Bhoo Chetana

Mission Project on Rainfed Agriculture:
Bridging Yield Gaps through Science-led Interventions for Sustainable Use of Natural Resources in Karnataka

Annual Report (2009-2010)

ICRISAT
Sciences with a human face

International Crops Research Institute for the Semi-Arid Tropics

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Contents

Executive Summary

Under Sujala-ICRISAT initiative, ICRISAT consortium demonstrated that through science-based integrated genetic and natural resource management (IGNRM) approach, productivity of dryland crops can be substantially increased upto 58% on a large scale (47 villages, 3700 ha). Widespread deficiencies of zinc, boron and sulphur observed in six districts served as an indicator for the studies of soil health in remaining 20 dryland districts of Karnataka.

Government of Karnataka took up an initiative to benefit millions of dryland farmers in 24 dryland districts by adopting Sujala-ICRISAT consortium and IGNRM approach to take up the science of soil science at the door steps of the farmers. Government of Karnataka requested ICRISAT to assist the state for bridging the yield gaps in dryalnd areas by helping them to implement and upscale science-based productivity enhancement initiative. Major objectives of the program are: 1) to identify and scale-up best-bet options (soil, crop and water management) including improved cultivars to enhance productivity by 20% of the selected crops in selected 24 districts; 2) to train DoA staff in stratified soil sampling at villages, analysis of macro- and micronutrients, preparation of GIS-based soil maps; and to guide DoA, to establish high quality soil analytical laboratory at Bengaluru and to undertake stratified soil sampling, their analyses and sharing results in nine districts; and 3) to build capacity of the stake holders (farmers and consortium partners) in the sustainable management of natural resources and enhancing productivity in dryland areas.

Government of Karnataka has converged all the government schemes through a mission mode project called as “Bhoo Chetana” meaning “reviving the soils” to benefit dryland farmers in 24 districts. Mission mode project as proposed by ICRISAT has adopted the principle of consortium, convergence, capacity building and collective action to address the issues of efficiency, economics, equity and environmental protection. Consortium partners involved in Bhoo Chetana are three State Agricultural Universities, Watershed Development Department, other line departments of Government of Karnataka, ICRISAT and Department of Agriculture which is the nodal agency for the mission project. The approach to reach large number of farmers for collective action and capacity building is achieved through using the concept of farmers facilitators and lead farmers as trainers to train large number of farmers. During the first year, project activities were started in six districts of Sujala

watershed program where soil health mapping was already completed earlier along with participatory selection of appropriate cultivars of the major crops. Other productivity enhancement interventions which are being scaled-up in the Bhoo Chetana program are : *in-situ*, soil and water conservation through appropriate land farm treatments such as conservation, furrow system, broad bed and furrows (BBF) to enhance rainwater use efficiency. Balanced integrated nutrient management based on the soil health assessment is one of the major pillar for productivity enhancement in Bhoo Chetana along with availability of good quality seeds of high yield stress tolerant cultivates of groundnut, soybean, pigeonpea, chickpea, maize and ragi in the targeted districts.

The Bhoo Chetana program was launched on 23 May 2009 by the Hon'ble Chief Minister of Karnataka, Mr. B. Yediyurappa, in the presence of the concerned partners and large number of farmers in Haveri district. Following the formal launching of the program, series of team building and capacity building courses for the DoA staff and other consortium partners were conducted at Bengaluru and district locations. Subsequent capacity building courses for the officials from the taluqs as well as farm facilitators and lead farmers were conducted at taluq level by the consortium partners including UAS scientists from the KVKs and research stations. Following the capacity building initiatives, awareness campaigns amongst the farmers through wall writings, posters and field publicity materials (brouchers, handouts, wall writings etc.) detailing the components of Bhoo Chetana was taken up in all the villages of the targeted taluqs in six districts. Based on the soil health diagnosis, soil health cards were distributed in the villages and suitable recommendations were provided to the farmers. At the same time, soil health studies of the taluqs and villages was put at the disposal of the villagers through maps and recommendations in local language.

In order to build capacity of the DoA to undertake soil health assessment for remaining districts as well as in future, ICRISAT scientists evaluated available facilities in Bengaluru and Mandy for soil analysis and suggested the interventions for up-gradation and integration of required facilities in both the laboratories. DoA soil analysis staff were trained at ICRISAT with the state of the art equipments used for undertaking micro-nutrient analysis as well as to maintain quality standards for their analysis.

In nine districts where the activities will be taken up during the rainy season of 2010, ICRISAT and DoA teams collected 35,460 soil samples from 1713 villages by adopting

participatory stratified sampling approach. During 2009 rainfall in all the six districts was erratic where early monsoon showers were there followed by long dry spell extending upto 52 days followed by heavy downpour when the crops were reaching maturity. Participatory crop cutting experiments to record the yields in the farmers practices were taken up in five villages in each taluq of all the six districts.

Maize grain yield increase in farmers' fields with improved management was between 37-51% in different taluqs of Haveri and 22% to 45% in different taluqs of Chitradurga. On an average, farmers harvested grain yield of 1.5 tons and 3 tons of fodder per hectare additionally with improved management "balanced nutrition" compared to grain and fodder yields with farmers' management in Haveri. In Dharwad, farmers harvested grain yields in the range of 1480 to 2990 kg ha^{-1} with improved management and the seed yield increase across the district was 39% over farmers' management.

Intense monitoring by state level high-power coordination committee at regular intervals, facilitated by ICRISAT to ensure good coordination of all stake holders to implement technologies in the project, resulted in successful implementation and crop yield increases between 35%-66% for farmers across six districts in the first year.

With Bhoo Chetana initiative, groundnut pod yields increased across all taluqs of six districts in the range of 32% to 41%, which varied from a lowest increase of 18% in Mulkalmur taluq of Chitradurga to the highest yield increase of 52% in Hubli taluq of Dharwad district. Ragi farmers harvested an additional one ton of grain yield and 1.5 tons of fodder per hectare by adopting improved management with along with balanced nutrition in Kolar. Weighted mean grain yield increase across Kolar, Tumkur and Chitradurga districts varied from 35% to 66%. Following the *kharif* season harvesting, *rabi* season rainfed crops sowing in Chitradurga, Haveri and Dharwad were undertaken successfully achieving coverage between 77% and 100% in three districts.

In conclusion, this novel approach as a proof of concept for demonstrating productivity enhancement through science-based approach has benefitted large number of farmers during the first year and has layed a strong foundation for scaling-up the initiative in six target districts as well as remaining 18 districts during the coming three years. The success within a short period for Bhoo Chetana is achieved largely because of close monitoring and

guidance by the senior policy makers in the state and efforts of the DoA staff in all the districts ensuring the convergence of various government schemes through Bhoo Chetana. Capacity building has played an important role in the success what is achieved in this program.

Background

Globally rainfed areas are hot-spots of poverty, malnutrition and degradation of natural resources. In India, out of 142 million ha of arable lands, 60% (8.2 million ha) is rainfed. Karnataka has the second largest area under rainfed agriculture after Rajasthan in the country. Crop yields in dry land areas are quite low (1-1.5 t ha^{-1}) which are lower by two to five folds of the yield from researchers managed plots. Recently, the findings from the comprehensive assessment of water for food and water for life revealed that the millennium development goal of reducing number of poor people by half can be met only through efficient use of the scarce water resources for agriculture. Food production can be increased substantially in rainfed areas through enhanced water use efficiency measures by adopting watershed management approach. Current rainwater use efficiency in dry land agriculture varies between 35-45% and vast potential of rainfed agriculture could be unlocked by using available scientific technologies including improved cultivars. The vast opportunities existing in dryland areas can be harnessed for improving rural livelihoods.

Sujala-ICRISAT Experiences

Government of Karnataka undertook an innovative approach through Sujala-ICRISAT initiative for taking the science at the door steps of the farmers in selected districts of Karnataka from 2005 to 2008 crop seasons. The Sujala-ICRISAT initiative was strongly based on building capacity of the farmers rather than only disseminating new technologies. The initiative which started with 13 watersheds in 2005 was scaled-up to 47 watersheds for demonstrating productivity enhancement measures. For that during 2008, the productivity enhancement initiative was scaled-up to large areas covering more than 3500 ha in the selected six districts by adopting the consortium approach. Under Sujala-ICRISAT initiative, ICRISAT has developed farmers' participatory stratified soil sampling in 20% of farmer's fields in a watershed and covered 20% of watershed villages in each district. In this approach farmers were trained on collecting soil samples scientifically for nutrient analysis. Further this approach was scaled-up to undertake spatial soil nutrient status mapping in the selected districts. This novel approach of soil diagnosis to build the capacity of the farmers has opened up new avenues for making farmers as our partners in the development of rainfed agriculture.

Learnings from the Sujala-ICRISAT Initiative are :

1. The yield gap analysis undertaken by ICRISAT revealed that large yield gap exists for all the major rainfed crops grown in these districts of Karnataka and there is a potential of increasing the productivity by 2 to 3 folds using available technologies in the farmers'fields.
2. Knowledge-based entry point activities enhanced the capacity of the farmers to undertake sampling by conducting the *Gram sabhas* and representative soil samples for 13 nucleus watersheds comprising 410 farmers fields were collected by the farmers.
3. Karnataka soils are not only thirsty are also hungry as 50-90% of the farmers fields are deficient in sulphur, zinc and boron. GIS maps of soil analysis revealed critical deficiency of zinc, boron and sulphur in large number of farmers' fields and policy makers can make informed decisions.
4. Soil deficiency results revealed that in the targeted six districts, there is no widespread deficiency of potassium, however, wide spread deficiency of nitrogen (31 to 81%), phosphorus (31 to 67%) and available sulfur (79 to 93%), available boron (39 to 91%) and available zinc (32 to 80%) is recorded.
5. Farmers participatory action research showed increased crop yields upto 345% with sunflower, 230% with ragi, 240% with groundnut, 150% maize, 116% soybean and 27% sorghum.
6. As a result of scaling-up initiative, farmers revealed that crop yields increased up to 58% (Table 1) even during the unfavorable year like 2008.
7. Farmers selected improved varieties based on the performance in their fields of different crops such as Ragi variety L 5 and MR 1, Groundnut ICGV 91114, GPBD 4, Kadiri 1375 and Kadiri-6 were identified along with improved hybrids of maize, sunflower by the farmers in different districts. The improved varieties like ICGV 91114 performed better almost by 148% increase in fodder as well as 159% increase in pod yields compared to farmers' cultivars and management. Improved cultivar GPBD 4 of groundnut was identified as a good cultivar. Soybean JS 9305 was preferred because of earlier maturity and input responsiveness trait.
8. Along with improved cultivars, farmers also evaluated suitable land and water management practices to conserve rainwater in the soil as well as to cope with dry spells during the crop growing period.

9. The economic benefits because of improved management practices in case of grain crops vary from Rs. 6300/- per ha in case of finger millet (ragi) to Rs. 21000/- per ha in case of sunflower.

Table 1. Crop yield estimates from farmers' fields under Sujala-ICRISAT scaling up productivity enhancement initiative.

	Grain yield (kg ha^{-1})		
Crop	**Farmers' Practice**	**Best-et practices**	**Percent increase**
Ragi	1750	2770	58
Groundnut	1300	1940	49
Maize	4760	6490	36
Soybean	1225	1635	33

The Bhoo Chetana initiative has been undertaken by the Department of Agriculture; Government of Karnataka is the path breaking approach for development and inclusive growth through enhanced productivity in dryland agriculture through use of science-based technologies and sustainable use of natural resources.

Goal of the Mission-Mode Project

The goal of Bhoo Chetana is to make a difference in the lives of farmers in the selected 24 districts of Karnataka (Figure 1) through increasing average productivity of selected crops by 20% in four years.

Objectives

The overall goal of this mission project is to increase average productivity of selected crops in the selected 24 districts by 20% in four years. The specific objectives are as follows:

1. To identify and scale-up best-bet options (soil, crop and water management) including improved cultivars to enhance productivity by 20% of the selected crops in selected 24 districts.
2. To train DoA staff in stratified soil sampling at villages, analysis of macro- and micronutrients, preparation of GIS-based soil maps. To guide DoA, to establish high quality Soil Analytical Laboratory at Bengaluru and to undertake stratified soil sampling, their analyses and sharing results in nine districts.

3. To build capacity of the stake holders (farmers and consortium partners) in the sustainable management of natural resources and enhancing productivity in dryland areas.

Figure 1. Selected 24 districts of Karnataka for Bhoo Chetana project

Consortium Partners

The consortium comprised of Karnataka State Department of Agriculture, with its commissioner and 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.
- Three Universities of Agricultural Sciences (Bengaluru, Raichuru, Dharwad) in the state of Karnataka with their Vice-Chancellors as SCC members supporting technical help from university scientists.
- 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 stake holder along with participating farmers.

Project Planning and Monitoring Mechanism

The nodal officers took the responsibility to bring together all consortium partners for their inputs, constituted coordination committees at different levels and related activities for successful implementation of the Mission project. The project has been implemented in a Mission mode and coordination at different levels starting with cluster of villages in each Taluk, linking-up with Taluk level coordination committees (TCCs) and TCCs linking-up with district level coordination committees (DCCs) and state level co-ordination committee (SCC). Roles and responsibilities of each consortium partner have been defined clearly as given in the project document for implementation. The details of planning and monitoring the implementation process at different levels for Bhoo Chetana are presented in Figure 2 below. The proposed plan of action, responsibilities of different partners were clearly outlined in the project document as a guide book to follow timelines.

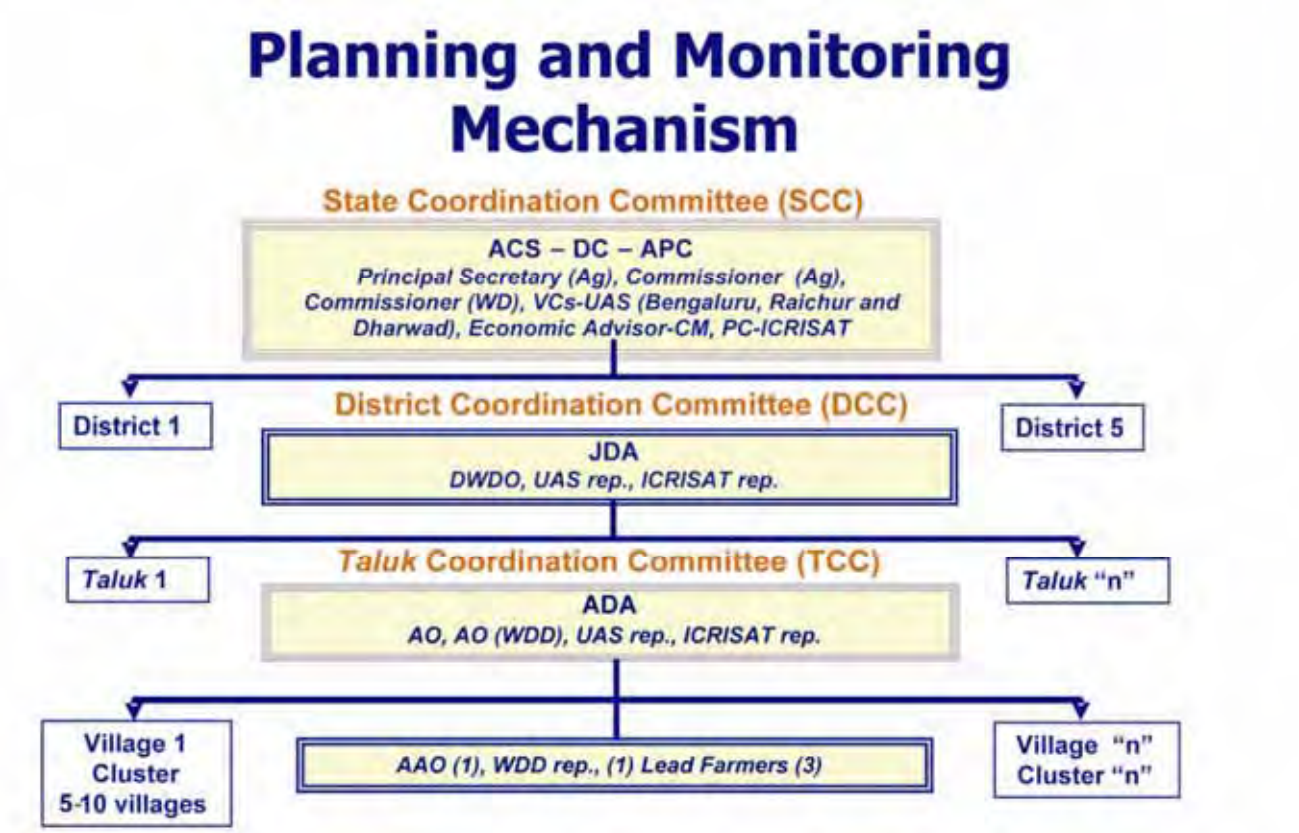


Figure 2. Planning and monitoring mechanism for implementing Bhoo Chetana mission mode project by DoA, Karnataka, facilitated by ICRISAT.

Appropriate Rainfed Agricultural Technologies

Farmers evaluated some of the improved watershed technologies during 2005-2008 crop seasons in ICRISAT facilitated science-led Sujala-ICRISAT project covered an area of 3500 hectares in 46 micro-watersheds of six districts of Karnataka. Some of the technological options were found to be appropriate in enhancing productivity and income to farmers and rural poor. Technologies listed below are popularized and recommended during the crop season 2009 in Bhoo chetana project districts.

In-situ Soil and Water Conservation Techniques

1. **Conservation furrow system**

   Contour furrows are simple and efficient method to conserve moisture. These are laid with the help of a country ploughs on a gradient of 0.2 to 0.4% at the time of sowing

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.

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. BBF system is laid out on a slope range of 0.4 – 0.8% with an optimum of 0.6% slope. BBF system (Figure 3) facilitates draining of excess rainwater as runoff and furrows act as traffic zone for plough bullocks. On Alfisols, raised beds suit well for groundnut cultivation as beds facilitate good aeration, store more moisture for the roots resulting in good crop growth.. BBF dimensions are shown below.

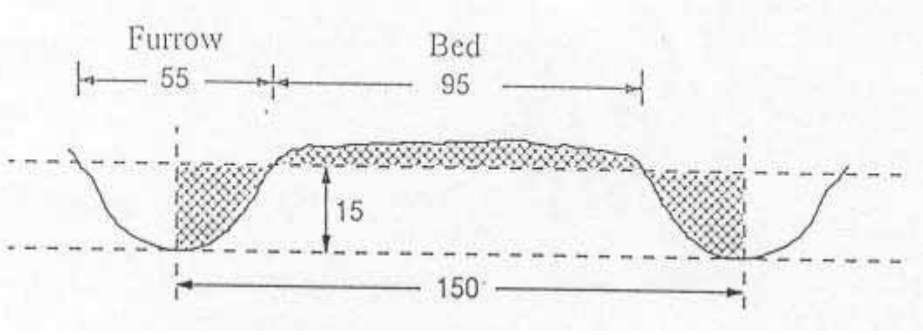


Figure 3. Broadbed and furrow system (all dimensions in cm)

Deep tillage, shallow cultivation and organic residues application are some of the promising *in-situ* moisture conservation practices.

4. Tropicultor

ICRISAT designed multipurpose wheeled tool carrier is known as tropicultor, were supplied to farmers during Sujala-ICRISAT watersheds. These were familiar among farmers in Chitradurga, Kolar and all other districts. Tropicultor usage saves not only work hours in land preparation but also proper inversion of soil as desired (Figure 4a). Its use during sowing is effective due to metered mechanism for uniform application of fertilizer as well as sowing of seed at uniform depth and also equidistant seeding.

During sowing operation, labor saving is critical as sowing opportunity in rainfed areas occur intensely for a short period and this equipment is quite useful to complete sowings of large holding in short period, as it has hitching arrangement to hook it to a tractor for speedier operations (Figure 4b).

Figure 4a. Applying fertilizer and seed at a time with animal drawn Tropicultor

Figure 4b. Applying fertilizer and seed at a time withTractor mounted Tropicultor in Kottur watershed, Dharwad

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, betters crop and environmental quality. In order to reap the benefits of balanced use of plant nutrients, it is important to have good quality seed, adequate moisture and better agronomic practices.

As a first step, soil sampling and diagnosing nutrient status of farmers' fields in six districts and providing soil health cards was completed. Balanced fertilizer rates differ from area to area and also from crop to crop. Hence we used soil analyses results, seasonal rainfall, as basis to recommend fertilizer doses. Availability of organic manures, crop residues, biofertilizers, was also considered to provide taluk-wise recommendations for different crops in all districts.

2. Biofertilizers

Biofertilizers are very important, low-cost, eco-friendly organic agro-input, supplementary to the 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 harmless and eco-friendly low cost agro-input, supplementary to chemical fertilizers. Improve soil structure (porosity) and water-holding capacity. Increase soil fertility, fertilizer use efficiency (FUE) and ultimately helps increasing yield by 15-20%.

Rhizobium strains are very selective to crops, for efficient nodulation on the roots of the leguminous plants. *Rhizobium* culture treatments for leguminous crops like groundnut, pigeonpea, soybean and chickpea were demonstrated to field facilitators and farmers during trainings and were encouraged to use by supplying them in the input package. We advised caution to farmers, use *Rhizobium* culture treatment to seeds of the crop mentioned on the packet at a dose of 250 g 10 kg^{-1} of seeds.

Azospirillum and Azotobacter cultures are useful for the cereals and cash crops viz. paddy, bajra, jowar, maize, cotton and castor. *Azospirillum* remains in association with the roots and fixes the atmospheric nitrogen. It is reported that the effective strains of *Azotobacter* or *Azospirillum* cultures fix about 15 – 20 kg ha^{-1} of atmospheric nitrogen.

Due to 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 the 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 increases 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, PSB and *Trichoderma viride* were applied to soil in Bhoo Chetana project as seed treatment with *Rhizobium* and fungicides were suggested for groundnut and soybean.

Aqua sap a sea algal extract which contains growth promoting harmones and micronutrients are evaluated through PR&D to assess its impact on crop yields through folior sprays.

3. Biocontrol agents

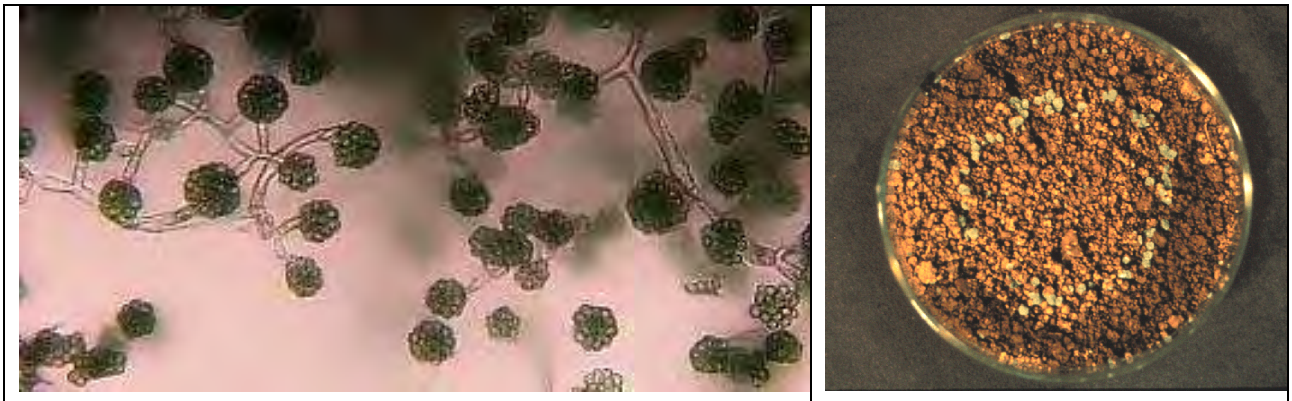


Figure 5. Trichoderma viride conidial spores in soil (left), commercial dried culture of conidial spores(right)

Trichoderma viride is a fungus used for seed and soil treatment for suppression of various diseases caused by fungal pathogens through seed and soil. Procedure to treat seed is to mix *Tricoderma viride* (Figure 5) with cooled rice gruel or Jaggery solution and thoroughly mix this solution with seeds required for an acre to have an uniform coating over the seeds. Dry these seeds for 30 minutes in shade and sow the treated seeds within 24 hours. We have also provided caution to farmers not to **use or mix** treated seeds with fungicides if seeds are to be treated with *Tricoderma viride.*

4. *Glyricidia* planting on field bunds

- Farmers were encouraged to plant 3-4 months aged plants from nursery or cutting of tender branches of *Glyricidia* at 50 cm apart on field bunds.
- *Glyricidia* plant produce green leaf and succulent green branches abundantly (Figure 6) which are rich in Nitrogen.
- Green leaf and loppings can be harvested leaving 1 m height plants of one year old and apply to topsoil for enriching organic carbon and nutrients in the soil.
- *Glyricidia* 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. Glyricidia planting on field bunds as green manure and reduce soil erosion

5. Vermicomposting

With an objective of converting farm residues and organic wastes in villages with the help of earthworms into valuable manure known as vermicompost was introduced to farmers and rural women as a technology through Sujala-ICRISAT project. Several compost pits were constructed in the watershed villages during the project period. Technology components mainly include selection and use of non-burrowing type of earth worms (*Eisenia sp., Eudrilus sp.*), use of weeds and crop residues and sericulture residues, animal and poultry manures and rock phosphate as materials.

Figure 7. Adoption of Vermicompost preparation methods by rural women in Bhoo chetana project.

During trainings, farmers and field facilitators were briefed about the benefits of vermicomposting as enriching soil organic carbon and thereby productivity, good storage quality of produce without toxic residues, fetches higher price for organic produce in the markets. Scientific methods of vermicompost preparation were provided to rural women SHG members (Figure 7), field facilitators during training programs in Bhoo Chetana project as a rural livelihood option.

Farmers' Preferred Varieties

High-yielding short-duration varieties of major rainfed crops were evaluated by large number of farmers in six districts through Sujala-ICRISAT project during crop seasons from 2005 to 2008. Farmers preferred some of these crop varieties suitable based on economic yield, acceptable quality of grain or pod and fodder in their region.

1. Ragi (finger millet)

Ragi is a staple food crop and is widely grown in Kolar, Chickballapur, Tumkur and Chitradurga districts. Based on some preferred traits, improved varieties of ragi released for Karnataka GPU 28, HR 911, L 5 and MR 1 were evaluated by farmers during 2005-2008 crop seasons under Sujala-ICRISAT initiative. In these evaluations farmers

preferred L 5 and MR 1 varieties based on yields and hence recommended to farmers in Bhoo Chetana project.

L 5

- Suitable for late season sowings and requires medium inputs.
- It is a medium duration (110-115 days) to grow and possess drought and disease tolerant traits.
- L 5 produces higher grain yield and palatable fodder.

MR 1

- It is a medium-duration variety, matures in 120-125 days.
- Suitable for early season sowings and perform better with high input management.
- Produces higher grain and fodder yields when farmers take up best management practices with good rainfall.

2. Groundnut

Short-duration cultivars of groundnut ICGV 91114, Kadiri 1375, Kadiri 6 and GPBD 4 were evaluated by large number of farmers in their fields for three seasons in these six districts under Sujala-ICRISAT initiative during 2005-2008 crops seasons. Farmers expressed interest to adopt ICGV 91114 in Kolar, Chickballapur, Tumkur and Chitradurga while farmers in Haveri and Dharwad expressed interest to adopt GPBD 4 for their cropping.

ICGV 91114

- Short duration (100-110 days) bunchy variety developed by ICRISAT and subsequently released by the GoK in 2009, was found suitable for Kolar, Chickballapur, Tumkur and Chitradurga districts.
- Higher pod and fodder yields recorded with this cultivar during Sujala-ICRISAT project evaluations, drought tolerant, performed well during short rainy seasons with mid-season dry spells.

GPBD 4

- Short-duration (100-110 days), foliar disease resistant cultivar, most suitable for rainy season in Haveri and Dharwad which receive well distributed rainfall. This variety was released by the University of Agricultural Sciences, Dharwad.
- High-yielding cultivar that produces small well-filled pods in bunches and good quality disease-free fodder. It was consistently better performer in Dharwad and Haveri districts during Sujala-ICRISAT evaluations in farmers' fields.

3. Soybean

Soybean cultivars JS 335 and JS 9305 were evaluated by large number of farmers in Dharwad and Haveri during 2005-2008 crop seasons under Sujala-ICRISAT initiative. JS 9305 showed good growth and was found to give higher yields despite drought. The variety has been introduced in Haveri and Dharwad as preferred by farmers in these districts.

JS 9305

- This cultivar is a short duration variety of 93-95 days duration
- Tolerant to drought and foliar diseases. Its grain quality is well-accepted by farmers

4. **Maize**

Commercially released high-yielding private hybrids used by farmers.

5. **Sunflower**

Commercially released high-yielding private hybrids and varieties accepted by farmers.

Integrated Pest Management

Farmers across all the six districts were trained on adopting cultural and biological methods of pest control, insect monitoring using pheromones traps (Figure 8), chemical control of insects on crossing threshold levels and growing tolerant cultivars.

Figure 8. Adult moth population monitoring pheromone trap in groundnut field.

Training modules on controlling the damage caused by major insect pests like *Helicoverpa sps* on pigeonpea and an epidemic causing red hairy caterpillar on groundnut; several approaches including spraying of Nuclear Polyhedrosis Virus (NPV) early stage larvae and its preparation in house were also included for the benefit of farmers' groups. Cost-effective eco-friendly biological control methods like shaking pigeonpea plants at flowering and pod formation was suggested, if *Heliothis* sps. infestation is severe in these stages. Field advisories were organized during crop season with the assistance of UAS, Bengaluru and Dharwad staff coordinating with DoA officials in the districts.

Income-generating Rural Livelihoods

1. Village seed banks

The concept of village seed banks was promoted successfully in Sujala-ICRISAT watersheds in Karnataka during 2005-2008, with an objective of ensuring quality and cheaper seed to farmers in the villages. The efforts to further strengthening the village seed banks are continued in several villages under Bhoo Chetana project to enhance

availability of ragi (L 5 and MR 1), groundnut (ICGV 91114 and GPBD 4) and soybean (JS 9305) cultivars which were preferred by the farmers.

2. Custom hiring centers for agricultural machinery

Tropicultors as either animal drawn or tractor drawn and animal drawn Penugonda ferti-cum seed drill (Figure 9) were placed in the control of each ADA to provide it for **the** needy farmers on hiring. This approach helped farmers who can not afford to buy them in the season, but use them based on their operational efficiency and to reduce dependence on labor for timely operations like sowing cum fertilizer application.

Figure 9. Tropicultor and Penugonda kurgi available for farmers in custom-hiring centers.

Project Strategy

Farmers' Participatory approach for enhancing crop productivity

- The most important strategy for this initiative is to adopt the Mission mode through convergence of different line departments of Government of Karnataka along with academic institutions like University of Agricultural Sciences, Bengaluru, Dharwad and Raichur with the international institution working in the area of dryland agriculture worldwide.
- Government of Karnataka has already constituted State level Coordination Committee (SCC) for Bhoo Chetana programme headed by the Additional Chief Secretary & Development Commissioner to review the performance of the programme at regular intervals.

The salient points for the Mission mode are as follows:

- The Mission will adopt the principle of 4 Cs i.e., Consortium, Convergence, Capacity-building and Collective action. The consortium will be of development agencies such as

line departments of state government and Field Facilitators' (FFS) along with academic and research institutions who are generators of the new technologies for improving the livelihoods of the rural poor in dryland area.

- 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 and inclusive development in the country.
- The approach of the Mission will be to ensure all backward linkages to meet the 4 Es through 4 Cs by 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 other best practices necessary financial incentive to undertake best-bet options for increasing agricultural productivity.
- To undertake improved best-bet management practices on large scale and share knowledge through their peer group. The lead farmers in the districts where already work has been done in the **last** four years under Sujala-ICRISAT initiative with the trained NGOs is an added strength for undertaking such a Mission in a short time.
- The scientific approach of mapping soil nutrient deficiencies in the remaining 18 districts will be the starting point for scaling up the soil analysis based integrated nutrient management practices for sustainable growth in dryland areas of Karnataka. The DoA is being empowered to adopt soil-test based approach for developing site specific fertilizer recommendations. This approach not only increases the productivity of the land but also reduced 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 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 guide for establishment of village seed banks for the self pollinated crops such as groundnut and chickpea as well as cross pollinated crops such as sorghum, pigeonpea etc., by training the farmers and establishing seed villages and village seed banks to ensure timely supply of seeds at reasonable prices for the farmers.

- Time lines are defined clearly for covering productivity enhancements in 24 districts, soil sampling and nutrient analysis mapping and capacity building of stakeholders during the project period as shown in Table 2.

Table 2. Timeline for execution of activities in Bhoo Chetana districts.

		% activity coverage in districts		
Activity	**Year**	**1-6**	**7-15**	**16-24**
Productivity enhancement	2009	25		
	2010	50	33	
	2011	75	66	50
	2012	100	100	100
Nutrient status mapping	2009	100		
	2010		100	
	2011			100
	2012			
Capacity-building	2009	100		
	2010		100	
	2011			100

Through various activities such as village seed banks and vermicomposting, women were the important stakeholders in the development **and** will be involved in this Mission to ensure ~~**the**~~ sustainability.

Table 2. Time lines for Bhoo Chetana project from 2009 to 2012

Activity: Productivity enhancement of rainfed crops coverage

Districts	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Year I																								
Year II																								
Year III																								
Year IV																								

Legend 25% 33% 50% 66% 75% 100% coverage of activity

Activity: Soil sampling, nutrient analyses and status mapping

Year I																								
Year II																								
Year III																								

Legend 100% coverage with soil sampling and nutrient status

Activity: Capacity-building and awareness of the project

2009																								
2010																								
2011																								

Legend 100% coverage of stake holders with capacity building

- In addition to the strength of convergence through consortium, the Mission will have planning and monitoring mechanism at cluster, taluk, district and state levels. The AC includes the decision makers from the different consortium partners including line

departments to take timely necessary action through suitable government orders to all the concerned Mission staff.

- The Mission has simple principle of accountability and delegation of authority at
- different levels without diluting the individual accountability to meet the Mission goal collectively.
- The Mission adopts in addition to the above, the rewarding mechanisms for the best performers i.e., the farmers at cluster, taluq, district and state level with appropriate personal recognitions. Similarly, the Mission staff those exhibit outstanding performance will also be recognized by the state government.

Visit of State Officials and Bhoo Chetana Mou

A delegation of state level officials from government of Karnataka include Dr. Subramanya, Principal Secretary of Agriculture, Government of Karnataka, Mr. Baburao Mudbi, Commissioner of Agriculture and Dr. K. V. Sarvesh, Director of Agriculture visited ICRISAT on 7th September 2009 (Figure 10). Director General of ICRISAT, Dr William D. Dar and Dr. Subrahmanya of Government of Karnataka signed a memorandum of understanding (MoU) for the Bhoo Chetana mission program at ICRISAT (Figure 11). Dr Subrahmanya mentioned that they value ICRISAT's contributions and help to the government of Karnataka through Bhoo Chetana initiative in a mission mode approach through consortium of institutions, which will benefit a large number of dryland farmers in 24 districts by enhancing productivity of dryland crops.

Karnataka team of officials was very much impressed with the development of high-yielding, stress-tolerant, short duration cultivars and was particularly interested in medium-duration pigeonpea cultivars suitable for Karnataka.

Figure 10. Senior officials of Government of Karnataka visited meteorological observatory, listening to ICRISAT scientists at ICRISAT, Patancheru

Figure 11. Dr. W D Dar, Director General of ICRISAT and Dr. Subrahmanya, Prinicpal Secretary, GoK signed the MoU on Bhoo Chetana project, 7th September 2009 **at ICRISAT, Patancheru.**

Bhoo Chetana Project Launching and Exhibition

The mission project named Bhoo Chetana was launched by Honourable Chief Minister Mr. B S Yeddyurappa, who was accompanied by Honourable Mr. S.A.Ravindranath, Minister of Agriculture, Government of Karnataka along with Dr. David Hoisington, Deputy Director General (Research) of ICRISAT on 23 May 2009 (Figure 12a).

A team of senior policy makers include Dr. Santhakumari Sunder, Additional Chief Secretary and Development Commissioner; Dr. K V Raju, Chief Economic Advisor to the Chief Minister; Mr. E Venkataiah, Secretary for Agriculture and Horticulture; and Dr C Somasekhar, Commissioner of Agriculture attended the project launching meeting. Senior member of team ICRISAT led by Dr David Hoisington, DDG-R participated in launch meeting.

Figure 12a. Bhoo Chetana project launching by Hon. Chief minister of Karnataka Mr. B S Yeddyurappa on May 2009 in Haveri

Figure 12b. Farmers visiting exhibition stalls of ICRISAT on the occasion of Bhoo Chetana launching ceremony

The project was initially approved for 20 districts covering 4 million ha; later the cabinet committee expanded the reach additionally for four more districts making it for 24 districts.

The Chief Minister in his address to farmers, high lightened the importance of soil heath comparing it with human health and emphasized the need to get the soils analyzed for nutrient status and apply required fertilizers based on the soil test results. The Chief Minister appreciated the support extended by ICRISAT under Sujala-ICRISAT initiative for four years for Karnataka farmers.

Dr David Hoisington, DDG-Research launched a GIS-based soil maps website for the selected six districts of Karnataka, which was developed by ICRISAT in collaboration with IITM-Karagpur. He also stressed the need to double the current crop yields of farmers easily with available technologies as established through Sujala-ICRISAT initiative and evaluated in large number of farmers' fields (3500 ha) of 46 watershed villages in these six districts since 2005 crop season. He reiterated that during 2008 crop season, farmers have reaped the benefits of the increased crop yields in the range of 30-47% over farmers practice.

Department of Agriculture, Karnataka, University of Agricultural Sciences, Dharwad and ICRISAT have arranged exhibition of technologies for the benefit of the farmers attended the launching session (Figure 12b) and farmers showed keen interest on tropicultor exhibit and sorghum cultivar seeds.

Project Activities

Rainy Season 2009

Capacity-Building of stakeholders on sustainable natural resource management

Team building

A team building workshop was organized on 2nd May 2009 in Bengaluru, to familiarize all stake holders of Bhoo Chetana project include nodal officers in the Commissionrates of Agriculture and Water Development Department, all Joint Directors of Agriculture (JDA), Assistant Directors of Agriculture (ADAs) and District Watershed Development Officers (DWDOs) from the districts along with ICRISAT Scientists and Scientific officers and Resident Research Technicians of the respective districts who participated in the workshop. Presentations made by Dr. Rajanna, the then Director of Agriculture, Karnataka State Department of Agriculture and Dr. S P Wani, Prinicipal Scientist (Watersheds) and Regional Theme Coordinator (Asia), Global Theme on Agroecosystems of ICRISAT, India. (Figure 13), set the perfect scenario for the team building of personnel from different institutions to come together.

In the Team building workshop, the mission staffs were exposed to goal of the mission-mode project and objectives of the project; planning, co-ordination and implementation arrangements among stake holders were discussed and mechanism for monitoring the progress of implementation was decided. Schedules for cluster-wise detailed work plans

preparation responsibilities were assigned to project staff. Modalities for ensuring availability of required inputs before the on-set of the season and strategy for their timely distribution to the farmers in each district were discussed.

Figure 13.Dr. S P Wani speaking to stakeholder during Team building exercise in Bengaluru on 2nd May2009

Trainings

Trainings were organized in three stages considering area of operation as 1. District level training; 2. Taluk-level training; and 3. Cluster-Village level training. Based on the levels of training, the course content was designed keeping in view the participants.

District level trainings were organized in the months of May and June in all the six districts for ADAs, AOs on aspects of soil sampling, soil nutrient status in their respective taluks of each district, nutrients recommendations based on soil nutrient deficiencies for major crops, suitable high-yielding varieties and integrated disease and pest management for different crops, livelihood options for rural landless poor and on best-bet management options for enhancing the productivity of agricultural crops (Figure 14 a,b). Details of number of meeting in each district for these trainings are provided in the table 3. Faculties were drawn from ICRISAT, UAS Bengaluru and its associated Krishi Vigyan Kendras. In each district, one to six district level trainings were arranged based on need and convenience of participants. The trainings comprise of lectures and extensive discussions to decide upon locally suitable technologies to be recommended for farmers in their respective districts.

Figure 14a.District level meetings with stake holders(ADAs and AOs) in Bengaluru district

Figure 14b.Demonstration of bullock-drawn Tropicultor for participants at district level training in Dharwad.

Taluk level trainings were organized in the months of June and July in all the districts for Agricultural Officers, Assistant Agricultural Officers, Agricultural Assistants, Field Facilitators and Lead farmers at their respective taluks. Training topics encompassed soil nutrient status in their respective taluks of each district; nutrients recommendations based on soil nutrient deficiencies for major crops, integrated disease and pest management for different crops, livelihood options for rural landless poor and on best-bet management options for enhancing the productivity of agricultural crops (Figure 15 a, b). A minimum of 3 taluk-level trainings in Kolar to a maximum of 23 taluk-level trainings were arranged in Haveri district. Faculty for these training comprised of scientists from KVKs of UAS, Bengaluru and Dharwad, Scientific officers from ICRISAT and JDAs or DWDOs in their respective districts.

Figure 15a.Taluk level training of stakeholders (AAOs, AAs, Field Facilitators and lead farmers) in Chickballapur.

Figure 15b.Hands on trainings to women on preparation of rural vermicomposting.

Cluster/Village level trainings were held for farmers in the village to create awareness about Bhoo Chetana project (Figure 16a) and its goal to achieve 20% yield increase in farmers' fields and information on best-bet management options for enhancing the productivity of agricultural crops. Village level trainings in the range of 90 to 689 were arrange in different districts (Table 3). They were also informed about input subsidies on total package of inputs and information on nutrient deficiencies in their village soils and required micronutrient availability for their use. These trainings were held in almost all selected villages providing hands-on trainings on techniques (Figure 16b) and well attended by farmers.

Figure 16a. Kottur village farmers' meeting in kottur village, Dharwad

Figure 16b. Hands-on training for farmers in Dummavada on mixing of micronutrients

Table 3. Trainings conducted in six districts under Bhoo Chetana program during 2009-10

District	Taluks	District-level		Taluk /village-level	
		No. of		No. of trainings	
		Trainings	Participants	Taluk level / participatnts	Village level/ participants
Dharwad	Dharwad, Hubli, Kalaghatagi, Kundagol	3	136	3 / 35	126 / 1399
Haveri	Haveri, Hirekere, Ranebennur, Savanur, Shiggaon	6	200	23 / 787	236 / 22071
Chitradurga	Chitradurga, Hiriyur, Holalkere, Hosadurga, Challakere, Molakalmor	2	333	17 / 80	689 / 8116
Tumkur	Madhugiri, Sira, Pavagada, Gubbi, CNHalli, Kunigal, Koratagere,	3	137	14 / 12	320 / 270
Chickballapur	Chickballapur, Bagepalli, Shidlagatta, Chintamani, Gudibandae	4	262	8 / 13	345 / 1010
Kolar	Kolar, Bangarpeta, Mulbagal	1	60	3 / 3	90 / 1130

Facilitation of project activities in the Mission mode

- To provide good beginning for the project, team building exercise at Bengaluru was organized by ICRISAT and DoA to facilitate all stake holders from six districts to come together for understanding of the mission mode approach to the project. Planning of activities, execution of trainings schedules, awareness campaigns and field publicity was organized in quick succession with active participation of DoA and ICRISAT staff.
- Coordination with DoA staff for inputs mobilization, especially expediting the procurements or placing inputs at the disposal of field staff for easy distribution to farmers timely was harmonized. ICRISAT facilitated timely procurement of groundnut (ICGV 91114), Pigeonpea cultivars, Bajra hybrids and soybean cultivars by DoA.
- ICRISAT arranged seeds of improved cultivars of Sorghum, safflower, chickpea for *rabi* sowings (Table 4) to farmers of Haveri and Dharwad through DoA, as these districts were flood affected and farmers have lost their stored seeds.
- ICRISAT staff participated and facilitated weekly review meetings in each district to provide update of field activities and any assistance required for farmers' problems.
- ICRISAT developed format for weekly progress reporting (Appendix D) and ICRISAT staff facilitated regular feedback weekly from districts to ICRISAT and SCC through comprehensive checklist format.
- Intense monitoring of field trials by DoA and ICRISAT SCC members through direct contact of ICRISAT staff, farmers and field facilitators, DoA officials in districts using pocket telephone directory (Annexure E) published by DoA in Bengaluru.
- Besides participation of project coordinator from ICRISAT and visiting scientist in regular SCC review meetings, their field visits in Kolar district (Figure 17a, b,c) as well as meeting with UAS scientists in Bengaluru and Dharwad had helped to invigorate ICRISAT staff morale and commitment for project activities.

Table 4. Details of seed quantities supplied to JDAs of Haveri and Dharwad

Crop	Cultivars	Quantity (kg)	Recipients, District
Sorghum	M 35-1	2000	JDA, Haveri and JDA, Dharwad received equal quantities of these crop seeds
	Phule Yashoda	500	
Safflower	Manjeera	1000	
Chickpea	ICCV 37	250	
	JG 11	250	

Figure 17a. Dr. S. P. Wani, Principal scientist (watersheds), Mr. Chikkanna, JDA, Kolar discussing with farmers in Kolar

Figure 17b. Mr Chikkanna and DoA and ICRISAT staff discussing with farmers on managing effects of drought.

Figure 17c.Dr. K. V. Raju advisor to Chief Minister distributing input package to farmers in Kolar

Awareness and Field Publicity Campaigns on Bhoo Chetana for Farmers

The DoA staff ensured wall writings (Figure 18) and exhibition of posters (Figure 21) in all villages within short period before the on-set of monsoon, indicating the main objective of the program and areas to be covered by the program. Additionally thousands of brochures (Figure 19, 20) and handouts were published in each district on improved management practices, information on nutrients status, nutrients recommended taluk-wise and widely distributed in all selected districts.

Figure 18a. Wall writings in Kannada, on Bhoo Chetana goal and extent of its spread in the district.

Figure 18b. Wall writing in Kannada on technologies appropriate to implement in farmers' fields for enhancing productivity

Figure 19. A brochure published by DoA, Karntaka from Bengaluru and distributed in all districts covered by Bhoo Chetana program for creating awareness.

Figure 20. Six page brochure published by JDA, Tumkur with details soil nutrient status and package of practices for major crops in the districts.

Figure 21a. A poster for farmers on package of practices for rainfed ragi published by DoA, Kolar

Figure 21b. A poster on Bhoo Chetana published by DoA, Bengaluru, for all selected districts

Print Media news coverage was extensive to introduce Bhoo Chetana program to farmers and also on activities during the season in all districts (Figure 22), besides field facilitators and lead farmers contacts with individual farmers in selected village.

Figure 22. Coverage of Bhoo Chetana program by daily news papers in different districts

Awareness Building on Soil Nutrient Status

Nutreint diagnostic studies

Soils samples from around 11000 farmers' fields in several taluk of each district were collected in six districts during 2008, were analyzed for diagnosing macro and micronutrients status of farmers' fields. Based on the established critical limits for each nutrient, fields were categorized as deficient or sufficient. Individual farmers were provided soil health cards based the mean nutrient status in the soils of the village as the soils analysed were representative of the village soils as they were done following a stratified soil sampling methodology. Soil nutrient status maps were provided for each district using interapolated soil nutrient status data and GIS techniques for the benefit of policy makers.

Kolar

In Kolar, more than 80% fields were deficient in organic carbon in four out of five taluks. Even in Malur taluk 70 % sulfur and boron were deficient in more than 80% of the fields in all taluks (Figure 23a). Olsen P, Potash and Zn were deficient in less than 50% of the farmers' fields in all taluks. Soils in different taluks of Kolar are light textured Alfisols.

Chickballapur

In Chickballpur, across all taluks organic carbon is low and deficient in more than 75% of fields in five taluks except in Gowribidunur where 64%.of the fields were deficient and soils in this district are mostly lighter Alfisols. Phosphorus is deficit in less than 50% of the fields in all taluks except in Bagepalli and Gudibanda taluks (Figure 23b), where application of DAP for groundnut has been a common practice. Potash is generally available sufficiently and deficient in less than 45% of the farmers' fields in this district. Sulfur and micronutrients boron and zinc were deficient in more than 50% farmers' fields in all taluks except in Chickballapur where Zn was available in 66% of the fields in the district.

Tumkur

Soils were poor in organic carbon, more than 75% of farmers' fields are considered deficient of OC in 8 taluks and Turuvekere was the only taluk where 48% of the fields were deficient. In the entire district of Tumkur, all other nutrients were particularly deficient that is covered by light textured Alfisols. OC, Olsen's P, sulfur, boron were deficient in all taluks (Figure 24). In this district, potassium is also becoming deficient nutrient unlike in other districts.

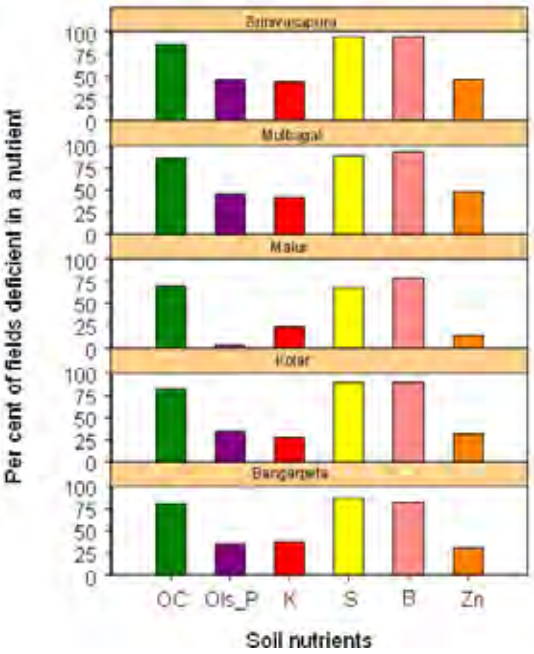


Figure 23a. Nutrient status of farmers' fields in different taluks of Kolar district

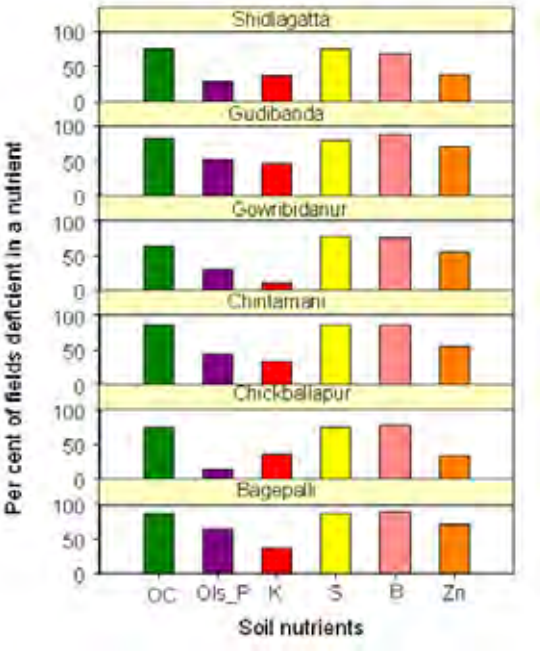


Figure 23b. Nutrient status of farmers' fields in different taluks of Chickballapur district

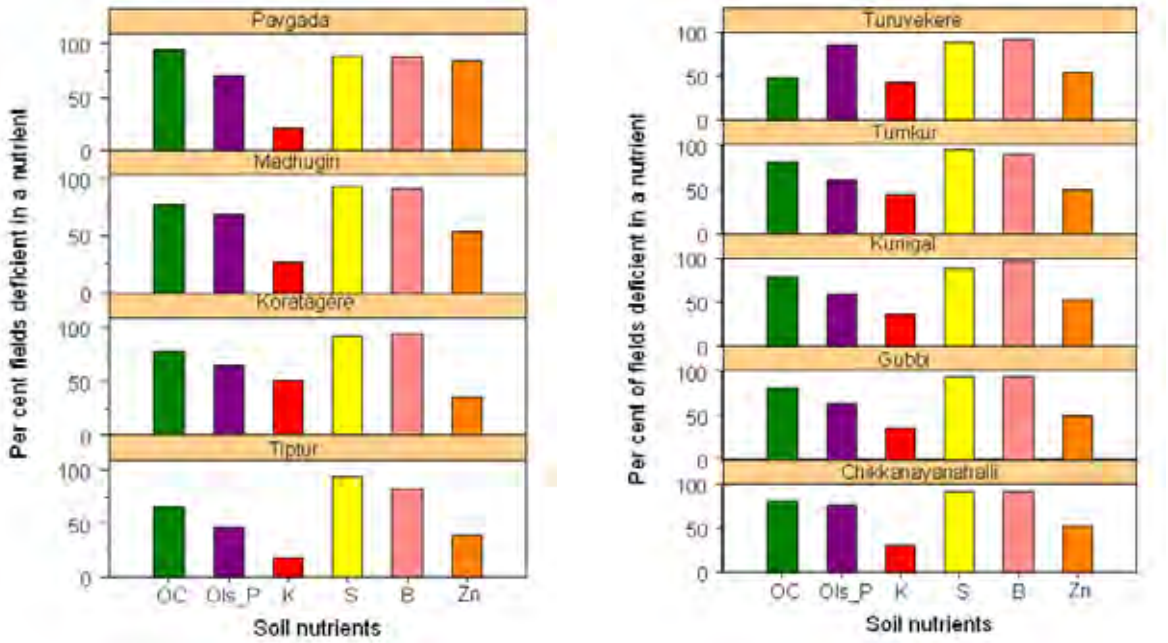


Figure 24. Nutrient status of farmers' fields in different taluks of Tumkur district

Chitradurga

In Chitradurga, fields in all taluks have deficiency of organic carbon, sulfur and micronutrients zinc and boron in more than 50% farmers' fields. Olsen P is deficient in black soil areas of Holalkere, Hiriyur, Chitraduraga taluks besides prominent alfisol areas in Chellakere taluk. Zinc deficiency is especially more pronounced in all taluk of this district (Figure 25a). However, soils in the entire district are sufficient in Potash

Haveri

Soils of farmers' fields were relatively better in terms of organic carbon with less than 50% fields were deficient in Byadagi, Hangal, Haveri and Shiggavi taluks, while soils in Hirekerur, Ranebennur and Savanur were deficient of organic carbon in more than 50% farmers' fields. Sulfur deficiency was conspicuously acute (>80% of farmers' fields) in all taluks of the district, followed by zinc deficiency in >50% fields in four taluks (Byadagi, Haveri, Ranebennur and Savanur) out of seven taluks. Boron deficiency in >50% of the fields in Hangal, Haveri and Shiggavi taluks were observed (Figure 25b).

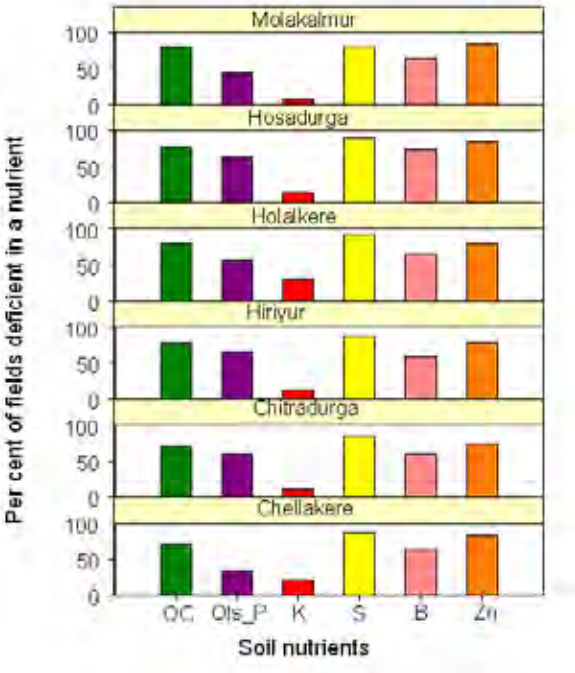


Figure 25a. Nutrient status of farmers' fields in different taluks of Chitradurga district

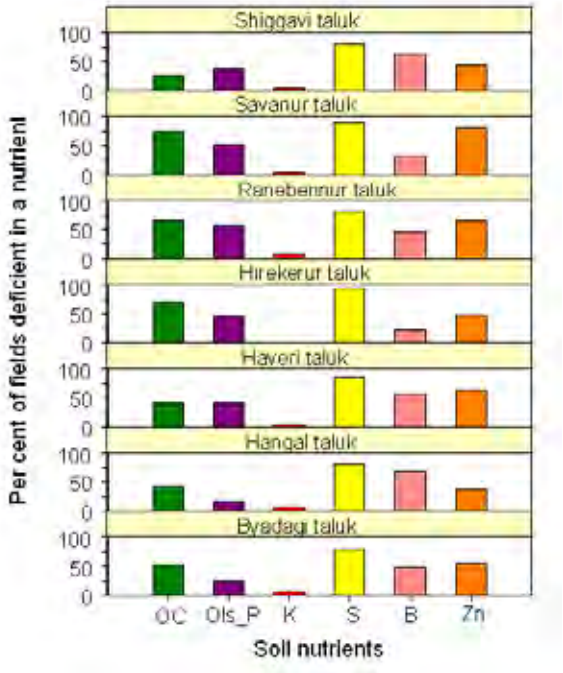


Figure 25b. Nutrient status of farmers' fields in different taluks of Haveri district

Dharwad

Farmer field soils were relatively richer with organic carbon in Dharwad, Hubbali and Kalaghatagi, but >50% fields were deficient in Kundagola and Navalgund.

Olsen P was generally deficient in all taluks except Dharwad, however, potassium was not deficient in all taluks (Figure 26). Sulfur deficiency was pronounced in all taluks of the district with >60% of farmers' fields deficient. Boron was deficient in Hubbali, Kalaghatagi and zinc was deficient in >50% fields of Kundagola and Navalagund.

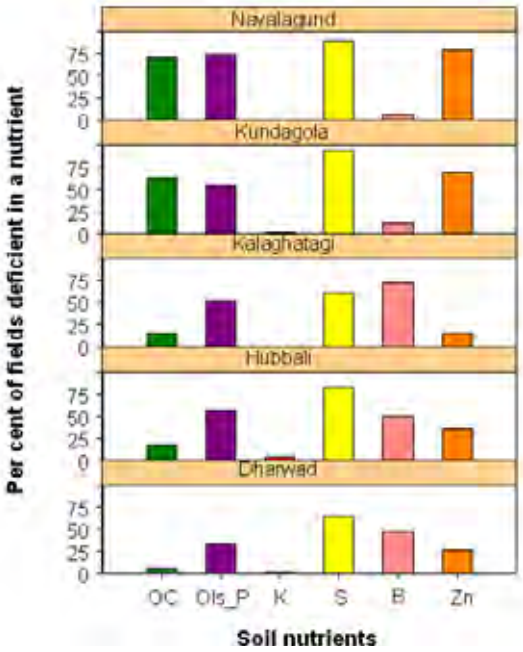
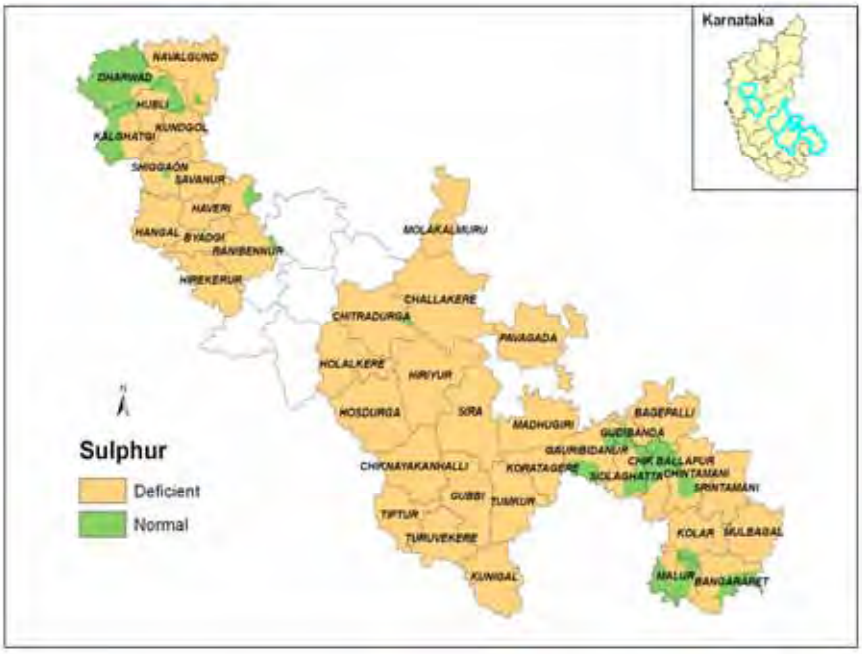


Figure 26. Nutrient status of farmers' fields in different taluks of Dharwad district.

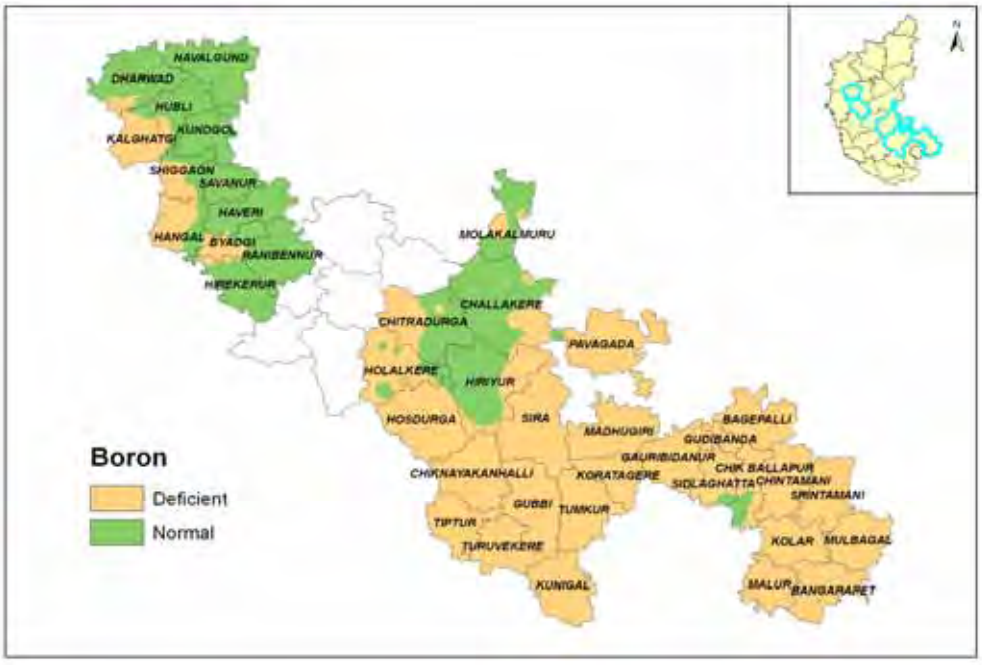
Soil Nutrient Status Mapping

Spatial maps of a nutrient (Maps 1, 2, 3) were prepared based on soil nutrient status of the sampled fields. GIS based extrapolation techniques were used to prepare taluk-wise maps based on the geo-referencing of sampled fields initially on stratified sampling approach in each watershed village.

Map 1. Status of available zinc in soils of selected six districts in Karnataka during 2008



Map 2. Status of available sulphur in soils of selected six districts in Karnataka during 2008



Map 3. Status of available boron in soils of selected six districts in Karnataka during 2008

Soil Health Cards as shown (front and back pages) in figure 27, were provided to individual farmers in local language (Kannada) with details of individual nutrient status and critical limits along with a comment on the nutrient status of the field.

Second side of the card contains recommend dose of nutrients for each crop as well as quantity of nutrients available in commercially marketed fertilizers, for the understanding of farmers.

Figure 27. Soil health cards with details printed on both sides of the sheet

Nutrient Recommendation in Pocket Guide

In Haveri, Joint Dirctor, Department of Agriculture assisted by ICRISAT published a pocket guide (Figure 28) with soil nutrient status maps and nutrient recommendations to different crops in taluks of Haveri, for use by staff and FFs.

Wall writings were quite conspicuous with details (Figure 29) of input quantities supplied to the farmer per one hectare, component of subsidy; inputs cost to be borne by the farmer under Bhoo Chetana initiative.

Nutrient recommendations (Table 5) were prepared by ICRISAT based on the nutrient status of soils in each taluk, recommendation of N, P and K for different crops by DoA and ICRISAT evaluated boron, zinc and sulfur recommendations. Based on farmers' affordability, locally adjustments were made as agreed by UAS scientists and DoA subject matter specialists.

These recommendations were transformed into quantities of commercially available grades of fertilizers (Table 6) and were suggested for farmers. Due to issues of subsidy to different categories of farmers, some farmers did not apply balanced nutrients as recommended, instead discreetly applied nutrients in parts.

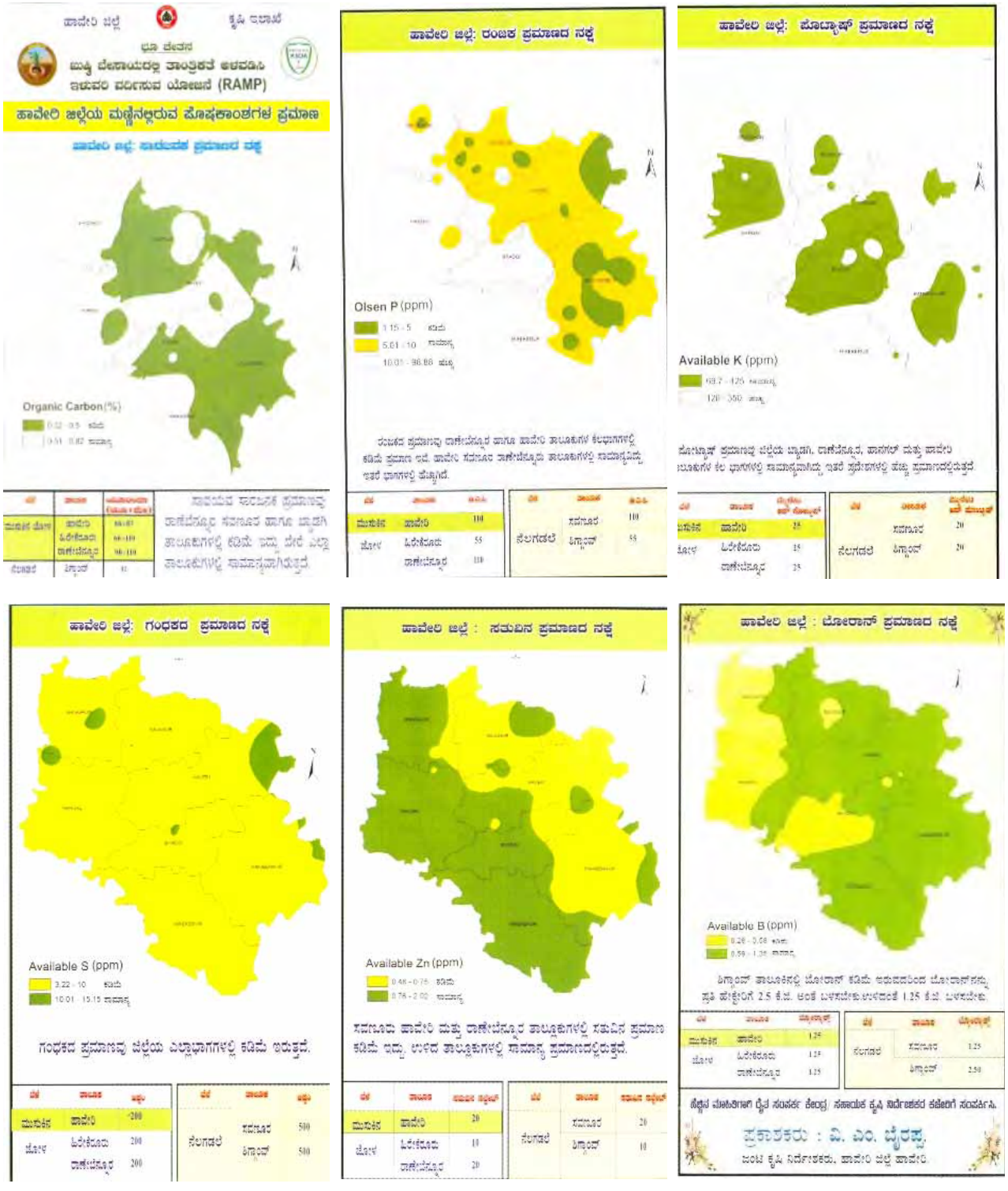


Figure 28. A six-fold pocket guide on single sheet of paper with nutrient deficiency maps for use of field facilitators and lead farmers as a ready-reckoner.

Figure 29. Details of quantities of inputs to be supplied (seeds, nutrients, pesticides as a package), government subsidy and farmers' payment required per hectare as a Wall writings in a village written in Kannada.

Table 5. Nutrient recommendations to different crops in kharif based on soil nutrient status

Crop	Nutrient recommendation (kg ha-1)					
	Nitrogen	P_2O_5	K_2O	Sulfur	Zinc	Boron
Ragi	50	40	20	30	10	0.5
Maize	100	50	25	30	10	0.5
Groundnut	25	50	25	70	10	0.5
Soybean	30	60	25	30	10	0.5

Table 6.Crop wise Fertilizer dosage recommended in Kharif based on crop requirements

	Fertilizers recommended (kg ha^{-1})					
Crop	Urea	DAP	MoP	Gypsum	Agribor*	$ZnSO_4$
Ragi	75	90	30	200	2.5	50
Maize	90	110	50	200	2.5	50
Groundnut	0	110	40	200	2.5	50
Soybean	25	110	40	200	2.5	50

If borax is applied in stead of Agribor, quantity needs to be doubled

Daily rainfall monitoring, seasonal rainfall situation 2009

Daily rainfall from the beginning of the season (May) was monitored with the close coordination of the staff of DoA, Karnataka in all taluks of six districts. We presented graphics of rainfall distribution in two taluks in each district, which are typical to areas cultivated to major crop in the district.

In Chickballapur rainfall (Figure 30a) in the first fortnight of August had mainly helped farmers to sow groundnut and ragi in all taluks. Although groundnut sowings started early in the first week of June in Mulbagal taluk of Kolar, a break in October rainfall and a long dry spell has affected groundnut crop performance to a considerable extent (Figure 30b).

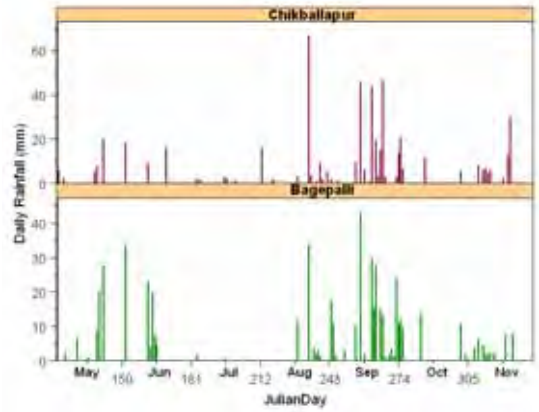


Figure 30a.Rainfall distribution between May-November in two taluks of Chickballapur

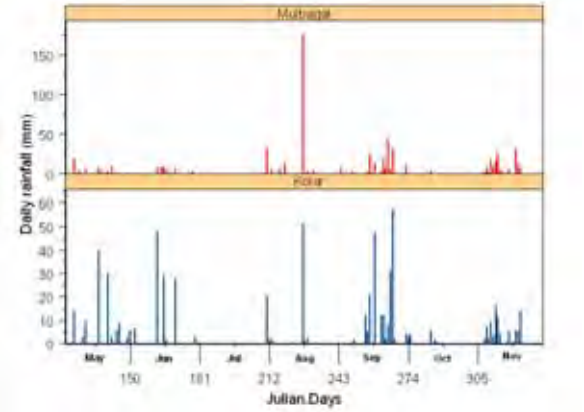


Figure 30b.Rainfall distribution between May-November in two taluks of Kolar

In Tumkur rainfall during second fortnight helped farmers to sow groundnut crop (Figure 31) and later ragi in different taluks. In Chitradurga rainfall was scanty during June, July and first fortnight of August, however rainfall occurred sufficiently for sowing during second fortnight of August in all taluks (Figure 32). September was almost a dry month and October rainfall only saved the crops and hence moderate crop harvest is expected. Sowings were undertaken briskly in June with good rainfall during the second fortnight of May followed by June in all taluks of Dharwad (Figure 33b).

Good rainfall in May and June helped sowings from last week of May to first fortnight of June in all taluks (Figure 33a), followed by good rainfall in July and August supported good crop growth and better yields of maize and groundnut in Haveri district.

Good distribution of rainfall in Haveri and Dharwad during third week of May and first week of June permitted sowing of soybean, Maize and groundnut crops show cased the influence of rainfall on these crops. However, distribution of rain in June and July were scanty resulting in delayed sowings in some taluks of Kolar, Chickballapur, Tumkur and Chitradurga, a contingency crop planning was necessitated for alternate crops.

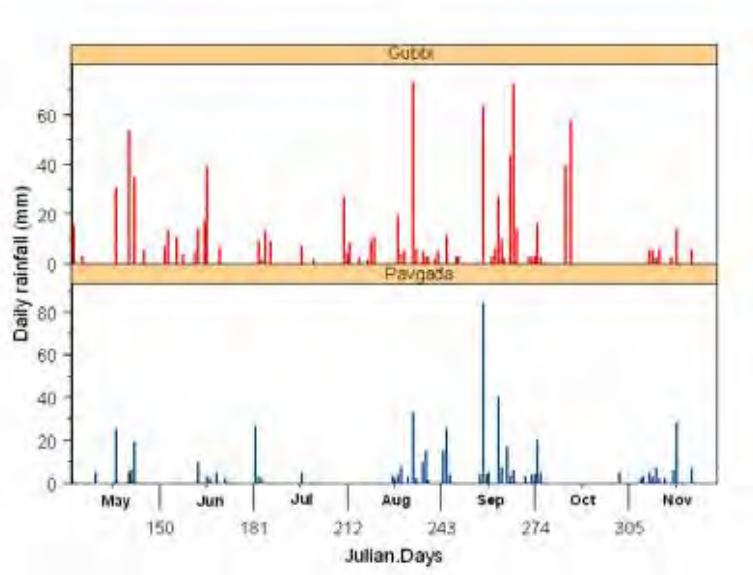


Figure 31. Rainfall distribution between May-November in two taluks of **Tumkur**

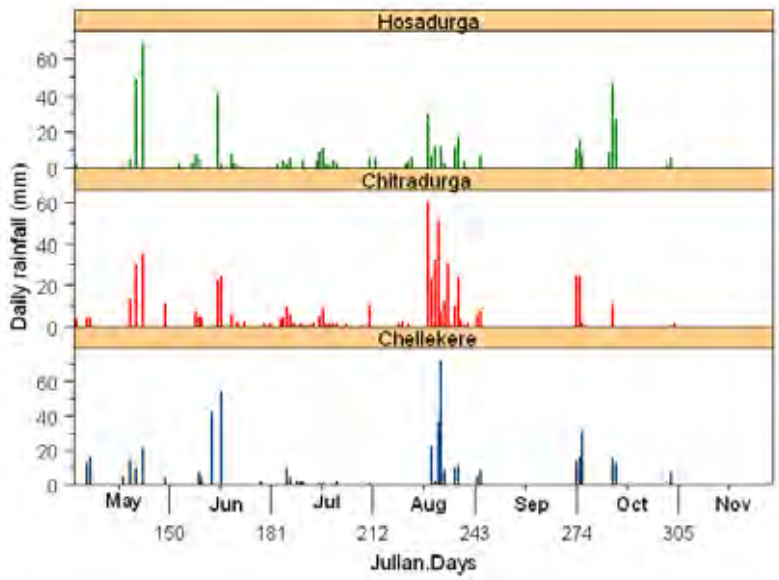


Figure 32. Rainfall distribution between May-November in three taluks of Chitradurga

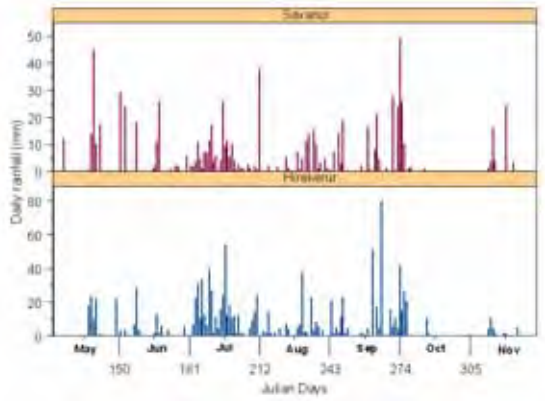


Figure 33a. Rainfall distribution between May-November in two taluks of Haveri

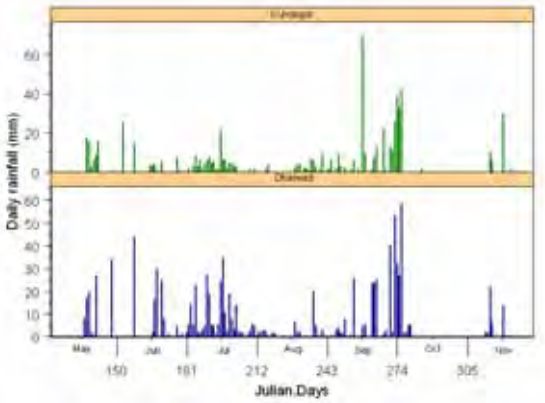


Figure 33b.Rainfall distribution between May-November in two taluks of Dharwad

Contingency crop planning

Delayed monsoon rainfall and uncertain sowing conditions were responsible to prompt farmers and policy-makers wait for contingency cropping options in different districts of Karnataka during 2009 kharif season. ICRISAT prepared contingency cropping plans district-wise based on soil type and established norms of farmers' priorities like food crops for annual family consumption requirements and fodder to feed cattle population.

Kharif Season Rainfed Crop Planning

Scaling-up Soil, crop and water management technologies for boosting Productivity of Selected Crops.

Table 7. Kharif season cropping planned and actual area sown during 2009.

District	Crop	Target area Crop-wise (ha)	Total areas sown (ha)	% area sown
Kolar	Groundnut	3500	2800	80
	Ragi	15000	8635	57.6
Chickballapur	Groundnut	12500	12203	97.6
	Ragi	10000	9350	93.5
Tumkur	Groundnut	35000	18200	52.7
	Contingent crops		13708	39
	Ragi	20000	19830	99
Chitradurga	Groundnut	33000	17308	52
	Ragi	10000	9850	99
	Maize	20000	19883	99
Haveri	Groundnut	6000	6000	100
	Maize	38000	38000	100
Dharwad	Groundnut	10000	10000	100
	Soybean	12000	12000	100
Total		188000	159546	

On through consultation, Department of Agriculture, University of Agricultural science, Bengaluru, Dharwad, Raichur and ICRISAT arrived at a consensus on identified major crops in the selected 24 target districts of Karnataka considering the historical annual crop statistics published by Directorate of Economics and statistics, Government of Karnataka, for enhancing productivity of major dryland crops in each selected district.

In each district, 25% of the cultivated area under two selected crops was identified in clusters of Sujala watershed villages (Table 7) and farmers were motivated about the project and possible benefits for participating in the technology uptake of the project. Input package kits were provided to the farmers on subsidy to encourage farmers' participation. Initial monsoon on-set rains and good follow-up rainfall helped farmers in Haveri and Dharwad to take up sowings of 100% target area under major crops in the districts (Table 8). However, difficult conditions of low rainfall and long break in the months of June, July and August in Kolar, Chickballapur, Tumkur and Chitradurga were responsible (Table 9) for a suggestion of contingency crop planning to farmers by ICRISAT and DOA and later staggered sowing opportunities in these districts were responsible for non-compliance of groundnut sowing in 100% target area. However the short fall in crop areas were made good with contingency crops by farmers in these districts.

Table 8. Window of sowing opportunities during kharif 2009 for crops in different districts

District	Crop	Sowing window
Chickballapur	Groundnut	4th week of June to 1st week of July, 1st & 2nd week of August
	Finger millet	1st week of July to 4th week of August
Chitradurga	Maize	3rd week of July
	Groundnut	1st week of August
	Finger millet	1st week of August
Dharwad	Groundnut	3rd week of May to 2nd week of June
	Soybean	3rd week of May to 2nd week of June
Haveri	Groundnut	1st week to 3rd week of June
	Maize	3rd week of May to 4th week of June
Kolar	Groundnut	1st to 2nd week of June
	Finger millet	2nd to 4th week of August
Tumkur	Groundnut	2nd week of July to 4th week of July
	Finger millet	25th July to 15th August

Table 9a. Contingency crop planning in *kharif* for *Kolar, Chickballapur and Tumkur (Alfisols)* districts of Karnataka

Main crop	Contingency crop options	Varieties	Remarks
1. Groundnut	Groundnut until first fortnight of August (Ready with seed)	Short-duration groundnut cultivars: ICGV 91114, K 1375, TMV 2, TCGS 28	Pod and fodder still preferred by farmers, hence not willing to switch to other crops
2. Ragi	Raising nursery of ragi for transplanting until September	Short duration variety: L 5 (115 days) and VR 708 (93 days)	Suitable for rainfed crop sowing up to 1st week of August, highly tolerant to neck and finger blast, high yielder of grain and quality fodder
	Raising nursery of ragi for transplanting until September	GPU 26 (90-100 days) and GPU 46	Suitable for rainfed crop sowing up to end of August
Pearl millet as an alternative to ragi	Sowing short - duration pearl millet hybrids and cultivars	HHB 67, ICMV 221, JBV 2 (70-80 crop maturity days)	For grain and fodder
Fox tail millet as an alternative to Ragi	Sowing short-duration foxtail millet (80 days crop maturity)	SR 11 (Gauri) SR 16 (Meera)	for grain and fodder Cultivar is high yielder of grain and fodder, the fodder remain stay-green at harvest
3. Pigeonpea Intercrop	Short-duration pigeonpea sole cropping	ICPL 88034, Prabhat (ICPL 87), UPAS 120 and Manak (<130 days duration)	Problem with blister beetle in Early varieties
	Intercropping vegetable Pigeonpea	ICP 7035 (160-180days duration)	Early harvesting of green pigeon pea as vegetable
	Intercropping *pro-rabi* varieties	Lakshmi (ICP 85063), PUSA 33 (duration 130-150 days)	One month early harvest will suit to delayed monsoon season sowing
4. Short duration legumes and oil seed	Cowpea	KBC 2, TVX 944, v-322	Dual purpose grain legumes
	Black gram	TAU 1, Kargaun, T-9	Short season grain legume
	Horse gram	KBH-1	Legume fodder and grain
	Dolichus	Hebbal Avare 3	Vegetable
	Mung bean	K 158, S 4, Pusa Baisaki (85-90 days), PS -16 (75-80 days)	For grain and fodder
	Cluster beans	Varsha	Vegetables in small areas
5. Short-duration oil seed	Sesame	T 7 (Suma), DS 1	Cash / oilseed crop

Table 9b. Contingency crop planning in kharif for Chitradurga (Vertisols) districts of Karnataka

Main crop	Contingency crop options	Varieties	Remarks
1. Maize (105-120 days)	Maize	Ganga 2, Rohini (80-85 days)	Early maturing amber dent seed
	Sorghum	CSH 14, SPV 1411	Early maturing (95 days) dual purpose varieties
	Proso millet	60-70 days duration	Grain and fodder producing crop
2. Pigeonpea Intercrop	Intercropping vegetable Pigeonpea	ICP 7035 (160-180days duration)	Early harvesting of green pigeonpea as vegetable
	Intercropping *pro-rabi* varieties	Lakshmi (ICP 85063), PUSA 33 (duration 130-150 days)	One month early harvest will suit to delayed monsoon season sowing
3. Soybean	Black gram / Mungbean	TAU 1, Kargaun, T-9	Black gram suits better during these months against yellow mosaic and powdery mildew
4. Sunflower	Sunflower	Morden	Short duration hybrids also does well
	Coriander / cumin	Varieties to identify or local	Cheap input costs and good production on black soils

Table 9c. Contingency crop planning in kharif for Chitradurga (Alfisols) districts of Karnataka

Main crop	Contingency crop options	Varieties	Remarks
1. Groundnut	Groundnut	Short duration groundnut cultivars: ICGV 91114, K 1375, TMV 2, TCGS 28	Pod and fodder still preferred by farmers, hence not willing to switch to other crops
2. Ragi	Raising nursery of ragi for transplanting until September	Short duration variety: L 5 (115 days) and VR-708 (93 days)	Suitable for rainfed crop sowing up to 1st week of August, highly tolerant to neck and finger blast, high yielder of grain and quality fodder
	Raising nursery of ragi for transplanting until September	GPU 26 (90-100 days) and GPU-46	Suitable for rainfed crop sowing up to end of August
3. Pigeonpea intercrop	Intercropping *pro-rabi* varieties	Lakshmi (ICP 85063), PUSA 33 (duration 130-150 days)	One month early harvest will suit to delayed monsoon season sowing
4. Sole pigeonpea	Short duration pigeonpea sole cropping	ICPL 88034, Prabhat (ICPL 87), UPAS 120 and Manak (<130 days duration)	Problem with blister beetle to be controlled with hand-picking in early varieties
5. Short-duration legumes.	Horse gram	KBH 1	Legume fodder and grain
	Dolichus	Hebbal Avare 3	Vegetable
	Mung bean	K 158, S 4, Pusa Baisaki (85-90 days), PS 16 (75-80 days)	For grain and fodder
6. Short-duration oil seed	Sesame	T 7 (Suma), DS 1, Gauri (75 days maturity)	Oil seed cash crop

Field visits and field days

Figure 34a. Farmers gathering on a field day in Haveri.

Figure 34b.Farmers visiting soybean field alongwith JDA Dharwad.

Figure 35a. Mr. Udasi, Minister for public works discussed with farmers on this field day visit.

Figure 35b. ICRISAT scientists visited farmers' fields, to conduct farmers' day in Haveri.

Field days were conducted for groundnut farmers in Kurubaramallapur village on 17 September 2009 and another field day for maize farmers in Kabur village of Haveri district on 12th September by DoA and ICRISAT successfully for more that 150 farmers**.** Farmers' day was arranged in Haveri to showcase the crop performance for improved management by ICRISAT jointly with DoA in Haveri during the month of September however due to flash floods at that time it was differed.

ICRISAT participated in Dharwad Krishimela

University of Agricultural Sciences, Dharwad jointly with ICRISAT and Departments of Agriculture and Horticulture, Karnataka organized a Krishimela on 19th September 2009. ICRISAT stall at the Krishimela was inaugurated by the minister for Agriculture, Mr

Ravindranath along with Dr. JH Kulkarni, Vice-Chancellor of the university of Agricultural sciences, Dharwad. ICRISAT displayed posters of interest to farmers on technologies and distributed brochures in Kannada on ICRISAT research information. About 50,000 farmers attended the Krishimela during the four-day program; farmers were particularly interested in ICRISAT's chickpea and sorghum cultivars suited for immediate rabi season.

Figure 36. ICRISAT visiting scientist and Scientific officers participated in Krishi Melaon 19th September 2009, Dharwad.

Assist in setting up of Analytical Laboratory

Department of Agriculture, Government of Karnataka has shown interest to upgrade their Soil Testing Laboratories in order to meet the growing demand for soil analysis under Bhoo Chetana initiative. ICRISAT has commitment in this project, to assist DoA based on its own expertise to set up soil analytical laboratory that can meet the standards and also to handle large number of samples analyses.

Dr. K L Sahrawat, Visiting scientist and Mr. K V S Murthy, Lead Scientific Officer visited soil testing laboratories of Department of Agriculture at Bengaluru and Mandya on 1st and 2nd June with clear objectives as:

- *To assess the capacity of the laboratories in Bangalore and Mandya to undertake a large scale analysis of soil samples for macro, secondary and micro-nutrients for the Bhoo Chetana project between GOK and ICRISAT on Productivity Enhancement and*
- *To suggest needs for the up-gradation of the laboratories in case the laboratories did not have the capacity at the present time to undertake the analysis of a large number of soil samples for such analysis (pH, organic C, macro, secondary nutrient sulfur and micro-nutrients including boron and zinc).*

Figure 37a. DoA officials visit to Charles Renard Analytical services laboratory (CASL), ICRISAT

Figure 37b. DoA laboratory staff visit to CASL at ICRISAT to familiarize setup and upgrade laboratory facilities

ICRISAT scientists evaluated the facilities guided by senior staff of DoA and had discussions with Dr. A. Rajanna, Director of Agriculture. They also submitted their assessment and recommendations for upgradation and integration of required facilities with these laboratories (Appendix C).

Later on, a team of laboratory staff of DoA also visited CASL at ICRISAT and had a grasp of the facilities in ICRISAT Analytical laboratory guided by Dr Sahrawat. Brief reports were submitted by the DoA staff after their visit to ICRISAT laboratories (Appendix D).

Figure 38a.Training of DoA staff on stratified soil sampling in villages

Figure 38b.Hands-on training of farmers on soil sampling in a village.

Table 10. Collection of soil samples in nine selected districts of Karnataka for soil nutrient analysis.			
S.No.	**Name of the district**	**No of villages soil sampling completed by ICRISAT**	**Total number of farmers' fields sampled**
1	Bidar	120	2400
2	Bijapur	140	2800
3	Gulbarga	284	5680
4	Raichur	171	3420
5	Gadag	68	1360
6	Bangalore Rural	228	4560
7	Davangere	157	3140
8	Chamarajnagar	83	1660
9	Hassan	522	10440
Total	**9 districts**	**1773**	**35460**

Soil sampling for nutrient status in nine target districts

During the year, with good coordination from DoA staff in respective districts, we conducted village meetings for farmers and emphasized the need of assessing soil nutrient status for balanced nutrient application. Hands-on trainings were organized to groups of farmers, on scientific methods of collecting representative soil samples from their fields in the village. With the active participation of farmers and DoA staff coordination, ICRISAT staff collected 35460 samples in 1773 villages of nine district from June to December as given in Table 10. In each district, 20% of the villages were selected and in each village 20 representatives fields were sampled based on stratified sampling technique considering topo-sequence of the fields in a watershed village. All these samples were transported to Hyderabad, processed by grinding, sieving and analyzing these samples in the ICRISAT laboratory for their nutritional status.

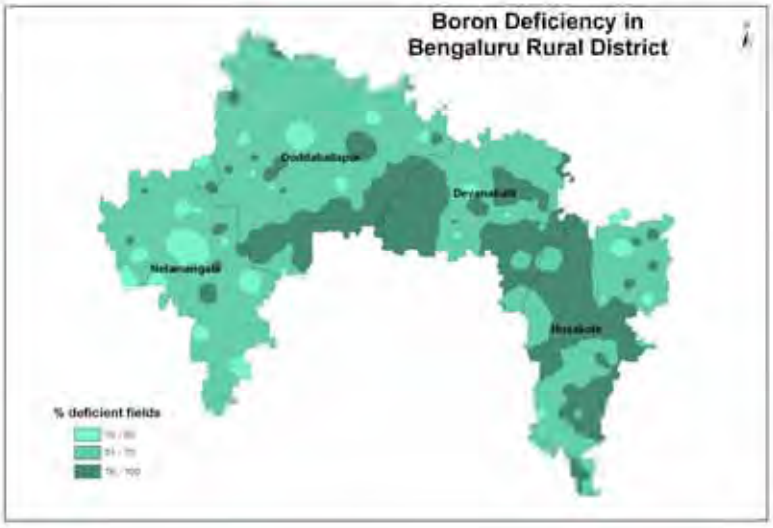
In order to develop suitable and timely recommendations, 50% of the samples from each village were analyzed. The results of soil samples analyzed from three districts (Bengaluru rural, Chamarajnagar and Raichur) are presented in Table 11. The results indicate Organic carbon which is an indicator for nitrogen supply, is deficient in about 70% of soils of Bengaluru rural, Chamarajanagara and Raichur. Olsen's-P is sufficient in soils of Bengaluru rural and it is deficient in less than 50% of the fields in Chamrajnagara and Raichur. Sulfur

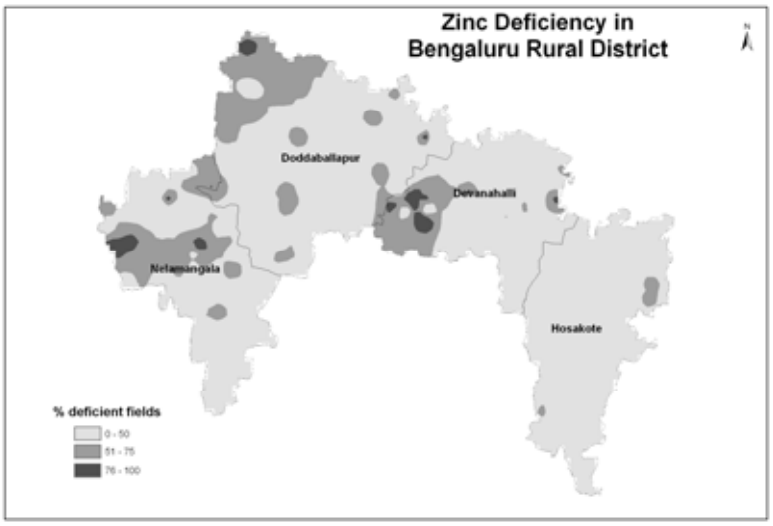
deficiency is pronounced in more than 90% of fields in all taluks of Bengaluru rural and Chamarajanagara, whereas it was deficient in 70% fields in all taluks of Raichur except Sindhanur taluk. Boron deficiency is recorded in the range of 50%-80% fields in all taluks of Bengaluru rural and Chamarajanagara, whereas its deficiency is observed in the range of 12% to 63% in different taluks of Raichur.

Table 11. Soil nutrient status of farmers' fields in different taluks of three districts in Karnataka.

District	Taluk	Percent of farmers' fields deficient in a nutrient					
		OC	P	K	Sulfur	Boron	Zinc
Bengaluru_R	Devanahalli	48	9	16	97	78	40
	Doddaballapura	73	19	33	95	68	39
	Hoskote	81	15	39	88	71	15
	Nelamangala	82	21	29	97	58	47
Chamaraja nagara	Chamarajanagara	78	47	1	87	59	47
	Gundlupete	72	40	2	92	49	76
	Kollegaala	69	28	9	89	67	68
	Yellanduru	55	30	0	100	70	65
Raichur	Deodurg	85	54	6	70	46	84
	Manvi	64	54	4	84	52	86
	Lingsugur	79	49	0	70	18	85
	Raichur	77	45	14	73	63	78
	Sindhanur	40	31	0	26	12	53

Zinc deficiency is observed in all taluks of Chamarajanagara and Raichur with more than 50% of farmers' fields analyzed deficient for this nutrient. However, zinc deficiency is low, in the range of 15% to 47% of farmers' fields in taluks of Bengaluru rural. Employing GIS based extrapolation techniques, district-wise nutrient status maps of three districts (Figure 39, 40, 41) are presented below and other nutrient status maps are attached (Appendix G) for the use of DoA staff and Policymakers.





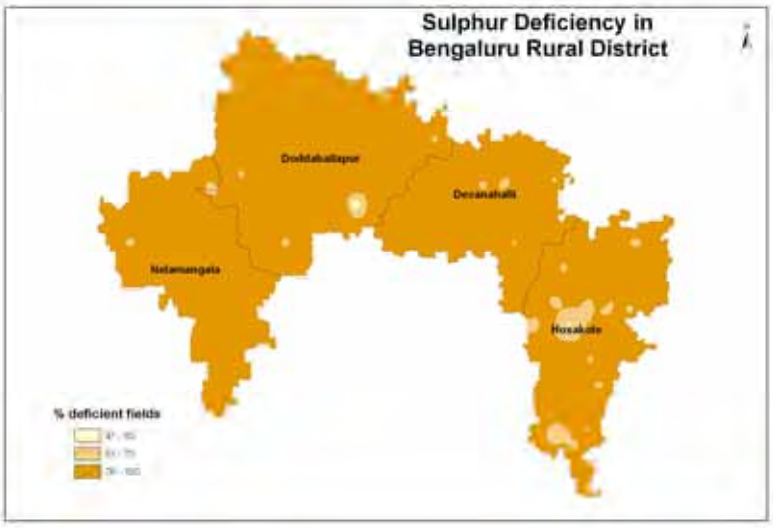
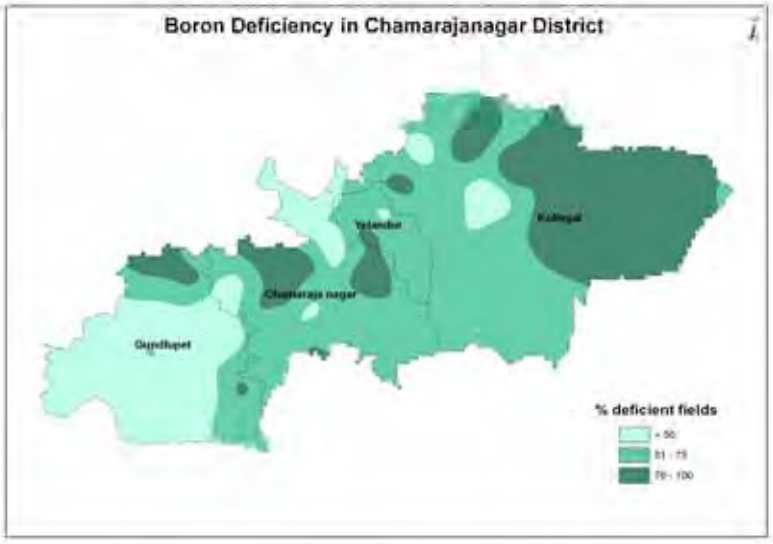
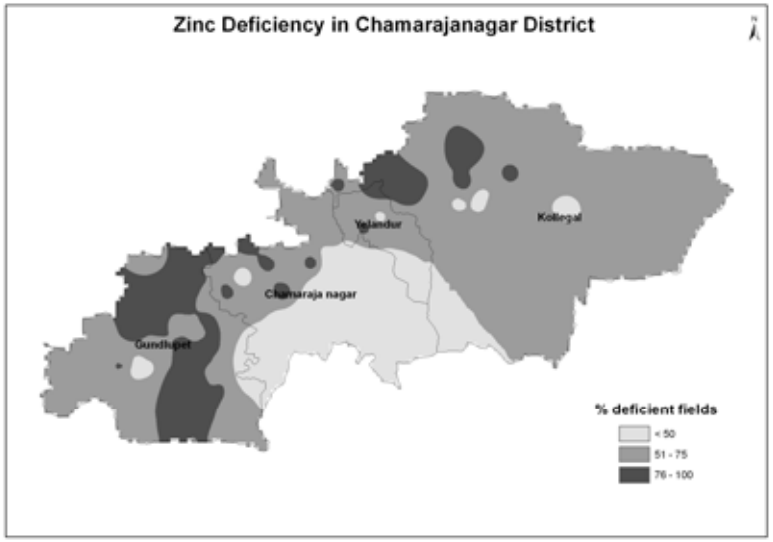


Figure 39. Bengaluru rural district maps on soil nutrient status of boron, zinc and sulfur





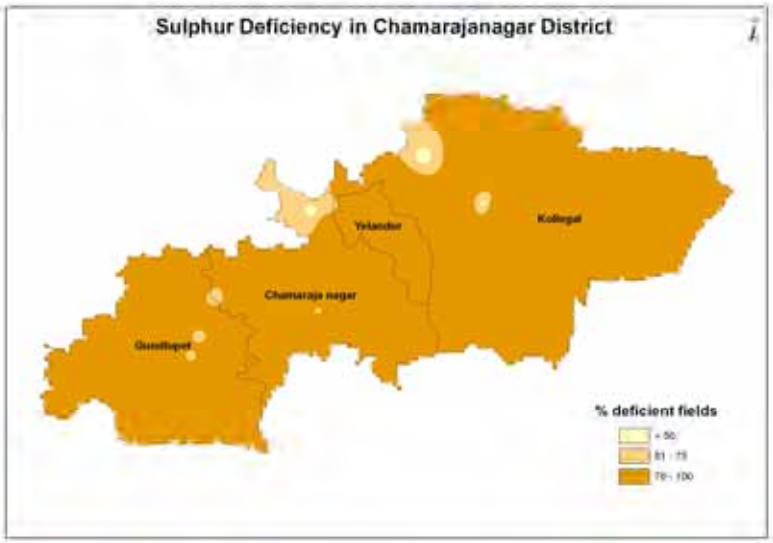
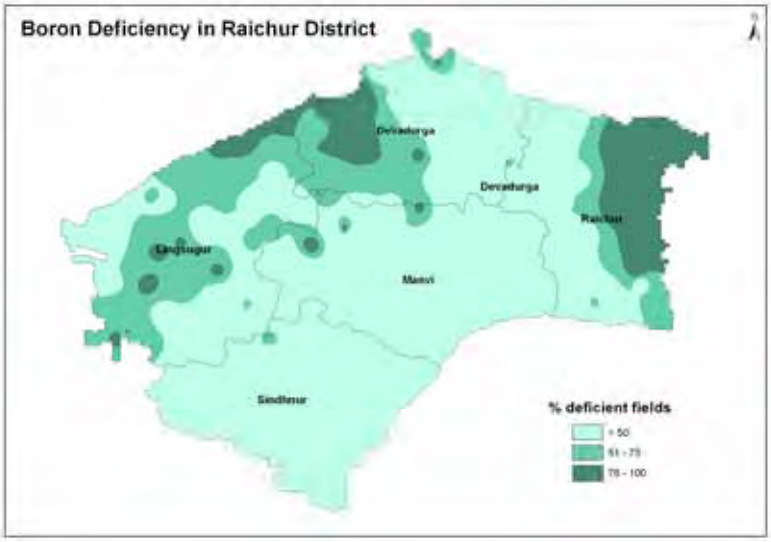
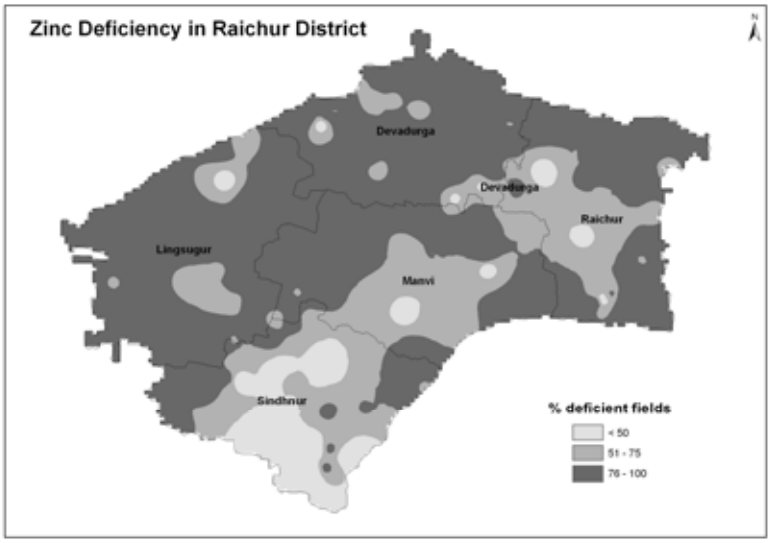


Figure 40. Chamarajanagara district maps on soil nutrient status of boron, zinc and sulfur.





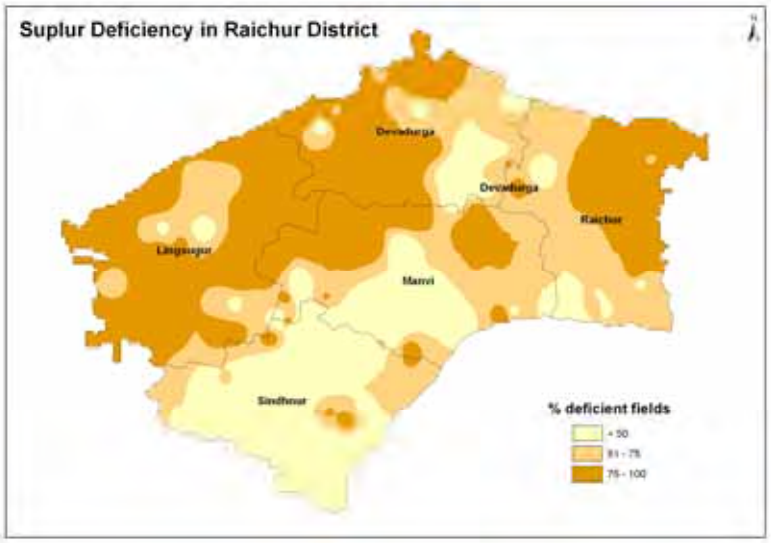


Figure 41. Raichur district maps on soil nutrient status of boron, zinc and sulfur.

Crop cutting experiments for crop yield estimation: A Joint Evaluation

Directions were issued from the Directorate of Agriculture, Government of Karnataka, Bengaluru to all 6 JDAs of the respective districts to conduct crop cutting experiments in Bhoo chetana project area for estimation of crop yields and outcomes by joint participation of DoA, ICRISAT and local KVKs staffs.

Accordingly ICRISAT staffs in each district were advised to follow statistically valid sampling procedures along with joint participation of department officials and farmers for proper (unbiased) estimation of crop yields as follows:

- In 20% of the total target villages, staffs were advised to plan for crop sampling keeping in mind the spread of selected villages in a cluster.
- In each selected village, sampling was done on 5 or more farmers' fields (Appendix E) both in improved management along with micronutrients applied plot as well as farmers' management plot in each of the farmer's field.
- Minimum area of crop sample collected shall be 9 sq meters for ragi and 10.8 sq m for groundnut depends on row spacing. Three or five such samples (replicated) were collected from both treatments (improved and farmers' practice) of one farmer's field. A total of six or 10 samples (1x2x3 or 5) were collected from one farmer's field.
- For each sample, ICRISAT and DoA staff jointly recorded total fresh weight of the whole plant sample and collected 6-8 plants from each of the replicated three samples to make it composite sub-sample and recorded the fresh weights.
- Fresh weights of separated pods (heads) and stalk weights of the sub-sample were recorded. By this process, we collected six (ten) weights for bigger whole plant samples, two sub-samples from each farmer's field; and each sub-sample whole plant weight separated into two weights for stalk and pod (head). Altogether, 12 (16) fresh weights for two treatments of a farmer's field were recorded.

- ICRISAT staffs were instructed to collect crop samples with care and accuracy in coordination with DoA officials (Figure 42), sun-dry the sample materials (groundnut) before dispatching samples to ICRISAT, as fresh samples (groundnut) may get spoiled in transit.
- On transporting the samples to ICRISAT, Patancheru, plant samples were oven-dried at 65^0c to completely dry the plant material, to estimated moisture percent and threshed for crop yields estimation.

Figure 42. Maize crop sampling in watersheds of Haver and groundnut crop sampling in Chickballapur districst.

Post rainy season 2009

Rabi season rainfed crop planning

Table 12. Rabi cropping planned and area of sowing completed in different districts during rabi season 2009.

District	Taluk(s)	Crop (s)	Target Area (ha)	Area covered (ha)
Chitradurga	Chitradurga, Hiriyur	Chickpea	5840	5302 (91.5%)
Dharwad	Dharwad, Hubli, Kundagol, Kalghataki, Navalgund	Rabi sorghum	18000	13990 (77.72%)
	Dharwad, Hubli, Kundagol, Navalgund	Chickpea	16500	16500 (100%)
Haveri	Haveri, Hirekerur, Savanur	Sunflower	3000	2654 (88.47%)
	Haveri, Hirekerur, Savanur, Shiggao, Ranebennur, Byadagi	Rabi Sorghum	16000	14550 (90.93%)

In Chitradurga, Haveri and Dharwad, vertisol areas provide opportunity for post rainy season rainfed crops based stored soil moisture in the profile. Some unseasonal rains during November and December also add some moisture for crop requirements. Predominent rabi

season crops in the area are chickpea, rabi sorghum and sunflower with life supporting irrigation. The area planned with these crops for production enhancement is given in table 12 below. DoA and ICRISAT staff coordinated efforts were rendered to support farmers by supplying inputs like seed, fertilizers and insecticides timely in the mission project and were successful in achieving target upto 78% in case of late sown sorghum, however wit early sown soybean chickpea and sunflower 90 to 100% targets of sowing was achieved.

Nutrient recommendations were prepared by ICRISAT based on the nutrient status of soils in each taluk. Nutrient recommendations of N, P, K for different crops were based on DoA data and boron, zinc and sulfur recommendations were based on ICRISAT evaluations in the farmers' fields.

These recommendations were transformed into quantities of commercially available grades of fertilizers (Table 13) and were suggested to farmers for rabi crops.

Table 13. Fertilizers recommended for rabi crops in Chitradurga, Haveri and Dharwad.

Crop	Fertilizers recommended (kg ha^{-1})					
	Urea	**DAP**	**MoP**	**Gypsum**	**Agribor***	**$ZnSO_4$**
Rabi sorghum	90	55	0	200	2.5	50
Chickpea	0	55	0	200	2.5	50
Sunflower	30	110	50	200	2.5	50
Rabi groundnut	10	110	40	200	2.5	50

** If borax is applied in stead of Agribor, quantity needs to be doubled*

MONITORING AND EVALUATION BY STATE COORDINATION COMMITTEE (SCC)

State level coordination committee is a high power committee constituted with state level senior administrators of government of Karnataka, directors of department of agriculture and watershed development department, vice-chancellors of the three universities of agriculture in Bengaluru, Raichur and Dharwad, Economic advisor to Chief Minister, Karnataka and project coordinator from ICRISAT.

The committee met frequently during the beginning of the season to take stock of inputs procurement and distribution arrangements, monsoon progression and crop sown statistics.

To fetch complete information from cluster villages, taluks to district, a checklist of activity progress weekly-report was prepared by ICRISAT (Appendix E) and ensured follow-up weekly reporting synchronized from JDA office and ICRISAT staff.

State level committee reviews the progress of project activities and interacts with district level officials instantaneously through vido-conferencing and take stock of solutions to address problems arising in the field and issue directives for each district (Figure 43a.).

Mr. S A Ravindranath, Minister of Agriculture attended a district level committee meeting (Figure 44a) and found out the progress of implementation and success achieved in enhancing the crop yields of ragi and groundnut during kharif season.

Figure 44a. A review meeting in Kolar by Mr.S.A.Ravindranath, Minister of Agriculture.

Figure 44b. Joint field visit by JDA, Dharwad to soybean field and discussions with farmers

State level coordination committee members attended district coordination committee meetings, conducted field visits along with JDA of the district (Figure 43b, 44b) to monitor and on-board guidance to problems in the district.

Figure 43a. State level coordination committee (SCC) review meeting through video conference in Bengaluru

Figure 43b. Field visit by Mr.Nataraj, JDA, Chikballpur and ICRISAT staff to Ramanapadi observing groundnut pods, root growth.

RESULTS OF PARTICIPATORY CROP YIELD ESTIMATION

Groundnut

Groundnut is one of the major rainfed crops during kharif season in all six selected districts. Crop target areas sown were in the range of 50% to 97% under Bhoo Chetana for productivity enhancement of the crop in Kolar, Chikballpur, Tumkur and Chitradurga as the rainfall was low in June-July, while 100% of the target area for the crop was sown in Haveri and Dharwad with good monsoon rainfall in these districts. Groundnut yield was affected by intermittent long dry spells in August and Octber in Kolar and Chickballapur and during September in Chitradurga district.

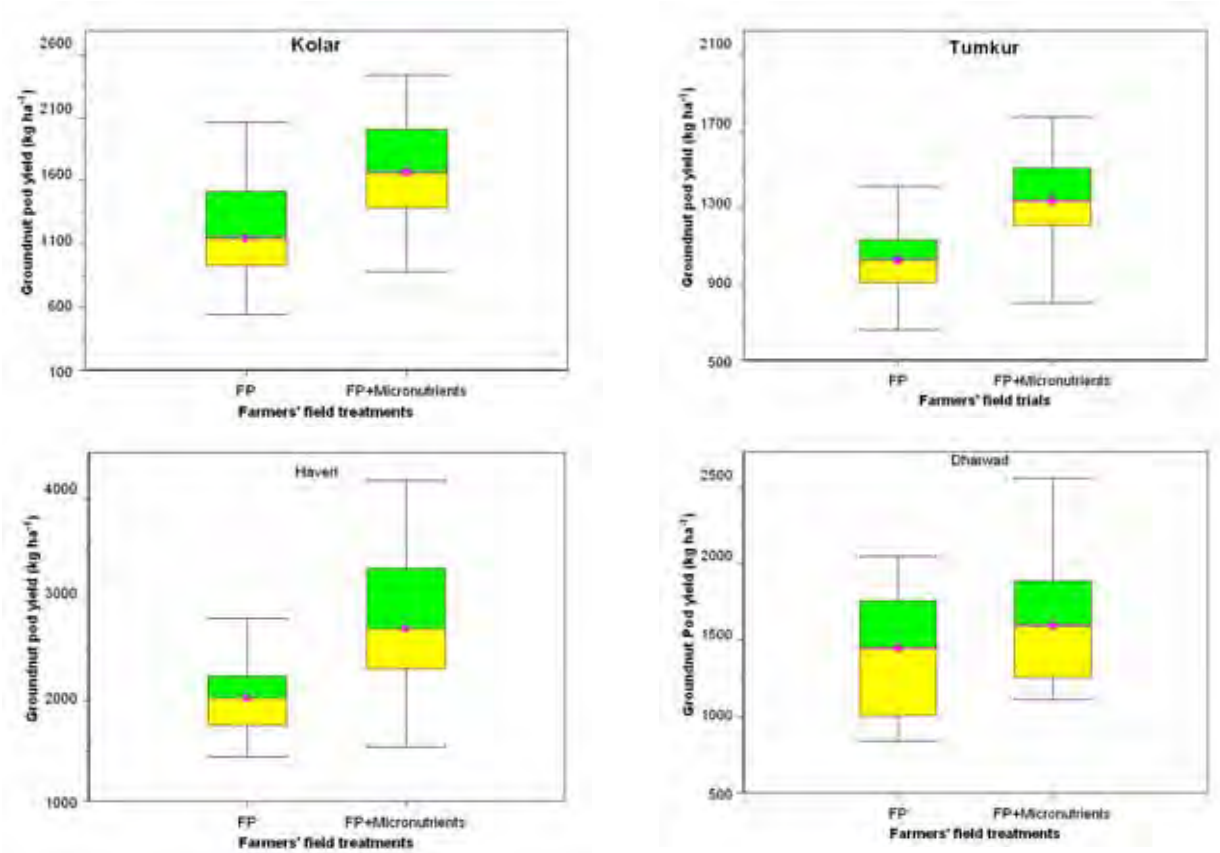


Figure 45. Box plots of groundnut pod yields in farmers' fields of Kolar, Tumkur, Dharwad and Haveri districts (clockwise from top left) indicating median, range and statistical distribution of yields.

Groundnut pod yield and total dry matter (TDM) were estimated from a total of 317 farmers' fields in Chickballapur (110), Chitradurga (40), Dharwad (11), Haveri (15), Kolar (50) and Tumkur (91) to asses over all performance of improved management and micronutrient application (IM) compared to farmers' management (FM).

In Kolar, groundnut pod yield estimated from FM were in the range of 540-2070 kg ha^{-1} with a mean of 1190 kg ha^{-1}, as the median (1145 kg ha^{-1}) which indicates 50% of farmers' yields were above this value. These yields are compared to pod yield with IM (mostly ICGV 91114) in the range of 880-2440 kg ha^{-1}, with a mean of 1660 kg ha^{-1}.

The median (1665 kg ha^{-1}) which indicates 50% of farmers' harvested pod yields were more than this value (Figure 45, top left), followed normal distribution pattern in Kolar district. In this district, weighted mean pod yield increase was 41% with improved management and micronutrient application compared to farmers' management.

In Chickballapur, groundnut pod yields estimated from FM were in the range of 300-650 kg ha^{-1} with a mean of 460 kg ha^{-1} and the median (437 kg ha^{-1}) which indicates 50% of farmers' yields were above this value. These yields are compared to pod yield with IM (mostly ICGV 91114) in the range of 430-950 kg ha^{-1} with a mean of 660 kg ha^{-1} and the median (582 kg ha^{-1}) in Kolar district. In this district, weighted mean pod yield increase was 42% with improved management and micronutrient application compared to farmers' management. Even though, yield increase was conspicuous with good management, under both managements, groundnut pod yields were much lower than one tone per hectare due to low and poor distribution of rainfall.

In Tumkur, groundnut pod yields estimated from FM were in the range of 660-1410 kg ha^{-1} with a mean of 1030 kg ha^{-1} and the median (1030 kg ha^{-1}), which is compared to pod yield with IM (mostly ICGV 91114) in the range of 800-1980 kg ha^{-1} with a mean of 1350 kg ha^{-1} and the median (1340 kg ha^{-1}) followed normal distribution statistically (Figure 45, top right). In this district, weighted mean pod yields increase was 32% with improved management and micronutrient application compared to farmers' management.

In Chitradurga, groundnut pod yield estimated from FM were in the range of 410-1390 kg ha^{-1} with a mean of 730 kg ha^{-1}, as the median (640 kg ha^{-1}) which indicates 50% of farmers' yields were above this value. These yields are compared to pod yield with IM (mostly ICGV 91114) in the range of 670-1870 kg ha^{-1} with a mean of 760 kg ha^{-1} and the median (770 kg ha^{-1}) indicating a normal distribution. The weighted mean pod yield increase for the district was 32% with improved management and micronutrient application compared to farmers' management.

In Haveri, groundnut pod yield estimated from FM were in the range of 1440-2820 kg ha^{-1} with a mean of 2000 kg ha^{-1}, with median (2020 kg ha^{-1}) which indicates 50% of farmers' yields were above this value. These yields are compared to pod yield with IM (mostly GPBD 4 cultivar) in the range of 1540-4190 kg ha^{-1} with a mean of 2830 kg ha^{-1} and the median (2670 kg ha^{-1}) showing skewed distribution (Figure 45, bottom left) in case of the upper 50% of farmers' yields. Mean difference between FM and IM treatment was larger than 800 kg ha^{-1} and the over all weighted mean pod yields increase for the district was 41% with improved management and micronutrient application compared to farmers' management.

In Dharwad, groundnut pod yield estimated from FM were in the range of 840-2050 kg ha^{-1} with a mean of 1410 kg ha^{-1}, as the median (1445 kg ha^{-1}) which indicates 50% of farmers' yields were above this value and compared to pod yield with IM (mostly GPBD 4 cultivar) in the range of 1100-2560 kg ha^{-1} with a mean of 1640 kg ha^{-1}, as the median (1590 kg ha^{-1}) shows a skewed distribution lower 50% of farmers' yields (Figure 45, bottom right). The weighted mean pod yield increase for all taluks in the district was 32% with improved management and micronutrient application compared to farmers' management.

Table 14. Groundnut pod yield increase recorded in farmers' fields with improved management and micronutrients application compared to farmers' management in different taluks of six districts during Kharif 2009.

Districts	Taluk	Farmers' practice (FM)		IM+ micronutrients		% Yield increase
		Pod (kg ha^{-1})	TDM (kg ha^{-1})	Pod (kg ha^{-1})	TDM (kg ha^{-1})	
Chickballapur	Bagepalli	550	1240	800	1660	45
	Chintamani	430	860	650	1080	51
	Gudibande	410	950	560	1240	37
Chitradurga	Chellakere	550	1000	680	1180	24
	Hiriyur	1210	2020	1770	2950	46
	Molakalmor	660	1210	710	1470	18
Dharwad	Kundgol	1600	2680	1940	3340	21
	Hubli	850	1740	1290	2760	52
Haveri	Savanur	1770	3800	2470	4170	39
	Shiggaon	2460	4540	3570	5270	45
Kolar	Mulabagal	1190	2940	1670	3920	41
Tumkur	Pavagada	1100	3230	1460	3770	32
	Madhugiri	1000	2220	1320	3010	32

Groundnut pod yields increased across all taluks of six districts (Table 14) in the range of 32% to 41%, which varied from a lowest increase of 18% in Mulkalmur taluk of Chitradurga

to the highest yield increase of 52% in Hubli taluk of Dharwad district. Although considerable yield increase was seen due to improved management, correcting nutrient deficiencies across all groundnut growing taluks in these districts, the variable increase was due to seasonal and temporal variability in rainfall affecting crop growth in rainfed systems.

Ragi (Finger millet)

Ragi is a major food crop in Kolar, Chickballapur, Tumkur and Chitradurga districts. Target area of ragi sowings were achieved between 90% and 99% in all the selected districts except in Kolar (58%), even after delayed monsoon rains. Due to non-availability of improved cultivars L 5 and MR 1 seed, DoA also recommended another improved variety GPU 28 for cultivation and seeds were supplied to farmers.

Table 15. Ragi grain yield increase in farmers' fields with improved management and micronutrients application compared to farmers' management in different taluks of Chitradurga, Kolar and Tumkur districts during Kharif 2009.

Districts	Taluks	Farmers' practice (FP)		IM+ micronutrients		% Yield increase
		Grain (kg ha^{-1})	TDM (kg ha^{-1})	Grain (kg ha^{-1})	TDM (kg ha^{-1})	
Chitradurga	Hosadurga	1890	7300	2550	9100	35
Kolar	Bangarpet	1630	5060	2690	7540	65
	Kolar	1690	5320	2810	8180	66
Tumkur	Chikkanaya kanahalli	1380	4510	2070	6140	50
	Gubbi	1490	5240	1910	6670	28
	Kunigal	2110	7090	2930	9630	39

Response of Ragi to improved management in terms of grain and fodder yield was considerably higher compared to farmers' management in all taluks of three districts and increase varied from 28% in Gubbi taluk of Tumkur to as high as 66% in Kolar taluk of Kolar district (Table 15). Yield estimations were made from farmers' field sampling in Chitradurga (20 fields), Kolar (93 fields) and Tumkur (53 fields). About one ton of grain yield and 1.5 tons of fodder per hectare was harvested by farmers adopting improved management with along with balanced nutrition. Weighted mean grain yield increase across three districts varied from 35% to 66%.

Maize

In Chitradurga and Haveri, farmers grow improved cultivars and private hybrids available in the markets, with high inputs of N, P and K, however ignore the secondary and micronutrient requirements to the crop. In these districts, micro- and secondary nutrients application to correct deficiencies and moisture conservation methods were the technologies ICRISAT promoted under improved management.

Table 16. Maize grain yield increase recorded in farmers' fields with improved management and micronutrients application compared to farmers' management in different taluks of Chitradurga and Haveri districts during Kharif 2009.

Districts	Taluk	Farmers' practice (FP)		FP + micronutrients		% Yield increase
		Grain (kg ha^{-1})	TDM (kg ha^{-1})	Grain (kg ha^{-1})	TDM (kg ha^{-1})	
Chitradurga	Chitradurga	4750	9530	6840	13650	44
	Holalkere	6410	13260	7840	17380	22
Haveri	Hirekerur	5440	9480	7900	12940	45
	Haveri	5820	7610	7960	10230	37
	Ranebennur	4940	6420	7460	9700	51

In Chitradurga, it was very encouraging for farmers to achieve yield increase between 22% and 45% in different taluks (Table 16) of Chitradurga, with balanced nutrient management and reduced costs on higher N and P fertilizers application.

Yield estimations were made from crop sampling in 56 farmers' field in Chitradurga and from 89 fields in Haveri. Farmers additionally harvested grain yield of 1.5 to 2.5 tons ha^{-1}, besides 3.5 to 4 tons ha^{-1} fodder additionally with improved management "balanced nutrition" compared to grain and fodder yields with farmers' management. In Chitradurga district, maize grain yield ranged between 3790 kg ha^{-1} and 6780 kg ha^{-1} and weighted mean grain yield was 5080 kg ha^{-1} in farmers' management compared to grain yields ranged between 4820 kg ha^{-1} and 8070 kg ha^{-1} and the weighted mean grain yield was 7040 kg ha^{-1} with improved management.

In Haveri, maize grain yield increase in farmers' fields with improved management was between 37-51% in different taluks (Table 16). Maize grain yields ranged between 4110 kg ha^{-1} to 5680 kg ha^{-1} and the weighted mean grain yield was 5320 kg ha^{-1} (median of 5390 kg

ha^{-1}) with farmers' management. Whereas maize grain yields harvested ranged between 6010 kg ha^{-1} to 9750 kg ha^{-1} and weighted mean grain yield was 7800 kg ha^{-1} (median 7650 kg ha^{-1}) with improved management. Yields recorded followed a normal distribution in both treatments (Figure 46). On an average, farmers harvested an additional grain yield of 1.5 tons and 3 tons of fodder additionally with improved management "balanced nutrition" compared to grain and fodder yields with farmers' management.

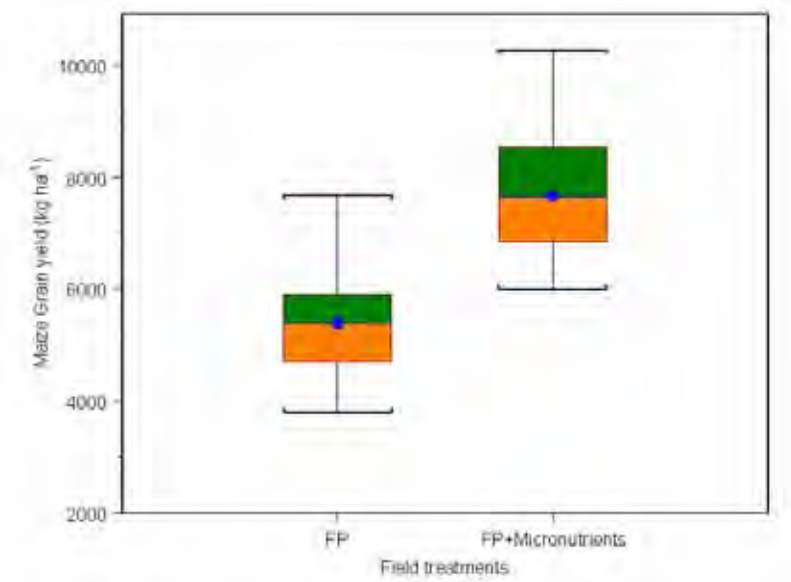


Figure 46. Maize grain yields indicating median, range and distribution depicted in box plots with FM and IM treatments in farmers' fields of Haveri district.

Soybean

In Dharwad, farmers in Dharwad and Kalaghatagi taluks prefer soybean as a commercial crop during kharif season. Through Sujala-ICRISAT initiative, farmers chosen JS 93-05 along with JS 335 as improved varieties of soybean and seeds of these cultivars were provided to farmers for increased productivity in Bhoo Chetana. Soybean yield estimations were made through crop sampling from 71 farmers' fields of Dharwad and Kalaghatagi taluks in Dharwad district. Grain yield estimates from farmers' fields ranged between 1110 and 2430 kg ha^{-1} with overall weighted mean of 1580 kg ha^{-1} from farmers' managed plots, whereas grain yields obtained by farmers with improved management were in the range of 1480 to 2990 kg ha^{-1} with overall weighted mean of 2190 kg ha^{-1} for the district. However, grain yields from farmers' management were skewed towards lower values from the median, whereas soybean grain yield with improved management skewed towards upper side above the median (Figure 47) indicating the bias upper shift of 50% of farmers' crop yields with

improved management. Weighted mean grain yield increase of soybean was estimated at 39% in the district.

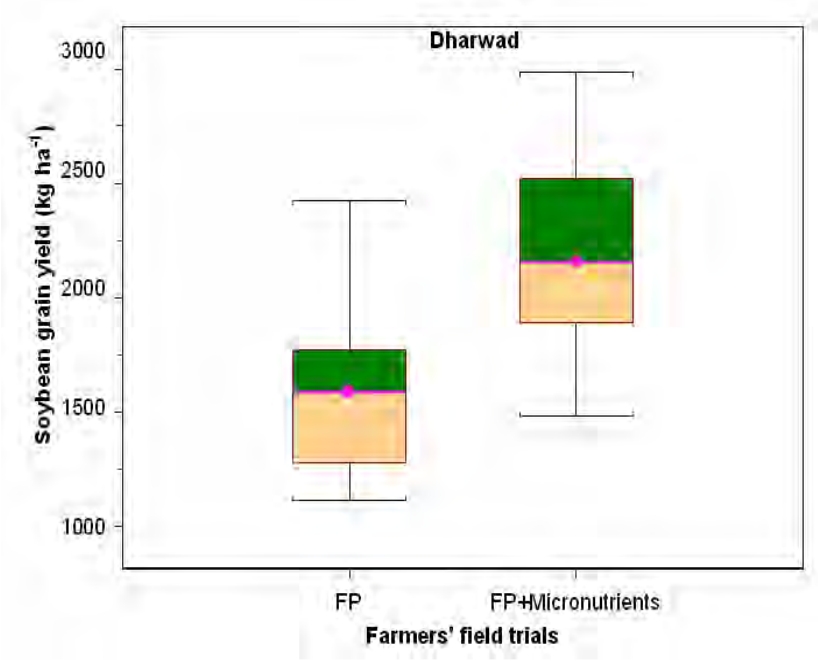


Figure 47. Soybean grain yields indicating median, range and distribution depicted in box plots with FM and IM treatments in farmers' fields of Dharwad district.

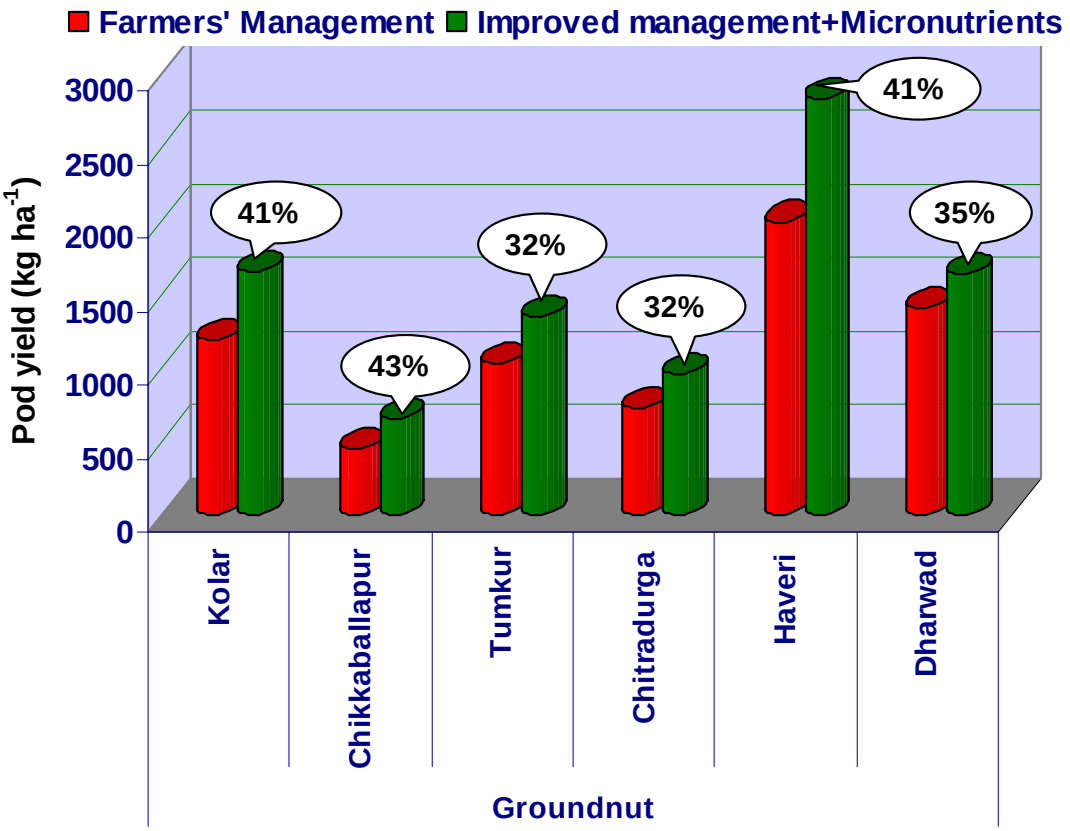


Figure 48. Groundnut pod yield increase (district-wise) with improved management compared to farmers' management in six districts of Karnataka during kharif 2009.

As a summary of the productivity enhancement efforts in the first year under Bhoo Chetana mission mode project during kharif 2009, the consortium emerged with success of achieving productivity enhancement in the range of 32%-66% with four major crops in selected in six districts (Figures 48,49) of Karnataka, even when June, July and September rain fall was unfavourable to crop production in some of these districts

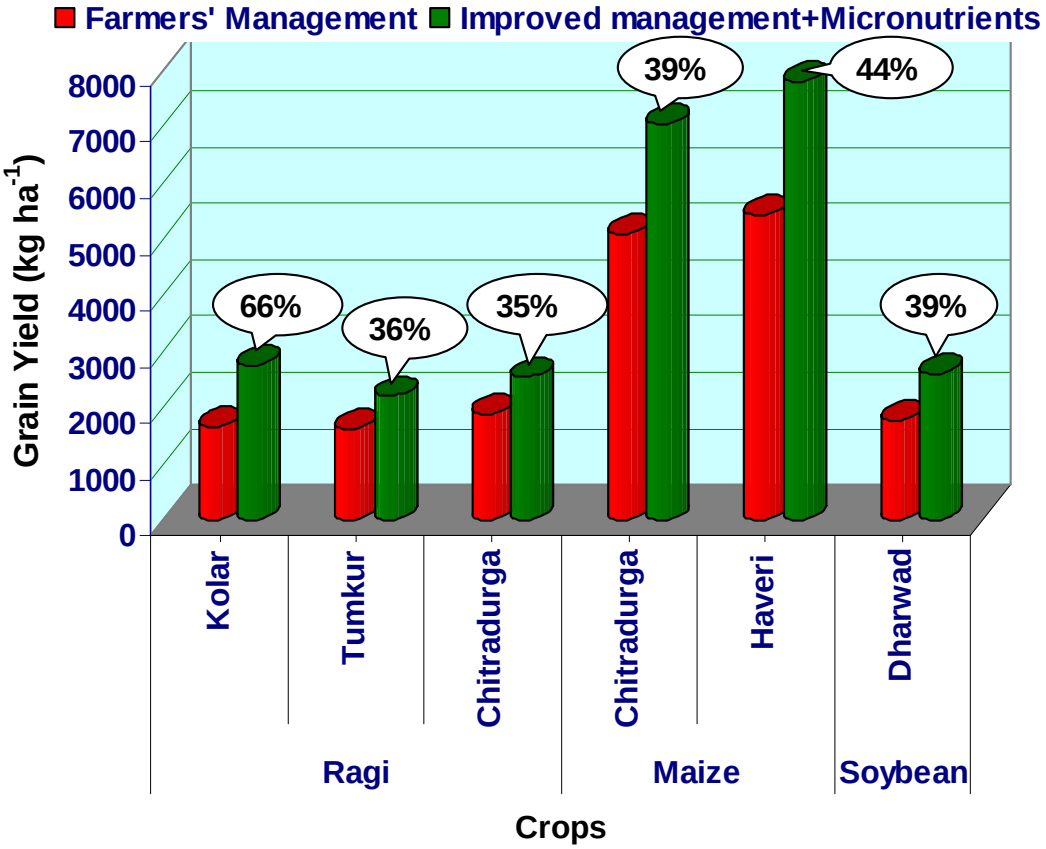


Figure 49. Grain yield increase in selected crops (district-wise) with improved management compared to farmers' management in five districts of Karnataka during kharif 2009.

Table 18. District-wise crop yield increase in farmers' fields with improved management compared to farmers' management under Bhoo chetana project, 2009.

Crop	District	Farmers' Management	Improved management + Micronutrients	% yield increase
Groundnut	Kolar	1190	1660	41
	Chickballapur	460	660	43
	Tumkur	1030	1350	32
	Chitradurga	730	960	32
	Haveri	2000	2830	41
	Dharwad	1410	1640	35
Ragi	Kolar	1660	2750	66
	Tumkur	1630	2210	36
	Chitradurga	1890	2550	35
Maize	Chitradurga	5080	7040	39
	Haveri	5420	7800	44
Soybean	Dharwad	1580	2190	39

Qualitative Impacts of Technology Interventions

In groundnut, shelling percentage has improved in the range of 2% to 7% in four districts for which data is available. Due to application of micronutrients with improved management treatment, their availability helped pod filling considerable at that crop stage and fully-filled pods are responsible for shelling percentage or out-turn in market parlance. This variation has considerable value to the farmer, as he sell groundnut pods in the market higher shell percentage fetches good price for the produce.

Table 19. Effect of micronutrients on groundnut pod filling with improved management compared to farmers' management in different districts of Karnataka.

District	FM	IM+micronutrients
	% Shelling	% Shelling
Haveri	67.8	74.9
Dharwad	57.7	59.2
Kolar	65	65.3
Tumkur	64.9	65.5

It was observed during crop growth by farmers and DoA officials that root growth and tillering were profuse in ragi with improved management compared to farmers' management in Chickballapur as shown in Figure 50a.

Figure 50a. A Field facilitator in sedlagatta taluk exhibiting ragi crop with profuse rooting with IM and low rooting with FM treatments to JDA, Chickballapur.

Figure 50b. A Farmer from Haveri exhibiting fully-filled cobs with IM and semi-filled maize cobs with FM treatments.

In Haveri, farmers exhibited fully-filled maize cobs from his field where improved management was practiced and he expected during the season a harvest of seven ton per hectare crop.

LESSONS

1. Communities can be effectively organized and utilized for increasing productivity of dryland agriculture.

2. All the incentivized inputs must be bundled together as a package else farmers are tempted to go for seeds etc., which they know.

3. Timely availability of inputs must be ensured.

4. Early identification of target villages, beneficiaries, lead farmers, facilitators and their training is critical for the success.

5. New technology inputs like micronutrients and improved seeds must be made available as a package well in advance of the monsoon and kharif season sowings for farmers to adopt and reap the benefits of the technologies.

6. Frequent meetings of the SCC facilitated the mission project and helped in overcoming the bottlenecks to certain extent.

7. Internalization and institutionalization of program has benefitted the Mission in few districts and impacts can be improved further.

8. Scientific approach and technical support enabled dryland farmers to enhance crop productivity significantly (32 to 66%).

9. Supply chain for quality inputs need to be strengthened and put in place ahead of the beginning of the season i.e., April end for northern Karnataka districts Mission project need to be treated as Mission for which team building to enhance commitment by one and all calls for attitudinal change.

10. Clear and timely flow of written communication to districts need to be ensured for timely actions.

11. Timely and well ahead planning increased success and last minute fire fighting operations only built pressure without clear results.

12. Timely release and availability of funds to districts enhanced commitments of staff which contributed for enhanced impacts.

13. Development of Seed banks by farmers' groups within villages help farmers to get quality seeds of their choice variety at cheaper rates, also help to certain extent use of high yielding varieties to increase productivity when invests on costly inputs like nutrients is hard to afford by risk averse farmers.

14. In the event of unfavourable and delayed monsoon conditions, farmers not only need to understand the contingency crop planning which was given, but they should be provided with some mitigation options if they chose to grow their favourite crops. As an example, farmers should be encouraged to apply foliar spray of micronutrients and urea at lesser doses to get compensatory yield increase.

HIGHLIGHTS

- A unique project in mission mode aimed at increasing crop productivity in 24 rainfed districts of Karnataka by 20% in four years.
- A project that takes up the integrated genetic and natural resource management through consortium of national and international research institutions to take care of the entire 'seed to food' chain.
- Bringing improved agricultural technologies, seed s and other inputs for farmers' doorstep, besides building capacities of stake holders.
- Farmer-friendly technologies besides improving soil quality helped farmers increased crop productivity in the range of 32 to 66% in rainfed groundnut, finger millet, maize and soybean during kharif 2009.
- Mission activities to be strengthened and expanded to cover 24 dryland districts of Karnataka.
- Intense monitoring by high-power state coordination committee at regular intervals
- Analysis of massive scale soil samples collected from farmers' fields in the districts to map nutrient status of soils using GIS.
- Public-private partnerships (PPPs) to ensure backward and forward linkages to benefit farmers are envisaged in the mission mode project.

Appendix A

Checklist format for weekly reporting of Bhoo chetana progress of activities in the district.

BHU CHETHANA - Rainfed Agricultural Mission Project, Karnataka 2009-10							
A.Name of the District :							
B. Name of Joint Director of Agriculture & contact no:							
C.Name of the Nodal Officer & Contact no:							
D.Name of the ICRISAT Special Project Technician & contact no:							
E.Names of the Talukas		**No. of Villages**			**No. of clusters**		
1							
2							
3							
4							
5							

F.Crops selected:						
1	Targetted area (ha)					
2	Area sown(ha)					
3	Percent area sown					
G.District level trainings conducted:						
1	Date					
2	No.of participants					
H.Takuk level trainings conducted:						
1	Date					
2	Name of Taluk					
3	No.of participants					
I.Cluster/Village level Meetings conducted:						
1	Date					
2	Name of cluster / village					

3	No.of participants					
J.Total no. of farmers						
1	Number of farmers registered					
2	% of Farmers Registered					
K.Details of inputs required						
1	Crop					
2	Seeds					
3	Gypsum					
4	Micronutrients					
5	Boron					
6	Zinc					
7	Bio-fertilizers					
8	Bio-pesticides					
L.Details of inputs positioned						
1	Crop					
2	Seeds					
3	Gypsum					
4	Micronutrients					
5	Boron					
6	Zinc					
7	Bio-fertilizers					
8	Bio-pesticides					
M.Details of inputs distributed:						
1	Crop					
1	Seeds					
1	Gypsum					
2	Micronutrients					
3	Boron					
4	Zinc					

5	Bio-fertilizers					
6	Bio-pesticides					
N.Technologies recommended for the crops:						
1	% Farmers aware of these technologies					
O.No.of Farmers Fecilitators selected:						
P.No.of Lead farmers selected:						
Q. Posters prepared						
R.Wall writings:						
1	Total no. of villages					
2	No. of villages completed					
3	Percent					
S.Awareness about Bhu chetana project						
	% awareness of new mission mode initiative by GOK					
T.Awareness about soil anaysis results						
	No.of Soil Health Cards distributed					
U	**Organic Manuring**					
1	**Glyricidia plantings-%area covered**					
2	**Vermi-composting- No.of units**					
V	**Bio-fuel Plantitings-Pongamia/Neem**					
% Area Covered						
W	**Farm Ponds**					
	Number of farm ponds					
X.Publicity through mass media/AIR/TV						

Y.Documentation being made						
Z.Any other observations						
	Suggestions by JDA/officials/farmers					
	Name of the Reporting Officer					
	Date					

Brief Report on Additional Jobs Assigned from Time to Time 1.Field Day

2.Micronutrient application in selected villages

3.Glyricidia plantings
4.Tropicultor usage
5.Vermicomposting
6.Survey on Area planted in selected villages

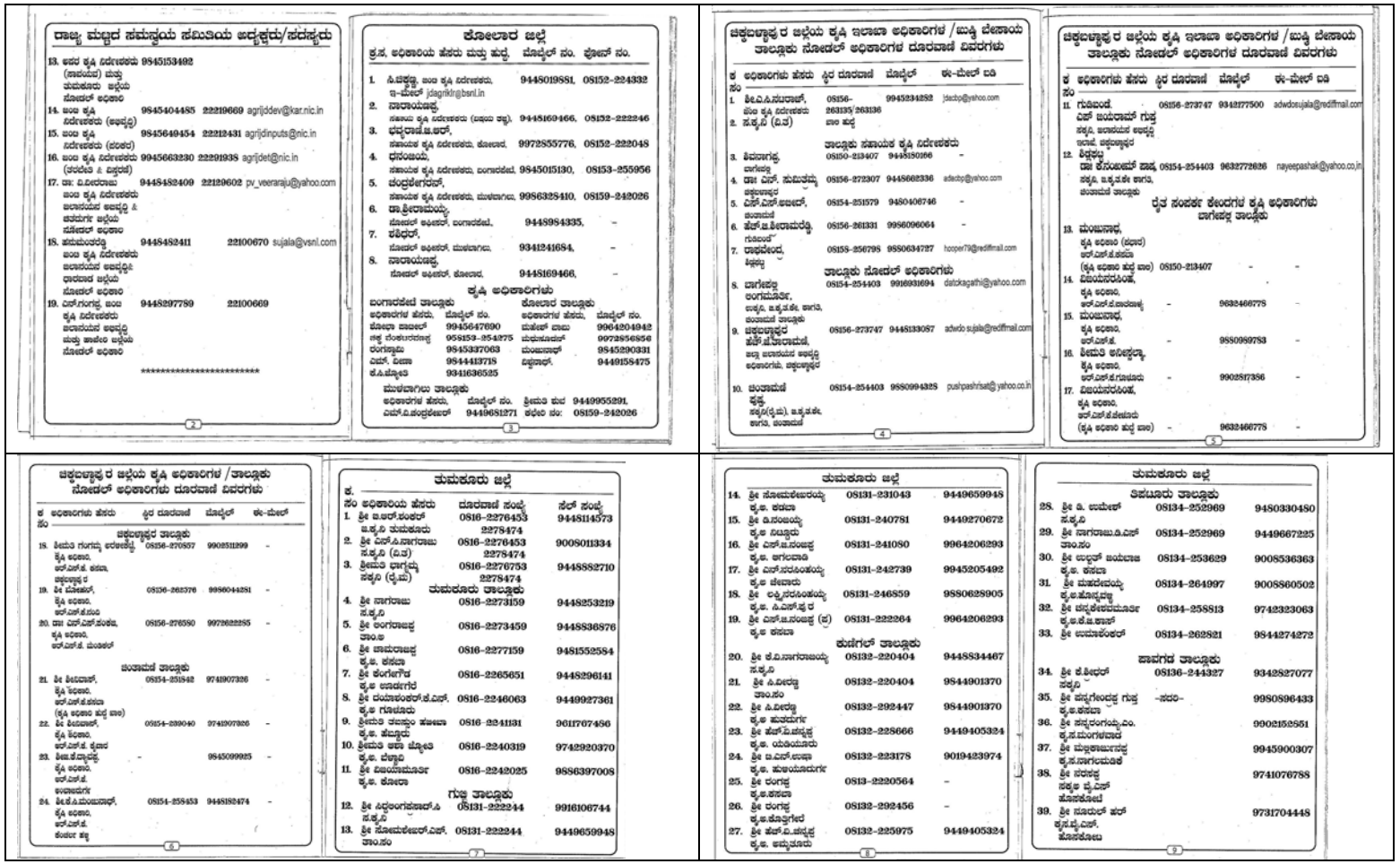
7.SAP demonstrations

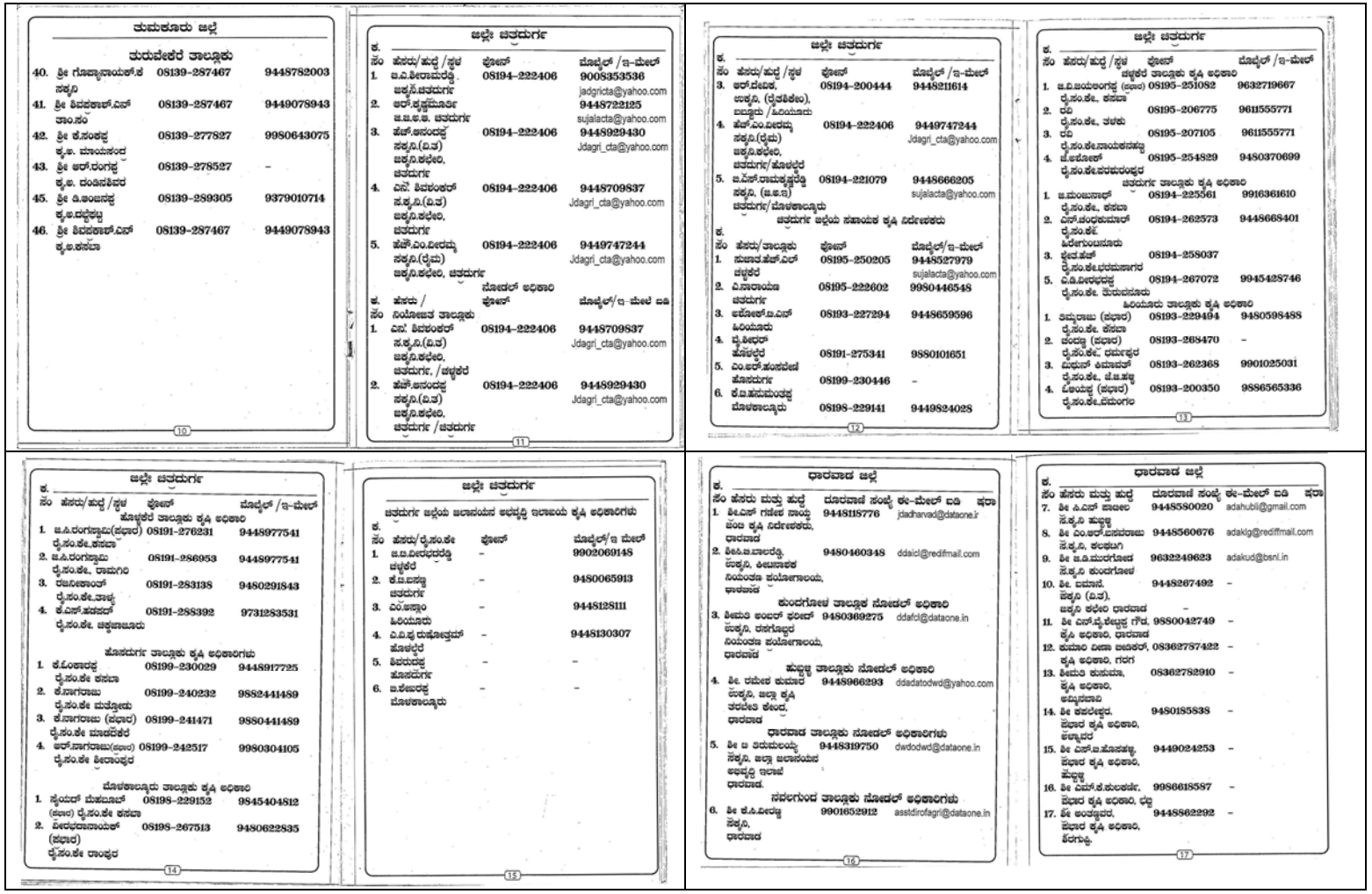
8.Monthly Rainfall data at targetted talukas of the district
9.Any other specific Job assigned

10.Unique Personal Innovative Theme selected for demonostration at villages
NOTE: Pl attach additional sheets (if required)& good photographs

Appendix B

A Pocket diary of project staff contacts published in Kannada and distributed to all staff and FFs in the districts.





ತುಮಕೂರು ಜಿಲ್ಲೆ

ತುರುವೇಕೆರೆ ತಾಲ್ಲೂಕು

40.	ಶ್ರೀ ಗೋಪ್ಯನಾಯಕ್.ಕೆ ಸಕೃಸಿ	08139-287467	9448782003
41.	ಶ್ರೀ ಶಿವಪ್ರಕಾಶ್.ಎಸ್ ತಾಂ.ಸಂ	08139-287467	9449078943
42.	ಶ್ರೀ ಕೆ.ಸಂಕಪ್ಪ ಕೃ.ಅ. ಮಾಂಪಸಂದ	08139-277827	9980643075
43.	ಶ್ರೀ ಆರ್.ರಂಗಪ್ಪ ಕೃ.ಅ. ದಂಡಿನಶಿವರ	08139-278527	–
45.	ಶ್ರೀ ಡಿ.ತಿಂಜಪ್ಪ ಕೃ.ಅ.ದಬ್ಬೆಘಟ್ಟ	08139-289305	9379010714
46.	ಶ್ರೀ ಶಿವಪ್ರಕಾಶ್.ಎಸ್ ಕೃ.ಅ.ಕಸವನ	08139-287467	9449078943

ಜಿಲ್ಲೇ ಚಿತ್ರದುರ್ಗ

ಕ್ರ.ಸಂ	ಹೆಸರು/ಹುದ್ದೆ /ಸ್ಥಳ	ಫೋನ್	ಮೊಬೈಲ್ /ಇ-ಮೇಲ್
1.	ಜಿ.ವಿ.ವೀರಾಮರೆಡ್ಡಿ ಜಕೃನಿ.ಚಿದುರ್ಗ	08194-222406	9008353536 jadgricta@yahoo.com
2.	ಆರ್.ಕೃಷ್ಣಮೂರ್ತಿ ಜ.ಜ.ಅ.ಚಿ. ಚಿದುರ್ಗ		9448722125 sujalacta@yahoo.com
3.	ಹೆಚ್.ಆನಂದಪ್ಪ ಸಕೃನಿ.(ಪಿ.ತ) ಜಕೃನಿ.ಕಛೇಲಿ, ಚಿದುರ್ಗ	08194-222406	9448929430 Jdagri_cta@yahoo.com
4.	ಎನ್. ಶಿವಲಿಂಕರ್ ಸ.ಕೃನಿ.(ಪಿ.ತ) ಜಕೃನಿ.ಕಛೇಲಿ, ಚಿದುರ್ಗ	08194-222406	9448709837 Jdagri_cta@yahoo.com
5.	ಹೆಚ್.ಎಂ.ವೀರಮ್ಮ ಸಕೃನಿ.(ರೈಮ) ಜಕೃನಿ.ಕಛೇಲಿ, ಚಿದುರ್ಗ	08194-222406	9449747244 Jdagri_cta@yahoo.com

ನೋಡಲ್ ಅಧಿಕಾರಿ

ಕ್ರ.ಸಂ	ಹೆಸರು / ನಿಯೋಜಿತ ತಾಲ್ಲೂಕು	ಫೋನ್	ಮೊಬೈಲ್/ಇ-ಮೇಲ್ ಐಡಿ
1.	ಎನ್. ಶಿವಲಿಂಕರ್ ಸ.ಕೃನಿ.(ಪಿ.ತ) ಜಕೃನಿ.ಕಛೇಲಿ, ಚಿದುರ್ಗ, /ಚಳ್ಳಕೆರೆ	08194-222406	9448709837 Jdagri_cta@yahoo.com
2.	ಹೆಚ್.ಆನಂದಪ್ಪ ಸಕೃನಿ.(ಪಿ.ತ) ಜಕೃನಿ.ಕಛೇಲಿ, ಚಿದುರ್ಗ /ಚಿದುರ್ಗ	08194-222406	9448929430 Jdagri_cta@yahoo.com

ಜಿಲ್ಲೇ ಚಿತ್ರದುರ್ಗ

ಕ್ರ.ಸಂ	ಹೆಸರು/ಹುದ್ದೆ /ಸ್ಥಳ	ಫೋನ್	ಮೊಬೈಲ್ /ಇ-ಮೇಲ್
3.	ಆರ್.ದೇವಿಕ, ಉಕೃನಿ, (ರೈತಶಿಕ್ಷಣ), ಐಮಂಗಲ / ಹಿರಿಯೂರು	08194-200444	9448211614
4.	ಹೆಚ್.ಎಂ.ವೀರಮ್ಮ ಸಕೃನಿ.(ರೈಮ) ಜಕೃನಿ.ಕಛೇಲಿ, ಚಿದುರ್ಗ/ಹೊಳಲ್ಕೆರೆ	08194-222406	9449747244 Jdagri_cta@yahoo.com
5.	ಜ.ಎನ್.ರಾಮಕೃಷ್ಣರೆಡ್ಡಿ ಸಕೃನಿ. (ಜ.ಅ.ಇ) ಚಿದುರ್ಗ/ಮೊಳಕಾಲ್ಮೂರು	08194-221079	9448666205 sujalacta@yahoo.com

ಚಿದುರ್ಗ ಜಿಲ್ಲೆಯ ಸಹಾಯಕ ಕೃಷಿ ನಿರ್ದೇಶಕರು

ಕ್ರ.ಸಂ	ಹೆಸರು/ತಾಲ್ಲೂಕು	ಫೋನ್	ಮೊಬೈಲ್/ಇ-ಮೇಲ್
1.	ಸುಜಾತ.ಹೆಚ್.ವಿ ಚಳ್ಳಕೆರೆ	08195-250205	9448527979 sujalacta@yahoo.com
2.	ವಿ.ನಾರಾಯಣ ಚಿದುರ್ಗ	08195-222602	9980446548
3.	ಆಶೋಕ್.ಜಿ.ಎನ್ ಹಿರಿಯೂರು	08193-227294	9448659596
4.	ವೈ.ಪೀರ್ ಹೊಳಲ್ಕೆರೆ	08191-275341	9880101651
5.	ಎಂ.ಆರ್.ಹಂಸವೇಣಿ ಮೊಸರುಗಿ	08199-230446	–
6.	ಕೆ.ಜಿ.ಹನುಮಂತಪ್ಪ ಮೊಳಕಾಲ್ಮೂರು	08198-229141	9449824028

ಜಿಲ್ಲೇ ಚಿತ್ರದುರ್ಗ

ಚಳ್ಳಕೆರೆ ತಾಲ್ಲೂಕು ಕೃಷಿ ಅಧಿಕಾರಿ

ಕ್ರ.ಸಂ	ಹೆಸರು/ಹುದ್ದೆ /ಸ್ಥಳ	ಫೋನ್	ಮೊಬೈಲ್ /ಇ-ಮೇಲ್
1.	ಜ.ಪಿ.ಜಯಲಿಂಗಪ್ಪ (ಪ್ರಭಾರ) ರೈ.ಸಂ.ಕೇ. ಕಸವನ	08195-251082	9632719667
2.	ರವಿ ರೈ.ಸಂ.ಕೇ. ತಳಕು	08195-206775	9611555771
3.	ರವಿ ರೈ.ಸಂ.ಕೇ.ಬಾಯಿಕನಹಳ್ಳಿ	08195-207105	9611555771
4.	ಜಿ.ಆರ್ಜೋಳ್ ರೈ.ಸಂ.ಕೇ.ಪರಶುರಂಪುರ	08195-254829	9480370699

ಚಿದುರ್ಗ ತಾಲ್ಲೂಕು ಕೃಷಿ ಅಧಿಕಾರಿ

1.	ಜ.ಮಂಜುನಾಥ್ ರೈ.ಸಂ.ಕೇ. ಕಸವನ	08194-225561	9916361610
2.	ಎಸ್.ಚಂದ್ರಶೇಖರಮೂರ್ ರೈ.ಸಂ.ಕೇ. ಹಿರೇಗುಂಟನೂರು	08194-262573	9448668401
3.	ಭೂತಪ್ಪ ರೈ.ಸಂ.ಕೇ.ಭರಮಸಾಗರ	08194-258037	
5.	ಎ.ಡಿ.ವೀರಭದ್ರಪ್ಪ ರೈ.ಸಂ.ಕೇ. ಮೊರನಹಳ್ಳಿ	08194-267072	9945425746

ಹಿರಿಯೂರು ತಾಲ್ಲೂಕು ಕೃಷಿ ಅಧಿಕಾರಿ

1.	ರಮ್ಯರಾಜು (ಪ್ರಭಾರ) ರೈ.ಸಂ.ಕೇ. ಕೆಸವನ	08193-229494	9480598488
2.	ಚಂದ್ರಪ್ಪ (ಪ್ರಭಾರ) ರೈ.ಸಂ.ಕೇ. ಧರ್ಮಪುರ	08193-269470	–
3.	ಮಧುಸೂ ಧಮಾವನ್ ರೈ.ಸಂ.ಕೇ. ಜೆ.ಜ.ಹಳ್ಳಿ	08193-262368	9901025031
4.	ಓಬಯ್ಯ (ಪ್ರಭಾರ) ರೈ.ಸಂ.ಕೇ.ವಿಮುಂಗಲ	08193-200350	9886565336

ಜಿಲ್ಲೇ ಚಿತ್ರದುರ್ಗ

ಹೊಳಲ್ಕೆರೆ ತಾಲ್ಲೂಕು ಕೃಷಿ ಅಧಿಕಾರಿ

ಕ್ರ.ಸಂ	ಹೆಸರು/ಹುದ್ದೆ /ಸ್ಥಳ	ಫೋನ್	ಮೊಬೈಲ್ /ಇ-ಮೇಲ್
1.	ಜ.ಸಿ.ರಂಗಸ್ವಾಮಿ(ಪ್ರಭಾರ) ರೈ.ಸಂ.ಕೇ.ಕಸವನ	08191-276231	9448977541
2.	ಜ.ಸಿ.ರಂಗಸ್ವಾಮಿ ರೈ.ಸಂ.ಕೇ. ರಾಮಗಿರಿ	08191-286953	9448977541
3.	ರಜನೀಕಾಂತ್ ರೈ.ಸಂ.ಕೇ.ತಾಳ್ಯ	08191-283138	9480291843
4.	ಕೆ.ಎಸ್.ಹಪಜರ್ ರೈ.ಸಂ.ಕೇ. ಚಿಕ್ಕಜಾಜೂರು	08191-288392	9731283531

ಮೊಸರುಗಿ ತಾಲ್ಲೂಕು ಕೃಷಿ ಅಧಿಕಾರಿಗಳು

1.	ಕೆ.ಪಿಂಕಾರಪ್ಪ ರೈ.ಸಂ.ಕೇ ಕಸವನ	08199-230029	9448917725
2.	ಕೆ.ನಾಗರಾಜು ರೈ.ಸಂ.ಕೇ ಮತ್ತೋಡು	08199-240232	9852441489
3.	ಕೆ.ನಾಗರಾಜು (ಪ್ರಭಾರ) ರೈ.ಸಂ.ಕೇ ಮಾಡದಕೆರೆ	08199-241471	9880441489
4.	ಆರ್.ನಾಗರಾಜು(ಪ್ರಭಾರ) ರೈ.ಸಂ.ಕೇ ತೀರ್ಥಪುರ	08199-242517	9980304105

ಮೊಳಕಾಲ್ಮೂರು ತಾಲ್ಲೂಕು ಕೃಷಿ ಅಧಿಕಾರಿ

1.	ಸೈಯದ್ ಮಹಬೂಬ್ (ಪ್ರಭಾರ) ರೈ.ಸಂ.ಕೇ ಕಸವನ	08198-229152	9845404812
2.	ವೀರಭದ್ರಪ್ಪನಾಯಕ್ (ಪ್ರಭಾರ) ರೈ.ಸಂ.ಕೇ ರಾಂಪುರ	08198-267513	9480622835

ಜಿಲ್ಲೇ ಚಿತ್ರದುರ್ಗ

ಚಿತ್ರದುರ್ಗ ಜಿಲ್ಲೆಯ ಜಲಾನಯನ ಅಭಿವೃದ್ಧಿ ಇಲಾಖೆಯ ಕೃಷಿ ಅಧಿಕಾರಿಗಳು

ಕ್ರ.ಸಂ	ಹೆಸರು/ರೈ.ಸಂ.ಕೇ	ಫೋನ್	ಮೊಬೈಲ್/ಇ ಮೇಲ್
1.	ಜ.ವಿ.ವೀರಭದ್ರರೆಡ್ಡಿ ಚಳ್ಳಕೆರೆ	–	9902069148
2.	ಕೆ.ಜಿ.ಬಸ್ಯಾ ಚಿದುರ್ಗ	–	9480065913
3.	ಎಂ.ಆಸ್ಲಾಂ ಹಿರಿಯೂರು	–	9448128111
4.	ಎ.ವಿ.ಪ್ರ ರುಹೋವ್ತಮ್ ಹೊಳಲ್ಕೆರೆ	–	9448130307
5.	ಶಿವರುದ್ರಪ್ಪ ಹೊಸದುರ್ಗ	–	–
6.	ಜ.ಬೆಜರಪ್ಪ ಮೊಳಕಾಲ್ಮೂರು	–	–

ಧಾರವಾಡ ಜಿಲ್ಲೆ

ಕ್ರ.ಸಂ	ಹೆಸರು ಮತ್ತು ಹುದ್ದೆ	ದೂರವಾಣಿ ಸಂಖ್ಯೆ	ಈ-ಮೇಲ್ ಐಡಿ	ಪ್ರದೇ
1.	ಶೀ.ಎಸ್ ಗಣೇಶ ನಾಯ್ಕ ಜಂಟಿ ಕೃಷಿ ನಿರ್ದೇಶಕರು, ಧಾರವಾಡ	9448118776	jdadharvad@dataone.ir	
2.	ಶೀಒ.ಜ.ಬಾಲರೆಡ್ಡಿ ಜಕೃನಿ, ಕಲಘಟಗಿ ನಿಯಂತ್ರಣ ಪರೀಕ್ಷಾಲಯ, ಧಾರವಾಡ	9480460348	ddaicl@rediffmail.com	

ಕುಂದಗೋಳ ತಾಲ್ಲೂಕ ನೋಡಲ್ ಅಧಿಕಾರಿ

3.	ಶೀಮತಿ ಅಂಬರ್ ಫರೀದ್ ಜಕೃನಿ, ರಸಗೊಬ್ಬರ ನಿಯಂತ್ರಣ ಪರೀಕ್ಷಾಲಯ, ಧಾರವಾಡ	9480369275	ddafcl@dataone.in	

ಹುಬ್ಬಳ್ಳಿ ತಾಲ್ಲೂಕು ನೋಡಲ್ ಅಧಿಕಾರಿ

4.	ಶೀ. ರಮೇಶ ಕುಮಾರ್ ಜಂಕೃನಿ, ಜಲ್ಲಾ ಕೃಷಿ ತರಬೇತಿ ಕೇಂದ್ರ, ಧಾರವಾಡ	9448966293	ddadatodwd@yahoo.com	

ಧಾರವಾಡ ತಾಲ್ಲೂಕು ನೋಡಲ್ ಅಧಿಕಾರಿಗಳು

5.	ಶೀ ಐ ರಮಾಬಲಪ್ಪ ಸಕೃನಿ, ಜಲ್ಲಾ ಜಲಾನಯನ ಅಭಿವೃದ್ಧಿ ಇಲಾಖೆ ಧಾರವಾಡ.	9448319750	dwdodwd@dataone.in	

ನವಲಗುಂದ ತಾಲ್ಲೂಕು ನೋಡಲ್ ಅಧಿಕಾರಿಗಳು

6.	ಶೀ ಕ.ಸಿ.ವೀರಣ್ಣ ಸೆಕ್ಷನ್, ಧಾರವಾಡ	9901652912	asstdirofagri@dataone.in	

ಧಾರವಾಡ ಜಿಲ್ಲೆ

ಕ್ರ.ಸಂ	ಹೆಸರು ಮತ್ತು ಹುದ್ದೆ	ದೂರವಾಣಿ ಸಂಖ್ಯೆ	ಈ-ಮೇಲ್ ಐಡಿ	ಪ್ರದೇ
7.	ಶೀ ಎ.ಎಸ್ ಪಾಟೀಲ ಸೆ.ಕೃ.ನಿ ಹುಬ್ಬಳ್ಳಿ	9448580020	adahubli@gmail.com	
8.	ಶೀ ಎಂ.ಆರ್.ಪಾಟವರಾಜು ಸೆ.ಕೃ.ನಿ, ಕಲಘಟಗಿ	9448560676	adakig@rediffmail.com	
9.	ಶೀ ಜಿ.ಮರಗೌಡ ಸೆ.ಕೃ.ನಿ ಕುಂದಗೋಳ	9632249623	adakud@bsnl.in	
10.	ಶೀ. ವಮಾನಿ. ಪೆಕೃನಿ (ಪಿ.ತ), ಜಕೃನಿ ಕಛೇಲಿ ಧಾರವಾಡ	9448267492	–	
11.	ಶೀ ಎಸ್.ಪೈ.ಲೆಬ್ಬಪ್ಪ ಗೌಡ ಕೃಷಿ ಅಧಿಕಾರಿ, ಧಾರವಾಡ	9880042749	–	
12.	ಕುಮಾರಿ ವೀಣಾ ಜಿಲಕರ್, ಕೃಷಿ ಅಧಿಕಾರಿ, ಗರಗ	08362787422	–	
13.	ಶೀಮತಿ ಕುಸುಮಾ, ಕೃಷಿ ಅಧಿಕಾರಿ, ಅಳ್ನಾವರ	08362782910	–	
14.	ಶೀ ಕಪಲೇಶ್ವರ, ಪ್ರಭಾರ ಕೃಷಿ ಅಧಿಕಾರಿ, ಕುಂಬಾರ	9480185838	–	
15.	ಶೀ ಎಸ್.ಐ.ಮೊಸಪಕ್ಕ ಪ್ರಭಾರ ಕೃಷಿ ಅಧಿಕಾರಿ, ಹುಬ್ಬಳ್ಳಿ	9449024253	–	
16.	ಶೀ ಎಸ್.ಸಿ.ಮುಲಕಣ್ಣ, ಪ್ರಭಾರ ಕೃಷಿ ಅಧಿಕಾರಿ, ಛಬ್ಬಿ	9986618587	–	
17.	ಶೀ ಅಂತಪ್ಪನವರ, ಪ್ರಭಾರ ಕೃಷಿ ಅಧಿಕಾರಿ, ಕೆರಗುಡ್ಡಿ.	9448862292	–	

ಹಾವೇರಿ ಜಿಲ್ಲೆ

ಕ್ರ. ಸಂ	ಅಧಿಕಾರಿಗಳ ಹೆಸರು/ಹುದ್ದೆ	ಮೊಬೈಲ್	ಫೋನ್/ಇ-ಮೇಲ್
1.	[illegible]	9449027552	(958375) 240021 dagrhav@yahoo.com
2.	[illegible]	9448036131	(958375) 240021
3.	[illegible]	9744057947	(958375) 290044 adamitha@gmail.com
4.	[illegible]	9448243592	(958375) 232593 [illegible]
5.	[illegible]	9880493374	(958375) 288275 adahvr@gmail.com
6.	[illegible]	9740599667	(958379) 262534 adabyd@gmail.com
7.	[illegible]	9972308039	(958379) 262534 adahanagal@yahoo.in
8.	[illegible]		adahkr@gmail.com
9	[illegible]	9448872781	(958373)267897 adamr@rediffmail.com
10.	[illegible]	9880423258	(958375) 241752 agriev@gmail.com
11.	[illegible]	9916014737	(958375) 253631 adasgn@gmail.com

ಹಾವೇರಿ ಜಿಲ್ಲೆ

ಕ್ರ. ಸಂ	ಅಧಿಕಾರಿಗಳ ಹೆಸರು/ಹುದ್ದೆ	ಮೊಬೈಲ್	ಫೋನ್/ಇ-ಮೇಲ್
	ತಾಂತ್ರಿಕ ನೋಡಲ್ ಅಧಿಕಾರಿಗಳು (RAMP ಯೋಜನೆ)		
1	[illegible]	9449620226	
2.	[illegible]	9448243592	(958375) 290044
3.	[illegible]		(958378) 262949
4.	[illegible]	9972506444	(958373) 249359
5.	[illegible]	9980609857	(958373) 245626
6.	[illegible]		(958376) 241752
7.	[illegible]	9901561895	(958379) 259057
8.	[illegible]	9731712950	(958373) 255133
9.	[illegible]	9740919581	(958378) 252067
10.	[illegible]	9900364790	(958375) 254025

International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)

1. Multidisciplinary team of Experts from ICRISAT for Rainfed Mission Project

Sl. No.	Name	Discipline	Phone No.			E-mail
			Office	Residence	Mobile	
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I.	Piara Singh	Soil Science	040-30713334	040-23730119	9963069122	p.singh@cgiar.org
I.	K L Sahrawat	Soil Fertility	040-30713529	040-30713420	-	k.sahrawat@cgiar.org
I.	RC Sachan	Agricultural Engineer	040-30713473	040-27114233	9391055839	r.sachan@cgiar.org
'.	S Marimuthu	Agronomy	040-30713438	040-30713815	9849814712	s.marimuthu@cgiar.org
I.	GV Ranga Rao	IPM Specialist	040-30713598	040-30713675	9440222016	g.rangarao@cgiar.org
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2. Details of Scientific Officers responsible for districts in Karnataka

Name	District	Phone No.			E-mail
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V Rameswara Rao	Kolar	040-30713595	040-27059027	9885609799	v.rameshwarrao@cgiar.org
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C H SrinivasaRao	Chitradurga	040-30713376	-	9346996199	s.rao@cgiar.org
GPardhasaradhi	Haveri	040-30713378	040-23241311	9440059699	g.pardhasaradhi@cgiar.org
S Raghavendra Rao	Dharwad	040-30713376	040-24043035	9866923551	s.r.rao@cgiar.org

Appendix C

Report on Visit to Soil Testing Laboratories in Bangalore and Mandya, Department of Agriculture, Karnataka.

K.L.Sahrawat and K.V.S. Murthy

Soil Chemistry, Global-Theme Agroecosystems, ICRISAT, Patancheru 502 324 andhra Pradesh, India

Context

- ICRISAT' efforts under the Sujala-ICRISAT project earlier resulted in the mapping of nutrient deficiencies in six districts of Karnataka.
- The results indicated widespread deficiencies of sulfur, boron and zinc in addition to those of nitrogen and phosphorus. Application of sulfur, boron and zinc along with nitrogen and phosphorus significantly increased the yields of several field crops.
- Government of Karnataka has now undertaken the scaling up these benefits through the Bhu Chetana project in 24 dryland districts of Karnataka.
- The project will cover 18 additional districts (work completed in 6 districts earlier) in which the job of mapping the nutrient deficiencies through soil testing will be undertaken.
- This job will require soil sampling the farmers' fields and analysis of the soil samples for fertility parameters in the target districts.

Mr. KVS Murthy and I visited Bangalore and Mandya Soil Testing Laboratories on 1-2 June 2009.

The objective of the visit:

- To assess the capacity of the laboratories in Bangalore and Mandya to undertake a large scale analysis of soil samples for macro, secondary and micro-nutrients for the Bhu Chetana project between GOK and ICRISAT on Productivity Enhancement and
- To suggest needs for the up-gradation of the laboratories in case the laboratories did not have the capacity at the present time to undertake the analysis of a large number of soil samples for such analysis (pH, organic C, macro, secondary including sulfur and micro-nutrient including boron and zinc).

The Visit

On 1 June, we had a short meeting with Dr. A. Rajanna, Director Agriculture, GOK and his staff including Ms. SM Deepaja, DD, Mr. PS Hanumanth Rao, AD, Dr. HR Prakash, AD, Ms. Padmini, AO and Ms. Shobha Patil, AO to set out the objective of the visit and make plan to achieve them. Dr. K Krishnappa (ICRISAT) also joined us at the meeting with Dr. Rajanna and his staff in Bangalore.

As per the plan, we visited the soil testing laboratories in Bangalore and Mandya in the afternoon of 1st June. We were accompanied by the DD and ADs during our visit to the Soil Health Center Laboratory in Mandya. We met the JDA in-charge in Mandya and his staff and interacted with them. It was very educative to learn as to how the soil health laboratories provide service to farmers. We returned to Bangalore in the evening.

Our meeting and interactions with Dr. Rajanna and his staff continued on 2nd June too. The interaction with staff and the Director were held in a very cordial environment. We returned to Hyderabad by the evening flight on 2nd June.

Assessment and Recommendations

Based on our observations and the interactions with the staff both in Bangalore and Mandya, we feel that

- The two laboratories in Bangalore and Mandya at the present time are not in a position to undertake the analysis of a large number of soil samples for macro, secondary and micro-nutrient elements.

- The facilities available and the basic infrastructure and instruments, etc. at the present time do not seem adequate to undertake soil analysis at such a scale as required for the project.
- In fact, the soil testing laboratories in Bangalore and Mandya are not conducting any soil testing for available sulfur at the present time.
- We suggest that the analysis for available sulfur in the soil samples should be undertaken using turbidimetric or colorimetric method (based on methylene blue).
- There are also difficulties in properly conducting the analysis for micronutrients.
- We however, feel that there is opportunity to up-grade these and other soil testing laboratories in the Karnataka state so that they can undertake the analysis of soil samples for various fertility parameters in a professional manner.
- At the present time, we were told that these laboratories unde take the analysis of soil samples from various districts, although the number of samples handled annually does not seem large.
- There is need to have a proper design of the soil testing laboratories so that various functions of the laboratory can be conducted without cross contamination.
- For example, there is need to have proper digestion rooms with digestion blocks (for total N; at the present time in the laboratory in Bangalore, the digestion of soil samples for total N determination is carried out in the open within the laboratory) and fume hoods and fume cupboards (for soil organic C analysis) to conduct digestion or transfer of acids and other hazardous chemicals.
- Also, there is need to have proper facilities for grinding and preparation of the soil samples for analysis in the laboratory. Such a facility should be away from the main laboratory involved in the dry and wet chemistry part of the analytical work.
- Wet and dry chemistry part of the laboratory in turn should be separated to avoid cross contamination.
- The most important part of the laboratory is the instrument room and this part of the laboratory should be in the vicinity but separated from the wet and dry part of the soil testing laboratory. The room should be enclosed such that

the entry to the instrument room is not a thoroughfare or common. This room has to be maintained at a constant temperature as well the room should be dust-free.

- The Department of Agriculture, Government of Karnataka should make a decision on adding instruments for up grading their soil health laboratories, which may include instruments such as ICP-MS (can take care of all the analytical needs including heavy metals and macro, secondary and micro-nutrient analysis), latest version of AAS, modern easy- to- operate balances, refrigerators, precision ovens, shakers, grinders and others based on the demand and need for analysis.
- There is need to have proper storage place for storing chemicals as per their hazardous nature. For example, volatiles and acids need separate storing facilities with proper exhaust fans and cooling etc as per the nature of the chemicals.
- The use of dispensers for transfer of acids and other hazardous solutions and the use of pipette aspirators are highly essential for the safety and convenience.
- General safety in the laboratory should also be considered relative to unexpected accidents and mishaps in a chemistry laboratory.
- The working benches in the two laboratories need to be replaced (the existing ones are in bad state of prepare) by acid-resistant and non-corrosive laboratory tops, now available in the market in ready made usable form.
- Proper benches / tables are also needed for the installation of balances. This is a prerequisite for properly carrying out various analytical activities on the laboratory benches.
- There is an urgent need to have facilities for proper washing and drying of the glass and plastic wares used in the laboratory. Use of a detergent, rather than the chromic acid used at the present time, is recommended.

As mentioned earlier, the up gradation of the soil testing laboratories is essential in case the laboratories have to conduct a large scale analysis of soil samples for macro, secondary and micronutrients.

During our interactions s with Dr. A. Rajanna and other staff we got a feeling that they are keen to up grade the soil testing laboratories to meet the increased demand for soil testing.

We feel that it is a good idea also to provide services for plant analysis as well. To bring out synergy in the working of various laboratories, we suggest that the soil, fertilizer, plant (proposed) and water testing laboratories better be combined under one overall umbrella supervision.

It is pertinent to mention the follow up visit by the laboratory officers from Bangalore and Mandya to ICRISAT on 4-5 June 2009 provided additional food for thought for providing need-based, timely analytical support through soil, plant, water and crop quality analysis. The feed up from the officers indeed stressed the need to up-grade the laboratories on similar lines as suggested by us (see above).

We hope that our observations plus interactions with staff in Bangalore and Mandya and observations by the GOK officers during the return visit to ICRISAT-Patancheru is helpful in the planning of the up gradation of the soil testing laboratories in Karnataka.

Appendix D

Staff of DoA Report on Visit to Soil Testing Division of ICRISAT

The soil testing division of ICRISAT is very impressive for its neatness and systematic arrangement of instruments. Infrastructure with separate wet lab, instrument room, sample preparation, and sample digestion makes work really a pleasure. Work friendly instruments like acid dispensers, ICP, more number of electronic balances comfortably spread across the working place, water accessibility at all work tables, safety handling of acids are required for our laboratory. One suggestion made is not to waste much water at washing place i.e. sensor taps could be fitted.

Other exposures by ICRISAT scientists on overall picture of ICRISAT, watershed activities at Kothapally were very informative. Kothapally stands as a good example of integration of works by various organizations. Information on GIS and soil fertility mapping was enlightening as this was my first exposure on GIS.

I thank ICRISAT for arranging and organizing the programme and look forward for further guidance and cooperation.

DDA (Soil Health)

Visit to ICRISAT

I am really impressed by the germplasm of different varieties of pigeonpea, chickpea, groundnut, jowar and pearl millet maintained in the museum.

Laboratories are neatly maintained and clean.

I got the information; I needed for preparing the nutrient maps in the districts of Karnataka.

I first time observed ICP in ICRISAT laboratory. It will be very useful instrument for analysis of B, S, Mo. I propose to purchase one ICP for our laboratory at Bangalore.

The laboratory use dispensers, auto brunettes, etc. which will reduce errors in dispensing the solution. Our laboratory would be upgraded by providing such equipments.

I really appreciate ICRISAT for transforming life of Kothapally farmers for transferring the technology in soil, water conservation, and nutrient management.

P S Hanumantha Rao
Asst. Director of Agriculture
Commissionerate of Agri.
Seshadri Road, Bangalore 1

VISIT to ICRISAT

Day 1

Visited the information centre to know the birds eye view of working of ICRISAT.
Mr Ravi Kumar explained the activities going on in ICRISAT.

Visited the soil science laboratory. Fruitful discussion with Dr Sahrawat about the soil analysis of micronutrients.

Live demonstrations of soil sampling

Visited the field along with scientists of ICRISAT. Methods to be followed in collection of soil sample. Soil sample to be collected to a depth of 15 cm. four sub samples from field. By …… technique half kg soil sample is collected. Visited GIS lab about selection of plots and village by soil sampling to prepare fertility maps. Mr Irshad explained about how to collect soil sample from each village depending upon soil type, cropping pattern. Visited soil science lab. Saw the working of AAS, organic carbon estimation and ICP instruments.

Day II field visit to Kothapally – adopted village

Visited the village. Met Mr Anjaiah, Secretary and discussed with him about the watershed activities. Visited check dam, visited open wells with water in them, which is used for irrigating the crops.

What is lacking in the watershed

1. Fodder security system is not there in watershed.
2. Majority of farmers have not followed broadbased furrow systems in village.

3. Animal husbandry component is missing.

4. Tree component agrihortisilvi pastural system is not there. Visited the lab discussed with Dr Sahrawat about requirements of the labs to upgrade it and recommendations to be followed.

Food and lodging

Food served is good and tasty.

Lodging provided was good. It was a good educational trip to ICRISAT.

Dr (HR P & Acc Asst.)

Visit to ICRISAT

To start with, it was an interesting session on the introduction part. The nature of work, the crop varieties stored, display on the types of soils, etc.

Then coming to the soil sample collection, we also follow the same method that is followed at ICRISAT.

The soil testing laboratories impressed me a lot. The cleanliness followed at each step. We would like to buy some of the basic things required in the lab, like acid dispensers, weighing balances, driers, working table tops, desks and chairs, masks, etc. I was also impressed by the way the glasswares were cleansed and the safety measures followed in the lab.

Further proceeding to the GIS lab, we had a good presentation on the mapping work.
On the second day visit, to the Kothapally village, the watershed concept followed was good. The self-help group approach was interesting.

Finally our food and stay at ICRISAT was very good. The hospitality shown by the staff at ICRISATmust be remembered for ever.

Thanking you,

Padmini
Agriculture Officer
Micronutrient lab, Bangalore
5 June 2009

Visit to ICRISAT

- Exposed to many things in ICRISAT campus
- Besides our purpose of visiting soil testing laboratory, we also come across many of the watershed activities.
- Visit to Kothapally village was good. Every drop of water stored will help the farmers in taking cultivation in off season and also feed the animals. Happy to see water in the farmers well even in this scorching heat.
- Very good introduction by Mr Ravi sir
- Visit to GIS lab was very effective and we learnt a lot regarding soil mapping
- Nice to see clean and well equipped laboratory
- Dr Sahrawat sir was there with us all the time in solving our problems and finding solutions.
- In general, we got a broad picture of ICRISAT, its objectives and in particular about a soil testing laboratory activities.
- Hospitality was good. Boarding and food facilities are superb.

Thanking you,

Shobha Patil
Agriculture Officer (Soil Health)
Bangalore

Visit to ICRISAT and soil testing in particular

1. The hospitality we received from the staff made the stay comfortable and memorable.

2. We got an opportunity / exposure to see the procedure adopted here right from cleaning of the glassware up to the arrangement of instruments for soil testing and the same can be employed in our state soil testing lab for better soil testing and service to the farmers.

3. The acid dispensers, digital ……, fume cupboards has made us to improve our state soil testing labs

4. The information given pertaining to GIS mapping and developing the fertility maps at the village level, has made us to think how efficiently we can use the soil test data which we have over the years can be used.

5. In future, we expect from you how better we can explore our available facility in our state labs to improve our soil testing methods / procedure, and the same can be accomplished by you as a part of training to the officers with a vision to grow the farmers.

Agricultural Officer
Soil Health Centre, Mandya

Appendix E

Table 1. List of farmers' fields selected for Ragi crop sampling and crop yield estimations in Kolar district.

S.No.	Viilage	Taluk	Farmer Name	FM Grain (kg ha^{-1})	FM TDM (kg ha^{-1})	IM Grain (kg ha^{-1})	IM TDM (kg ha^{-1})
1	Yalacha mande	Bangarpet	Narayanamma	860	3600	1630	5160
2	Yalacha mande	Bangarpet	Srinivas	790	3330	1350	4530
3	Yalacha mande	Bangarpet	Anjanappa	960	3320	1830	5290
4	Yalacha mande	Bangarpet	Ganesh	1830	5800	2700	6930
5	Yalacha mande	Bangarpet	Bai gowad	1880	5400	2700	8080
6	D.P. Halli	Bangarpet	Shantharamarao	1520		2820	7640
7	D.P. Halli	Bangarpet	B.Satyanarayarao	1160	3570	2560	6100
8	D.P. Halli	Bangarpet	Chikaramji rao	1280	3940	3000	7430
9	Budikote	Bangarpet	Jayashankar	2770	11440	4850	15570
10	Budikote	Bangarpet	Srinivas shetty	2030	5860	4480	13030
11	Budikote	Bangarpet	Markand gowda	2080	8110	2290	9100
12	Marandahalli	Bangarpet	Chandraiah gowda	950	2410	1940	5160
13	Marandahalli	Bangarpet	Mason Venkateshappa	1840	6260	3780	9710
14	Marandahalli	Bangarpet	Kempanna	2360	6800	3410	10650
15	Marandahalli	Bangarpet	Ameresh	1460	3940	2020	5340
16		Bangarpet	Basi gowda	2250	7800	3400	9210
17		Bangarpet	Yasraiappa	2600	5390	3510	8180
18		Bangarpet	B.Venkateshappa	1560	4940	2390	5980
19		Bangarpet	Muniraju	1110	5000	1920	6150
20		Bangarpet	Narayanaswamy	1780	7680	2480	8780
21	Sontiganahalli	Bangarpet	Munivenkatappa	1210	5220	2960	8790
22	Sontiganahalli	Bangarpet	Bodeppa	1650	5480	2890	8490
23	Sontiganahalli	Bangarpet	Venkab rao	1230	4640	2530	9140
24	Chambenahalli	Bangarpet	Govindarao S/o Manojirao	1870	4350	3020	6660
25	Chambenahalli	Bangarpet	Venkatarao S/o A manojirao	2560	5640	4230	7970
26	M.Hosa halli	Bangarpet	Lakshmi bai	1700	4470	3350	7520

27	M.Hosa halli	Bangarpet	Neela bai	1830	4670	3270	7410
28	M.Hosa halli	Bangarpet	Muniappa	1270	3920	2660	7040
29	M.Hosa halli	Bangarpet	K.Govindappa	1740	5160	2940	7200
30	M.Hosa halli	Bangarpet	Kumitippa	1270	4320	3020	7840
31	Chambenahalli	Bangarpet	Shantakumar S/o Muniyappa	1160	3260	1780	5070
32	Chambenahalli	Bangarpet	Pojire Krishnappa	1670	5670	2740	8420
33	Chambenahalli	Bangarpet	Muni Thimappa S/o Muniswamy	2180	5790	3170	9230
34	Gollahalli	Bangarpet	Nagesh	1660	3970	2830	7900
35	Gollahalli	Bangarpet	Muniappa	2310	6050	4560	11480
36	Gollahalli	Bangarpet	Muniappa	1140	3230	1540	4000
37	Gollahalli	Bangarpet	Ramchandraappa	950	2650	1600	4520
38	Gollahalli	Bangarpet	Munivenkatappa	1450	3330	1960	4170
39	Kondaenahalli	Bangarpet	Mahadevappa	1440	4610	1800	7010
40	Kondaenahalli	Bangarpet	Muniappa	1140	3980	1560	5480
41	Kondaenahalli	Bangarpet	Narayana swamy	1400	4410	2020	6920
42	Kondaenahalli	Bangarpet	Ramesh	1250	4430	1650	5870
43	Kondaenahalli	Bangarpet	Venateshappa			1090	5430
44	Budikote	Bangarpet	Basavaraj	1840	4910	2960	7000
45	Budikote	Bangarpet	Naryanaswamy	2740	8690	4020	10710
46	Kakinatha	Kolar	Srinivasappa	1850	6270	2770	11240
47	Kakinatha	Kolar	Srinivasappa	1830	8270	1830	9010
48	Kakinatha	Kolar	B.Munivenkatappa	2060	5570	3380	10340
49	Kakinatha	Kolar	Rajgopal	1530	5610	2580	7710
50	Kakinatha	Kolar	Muni krishanapp	1620	5020	2050	7510
51	Chitnahalli	Kolar	C.L.Purshotham	2780	8300	4810	14080
52	Chitnahalli	Kolar	Bachegowda	1620	5780	2830	9130
53	Chitnahalli	Kolar	Sonegowda	1830	6580	3500	11570
54	Chitnahalli	Kolar	Ramappa	1990	7010	3780	12770
55	Chitnahalli	Kolar	Naryanaswamy	1190	6520	3820	12400

56	Thotli	Kolar	Ramkrishanappa			1310	4820
57	Thotli	Kolar	Chowdareddy	1640	4640	2500	7430
58	Thotli	Kolar	Narappa	1540	3590	1970	5180
59	Thotli	Kolar	T.M.Ashwathappa	1130	3070	1890	4530
60	Thotli	Kolar	Gopal			2360	6190
61	Vadugur	Kolar	Laksmamma	1520	4310	3000	6630
62	Vadugur	Kolar	Chowdappa	1320	5360	3450	9190
63	Vadugur	Kolar	Krishanappa	1760	4800	3300	7770
64	Vadugur	Kolar	Patil muniappa	910	3330	1630	5300
65	Vadugur	Kolar	Guru murthy	940	3080	1130	4050
66	Haralekunte	Kolar	Manjunath	1240	3470	2190	6510
67	Haralekunte	Kolar	Venkatamma			2010	6390
68	Haralekunte	Kolar	Shanthamma	1880	6050	3670	9000
69	Haralekunte	Kolar	Rathnamma	2500	6740		
70	Haralekunte	Kolar	Venkateshappa	910	2740	2090	5160
71	Muduvadi	Kolar	Krishanamurthy	1230	4280	2600	7750
72	Muduvadi	Kolar	M.N.Venkatesh	2660	9450	4970	12420
73	Muduvadi	Kolar	Sampagi ramiah	2620	7540	3980	10540
74	Vanarashi halli	Kolar	Venkataswamy	1770	4390	2880	7760
75	Vanarashi halli	Kolar	Munegowda	860	3430	1810	5460
76	Vanarashi halli	Kolar	Ramchandraieh	1290	6020	2750	7880
77	Kondenahalli	Kolar	Chowda reddy	2520	7560	4690	11000
78	Kondenahalli	Kolar	Venkatswamy	2400	6820	4620	11160
79	Muduvadi	Kolar	Syed pasha	2620	6590	3830	10490
80	Muduvadi	Kolar	Vazeer pasha	3280	6870	3410	7910
81	Somasandra	Kolar	Venkatramana	1400	4100	1890	5410
82	Somasandra	Kolar	Krishanappa	870	2860	1340	4730
83	Somasandra	Kolar	Gopalappa	850	2890	1700	4880
84	Kondenahalli	Kolar	Baithappa	1880	5000	3030	9500
85	Kondenahalli	Kolar	Nagraj	1620	4320	2720	7680
86	Kondenahalli	Kolar	Muni swamy reddy	1310	4440	2250	6760

87	Holali	Kolar	Chandrappa				
88	Holali	Kolar	Uyala venkateshappa	2090	6050	3690	10000
89	Holali	Kolar	Manjunath H.K	2030	5880	3670	10480
90	Holali Hosur	Kolar	Vardappa	1130	4310	1840	6090
91	Holali Hosur	Kolar	Muniamma	1080	3780	2050	7120
92	Holali Hosur	Kolar	Master Muni venkatappa	1520	5860	3190	8940
93	Holali Hosur	Kolar	Rama krishanappa			2280	8370

Table 1.1. List of farmers' fields selected for Groundnut crop sampling and crop yield estimations in Kolar district.							
S.No.	**Name of Village**	**Name of Taluk**	**Name of the Farmer**	**POD (kg ha^{-1})**	**TDM (kg ha^{-1})**	**Pod (kg ha^{-1})**	**TDM (kg ha^{-1})**
1	Gudipally		Amarnath	1210	3070	1710	3320
2			Srinappa	1120	2990	1600	3890
3			Manjunath	980	2870	1770	4150
4			Muniswami	880	2860	1120	2930
5			Mallappa	1540	2790	2020	3650
6	B.Kurubara halli		Ratnamma w/o	1110	1960	1290	3700
7			Reddamma	730	2540	1640	3180
8			Subbanna	670	2200	1390	3400
9			Gopalapaa	1160	2420	1200	2870
10			Yellamma w/o	1720	3270	2350	4370
11	Kodihalli		Shivashankarappa s/o venkatappa	540	1710	880	2120
12			Venkataramaiah s/o nareppa	650	1680	1060	2310
13			Changappa s/o Muniyappa	1020	2500	1010	2150
14			Chikkamuniyappa s/o Gurappa	710	1730	1420	3360
15			Sonappa s/o Chowdappa	740	1930	1000	2320
16	Bairakur		Munivenkatappa	700	2470	1370	3770
17			Venkatappa	830	2640	1510	3670
18			Srinappa	950	3160	1300	2900
19			Mareppa	1380	2860	1780	4770
20			Ramaiah	1180	2430	1710	4650
21	Chikkur C. Hosahalli		C.Venkatramaiah	1170	2970	1500	3490
22			C.H. Shankarreddy	1250	3170	2050	4590
23			Viswanath	1110	3410	2210	5530
24			C.N. Baireddy	1440	3790	1660	5640
25			Venkateshappa	1560	3940	2040	5080
26	Rajendrahalli		Thimmanna	1040	3060	1480	3200
27			Chowde.gowda	1340	2420	1790	5700
28			Jaipathi	1150	3150	1910	4150
29			Shiva ramappa	930	2700	1630	4260
30			Kumbari Lakshmaiah	1000	4390	1430	4250
31	H.G Halli		Bairappa	1710	3070	2190	3840

32			Anjanappa s\o	1580	3640	1890	4070
33			Venkateshappa	1550	3280	1920	3370
34			Sanjeevappa	1670	2750	2140	4360
35			Shankarappa	1010	3000	1840	4670
36	N.Chamkanahalli		Annireddy	1060	2450	2050	4570
37			Changareddy	1570	3580	1860	5830
38			Mareembhee w\o	1440	3260	1480	4480
39			Ramya reddy	1520	3530	1920	5970
40			Mastanshab	1650	3780	2320	4940
41	Eruge muthna halli		Krishnappa s/o	1280	2500	1610	2610
42			Munivenkataramappa	720	2300	1040	3100
43			Gangappa	1420	2550	2020	4150
44			Changalrayappa	1140	2670	1560	4290
45			Keshava	910	3040	1310	2970
46	Lakkadoddi		Gattappa s/o	850	2260	1140	2570
47			Munivenkataramappa s/o	1110	2920	2440	4380
48			Mohan	1580	4090	2020	4450
49			Srinappa	1600	3930	1670	3070
50			Sadha shiva	2070	5510	2010	4840

Table 2. List of farmers' fields selected for Groundnut crop sampling and crop yield estimations in Chickballapur district.							
Sl.No	Village	Taluk	Name of the Farmer	FM Pod (kg ha^{-1})	FM TDM (kg ha^{-1})	IM Pod (kg ha^{-1})	IM TDM (kg ha^{-1})
1	Thirumani	Gudibande	T.N.Narasimhaiah.	323	586	507	1189
2	Thirumani	Gudibande	Nagaraja.	440	1132	461	1172
3	Thirumani	Gudibande	Suryanarayana.	319	668	473	1128
4	Thirumani	Gudibande	Narayanaswamy.	379	815	577	1992
5	Thirumani	Gudibande	Venkateshappa.	313	527	410	742
6	Somanathapura	Bagepalli	Byrareddy.	291	691	1369	3035
7	Somanathapura	Bagepalli	B.S. Shvirama Reddy	780	1862	631	1346
8	Somanathapura	Bagepalli	Uthanna	232	688	1428	3434
9	Somanathapura	Bagepalli	Chick Byra Reddy	463	1100	646	1420
10	Somanathapura	Bagepalli	Papreddy.	537	1292	562	1105
11	Ramaganahalli	Gudibande	Venkatarayappa.	752	1388	1064	2348
12	Ramaganahalli	Gudibande	Bachappa.	410	978	982	2184
13	Ramaganahalli	Gudibande	Bheemappa.	859	1346	1073	1792
14	Ramaganahalli	Gudibande	Chickanappa.	744	1462	957	2025
15	Ramaganahalli	Gudibande	Buddappa.	352	557	564	1030
16	Devavarlapalli	Bagepalli	Chandrappa.	387	1189	570	1227
17	Devavarlapalli	Bagepalli	Jayachandra Reddy.	313	781	1437	2687
18	Devavarlapalli	Bagepalli	M.Byappa.	577	1365	664	1362
19	Devavarlapalli	Bagepalli	Koda Reddy.	796	1569	664	1364
20	Devavarlapalli	Bagepalli	Venkataramma.	575	1368	681	1432
21	Chakavelu(Kothapalli)	Bagepalli	Thyrappa	589	1450	777	1712
22	Chakavelu(Kothapalli)	Bagepalli	Venkataravarappa.	608	1149	742	1446
23	Chakavelu(Kothapalli)	Bagepalli	Narayana Reddy.	687	1499	726	1453
24	Chakavelu(Kothapalli)	Bagepalli	Venkataravana.	640	1434	724	1324
25	Chakavelu(Kothapalli)	Bagepalli	Aswathappa.	711	1568	697	1189
26	Kallarollapalli	Bagepalli	Srinivasa.	679	1181	798	1541
27	Kallarollapalli	Bagepalli	Manjunatha.	249	644	1570	3076
28	Kallarollapalli	Bagepalli	S.Venkataravana.	320	872	807	1920

29	Kallarollapalli	Bagepalli	RB.Venkataravanappa	572	996	856	1677
30	Kallarollapalli	Bagepalli	Shankarappa.	725	1417	741	1573
31	Arigevarigutta(Mamadimakalapalli)	Bagepalli	Marapa Reddy.	523	907	716	1365
32	Arigevarigutta(Mamadimakalapalli)	Bagepalli	Ramachandra Reddy	640	1512	721	1361
33	Arigevarigutta(Mamadimakalapalli)	Bagepalli	Byra Reddy	307	730	747	1435
34	Arigevarigutta(Mamadimakalapalli)	Bagepalli	Kalavathamma.	567	945	672	1369
35	Arigevarigutta(Mamadimakalapalli)	Bagepalli	T.Byra Reddy.	667	1560	696	1318
36	Kondavabanahalli	Gudibande	Narashimappa.	332	674	439	1069
37	Kondavabanahalli	Gudibande	Naramma.	345	835	488	764
38	Kondavabanahalli	Gudibande	Venkatamma	503	966	702	1344
39	Kondavabanahalli	Gudibande	Sriramappa.	382	836	529	981
40	Kondavabanahalli	Gudibande	Narasihmaiah.	360	717	433	1066
41	Kondavabanahalli	Gudibande	Aswathappa.	360	719	457	1156
42	Kondavabanahalli	Gudibande	Aswathanarayana.	437	1302	514	1124
43	Kondavabanahalli	Gudibande	Venkata Reddy.	212	548	410	874
44	Kondavabanahalli	Gudibande	Gopalappa.	292	664	513	1266
45	Kondavabanahalli	Gudibande	Chick Thirumalappa.	334	860	529	943
46	Chick Kurubarahalli	Gudibande	Subba Reddy	475	1222	644	1146
47	Chick Kurubarahalli	Gudibande	Gopalappa.	458	1112	537	1013
48	Chick Kurubarahalli	Gudibande	Chick Devaiah.	397	1324	572	1262
49	Chick Kurubarahalli	Gudibande	Narayanaswamy.	536	1298	591	1162
50	Chick Kurubarahalli	Gudibande	Chinnappaiah.	450	1302	410	928
51	Balenahalli	Gudibande	Balappa.	316	786	447	1983
52	Balenahalli	Gudibande	Jettappa.	275	667	647	1377
53	Balenahalli	Gudibande	Nanjundappa.	305	894	490	1434
54	Balenahalli	Gudibande	Thimmaiah.	661	1103	1225	2506
55	Balenahalli	Gudibande	Narayanaswamy	348	999	445	2320
56	Kadirannagarikote	Bagepalli	Papanna.	751	1946	691	1436
57	Kadirannagarikote	Bagepalli	Anjinaya Reddy	520	1008	767	1415
58	Kadirannagarikote	Bagepalli	Myakalamarappa.	646	1724	635	1545
59	Kadirannagarikote	Bagepalli	Bhagyamma.	644	1637	732	1585

60	Kadirannagarikote	Bagepalli	Narasihmaiah.	629	1428	405	904
61	Ramanapadi	Bagepalli	Narasimhappa	659	1538	812	2252
62	Ramanapadi	Bagepalli	Raghavendra	462	915	758	1720
63	Ramanapadi	Bagepalli	Ramachandra Reddy	642	1668	554	1303
64	Ramanapadi	Bagepalli	Byra Reddy	362	868	1312	2465
65	Ramanapadi	Bagepalli	Venkata Reddy	589	867	655	1301
66	Chanduru	Gudibande	Pedda Anjinappa	517	1196	554	1115
67	Chanduru	Gudibande	Nagappa	278	899	462	1290
68	Chanduru	Gudibande	Thippanna	354	680	462	1041
69	Chanduru	Gudibande	Narayanappa	380	994	480	929
70	Chanduru	Gudibande	Sanjeevappa	372	803	512	1139
71	Dhoomakuntahally	Gudibande	Kadirappa	386	940	554	1150
72	Dhoomakuntahally	Gudibande	Narasimhappa	469	1153	483	841
73	Dhoomakuntahally	Gudibande	Venkatamma	414	1177	511	1014
74	Dhoomakuntahally	Gudibande	Doddanarasimhappa	329	1121	519	1074
75	Dhoomakuntahally	Gudibande	Chikka venkatarayappa	371	1189	442	975
81	Doddakurubarahally	Gudibande	Gopalla	335	794	588	1501
82	Doddakurubarahally	Gudibande	Muniswamy	437	995	437	1137
83	Doddakurubarahally	Gudibande	Ramaiah	430	890	520	994
84	Doddakurubarahally	Gudibande	Bovi Venkatarayappa	385	1059	389	1065
85	Doddakurubarahally	Gudibande	Ramappa	390	944	403	798
86	Yenigadale	Gudibande	S.Srinivas Reddy	204	475	511	811
87	Yenigadale	Gudibande	Srirama Reddy	476	909	582	975
88	Yenigadale	Gudibande	R.N.Venkataravanappa	456	774	469	830
89	Yenigadale	Gudibande	C.Raja Reddy	440	944	556	975
90	Yenigadale	Gudibande	P.Venkata Reddy	464	1167	568	972
91	Chilakalanerpu	Chitamani	Manjunath	411	712	508	831
92	Chilakalanerpu	Chitamani	Anjinappa	460	732	465	755
93	Chilakalanerpu	Chitamani	Lakshmana Reddy	435	757	556	803
94	Chilakalanerpu	Chitamani	Shivappa	411	861	479	796

95	Chilakalanerpu	Chitamani	Narayana Swamy	287	996	389	719
96	Diguru	Chitamani	M.Kayappa	344	818	557	998
97	Diguru	Chitamani	K.R.Venkatarayappa	394	641	551	897
98	Diguru	Chitamani	Muniyappa	201	407	1107	1722
99	Diguru	Chitamani	K.V.Srinivas Reddy	223	413	1054	1709
100	Diguru	Chitamani	V.Narayana Swamy	357	967	462	716
101	Tuluvanuru	Chitamani	T.Y.Subbarayappa	509	950	572	1035
102	Tuluvanuru	Chitamani	Lakshmanna	568	1004	685	1089
103	Tuluvanuru	Chitamani	Sriramappa	438	847	634	1054
104	Tuluvanuru	Chitamani	Gangalappa	511	986	622	1077
105	Tuluvanuru	Chitamani	T.V.Krishnappa	582	1133	593	1059
106	Dharmavarahally	Chitamani	D.R.Chowda Reddy	588	1067	613	969
107	Dharmavarahally	Chitamani	R.Chowda Reddy	573	1177	585	869
108	Dharmavarahally	Chitamani	Venkata Reddy	273	552	1244	2351
109	Dharmavarahally	Chitamani	Venkata Reddy	426	1330	604	1131
110	Dharmavarahally	Chitamani	G.K.Sriramappa	536	914	638	1005

Table 3. List of farmers' fields selected for Ragi crop sampling and crop yield estimations in Tumkur district.							
S.No.	**Name of Village**	**Name of the Taluk**	**Name of the farmer**	**Grain (kg ha^{-1})**	**TDM (kg ha^{-1})**	**Grain (kg ha^{-1})**	**TDM (kg ha^{-1})**
1	Nagulapura	Gubbi	Veeranna / Channaiah	1320	5490	2240	6960
2	Nagulapura	Gubbi	Palakshi / Veeranna	990	3490	1620	3790
3	Nagulapura	Gubbi	Chandraiah / Hanumanthaiah	1650	5700	2290	8050
4	Samudranakote	Gubbi	ShettyYellaiah / Hanumanthaiah	1500	5000	1660	6240
5	Samudranakote	Gubbi	Parameshwar / ShettyYellaiah	1530	5590	2190	7300
6	Samudranakote	Gubbi	Shivagangappa / Linganna	1570	5200	2030	7190
7	Adalagere	Gubbi	Basavarajaiah / Hanumaiah	1920	6860	3300	10870
8	Adalagere	Gubbi	Jagadeesh / Hanumaiah	1560	5230	2410	7610
9	Adalagere	Gubbi	Shivanna / Sanna Dharmaiah			2560	8270
10	Adalagere	Gubbi	Mallesha / Sanna Dharmaiah	1870	5870	2340	7160
11	Kundaranahalli	Gubbi	Kumar / Krishnappa	2560	6480	1540	5500
12	Kundaranahalli	Gubbi	Huchappa / Siddaiah	1430	5030	930	4550
13	Kundaranahalli	Gubbi	Parvathamma / Shankarappa			2320	7590
14	Kundaranahalli	Gubbi	K.R. Siddalingaiah	1510	4370	1620	5020
15	Sagaranahalli	Gubbi	Mahadevaiah / Thirthaiah	650	4060	2130	6830
16	Sagaranahalli	Gubbi	Siddaramaiah / Shabanna		3630	1550	6250
17	Sagaranahalli	Gubbi	Nanjundaiah / Siddaramaiah	1020	5050	1960	7010
18	Sagaranahalli	Gubbi	Shanthappa / Parameshappa			1700	6110
19	Sagaranahalli	Gubbi	Omkar / Basavaraju	1270	5490	1780	5890
20	Thimmalipalya	Gubbi	Mahaveeranna / Shantharaju	1710	6260	1810	6550
21	Thimmalipalya	Gubbi	Lingaraju / Veeranna	1700	5610	1880	6560
22	Thimmalipalya	Gubbi	Doddaiah / Veera Chikkaiah	1470	5660	1140	5980
23	Nittur	Gubbi	Rajanna / Ganganna	1060	4830	1580	7190
24	Nittur	Gubbi	Somashekar / Mahalingappa			1540	6170
25	Nittur	Gubbi	Prabhanna / Hanumantharayappa	1450	5210	1700	6050
26	Madhugonahalli	Kunigal	Nanjundaiah / Kallaiah	2540	7800	2720	7160
27	Madhugonahalli	Kunigal	Gangamma / W / o Late Gangadaraiah	2270	6020	2530	6640

28	Madhugonahalli	Kunigal	Kadaiah / Kalla Boraiah	3010	8420	3880	9000
29	Borugona Halli	Kunigal	Thammaiah / Kullaiah	3010	10360	4380	13550
30	Borugona Halli	Kunigal	Yale Mariyappa / Kullaiah	2300	7470	2780	8580
31	Benachakallu	Kunigal	Mahesh / Giriyappa	1920	7940	2800	13040
32	Benachakallu	Kunigal	Venkatesh / Govindaiah	1260	6170	2360	8810
33	Benachakallu	Kunigal	Sathish / Ramachandrappa	2400	3040	3240	8500
34	Chowdanakuppe	Kunigal	PuttojiRao / Siddoji Rao	1700	6500	2610	9350
35	Chowdanakuppe	Kunigal	Mayanna / Channaiah	1570	8050	3570	13390
36	Madappanahalli	Kunigal	Thimmaiah / Madhavaiah	1500	6680	1860	8050
37	Madappanahalli	Kunigal	Dasappa / Venkatappa	1850	6650	2260	9330
38	Madappanahalli	Kunigal	M.C.Rajanna / Channa Gowda			3060	9840
39	Lakmenahalli	Chikkanayakana halli	ThammeGowdfa / Siddappa	1910	5350	2230	6770
40	Lakmenahalli	Chikkanayakana halli	Rajanna / Shivanna			2560	7720
41	Lakmenahalli	Chikkanayakana halli	Basavaiah / Boraiah	1360	4950		3810
42	Sadarahalli	Chikkanayakana halli	Ramachandrachar / Hanumanthappa	1120	4440	2110	6390
43	Sadarahalli	Chikkanayakana halli	Shankarappa / Julaiah			2500	7400
44	Sadarahalli	Chikkanayakana halli	Khalandarsab / Mydensab	1300	4470	1900	6050
45	Kandikere	Chikkanayakana halli	Niranjanmurthy / Ganganna	1430	4410	2260	6590
46	Kandikere	Chikkanayakana halli	Nagaraju / Ramaiah			2090	6870
47	Kandikere	Chikkanayakana halli	Shivanna / Ninganna	1580	5320	2240	6510
48	Pochakatte	Chikkanayakana halli	Byranna / Hanumaiah	1220	4260	1770	4810
49	T.S. Halli	Chikkanayakana halli	Lakshmaiah / Ramappa	1410	3490	1590	5060

50	Ballekatte	Chikkanayakana halli	Honnappa/Rangappa	1180	3600	1740	4680
51	Ballekatte	Chikkanayakana halli	Shivaiah/Ramaiah	1230	5340	1940	7670
52	Nandi Halli	Chikkanayakana halli	Eswaraiah/Pathaiah	1440	4260	2120	5350
53	Nandi Halli	Chikkanayakana halli	Basappa/Gaviyappa	1380	4200	1980	6370

Table 3.1. List of farmers' fields selected for Groundnut crop sampling and crop yield estimations in Tumkur district.							
S. No.	**Name of Taluk**	**Name of the village**	**Name of the farmer**	**Pod (kg ha^{-1})**	**TDM (kg ha^{-1})**	**Pod (kg ha^{-1})**	**TDM (kg ha^{-1})**
1	Pavagada	Venkatapura	K.S.Hanumanthappa / K.Sanjanna	1370	4660	1150	4360
2			Salekondappa / Salerangappa	1350	3440	1780	3960
3			Adeppa / Kunte malappa			1600	3730
4			Sujatha / Anjanappa	1410	4560	1480	4750
5			Vishvanathappa / Shashappa	1150	3970	1980	4510
6	Pavagada	Srinivasapura	Srirama reddy / Venkatappa	880	2340	1320	3370
7			Narayana reddy / Venkatappa			1400	2720
8			Nanja reddy			1490	3330
9			Savithramma	1040	2610	1430	3150
10			Venkatareddy	950	2900	1130	3760
11	Pavagada	Bordarahalli	B.N.Narasappa / Padayappa	910	2760	1340	3870
12			Lakshmi / Narashima Murthy	990	2770	1340	4180
13			Narayana reddy / Anjanareddy	950	2660	1130	3500
14			Subba reddy / Hanumanthappa			1510	2830
15			Ningamma / Malappa	1100	2880	1740	4480
16	Madhugiri	Basavanahally	Chinna lingappa / Dodda lingappa	730	1760	950	2430
17			Goppakka / Veeramalaiah		2060	1200	2580
18			Nagarajappa / Veeramalaiah	930	2055	1320	2650
19	Madhugiri	Jadagondanahalli	Sanna Kumaraiaha / Chikkayelappa	1040	2140	1310	2520
20			Shivaraju	1040	2140	1200	2540
21	Madhugiri	Keregalapalya	Putta Rangappa / Veerappa	790	2280	800	2250
22			K.J. Paramesh / Jagadeesh			1010	2090
23			Shivanna / Linganna	980	2360	1080	2600
24			Basavaraju / Veeranna	860	2390	1270	2790

25			K.M. Kemparaju / Mallaiah			1300	2850
26	Madhugiri	Amaravathi	Bheemanna / Ramaiah			1680	3380
27			Veeranna / Ramaiah	1320	2850	1530	3840
28			Narayanappa / Hanumanthappa	1040	2730	1520	3290
29			Sanjeevappa / Hanumanthappa			1280	2990
30			Ganganna / Ugrappa			1480	3030
31	Madhugiri	Maruvekere	Rangashamaiah / Rangappa		960	1350	3060
32			G.S. Mahadevappa / G.V. Siddappa			1300	3230
33			Asif S/o Shamiulla Khan	1410	3230	1120	2940
34			Mallaiah / Murudappa			830	2470
35	Madhugiri	Guru Vaddana Halli	Chikka Hanumanthappa / Hanumaiah	860	1910	1220	2530
36	Madhugiri	Palyada Halli	Muddamma / Ramanna	980	2460	1060	2620
37			Betta Lingappa / Lingappa	980	2460	1320	2920
38	Madhugiri	Sogenahalli	Veeramallppa / Rangadhama	1020	2720	1660	3970
39	Madhugiri	Shetty Halli	Sidda gangamma / Govindappa	840	2360	1520	2790
40		D.V. Halli	Chikka Ramappa / Ramappa			1390	2880
41			Gangadharaiah / Veera Chikkappa	660	660	840	2390
42			Chikka Thimmaiah / Rangappa			1270	3300
43	Madhugiri	Tungoti	T. Kote Kallaiah / Thimme Gowda	950	950	1460	3650
44			Nagarajappa / Veerakyathappa	1130	2300	1540	3370
45	Madhugiri	Vaddarahalli	Rajanna / Sanna kurmaiah	1130	2560	1660	3600
46			Rajanna / Dodda Kurmaiah	1090	2370	1290	3130
47	Madhugiri	Jade Gondana Halli	Lakshmamma / Late Muddappa	1160	2540	1350	3380

48			Mallesha / Putta Kurmaiah			1660	4110
49			Bheemanna / Kariyanna	1370	2490	1180	2710
50	Madhugiri	Dabbegatta	Sanna Uchappa / Dasappa	890	1910	1060	2840
51			Chikka Uchappa / Dasappa	1050	2680	1610	3690
52			Sreeramaiah / Dodda Ramaiah			1280	2820
53			Byatappa / Sanna Uchappa	1160	2870	1420	2930
54			Sakamma / Late Rangappa			1240	2950
55	Madhugiri	Kurubarahalli	Doddarangappa / Chikkarangappa	1160	2650	1650	3400
56			Kariyanna / Putta Rangappa	700	1890	1440	3260
57			Jayaramanna / Dodda Ramaiah			1210	3560
58			Ammajakka / Late Alappa			1490	3670
59	Madhugiri	Rangapura	Sharadhamma / R.B. Chandranna	910	1920	1680	3170
60			Prashanth / R.B. Chandranna	1130	2290	1400	2800
61			Chowdappa / Chikkanna	720	2020	1260	2960
62			Katappa / Lingappa	1050	2260	1440	2640

Table 4. List of farmers' fields selected for Maize crop sampling and crop yield estimations in Chitradurga district.							
Sl.NO	Name of Village	Name of the Taluk	Name of the farmer	Grain (kg ha^{-1})	TDM (kg ha^{-1})	Grain (kg ha^{-1})	TDM (kg ha^{-1})
1	Hirekabbigere	Chitradurga	Surappa / ramaiah	3860	8860	6960	13450
2	Hirekabbigere	Chitradurga	Palanna / Nagappa	4490	10020	6600	13630
3	Hirekabbigere	Chitradurga	Nagamma / Timmanna	4340	8410	6950	14290
4	Hirekabbigere	Chitradurga	Ranganna / Obanna	4530	10350	6660	13670
5	Hirekabbigere	Chitradurga	Palaiah / Palaiah	4740	10240	7380	14960
6	Chikkabbigere	Chitradurga	Nagaraja / Rajanna	4690	10230	7200	12940
7	Chikkabbigere	Chitradurga	Papamma / Papanna	5280	10680	7730	14670
8	Chikkabbigere	Chitradurga	Tippamma / Nagarajappa	4470	9320	7460	14920
9	Chikkabbigere	Chitradurga	Rajamma / Rajappa	4710	9410	7330	13710
10	Chikkabbigere	Chitradurga	Bosaiah / Palaiah	5090	11230	7750	14630
11	Hireguntanor	Chitradurga	Basappa / Kariveerappa	4340	9300	7290	13180
12	Hireguntanor	Chitradurga	Shankarappa / Rajanna	4300	10070	7000	12830
13	Hireguntanor	Chitradurga	Viswanadhaiah / tipperudrappa		9210	7310	13920
14	Hireguntanor	Chitradurga	savittramma / Jayappa	4070	8350	6380	12120
15	Hireguntanor	Chitradurga	Rajanna	4380	9070	6780	13110
16	Singapura	Chitradurga	Ravishankar	4510	8450	6220	12120
17	Singapura	Chitradurga	Eswarappa	4300	7450	7200	14170
18	Singapura	Chitradurga	Rajappa / tipperudrappa	3930	7000	6610	12850
19	Singapura	Chitradurga	Ramachandrappa	4410	8090	7360	14080
20	Singapura	Chitradurga	Rudrappa	4160	8190	6500	12370
21	Hullur	Chitradurga	Rudrappa / Tipperudrappa	4560	8620	6570	12580
22	Hullur	Chitradurga	Ravishankar / shankarappa	3910	7570	7050	13240
23	Hullur	Chitradurga	udaykumar / veerabhadrappa	4040	7590	5620	10450
24	Hullur	Chitradurga	Kumar	3940	7840	7300	14080
25	Hullur	Chitradurga	Shankarappa	4220	8530	7150	14100
26	Chilangi	Chitradurga	Mallappa / Gourappa	5710	11900	7850	17080
27	Chilangi	Chitradurga	sammadamma / Guddappa	5890	12150	7430	16490
28	Chilangi	Chitradurga	Pushpa / Guddappa	5400	10930	8060	16930

29	Chilangi	Chitradurga	Chandranna / Guddappa	7030	11920	7970	16850
30	Chilangi	Chitradurga	Mailarappa / Kencheppa	5520	9880	7290	15260
31	Lingavanagatihalli	Chitradurga	Sekarappa / kuriningappa	5750	11460	7290	16050
32	Lingavanagatihalli	Chitradurga	Chandrappa / Ningappa	7140	12530	7420	16740
33	Lingavanagatihalli	Chitradurga	Eswarappa / borappa	7260	12890	7540	16680
34	Lingavanagatihalli	Chitradurga	Borappa / Murtappa	5850	12000	7540	16100
35	Lingavanagatihalli	Chitradurga	Obappa / Borappa	7090	13340	8560	17470
36	Godanahall	Chitradurga	Onnappa / Mallappa	5240	10890	7770	15080
37	Godanahall	Chitradurga	Ravikumar / Onnappa	5190	10840	7480	14150
38	Godanahall	Chitradurga	Malleshappa / Parameswarappa	4090	8990	6220	11520
39	Godanahall	Chitradurga	Rajappa / Ramalingappa	4120	8650	5910	12110
40	Godanahall	Chitradurga	Yashodamma / Rajappa	3720	7810	5120	9350
41	Sondekola	Chitradurga	seenappa / Hanumantappa	3930	8340	5030	11130
42	Sondekola	Chitradurga	Jagadeesh	3640	7990	4860	8790
43	Sondekola	Chitradurga	Halappa / Parameshappa	3760	6440	4760	10130
44	Sondekola	Chitradurga	Channappa / Beemappa	3690	7570	4760	10120
45	Sondekola	Chitradurga	Sanneswarappa / Timmaraju	3930	8170	4720	9970
46	Apparasanahalli	Holalkere	Narasimhamurthy / Bosappa	6230	13700	7980	18840
47	Apparasanahalli	Holalkere	Maharudrappa / Sannappa	6050	12540	7730	16850
48	Apparasanahalli	Holalkere	Sankarappa / Veerappa	7630	14060	8540	18450
49	Apparasanahalli	Holalkere	Chidanand / Siddalingappa	7870	14290	8750	18840
50	Apparasanahalli	Holalkere	Harsha / Basavarajappa	6110	13210	7370	18280
51	Adanur	Holalkere	Mahantesh / Nanjundappa	6100	14780	7830	18030
52	Adanur	Holalkere	Ravikumar / Rangappa	6010	12590	7730	18000
53	Adanur	Holalkere	Timmanna / Basappa	4950	10680	7770	16320
54	Adanur	Holalkere	Tippeswamy / Sannarangappa	6640	13460	6850	16250
55	Adanur	Holalkere	Pandurangappa / Sannarangappa	6330	12630	8030	14530
56	Adanur	Holalkere	Rangappa	6650	13900	7700	16760

Table 4.1.List of farmers' fields selected for Groundnut crop sampling and crop yield estimations in Chitradurga district.							
Sl.NO	Name of Village	Name of the Taluk	Name of the farmer	Pod (kg ha^{-1})	TDM (kg ha^{-1})	Pod (kg ha^{-1})	TDM (kg ha^{-1})
1	Kannenahalli	Chellakere	Siddesh / Siddalingappa	640	1050	910	1410
2	Kannenahalli	Chellakere	Hanumappa / rudrappa	480	1020	630	1230
3	Kannenahalli	Chellakere	tipperudrappa / pallakappa	690	1140	780	1400
4	Kannenahalli	Chellakere	tippeswamy / Chikkasiddaramanna	330	880	540	1030
5	Kannenahalli	Chellakere	Jayanna / sannasiddanna	610	1050	650	1150
6	Somaguddu	Chellakere	Lalitamma / Chandranna	730	1180	780	1320
7	Somaguddu	Chellakere	rudranna / tippamma	270	720	910	940
8	Somaguddu	Chellakere	kednchenna / dyamanna	600	1030	770	1370
9	Somaguddu	Chellakere	sekharappa / rudranna	770	1250	830	1360
10	Somaguddu	Chellakere	basanna / veeranna	630	1060	770	1370
11	Laxmipura	Chellakere	lokesh / ramanna	490	870	660	1150
12	Laxmipura	Chellakere	veeranna / kenchenna	260	620	400	840
13	Laxmipura	Chellakere	sankarappa	290	690	280	750
14	Laxmipura	Chellakere	prahalladareddy / tippareddy	590	1030	650	1090
15	Laxmipura	Chellakere	Laxmareddy / venkatramreddy	430	830	400	790
16	Siddapura	Chellakere	sirianna / kenjedappa	560	1040	750	1300
17	Siddapura	Chellakere	gangamma / sannappa	670	1110	760	1260
18	Siddapura	Chellakere	Chikkanna / Chikkamma	650	1140	740	1290
19	Siddapura	Chellakere	tippeswamy / Chikkanna	670	1110	730	1260
20	Siddapura	Chellakere	Krishnappa / Chikkanna	600	1100	690	1330
21	Oderahalli	Molakalmor	sivarudrappa / hanumantappa	430	1220	550	1310
22	Oderahalli	Molakalmor	ulugappa / yellamma	780	1510	920	1730
23	Oderahalli	Molakalmor	timmappa / basappa	640	1220	690	1520
24	Oderahalli	Molakalmor	Basavaraj / Basanna	610	1420	800	1590
25	Oderahalli	Molakalmor	tuppadappa / kollarappa	830	1470	740	1530
26	Dodaguru	Molakalmor	Basavaraj / kuntimarappa	590	1060	900	1620
27	Dodaguru	Molakalmor	Anjanappa / marappa	620	1110	550	1300

28	Dodaguru	Molakalmor	parameshappa / hanumantappa	320	840	360	1010
29	Dodaguru	Molakalmor	Maranna / Chikkanna	720	1200	720	1440
30	Dodaguru	Molakalmor	Tippeswamy / Chinnappa	460	1060	830	1600
31	V.K.Gudda	Hiriyur	Gouramma / G.M.veeranna	1010	1690	2170	3220
32	V.K.Gudda	Hiriyur	Veeranna / veerappa	1400	2230	1840	2990
33	V.K.Gudda	Hiriyur	saradamma / Rangaswamy	1010	2080	1430	3050
34	V.K.Gudda	Hiriyur	rangappa / rajanna	900	1780	1390	2850
35	V.K.Gudda	Hiriyur	revanna / rajanna	770	1770	1550	2910
36	Sakkara	Hiriyur	Modalalingaswamy / lingaswamy	1300	2160	2000	3250
37	Sakkara	Hiriyur	Ranganna / sekarappa	1510	2090	1490	3200
38	Sakkara	Hiriyur	laxmidevi / tippeswamy	1950	2160	2140	3070
39	Sakkara	Hiriyur	somasekhar / diddalingaswamy	1210	2100	2720	2940
40	Sakkara	Hiriyur	Ranganadh / pandurangappa	970	2080	990	1930

Table 4.2. List of farmers' fields selected for Ragi crop sampling and crop yield estimations in Chitradurga district.							
Sl.No	Name of Village	Name of the Taluk	Name of the farmer	Grain (kg ha^{-1})	TDM (kg ha^{-1})	Grain (kg ha^{-1})	TDM (kg ha^{-1})
1	Devigere	Hosadurga	Giriappa / veerabhadrappa	2710	7150	3280	10130
2	Devigere	Hosadurga	thimmappa / timmappa	1490	6700	2270	7730
3	Devigere	Hosadurga	srinivas / Chandrappa	1860	7580	2440	9920
4	Devigere	Hosadurga	srisailappa / eswarappa	2180	7840	2730	9560
5	Devigere	Hosadurga	Hanumantappa / timmappa	1960	7980	2600	9690
6	Kumbarakatte	Hosadurga	Suvarnamma / ramchandrappa	1890	7530	2510	9090
7	Kumbarakatte	Hosadurga	suvarna / Rudrappa	2070	7780	2870	9440
8	Kumbarakatte	Hosadurga	ranganadh / Hanumantappa	2300	7880	2760	9610
9	Kumbarakatte	Hosadurga	srinivas / ramaiah	1790	6830	2250	9060
10	Kumbarakatte	Hosadurga	ramesh / veerabhadrappa	1250	5460	1690	9730
11	Navinakatte	Hosadurga	MT.Krishnamurthy / timmappa	1990	6940	2460	9730
12	Navinakatte	Hosadurga	sunanda / Jayappa	1820	7490	2650	9000
13	Navinakatte	Hosadurga	Timmesh / omkarappa	2130	7640	2780	9080
14	Navinakatte	Hosadurga	lokesh / Obulappa	1370	6340	2190	8930
15	Navinakatte	Hosadurga	saradamma / krishnamurthy	2020	8310	3000	9600
16	Beesanahally	Hosadurga	prakash / sannappa	1450	7400	2050	8310
17	Beesanahally	Hosadurga	Mahalingappa / Chikkappa	1250	7750	1880	6700
18	Beesanahally	Hosadurga	Basavanth nail / ram Naik	2320	6950	2940	8990
19	Beesanahally	Hosadurga	herappa / eswarappa	1790	7510	2800	8280
20	Beesanahally	Hosadurga	nagaraju / sannappa	2130	7000	2740	9370

Table 5. List of farmers' fields selected for Maize crop sampling and crop yield estimations in Haveri district							
				Farmers' Management		IM+Micronutrients	
Sl.No	Name of Village	Name of Taluk	Farmers Name	Grain (kg ha^{-1})	TDM (kg ha^{-1})	Grain (kg ha^{-1})	TDM (kg ha^{-1})
1	Rattihalli	Hirekerur	Narayanappa Bilachi	4840	7829	6867	12531
2	Rattihalli	Hirekerur	Parasuram Ajjappa Devanakatti	5492	10410	7231	13312
3	Rattihalli	Hirekerur	Nagaraj K Bidari	4509	7777	6113	11569
4	Rattihalli	Hirekerur	Jafar Saab Sunakal			6086	12132
5	Rattihalli	Hirekerur	V.B.Bennur			8432	14174
6	Hire Madapura	Hirekerur	Sivana gowda.C.Harnalli	4134	7990	6683	13584
7	Hire Madapura	Hirekerur	Veerana Gowda Hetanahalli	3790	7484	7055	14418
8	Hire Madapura	Hirekerur	Karibasappa Bankar	6185	11212	8435	16500
9	Hire Madapura	Hirekerur	Karebasappa Gubbar			6544	13394
10	Hire Madapura	Hirekerur	Ramesh Angadi			7675	14825
11	Kudapali	Hirekerur	Nagaraj .H.Banakannavar	4177	7988	6600	11173
12	Kudapali	Hirekerur	Malatesh Siddappa Ujjannavar	4462	8622	6954	11364
13	Kudapali	Hirekerur	Maheshappa Sivamurteppa	5824	9855	9087	14917
14	Kudapali	Hirekerur	Sidappa Halappa Kusugar			7069	11399
15	Kudapali	Hirekerur	Basavantappa.V.Kurubar			6365	11450
16	Ingala Gundi	Hirekerur	Revanappa.C.Tambaka	5863	12300	7397	14119
17	Ingala Gundi	Hirekerur	Vijaya Pujar	5402	13177	7363	14412
18	Ingala Gundi	Hirekerur	Mangalavva.R.Harambuchadi	11216		6990	15365
19	Ingala Gundi	Hirekerur	Mallanavar.H			6742	13424
20	Ingala Gundi	Hirekerur	Rudrappa Mallanavar			7575	14274
21	Tavageri	Hirekerur	Shankara Gowda Ajjappanavar	6310	11859	8508	14647
22	Tavageri	Hirekerur	Shambanna Gowda Patil	6803	15117	9952	17944
23	Tavageri	Hirekerur	Hanumantappa Kurubar	7068	12395	9578	18001
24	Tavageri	Hirekerur	Sanna Gowda Patil			8678	14738
25	Tavageri	Hirekerur	Chandrappa Ajjappanavar			9474	15109
26	Hire Maraba	Hirekerur	Karebasappa Hosmani	5914	6955	9413	10867

27	Hire Maraba	Hirekerur	Parwat Gowda patil	6670	7862	9023	10235
28	Hire Maraba	Hirekerur	Basana Gowda.C.Patil	5303	6292	7488	8491
29	Hire Maraba	Hirekerur	Siddappa.C.Bankar			9576	10794
30	Hire Maraba	Hirekerur	Jagadeesh Henchinamani			8795	9935
31	Kanivi Siddagiri	Hirekerur	Mahesh Gowda Nagammunur	5871	8082	8422	10496
32	Kanivi Siddagiri	Hirekerur	Siddappa.C.Hettihalli	5244	7245	8285	10205
33	Kanivi Siddagiri	Hirekerur	SadaSivappa Halwani	5488	7504	8904	11060
34	Kanivi Siddagiri	Hirekerur	Kuberappa Sivanagappa Kariyannavar			8946	11242
35	Kanivi Siddagiri	Hirekerur	Churi Sivanagappa Sivappa			8315	10699
36	Kulainur	Haveri	Suresh Swaoor	6593	8912	9460	12385
37	Kulainur	Haveri	Mattihalli Sivappa Chennappa	5987	8478	7842	10429
38	Kulainur	Haveri	Asundi Manju Bailappa	5296	7216	7714	9657
39	Kulainur	Haveri	Mallashetty Mahadevappa Kariyappa			8899	11739
40	Kulainur	Haveri	Gadiyappa Gowda Bapu Gowda			8231	10667
41	Kabbur	Haveri	Chandra Hunnatti	4630	5872	6347	7832
42	Kabbur	Haveri	Umesh Kummar	5263	6955	7805	9926
43	Kabbur	Haveri	Basava Devihosur	5520	7064	7707	9353
44	Kabbur	Haveri	Shankrappa Honnatti			7541	9361
45	Kabbur	Haveri	Siddalingappa Vasakeri			7056	8708
46	Basapur	Haveri	Paramappa Durgappa Chawadi	5699	7239	7656	10140
47	Basapur	Haveri	Lingappa Mallappa Muddi	4856	6138	6855	9316
48	Basapur	Haveri	Fakhiresh Ningappa Kambli	3965	5312	6330	8385
49	Basapur	Haveri	Shivappa.S.Kanavalli			7308	10019
50	Basapur	Haveri	Kare Yellappa.H.Kesaralli			7208	9851
51	Belavigi	Haveri	Govinda Reddy / Marasa Reddy		8473	8911	12167
52	Belavigi	Haveri	Hanuma Reddy.K.Chikbaramanavar	5982	7751	7508	10108

53	Belavigi	Haveri	Fakeresh.H.Kali	6442	8232	7628	10419
54	Belavigi	Haveri	Tirakana Gowda.M.Dodda Gowar			8624	11133
55	Belavigi	Haveri	Marasa Reddy Govinda Reddy				
56	Kurubugonda	Haveri	Malatesh Gowda Tirakana Gowda Kulkarni	7675	9397	9585	12051
57	Kurubugonda	Haveri	Girijamma Tirakana Gowda Kulkarni	6433	7796	8534	10798
58	Kurubugonda	Haveri	Chennabasappa Puttappa Mallapur	8010	10189	9743	12263
59	Kurubugonda	Haveri	Chennabasappa Kari Gowdar			10271	12460
60	Kurubugonda	Haveri	Shankar Gowda Bojana Gowda Police Gowdar			9847	11490
61	Nelogal	Haveri	Danappa Gowda Siddana Gowdar	4637	5914	7651	9811
62	Nelogal	Haveri	Karebasappa Nagappa Bankar	5778	8089	7408	9252
63	Nelogal	Haveri	Somaiah Trilochanaiah Hiremath	6118	8002	6603	8362
64	Nelogal	Haveri	Gudlappa Veerabhadrappa Kallappanavar			7685	9539
65	Nelogal	Haveri	Jayappa Neelappa Dillappanavar			6848	8895
66	Kuppelur	Ranebennur	Basanna Gowda Shankar Gowda	4771	6377	6288	8121
67	Kuppelur	Ranebennur	Jamal saab halgeri	4113	5243	9747	12367
68	Kuppelur	Ranebennur	Hanuma Gowda Halana Gowda Shankar Goudar	4601	6374	7492	10089
69	Kuppelur	Ranebennur	Mahadeva Gowda Veerana Gowda			7557	10104
70	Kuppelur	Ranebennur	Ganeshappa Manakur			6897	8748
71	Kamdod	Ranebennur	Mallappa Siddappa Marrenagoudar	4934	5946	6349	8597
72	Kamdod	Ranebennur	Bettappa Kotrappa Angadi	4715	6263	6596	9257

73	Kamdod	Ranebennur	Mallikarjun Duvalli	4803	5919	6492	8696
74	Kamdod	Ranebennur	Shivakumar Kethalli			9167	0.746
75	Kamdod	Ranebennur	Chengowda Sivanpatil			6834	9112
76	Yediyaala	Ranebennur	Mruthunjappa Sawagi	5677	7664	9430	11896
77	Yediyaala	Ranebennur	Pakshappa Sawagi	5329	6867	9693	12340
78	Yediyaala	Ranebennur	Basavaraj Masanagi	5422	7184	8009	10252
79	Yediyaala	Ranebennur	Rudrappa Chikkury			8224	10984
80	Yediyaala	Ranebennur	Mahesh Masanagi			7989	10360
81	Y.T.Medleri (Yallapur)	Ranebennur	Lingappa Hanumappa Kokkenavar	5385	6883	7577	9298
82	Y.T.Medleri (Yallapur)	Ranebennur	Rajeeva Asureddy Belahalli	5379	7033	7754	10063
83	Y.T.Medleri (Yallapur)	Ranebennur	Lingaraj Sivappa Reddyar	5596	7299	8023	10059
84	Y.T.Medleri (Yallapur)	Ranebennur	Yellappa Mudiyappa Ambanur			8181	10151
85	Y.T.Medleri (Yallapur)	Ranebennur	Sivappa Kariyellappa Sattappanavar			8149	10135
86	Chelgeri	Ranebennur	Eshappa Adapad	4713	6048	6009	7887
87	Chelgeri	Ranebennur	Koteppa N Talwar	4456	5732	6717	8787
88	Chelgeri	Ranebennur	Basana Gowda Siddappa Gowda M Ujjanagoudar	4181	5425	6646	9126
89	Chelgeri	Ranebennur	Venkappa Ramappa Madapur			6416	8551
90	Chelgeri	Ranebennur	Neelappa Durgappa Summakkanavar			6512	8406

Table 5.1. List of farmers' fields selected for Groundnut crop sampling and crop yield estimations in Haveri district.							
Sl.No	Name of Village	Name of Taluk	Farmers Name	POD (kg ha^{-1})	TDM (kg ha^{-1})	POD (kg ha^{-1})	TDM (kg ha^{-1})
1	Savanur	Savanur	Rajshekhar Mattigar	1440	3160	2450	4000
2			Ashok Ganiger	1780	4050	2710	4490
3			Ganesh Ganiger	1510	3470	2290	4170
4			Sanganna Gowda Naganna Gowda Patil			2550	4740
5			Sivana Gowda Rudra Gowda Patil			2270	3910
6	Chillur	Savanur	Yellavva Durgappa Talwar	2110	4470	2670	4320
7			Basappa Fakhirappa Tirakannavar	1760	3610	2320	3930
8			Parasappa Mahadevappa Tirakannavar	2020	4060	3080	4510
9			Siddana Gowda Devana Gowda			2780	4580
10			Murthu saab Raja saab Nadaf			1540	3100
11	Kundur	Shiggaon	Puttappa Hanagal	2310	4230	3490	5850
12			Basanna Gowda B Patil	2820	5010	4190	6110
13			Nagappa Kadakol	2240	4390	3750	6050
14			Rudrappa Bangi			3090	3090
15			Suresh Ullagaddi			3320	5270

Table 6. List of farmers' fields selected for Soybean crop sampling and crop yield estimations in Dharwad district.							
Sl.No	Name of the village	Name of the Taluk	Name of the farmer	Grain (kg ha^{-1})	TDM (kg ha^{-1})	Grain (kg ha^{-1})	TDM (kg ha^{-1})
1	Hosatti	Dharwad	G.M.Doddawad	1860	3900		
2			Girappa M Navalur	1600	3260		
3			Rajshekhar patil	1790	3490		
4			Lakshappa M Doddawad	1700	3390		
5			Devappa Dhalawayi	1260	2420		
6			Siddappa.G.Hosatti			2370	5450
7			Fakkirappa.S.Murari			2530	5080
8			Rayappa.B.Murari			2840	6430
9			ShantVeerappa Doddawad			2520	5270
10			Ningappa SannaGowdar			2360	4290
11	Madanabavi	Dharwad	Irappa Kagrannavar	1200	2600		
12			Madivalappa.C.Kalled	1690	3730		
13			Mantesh.V.Sampgaov	1310	2460		
14			Basappa.P.Kalled	1540	3340		
15			Irappa Karennavar			2420	4850
16			Ravivarma Patil			1970	4150
17			Hanumanthanayak.K.Patil			1940	3940
18	Kamalapur	Dharwad	Sivappa Akkotti	1950	3790		
19			Channappa M Badiger	2250	4930		
20			Lingappa B Talwar	1760	3850		
21			Sayed Mukthum saithsanathi	2320	4340		
22			Sayed.H.Saithsanathi	2430	5040		
23			Gangadhar.B.Badiger			2200	4790
24			Mallikarjun.C.Badiger			2620	5000

25			Sivalingappa.B.Anaad			2700	5620
26			Siddalingappa Akki			2620	5460
27			Sayed Hussain Saithsanathi			2990	5950
28	Malapur	Dharwad	Nagappa.M.Yeravatti	1990	4040		
29			Basappa.N.Soudatti	1740	3550		
30			Madivalappa Eshannavar			2270	4950
31			Madivalappa Eshannavar			2610	5970
32	Dastikoppa	Kalaghatagi	Chandragouda Agasimani	1780	4710		
33			Madevappa.B.Adavappanavar	1440	3590	1810	4930
34			Nagappa.S.Savanur	1300	3250		
35			Shankargouda.B.Jangalappagouda	1110	2550		
36			Ningappa.B.Koti	1140	2540	2750	6480
37			Adappa.D.Adavappanavar			1700	4480
38			Ningappa.B.Bammigatti			1960	4820
39			Madevappa.B.Savanur			1590	4080
40	Hindasgeri	Kalaghatagi	Saivaputrappa.B.Sutagatti	1200	3030		
41			Kallappa.S.Tavargeri	1300	3030		
42			Madevappa.H.Betgeri	1370	3140		
43			Malleshappa.H.Betgeri	1820	3750		
44			Sangappa.C.Machapur	1190	2450		
45			Sadevappa.H.Makandar			1720	3840
46			Basappa.C.Machapur			1890	4740
47			Sivakumar.K.huddar			2050	4840
48			Budappa.S.Huddar			2060	5010
49			Basappa.S.Huddar			2270	5590
50	Dummawad	Kalaghatagi	Yellappa.Y	1660	3140		
51			Basappa.N.Bairidevarkoppa	1150	2430		
52			Channabasappa.G.Hubbali	1380	2780		
53			Basappa.B.Kittur	1640	3200		
54			Bheemappa Lakmapur	1770	3640		

55			C.N.Bairidevarakoppa			1750	3410
56			Fakkirappa Basappa			2130	4890
57			Sangappa.B.Hubbali			2440	5830
58			Fakkirappa.N.Bairidevarakoppa			2300	5180
59			U.B.Lakmapur			2150	4100
60	Kuruvinkoppa	Kalaghatagi	Tadar Siddappa Mallappa	1580	3440		
61			Ruyanal Sivaputrappa Tippanna	1770	3820		
62			Prabhu.P.Ittigatti	1220	3440		
63			Basavantappa.P.Metti	1180	2470		
64			Basavanneppa.D.Chendumkar	1470	2920		
65			Panchaiah.B.Hiremath			2160	4360
66			Sangayya.b.heremath			2060	4160
67			Gangayya.G.Hiremath			1750	3810
68			Basayya.S.Hiremath			1480	3150
69			Prabhuswamy Hiremath			1680	3410

Table 6.1. List of farmers' fields selected for Groundnut crop sampling and crop yield estimations in Dharwad district.							
Sl.No	Name of the village	Name of the taluk	Name of the farmer	Pod (kg ha^{-1})	TDM (kg ha^{-1})	Pod (kg ha^{-1})	TDM (kg ha^{-1})
1	Pashupathihal	Kundgol	Irappa Katagi	1340	2540		
2			Tippanna.S.Arlikatti	1580	2580		
3			Darendrappa.S.Hadgar	1550	2500		
4			Basavantappa.S.Katrihal			1430	2730
5			Arooda Hannappa Katrihal			1850	2910
6			Irappa .S.Hadapad			1880	3370
7	Saunshi	Kundgol	Chandrashekhar.H.Kudder	1160	1810		
8			Basamma.H.Kudder	1930	3390		
9			Sangappa Mulimane	2050	3230		
10						1790	2840
11						2560	4490
12						2140	3700
13	Shirugoppi	Hubli	Channabasaiah.B.Virakthamath	840	1710		
14			Shivayya Virakthamath	850	1770		
15			Fakkirappa Nelgudda			1590	2660
16			Channabasappa Nelgudda			1350	2850
17			Somappa Annigeri			1120	2690
18			Channappa.S.Annigeri			1110	2750
19			Mallappa.S.Annigeri			1260	2870

APPENDIX F

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About ICRISAT

The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is a non-profit, non-political organization that does innovative agricultural research and capacity building for sustainable development with a wide array of partners across the globe. ICRISAT's mission is to help empower 644 million poor people to overcome hunger, poverty and a degraded environment in the dry tropics through better agriculture. ICRISAT belongs to the Alliance of Centers of the Consultative Group on International Agricultural Research (CGIAR).

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