory demonstrations of machine transplanting of rice in Chilkensal area of Kundapura taluk, Udupi District***


***Figure 58. Farmer participatory demonstrations of machine-transplanted MO4 in Hakadi panchayat, Nujadi Village, Udupi District.***

During rabi season, rice variety of MO-21 and MO-13 are being promoted with machine transplantation in Bhoosamrudhi villages. The crop is about 12 days old and good growth is observed (Figure 59 & 60).

***Figure 59. MO-21 and MO-13 rice varieties nursary raised at Azri village, Udupi district***

***Figure 60. MO-21 rice variety demonstration plot at Azri village, Udupi district***

The initial fresh yield data revealed that the yield under improved management practices is higher by 11% compared to farmers' practice in Vandse and 10.6% in Brahmavara taluk (Figure 61). Similarly, the straw yield is higher by 14.5% in Vandse and 13.6% in Brahmavara taluk (Figure 62). This reveals that the improved management practices has the potential to bridge large yield gaps exists in most of the areas.

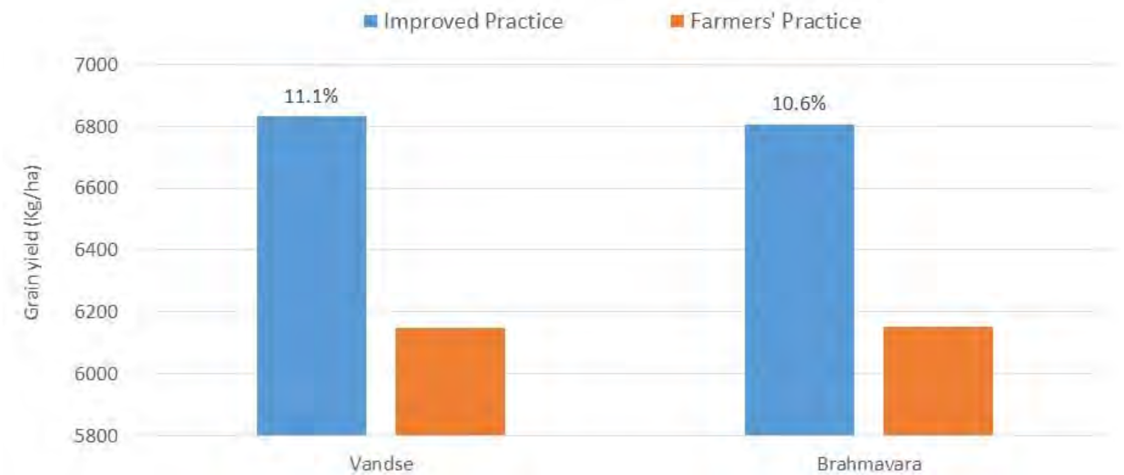



***Figure 61. Performance of MO13 variety of rice in Vandse and Brahmavara taluks of Udupi district during kharif 2016***


***Figure 62. Straw yield of MO13 variety of rice in Vandse and Brahmavara taluks, Udupi district during kharif 2016***

**Cowpea (Arka mangala)**

As there is a high demand for cowpea in the district, ICRISAT supplied around 120 kg of cowpea (Arka mangala) seeds during *kharif* 2016. Farmers who have cultivated cowpea crops, found it very remunerative as the yield was good (Figure 61). During rabi 2016-17 season, farmers are taking cowpea cultivation in paddy fallow areas (Figure 62).

***Figure 61. Cowpea field demonstration under Bhoosamrudhi during kharif 2016 in Udupi district***

***Figure 62. Cowpea (Arka mangala) demonstration plot at Cherkadi village during rabi 2016-17, Udupi***

Crop intensification is given high priority in Udupi district to demonstrate the potential of agriculture in improving livelihood and income levels of farmers. During *rabi* 2016-17, after the harvest of paddy, short duration legume crops such as greengram and blackgram are being promoted with farmers' participation in Bhoosamrudhi pilot villages. During this year, greengram – SML-668 and LGG-460 are already sown (Figure 63). Blackgram (LBG-752) suitable to coastal environment are promoted (Figure 64).

***Figure 63. Greengram in paddy-fallow areas at Birti village, Udupi district***

***Figure 64. Blackgram - LBG-752 under paddy fallow in Varamballi village, Udupi district***

**Decentralized wastewater treatment utilizing sub-surface constructed wetland**

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

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

Initial field visit made and location identified in Varamballi panchayat area near Brahamavar (KVK farm). The discussion held with ZP CEO and Assistant Director of Research, Zonal Research Station, University of Agricultural Sciences, Shivamogga (Figure 65). Based on the location, basic design was shared with JDA for further action.

***Figure 65. Discussion with CPO, ZP, president GP and ADR ZARS for Site selection***

The basic structure and media of a sub-surface flow horizontal CW for the treatment of wastewater generated by rural households is given Figure 66 & Figure 67.

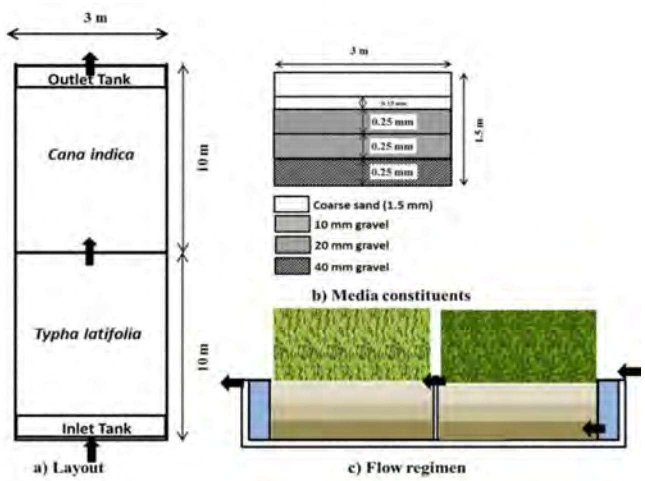



***Figure 66. General design of SSF CW: a) general layout; b) media constituents and c) flow regimen***

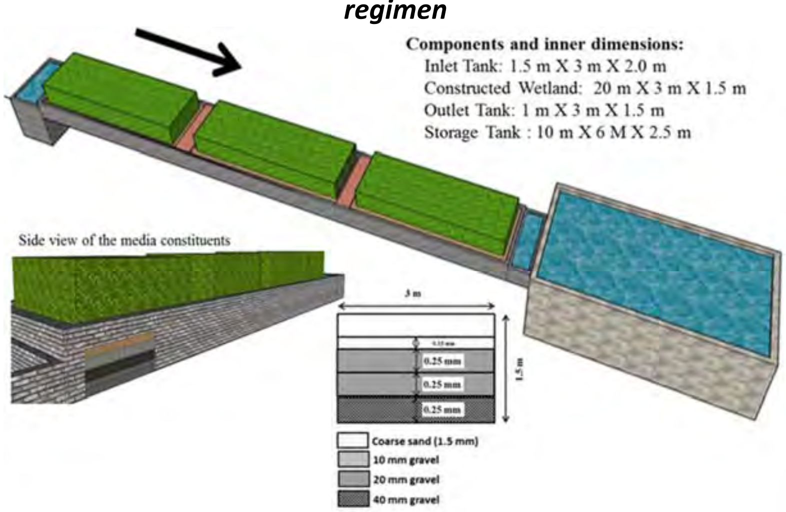



***Figure 67. A typical DWAT system with its components and media constituents***

**Site selection criteria for decentralized wastewater treatment (DWAT) units**

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

The Google Earth image (Figure 68) of the site selected is given below along with its latitude and longitude. The site receives domestic wastewater from nearby households, college hostels, and small lodges. The site does not get any significant industrial wastewater inflow. The site is adjacent to agricultural fields so reuse potential of the treated water is quite high. We could actually see local farmers relying on tanker supplied water for irrigating the plantations, hence the demand for the treated water was evident.


***Figure 68. Google image of the site selected (shown in yellow borders) and the surrounding land use***

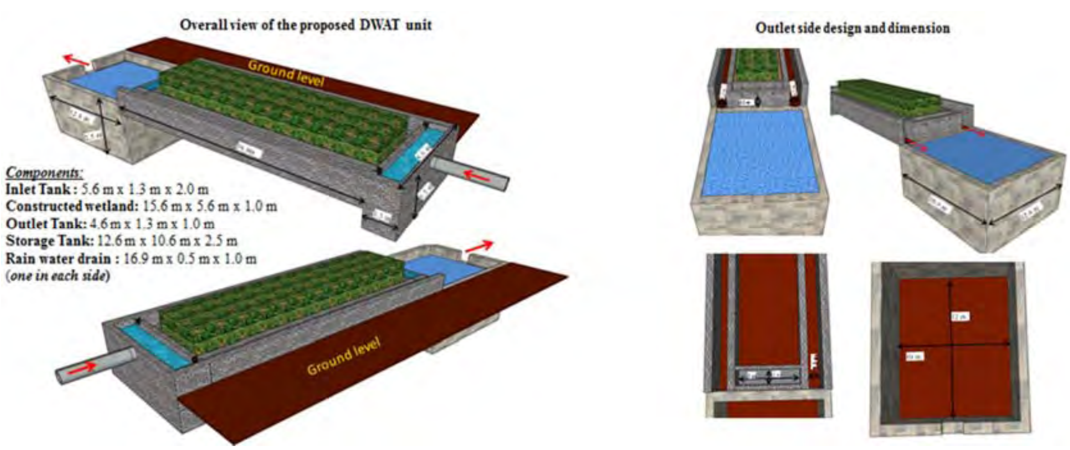
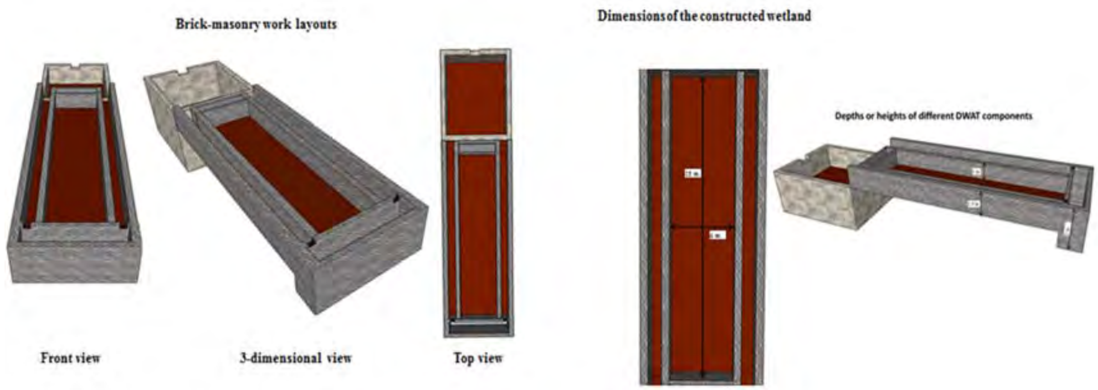
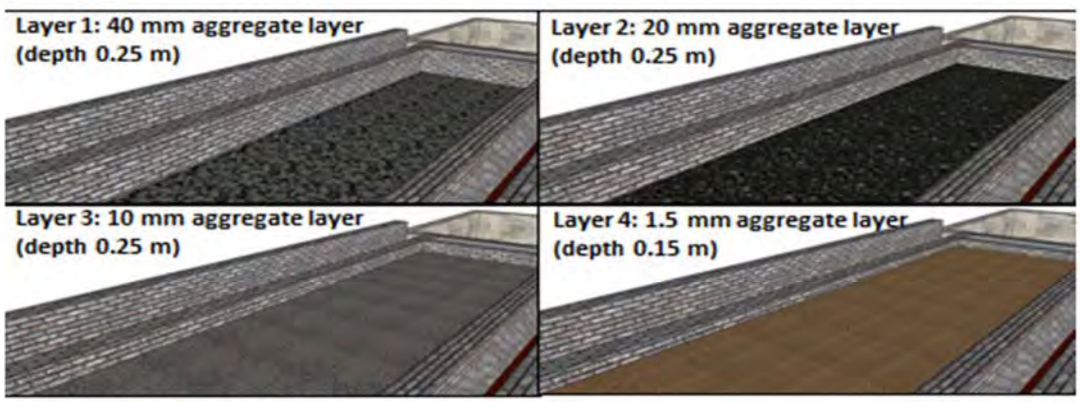



***Figure 69. Overall view of the proposed DWAT unit***




**Constituents of constructed wetland media**




***Quantity of materials required (in cubic meter)***

40 mm aggregate: 15 cum
20 mm aggregate: 15 cum
10 mm aggregate: 15 cum
1.5 mm coarse sand: 9 cum

**Up-side down view to highlight the RCC and clay compacted area**

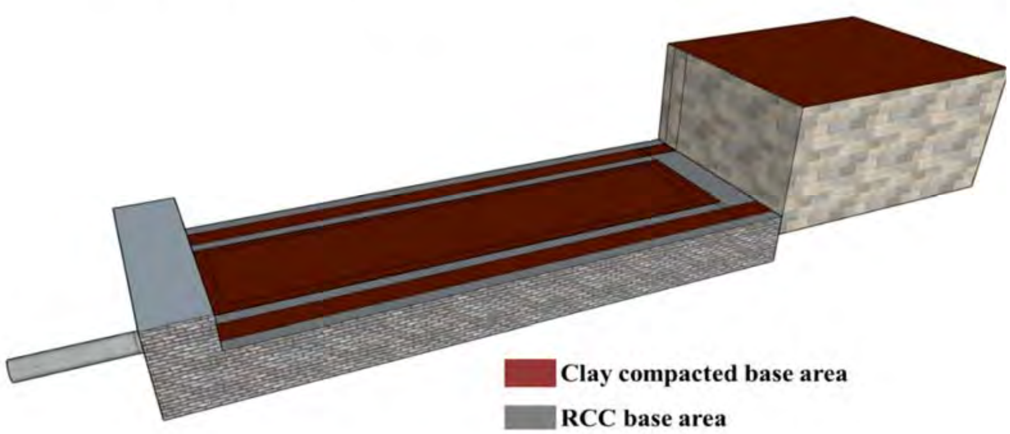



***Figure 70. Constituents of constructed wetlands***

**Cost:** The key cost components for the CW systems are listed in Table 28.

**Table 28. Cost components of the proposed DWAT system (Tentative)**

| Item | Components | Dimensions | Sub-total (cum) | Total (cum) | Rate (PWD) | Cost (INR) | Grand Total (INR) |
|---|---|---|---|---|---|---|---|
| Brick Masonry work | Inlet Tank | 2 x 5.6 x 2.0 x 0.23 | 5.152 | | | | |
| | | 2 x 1.3 x 2.0 x 0.23 | 1.196 | | | | |
| | Constructe wetland | 2 x 15.6 x 1 x 0.23 | 7.176 | | | | |
| | Outlet tank | 2 x 4.6x 1 x 0.23 | 2.116 | | | | |
| | | 2 x 1 x 1 x 0.23 | 0.46 | 16.1 | | | |
| Plaster work | Inlet Tank | 2 x 2 x 2.0 x 5.6 | 44.8 | | | | |
| | | 2 x 2 x 2.0 x 1.0 | 8 | | | | |
| | Constructed wetland | 2 x 2 x 1 x 15.6 | 62.4 | | | | |
| | Outlet Tank | 2 x 2 x 1 x4 | 16 | | | | |
| | | 2 x 2 x 1 x 1 | 4 | 135.2 | | | |
| Excavation Work | Inlet Tank | 5.6 x 1 x 2 | 11.2 | | | | |
| | Constructed wetland and drain | 5.6 x 15.6 x 1 | 87.36 | | | | |
| | Outlet Tank | 5.6 x 1 x 1 | 5.6 | | | | |
| | Treated wastewater pond | 12.6 x 10.6 x 2.5 | 333.9 | 438.06 | | | |
| Materials | | | | | | | |
| 40 mm aggregates | Constructed wetland | 4 x 0.25 x15.6 | 15.6 | | | | |
| 20 mm aggregates | Constructed wetland | 4 x 0.25 x15.6 | 15.6 | | | | |
| 10 mm aggregates | Constructed wetland | 4 x 0.25 x15.6 | 15.6 | 46.8 | | | |
| 1.5 mm coarse sand | Constructed wetland | 4 x 0.15 x 15.6 | 9.36 | 9.36 | | | |

* Costs not included in this estimate are

i) Cost of PVC pipes (20 feet) and bends (10 pcs) (both 4-inch);

ii) Jungle clearance cost;

iii) Upstream drainage cleaning cost;

iv) Excavated earth disposal cost

v) clay compaction and RCC cost

Note: The rate of different components depends on local circle rates and has to be given by local engineering departments.

### Capacity Building

Capacity building and empowering farmers and other stakeholders is one of the major objectives of the project. To empower farmers and provide information on integrated pest management and related technologies 5 training programs were organized. Nearly 80 farmers including women participated (Figure 71).

***Figure 71. Integrated pest management training to the farmers conducted at Haladi village Udupi district***

**Newspaper clippings**

ರಾಜ್ಯದ ಭೂ ಸಮೃದ್ಧಿ ಯೋಜನೆಗೆ ಹೈದರಾಬಾದ್ ಕೇಂದ್ರ ಸಾಥ್

# ಕಗ್ಗ ಹೊಸ ಭತ್ತ ತಳಿ ಹೆಮ್ಮಾಡಿಯಲ್ಲಿ ಕೃಷಿ

ಹೊಸ ತಳಿ ಪ್ರಯೋಗ

ವಿಜ್ಞಾನಿಗಳ ಸಲಹೆ ಮತ್ತು ಕೃಷಿ ಇಲಾಖೆಯ ಸಹಯೋಗದೊಂದಿಗೆ, ಉಡುಪಿ ಜಿಲ್ಲೆಯಲ್ಲಿಯೇ ಪ್ರಥಮ ಬಾರಿಗೆ ಹೆಮ್ಮಾಡಿ ಕೃಷಿ ಭೂಮಿಯಲ್ಲಿ ಕಗ್ಗ ಹೆಸರಿನ ವಿಶಿಷ್ಟ ಭತ್ತದ ತಳಿಯ ಪ್ರಯೋಗ ನಡೆಸಲಾಗಿದೆ. ಹೆಮ್ಮಾಡಿಯ ಕಟ್ಟು ಎಂಬಲ್ಲಿ ರೈತರಾದ ಪಾಂಡು ದೇವಾಡಿಗ, ಗಣಪ ಪೂಜಾರಿ, ದಿನೇಶ್ ಗಾಣಿಗ, ಚಂದ್ರ ನಾಯ್ಕ್ ಕೃಷಿ ಭೂಮಿಯಲ್ಲಿ ಕಗ್ಗ ತಳಿಯ ನಾಟಿ ಕಾರ್ಯ ನಡೆಸಲಾಗಿದೆ.

## ಯಾಂತ್ರೀಕೃತ ವಿಧಾನ ಲಾಭದಾಯಕ