Annual Report (2014-15)

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

Submitted to

Government of Karnataka

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Science with a human face

International Crops Research Institute for the Semi-Arid Tropics

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Background

India has 142 million ha agricultural land with very low cropping intensity and 60% of which is rainfed and characterized by water scarcity, land degradation, low inputs use and low productivity. Agricultural productivity of these areas low ranging between 0.5 and 2.0 ton ha^{-1} with average of one ton per ha. Irrigated land which covers 40% of total agricultural area significantly contributes in satisfying 55% of total food requirement of the country (GOI, 2012). However, on the other hand it consumes almost 70% of fresh water resources with limited scope for further expansion. Thus, achieving food security of the country at present and future is largely dependent on rainfed agriculture. Many researchers showed that there is a huge untapped potential exists for enhancing crop yield through improved land, water, nutrient and other natural resource management. In this context, Bhoochetana Mission Program was launched during 2009 and later implemented in all 30 districts of Karnataka state. Over the period, Bhoochetana program has reached millions of small holder farmers with new technologies to unlock the potential of rainfed agriculture and became huge success in the state.

Based on the success of the Bhoochetana mission project, the GoK has decided to extend the science-led productivity enhancement initiative not only to 30 districts but also to extend the initiative to irrigated crops in the state. This is the best opportune time to harness the positive energy generated in the DoA and to adopt and institutionalize the science-led development approach in the state by bringing together the knowledge-generating academic institutions like the four state agricultural universities (SAUs) and the horticultural university with the knowledge translator agencies like DoA and operationalize the Research for Development (R4D) approach in the state for the first time in the country.
There is an urgent need to develop sustainable agricultural practices considering the vulnerability of the fragile rainfed agro-ecosystems while intensifying the systems. The intensification must be sustainable and able to build the resilience of the systems and the small and marginal farmers to cope with the impacts of climate change. The localized impacts of climate change need to be understood and assessed and the knowledge need to be shared with the farmers.

The soil health assessment initiative undertaken by the GoK need to be fully developed and harnessed to enhance not only the productivity but also to enhance the nitrogen use efficiency (NUE) and bring in the balanced use of nitrogenous and phosphatic fertilizers in the state to reduce the cost of cultivation for the farmers on one hand and also to minimize the damage to the environment through pollution of groundwater with the nitrates and release of the nitrous oxide which is 22 folds more damaging gas than the CO_2.

With the global warming and associated impacts of climate change the available water resources will be adversely affected. It is estimated from our studies at ICRISAT that 3 million ha additional geographical area in Karnataka will become semi-arid and water availability per capita will be further decreased. With this scenario ahead of us we need to bring in urgent measures for enhancing the water use efficiency in agriculture for food production to achieve the target of inclusive growth and food security for all in the state.

Vision of Bhoochetana Mission Program (BCMP)

The vision of Bhoochetana Mission Program (BCMP) is to sustainably improve the livelihoods of small and marginal farmers in the state by developing farmers' centric, science-led inclusive market-oriented integrated farming systems participatory development approach.

Mission Goal of the BCMP

The goal of the Bhoochetana Mission Program (BCMP) is to operationalize an integrated and participatory knowledge-led farming systems development approach for increasing agricultural productivity by 20 per cent in five years through convergence and better coordination amongst different agriculture research-extension and development sectors in the state for sustainably improving the livelihoods of the farmers through empowerment, capacity development with knowledge-based and market oriented farmers' centric partnership approach.

Objectives

The specific objectives of the second phase of Bhoochetana Mission Program are:

1. To strengthen the Bhoochetana consortium for increasing the crops (irrigated and rainfed) yields by 20 per cent over the first phase of Bhoochetana in five years in 30 districts (Figure 1) of Karnataka through science-led development and new innovation systems.

2. To strengthen the institutional mechanisms such as seed villages, village seed banks, participatory research for development (PR4D), inputs supply, agricultural machinery hiring centres, farm extension thru farm facilitators and communication systems for small and marginal farmers in the state for the DoA through capacity development, convergence, collective action, and partnerships.

3. To assess the impact of climate change in different agro-eco regions of the state in terms of anticipated shifts in the crop growing periods, water availability, major crop yields, and evaluate adaptation strategies for developing climate resilient farming systems.

4. To document the process of consortium functioning, learning, and impact of BCMP in terms of increased crop yields, institutional development and capacity building of different stakeholders in the state.

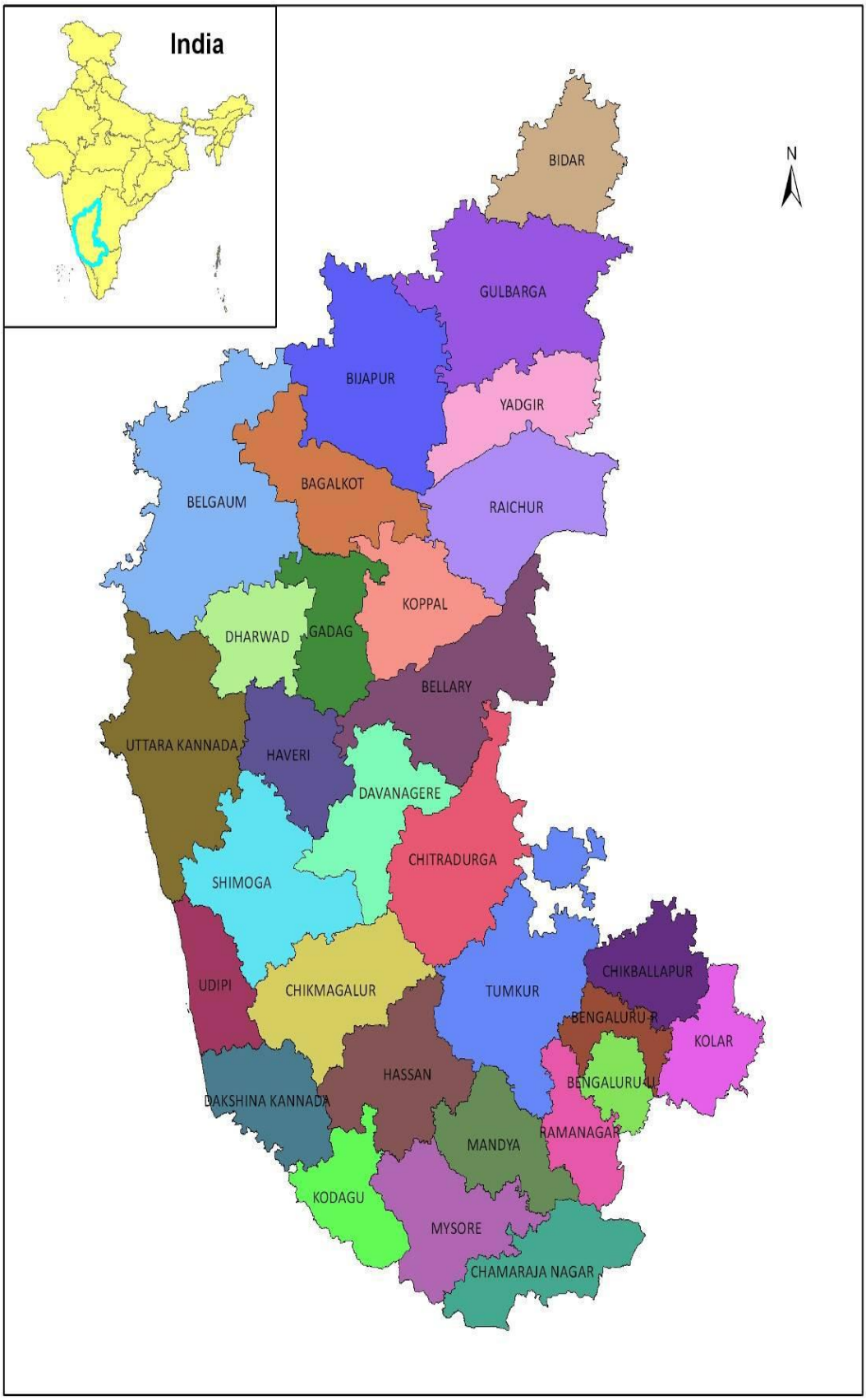


Figure 1: All 30 Districts included for productivity enhancement under the Bhoochetana II program.

Consortium Partners

The consortium comprised of Karnataka State Department of Agriculture, with Director as the nodal officers for implementing the project and other partners include:

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

Project Strategy

The most important strategy for this initiative is to expanded and strengthen the consortium formed during the implementation of the first phase of the BC and translate the mission mode project in to Bhoochetana Mission Program (BCMP). The principle of convergence tried and found good during the first phase of BC will be institutionalized for successful implementation of the BCMP. The salient strategies for the mission mode program are as follows:

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

The mission program will adopt the principle of 4 ICEs as indiacted - **Is**: Innovative, Inclusive, Integrated, Intensification; **Cs**: Collective, Cooperation, Capacity-Building, Consortium; **Es**: Efficiency, Equity, Environmnet protection, Economic gain. The consortium will be of knowledge transforming development agencies such as line departments of state government viz; Department of Agriculture, Karnataka State Seeds Corporation (KSSC), Watershed Development Department (WDD), Department of Horticulture (DoH), Department of Economics and Statistics (DES) along with knowledge generating academic and research institutions like State Agricultural Universities (SAUs), University of Horticultural Sciences (UoH) in the state, Karnataka State Disaster Management Center (KSDMC) and ICRISAT for improving the livelihoods of the rural poor in dryland area.

ICRISAT will lead the consortium and work with the experts from the SAUs for addressing the issues of climate change. During the second phase of BCMP the SAUs and UoH will need to play more active role in supporting and institutionalizing the concept of convergence and consortium for capacity development.

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

By adopting the principle of 4 Cs we will address the mission goal through 4 Es i.e, Efficiency, Economic gain, Equity and Environment protection, which are the important pillars of the sustainable intensification and inclusive development in the state. The emphasis will be on enhancing the efficiency of land and water resources along with the applied fertilizer nitrogen for sustainable intensification while maintaining the environment.

The approach of the mission will be to strengthen backward linkages to meet the 4 Es through 4 Cs by establishing seed villages, village seed banks, custom hire centres for agricultural equipment, ensuring timely supply, availability and access to the necessary vital inputs such as knowledge-based soil nutrient management options, acquiring micro nutrients, availability of good quality seed and necessary financial incentive to undertake best-bet options for increasing agricultural productivity through sustainable intensification. The institutionalization of CBOs and service providers is envisaged for enhancing the impact of the BCMP.

The new extension system piloted in the state during the first phase of BC using FFs and LFs for sharing the knowledge with farmers will be strengthened and efforts will be made to enhance its effectiveness through capacity development and building the partnerships for large scale scaling-up of the improved best-bet management practices.

ICT-tablet based knowledge information sharing systems will be piloted in selected RSKs of four districts.

The scientific approach of mapping soil nutrient deficiencies initiated during the first phase of BC need to be continued further by monitoring the changes in soil fertility status after adoption of best-bet management practices for five years. This approach not only will increase the productivity of the land, water and applied fertilizers thru sustainable intensification but also will reduce the cost of cultivation by advising the farmers not to apply the fertilizers, which are not required by their soils.

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

The most important constraint in dryland areas is the establishment of good crop stand and availability of good quality seeds of high yielding, improved cultivars. The mission will

emphasize integration of the KSSC's seed production program under BCMP to ensure production of improved quality of seeds with best-bet management practices (BBMPs) as well as ensuring timely supply of good quality seeds to the farmers in the villages through establishment of seed villages and village seed banks for the self-pollinated crops such as groundnut and chickpea as well as cross pollinated crops such as sorghum, pigeon pea etc., by training the farmers and providing opportunities for the producers to value addition in the villages.

Building soil organic matter is a great challenge in the tropical countries and through this innovative BCMP by integrating the income-generating activities sponsored under the integrated watershed development program (IWMP) women and landless members of the SHGs and AGs will produce vermicompost and *Gliricidia* seedlings for increasing the soil organic matter. This will also increase the income of the vulnerable groups in the villages.

The BCMP will have planning and monitoring mechanism at cluster, taluka, district and state levels. The ACS & DC will be the chair of the Statelevel Coordination Committee (SCC) which will include the decision makers from the different consortium partners including line departments to pass on suitable government orders to all the concerned mission staff. The SCC will meet regularly for ensuring smooth convergence and CD through institutionalization process and to strengthen the consortium. Based on the learning from the first phase of BC implementation regular meetings and guidance from the SCC contributed immensely in success of the innovative approach adopted by the GoK for unlocking the potential of rainfed agriculture in the state.

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

The mission would adopt in addition to the above, the rewarding mechanisms for the best performers i.e., the farmers at cluster, taluk, district and state level with appropriate personal recognitions. Similarly, the mission staff who will be having the outstanding performance will also be recognized by the state government suitably by adopting a predefined and transparent criteria.

Rainfed Agricultural Technologies

During Bhoochetana first phase, farmers evaluated some of the improved technologies in different districts of Karnataka. Some of the technological options were found to be appropriate for enhancing productivity and income to farmers and rural poor. The technologies listed below have been popularized and recommended in different districts for enhancing the benefits.

In-situ Soil and Water Conservation Techniques

1. Conservation furrow system

Contour furrows are simple and efficient for conserving moisture (Figure 2). These are laid with the help of country ploughs on a gradient of 0.2 to 0.4% at the time of sowing or during intercultural operations

Figure 2. Conservation furrow system at Hedigonda watershed, Haveri, Karnataka

2. Cultivation across slope

Cultivation across the slope, or contour cultivation, is the most common practice for conserving soil moisture. In this method, all field activities including ploughing, planting, and intercultivation are done across the slope (Figure 3).

Figure 3. Contour Cultivation

3. Broad-bed and furrow (BBF)

For *in-situ* soil and water conservation, broad-bed (1 m) and furrow (0.5 m) system (BBF) has been found to be satisfactory on deep black soils. The BBF system is laid out on a slope range of 0.4–0.8% with an optimum of 0.6% slope. The BBF system (Figure 4) facilitates draining of excess rainwater as runoff and furrows act as traffic zones for plough bullocks. On Alfisols, raised beds are well-suited for groundnut cultivation as beds facilitate good aeration, store more moisture for the roots resulting in good crop growth. Deep tillage, shallow cultivation and application of organic residues are some of the other promising *in-situ* moisture conservation practices.

Figure 4. Prototype seed drill cum BBF maker in Bijapur

Integrated Nutrient Management Techniques

1. Balanced nutrient application

Balanced use of plant nutrients involves correcting nutrient deficiency, restoring soil fertility of degraded lands (due to over exploitation), increases nutrient and water use efficiency, enhances crop yields and farmers' income, and improves crop and environmental quality. Hence we used soil analyses results and seasonal rainfall as the basis to recommend fertilizer doses. Availability of organic manures, crop residues, and biofertilizers, was also considered in order to provide taluk-wise recommendations for different crops in all districts.

2. Biofertilizers

Biofertilizers are very important, low-cost, eco-friendly organic agro-inputs, supplementary to chemical fertilizers. *Rhizobium, Azospirillum*, Azotobacter add nitrogen to the soil, and phosphate-solubilizing bacteria make citrate soluble phosphorous available to crops and also secretes certain growth promoting substances. Biofertilizers are considered a harmless and eco-friendly low cost agro-input, supplementary to chemical fertilizers. It improves soil

structure (porosity) and water-holding capacity. It also increases soil fertility, fertilizer use efficiency (FUE) and ultimately helps by increasing yield by 15-20%. Due to a higher concentration of calcium in alkaline soils, large quantities of applied phosphatic fertilizers get fixed as citrate soluble tri-calcium phosphate and become unavailable to the crops.

Phosphate solubilizing bacteria (PSB) are useful for all crops i.e., cereals, cash crops, leguminous crops and vegetables, by secreting certain organic acids to make citrate soluble tri-calcium phosphate available to the crop in alkaline soils. The effective strains of PSB used increase the level of available P_2O_5 in the soil. About 10 to 15% increase of crop yield can be achieved with the use of this culture. Seed Treatment with 250 g 10 kg^{-1} of seed is advised. However, as suggested, PSB and *Trichoderma viride* were applied to soil in Bhoochetana project as seed treatment along with *Rhizobium* and fungicides for groundnut and soybean.

3. Vermicomposting

A method known as vermicomposting that converts farm residues and organic waste in villages with the help of earthworms into valuable manure was introduced to farmers and rural women as a technology through the Sujala-ICRISAT project. Several compost units were constructed in the watershed villages during the project period. Technology components mainly include selection and use of non-burrowing type of earthworms (*Eisenia sp*., *Eudrilus sp*.), and the use of biodegradable materials like weeds, crop residues and sericulture residues, animal and poultry manure, and rock phosphate.

During trainings, farmers and field facilitators were briefed about the benefits of vermicomposting for enriching soil organic carbon and raising productivity, good storage quality of produce without toxic residues, and thereby fetching a higher price for organic produce in the markets. Training on scientific methods of vermicompost preparation were provided to rural women SHG members (Figure 5) and field facilitators during training programs under Bhoochetana project as a rural livelihood option.

Figure 5. Vermicompost preparation units at Chitradurga

4. *Gliricidia* planting on field bunds

Farmers were encouraged to plant 3-4 month-old saplings acquired from nursery or cuttings taken of tender branches of *Giyricidia,* at a spacing of 50 cm apart on field bunds. *The Gliricidia* plant produces green leaves and succulent green branches abundantly (Figure 6) which are rich in Nitrogen. Green leaf and loppings can be harvested, leaving one-year-old 1 m tall plants in place, and apply that to the topsoil for enriching organic carbon and nutrients in the soil. *Gliricidia* on bunds can be harvested thrice in a year and applied before sowing of rainy season crop, *Rabi* season crop and summer season crop.

Figure 6. Gliricidia planting on field bunds

5. *Azolla* Fern

Farmers grow *Azolla* fern in small ponds to use as soil fertilizer as well as to enrich the feed for their livestock. Given the current drought in the state that has affected their livestock and deprived them of extra income for the family, farmers are enthusiastic to adopt this method as this has improved milk yield as well as fat content in the milk (Figure 7).

Figure 7. Farmers grow Azolla fern in their field in Davanagere

Improved Crop Production Practices

1. Transplanting in pigeonpea

Transplanting Pigeonpea, new technique adopted by farmers in Bidar, Gulbarga, Yadgir and Kolar districts of Karnataka (Figure 8). In this method seedlings grown in polythene bags are transplanted to the main field. It is an alternate agronomic practice to overcome late sowing and related lower yields. The process involves raising the seedlings in polythene bags in the nursery for one month and transplanting them in the field during onset of monsoon. The main challenge in pigeonpea is the time of sowing. Farmers sow during late June or early July. Delay in sowing affect yields badly. Sowing is completely dependent on monsoon.

To overcome this natural problem today several hundred farmers grow this crop in polybags first and then transplant them in the main field thus getting a better yield. The major advantages for the farmers such as: sowing can be done in the second week of May every year even if it does not rain at the right time; due to early sowing, pod borer insect damage can be avoided; drought tolerance develops due to deep rooting; it is easy to spray insecticides as plants are at definite intervals; wider spacing allows enough sunlight to reach the leaves of each pigeonpea plant thus reducing competition for water, space and nutrients. Seed saving is also considerable as only 2 kgs of seeds are required per hectare against 10-12 kgs per hectare in normal practice.

Figure 8. Transplanting in pigeonpea

2. Guli method of Ragi cultivation

Farmers have continuously practiced need based location specific research on their farms to satisfy the diverse needs of their family. Guli method has been a best example for farmer's wide knowledge in cultivation methods. Despite resorting to high yielding varieties and application of fertilizers and chemicals, the farmers get at the most 15 quintals of finger millet (ragi) grain yield per acre. But the farmers in Karnataka practice a unique method of cultivating ragi called as GULI VIDHANA – square planting. The experienced farmers from Karnataka have designed and developed simple steps that can be adopted by anyone who

desires to follow Guli Vidhana of ragi cultivation and can be adopted in any other place. By following this method they harvest around 18-20 quintals of ragi per acre. Guli Vidhana is simple and similar to SRI popularly known as Madagascar method of cultivation. Even when high yielding varieties are sown and chemical fertilizers are applied to the crop, the yield is not more than 15 quintals per acre. But in guli method (square method of finger millet transplanting), just 1kg of local variety seeds are sown and the yield per acre was observed to be 18 to 20 quintals. In this method 1kg/acre Ragi seed is enough, planted with 1.5 feet row spacing, less attack of disease, 40 to 80 tillers and more no of ear heads were observed.

3. Paired row planting of pigeonpea

Pigeonpea is often intercropped with legumes or cereals in rainfed areas. Recent interest in integrated weed management has brought attention to the possibility of suppressing weeds with intercrops. Short duration legumes which have fast early growth and close canopies are good competitors with weeds. Short duration of a legume intercrop means that it only competes with the pigeonpea for a short period of time; this minimizes pigeonpea yield loss due to intercropping. In addition, the intercrop itself can contribute to total productivity of the plot. Intercropping in legumes (Greengram, Blackgram, Cowpea, Groundnut, and Soybean) and cereals (Sorghum, Ragi and Maize) with paired row planting of pigeonpea could greatly reduce the need for other financially and environmentally costly weed control measures and increases the productivity of the system (Figure 9).

Figure 9. Paired row planting of pigeonpea in Maize crop in Davanagere district

Integrated pest management (IPM)

The basic concept of IPM is the containment of a pest below economically damaging levels using a combination of all feasible control measures. The following are the primary components of IPM:

- Effective monitoring using pheromone traps (wherever possible)
- Host plant resistance

- Manipulation of the farming system to minimize pest infestation or damage
- Enhanced natural control process
- Selective use of bio-rational and/or synthetic pesticides

4. Pest monitoring by using pheromone traps

Sex pheromones are used to monitor populations of number of pest species including *Helicoverpa* spp and *Spodoptera* spp. Pheromones are specific to individual insects, saving time in the sorting and identification of the seizure. Pheromone traps cannot control crop pests but the data obtained from these traps helps predict infestations and assists in the timely use of control measures. Farmers in Bhoochetana project are using pheromone traps to monitor pest incidence as well to take suitable control measures at appropriate time.

5. Pest tolerant cultivars

ICRISAT has developed cultivars resistant to pests, diseases and drought in sorghum, pearl millet, groundnut, pigeonpea and chickpea. By choosing and adopting the cultivars resistant to insect pests and diseases farmers can avoid crop losses with minimum usage of pesticides. High yielding, pest, disease and drought tolerant cultivars of different crops were supplied from ICRISAT for farmer participatory varietal evaluation and selection in all the districts of Karnataka.

6. Cultural control method

Another major component of an IPM program is cultural control. Farming systems can be manipulated and adjusted in various ways. These options include early or delayed sowing, selection of intercrops, altering plant density or arrangement and sowing genetic mixtures to reduce the impact or severity of insect pests. These options are location-specific and must be designed to suit local practices and customs. Farmers in Karnataka are adopting the following cultural control methods.

- Intercropping coriander with chickpea may provide nectar source for adult parasitoids improving natural control of *Helicoverpa* in chickpea.
- Castor or sunflower attracts *Spodoptera* when intercropped with groundnut and thus reduces the pest infestation on groundnut (Figure 10).
- Manually shaking pigeonpea plants helps dislodge *Helicoverpa* larvae when heavy infestation occurs.
- Ahid or jassid infestation can be minimized by growing mung bean or cowpea as an intercrop or border crop with cotton.

7. Increasing the natural control process

All pests present on crops are not harmful. There are several “farmer-friendly” pests which live on crop pests. These pests are categorized into three groups: parasites, predators and pathogens. Predators hunt and consume all or part of their prey; e.g., spiders, lady-bird beetles, dragon flies and insectivorous birds. Parasitoids live on or in the body of their host. Many parasitoids have been reported to feed on Helicoverpa and Spodoptera. Parasitoids can be mass-reared and released into an infested field (Figure 11). In addition, departmental biological control labs and a number of commercial companies are making parasitoids, the most common being the egg parasitoid, Trichogramma spp which attack eggs of Helicoverpa and other lepidopterans. Among insect pathogens that cause severe mortality, viruses are important. Of viruses that kill pests, the nuclear polyhedrosis virus (NPV) is the most

important. Farmers in Karnataka are adopting the following control measures to increase natural enemies in crop fields.

- Installing bird perches in the field to attract predatory birds (egrets) which prey on insect pests.
- Irrigating groundnut fields during the day; *Spodoptera* larvae will come out of the soil and are eaten by birds.
- Using eco-friendly bio-rational and synthetic pesticides to save natural enemy populations.

Figure 10. Growing of castor plants in groundnut as trap crop to attract Spodoptera pest in Challakere taluk, Chitradurga district

Figure 11. Release of Trichogrammatid Egg Parasitoids to control shootborers in Sugarcane

8. Bio-rational pesticides

Bio-rational pesticides contain biologically active products such as plat derived products, hormones, microbial agents (*Bacillus thuringiensis*, NPV), pathogenic fungi, etc. These are products are usually safe for human beings and for the environment. Among various bio-rational products, neem and NPV are used by farmers in Karnataka for plant protection.

9. Bio-fungicide

Trichoderma viride is a fungus used for seed treatment and soil application by mixing with FYM for suppression of various diseases caused by fungal pathogens through seed and soil. The procedure to treat seed is to mix ***Trichoderma viride*** with cooled rice gruel or Jaggery solution and thoroughly mix this solution with seeds required for an acre to have a uniform coating over the seeds. Dry these seeds for 30 minutes in shade and sow the treated seeds within 24 hours. For soil application, the culture can be mixed with 50 kg or 100 kg FYM and incorporated in the field.

Technology Adopted in Irrigated Paddy and Sugarcane under Bhoochetana Mission Program

Since the focus of Bhoochetana Mission Program is to expand it to irrigated crops, different technologies have been promoted to spread its benefits to farmers. The prominent technologies used in irrigated paddy during kharif season 2014 are, machine transplantation in 4278 ha and Dry Seeded Rice method in 15,435 ha in 14 major rice growing districts in Karnataka. Similarly, new technologies used in sugarcane are single eyebud demo (746 ha), wider row spacing (28925 ha), and drip irrigation (16075 ha) in 12 major districts. Apart from these technologies, few other technologies related to integrated nutrient management, integrated pest management were also adopted and as a result benefits are increasing.

1. Direct seeded rice (DSR)

Production of conventional puddled transplanted rice is facing severe constraints because of water and labour scarcity and climatic changes. Direct-seeded rice (DSR) is a feasible alternative to conventional puddled transplanted rice with good potential to save water, reduce labour requirement, mitigate green-house gas (GHG) emission and adapt to climatic risks. The yields are comparable with transplanted rice if crop is properly managed. In recent years, efforts have been made in promoting the DSR technology by various organizations. Scientists are concentrating in developing suitable varieties and agronomic packages for promoting the DSR. However, the DSR suffers from some constraints particularly high weed infestation. The system has been proved cost-effective and farmers' friendly but require further improvement in technological approach to realize greater benefits.

Under direct seeding, the rice seeds are directly sown to the well prepared main field (either in dry or wet condition). In dry rice cultivation, seeds are treated with 1% KCl and sown at 15-20 cm distance using seed drills at 5cm depth. The seeds are soaked in water and kept in dark for sprouting before sowing in wet rice cultivation. The sprouted seeds are sown in well puddled and leveled fields using drum seeders. Both the methods are having their own merits and demerits.

2. Drum seeded rice plantation

In direct seeding method of rice cultivation, need for a nursery and tasks such as pulling, transporting and transplanting seedlings are avoided as the pre-germinated seeds are directly sown using a in a well puddled and leveled wet field. The seed is dropped in rows @ 20 cm row to row spacing and the seed rate is about 25 – 37.5 kg / ha. The drum-seeder is made of fibre material and hence requires low pulling force to operate. It allows one person to sow one hectare in 5-6 hours compared to three to four days of transplanting by 30- 40 people in case of traditional cultivation method.

3. Machine transplanting

Machine transplanting using rice transplanters requires considerably less time and labor than manual transplanting. It increases the approximate area that a person can plant from 700 to 10,000 square metres per day. A rice transplanter is a specialized transplanter fitted to transplant rice seedlings onto paddy field. A common rice transplanter comprises:

- a seedling tray like a shed roof on which mat type rice nursery is set;
- a seedling tray shifter that shifts the seedling tray like a carriage of typewriters; and
- plural pickup forks that pick up a seedling from mat type nursery on the seedling tray and put the seedling into the earth, as if the seedling were taken between human fingers (Figure 12).

Figure 12. Paddy nursery for machine transplanting (Left) and Machine transplanting of paddy (right) in Davanagere district

4. Bud chip method of sugarcane planting

Sugarcane is a vegetatively propagated crop. Cane cuttings with one, two or three buds known as setts are used as seed. In India, for conventional system of sugarcane cultivation, about 6 – 8 tonnes seed cane/ha is used as planting material, which comprises of about 32,000 stalk pieces having 2-3 buds. This large mass of planting material poses a great problem in transport, handling and storage of seed cane and undergoes rapid deterioration thus reducing the viability of buds and subsequently their sprouting. One alternative to reduce the mass and improve the quality of seed cane would be to plant excised axillary buds of cane stalk, popularly known as bud chips. These bud chips are less bulky, easily

transportable and more economical seed material. The bud chip technology holds great promise in rapid multiplication of new cane varieties. The left-over cane can be well utilized for preparing juice or sugar or jaggery.

5. High Density Planting (HDP) of sugarcane:

One approach to addressing the disadvantages of traditional commercial sugarcane planting while increasing the yield of sugarcane per unit area is the use of High Density Planting (HDP). Increased planting density can significantly improve the yield per unit area from a sugarcane crop (Figure 13). HDP generates a more rapid ground cover than the traditional crop grown with 1.5 meter (5.0 foot) row spacing, thereby increasing solar radiation interception and absorption of water and nutrients. In various studies, increased plant density has translated into increased numbers of sugarcane stalks per unit area, and increased stalk number is directly correlated to increased yield.

Figure 13. Paired row planting of sugarcane (left) in Gowribidanur taluk, Chikkaballapur district and sugarcane crop under drip irrigation with green manure crop for incorporation (right) in Maddur taluk of Mandya district

6. Evaluation of Improved Cultivars

Raichur: Field trials for groundnut crop with cultivar ICGV 91114 were conducted in Raichur district. The variety is high-yielding, matures in 90-95 days, tolerant of mid-season and end-of-season drought, average shelling percentage 75%, oil content 48%, and has better digestibility and palatability of haulms for animals. Due to its early and uniform maturity, attractive pod and seed shape and high shelling perfentage, ICGV 91114 is becoming popular among farmers of Karnataka. Total 10 trials were conducted on 5 ha area and the average pod yield was maximum more than 2540 kg/ha in improved practice compared to farmers practice 1450 kg/ha (Fig. 14). The increase in pod yield with improved management using ICGV 91114 variety was up to 75 per cent compared to local variety TMV-2.

Similarly, as regards to Pigeonpea cultivar evaluation, two hybrids viz, ICPH 2671 and ICPH 2740 were tired with popular ICRISAT varieties Viz, Asha and Maruti. These hybrids are the first in pigeonpea (first in world in any legume) commercial cytoplasmic-nuclear male-

sterility- (CMS) based hybrid are the results of the crop improvements efforts by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) based in Hyderabad. These are CMS-based medium-duration pigeonpea hybrids developed by ICRISAT, ICAR, and partners under a project supported by ISOPOM, Ministry of Agriculture, Government of India. These hybrids are found most promising with respect to yield, stability and disease resistance and are resistant to shattering and have more root biomass compared to other existing varieties. The special characteristic of the hybrids is the good dal quality and by most (80%) respondents it was rated as "better than the market sample" in flavor, taste, and cooking time.

As regards to hybrid ICPH 2671 (Pushkal), four varietal evaluation trials were carried and the hybrid performed quite well under good management condition and has recorded maximum yield in Raichur (1545 kg ha^{-1}) whereas average yield across the district was 971 kg ha^{-1} which is 66 per cent higher than farmer practice (525 kg ha^{-1}). The evaluation of Hybrid ICPH 2740 were taken on two farmer's fields and the hybrid ICPH 2740 responded well to good management practices.

The varietal trials on castor were conducted with Hybrid DCH 177 to evaluate performance of the hybrid. This hybrid is high yielding (1550 to 2130 kg ha^{-1}) and early maturing (90 to 100 days) and has oil content of about 49 % and is recommended for growing in Karnataka, Tamil Nadu, Maharashtra and Orissa. More importantly, this hybrid has got toleance for *Fusarium* wilt and Whitefly insect. Overall, average increase in yield across all the districts over traditional variety was 28 per cent. As regards to castor cultivar Jyothi, trials were conducted in for which seed was supplied from ICRSIAT. Maximum yield of Jyothi in Raichur district was observed 2170 kg ha^{-1} that recorded 25 to 37 per cent increase in seed yield compared to farmers' practice of using traditional variety.

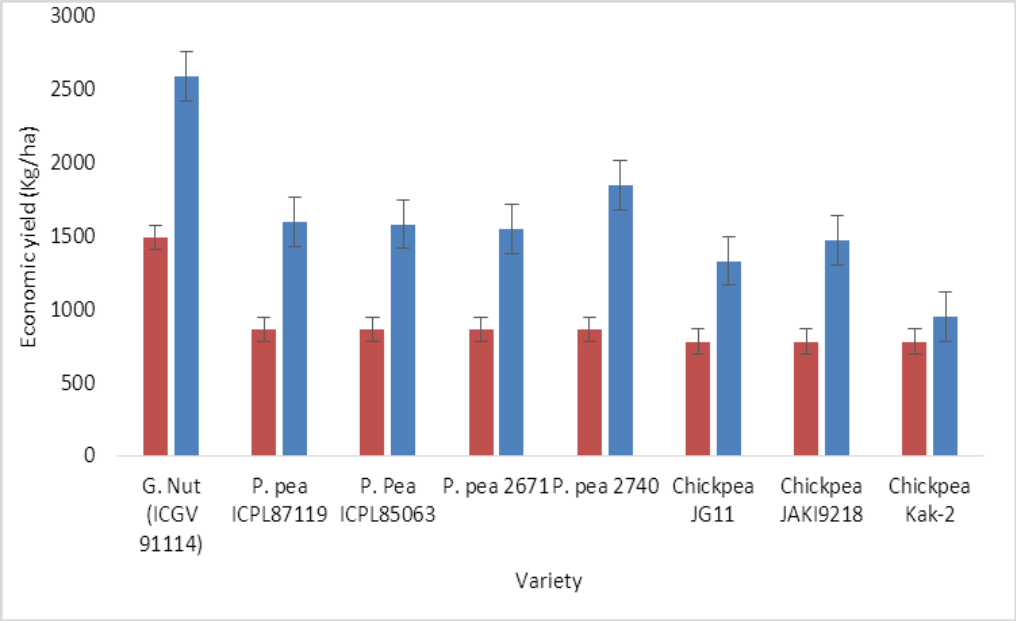


Figure 14. Farmer participatory varietal evaluation of pulses in Raichur district

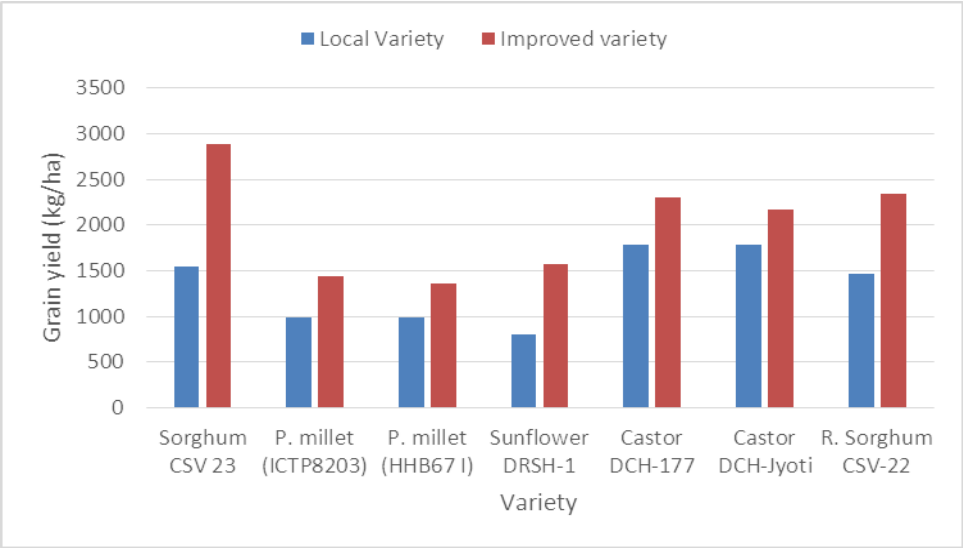


Figure 15. Farmer participatory varietal evaluation of cereals and oilseeds in Raichur district

Tumkur: Ragi/finger millet (Elusine coracana) is the important cereal food crop in Tumkur and farmers continued to be interested in evaluating ragi varieties for higher productivity. As part of participatory field evaluations, ragi cultivar MR 1 was extensively taken up for demonstrations in Tumkur as against their traditional variety GPU 28. Finger millet is a hardy crop required less water, but higher yield can be achieved with supplemental irrigation. The average yield of all the trials was 2550 kg ha-1 which is 63 % higher than the farmer's practice of using their traditional variety.

As regards to other evaluations, groundnut variety ICGV 91114 recorded 35 to 40 per cent increase in yield as compared to local existing variety. Farmers like the cultivar because of its ability to sustain the drought situations and yield more in the prevailing situations. The pigeonpea variety ICPL 87119 responded well under the low rainfall situation and yielded 40 to 45 per cent higher than the existing local variety which is susceptible to sterility mosaic virus disease.

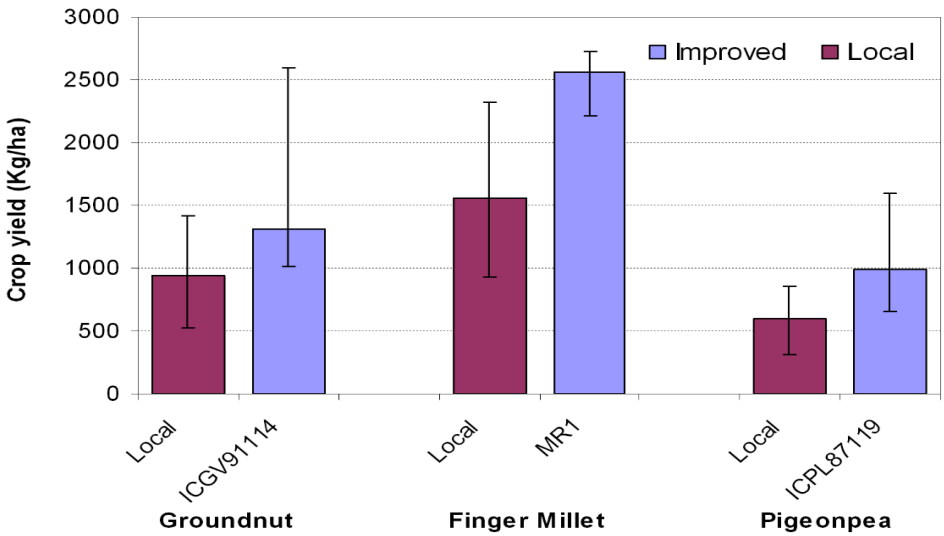


Figure 16. Farmer participatory varietal evaluation in Tumkur district

Chickmangaluru: Trials for pigeonpea with six improved cultivars were conducted in Chickmangaluru with local check. The pigeonpea hybrids were found to be better in performance compared to local variety whereas other ICRISAT varieties also found to be the better option in the targeted sites in the district. All these varieties and hybrids recorded 15 to 20 per cent increase in the yield over local check.

The variety CSV 15 was tested in seven districts. Maximum grain yield was observed in Koppal (2640 kg ha-1) district whereas low yield was recorded in Haveri district (1800 kg ha-1) (Figure 17). Overall average yield for CSV 15 cultivar (2240 kg ha-1) is 23 per cent higher than farmer's practice of using traditional variety (1820 kg ha-1).

Twenty trials on sorghum variety CSV 23 were conducted in eight districts on 9.6 ha area. Overall, average grain yield from four districts was 2580 kg ha^{-1} (28% higher) against 2020 kg ha^{-1} with their local variety (Figure 18). Heavy rainfall during crop season damaged trials in four districts. Observed data from the districts indicated that CSV 23 has recorded 13 to 33% more grain yield across all the districts compared to their practice of using traditional variety.

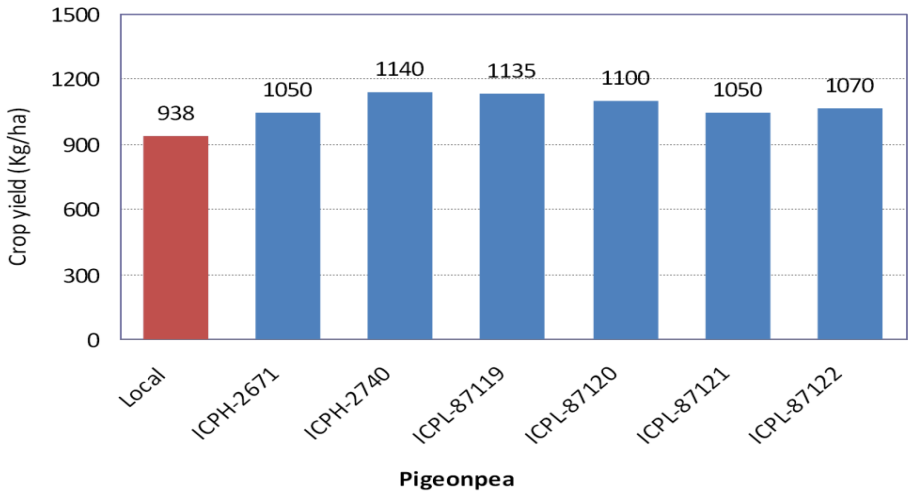


Figure 17. Farmer participatory varietal evaluation of pigeonpea cultivars

As regards to ragi, the variety evaluated under varietal evaluation MR 1 was found to have 15 to 25 per cent higher yield as compared to local variety GPU 28. As regards to groundnut crop, the cultivar ICGV 91114, ICGV 00308, ICGV 44 were used for varietal evaluation. These varieties are high-yielding, matures in 90 to 95 days, tolerant of mid-season and end-of-season drought, average shelling turnover 75%, oil content 48%, and has better digestibility and palatability of haulms. Due to its early and uniform maturity, attractive pod and seed shape and high shelling turnover, ICGV 91114 is becoming popular among farmers of Karnataka. The average pod yield was maximum 2790 kg ha^{-1} for ICGV 91114 whereas for local variety the pod yield was only 1120 kg ha^{-1}). The increase in pod yield with improved management with these three varieties was ranging from 120 to 150 per cent compared to local variety TMV 2.

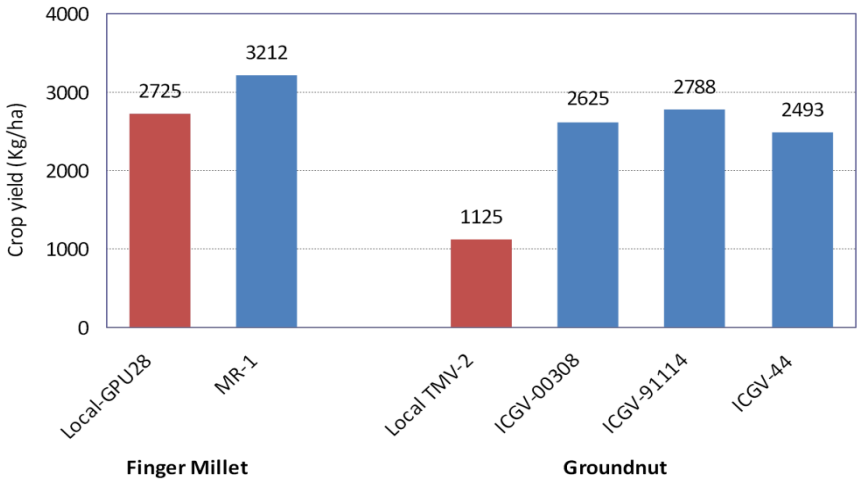


Figure 18. Farmer participatory varietal evaluation in Chikkamagaluru district

Vijayapura: Evaluation of pearl millet crop with two hybrid cultivars ICTP 8203 and HHB67 (improved) were conducted in Vijayapura. As regards to hybrid ICTP 8203, it is of medium duration variety (75 to 80 days) with medium height (1.5-1.6 m) and has good resistance to downy mildew and tolerance to drought. The hybrid HHB 67 performed quite well and recorded 29 per cent higher yield as compared to their traditional variety.

The next improved introduction was hybrid HHB 67-2 (improved) which is the first product of marker-assisted breeding to reach cereal farmers in India. It is the Downy mildew tolerant improved version of HHB 67, a single-cross grain hybrid developed at Chaudhary Charan Singh Haryana Agricultural University, Hisar in collaboration with ICRISAT. HHB 67-2 like HHB 67 is early maturing, has high-tillering, extra-early maturity (64-65 days) and medium-tall height (170-200 cm). The hybrid has really performed well and has recorded 46 per cent higher yield over traditional variety.

As regards to pigeonpea, variety Asha performed well as compared to mosaic susceptible local variety and has recorded 12 per cent higher yield over local.

Farmer participatory varietal evaluation of two chickpea cultivar viz, JG 11, JAKI 9218 were conducted in the district. JG 11 (ICCV 93954) is a desi chickpea variety developed by ICRISAT in partnership with Jawaharlal Nehru Krishi Vishwa Vidyalaya (JNKVV), Jabalpur, Madhya Pradesh, India. It was released by the Central Variety Release Committee of India for southern India. JG 11 has spread rapidly in southern India during the past five years. It is gradually replacing the variety 'Annigeri' that has been holding sway here for over four decades. Farmers prefer JG 11 because of its early maturity (95-100 days), high yield (up to 2.5 t ha^{-1} in rainfed condition and up to 3.5 t ha^{-1} under irrigated conditions), attractive large seed (22 g 100 seed-1) and most preferably high tolerance to *Fusarium* wilt (<10% mortality). The average recorded yield in the district was 55 per cent higher than farmers preferred traditional variety.

As regards to variety JAKI 9218, the variety is semi-spreading, profuse branching, bold seeded one having excellent seedling vigour and golden yellow grain colour. The variety has recorded 45 per cent higher grain yield than farmers' practice of using local variety.

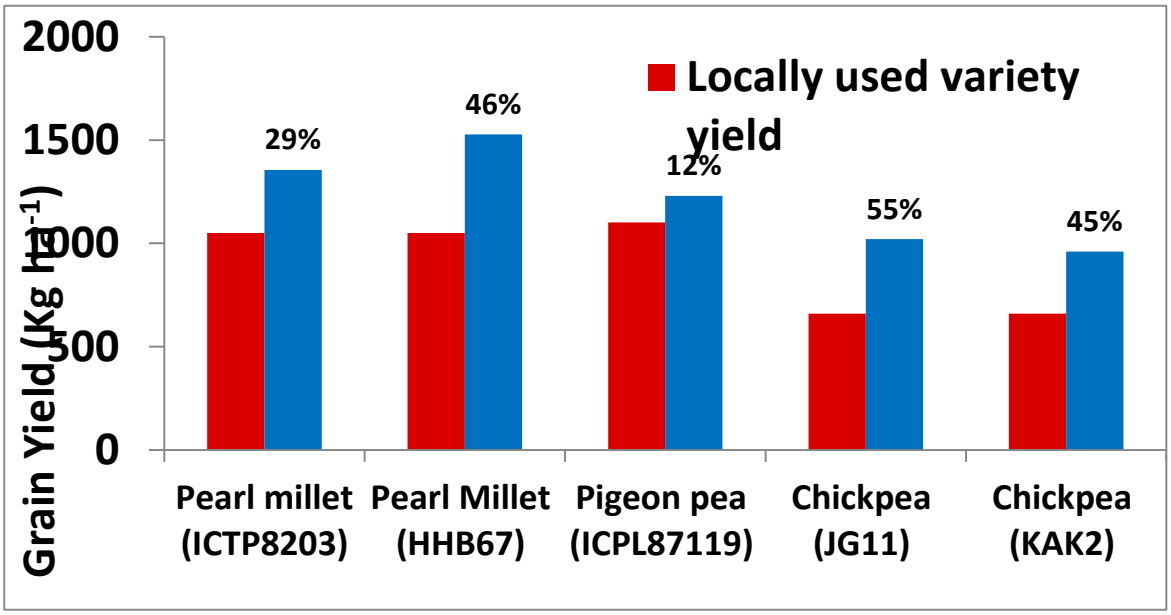


Figure 19. Farmer participatory varietal evaluation in Vijayapura district

Karnataka: Rainfall Situation in 2014

Karnataka is divided in to four regions viz., South Interior Karnataka (SIK), North Interior Karnataka (NIK), Malnad and Coastal region. Southwest monsoon was set over coastal Karnataka on 09 Jun 2014, which is late by one week. The monsoon was stagnant for about five days, slowly progressed and it covered the whole of Karnataka by about 20 Jun. Koppal, Hassan, Mandya, Chitradurga and Davanagere received excess rainfall, Chikkaballapur, Bidar, Kolar and Gulbarga received deficit rainfall, while the remaining 21 districts received normal rainfall during the southwest monsoon period 2014. The year 2014 was a good for Karnataka as the state received about 833 mm of rainfall during southwest monsoon period against the normal of 839 mm; and the percentage departure is only -1%.

During the post-monsoon period (Oct-Dec), Karnataka state as a whole received only 162 mm compared to a normal of about 188; percentage departure is -13% and categorized as "Normal". Thus, Karnataka received normal rainfall both during the southwest monsoon and post-monsoon periods in the year 2014. In the post-monsoon period, fifteen districts received normal rainfall, two districts excess rainfall and thirteen districts received deficit rainfall (Figure 20). Bidar, Chikkaballapur, Gulbarga and Kolar districts received deficit rainfall in both the seasons.

Table 1. Region-wise rainfall in Karnataka for the year 2014

Region	Southwest Monsoon (Jun-Sep)			Post-monsoon (Oct-Dec)		
	Normal (mm)	Actual (mm)	Percentage departure	Normal (mm)	Actual (mm)	Percentage departure
South Interior Karnataka	359	379	6	210	204	-3
North Interior Karnataka	494	475	-4	145	112	-23
Malnad	1504	1592	6	228	171	-25
Coastal Karnataka	3019	2866	-5	261	260	0
State	839	833	-1	188	162	-13

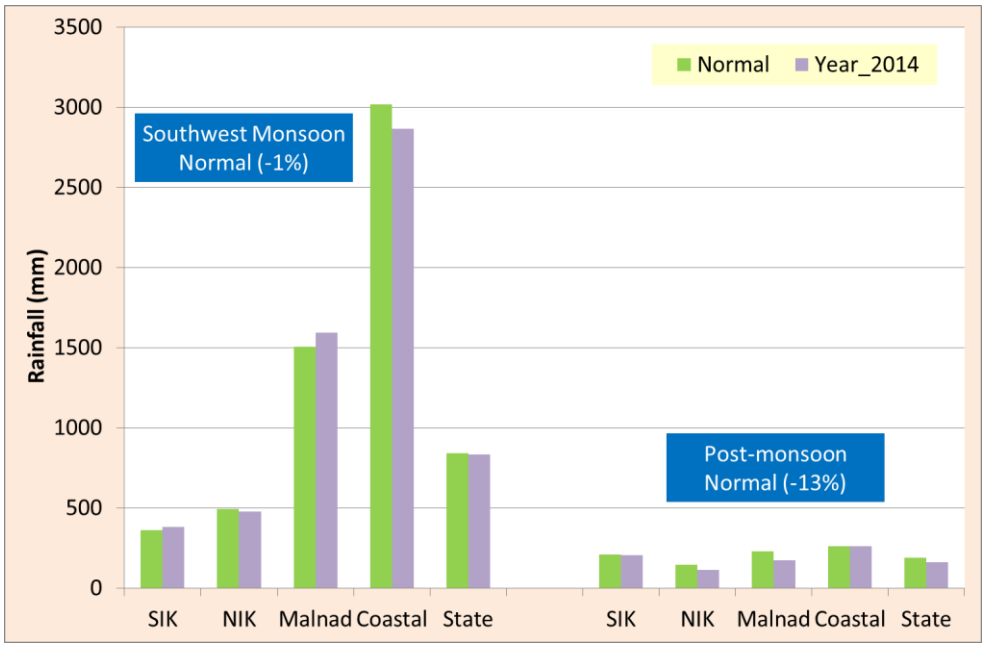


Figure 20. Normal and actual rainfall received in different regions of Karnataka in the year 2014

It is observed from the weekly rainfall departures from normal during Jun to Dec 2014 that rainfall was below 50 per cent of normal in two consecutive weeks (25 Jun to 08 Jul) in the southwest monsoon season. On the other hand, during the post-monsoon period, rainfall departures were always negative except for three weeks ending on 28 Oct, 18 Nov and 16 Dec. The 3-week period from 19 Nov to 09 Dec experienced deficit rainfall conditions and has restricted water availability to crops (Figure 21).

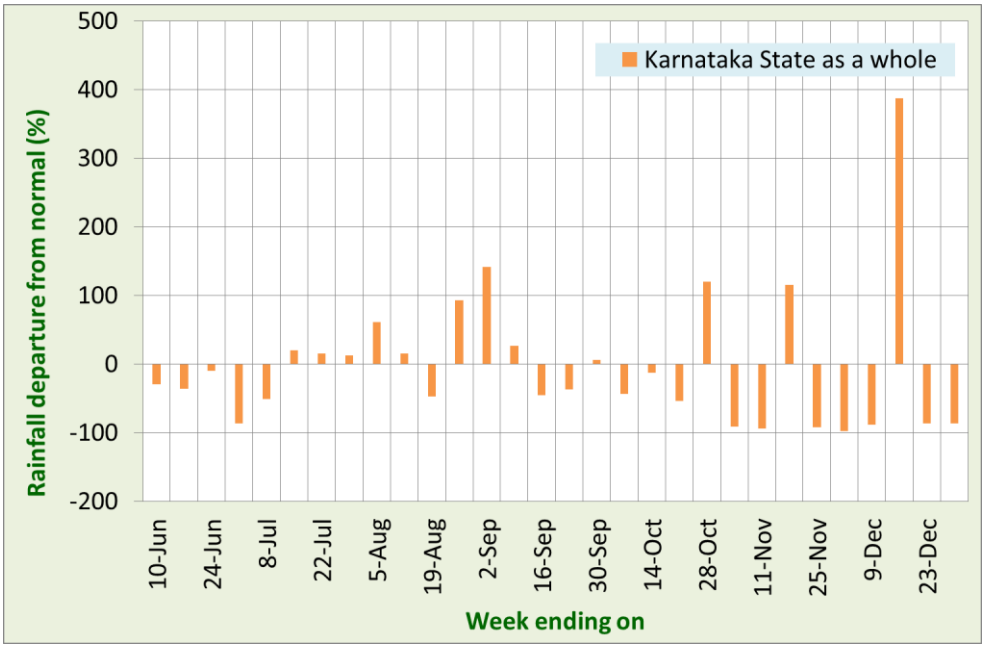


Figure 21. Weekly rainfall in Karnataka

Table 2. District-wise rainfall in Karnataka for the year 2014						
District	Southwest Monsoon (Jun-Sep)			Post-monsoon (Oct-Dec)		
	Normal (mm)	Actual (mm)	Percentage departure	Normal (mm)	Actual (mm)	Percentage departure
Chikkaballapur	399	221	-45	222	143	-36
Bidar	684	443	-35	116	50	-57
Kolar	387	263	-32	236	182	-23
Gulbarga	614	491	-20	127	80	-37
Bangalore Urban	460	376	-18	234	269	15
Yadgir	592	484	-18	150	88	-41
Udupi	4071	3438	-16	299	310	4
Bijapur	428	373	-13	141	71	-50
Kodagu	2345	2116	-10	288	193	-33
Ramanagara	430	396	-8	238	209	-12
Dakshina Kannada	3441	3195	-7	367	336	-8
Dharwad	498	477	-4	159	177	11
Bangalore Rural	441	428	-3	229	257	12
Uttara Kannada	2457	2513	2	198	207	5
Raichur	450	464	3	143	67	-53
Tumkur	361	379	5	204	221	8
Bagalkot	350	373	6	144	86	-40
Belgaum	612	649	6	153	166	9
Shimoga	1889	2012	6	202	156	-23
Chamarajanagar	305	336	10	257	177	-31
Bellary	352	393	12	150	143	-5
Chikkamagalur	1349	1525	13	228	179	-22
Gadag	382	438	15	162	132	-18
Mysore	395	463	17	211	181	-14
Haveri	485	576	19	168	188	12
Koppal	376	452	20	142	125	-12
Hassan	673	818	22	225	167	-26
Mandya	304	387	27	233	217	-7
Chitradurga	276	363	32	160	212	33
Davanagere	373	507	36	173	212	23
State	**839**	**833**	**-1**	**188**	**162**	**-13**

Project Activities

District, Taluk and Cluster/Village Level Trainings

District level trainings were organized at different levels to sensitize Department staff, Farm Facilitators and ICRISAT staff located at different districts. The trainings were attended by DoA officials (JDA, ADAs, AOs, AAOs), Scientists from Universities, KVKs, and Scientists, Scientific officers and Research Technicians of ICRISAT. Wide range of topics were covered in the trainings. Till date, 75 trainings were organized at district level and 7,165 staff were trained through these trainings (Table 3).

Taluk level trainings were organized for agricultural assistants, newly appointed field facilitators and lead farmers in each taluk during different intervals in all the districts. These trainings were organized with the objective of hands-on training and demonstration of technologies, such as seed treatment, soil sampling, use of tropicultor, crop harvest sampling, and village level record keeping by field facilitators. In all the 30 districts, 187 taluk level trainings were conducted and a total of 15,769 men and women were trained on bhoochetana technologies (Table 3).

Cluster/village level trainings were organized by AOs of DoA and research technicians of ICRISAT who were assisted by resource persons, either scientists or scientific officers from ICRISAT. These were even informal gatherings of a group of farmers in a village to discuss the issues of input distribution or specific soil/crop related issues, pest management issues etc in their villages. These trainings were conducted in large numbers covering more than 3.67 lakhs farm men and women before the start of the season and during crop seasons in all 30 districts which were generally very effective in communicating and proper implementation of technologies.

Figure 22. Field day of Bhoochetana in Bellary district

Figure 23. Training program of Bhoochetana for farmer facilitator in Chigateri RSK, Harapanahalli taluk, Davanagere district.

Table 3. Trainings conducted in all districts under Bhoochetana 2nd phase during (Kharif) 2014							
District	**Taluks**	**District-level**		**Taluk/village-level**			
		No. of Trainings		**No. of trainings**			
		District level	**Partici-pants**	**Taluk level**	**Partici-pants**	**Village level**	**Partici-pants**
Bagalkote	Badami, Bagalkot, Bilagi, Hungund, Jamakhandi, Mudhol	2	130	12	592	192	39809
Bellary	Bellary, Kudligi, Sandur, Hospet, Siryguppa, H.B.halli, Hadagali	3	300	7	393	412	15230
Bengaluru Rural	Devanahalli, Nelamangala Doddaballapura, Hoskore	3	150	4	374	81	2947
Bengaluru Urban	Anekal, Bengaluru (S), Bengaluru(N), Bengaluru(E)	1	55	4	379	59	1956
Belgaum	Athani, Bailhongal, Raibag, Chikodi, Belgaum, Gokak, Hukkeri, Ramdurg, Khanapur, Soundatti	3	300	10	1013	347	16357
Bidar	Bidar, Bhalki, Aurad, Humnabad, Basavakalyan.	3	485	5	975	405	20453
Bijapur	B. Bagewadi, Bijapur, Indi, Muddebihal, Sindagi	3	153	5	350	559	16770
Chamarajan agara	Chamarajanagara, Kollegal, Gundalpet, Yelandur	3	381	8	124	112	4480
Chikkaballa-pur	Chickballapur, Bagepalli, Shidlagatta, Chintamani, Gouribidanur, Gudibandae	2	66	6	469	208	10060
Chikkaman-galuru	Chikkamangaluru, Kadur, Tarekere	1	65	7	450	202	8986
Chitradurga	Challakere, Chitradurga, Hiriyuru, Holalkere, Hosadurga, Molakalmuru	2	241	6	382	412	12964
Davangere	Davanagere, Harapanahalli Harihar, Honnali, Jagaluru Channagiri	2	652	6	736	471	91344
Dharwad	Dharwad, Hubli, Kalghatgi, Kundgol, Navalgund	3	608	5	450	123	5315
Dakshina Kannada	Mangalore, Bantwal, Belthangady, Puttur, Sulia	2	187	5	452	62	1569
Gadag	Gadag, Ron, Mundargi, Shirahatti, Naragunda	4	260	12	850	286	10527
Gulburga	Aland, chincholi, Gulburga, Sedam,	3	559	7	805	184	5336
Hassan	Alur, Arklgud, Arsikere, Belur, Chanrayapatna, Hassan, Holenarsipura	3	360	8	1849	304	13059
Haveri	Haveri, Hangal, Savanur, Hirekerur, Ranebennur, Byadagi, Shiggaon	1	75	7	668	275	7150
Kolar	Kolar, Mulbagal, Malur, Srinivaspura, Bangarpet,	1	102	5	517	201	6892

Table 3. Trainings conducted in all districts under Bhoochetana 2nd phase during (Kharif) 2014							
District	**Taluks**	**District-level**		**Taluk/village-level**			
		No. of Trainings		**No. of trainings**			
		District level	**Partici-pants**	**Taluk level**	**Partici-pants**	**Village level**	**Partici-pants**
Kodugu	Somwarpet, Madikeri, Virajpet	4	156	3	115	95	4183
Koppal	Gangaavathi, Koppala. Kustagi, Yalburga	3	180	4	200	160	7027
Mandya	Mandya, Malavalli, Maddur, Pandavapura, Srirangapatna, K R Pet, Nagamangala	3	214	7	382	201	9967
Mysore	H D Kote, Piriyapattana Hunasuru, Mysore, K R Nagara, T Narasipura, Nanjanagudu	3	282	7	612	292	11997
Raichur	Manvi, Lingasugur, Raichur, Sindhanur, Devadurga	6	220	11	750	184	7852
Ramnagara	Ramanagera, Magidi, Chanapatatna, Kankapura	3	180	4	426	187	5546
Shimago	Bhadravathi, Hosanagar, Sagara, Shikarpur, Shimago, Soroba	1	65	7	450	202	8986
Tumkur	Tumkur, Tiptur, Turuvekere, Cnhalli, Gubbi, Kunigal, Sira, Koratagere, Madugiri, pavgada	3	213	10	1019	365	14927
Udipi	Udupi, Kundapura, Karkala	3	197	3	232	104	5893
Uttara Kannada	Karwar, Ankola, Bhaktal, Kumta, Honnavar, Sirsi	3	148	11	448	198	4356
Yadgiri	Shahapur, Shorapur, and Yadgiri	2	246	3	274	68	4654
Total		**75**	**7165**	**187**	**15769**	**6749**	**367606**

Field days

ICRISAT Staff along with DoA officials coordinated field days in all 30 districts with the full support and participation of DoA district-level staff during the cropping season (Table 4). Field days were organized to demonstrate crop growth and yield enhancement with improved management including use of micronutrients and suitable improved varieties in different districts. Besides, ICRISAT-DoA staffs were making several field visits to contact farmers and guide them on crops management to ensure proper sowing and appropriate plant stand which are more important for higher productivity. Nearly 2163 field days were organized in 30 districts of Karnataka. Nearly 1,33,286 farmers were exposed to science-led improved technologies to enhance crop productivity on dry lands. These participants include both men (98,445) and women (35,477) farmers. These field days are more effective in transfer of technology as farmers from surrounding villages and trial farmers interacted with each other and observed standing crop that helped in adoption of technology more effective and faster way adopting the principle of “seeing is believing”.

Table 4: Details of field days held in different districts of Karnataka during 2014 kharif cropping seasons.

Sl. No	District	No. of Field Days held	No. of Farmers participated	Men	Women
1	Bagalkote	271	8130	5420	2710
2	Bellary	29	1973	1702	271
3	Bengaluru Rural	83	4378	3469	909
4	Bengaluru Urban	58	3842	3095	747
5	Belgaum	152	15504	8534	6970
6	Bidar	15	723	635	88
7	Bijapur	140	7250	5900	1350
8	Chamarajanagara	10	450	385	65
9	Chikkaballapur	9	79	320	399
10	Chikkamagalur	171	9405	8465	940
11	Chitradurga	26	2453	1638	815
12	Davangere	38	4926	2886	2040
13	Dharwad	39	1343	1090	253
14	Dakshina Kannada	41	2050	1230	820
15	Gadag	144	11015	9178	1837
16	Gulburga	37	2056	1839	217
17	Hassan	178	10097	4515	5582
18	Haveri	28	2078	1627	451
19	Kolar	5	285	224	61
20	Kodugu	58	3822	2904	918
21	Koppal	4	200	138	62
22	Mandya	98	4900	3800	1100
23	Mysore	22	1814	1623	191
24	Raichur	140	9808	8356	1448
25	Ramnagara	29	870	760	110
26	Shimoga	131	8342	6551	1791
27	Tumkur	46	5784	4679	1105
28	Udipi	50	2700	1826	874
29	Uttara Kannada	94	5745	4596	1149
30	Yadgir	17	1264	1060	204
Total		**2163**	**133286**	**98445**	**35477**

Awareness and Field Publicity Campaigns on Bhoochetana II for Farmers

In Bhoochetana II phase also the Department of Agriculture staff ensured that wall writings (Figure 24) and exhibition of posters in the local language were set up in all villages before the onset of monsoon, pointing out the main objectives of the program and areas to be covered by the program. Additionally thousands of brouchures and handouts were published and distributed widely in each district on improved management practices, information on nutrients status, and nutrients recommended taluk-wise (Figure 25).

Figure 24. Wall writing in Gowribidanur, Chikkaballpur district; Bhoochetana awareness Tablow in Davanagere taluk

Figure 25. Information brouchure were prepared and distributed to farmers in RSKs

Climate Change Workshops

As a part of awareness building and capacity enhancement in climate change science and adaptation strategies, district level climate change workshops were held. Presentations were made by ICRISAT scientists that included topics of global warming, climate variability and change scenarios in India, Karnataka and the specific district, climate change impacts and adaptation strategies, climate change projections for the specific district. These presentations were followed by discussions and active participation by the officers of the Department of Agriculture.

Table 5. Details of District Level Climate Change Workshops held during 2014

Sl. No	District	Date held
1	Gulbarga	21 Apr 2014
2	Hassan	25 Apr 2014
3	Yadgir	28 Apr 2014
4	Dakshina Kannada	07 May 2014
5	Udupi	07 May 2014
6	Kolar	13 May 2014
7	Gadag	28 May 2014
8	Belgaum	31 May 2014
9	Bellary	31 May 2014
10	Mysore	03 Jun 2014
11	Bidar	10 Jun 2014
12	Davanagere	14 Jun 2014
13	Bijapur	17 Jun 2014
14	Chikkaballapur	20 Jun 2014
15	Kodagu	20 Jun 2014
16	Mandya	21 Jun 2014
17	Uttara Kannada	23 Jun 2014
18	Tumkur	14 Jul 2014
19	Ramanagara	19 Jul 2014
20	Chamarajanagar	22 Jul 2014
21	Bagalkot	24 Jul 2014
22	Bengaluru Rural	24 Jul 2014
23	Koppal	21 Aug 2014
24	Dharwad	26 Aug 2014
25	Chikkamagaluru	21 Oct 2014

Figure 26. DATC, Kotnoor-Gulbarga on 21 Apr 2014 (L); KVK, Mysore on 12 Jun 2014 (R)

Rainfed Crop Planning during 2014-15

Target Area Sown to Major Crops

During 2014-15 crop season under Bhoochetana II phase, farmers were motivated to cover a large area under Bhoochetana activities for possible benefits to participating farmers in the technology uptake of the project. During the season, Bhoochetana activities were targeted to cover an area of 58.92 lakh ha with improved management to enhance rainfed as well as irrigated crop productivity in all the 30 districts. The project implemented crop productivity enhancement technologies on 51.70 lakh ha in Karnataka which was 87.7% of the target area with major cererals, legumes and oilseeds (Table 6).

Table 6. District-wise target cropping area (hectares) sown to major crops during crop season 2014-15.

District	Major rainfed crop	Target area	Sown area	% achieved
Ballari	Kharif Cotton	15000	34839	232
	Kharif Groundnut	56000	46876	84
	Kharif Sorghum	25000	14112	56
	Kharif Sunflower	28000	8862	32
	Kharif Maize	59000	77018	131
	Kharif Paddy	70000	70414	101
	Kharif Pearl Millet	12000	15986	133
	Kharif Pigeonpea	9000	6486	72
Bidar	Kharif Sorghum	33000	26498	80
	Kharif Paddy	1000	1095	110
	Kharif Pigeonpea	64000	56396	88
	Kharif Blackgram	24000	13500	56
	Kharif Greengram	33000	13474	41
	Kharif Soybean	115000	142270	124
	Kharif Sugarcane	20000	3850	19

Table 6. District-wise target cropping area (hectares) sown to major crops during crop season 2014-15.				
District	**Major rainfed crop**	**Target area**	**Sown area**	**% achieved**
	Rabi Chickpea	59000	29631	50
	Rabi Safflower	10000	7018	70
	Rabi Sorghum	26000	9557	37
	Rabi Wheat	8300	2439	29
Haveri	Kharif Cotton	82000	82000	100
	Kharif Groundnut	17000	15235	90
	Kharif Maize	106800	106560	100
	Kharif Paddy	15500	15500	100
	Kharif Pulses	6000	2768	46
	Kharif Sorghum	27700	26950	97
	Kharif Soybean	6000	5335	89
Koppal	Kharif Cotton	15000		0
	Kharif Greengram	16000	15274	95
	Kharif Groundnut	20000	12665	63
	Kharif Horsegram	3500	3595	103
	Kharif Maize	30000	43930	146
	Kharif Paddy	35000	35000	100
	Kharif Pearl Millet	55000	51010	93
	Kharif Pigeonpea	8500	12170	143
	Kharif Sorghum	6500	1180	18
	Kharif Sunflower	20500	12894	63
Udupi	Kharif Paddy	10000	10000	100
Chitradurga	Kharif Cotton	9000	8196	91
	Kharif Greengram	3000	2998	100
	Kharif Groundnut	146000	115082	79
	Kharif Maize	81000	76378	94
	Kharif Pigeonpea	11000	7231	66
	Kharif Ragi	35000	33061	94
	Rabi Chickpea	15000	14465	96
	Rabi Sorghum	5000	4340	87
Davanagere	Kharif Cotton	29450	25735	87
	Kharif Fieldbean	990	524	53
	Kharif Groundnut	12025	5287	44
	Kharif Maize	154415	171816	111
	Kharif Maize	850	328	39
	Kharif Paddy	55000	55788	101
	Kharif Pigeonpea	4000	5407	135
	Kharif Ragi	10980	9193	84
	Kharif Sorghum	11100	7419	67
	Kharif Sugarcane	3060	5246	171
	Kharif Sunflower	3980	1031	26
	Rabi Chickpea	5065	968	19

Table 6. District-wise target cropping area (hectares) sown to major crops during crop season 2014-15.				
District	**Major rainfed crop**	**Target area**	**Sown area**	**% achieved**
	Rabi Ragi	585	164	28
	Rabi Sorghum	6000	1532	26
Mandya	Kharif Cowpea	4500	3038	68
	Kharif Groundnut	1000	212	21
	Kharif Maize	5000	1705	34
	Kharif Paddy	54000	27730	51
	Kharif Ragi	62000	41260	67
	Kharif Sugarcane	19000	16207	85
Mysuru	Kharif Blackgram	10000	9341	93
	Kharif Cotton	50500	82883	164
	Kharif Cowpea	26000	23992	92
	Kharif Fieldbean	18000	8347	46
	Kharif Greengram	5900	7195	122
	Kharif Groundnut	3700	4005	108
	Kharif Maize	26800	27563	103
	Kharif Paddy	96500	84506	88
	Kharif Pigeonpea	3000	2154	72
	Kharif Ragi	38000	34992	92
	Kharif Sorghum	5000	4674	93
	Kharif Sugarcane	7600	7698	101
	Kharif Sunflower	1000	824	82
Ramanagara	Kharif Cowpea	2500	2157	86
	Kharif Fieldbean	4000	3705	93
	Kharif Groundnut	7000	4175	60
	Kharif Maize	1500	1305	87
	Kharif Pigeonpea	4000	3393	85
	Kharif Ragi	75000	67956	91
Bagalkot	Kharif Greengram	26500	22000	83
	Kharif Groundnut	800	665	83
	Kharif Maize	34000	32700	96
	Kharif Pearl Millet	24700	18000	73
	Kharif Pigeonpea	5000	3500	70
	Kharif Sorghum	2500	2100	84
	Kharif Soybean	6000	5500	92
	Kharif Sugarcane	28500	26100	92
	Kharif Sunflower	8000	7000	88
Belgavi	Kharif Blackgram	3000	3000	100
	Kharif Cotton	31000	31000	100
	Kharif Greengram	17000	17000	100
	Kharif Groundnut	23500	23500	100
	Kharif Maize	96500	96500	100
	Kharif Paddy	63000	63000	100

Table 6. District-wise target cropping area (hectares) sown to major crops during crop season 2014-15.				
District	**Major rainfed crop**	**Target area**	**Sown area**	**% achieved**
	Kharif Pearl Millet	21000	19498	93
	Kharif Sorghum	24000	24000	100
	Kharif Soybean	60000	56800	95
	Kharif Sugarcane	40000	40000	100
Dharwad	Kharif Cotton	24500	38656	158
	Kharif Greengram	22000	18175	83
	Kharif Groundnut	30000	22040	73
	Kharif Maize	33000	24481	74
	Kharif Paddy	18000	20400	113
	Kharif Soybean	33500	30923	92
Gadag	Kharif Cotton	20500	36055	176
	Kharif Greengram	70000	57506	82
	Kharif Groundnut	56000	33356	60
	Kharif Maize	49500	24727	50
	Kharif Paddy	1000	377	38
	Kharif Pearl Millet	2000	1600	80
	Kharif Pigeonpea	3000	1342	45
	Kharif Sorghum	9000	2889	32
	Kharif Sunflower	20000	3761	19
Vijayapura	Kharif Greengram	7500	5204	69
	Kharif Groundnut	14600	11488	79
	Kharif Maize	59300	49426	83
	Kharif Pearl Millet	34700	29635	85
	Kharif Pigeonpea	162600	147876	91
	Kharif Sugarcane	4500	4663	104
	Kharif Sunflower	21300	17005	80
Bengaluru Rural	Kharif Ragi	44000	35537	81
	Kharif Maize	10000	11074	111
Bengaluru Urban	Kharif Ragi	30000	19670	66
Raichur	Kharif Cotton	50200	86078	171
	Kharif Groundnut	5620	4468	80
	Kharif Paddy	105500	96022	91
	Kharif Pearl Millet	27342	27315	100
	Kharif Pigeonpea	23842	24915	105
	Kharif Sunflower	33300	11037	33
	Rabi Chickpea	115000	101000	88
	Rabi Groundnut	36400	27328	75
	Rabi Paddy	70900	69000	97
	Rabi Sorghum	118000	96500	82
	Rabi Sunflower	33100	21450	65
Uttara Kannada	Kharif Cotton	2000	1413	71
	Kharif Maize	6000	5140	86

Table 6. District-wise target cropping area (hectares) sown to major crops during crop season 2014-15.				
District	**Major rainfed crop**	**Target area**	**Sown area**	**% achieved**
	Kharif Paddy	66000	65046	99
	Kharif Sugarcane	4000	4000	100
Chikkamagaluru	Kharif Paddy	23000	21495	93
	Rabi Chickpea	11700	9145	78
	Rabi Horsegram	7300	8170	112
	Rabi Sorghum	10000	8285	83
Shivamogga	Kharif Maize	55000	50070	91
	Kharif Paddy	72200	67500	93
	Kharif Sugarcane	2000	1080	54
Chamarajanagar	Kharif Fieldbean	2750	2434	89
	Kharif Blackgram	5000	3011	60
	Kharif Cotton	12200	12325	101
	Kharif Cowpea	3300	2957	90
	Kharif Greengram	3100	2857	92
	Kharif Groundnut	14900	11150	75
	Kharif Sorghum	10000	9600	96
	Kharif Sunflower	8450	8400	99
	Kharif Maize	41100	24890	61
	Kharif Paddy	16000	11277	70
	Kharif Ragi	15940	10155	64
	Kharif Sugarcane	4000	3765	94
Kodagu	Kharif Maize	3000	3000	100
	Kharif Paddy	29500	28380	96
Kalaburagi	Kharif Blackgram	54000	17923	33
	Kharif Greengram	41000	17010	41
	Kharif Groundnut	5000	429	9
	Kharif Pearl Millet	18000	15165	84
	Kharif Pigeonpea	320000	299958	94
	Kharif Soybean	14500	22127	153
	Kharif Sunflower	46000	16954	37
Dakshina Kannada	Kharif Paddy	25000	25000	100
Hassan	Kharif Blackgram	1600	1230	77
	Kharif Castor	800	310	39
	Kharif Cowpea	13000	11480	88
	Kharif Fieldbean	2100	1685	80
	Kharif Greengram	4400	3975	90
	Kharif Groundnut	1100	343	31
	Kharif Maize	72500	70070	97
	Kharif Paddy	42000	37441	89
	Kharif Pigeonpea	800	885	111
	Kharif Ragi	67000	60530	90

Table 6. District-wise target cropping area (hectares) sown to major crops during crop season 2014-15.				
District	**Major rainfed crop**	**Target area**	**Sown area**	**% achieved**
	Kharif Sorghum	1800	1175	65
	Kharif Sunflower	700	608	87
	Kharif Sugarcane	2000	1655	83
Tumakuru	Kharif Cotton	150	150	100
	Kharif Cowpea	3500	3210	92
	Kharif Fieldbean	13850	8455	61
	Kharif Greengram	12000	8902	74
	Kharif Groundnut	141500	83504	59
	Kharif Maize	20000	24912	125
	Kharif Paddy	16000	3846	24
	Kharif Pigeonpea	22400	13811	62
	Kharif Ragi	186600	167853	90
Chikballapur	Kharif Groundnut	35000	16562	47
	Kharif Maize	39200	49506	126
	Kharif Pigeonpea	2000	2479	124
	Kharif Ragi	41300	44951	109
	Total	**5892244**	**5170074**	**87.7**

Input Distribution

Distribution of fertilizers and micronutrients to farmers did not follow any particular pattern and in all the districts use of one nutrient or the other is high as balanced and recommended usage of nutrients was not achieved. Since Bhoochetana was operationalized in all the 30 districts, farmers purchased inputs knowing the advantage of inputs as well as their economic ability and availability of nutrients. Enhanced awareness amongest farmers about the advantage of correcting nutrient deficiencies in a balanced manner and ensuring timely availability would help in changing farmers' practice in the use of micronutrients to enhance their crop productivity and incomes (Table 7).

Table 7. District-wise micronutrients (requirements based on soil analysis) actual distribution to farmers during 2014-15				
District	**Crops covered**	**Nutrients distributed (tons)**		
		Gypsum	**Zinc Sulphate**	**Borax**
Ballari	Kharif Cotton, Kharif Groundnut, Kharif Sorghum, Kharif Sunflower, Kharif Maize, Kharif Paddy, Kharif Pearl Millet, Kharif Pigeonpea	5134.89	686.48	145.53
Bidar	Kharif Sorghum, Kharif Paddy, Kharif Pigeonpea, Kharif Blackgram, Kharif Greengram, Kharif Soybean, Kharif Sugarcane, Rabi Chickpea, Rabi Safflower, Rabi Sorghum, Rabi Wheat	5452.00	1025.00	405.00

Table 7. District-wise micronutrients (requirements based on soil analysis) actual distribution to farmers during 2014-15				
District	**Crops covered**	**Nutrients distributed (tons)**		
		Gypsum	**Zinc Sulphate**	**Borax**
Haveri	Cotton, Kharif Groundnut, Kharif Maize, Kharif Paddy, Kharif Pulses, Kharif Sorghum, Kharif Soybean	1874.54	529.04	101.74
Koppal	Kharif Cotton, Kharif Greengram, Kharif Groundnut, Kharif Horsegram, Kharif Maize, Kharif Paddy, Kharif Pearl Millet, Kharif Pigeonpea, Kharif Sorghum, Kharif Sunflower	3300.00	570.00	210.00
Udupi	Kharif Paddy	399.90	29.30	4.40
Chitradurga	Kharif Cotton, Kharif Greengram, Kharif Groundnut, Kharif Maize, Kharif Pigeonpea, Kharif Ragi Rabi Chickpea, Rabi Sorghum	3600.00	244.00	183.00
Davanagere	Kharif Cotton, Kharif Fieldbean, Kharif Groundnut, Kharif Maize, Kharif Maize, Kharif Paddy, Kharif Pigeonpea, Kharif Ragi, Kharif Sorghum, Kharif Sugarcane, Kharif Sunflower, Rabi Chickpea, Rabi Ragi, Rabi Sorghum	9218.33	497.04	207.59
Mandya	Kharif Cowpea, Kharif Groundnut, Kharif Maize, Kharif Paddy, Kharif Ragi, Kharif Sugarcane	721.68	23.44	0.20
Mysuru	Kharif Blackgram, Kharif Cotton, Kharif Cowpea, Kharif Fieldbean, Kharif Greengram, Kharif Groundnut, Kharif Maize,Kharif Paddy, Kharif Pigeonpea, Kharif Ragi, Kharif Sorghum, Kharif Sugarcane, Kharif Sunflower	1979.00	124.00	57.00
Ramanagara	Kharif Cowpea, Kharif Fieldbean, Kharif Groundnut, Kharif Maize, Kharif Pigeonpea, Kharif Ragi	1681.30	103.61	37.63
Bagalkot	Kharif Greengram, Kharif Groundnut, Kharif Maize, Kharif Pearl Millet, Kharif Pigeonpea, Kharif Sorghum, Kharif Soybean, Kharif Sugarcane, Kharif Sunflower	3124.88	285.68	91.70
Belgavi	Kharif Blackgram, Kharif Cotton, Kharif Greengram, Kharif	7463.50	1354.96	363.07

Table 7. District-wise micronutrients (requirements based on soil analysis) actual distribution to farmers during 2014-15				
District	**Crops covered**	**Nutrients distributed (tons)**		
		Gypsum	**Zinc Sulphate**	**Borax**
	Groundnut, Kharif Maize, Kharif Paddy, Kharif Pearl Millet, Kharif Sorghum, Kharif Soybean,Kharif Sugarcane			
Dharwad	Kharif Cotton, Kharif Greengram, Kharif Groundnut, Kharif Maize, Kharif Paddy, Kharif Soybean	2132.97	671.29	142.30
Gadag	Kharif Cotton, Kharif Greengram, Kharif Groundnut, Kharif Maize, Kharif Paddy, Kharif Pearl Millet, Kharif Pigeonpea, Kharif Sorghum, Kharif Sunflower	4854.23	446.05	169.69
Vijayapura	Kharif Greengram, Kharif Groundnut, Kharif Maize, Kharif Pearl Millet, Kharif Pigeonpea, Kharif Sugarcane, Kharif Sunflower	3562.94	502.21	149.36
Bengaluru Rural	Kharif Ragi, Kharif Maize	888.7	50.32	22.8
Bengaluru Urban	Kharif Ragi	325	29.3	17.33
Raichur	Kharif Cotton, Kharif Groundnut, Kharif Paddy, Kharif Pearl Millet, Kharif Pigeonpea, Kharif Sunflower, Rabi Chickpea, Rabi Groundnut, Rabi Paddy, Rabi Sorghum, Rabi Sunflower,	6357.98	621.03	90.16
Uttara Kannada	Kharif Cotton, Kharif Maize, Kharif Paddy, Kharif Sugarcane	1233.71	60.48	22.3
Chikkamagaluru	Kharif Paddy, Rabi Chickpea, Rabi Horsegram, Rabi Sorghum	2705.40	172.46	91.50
Shivamogga	Kharif Maize, Kharif Paddy, Kharif Sugarcane,	3935.15	222.22	91.78
Chamarajanagar	Kharif Fieldbean, Kharif Blackgram, Kharif Cotton, Kharif Cowpea, Kharif Greengram, Kharif Groundnut, Kharif Sorghum, Kharif Sunflower, Kharif Maize, Kharif Paddy, Kharif	1751.44	74.47	23.06

Table 7. District-wise micronutrients (requirements based on soil analysis) actual distribution to farmers during 2014-15				
District	**Crops covered**	**Nutrients distributed (tons)**		
		Gypsum	**Zinc Sulphate**	**Borax**
	Ragi, Kharif Sugarcane			
Kodagu	Kharif Maize, Kharif Paddy	1675.85	26.83	16.66
Kalaburagi	Kharif Blackgram, Kharif Greengram, Kharif Groundnut, Kharif Pearl Millet, Kharif Pigeonpea, Kharif Soybean, Kharif Sunflower	49412.00	599.95	123.03
Dakshina Kannada	Kharif Paddy	1636.00	31.54	25.64
Hassan	Kharif Blackgram, Kharif Castor, Kharif Cowpea, Kharif Fieldbean, Kharif Greengram, Kharif Groundnut Kharif Maize, Kharif Paddy, Kharif Pigeonpea, Kharif Ragi, Kharif Sorghum, Kharif Sunflower, Kharif Sugarcane	6153.09	403.83	122.49
Tumakuru	Kharif Cotton, Kharif Cowpea, Kharif Fieldbean, Kharif Greengram, Kharif Groundnut, Kharif Maize, Kharif Paddy, Kharif Pigeonpea, Kharif Ragi	5945.50	320.10	133.68
Chikballapur	Kharif Groundnut, Kharif Maize, Kharif Pigeonpea, Kharif Ragi	2894.30	176.00	65.00

Uniform sampling procedure for crop yield estimations: CCE guidelines

CCE Committee at district level:

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

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

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

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

4. Each farmer will be provided Unique Identification Number (UIN) by ICRISAT (Appendix 1) and before the CCE start it's the responsibility of ICRISAT Research Technician and the concerned in-charge scientist/Scientific Officer to ensure timely provisioning of harvest bags (Muslin cloth bags for stalk sub-samples and Kora cloth bags for pod/head sub-samples), unique identification number and necessary data sheets for the CCEs in the district.

5. The Improved Practice (IP) and Farmers' Practice (FP) samples should be from the same farmer field.

6. In each of the selected Bhoochetana farmers' field for improved practice (IP), randomly selected representative area of 5 m X 5 m (total area of 25 m^2) at one spot need to be identified for undertaking crop cutting experiment.

7. Similarly, in each of the selected Bhoochetana farmers' field for farmers' practice (FP), randomly selected representative area of 5 m X 5 m (total area of 25 m^2) at one spot need to be identified for undertaking crop cutting experiment.

8. From the demarcated areas cut all the plants at ground level from each plot separately and then separate pod/head from the stalk and record total fresh weight separately for pod/head, stalk (25 m^2) after checking the provided balance properly each time (please ensure that the needle is at zero level). Record total fresh weights both parts of the plant in the field (Appendix 2).

9. From each harvested sample collect a representative sub-sample of minimum of two kg separately for earheads/pod and stalk and record the fresh weight and put the samples in the sampling bags properly labeled with the unique identification number of the farmer.

10. Record sub-sample fresh weight of pod/head and stalk immediately after sub-sample drawn and ensure that it is minimum of two kg for each sub-sample.

11. From each of the selected farmers' field Collect two samples– (one IP; one FP).

12. Please record the weights in the given format and obtain the signatures of all the representatives of the CCE Committee present in the field.

13. Dry and send sub-samples to ICRISAT for calculating yield (kg ha^{-1}) on dry weight basis.

14. All the identified team members should participate in CCEs and the concerned JDA will give the responsibilities to the ADAs and AOs for undertaking CCEs in the respective taluks.
15. Please collect GPS enabled photographs of crop cutting experiments and it should be available with the JDA office.

Yield Analysis of Major Crops

Kharif 2014 season

In all the 30 districts, crop cutting experiements were undertaken by following uniform CCE guidelines. The harvest data is collected with the help of staff of DoA, DE&S, Farm facilitator, farmers and ICRISAT Research Technicians.

Davanagere

Maize

During kharif 2014 season, there was a target to cover 1,55,256 ha of maize cultivated area in the district with improved management interventions, however beyond target, 110% (1,72,144 ha) of the maize cultivated area was covered under improved management. Results of CCEs showed huge benefits through adoption of improved management in enhancing maize grain and fodder production across all taluks in the district. As compared with the farmers' management, grain productivity increased by 18% to 29% and fodder productivity by 24 to 42%. On an average, there was 22% increase in grain yield and 31% increase in fodder yield in the district which translates to additional 1,210 kg ha^{-1} grain production and 1,077 kg ha^{-1} fodder production (Table 8).

Table 8. Maize yield (kg ha^{-1}) with improved management compared to farmers' management in different taluks of Davanagere district during kharif 2014.

	Farmers' management			Improved management			% increase over FP		
Taluk	Grain	Fodder	TDM	Grain	Fodder	TDM	Grain	Fodder	TDM
Channagiri	5950	3430	11400	7050	4290	13800	18	25	21
Davanagere	5540	2750	9950	7130	3900	13300	29	42	34
Harihar	5740	4220	11840	6900	5240	14250	20	24	20
Honnali	4310	3370	8840	5300	4650	11240	23	38	27
Mean	5385	3443	10508	6595	4520	13148	22	31	25

Paddy

After maize, paddy was the major crop in Davanagere district with the target of 55,000 ha during kharif 2014 season with improved management interventions, however beyond target, 101% (55,788 ha) of the paddy cultivated area was covered under improved management. Results of CCEs showed huge benefits through adoption of improved management in enhancing paddy grain and fodder production across all taluks in the district. As compared with the farmers' management, grain productivity increased by 13% to 30% and fodder productivity by 12 to 21%. On an average, there was 19% increase in grain yield and 15% increase in fodder yield in the district which translates to additional 1,110 kg ha^{-1} grain production and 953 kg ha^{-1} fodder production (Table 9).

Table 9. Paddy yield (kg ha^{-1}) with improved management compared to farmers' management in different taluks of Davanagere district during kharif 2014.									
	Farmers' management			Improved management			% increase over FP		
Taluk	**Grain**	**Fodder**	**TDM**	**Grain**	**Fodder**	**TDM**	**Grain**	**Fodder**	**TDM**
Channagiri	6510	7460	13970	7330	8320	15650	13	12	12
Davanagere	4310	5220	9530	5590	6340	11930	30	21	25
Harihar	6430	6490	12910	7660	7370	15020	19	14	16
Mean	**5750**	**6390**	**12137**	**6860**	**7343**	**14200**	**19**	**15**	**17**

Sorghum

During Kharif 2014 season, the target area of sorghum was 11,100 ha with improved management interventions, however, the only 67% of the target (7419 ha) was covered under improved management due to poor rainfall in the season. The CCE results indicated good benefits through adoption of improved management in enhancing sorghum grain and fodder production in the district. As compared with the farmers' management, grain productivity increased by 22% and fodder productivity by 16% which translates to additional 600 kg ha^{-1} grain production and 740 kg ha^{-1} fodder production (Table 10).

Table 10. Sorghum yield (kg ha^{-1}) with improved management compared to farmers' management in different taluks of Davanagere district during kharif 2014.									
Taluk	**Farmers' management**			**Improved management**			**% increase over FP**		
	Grain	**Fodder**	**TDM**	**Grain**	**Fodder**	**TDM**	**Grain**	**Fodder**	**TDM**
Harpanahalli	2740	4650	8260	3340	5390	9650	22	16	17
Mean	**2740**	**4650**	**8260**	**3340**	**5390**	**9650**	**22**	**16**	**17**

Finger millet

The target for finger millet during Kharif 2014 season was 585 ha but actual sowing was taken place was only 164 ha with with improved management interventions due to poor rainfall in the season. The CCE results indicated that the benefits of improved management in enhancing fingermillet grain and fodder production in the district was quite impressive. As compared with the farmers' management, grain productivity increased by 25% and fodder productivity by 19% which translates to additional 260 kg ha^{-1} grain production and 500 kg ha^{-1} fodder production (Table 11).

Table 11. Finger millet yield (kg ha^{-1}) with improved management compared to farmers' management in different taluks of Davanagere district during kharif 2014									
	Farmers' management			Improved management			**% increase over FP**		
Taluk	**Grain**	**Fodder**	**TDM**	**Grain**	**Fodder**	**TDM**	**Grain**	**Fodder**	**TDM**
Jagalur	1040	2660	4200	1300	3160	5050	25	19	20
Mean	**1040**	**2660**	**4200**	**1300**	**3160**	**5050**	**25**	**19**	**20**

Groundnut

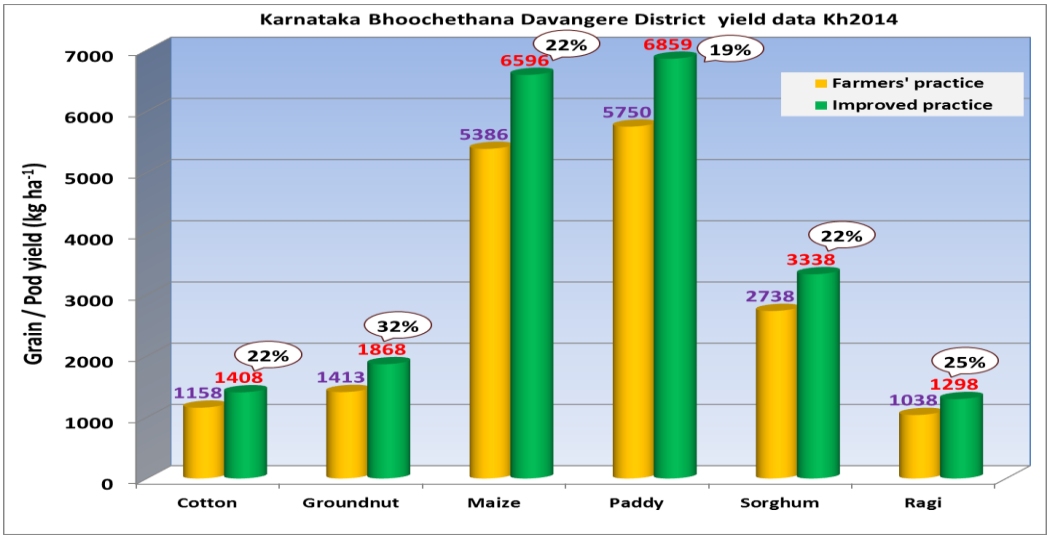
During Kharif 2014 season, the target area of groundnut was 12,025 ha with improved management interventions, however, only 44% of the target (5,287 ha) was covered under improved management due to poor rainfall in the season. The CCE results indicated that a huge benefits through adoption of improved management in enhancing groundnut grain and fodder production in the district. As compared with the farmers' management, grain

productivity increased by 33% and fodder productivity by 26% which translates to additional 460 kg ha^{-1} grain production and 720 kg ha^{-1} fodder production (Table 12).

Table 12. Groundnut yield (kg ha^{-1}) with improved management compared to farmers' management in different taluks of Davanagere district during kharif 2014.

Taluk	Farmers' management			Improved management			% increase over FP		
	Grain*	Fodder	TDM	Grain*	Fodder	TDM	Grain	Fodder	TDM
Honnali	1410	2760	4170	1870	3480	5340	33	26	28
	1410	2760	4170	1870	3480	5340	33	26	28

* Pod yield



Bellari

Maize

During kharif 2014 season, there was a target to cover 59,000 ha of maize cultivated area in the district with improved management interventions, however beyond target, 131% (77,018 ha) of the maize cultivated area was covered under improved management. Results of CCEs showed good benefits through adoption of improved management in enhancing maize grain and fodder production across all taluks in the district. As compared with the farmers' management, grain productivity increased by 21% to 43% and fodder productivity by 29 to 53%. On an average, there was 29% increase in grain yield and 36% increase in fodder yield in the district which translates to additional 1,432 kg ha^{-1} grain production and 1,040 kg ha^{-1} fodder production (Table 13).

Table 13. Maize yield (kg ha^{-1}) with improved management compared to farmers' management in different taluks of Ballari district during kharif 2014.

Taluk	Farmers' management			Improved management			% increase over FP		
	Grain	Fodder	TDM	Grain	Fodder	TDM	Grain	Fodder	TDM
H.Hadagalli	6350	4960	12320	7850	6380	15600	24	29	27
Hosapete	5660	2250	8980	6830	3110	11370	21	38	27
Kampli	3230	1870	5640	4610	2860	8250	43	53	46
Kudligi	4290	2240	7260	5540	3030	9530	29	35	31
Sanduru	5390	3120	9450	7250	4260	12730	35	37	35
Mean	**4984**	**2888**	**8730**	**6416**	**3928**	**11496**	**29**	**36**	**32**

Groundnut

During Kharif 2014 season, the target area of groundnut was 56,000 ha with improved management interventions, however, 84% of the target (46,876 ha) was covered under improved management. The crop cutting results indicated that good increased yields through adoption of improved management in groundnut grain and fodder production in the district were recorded. As compared with the farmers' management, grain productivity increased by 39% and fodder productivity by 33% which translates to additional 290 kg ha^{-1} grain production and 250 kg ha^{-1} fodder production (Table 14).

Table 14. Groundnut yield (kg ha^{-1}) with improved management compared to farmers' management in different taluks of Ballari district during kharif 2014.

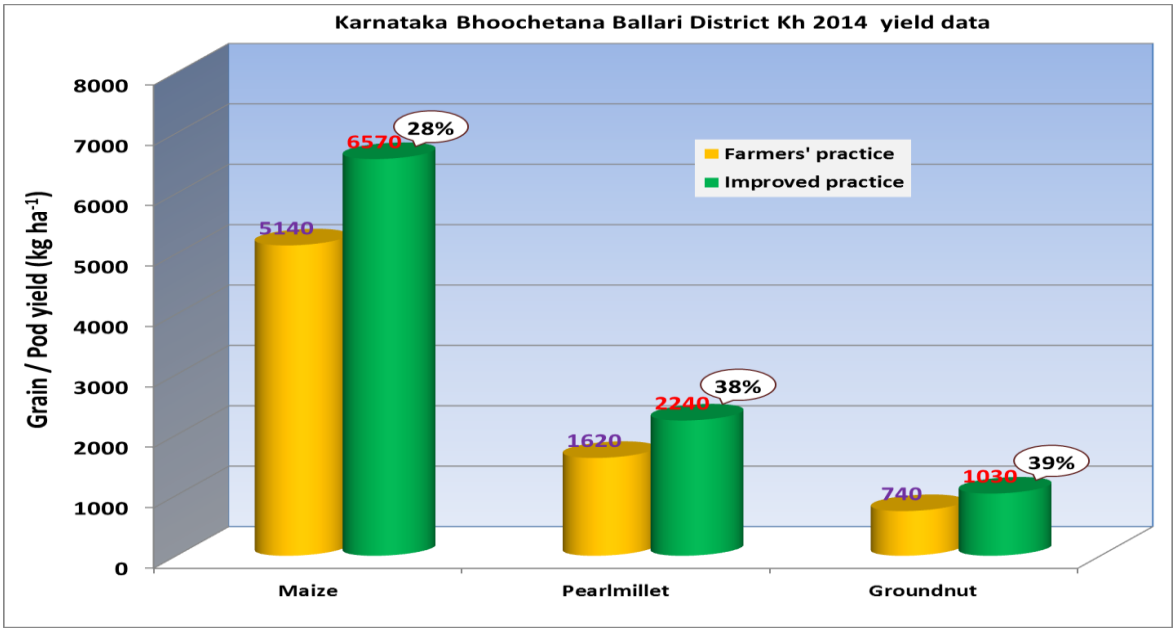
	Farmers' management			Improved management			% increase over FP		
Taluk	**Grain**	**Fodder**	**TDM**	**Grain**	**Fodder**	**TDM**	**Grain**	**Fodder**	**TDM**
Kudligi	740	850	1600	1030	1130	2160	39	33	35
Mean	**740**	**850**	**1600**	**1030**	**1130**	**2160**	**39**	**33**	**35**

Pearlmillet

The target for pearl millet during Kharif 2014 season was 12,000 ha but actual sowing was in 133% more area (15,986 ha) than the target area with with improved management interventions. The CCE results indicated that the benefits of improved management in enhancing pearlmillet grain and fodder production in the district was quite impressive. As compared with the farmers' management, grain productivity increased by 38% and fodder productivity by 34% which translated to additional 620 kg ha^{-1} grain production and 1,110 kg ha^{-1} fodder production (Table 15) with improved management for the farmers.

Table 15. Pearl millet yield (kg ha^{-1}) with improved management compared to farmers' management in different taluks of Ballari district during kharif 2014.

	Farmers' management			Improved management			% increase over FP		
	Grain	**Fodder**	**TDM**	**Grain**	**Fodder**	**TDM**	**Grain**	**Fodder**	**TDM**
Kampli	1620	3270	5710	2240	4380	7710	38	34	35
Mean	**1620**	**3270**	**5710**	**2240**	**4380**	**7710**	**38**	**34**	**35**



Bidar

Soybean

During kharif 2014 season, there was a target to cover 1,15,000 ha of soybean cultivated area in the district with improved management interventions, however, beyond target, 124% (1,42,270 ha) of the soybean cultivated area was covered under improved management. Results of CCEs showed huge benefits through adoption of improved management in enhancing soybean grain and fodder production across all taluks in the district. As compared with the farmers' management, grain productivity increased by 19% to 24% and fodder productivity by 14 to 35%. On an average, there was 22% increase in grain yield and 21% increase in fodder yield in the district which translates to additional 206 kg ha^{-1} grain production and 224 kg ha^{-1} fodder production (Table 16).

Table 16. Soybean yield (kg ha^{-1}) with improved management compared to farmers' management in different taluks of Bidar district during kharif 2014.

Taluk	Farmers' management			Improved management			% increase over FP		
	Grain	Fodder	TDM	Grain	Fodder	TDM	Grain	Fodder	TDM
Aurad	1000	1250	2250	1240	1510	2750	24	21	22
Basavakalyan	760	890	1650	910	1040	1950	20	17	18
Bhalki	1070	1200	2270	1310	1440	2750	22	20	21
Bidar	1070	1250	2320	1310	1420	2740	22	14	18
Homnabad	860	850	1710	1020	1150	2160	19	35	26
Mean	**952**	**1088**	**2040**	**1158**	**1312**	**2470**	**22**	**21**	**21**

Blackgram

The target for blackgram during Kharif 2014 season was 24,000 ha but actual sowing was taken place only in 56% area (13,500 ha) with improved management interventions. The CCE results indicated that the benefits of improved management in enhancing blackgram grain and fodder production in the district was quite impressive. As compared with the farmers' management, grain productivity increased by 34% and fodder productivity by 31% which translates to additional 130 kg ha^{-1} grain production and 240 kg ha^{-1} fodder production (Table 17).

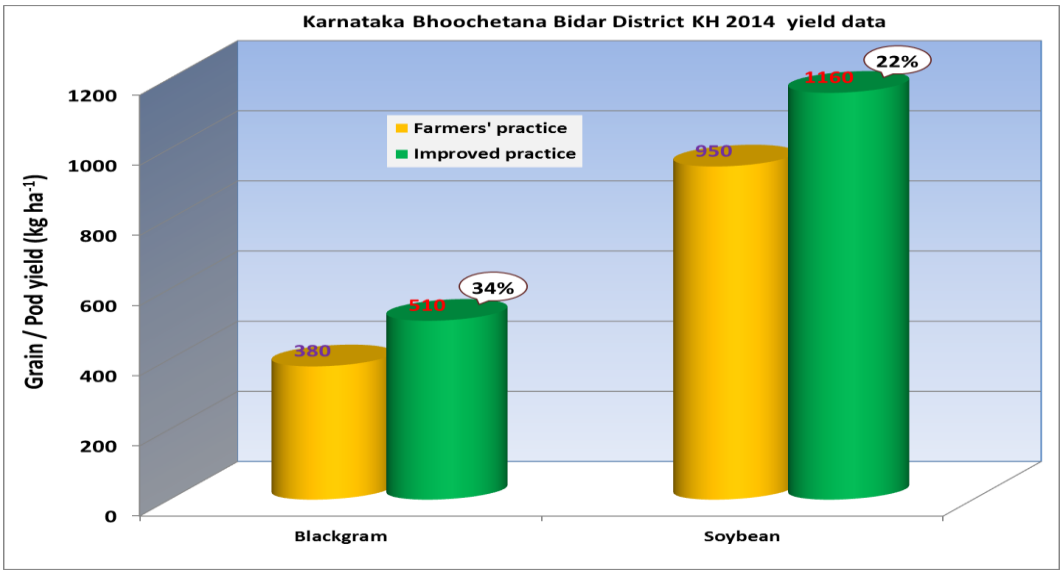


Table 17. Blackgram yield (kg ha^{-1}) with improved management compared to farmers' management in different taluks of Bidar district during kharif 2014.									
	Farmers' management			Improved management			**% increase over FP**		
Taluk	**Grain**	**Fodder**	**TDM**	**Grain**	**Fodder**	**TDM**	**Grain**	**Fodder**	**TDM**
Aurad	380	770	1150	510	1010	1520	34	31	32
Mean	**380**	**770**	**1150**	**510**	**1010**	**1520**	**34**	**31**	**32**

Haveri

Maize

During kharif 2014 season, there was a target to cover 1,06,800 ha of maize cultivated area in the district with improved management interventions and the targeted area was covered under improved management. Results of CCEs showed huge benefits through adoption of improved management in enhancing maize grain and fodder production across all taluks in the district. As compared with the farmers' management, grain productivity increased by 16% to 23% and fodder productivity by 13 to 34%. On an average, there was 20% increase in grain yield and 22% increase in fodder yield in the district which translates to additional 953 kg ha^{-1} grain production and 732 kg ha^{-1} fodder production (Table 18).

Table 18. Maize yield (kg ha^{-1}) with improved management compared to farmers' management in different taluks of Haveri district during kharif 2014.									
	Farmers' management			**Improved management**			**% increase over FP**		
Taluk	**Grain**	**Fodder**	**TDM**	**Grain**	**Fodder**	**TDM**	**Grain**	**Fodder**	**TDM**
Byadgi	5960	3000	10110	7120	3380	11670	19	13	15
Hangal	5710	2740	9340	6920	3330	11500	21	22	23
Haveri	5150	4060	10100	6040	4790	11920	17	18	18
Hirekerur	5030	4130	10110	6170	5160	12430	23	25	23
Ranibennur	2820	2820	6130	3270	3440	7280	16	22	19
Savanur	4010	3040	7990	4880	4080	9850	22	34	23
Mean	**4780**	**3298**	**8963**	**5733**	**4030**	**10775**	**20**	**22**	**20**

Soybean

The target for soybean during Kharif 2014 season was 6,000 ha but actual sowing was taken place in 89% area (5,335 ha) with with improved management interventions. The CCE results indicated that the benefits of improved management in enhancing soybean grain and fodder production in the district was quite impressive. As compared with the farmers' management, grain productivity increased by 31% and fodder productivity by 26% which translates to additional 590 kg ha^{-1} grain production and 530 kg ha^{-1} fodder production (Table 19).

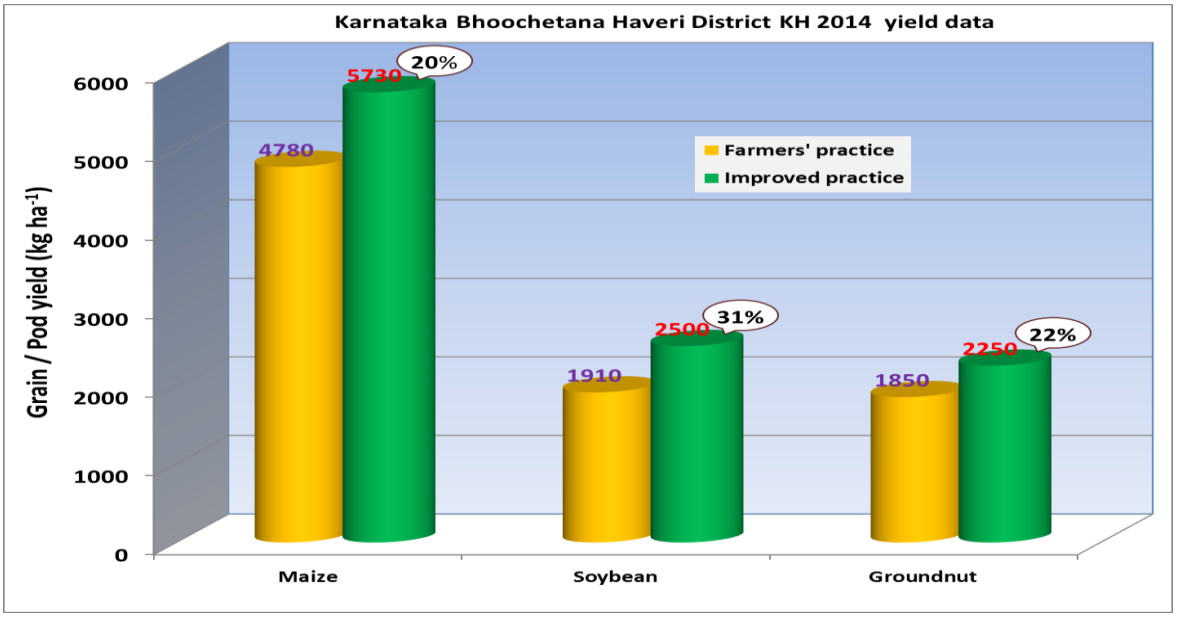
Table 19. Soybean yield (kg ha^{-1}) with improved management compared to farmers' management in different taluks of Haveri district during kharif 2014.									
Taluk	**Farmers' management**			Improved management			**% increase over FP**		
	Grain	**Fodder**	**TDM**	**Grain**	**Fodder**	**TDM**	**Grain**	**Fodder**	**TDM**
Shiggaon	1910	2060	3970	2500	2590	5090	31	26	28
Mean	**1910**	**2060**	**3970**	**2500**	**2590**	**5090**	**31**	**26**	**28**

Groundnut

During kharif 2014 season, there was a target to cover 17,000 ha of groundnut cultivated area in the district with improved management interventions but only about 90% (15,235 ha) area with improved management. Results of CCEs showed huge benefits through adoption of improved management in enhancing groundnut grain and fodder production across all taluks in the district. As compared with the farmers' management, grain productivity increased by 21% to 24% and fodder productivity by 12 to 20%. On an average, there was 22% increase in grain yield and 16% increase in fodder yield in the district which translates to additional 405 kg ha^{-1} grain production and 425 kg ha^{-1} fodder production (Table 20).

Table 20. Groundnut yield (kg ha^{-1}) with improved management compared to farmers' management in different taluks of Haveri district during kharif 2014.

Taluk	Farmers' management			Improved management			% increase over FP		
	Grain	Fodder	TDM	Grain	Fodder	TDM	Grain	Fodder	TDM
Haveri	1170	2260	3430	1450	2540	3980	24	12	16
Savanur	2530	2900	5430	3060	3470	6530	21	20	20
Mean	**1850**	**2580**	**4430**	**2255**	**3005**	**5255**	**22**	**16**	**19**



Koppal

Pearl millet

During kharif 2014 season, there was a target to cover 55,000 ha of pearlmillet cultivated area in the district with improved management interventions, however beyond target, 93% (51,010 ha) of the pearlmillet cultivated area was covered under improved management. Results of CCEs showed huge benefits through adoption of improved management in enhancing pearlmillet grain and fodder production across all taluks in the district. As compared with the farmers' management, grain productivity increased by 27% to 30% and fodder productivity by 16 to 30%. On an average, there was 30% increase in grain yield and 25% increase in fodder yield in the district which translates to additional 643 kg ha^{-1} grain production and 703 kg ha^{-1} fodder production (Table 21).

Table 21. Pearlmillet yield (kg ha^{-1}) with improved management compared to farmers' management in different taluks of Koppal district during kharif 2014.									
	Farmers' management			Improved management			% increase over FP		
Taluk	Grain	Fodder	TDM	Grain	Fodder	TDM	Grain	Fodder	TDM
Gangawati	2320	2600	6100	3040	3350	7470	31	29	22
Koppal	2090	2540	5450	2660	3310	6920	27	30	27
Kushtagi	2280	3810	6940	2960	4750	8520	30	25	23
Yelbarga	2010	2210	5350	2610	2560	6150	30	16	15
Mean	**2175**	**2790**	**5960**	**2818**	**3493**	**7265**	**30**	**25**	**22**

Maize

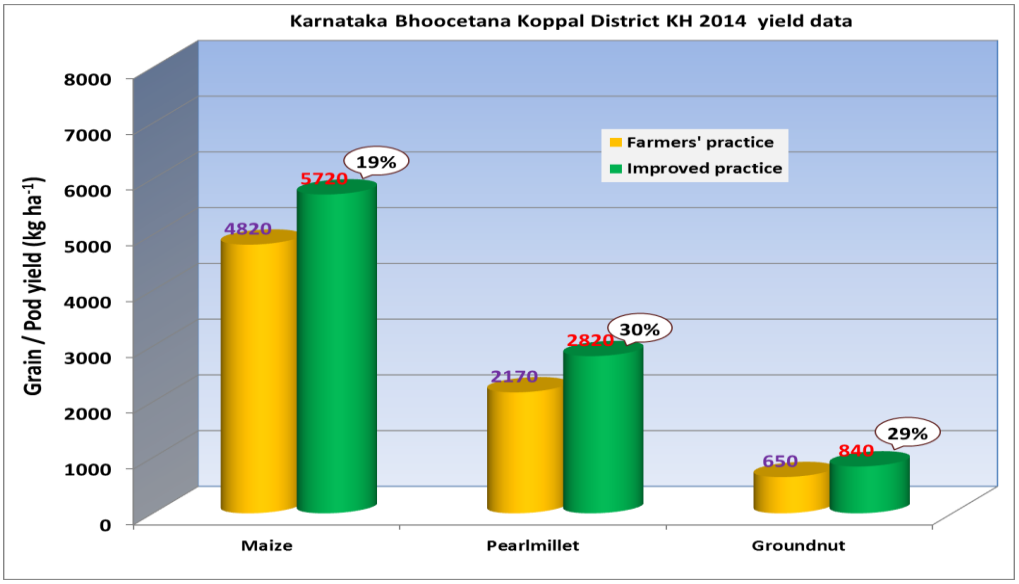
During kharif 2014 season, there was a target to cover 30,000 ha of maize cultivated area in the district with improved management interventions, however, beyond target, 146% (43,930 ha) of the maize cultivated area was covered under improved management. Results of CCEs showed benefits through adoption of improved management in enhancing maize grain and fodder production across all taluks in the district. As compared with the farmers' management, grain productivity increased by 18% to 20% and fodder productivity by 23 to 30%. On an average, there was 19% increase in grain yield and 26% increase in fodder yield in the district which translates to additional 905 kg ha^{-1} grain production and 1,360 kg ha^{-1} fodder production (Table 22).

Table 22. Maize yield (kg ha^{-1}) with improved management compared to farmers' management in different taluks of Koppal district during kharif 2014.									
	Farmers' management			Improved management			% increase over FP		
Taluk	Grain	Fodder	TDM	Grain	Fodder	TDM	Grain	Fodder	TDM
Koppal	4840	5640	11650	5790	6910	13920	20	23	19
Kushtagi	4790	4900	10650	5650	6350	13030	18	30	22
Mean	**4815**	**5270**	**11150**	**5720**	**6630**	**13475**	**19**	**26**	**21**

Groundnut

The target for groundnut during Kharif 2014 season was 20,000 ha but actual sowing was taken place in 63% area (12,665 ha) with improved management interventions. The CCE results indicated that the benefits of improved management in enhancing groundnut grain and fodder production in the district was quite impressive. As compared with the farmers' management, grain productivity increased by 29% and fodder productivity by 43% which translates to additional 190 kg ha^{-1} grain production and 780 kg ha^{-1} fodder production (Table 23).

Table 23. Groundnut yield (kg ha^{-1}) with improved management compared to farmers' management in different taluks of Koppal district during kharif 2014.									
	Farmers' management			Improved management			% increase over FP		
Taluk	Grain	Fodder	TDM	Grain	Fodder	TDM	Grain	Fodder	TDM
Yelbarga	650	1820	2480	840	2600	3430	29	43	38
Mean	**650**	**1820**	**2480**	**840**	**2600**	**3430**	**29**	**43**	**38**



Integrated Water Resource Management in Kolar

With the help of Coca Cola India foundation along with Government of Karnataka, a new initiative on integrated water resource management to improve the livelihood was initiated in Kolar district. The aim of this initative is to improve the availability of water resources by adopting watershed approach and improve the crop yield and enhancing the water use efficiency. Kolar is the hotspot of water scarcity. The watershed covers an area of 1,333 ha and divided into 4 micro watersheds with a population of 5556 that has an average family size 4.7 and population density of 4.01 persons per ha. About 67 per cent of household belongs to small, 27 per cent in medium, 3 per cent in big and landless category respectively.

Kolar area falls in the hot moist semi-arid Agro Ecological Sub Region (AESR) with medium to deep Red loamy soils. Available water capacity is low and the rainfed length of growing period is about 120-150 days. Summer showers are experienced at Kolar in May. Though the southwest monsoon sets by the first week of June, rainfall more than the PET is received only during middle of September to third week of October. This period has potential for runoff water harvesting and storage for use by *Rabi* crops. Annual PET is 1638 mm and the annual average rainfall is 711 mm.

Table 24. General information of proposed locations for project in Kolar taluk, Karnataka

Villages	Area (ha)	Population*	House holds*	Family Size (No.)	Population density (persons/ha)
Muduvatti	303.51	2100	710	3.0	6.92
Jangalahalli	87.23	310	78	4.0	3.55
Konepura	67.79	255	46	5.5	3.76
Papenahalli	66.90	NR	NR	NR	NR
Shettiganahalli	260.24	968	208	4.7	3.72
Shettikothanuru	214.92	1115	221	5.0	5.19
Dandiganhally	179.32	361	63	5.7	2.01
Nernahally	153.08	447	85	5.3	2.92
Total	**1332.99**	**5556**	**1411**	**4.7#**	**4.01#**

* Population and household data is present time data mentioned by GP members and others.

Mean of villages

Major land area is under rain-fed agriculture, while with bore well as a main source vegetable cultivation is coming up. The present land use is 88% cultivated (46 % rain-fed, 31 % under vegetable and irrigated annual crops) 12% under other uses that includes habitat, forest, road and drains. Community-based organizations like watershed committee with 15 members have been formed representing each village, women members and small farmers. There are 30 SHGs in the watershed. A watershed committee monitors and executes the watershed activities. As per the guidelines seven are women members and appropriate number of other landless and scheduled caste represent in the committee.

Baseline Survey

In each of these villages, available secondary data was collected from village accountant and Gram panchayat on land use pattern, demographic composition, agricultural practices, etc. We also conducted a household survey based on random sampling technique. About 20 per cent of the households have been covered for the survey which includes landless and women. Well trained data enumerators have collected the information. The information was cross checked by Scientific Officer and Research Technicians located at the site and an NGO (MYRADA) helped in identifying, training and monitoring enumerators.

Registration of Farmers using Tablet-based Application

We have conducted preliminary survey to record basic information of each households in watershed area. Android based tablet devices and ODK Collect app were used to record farmers' information along with their photographs.

Baseline Information

The proposed watershed is spread over 1333 ha cultivated area with 1411 households and covers eight villages. The eight villages of Vakkaleri Hobli are in vicinity of Kolar town that is about 6-16 km distance. The selected villages in the watershed are having dry climate and average rainfall is about 710 mm. The population represents both forward and backward caste, however, majority of the population is from forward caste. About 67% of households are in small, 27% in medium, 3% each in big and landless category. Watershed covers both common land and arable land. The arable land in the watershed is about 55 per cent of total geographical area. The common land which is about 25 per cent is the source of grazing. The watershed villages were geo-referenced and the details of the villages selected, drainage network and digital elevation map are shown in Figure 27 and Figure 28.

Rainwater Harvesting

Groundwater level is very deep in Kolar district, however some vegetable farmers are pumping water for cultivation. Constructing low-cost water harvesting structures is one of the important interventions considered for groundwater recharge (Figure 29 and Figure 30). These structures harvest substantial amount of surface runoff, allow them to percolate into aquifer and facilitate groundwater recharge. Through this project, farm ponds are promoted in these villages. Farm ponds serves as dual purpose as water storage and as groundwater recharge. A list of water harvesting structures constructed during 2012 and 2013, along with their storage capacity, is shown in Table 2. Nearly 7000 m3 of storage capacity was developed which would facilitate on average 20,000 m3 of runoff water to groundwater recharge.

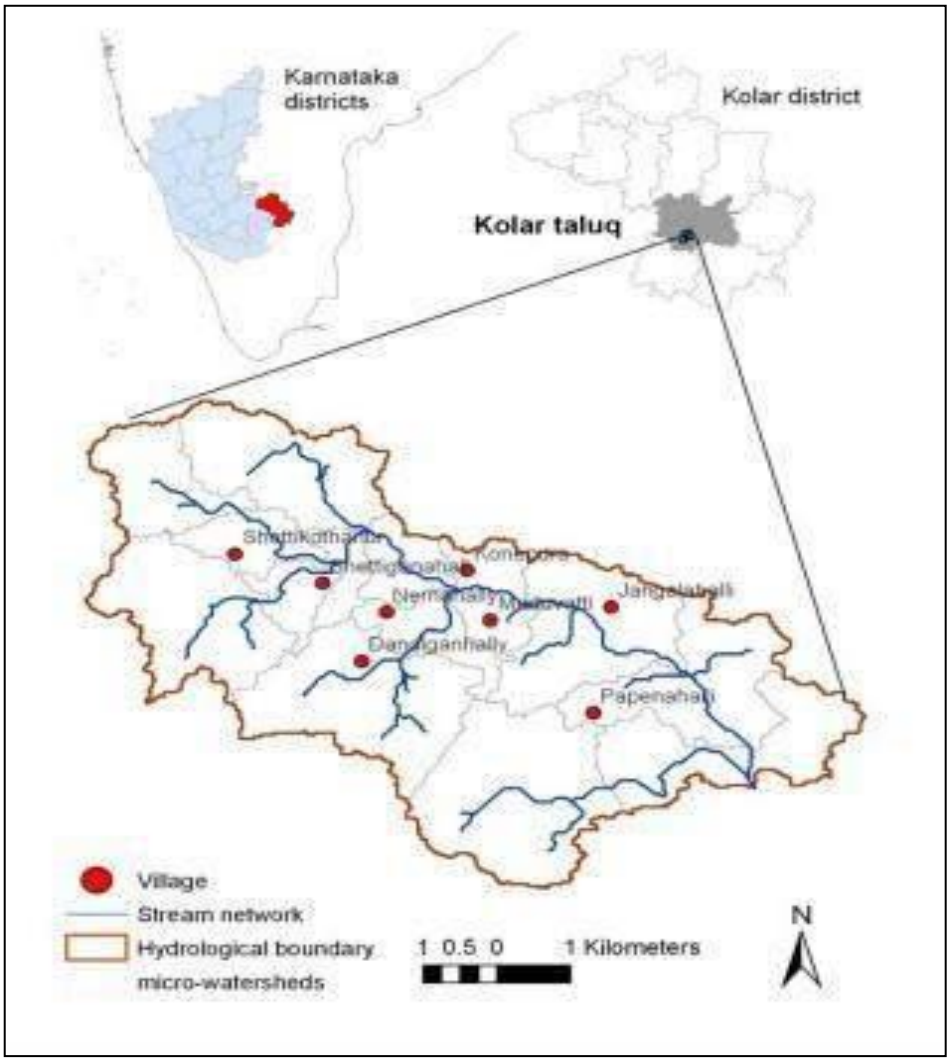


Figure 27. Location of study villages, stream network and micro-watersheds of selected pilot area

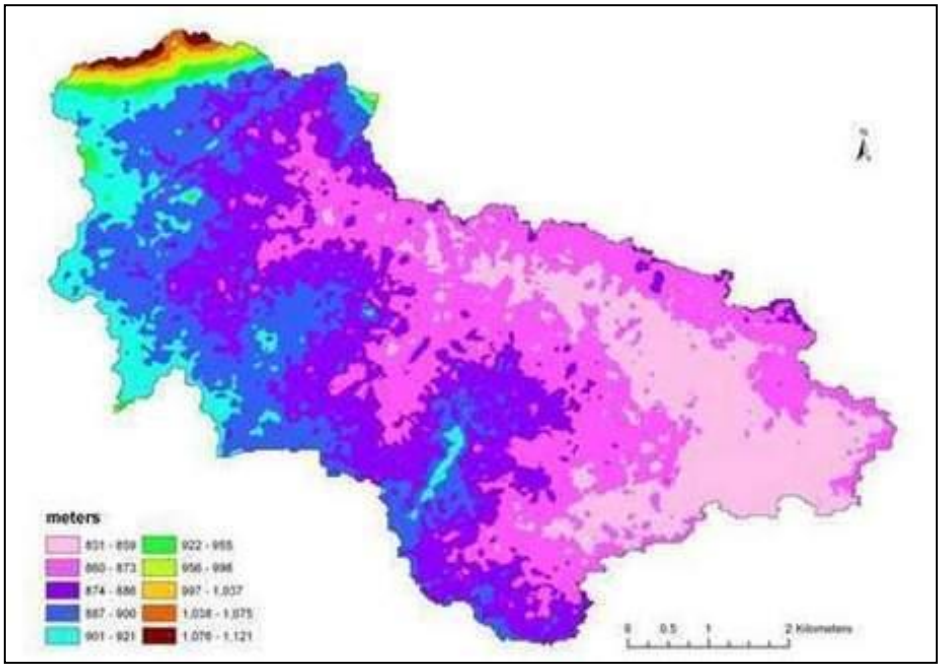


Figure 28. Digital Elevation Model (DEM) of selected villages in Kolar Taluk.

Figure 29. Pictures showing farm pond and Gokatte (percolation tank) constructed at different locations in watershed for rainwater harvesting during monsoon period

Figure 30. Pictures showing before and after construction of water harvesting structures in different watershed villages in Kolar

Table 25. Details of water harvesting structures and storage capacity developed in Kolar watershed		
Structure	**Number**	**Net Storage capacity (m^3)**
Farm ponds	16	7000
Field drain	500m	-
Total effective storage capacity (m^3)		20000

Productivity Enhancement Interventions

The yield gap analysis undertaken by the ICRISAT revealed that large yield gap exists for all the major rainfed crops grown in the semi-arid Tropics. Further, there is a potential of increasing the productivity by two to three folds using available technologies in the farmers' fields (Wani et al., 2009; 2012). Soils in rainfed areas are not only water scarce but also deficient in essential nutrients as 50-90% of the farmers' fields are found deficient in sulphur, zinc and boron (Table 26 and Table 27).

Table 26: Soil fertility status in eight watershed villages, Kolar							
Villages	**EC (ds/m)**	**Exch-K (mg/kg)**	**Ols-P (mg/kg)**	**Org-C (%)**	**Avail-Zn (mg/kg)**	**Avail B (mg/kg)**	**Avail-S (mg/kg)**
Jangalahalli	0.13	177	44.6	0.39	2.73	0.65	7.4
Dandiganahalli	0.08	138	51.5	0.32	1.89	0.36	10.3
Konepura	0.07	115	50.4	0.32	1.60	0.46	3.9
Muduvatti	0.25	240	79.3	0.48	4.69	0.82	12.6
Nernahalli	0.13	116	56.0	0.40	3.16	0.50	7.6
Papenahalli	0.22	222	67.3	0.43	3.18	0.83	15.0
Shettiganahalli	0.18	154	77.9	0.39	2.98	0.52	13.5
Shettikottanuru	0.15	110	43.1	0.36	2.42	0.47	7.7
Mean of villages	0.14	146	57.6	0.37	2.65	0.53	9.6

Table 27. Soil health Status: Per cent farmers' fields deficient in nutrients, Kolar.						
District	**% farmers fields deficient**					
	OC	**Av P**	**Av K**	**Av S**	**Av Zn**	**Av B**
Jangalahalli	75	0	0	75	0	38
Dandiganahalli	88	0	13	88	0	88
Konepura	100	0	13	100	0	88
Muduvatti	67	0	0	0	0	0
Nernahalli	86	0	0	71	0	71
Papenahalli	80	0	0	20	0	20
Shettiganahalli	81	6	6	69	0	63
Shettikottanuru	87	7	33	87	0	67
Mean of watershed	84	3	11	73	0	61

Wastewater treatment and reuse

Water scarcity is particularly acute in Kolar where an urgent need exists to enhance water resource availability and also for demand management. Water availability for food production is not only restricted to fresh water but waste water re-use is also emerging as an integral part of demand management. With increasing domestic water use, quantity of gray/wastewater is increasing in the same proportion. Almost 90% of total water supplied for domestic use gets generated as wastewater which could be diverted for agriculture

purpose. There are several benefits and challenges on wastewater use. Grey water is a valuable resource for encouraging plant growth because of its higher nutrient content. Grey water use in agriculture contributes significantly to the supply of fresh fruit and vegetables to urban markets. Literature shows that the problem of blue green algae in sewerage ponds and water reservoirs is significantly reduced by house hold use of grey water.

In the above context, we have planned to harness the domestic wastewater and use it for vegetable cultivation after the primary treatment. Therefore one constructed wet-land setup is constructed in Mudavatti village (Figure 31).

Figure 31. Constructed wetland for domestic wastewater treatment in Mudavatti village, Kolar

Integrated Watershed Management in Bellary district

Integrated watershed management approach is proved to be the suitable strategy for achieving holistic development in these regions through collective action. The very purpose of the watershed development programs is to reduce water related risks in rainfed agriculture by improving the local soil-water balance by implementing both in-situ and ex-situ interventions. Since, water and soil are important components of agricultural development, proper management of these resources is crucial to build the resilience of these systems to cope with varying climatic risks and to improve livelihoods. In this background, JSW foundation supported a project on integrated watershed management. This project is jointly implemented by Government of Karnataka, Community-based organisations, farmers with technical backstopping by ICRISAT.

Target area for the proposed study is Sandur taluk of Bellary district in Karnataka state. The district is the hotspot of mining and related industrial activities which caused most of the surrounding villages to face severe resource endowment and utilization problems. As a result of mining activities agriculture was on the verge of abandoning coupled with unavailability of labor force and falling returns due to yield and price constraints. Land degradation and improper water management along with poor market and infrastructure facilities are the root causes for imbalanced development in this area.This project target to cover four villages namely Doddanthapura, Chikkanthapura, Kodalu and Joga in Sadhur taluk with 1,930 families engaged in agriculture and 293 families are landless.

The specific objectives of the project are:

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

Soil Analysis to Assess Soil Health

Stratified soil sampling was carried out to collect soil samples across four villages along with geo-referencing using GPS. Around 100 samples were collected and analyzed in soil testing lab, ICRISAT. Majority of samples reveal a significant Zinc deficiency in the villages. Based on soil results fertilizer recommendations were developed for different crops.

Table 28. Soil health status: percent farmers' fields deficient in nutrients

Village	% deficiencies					
	OC	Av P	Av K	Av S	Av Zn	Av B
Chikanthapura	0	20	0	0	90	0
Doddanthapura	27	13	0	10	77	10
Joga	5	15	0	5	80	15
Kodalu	18	4	0	21	75	7

Kodalu

Soil and Water Conservation Measures

During the year various soil and water conservation structures viz. gully plugs, farm ponds, percolation tanks, check dams, nala bunds and field bunds were constructed (Table 29 & Fig. 26). Ninety gully plugs were put in place in the small water channels to start the treatment of the watershed from the top of the toposequence. In addition, nine farm ponds of with a net storage capacity of 80 m^3 each were prepared which has created the effective storage capacity to harvest about 2400 m^3 of rainwater which can be used for groundwater recharging and supplementary irrigation. Three check dams, one check wall and one *nala* bund in the secondary drainage lines have been constructed to reduce the soil erosion as well as store the runoff water and have created additional capacity of 6000 m^3 for recharging the groundwater. About 17000 m length field bunding has been done in 96 farmers fields (Table 29). One domestic waste water reuse system is also being established (Figure 32).

Table 29. Soil and water conservation structures constructed in JSW watershed villages, 2013-14.

Sl.	Water harvesting structures	D Anthapur	Chikkanthapur	Kodalu	Joga	Total
1.	Gully plugs	25	35	13	17	**90**
2.	Farm Pond (FP)	3	-	3	3	**9**
3.	Mini Percolation Tank (MPT)	-	-	2	-	**2**
4.	Bore well Recharge Pit	1	1	9	4	**15**
5.	Nala bund (NB)	-	-	-	-	**1**
6.	Check Wall	-	-	1	-	**1**
7.	Check Dam (CD)	1	2	-	-	**3**
8.	Waste water treatment tank	1				**1**

Gully plug, Joga

Farm pond, Kodalu

Check dam, Chikkanthapur

Bore well recharge pit, Doddanthapur

Percolation tank, Kodalu

Field Bunding in D. Anthapur

Figure 32. Various water harvesting structures constructed in Jsw villages

Table 30. Field Bunding in watershed villages.			
Sl. No.	**Village Name**	**Total Length of Bund (m)**	**Total farmers covered**
1.	D. Anthapur	7283	41
2.	Chikkanthapur	510	5
3.	Kodalu	2897	16
4.	Joga	6447	34
	Total	17,137	96

Figure 33. Domestic waste water reuse system in Doddanthapur.

Monitoring and Evaluation

Automatic Weather Station

An automatic weather station has been established to collect climatic data on rainfall, air and soil temperature, solar radiation and wind velocity and direction (Fig ure 34). Additional rainfall data will also be collected from different parts of watershed through four rain gauges installed across the watershed.

Most of the rainfall in Bellary district is received in the three month period Aug-Oct; with September being the rainiest month with about 135 mm of rainfall. Year-to-year variability in rainfall is very high and the coefficient of variation of rainfall in these three months varies from 53 to 66%. Seasonally, the southwest monsoon period (Jun-Sep) receives about a rainfall of 352 mm with a CV of 28% and the post-monsoon period (Oct-Dec) receives a rainfall of 144 mm with a CV of 56%. There is also considerable spatial variability in rainfall in the Bellary district. The above clearly shows the importance of rainfall measurements at watersheds to help quantify the amount of moisture availability in different phenophases of crop growth and to relate with the crop water requirements. Therefore, rainfall monitoring

is also necessary to assess runoff, soil loss and groundwater recharge. Most importantly it helps the community to understand about crop water usage and for irrigation scheduling.

Figure 34. Automatic weather station installed in Chikkanthapur and one of the raingauge installed in Doddanthapur.

Hydrological Gauging Station

invariably requires the continuous recording by using Automatic Runoff Recorder and Automatic micro-processor based Sediment Samplers, which monitor the temporal changes in the suspended sediment concentration during the runoff event.

Hydrological gauging station consisting of automatic runoff recorder and microprocessor-based sediment sampler along with an appropriate masonry hydraulic measuring structure (viz. broad-crested rectangular weir or notch) was installed (Figure 35) to monitor unoff, peak runoff rate and soil loss from watershed.

Figure 35. Installation of Hydrological gauging station at JSW villages

Groundwater Level Monitoring

There are 220 bore wells exist in the watershed. Groundwater levels are monitored by using a groundwater level meter in the watershed at 52 selected wells on toposequence at a fortnightly intervals through farmers' participatory mode to assess the impact of various watershed interventions in improving groundwater levels. Necessary training has been given to the local community members for collecting the groundwater levels using this equipment. The groundwater level during first year serves as baseline values to assess the impact of various watershed interventions in improving groundwater levels.

Table 31. Ground water level depths (monthly mean of wells) in JSW_ICRISAT Watershed, Bellary district.

Month	D. Anthapur	Chikkanthapur	Kodalu	Joga	Mean of all villages
Aug 13	16.81	15.79	12.99	16.00	15.40
Sep 13	18.81	19.46	14.33	20.78	18.35
Oct 13	19.81	17.42	18.29	21.18	19.18
Nov 13	20.35	20.27	16.76	21.88	19.81
Dec 13	20.81	22.15	20.43	23.08	21.62
Jan 14	21.96	22.46	21.50	23.91	22.46
Feb 14	21.00	20.77	19.32	21.45	20.64
Mar 14	20.96	21.00	20.36	22.60	21.23
Apr 14	24.98	27.25	23.09	26.10	25.36
May 14	21.01	25.40	22.43	24.17	23.25
Jun 14	19.73	23.12	17.14	24.02	21.00
Mean of each Village	20.6	21.4	18.8	22.3	20.8

Avenue Plantation

In order to increase the greenery as well as to prevent the dust problem, avenue planation has been taken up (Figure 36). Four hundred plants are planted and a nursery with large number of plants of *Glyricidia* for generating the organic matter *in-situ is established to take up plantaion during this rainy season.*

Figure 36. Avenue plantations and rubble checks activities at JSW watershed villages

Income generating Activities

Vermi-composting: There are 32 vermi-compost pits constructed in JSW-ICRISAT watershed (Figure 37).

Figure 37. Vermicompost pits constructed at Kodalu village

Vegetable seed distribution to SHG's women's for kitchen gardening:

The vegetable seed distribution: Vegetable seeds were distributed to SHG's for kitchen gardening covering 147 beneficiaries to improve their home nutrition and additional income.

Capacity Building Programs to Improve Livelihoods

- A three Days Institutional Training programme to SHG's women's (20 women's participated) at DATC, Kampli.
- The training programme to JSW village women (35) at Kurekoppa farm was organized on Maize productivity enhancement through improved Agronomic practices; Bio diesel plantation on waste lend; integrated livestock management.
- Exposure visit to Shivamugga as Agriculture study tour was organizedfor 4 progressive farmers.
- A visit to Krishimela at ARS Hagari, Bellary Dist. farmers for 27 under Atma Project convergence was organized.
- International women's day celebration conducted in D Anthapur village (55 women's from 4 villages participated).
- Training on Organic farming conducted at Kodalu village with the convergence of DoA program for 25 farmers.
- SHG's Capacity Building Trainings conducted in all villages (173 women have participated). During SHG's capacity building training program discussed with the following information.
- World environment day celebrated in the Doddanthapur
- Animal health camp was conducted benefiting more than 85 farmers.
- "Improved technology and dry land field demonstration at ICRISAT" was organized.
- The DATC conducted training programme for JSW village women for three days (22 women) at Kampli. During training programme information was provided about agriculture, dairy, poultry and Sheep raring. Vermicomposting pits were demonstrated and materials and methods for vermicomposting were explained

- The “Animal Husbandry Training Programme” was conducted in JSW village women (38 women) in Torangallu, kurekoppa farm.
- Training programme on “Balance inorganic fertilizer application to crops” in Torangallu, kurekoppa farm. (40 farmers attended)
- Exposure visit to Dharwad (10 farmers) and Raichur (4 farmers) Krishimela.

Various capacity building programs were conducted during the year (Figure 38 & 39).

Figure 38. ARS, Hagari krishi mela visit and SHG’s training programme

Figure 39. SHG’s Capacity Building training Programe and Cluster level Bhoochetana awareness training program at Joga village

Evaluation of Quality of Extension Services under Bhoochetana Mission Project

In order to enhance the production and overcome the drudgery that results from the use of traditional farm practices and tools, farmers need to adopt new technologies. But in practice, farmers have limited access to education and credit, and also lack of information and knowledge about a wide range of technological alternatives. Agricultural extension involves offering advice and sharing information (Garforth 1997). Farmers obtain information from several sources including the mass media, other farmers, extension

services, trainings, etc. The results of the NSSO survey clearly showed that only less than 20 per cent of the farmers are availed public extension services for performing their agricultural activities (NSSO 2005). A major requirement for the implementation of the recommendations of extension is inputs. Even though these must be available and affordable, farmers sometimes complain of their untimely delivery and high cost. An important service that extension agencies render is monitoring and evaluation. It is critical to the effective implementation of projects. It provides timely information on project progress and performance and gives an assessment of whether the target group is getting the benefits. There is an inadequate level of published literature on the services of contract based extension personnel. The innovative agricultural knowledge dissemination by contractual extension workers prompted this study.

The main objective of the study was to assess farmers' perception of the quality of contractual mode of extension services in Mysore (Mysore, Chikmagalur), Bengaluru (Tumkur and Davanagere), Belgaum (Dharwad and Bijapur) and Gulbarga (Gulbarga and Raichur) revenue divisionsof Karnataka state. A survey of farmers benefiting from services provided by the farm facilitators in four revenue divisions consisting of eight districts of Karnataka was undertaken over 4 months from July to October 2014. Stratified random sampling procedure based on farm size, participation in the program and crop was used in selecting 640 farmers based on the population of farmers in the eight districts. The survey approach involved direct face-to-face interviewing to elicit data and information on farmers' perceptions about the services provided by the state through contractual mode of extension services. The information requested from respondents consisted of various agricultural support services. The quality of these services was assessed using a simple 1-5 Likert scale of measurement.

Farmers' participation in Bhoochetana for enhancing crop yield

Bhoochetana is a mission project with an objective of enhancing the crop yield by adopting science-led innovations through farmer participation. Therefore, the issue of participation had taken centre stage in the initiative. During the first phase of Bhoochetana initiative, we have witnessed a huge participation of farmers with different landholding size in the program to enhance their crop productivity and income. About 86 per cent of the respondents have participated in the program with an average landholding of 1.5 ha (Figure 34). Nearly 50 per cent of the respondents are small and marginal farmers with less than 2 ha landholding; about one-fourth of the respondents with 2 to 5 ha landholding and only about 11 per cent farmers with more than 5 ha were participated in the program.

The district-wise analysis indicates that districts like Dharwad (96.3%), Davanagere (95%), Mysore (95%) and Gulbarga (92.5%) have performed well in covering more farmers under Bhoochetana. Remaining districts have performed better as compared to Tumkur where only about 50% of the respondents have registered into Bhoochetana. This implies that the role of farm facilitators as well as awareness programs is very critical in mobilizing large number of farmers to obtain the benefits of the program and to enhance their crop productivity.

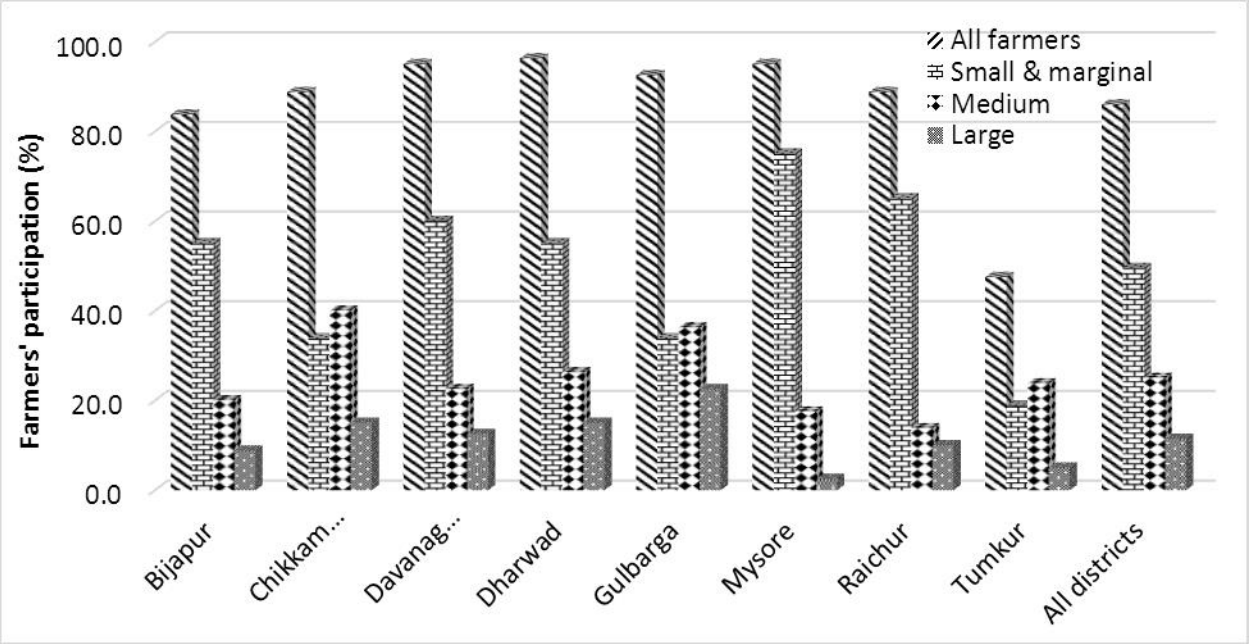


Figure 40. Farmers' participation in Bhoochetana by different category of farmers

Contact with farmers

The Farm Facilitators concept was introduced to reach the unreached farming community and disseminate the science-led information for improving the productivity. This innovative institutional arrangement facilitated the knowledge sharing and transformation to achieve impact in agricultural sector. Clark, Smith and Hirvonen (2007) defined an innovation system 'as a network of agents whose interactions determine the innovative impact of knowledge interventions, including those associated with scientific research'. It is in this context, Farm facilitator concept had an impact on agricultural extension system in the state and farm facilitators have reached large number of smallholder farmers and facilitated for adopting new knowledge to bridge the yield gaps. One way of measuring the effectiveness of Farm facilitator is to look at the number of times they visited farmers and advised with new knowledge. Our survey data revealed that the average visit of a farm facilitator is about 14 times in three months that works out to be about 4.5 visits in a month (Figure 35). The number of visits by FFs indicated that Tumkur has the lowest visits (6.4 visits in 3 months) whereas the highest number of visits observed in Dharwad with 17 visits in 3 months. The remaining districts like Mysore, Davanagere, Bijapur and Gulbarga have more than 14 visits in 3 months respectively. Chikmagalur and Raichur have less than 12 visits by FFs in 3 months. This is due to variety of reasons. First, it is observed during our field visit that majority of farm facilitators required to perform multi functions as extension agents in the Department of Agriculture. The most prevalent duty which they have to perform is the selling of inputs (micro nutrients, seeds and chemical fertilizers) in the RSK in the absence of regular departmental extension officers. This hinders them to visit to farmers' fields regularly. This also suggests that there is a need to revisit the idea of hiring farm facilitators to act as extension agents as their job nature is not matching with the original idea of extension. Second, lack of incentives to motivate FFs to take extra interest to perform better and create healthy competition among fellow FFs. Third, majority of FFs have shown lack of willingness in the job due to irregular payment of salaries. This could affect their personal life as they have to deal with domestic as well as their personal expenditures.

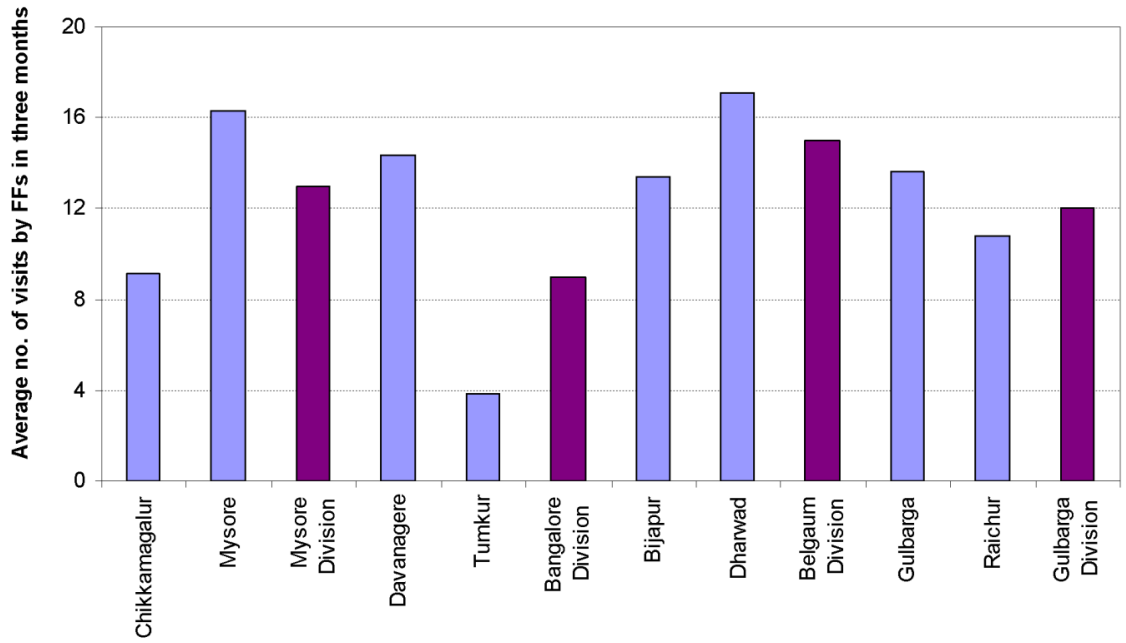


Figure 41. Average number of visits by Farm facilitators in last three months in different districts of Karnataka

The above factors reflect in their poor performance and they are unable to have good working relationship with farmers. Our survey results also showed that there is a great variation in farmers knowing FFs by their name. In Chikmagalur, Mysore and Davanagere about 90% of farmers able to name their FFs whereas other districts have poor proportion of farmers who could name their FFs (Figure 42). This is due to lack of visits and contact by FFs in their assigned work place.

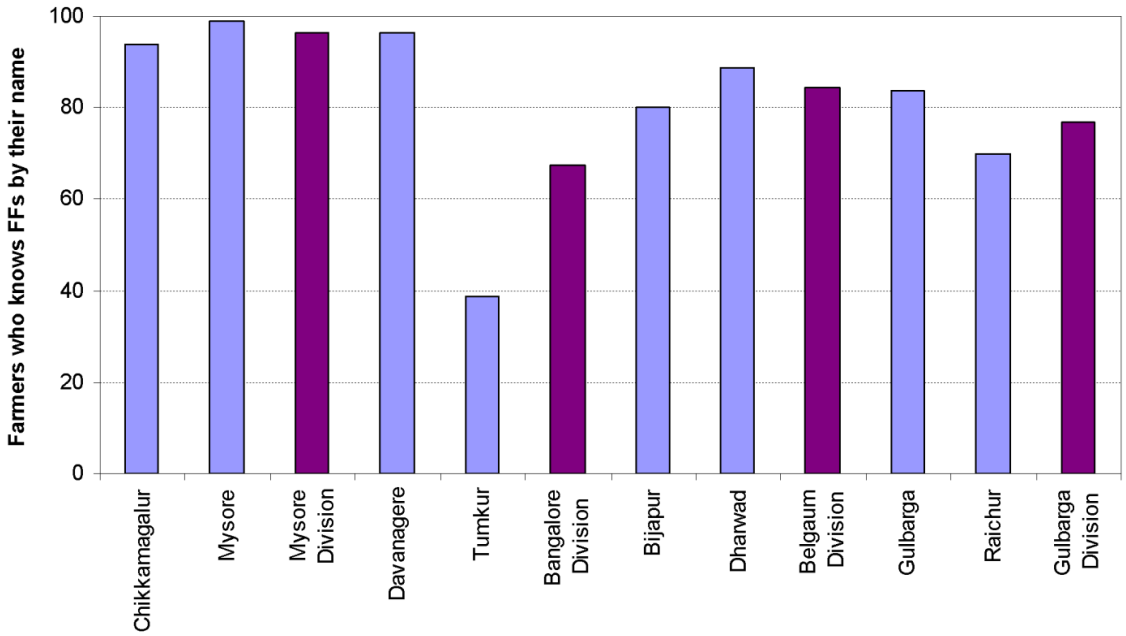


Figure 42. Farmers (%) who could name Farm facilitators in their village

Farmer Field School

In Bhoochetana, Farmer Facilitator took the lead to organize planning meeting and conduct FFS sessions in a selected village with 20-30 farmers. Crop specific information is imparted through the short studies and long term experiments. Capacity building and demonstrations in all aspects of crop cultivation are imparted to the participating farmers. Almost 20 weekly sessions were held to analyze the abiotic and biotic stress on the plant. The observations recorded in the field were pooled and the subsequent operations and conclusions were arrived by the farmers themselves.

Through FFS, farmers were able to take the right crop management decisions at every stage of the crop and farmers develop a habit of visiting their field regularly and monitoring crop pest and diseases. This extension system was found effective in imparting the required knowledge and skill to crop cultivation as there is a frequent contact between farmers and farmer facilitators. Group dynamics, participatory group presentation and discussion were part of the FFS and as a result, a sense of cooperation and team coordination developed among farmers which were helpful in spreading and sharing the technologies with each other. The method capitalizes on existing local social networks, based on the belief that experienced and skilled farmers are the people best suited to train other farmers. The trainees familiarize themselves with the technology since training takes place in the field where they have the opportunity to see how things are done, make mistakes, learn from them and receive advice. This approach proved a common and important vehicle for diffusing technology under Bhoochetana.

Farm Facilitators are the main contact points for conducting Farmer Field Schools in all the districts with handholding from DoA staff. However, the performance of FFS is not expected as it would be. The survey results indicated that only about 50 per cent of the respondents attended FFS. Figure 37 depicts that only Dharwad has highest proportion of farmers (84.4%) attended the FFS and Raichur (62%), Bijapur (59.7%) and Mysore (50%) in that order of hierarchy. It is disheartening to note that Chikmagalur (46.5%), Davanagere (36.8%), Gulbarga (40.5%) and Tumkur (18.4%) have performed very low in terms of attending FFS. It is important to note that FFS are critical knowledge dissemination point that needs to be strengthened for wider knowledge dissemination and awareness building among farming community.

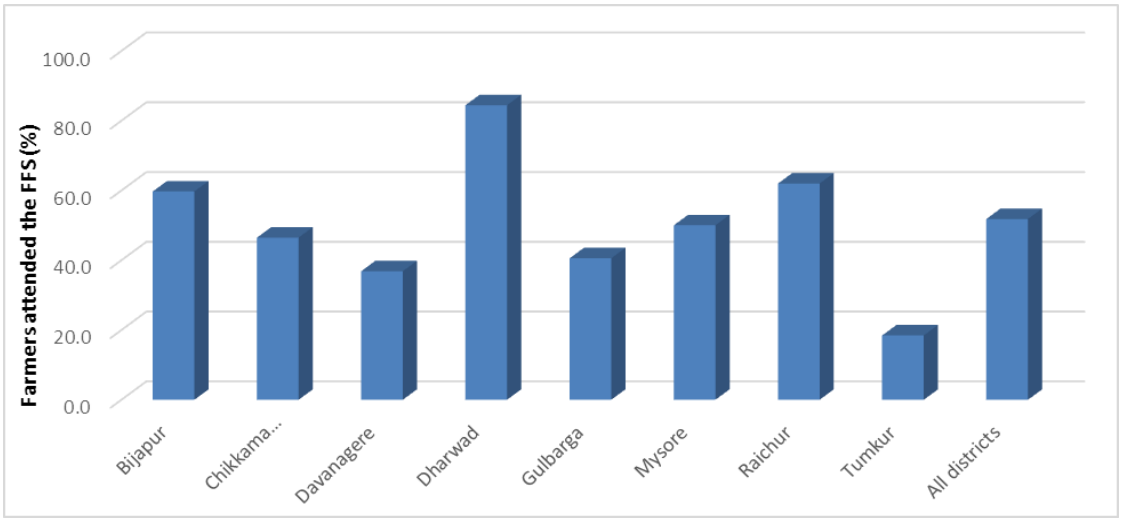


Figure 43. Farmers' who have attended the Farmer Field School in different districts of Karnataka

Wall writings

Under Bhoochetana initiative wall writings were done in each and every village to create awareness amongst the farmers. Wall writings were quite conspicuous with details of soil health status, input quantities supplied to the farmer per hectare, component of subsidy, etc. Wall writings were the effective communication channels in rural areas which has gained movement in Bhoochetana on a large scale helping farmers to understand their soil and agricultural practices, objective of the program and areas to be covered by the program. Additionally thousands of brochures and handouts were published and distributed in each district on improved management practices, information on nutrients status, nutrients recommended taluk-wise and widely distributed in all selected districts.

Figure 38 depicts that among participated farmers, about 80% of them are aware about wall writings in their villages. Except Tumkur, in all other districts, the proportion of farmers who are aware about wall writings is considerably high (> 80%). In Tumkur, only 50% of the respondents are aware of wall writings. The usefulness of these wall writings is more relevant in all the districts irrespective of their performance in other indicators. Overall, about 87% of respondents expressed their happiness towards wall writings in their respective districts (Figure 44). However, as wall writings are effective means of information dissemination, more such writings are required with relevant information to spread awareness about the program as well as the technologies which are useful in their agricultural operations.

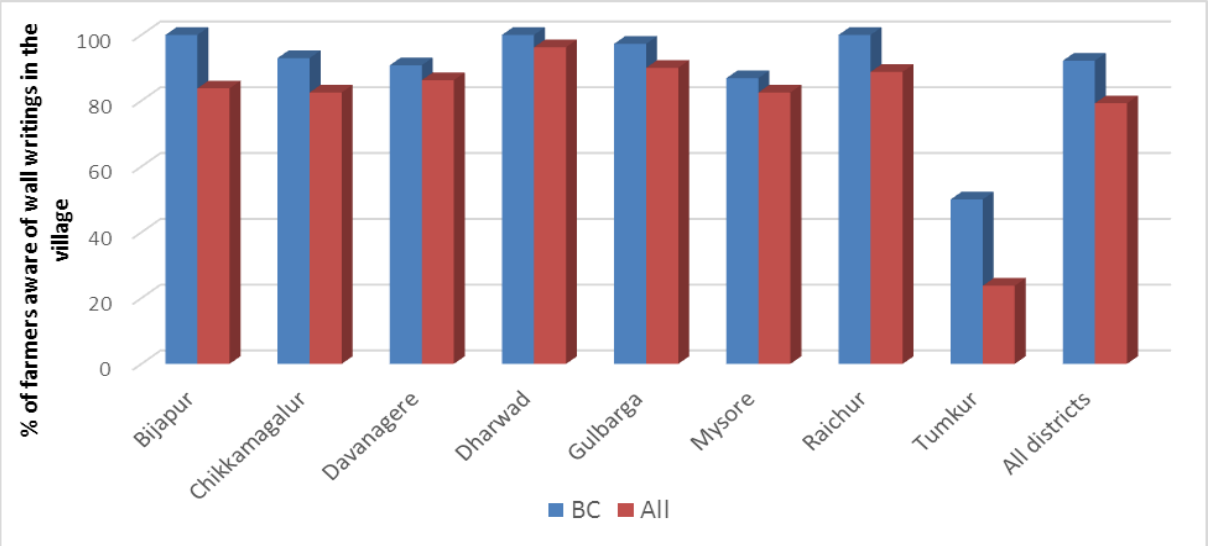


Figure 44. Farmers aware of wall writings about Bhoochetana in their village in different districts of Karnataka

Sources of extension services

In rural areas, farmers depend on more than one source of information. This is more so in agricultural extension services too. The question asked was whether they receive any extension services related to agriculture other than from farm facilitators. The results suggested that there is more than one source of information and the sources include private agencies also. Overall, about 88% respondents receive extension services from RSKs as the primary source of information. In all the districts, RSKs were the primary source of extension services with other source play a meagre role as they comprises only 12% including farmers' group, KVKs and private companies (Figure 45).

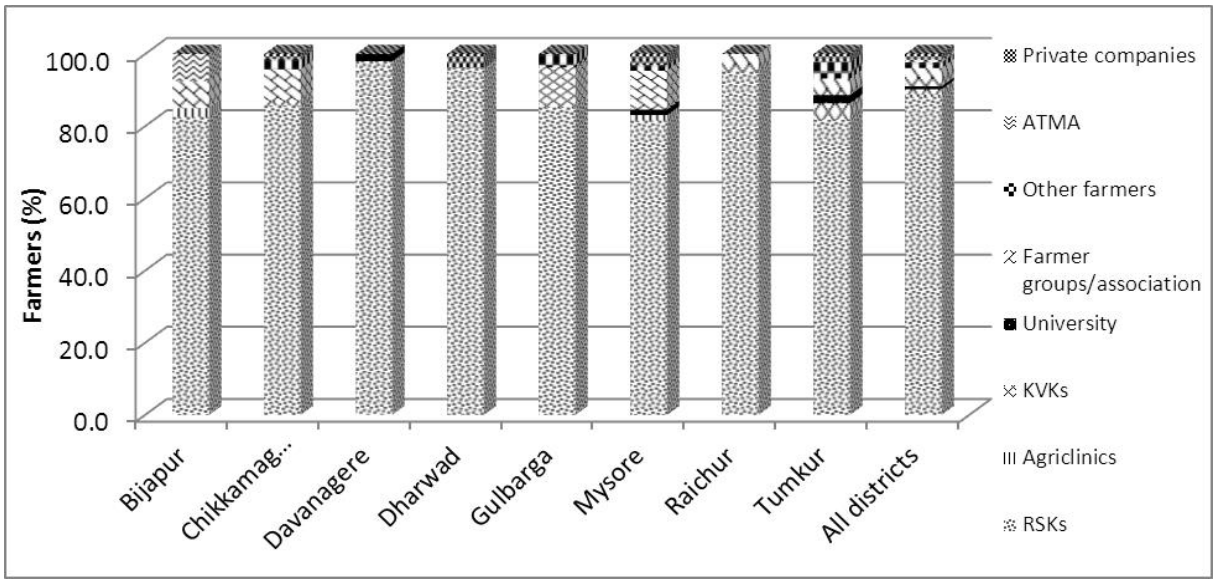


Figure 45. Sources of extension services (other than FFs) in selected districts of Karnataka

Usefulness of extension services

The usefulness of the above extension services were evaluated by asking respondents to rank the quality of the services in 1-4 likert scale, 1 being very useful while 4 is very poor. The Figure 40 indicates that only about 40% respondents said the information was very useful while more than 50% respondents opined that the information was good (Figure 46). This implies that the content and the quality of information need to be improved to meet the requirement of farmers.

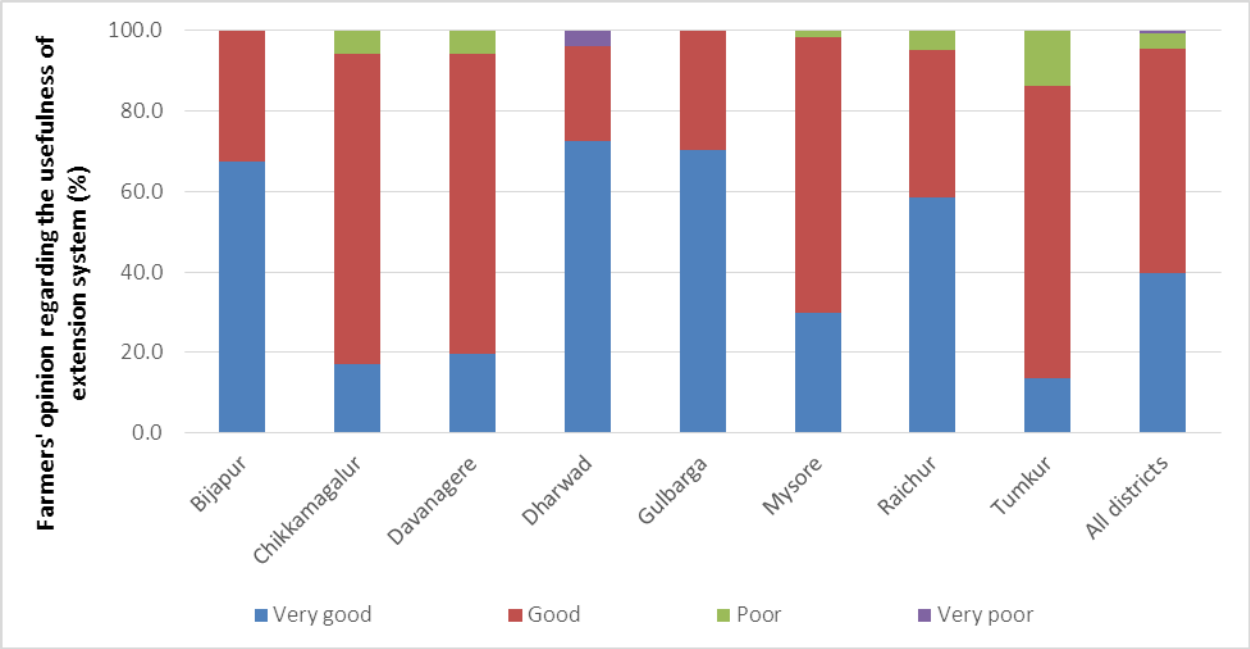


Figure 46. Farmers' opinion regarding the usefulness of extension system

Extension services by Farm facilitators

In order to meet growing demand of farmers for effective extension services, Farm Facilitator concept was introduced in Bhoochetana. This innovative extension system is on

contract mode which is being operated by the Department of Agriculture. The Farm facilitators are liaising between farmers and the Department of Agriculture. The survey results indicate that nearly 90 per cent of the respondents have received extension services from farm facilitators. Therefore, it is imperative that the relevance, adequacy and feasibility of these services need to be evaluated for understanding its implications for upscaling.

The relevance of extension services provided by Farm Facilitators

The importance of the relevance of the services rendered by farm facilitators is shown in Table 32. With the exception of weather problems, marketing advice and help getting credit, all other services were perceived by farmers to have medium levels of relevance for their work. The services the highest relevance ranking in order of importance were fertilizer information, general advice, disease problem, new seed varieties, irrigation and soil problems. This revealed that the information provided by the farm facilitators is having impact on the farmers' day-to-day agriculture activities to increase their productivity and income. The overall mean for relevance of services provided by Farm facilitators in our study was 2.12 with standard deviation (SD) of 1.17 and a coefficient of variation (CV) of 0.55. The mean value of 2.12 indicated that the services were perceived by farmers to be relevant to their agricultural activities. The relatively low CV suggested that the farmers had common opinion with respect to the relevance of services provided by Farm facilitators for their agricultural operations (Table 32).

Adequacy of services provided by farm facilitators

Table 33 shows the means and standard deviations of the degree of adequacy of various services rendered by Farm facilitators in the selected four revenue divisions. The mean values ranged from 1.87 to 2.32 with the overall mean value of 2.13 which can be explained as adequate. The farmers rated fertilizer information as the service with the highest level of adequacy with a mean score of 2.32 with standard deviation and Coefficient of 5.7 and 0.55 respectively. This ranking of importance was followed by disease problem and new seed varieties (μ= 2.4), irrigation and soil problems (μ= 2.2), training, weather problems, and marketing (μ= 2.0). The information on getting credit was ranked last with a level that could be considered to fair but not adequate. This has significance given the importance of credit in agricultural operations in rural areas. However, farm facilitators were trained to provide science-based information to carry out agricultural operations but not credit facilities in general. The district-wise analysis also indicates the similar trend. In this context, we can conclude that the performance of Farm facilitators in sharing new scientific knowledge is adequate to carry out agricultural operations but needs substantial improvement to enable farmers to adopt improved practices (Table 33).

Timeliness of services provided to farmers

As we are expecting good agricultural production, the timeliness of the provision of extension service is crucial and this will enhance the efficiency of farm production. With regard to timeliness of the provision of extension service by farm facilitators, the majority of respondents (59.7 %) indicated that the fertilizer and general information was provided on time by the farm facilitators (Table 34). The timely supply of fertilizer is particularly important for seasonal activities such as agriculture. About 58 per cent of respondents felt that they get timely advice on disease problems as well as new seed varieties. However,

majority of farmers also felt that they are lack of getting timely services on credit (65 %), weather related information (60 %), marketing advice (60 %) and training (55 %). Farmers in dryland areas generally wish to carry out land preparation and planting on schedule so that their crops can take advantage of the rains. Delays in the supply of inputs could have negative consequences on the farm productivity and performance. Therefore, timely provision of services on inputs assumes greater importance in these areas (Table 34).

Efficiency of the monitoring and evaluation of extension services

Monitoring and evaluation of activities by farm facilitators is another important aspect of measuring the efficiency of these services. Table 35 shows the means and standard deviations of farmers' opinions on the extent to which the Farm facilitators carried out monitoring and evaluation activities. As shown in Table 35, the overall mean of respondents' perceptions on the extent of monitoring and evaluation is 3.26 with a standard deviation of 0.71 and overall CV is 0.22. The mean score ranging from 3.15 on adequacy of inputs to 3.37 on quality of seeds. In fact, for all the 10 activities being assessed, respondents considered the efficiency of monitoring and evaluation was at least of average quality for all the services. The low standard deviation and CV indicated that there is common opinion of respondents on the monitoring and evaluation of services. It is important to note that all the activities were ranked average quality. This suggests that there need to be considerable efforts to improve monitoring and evaluation of activities by FFs (Table 35).

Availability of inputs for crop production

The availability of inputs on time is the most critical factor in agriculture. The survey results indicated that the inputs for crop production, storage and marketing are available as the overall mean is above 3 (μ=3.18) with standard deviation of 0.76 and CV of 0.24 (Table 36). The low level of CV indicates that the farmers have consensus over the opinion in selected districts. The results are most revealing. First, the farmers are concerned over tillage equipment (μ=2.95), storage facilities (μ=2.86), market facility (μ=2.95) and processing units (μ=2.98) which are most critical inputs to undertake sowing operations on time and reducing postharvest losses respectively. However, the inputs available through RSKs are reaching farmers as the mean score on availability is ranging from 3.19 to 3.57. Therefore, efforts are needed to ensure storage and marketing facilities in rural areas which may reduce grain losses and encourage farmers to diversify crop pattern (Table 36).

The quality of agricultural extension services provided by Farm facilitators was assessed in eight districts of four revenue divisions of Karnataka state. The sample respondents have indicated their perceptions on the quality of extension services provided by Farm Facilitators on daily basis. The analysis was carried out based on five major indicators viz., relevance; availability; adequacy; timeliness; monitoring and evaluation. The overall mean score on different services provided by farm facilitators indicated that their performance is falling between average to good. However, the respondents had difference of opinion on these services with respect to their adequacy, timeliness, and relevance. Farmers were generally content with the quality of monitoring and evaluation of these services. Therefore, there is a need for strengthening this system to facilitate farmers on new innovative activities to enhance crop productivity as well as improving livelihood system.

Table 32. Relevance of extension services by revenue division

	Belgaum (n=144)			Bengaluru (n=114)			Gulbarga (n=145)			Mysore (n=147)			All districts (n=550)		
	Mean	**SD**	**CV**	**Mean**	**SD**	**CV**	**Mean**	**SD**	**CV**	**Mean**	**SD**	**CV**	**Mean**	**SD**	**CV**
Fertilizer	2.57	1.39	0.54	2.11	0.91	0.43	2.01	1.27	0.63	2.53	0.92	0.37	2.32	1.18	0.51
Irrigation	2.56	1.38	0.54	1.94	0.87	0.45	2.01	1.27	0.63	2.09	1.01	0.48	2.16	1.18	0.55
New seed varieties	2.57	1.39	0.54	2.08	0.89	0.43	2.02	1.27	0.63	2.42	0.94	0.39	2.28	1.17	0.51
Disease problem	2.58	1.39	0.54	2.08	0.94	0.45	2.01	1.27	0.63	2.46	0.95	0.39	2.30	1.19	0.52
Soil problems	2.57	1.38	0.54	1.74	0.85	0.49	2.01	1.27	0.63	2.17	1.00	0.46	2.14	1.19	0.56
Training	2.44	1.37	0.56	1.48	0.74	0.50	1.99	1.25	0.63	2.03	0.94	0.46	2.01	1.16	0.58
Weather problems	2.32	1.34	0.58	1.55	0.75	0.49	1.87	1.28	0.69	1.93	0.89	0.46	1.94	1.14	0.59
Marketing advice	2.32	1.34	0.58	1.60	0.74	0.46	1.82	1.28	0.70	1.92	0.87	0.45	1.93	1.13	0.58
Help getting credit	2.33	1.34	0.58	1.46	0.73	0.50	1.80	1.27	0.71	1.77	0.84	0.47	1.86	1.13	0.61
General advice	2.60	1.41	0.54	2.08	0.98	0.47	2.02	1.28	0.63	2.45	1.01	0.41	2.30	1.21	0.53
Overall mean	2.49	1.37	0.55	1.81	0.84	0.47	1.96	1.27	0.65	2.18	0.94	0.43	2.12	1.17	0.55

Note: SD=Standard deviation; CV=Coefficient of variation

Likert scale: 1=not relevant; 2=relevant; 3=very relevant; 4=relevance is excellent

Table 33. Adequacy of extension service information by revenue division															
	Belgaum			Bengaluru			Gulbarga			Mysore			Grand Total		
	Mean	SD	CV	Mean	SD	CV	Mean	SD	CV	Mean	SD	CV	Mean	SD	CV
Fertilizer	2.57	1.39	0.54	2.11	0.91	0.43	2.01	1.27	0.63	2.54	0.92	0.36	2.32	1.18	0.51
Irrigation	2.56	1.38	0.54	1.98	0.90	0.46	2.01	1.27	0.63	2.11	1.01	0.48	2.17	1.19	0.55
New seed varieties	2.56	1.39	0.54	2.04	0.88	0.43	2.02	1.27	0.63	2.41	0.94	0.39	2.27	1.17	0.52
Disease problem	2.58	1.39	0.54	2.04	0.90	0.44	2.01	1.27	0.63	2.48	0.95	0.38	2.29	1.18	0.52
Soil problems	2.57	1.38	0.54	1.77	0.88	0.50	2.01	1.27	0.63	2.16	0.99	0.46	2.15	1.19	0.55
Training	2.44	1.37	0.56	1.55	0.82	0.53	1.99	1.25	0.63	2.02	0.93	0.46	2.03	1.16	0.57
Weather problems	2.35	1.37	0.58	1.55	0.74	0.48	1.88	1.28	0.68	1.93	0.90	0.46	1.95	1.15	0.59
Marketing advice	2.36	1.37	0.58	1.59	0.73	0.46	1.83	1.28	0.70	1.92	0.87	0.45	1.94	1.14	0.59
Help getting credit	2.37	1.38	0.58	1.46	0.73	0.50	1.81	1.27	0.70	1.77	0.84	0.48	1.87	1.15	0.61
General advice	2.60	1.41	0.54	2.08	0.98	0.47	2.02	1.28	0.63	2.48	1.02	0.41	2.31	1.22	0.53
Overall mean	2.50	1.38	0.55	1.82	0.85	0.47	1.96	1.27	0.65	2.18	0.94	0.43	2.13	1.17	0.55

Note:SD=Standard deviation; CV=Coefficient of variation

Likert scale: 1=not adequate; 2=adequate; 3=very adequate; 4=adequacy is excellent

Table 34. Timeliness of services provided by FFs in selected districts of Karnataka										
	Fertilizer	Irrigation	Seed varieties	Disease problem	Soil problem	Training	Weather problem	Market	Help getting credit	General advice
Bijapur	51.3	51.3	51.3	51.3	51.3	43.8	42.5	42.5	42.5	51.3
Chikkamagalur	85.0	58.8	66.3	81.3	70.0	52.5	38.8	33.8	28.8	86.3
Davanagere	63.8	56.3	62.5	63.8	52.5	36.3	42.5	45.0	32.5	62.5
Dharwad	62.5	62.5	62.5	62.5	62.5	62.5	61.3	61.3	60.0	62.5
Gulbarga	37.5	37.5	37.5	37.5	37.5	37.5	28.8	27.5	27.5	37.5
Mysore	78.8	61.3	80.0	80.0	67.5	66.3	66.3	66.3	55.0	78.8
Raichur	51.3	50.0	51.3	51.3	51.3	51.3	37.5	31.3	28.8	51.3
Tumkur	47.5	42.5	45.0	36.3	26.3	12.5	8.8	15.0	6.3	47.5
All districts	59.7	52.5	57.0	58.0	52.3	45.3	40.8	40.3	35.2	59.7

Table 35. Monitoring and evaluation activities by FFs

	Belgaum			Bengaluru			Gulbarga			Mysore			Grand Total		
	Mean	**SD**	**CV**	**Mean**	**SD**	**CV**	**Mean**	**SD**	**CV**	**Mean**	**SD**	**CV**	**Mean**	**SD**	**CV**
Good land preparation	3.61	0.62	0.17	2.97	0.70	0.23	3.34	0.50	0.15	3.10	0.69	0.22	3.27	0.67	0.20
Quality seeds	3.63	0.61	0.17	3.14	0.68	0.22	3.35	0.51	0.15	3.31	0.63	0.19	3.37	0.63	0.19
Early planting	3.63	0.61	0.17	2.99	0.72	0.24	3.36	0.51	0.15	3.17	0.69	0.22	3.30	0.67	0.20
Farmer to get info regularly	3.65	0.61	0.17	2.97	0.80	0.27	3.37	0.51	0.15	3.15	0.63	0.20	3.30	0.68	0.21
Timely weed control	3.63	0.61	0.17	2.81	0.84	0.30	3.37	0.51	0.15	2.99	0.76	0.25	3.22	0.75	0.23
Collection of yield data	3.59	0.63	0.18	2.78	0.87	0.31	3.34	0.52	0.15	2.88	0.79	0.28	3.17	0.78	0.25
Fertilizer/manure application	3.70	0.64	0.17	3.19	0.83	0.26	3.39	0.53	0.16	3.35	0.70	0.21	3.42	0.70	0.20
Adequacy of inputs	3.47	0.63	0.18	2.83	0.83	0.29	3.32	0.51	0.15	2.92	0.79	0.27	3.15	0.74	0.23
Disease control	3.49	0.63	0.18	2.95	0.90	0.31	3.32	0.51	0.15	3.17	0.68	0.21	3.25	0.70	0.22
Pest control	3.50	0.63	0.18	2.76	0.84	0.31	3.32	0.51	0.15	2.97	0.76	0.25	3.16	0.74	0.23
Overall mean	3.59	0.62	0.17	2.94	0.80	0.27	3.35	0.51	0.15	3.10	0.71	0.23	3.26	0.71	0.22

Note:SD=Standard deviation; CV=Coefficient of variation;

Likert scale: 1=very low; 2=low; 3=average; 4=high; 5=excellent

Table 36. Availability of inputs for crop production, storage and marketing by revenue divisions

	Belgaum			Bengaluru			Gulbarga			Mysore			Grand Total		
	Mean	**SD**	**CV**	**Mean**	**SD**	**CV**	**Mean**	**SD**	**CV**	**Mean**	**SD**	**CV**	**Mean**	**SD**	**CV**
Seeds/ planting	3.53	0.90	0.25	2.89	0.63	0.22	3.39	0.78	0.23	3.05	0.71	0.23	3.23	0.81	0.25
Seedlings	3.60	0.83	0.23	3.04	0.64	0.21	3.45	0.76	0.22	3.12	0.68	0.22	3.32	0.77	0.23
Hand tools	3.72	0.69	0.19	3.22	0.71	0.22	3.58	0.77	0.22	3.31	0.60	0.18	3.47	0.72	0.21
Fertilizer/ Manure	3.85	0.38	0.10	3.32	0.58	0.18	3.70	0.58	0.16	3.37	0.51	0.15	3.57	0.56	0.16
Micronutrients	3.68	0.52	0.14	3.06	0.68	0.22	3.39	0.67	0.20	3.12	0.70	0.22	3.33	0.69	0.21
Harvesting quipment	3.49	0.77	0.22	3.06	0.73	0.24	3.20	0.74	0.23	2.99	0.74	0.25	3.19	0.77	0.24
Tillage equipment	3.01	1.06	0.35	2.79	0.76	0.27	3.17	0.71	0.22	2.80	0.75	0.27	2.95	0.85	0.29
Storage /Preservation facilities	2.96	1.08	0.36	2.60	0.88	0.34	3.12	0.64	0.21	2.70	0.67	0.25	2.86	0.85	0.30
Market facility	3.10	1.00	0.32	2.78	0.76	0.27	3.19	0.54	0.17	2.71	0.64	0.24	2.95	0.78	0.26
Processing units	3.32	0.86	0.26	2.75	0.75	0.27	3.18	0.55	0.17	2.62	0.61	0.23	2.98	0.76	0.25
Overall mean	3.43	0.81	0.24	2.95	0.71	0.24	3.34	0.67	0.20	2.98	0.66	0.22	3.18	0.76	0.24

Social Benefits of Bhoochetana

Apart from yield and economic benefits, we also have attempted to analyse social benefits of the program as the yield and economic benefits have immensely contributed to improving the social status of the participating farmers. The ensuing section focused on the investment of additional income obtained from adopting improved management, knowledge enhancement as well as gender equity in terms of decision making in different activities.

Re-investment of additional income on asset formation

About 40% of farm households have re-invested the additional income obtained from Bhoochetana on agriculture and agriculture related infrastructure. The major proportions (13%) of households have also invested on white goods (luxury goods) such as fridge, ceiling fan, mixer grinder, mobile and vehicles. It is important to note that about 10 per cent of the households have invested income obtained from Bhoochetana on loan repayment, house infrastructure and education, respectively. The additional income was useful for majority of households (7%) to overcome health related expenditure which is significant as it ensures better working condition for the family members. The Bhoochetana program also helped to take care of domestic expenditures as it facilitates small savings due to crop improvement (Figure 47).

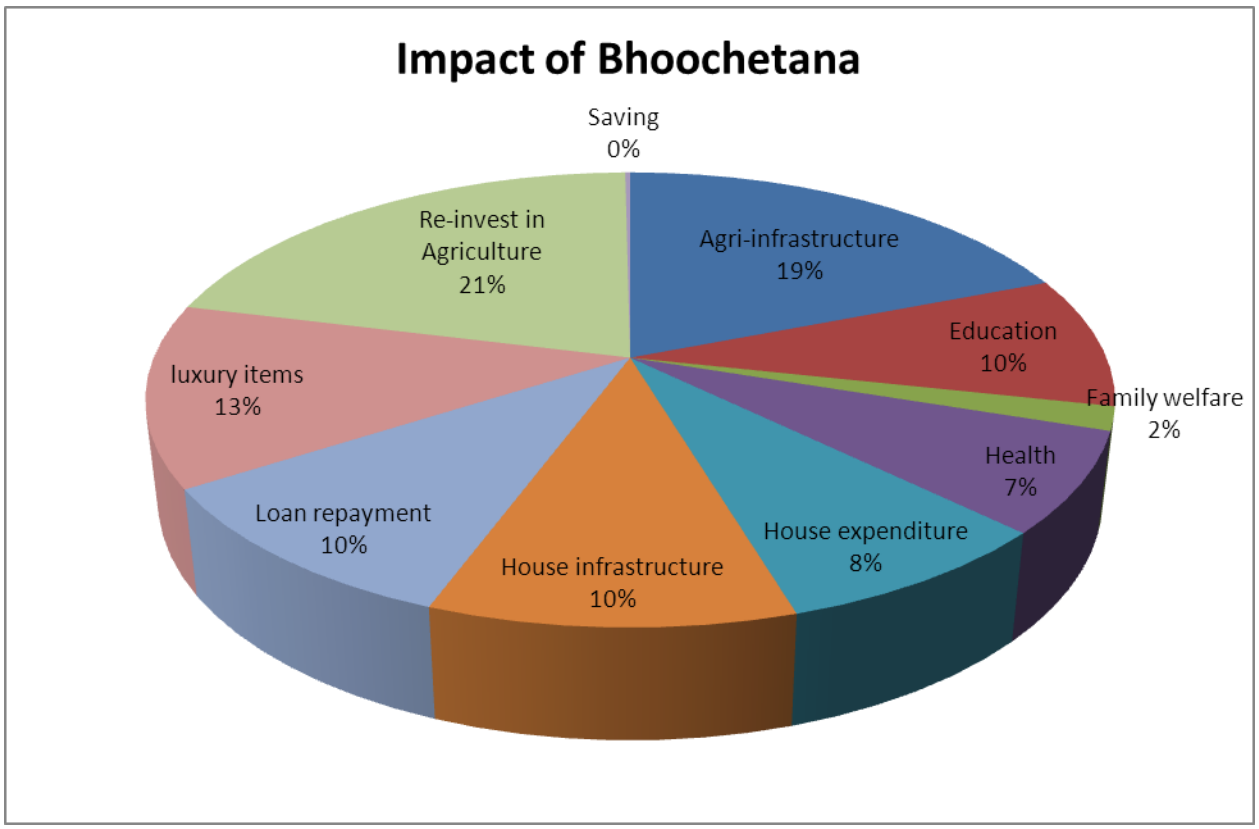


Figure 47. Contribution of Bhoochetana for household asset formation, re-investment on agriculture, health and education due to increased income in Karnataka

Knowledge improvement

Bhoochetana is a holistic process based mission project which intended not only to increase crop productivity but also enhance stakeholders' knowledge regarding agriculture operations. The analysis covered major activities which are part of Bhoochetana mission project and periodic trainings/capacity building programs were organized to disseminate the knowledge. The results are more revealing. First, the knowledge dissemination process initiated by ICRISAT through master trainers from University of Agricultural Sciences and Department of Agriculture impacted most positively on farmers as more than 50% of the households have acknowledge improved knowledge on major aspects of agriculture development in the state. Second, the knowledge about soil health status, micronutrient application and seed varieties improved significantly which are critical components of agriculture development. More than 85 per cent of rural households reported that their knowledge enhanced on these critical components. Third, nearly 80 per cent of households have learnt new methods to control pests and diseases to enhance their crop yield in the rainfed agriculture (Figure 48).

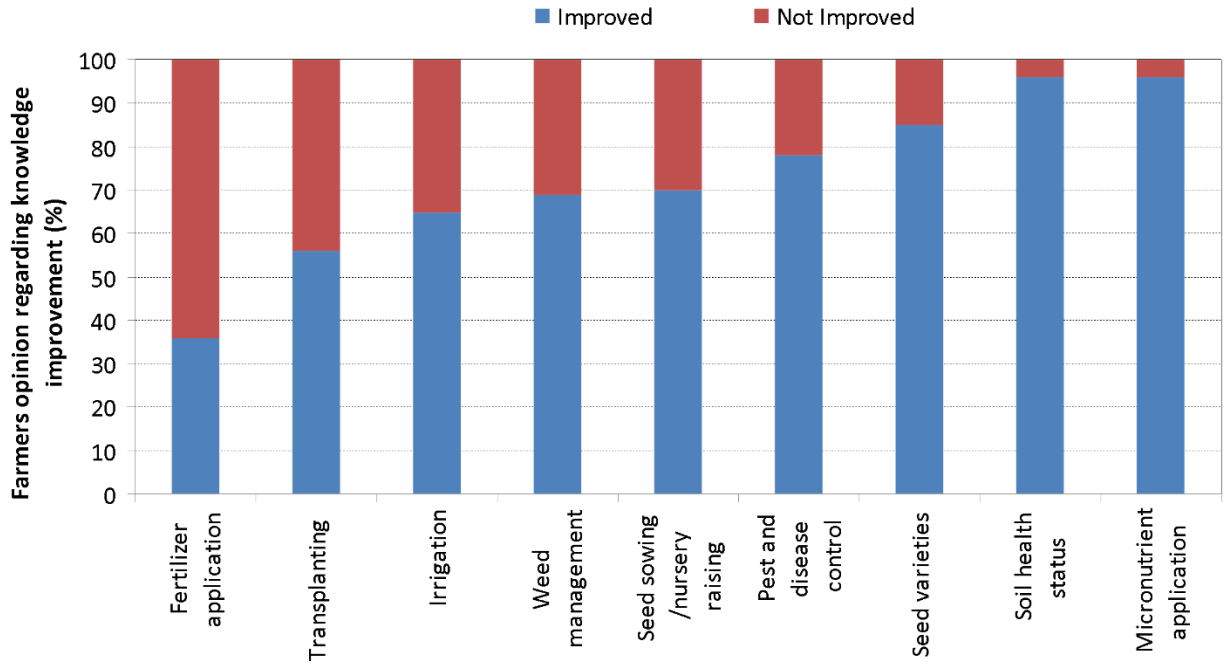


Figure 48.Bhoochetana contributed to increased farmers' knowledge regarding agriculture development in Karnataka

Addressing gender equity

Gender equity issue was addressed by analyzing the decision making process by men and women farmers who are following Bhoochetana practices. The analysis revealed that women exclusively have very meager role in decision making with regard to selection of crop, variety, land preparation, fertilizer and manure application, irrigation, harvesting, threshing and marketing (Figure 43). However, most of the critical decisions related to above mentioned activities were taken jointly which shows that there is a consensus among men and women to carry out agriculture activities in the dryland areas. It is evident that women are mostly involved in laborious activities on which they have decision making

control viz., transplanting (23%), hand weeding (19%) and interculture (12%). It is worth mentioning that men have greater control over decision making in almost all the activities and among which marketing is the critical aspect. More than 70% of the men and women farmers jointly made decision regarding harvesting, threshing and seed selection and storage. This reflects that certain activities are essentially required women's decisions which are critical in agricultural operations.

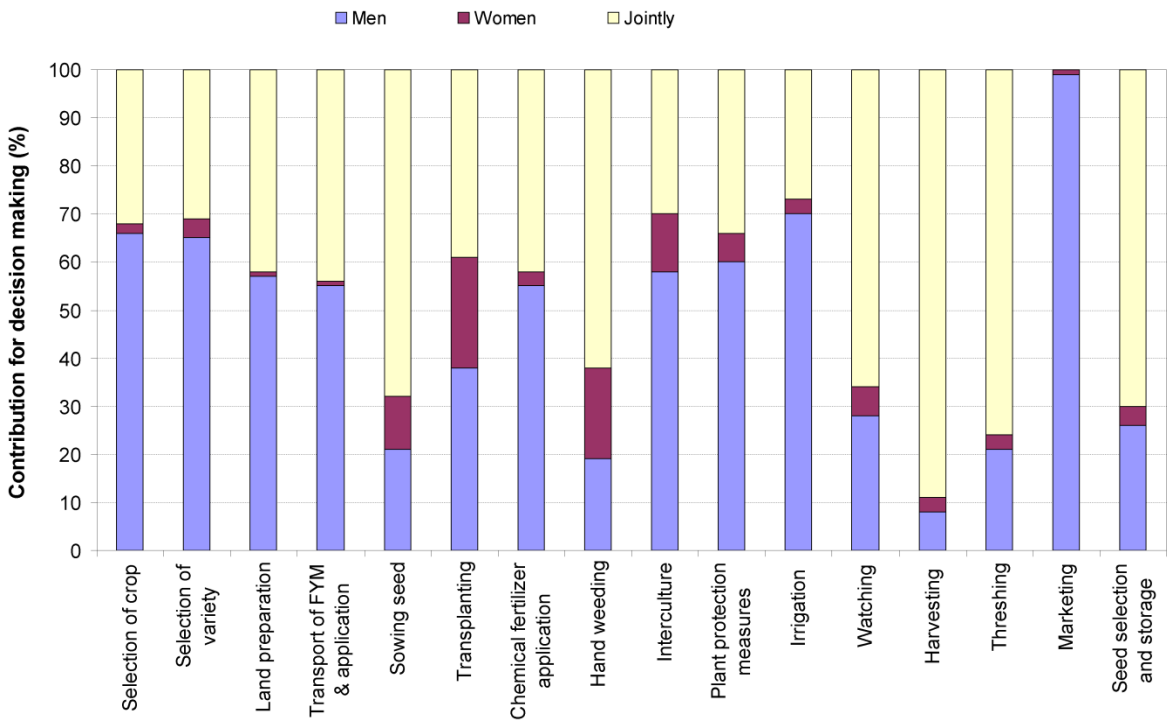


Figure 49. Bhoochetana implementation helped to minimize gender inequality and enhanced decision making of women and men in agriculture related activities

About ICRISAT

ICRISAT
Science with a human face

International Crops Research Institute for the Semi-Arid Tropics

CGIAR

ICRISAT is a member of the CGIAR Consortium

The **International Crops Research Institute for the Semi-Arid Tropics** (ICRISAT) is a non-profit, non-political organization that conducts agricultural research for development in Asia and sub-Saharan Africa with a wide array of partners throughout the world. Covering 6.5 million square kilometers of land in 55 countries, the semi-arid tropics have over 2 billion people, of whom 644 million are the poorest of the poor. ICRISAT innovations help the dryland poor move from poverty to prosperity by harnessing markets while managing risks – a strategy called Inclusive Market-Oriented Development (IMOD).

ICRISAT is headquartered in Patancheru near Hyderabad, Andhra Pradesh, India, with two regional hubs and five country offices in sub-Saharan Africa. It is a member of the CGIAR Consortium. CGIAR is a global research partnership for a food secure future.

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