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– A Case study from D.Nagenahalli village of Tumakuru District, Karnataka

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FOREWARD

Climate change has become a topic of great concern these days. Apart from biotic stresses, the abiotic stresses due to climate related aberrations are posing huge threats to the agriculture growth. Every institute associated with agricultural research and extension has taken special interest in this regard. The project NICRA (National Initiative on Climate Resilient Agriculture), supported by ICAR is helping in identifying the amicable solutions to these problems.

The TDC (Technology Demonstration Component) of NICRA has been implemented by about 100 KVKs in the past four years in the country. The Krishi Vigyan Kendra, Hirehalli has also taken up this project at Durgada Nagenahalli village of Tumakuru district, and showed significant results in the field of resilient agriculture, which is very much commendable. The outcome of this project can be emulated in similar situations elsewhere in the country.

I am happy that they brought out this publication on different field level interventions implemented by them and their impact. I believe that this publication would help other agencies who take up similar kind of works to learn and execute their climate resilient agriculture practices in a proper way.

I wish them all the success.

T. Manjunatha Rao
Director (Acting)
ICAR-IIHR, Bengaluru

Bengaluru
23rd July, 2015

PREFACE

The National Initiative on Climate Resilient Agriculture (NICRA) is a network project launched by ICAR in 2011. The project aims to enhance resilience of Indian agriculture to climatic change and climatic variability. The Technology Demonstration component (TDC) of NICRA deals with demonstration of an integrated package of proven technologies for adaptation of the crop and livestock production systems to climate variability. KVK (IIHR) Hirehalli had implemented this project at D.Nagenahalli of Koratagere Taluk and Tumkur District. The village is relatively more vulnerable to climatic variability like drought, dry spells and extreme temperature. The village has acute shortage of water and preponderance of waste and common land. After the analysis of climatic vulnerability of the village the climatic resilient interventions are finalized through the following four modules.

Module I : Natural resources. This module consists of interventions related to in-situ moisture conservation, water harvesting and recycling for supplemental irrigation, improved drainage, artificial ground water recharge and water saving irrigation methods. Module II : Crop Production. This module consists of introducing drought/temperature tolerant varieties, water saving paddy cultivation methods, community nurseries for delayed monsoon, custom hiring centers for timely planting, location specific intercropping systems with high sustainable yield index. Module III : Livestock and Fisheries. This module consists use of community lands for fodder production during droughts/ floods, improved fodder/feed storage methods, preventive vaccination, improved shelters for reducing heat stress in livestock , management of fish ponds/tanks during water scarcity and excess water, etc. Module IV : Institutional Interventions. This module consist of institutional interventions either by strengthening the existing ones or initiating new ones relating to seed bank, fodder bank, commodity groups, custom hiring centre, collective marketing, introduction of weather index based insurance and climate literacy through a village level weather station. The overall focus of technology demonstrations under NICRA is to enhance resilience of farm and the farming community to climatic risks as to ensure sustainability over a period of time.

This publication attempts to highlight the key interventions demonstrated at D.Nagenahalli to cope with the climatic vulnerability and build climate resilient agriculture practice.

It is our sincere previlage to thank Dr. P.C.Tripathi, Principal, Scientist, IIHR, Bengaluru for his valuable comments during editing.

- Authors

Contents

1. The Climate change – An area of major concern

Climate change has become an important area of concern for India to ensure food and nutritional security for growing population. The impact of climate change is global, but countries like India are more vulnerable in view of the high population depending on agriculture. In India, significant negative impacts have been implied with medium-term (2010-2039) climate change, predicted to reduce yields by 4.5 to 9 percent, depending on the magnitude and distribution of warming. Since agriculture makes up roughly 15 percent of India's GDP, a 4.5 to 9% negative impact on production implies a cost of climate change to be roughly up to 1.5 percent of GDP per year. The Government of India has accorded high priority on research and development to cope with climate change in agriculture sector.

The Government of India formulated the National Action Plan on Climate Change (NAPCC) in 2010 to be implemented through 8 National Missions in which the National Mission for Sustainable Agriculture (NMSA) addresses climate change effect on agriculture. Under this mission, rainfed agriculture, on-farm water management, soil health and climate change adaptation/ resilience are the key components envisaged. The southwest monsoon accounts for nearly 75% of the rainfall received during a short period of four months (June to September) in India. Onset and progress of monsoon across the country influences

production of food grains and the agricultural economy. Rainfed agriculture in India constitutes 58% of the net cultivated area and accounts for 40% of the country's food production. The probability of rainfall being erratic is 40% i.e. 4 out of 10 years. Recurrent drought adversely affects the food production and livelihood security of small and marginal farmers in the rainfed areas. Enabling mechanisms and implementation of coping strategies will enhance the resilience of the rainfed farmers. The new challenges posed by climate change and extreme weather events like long dry spells, drought and extreme temperatures were also considered by the nominees in refining the technologies. The improved water harvesting technologies have been extensively tested on farmers' fields across several districts. Economic benefits were assessed and up-scaling opportunities were identified as the nominees believe that this is the only way to adapt dryland agriculture to climate change. There is significant change in the number of rainy days observed in this area. It is used to be 56 days during the 80's and over the past three decades the number of rainy day reduced to 49 days. Similarly number of dry spells during the monsoon and number of intensive rain spells have increased drastically. These changes, indicated below (Table 1), have drastic effect on crop production activities in the region and increased the risks of farming. Hence there was a need for a project to address the constraints emerging out of these aberrant climatic situations by adopting best technologies for this rainfed area.

Table 1. Historical trends in rainfall of project area.

Historical trends in rainfall		Decadal average		
		1980-90	1990-2000	2000- 2010
No. of rainy days		55.6	54.7	49.25
No. of dry spells during kharif season	> 10 days	2	5	8
	> 15 days	2	3	8
	> 20 days	0	1	3
No. of Intensive rain-spells	> 60 mm per day	--	1	2

2. National Initiative on Climate Resilient Agriculture:

An Introduction

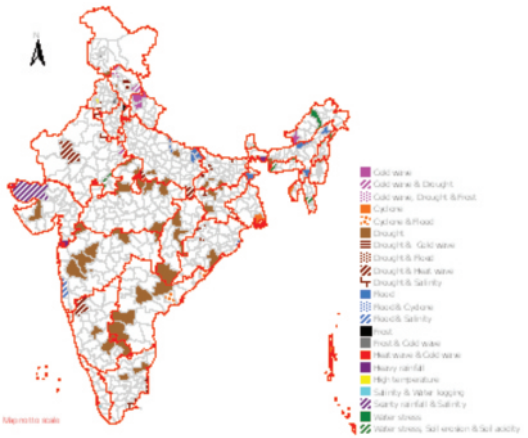
National Initiative on Climate Resilient Agriculture (NICRA) is a network project of the Indian Council of Agricultural Research (ICAR) launched in February, 2011. The Project aims to enhance resilience of Indian agriculture to climate change and climate vulnerability through strategic research and technology demonstration. The research on adaptation and mitigation covers crops, livestock, fisheries and natural resource management. The Project consists of four components viz. Strategic Research, Technology Demonstration, Capacity Building and Sponsored/Competitive Grants. The project was formally launched by the Hon'ble Union Minister for Agriculture & Food Processing Industries Shri Sharad Pawarji on 2nd February 2011, with an outlay of Rs.350 crores for the XI Plan with the following objectives.

Objectives of the Project

- To enhance the resilience of Indian agriculture covering crops, livestock and fisheries to climatic variability and climate change through development and application of improved production and risk management technologies
- To demonstrate site specific technology packages on farmers' fields for adapting to current climate risks
- To enhance the capacity building of scientists and other stakeholders in climate resilient agricultural research and its application.

TDC component of NICRA

NICRA deals with demonstration of an integrated package of proven technologies for adaptation of the crop and livestock production systems to climate variability. This is implemented in 100 most vulnerable districts of the country by demonstrating location specific technologies through Krishi Vigyan Kendra's in a participatory mode.



The technology demonstration component addresses climatic vulnerabilities such as droughts, floods, salinity, frost, cyclone, heat wave, cold wave and the like. The interventions are categorized into four modules as given below:

Module I: Natural resources: This module consists of interventions related to in-situ moisture conservation, water harvesting, supplemental irrigation, improved drainage in flood prone areas, conservation tillage where appropriate, artificial ground water recharge and water saving irrigation methods.

Module II: Crop Production: This module consists of introducing drought/temperature/flood tolerant varieties, advancement of planting dates of rabi crops in areas with terminal heat stress, water saving paddy cultivation methods (SRI, aerobic, direct seeding), frost management in horticulture through trash burning, community nurseries for delayed monsoon, custom hiring centers for timely planting, location specific intercropping systems with high sustainable yield index.

Module III: Livestock and Fisheries: Use of community lands for fodder production during droughts/floods, improved fodder/feed storage methods, preventive vaccination, improved shelters for reducing heat stress in livestock , management of fish ponds/tanks during water scarcity and excess water, etc.

Module IV: Institutional Interventions: This module consist of institutional interventions either by strengthening the existing ones or initiating new ones relating to seed bank, fodder bank, commodity groups, custom hiring centre, collective marketing,

introduction of weather index based insurance and climate literacy through a village level weather station.

3. Krishi Vigyan Kendra, Hirehalli, Tumakuru

Krishi Vigyan Kendra, Hirehalli in Tumakuru District was also chosen for this project to address the climate related vulnerability of the areas under this district. Krishi Vigyan Kendra, Hirehalli was established on 24th March, 2009 under Indian Institute of Horticultural Research, Bangalore. The KVK is located near the Hirehalli railway station in Tumakuru district (Poona - Bangalore national highway-4) 58 km from Bangalore. The KVK is actively involved in conducting technology demonstrations and training programmes to the farming community of Tumakuru district.

Tumakuru district: A profile

Tumakuru is an administrative district in the state of Karnataka. The district occupies an area of 10,64,755 ha and had a population of 25,84,711. The annual rainfall of the station is about 584 mm. The main occupation of the district is agriculture; the net area sown is 5,09,542 ha. Mostly the cultivation is under dry lands as the irrigated area is only 30% of the cultivated area. The main crops grown are Ragi, Jowar, Millets, and Pulse, Oil seeds like Caster and Ground nut and paddy in wetlands. Coconut and Areca nut are the major crops of the District. Banana and vegetables are also grown.

Constitution of Steering Committee:

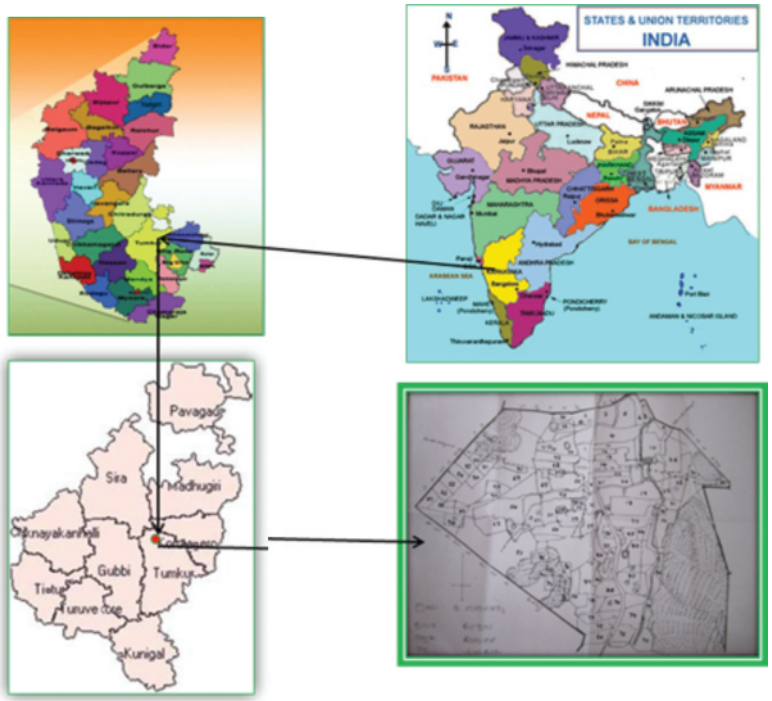
Immediately after the receipt of the Project, a Steering Committee was formed including heads of the line department of the district. The first Steering committee meeting was held on 23.07.2010 at Krishi Vigyan Kendra, Hirehalli, Tumakuru in connection with the implementation of the scheme. The meeting was held to discuss about the following points

- ✓ Selection of village for implementing the scheme (One village)
- ✓ Implementation of Technology demonstrations
- ✓ Discuss about the constraints faced by the farmers
- ✓ Climate variability in the district
- ✓ Finalizing climate resilient technology package

4. Target area of NICRA Project

Durgada Nagenahalli of Koratagere taluk, Tumakuru district has been identified by Krishi Vigyan Kendra (IIHR), Hirehalli, Tumakuru for Technology Demonstration under NICRA based on vulnerability of its agriculture to climatic variability. The village falls under Central Dry Agro climatic zone of Karnataka with on average rainfall of 690 mm. The village is relatively more vulnerable to climatic variability like drought, dry spells and extreme temperature. The village has acute shortage of water and preponderance of waste and common land.

Map of D.Nagenahalli



Satellite Image of D.Nagenahalli

The village is relatively more vulnerable to climatic variability like drought, dry spells and extreme temperature. The village has acute shortage of water and preponderance of waste and common land. Benchmark information of D.Nagenahalli village was collected from the Koratagere taluk office on land use pattern, area, production and productivity of different agricultural and horticultural crops, livestock composition and production, fishery production, awareness level of farmers about climate change, groundwater level and its use, income from agriculture. This data has been utilized for the preparation of technical programme of the scheme.

The total geographical area of the village is 378 ha of which 190 ha (50.24%) is under cultivation while 79.4 ha (20.9%) is under forest. About 23.14 % of the land is classified as degraded land. In the total area 15.6 ha (8.2%) is under irrigation and 174

ha (91.8%) is rainfed The village has total population of 932 (male: 483 & female: 449). The village has 269 households out of which 42.7% belongs to marginal farmers, 36.4% to small farmers, 7.4% belongs to landless labors and 2.2% to large farmers. .

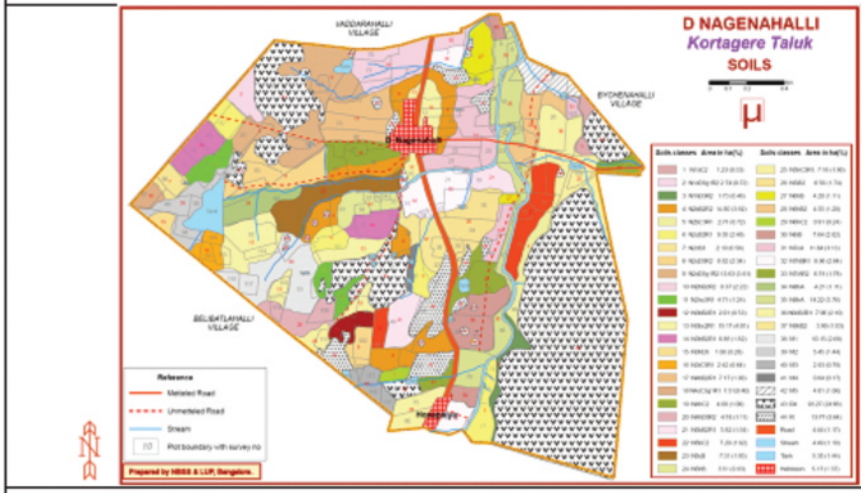
The soils of the village are predominantly red sandy soils (75%) followed by red loamy soil (20%) and black soils (5%). The major source of irrigation is through open wells covering an area of 8 ha (51.3 %) followed by bore wells covering an area of 4.6 ha (29.5%). There are two tanks under which irrigated crops like paddy are being predominantly grown. Major crops grown in the village are Ragi (98.9 ha), ground nut (38.9 ha), paddy (13 ha), red gram (10.1 ha) and maize (8.9 ha) and vegetables (7.5 ha). About 92 per cent of the area in the village is under rainfed cultivation and only a small proportion of land area is under irrigation, either from open or bore wells and tanks. More than 75 per cent of the wells have failed in recent times due to insufficient recharge. Only four out of 32 water lifting pumps are working. Water efficient irrigation techniques are not prevalent in the village (Table 2).

Table 2: Details of source of irrigation in the village

Sl. No.	Sources of Irrigation	Number	Area (ha)	% area
1	Tanks	2	3 ha	19.2
2	Open wells	32 (22 fail)	8 ha	51.3
3	Bore wells	29 (19 fail)	4.6 ha	29.5
4	Lift irrigation	0	--	--
5	Other sources	0	--	--
	Total	**62**	15.6 ha	--
1	Pump sets	32 (28 not functioning)	--	--
2	Sprinkler/ drip systems	0	0	--
3	Defunct rain-water harvesting structures in the village	20		
5.8	**Groundwater availability and use**			
1	Depth of water table in bore wells (feet)	700-800		
2	Decrease of water table, if any over the past 10 years (feet)	400		
3	Quality of water:	Safe		
4	Area irrigated by one bore-well (ha)	0.4-0.8		
5	Area irrigated by one open-well (ha)	0.4		

Table 3: Details of NICRA site D. Nagenahalli

Zone	Tehsil	Rainfall (mm)	Elevation (msl)	Soil	Crops grown
Central dry zone (KA-4)	Korategere (Tumakuru)	690 (456-717 mm)	800 m	Red loams, shallow to deep black soils	Fingermillet, pigeonpea, groundnut, paddy etc.



Soil Map of D.Nagenahalli

5. Plan of work

The survey of entire D.Nagenahalli village was done by NICRA Project team of the KVK in collaboration with National Bureau Soil Survey and Land Use Planning (NBSS&LUP) and identified the impact of climate change on Agriculture, Horticulture, Forestry, Animal Husbandry and allied fields and its problems. Land is scarce resource and basic unit for any material production. It can support the needs of the growing population, provided they use in rational and judicious manner. Totally there are 269 farm households and average size of the farm holding is 1.2 ha. Marginal and small farmers form the major groups accounting 79 per cent.

The literacy rate in the village is 50 per cent. The area available for agriculture is about 51 per cent of the total area and more than 60 per cent of the people are still relying on agriculture. The land degradation and water scarcity is emerged as a serious problem. Almost all cultivated areas are facing various degrees of degradation, particularly soil erosion and water erosion. Nutrient depletion and declining factor productivity is common in rain fed areas. In recent times, aberrations of weather due to climate change phenomenon added number of additional constraints and unpredictable situation to be tackled by farmers. The data base from the farm level planning was obtained by carrying out detailed characterization and mapping of all the existing land resources like soils, climate, water, minerals and rocks, vegetation, crops, land use pattern, socio economic conditions, infrastructure, marketing facilities etc. From the data collected at farm level, the specific problem and potential of the area was identified and highlighted, conservation measures required for the area was planned on a scientific footing, suitability of the area for various uses was worked out and finally viable and sustainable land uses option suitable for each and every land holding was prescribed to the farmer and other land users of the area.

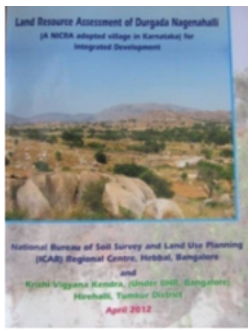
Based on these surveys, Soil depth, Soil texture, Soil erosion and Soil slope, runoff characteristics and depth of underground water table were identified. The extent of engineering works like soil and water conservation, new farm ponds, renovation of defunct farm ponds, new percolation ponds, new check dams, renovation of check dams, recharge of bore wells, renovation of defunct D.Nagenahalli lake, and micro irrigation systems were identified and properly designed and cost estimates were prepared. The types of existing vegetation and their extent of

coverage and development of land for forest, horticulture, field crops, and grasses were determined and a list of requirement of seeds and planting materials for Kharif season was also prepared. The land suitability was assessed for the major crops like Ragi, Groundnut, Redgram, Castor and Mango.

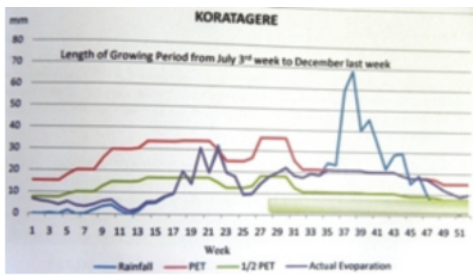
Land survey of D. Nagenahalli village

Dr. S. Ayyappan, DG, ICAR Observing the Soil

Dr. A.K. Singh, DDG (NRM), Dr. B.Venkateshawaralu, Director CRIDA and Dr. Dixit, CRIDA, visited NICRA site.



Land Resource Survey



Length of growing period

Overall implementation framework was formulated through interactions with all stakeholders, the scientists of Central Research Institute for Dry land Agriculture (CRIDA) which is the lead centre for NICRA project and the Zonal Project Directorate. Identification of appropriate coping practices and technologies relevant to address specific climatic vulnerabilities was accomplished through interactions with farmers in the village by KVK team based on participatory rural appraisal (PRA) and focused group discussions (FGDs). The National Agricultural Research System (NARS) comprising of ICAR and State Agricultural Universities (SAUs) served as the source of proven technologies along with the indigenous technical knowledge (ITK) of participating farmers. Technology needs of farmers fell into four broad categories viz., natural resource management especially rainwater harvesting and efficient use; practices and technologies for efficient crop, livestock and fisheries production, and promotion of village level institutional interventions to rope in communities in the decision making processes.

a. Soil Management, through
   - o Land leveling and making compartments
   - o Trench cum bunding
   - o Deep ploughing
   - o Ploughing across the slope
   - o Crop mulching and Stubble mulching
   - o Soil health card as monitoring tool
   - o Tree based farming system

b. Water Management, through
   - o New farm ponds
   - o Check dams
   - o Recharge of bore wells
   - o Water storage structures
   - o Desilting and widening of catchment channels
   - o Blocking leakage of D.Nagenahalli tank
   - o Desilting and widening of defunct farm ponds
   - o Desilting and widening of check dams
   - o Micro irrigation

c. Crop interventions
   - o Field crops: Ragi, Maize, Red gram and Ground nut
   - o Vegetable crops: Tomato and Chilli
   - o Fruit crops: Mango, Amla, Tamarind, Lemon, Cashew

d. Cropping system interventions
   - o Ragi + Red gram
   - o Maize + Red gram
   - o Ground nut + Red gram
   - o Ragi + Dolichos
   - o Agri horti silvi pasture system

e. Institutional arrangements
   - o Village Climate Risk Management Committee
   - o Custom Hiring Centre
   - o Seed bank

f. Farm level value addition.

6. Significant findings and their potential in meeting the goals of the project

The technological interventions for enhancing resilience of farming systems to climatic variability were identified and finalized involving the multidisciplinary team of KVK and major stakeholders (farmers, researchers, NGOs and extension specialists) through brainstorming and group discussions. The details of climate resilient interventions implemented were as under.

6.1. Soil Management

6.1.1 Leveling and formation of compartments:

Leveling combined with bunding helps in reducing soil erosion as well as run off to an appreciable extent by enhancing infiltration of water into the soil. Around 6 ha land was developed under leveling and compartmenting and 15 farmers were benefited. The Paddy crop is introduced in that place thereby increased the area of the paddy crop. This resulted in higher paddy and ragi yields (15- 20%) compared to be check plots (Table 4).

Leveling and Compartmenting

Paddy cultivation on leveled land

Table 4: Effect of leveling and formation of compartments on soil moisture storage

Details	Water storage profile (cm /180cm depth)	Per cent increase in water storage profile
Without leveling and formation of compartments	**21.5**	**23.2**
Leveled and formation of compartments	**26.5**	

6.1.2 Trench cum bunding:

The trench cum bunding technology was adopted in the NICRA project. This method served dual purpose: firstly the bunds built across the slope with appropriate sections arrested soil erosion and secondly the trenches served as water reservation pits that keep soil moisture intact for longer duration. As per the research estimates, in one hectare of land around 50,000 liters of water could be harvested in one filling.

Forest tree species like Melia dubia, Acacia aurculiformis, Teak, Casuarina, Silver oak, Glyricidia, Bahuemia papureia were planted on the bunds, intended to meet the timber, fodder and fuel wood related needs to some extent. It also increased the

vegetative cover in the area. Around 107 ha of bunds were developed benefiting around 182 farmers. Farmer Sri Yogesh had cultivated Maize in his 1 ha farm. The yield of Maize with trench cum bunding was 39.1 Quintal/ha compared to that of Maize without trench cum bunding (34.4 Quintal/ha). The yield of the Maize increased to an extent of average 12%. The farmer benefitted with additional yield of 4.7 quintal and an additional income of Rs. 4500.

Trench cum bunding

Runoff harvested in trenches

6.1.3 Tank silt application:

Tank silt application helps to build soil fertility and water holding capacity. Around 300 tonnes of tank silt was applied in 20 ha of farmers' fields which benefited 35 farmers and yield of rain fed finger millets was increased by 17.9% on an average (Table 5) compared to control plot.

Table 5: Effect of tank silt application on Ragi yield.

Intervention Crop :Ragi	Yield (q/ha)	Per cent increase	Economics of Demonstration (Rs./ha)			
			Gross Cost	Gross Return	Net Return	BCR
Tank silt	27.6		8350	20400	12050	2.44
Without tank silt	23.4	17.9	7520	16380	8860	2.17

6.1.4 Deep Ploughing

Ploughing or sub soiling with a chisel plough helps roots in breaking the hard pan layer and reduces runoff and soil loss and promote deeper rooting leading to better crop yield. The low cost interventions like deep ploughing and ploughing across the slope were demonstrated in 15 ha which benefitted 40 farmers (Table 6).

Table 6 : Effect of Deep Ploughing on soil loss

Details	Soil loss (kg/ha)
Un ploughed	2384
Deep ploughed	2018

6.1.5 Crop mulching:

Horse gram was sown during kharif season. This crop covers the land completely because of their spreading nature. This reduces the splash effects of rain drops on the soil, conserves more moisture, and increases organic carbon content of the soil, improves the soil fertility when the plant residues are incorporated. and increases the crop yield. Around 6 hectares of land was brought under this intervention for demonstration, which benefited 14 farmers (Table 7).

Table 7: Effect of crop mulching on moisture and organic carbon content

Intervention	Moisture content (% w/w basis)		Organic carbon content (%)	Yield of Ragi (q/ha)
	0-15 cm	15-30 cm		
Control	8.5	10.9	0.3	17.3
Crop mulching	13.1	16.1	0.8	22.5

6.1.6 Stubble mulching:

The stalks are left on the soil surface after harvest of the maize crop and the stalk initially used as mulch and later incorporated into the soil. It reduces soil erosion and increases the organic matter and biological activity. Around 4 hectares of land was brought under this demonstration, which benefited 11 farmers. Stubble mulches enhanced the soil moisture storage and organic carbon content in the soil that helped in retention of higher moisture content in the surface soil, and consequently better crop yield in rainfed area (Table 8).

Table 8: Effect of stubble mulching on moisture and organic carbon content.

Intervention	Moisture content (% w/w basis)		Organic carbon content (%)	Yield of Maize (q/ha)
	0-15 cm	15-30 cm		
Control	8.6	11.4	0.4	27.4
Stubble mulching	12.6	15.8	0.8	31.5

6.1.7 Soil Health Card as monitoring tool:

Soil fertility status information helps to overcome constrains affecting the fertility and productivity of soil resources from land. In this regard fertility assessment was carried out by IIHR and NBSS & LUP after collecting and analyzing 160 surface soil samples from different survey numbers of the village for the following parameters.

Macro nutrients – Nitrogen, Phosphorus and Potassium

Secondary nutrients – Sulphur

Micro nutrients – Copper, Iron, Zinc, Manganese

The analytical values for different parameters were used to generate the soil health cards for major crops. These Soil health cards can be used to recommend the nutrient application for the major crops. Over 160 Soil Health Cards were distributed to the farmers by the Director General, ICAR (Table 9).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CENTRAL RESEARCH INSTITUTE FOR DRYLAND AGRICULTURE, HYDERABAD

NATIONAL INITIATIVE ON CLIMATE RESILIENT AGRICULTURE

SOIL HEALTH CARD No. 1

I. General Information

1. Name of the Farmer : Suresh S/o Hanumantharayappa
2. Survey Number : 50
3. Village : D.Nagenahalli, Koratagere Taluk
4. District : Tumkur, Karnataka State

II. Soil Chemical Analysis Report

Soil health information	Units	Observed	Critical limit	Remarks
Soil pH	(1 : 2)	4.63	6.50 - 7.50	Low
Electrical Conductivity	(dSm-1)	0.096	<1.00	Safe
Organic Carbon	(%)	0.21	0.75 - 1.00	Low
Major nutrients				
Available Nitrogen	(mg kg-1)	34.62	125-180	Low
Available Phosphorous	(mg kg-1)	21.20	5 - 10	High
Available Potassium	(mg kg-1)	45	62- 125	Low
Secondary nutrients				
Available Calcium	(mg kg-1)	75	800 -1500	Low
Available Magnesium	(mg kg-1)	99	150 - 250	Low
Available Sulphur	(mg kg-1)	18.7	10 - 15	High
Trace nutrients				
Available Iron	(mg kg-1)	19.7	5 - 10	High
Available Manganese	(mg kg-1)	19.3	3 - 8	High
Available Zinc	(mg kg-1)	0.45	0.75 - 1.00	Low
Available copper	(mg kg-1)	0.28	0.50- 1.00	Low

Programme Coordinator | Subject Matter Specialist (Soil Science)

KRISHI VIGYAN KENDRA, HIREHALLI, TUMKUR

Soil health card

Dr. S. Ayyappan, DG, ICAR Distributing Soil Health card to farmers of NICRA village

Table 9: Summary of results of soil testing across the village (160 Samples)

Particulars	Units	Range	Mean	Remarks
P^H	(1:2)	4.17-8.32	5.66	Low
Electrical conductivity	dsm-1	0.036-0.277	0.12	Safe
Organic carbon	%	0.15-1.2	0.46	Low
Nitrogen	mg kg-1	24.3-194.4	74.72	Low
Phosphorus	mg kg-1	0.6-41.5	8.74	Normal
Potassium	mg kg-1	18-255	56.62	Low
Calcium	mg kg-1	75-2150	778.61	Low
Magnesium	mg kg-1	72-580	203.4	Normal
Sulphur	mg kg-1	1.4-61.1	11.49	Normal
Iron	mg kg-1	5.2-208.9	22.60	High
Manganese	mg kg-1	3.4-47.7	14.67	High
Zinc	mg kg-1	0.25-1.84	0.49	Low
Copper	mg kg-1	0.06-2.47	0.60	Normal

6.1.8 Compost pit:

Compost pit is used to prepare the compost in a scientific way. The compost is beneficial for the land in many ways, as soil conditioner, fertilizer, and natural pesticide for soil. In ecosystems, compost is useful for erosion control, land and stream reclamation and wetland construction. Twelve compost pits were developed in the village benefitting 12 farmers. About 36000 kg compost was produced and utilized in the production of crops in 12 acres area, besides rejuvenating soil health.

6.1.9 Tree based farming system:

Tree planting was taken up on degraded ridge lands in the village. In order to ensure better survival rate, the planting was

done on the bunds after digging the trenches in the entire area. Nearly 80% area was brought under the cover of plants by involving 100 farmers. The block plantation of Melia dubia and Acacia aurculiformis was established. A total of 32000 plants belonging to different fruits and forest species were planted (Table 10). Nearly 80 % have survived despite very poor rain fall during last two seasons. The exercise has created great awareness among the farmers about the role of trees in improving soil and water conservation besides helping in improving micro climate and carbon sequestration in the long run. It supplies fodder to goat and sheep during summer. An agri-hori system of Mango/Tamarind/Amla-finger millet (23.8 q/ha) gave higher yield as compared to sole finger millet grain yield (17.0 q/ha) of three years of planting.

Table 10: Area under perennial crops

Perennial crops	Before NICRA (ha)	After NICRA (ha)
Mango	15.5	19.5
Tamarind	1.7	8.7
Amla	0.4	4.4
Cashew	00	01
Banana	1.5	2.5
Melia dubia	00	15
Acacia aurculiformis	00	07
Silver oak	01	03
Pongemia	02	03
Teak	0.5	1.5
Neem	0.2	0.3
Arecanut	13	14

Cashew

Amla

Melia dubia

Mango

Teak

Silver oak

Tamarind

Acacia aurculiformis

6.2 Water Management

6.2.1 Rain Water Storage

Considering the potential for farm pond in the village, 72 farm ponds have been created. The total rainwater storage capacity of the 72 farm ponds dug during the project implementation is 18000 Cu m and it has benefited over 85 farmers. The total water storage capacity of the newly constructed 5 check dams is 6750 Cu m and has benefited 11 farmers. The total rainwater storage capacity of the 13 percolation ponds for underground recharge is 1750 Cu m and has benefited over 20 farmers. The total water storage capacity of 4 cement/ plastic lined storage structures is 760 Cu m and has benefited 4 farmers. The total water storage capacity of the 15 rejuvenated farm ponds is 7500 Cu m benefited 20 farmers. The total water storage capacity of the 8 rejuvenated check dam is 10700 Cu m and benefited 15 farmers. The total rainwater storage capacity of the 2 rejuvenated community tanks is 7500 Cu m and has benefited 12 farmers. The total water storage capacity of the village tank due to desilting and widening of catchment channel is 145600 Cu m and benefited 18 farmers. The overall water storage capacity of water harvesting structures is the D.Nagenahalli village is 196560 Cu m. Seventeen out of 32 open wells were recharged and 11 out of 29 bore wells were recharged due to water harvesting structures. The water storage capacity of the various water harvesting structures is shown in the table below (Table 11).

Table 11: Details of rainwater harvesting structures and their capacity

Name of the Intervention	No. of Units	No. of farmers took part	Water Storage Capacity (Cu m)
New farm pond	72	85	18000
Percolation pond	13	13	1750
New check dam	05	11	6750
Water storage structure	04	04	760
Rejuvenation of farm pond	15	20	7500
Rejuvenation of check dam	08	15	10700
Rejuvenation of community tank	02	12	5500
Increased water storage capacity of village tank due to desilting and widening of catchment channel (1200 m) and blocking of leakage	01	18	145600
		Total	**196560**

Water storage capacity (in cu m) created in the village by different interventions

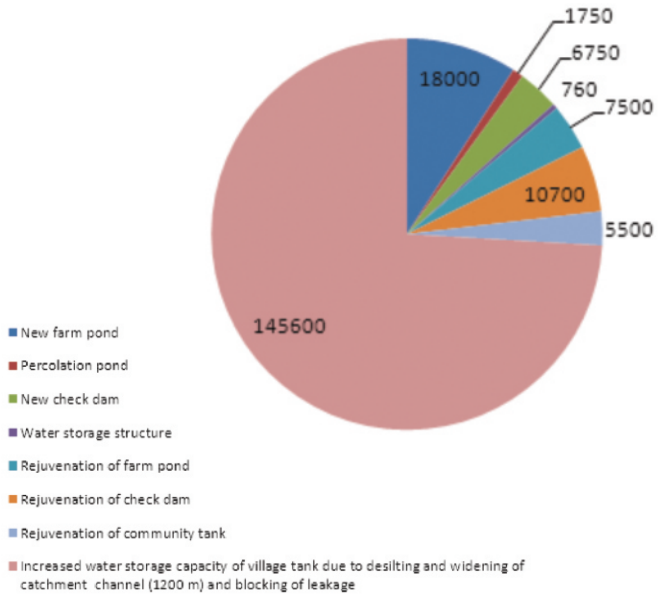


Table 12. Details of total area cultivated.

Particulars	Before NICRA	After NICRA	% increase
Irrigation area (ha)	15.6	39.6	153%
Area cultivated in Kharif (ha)	185.0	199.3	7.72%
Area cultivated in Rabi (ha)	7.5	22.5	200%

6.2.2 New farm ponds :

Farm ponds were constructed in the fields with a dual purpose viz., firstly to help farmers provide supportive irrigation to the crops when required and secondly to allow maximum seepage of water into the ground so as to recharge the underground aquifers.

In a period of three years from 2010-11 to 2013-14, there have been about 72 farm ponds of various capacities developed under NICRA as per the suggestion of the villagers and farmer needs. The total storage capacity of these farm ponds has been estimated to be about 18,000 cubic meters. This terrain is being very much undulated in nature and located in the foot hills. The farm ponds thus developed helped in conserving the rain water efficiently, irrespective of their sizes. Details of farm ponds dug in farmers field are appended as Annexure-1

New farm ponds

Cases of successful rainwater harvesting structures

1. Venkatappa S/o Giriyappa

Survey no : 120
Farm pond dimension : 10 x 10 x 2 (l m x b m x d m)
Water storage capacity : 200 Cu.m
Total area : 3 acre
Area used : 1.5 acre

Sri Venkatappa is a marginal farmer of D.Nagenahalli village. He has one acre of dryland with slight slope. The land is low in fertility where he normally cultivated one crop during kharif season. Due to high variability in southwest monsoon, he had difficulty in meeting his family requirement. Under NICRA interventions, his one acre land was leveled and divided into compartments. Besides a farm pond measuring 20 m x 20 m x 2 m was dug to harvest the runoff. His cropping intensity has now tripled as he is able to take 3 crops by utilizing harvested rainwater from his 800 cu m dug out pond. He cultivates tomatoes, green chilies and coriander on his small farm by irrigating the crop in small compartments. He produced 7 tonnes of Tomatoes from 0.50 acre and earned another Rs.27030 by producing 700 kg green Chilies from another 0.25 ac. Besides, he also cultivated coriander during post rainy season he cultivated coriander in 0.25 ha land earned about Rs.16000 (Table 13).

Table 13: Details of impact of new farm pond in Sri Venkatappa farm

Crop	Variety	Area (Acre)	Yield	Gross Cost (Rs.)	Gross Return (Rs.)	Net Return (Rs.)
2010-11 (Before NICRA)						
Paddy	Local	0.5	7 q	6150	9570	3420
Ground nut	Local	1.0	5.7 q	4492	14872	10380
			Total	**10642**	**24442**	**13800**
2011-12 (After NICRA)						
Paddy	Local	0.75	14 q	9100	14400	5300
Tomato	Lakshmi	0.5	7 tonnes	13700	40730	27030
Chilli	Local	0.25	7 q	5500	37500	32000
Coriander	Local	0.25	8 q	2500	18500	16000
			Total	**30800**	**111130**	**80486**
2012-13						
Paddy	Local	0.75	16 q	9500	15500	6000
Aster	Local	0.5	14 q	4500	17900	13400
Tomato	Local	0.5	5 tonnes	10500	21500	11000
			Total	**29500**	**54900**	**30400**
2013-14						
Paddy	Local	0.75	18 q	10500	19500	9000
Aster	Local	0.5	16 q	6000	20500	14500
Tomato	Lakshmi	0.5	6 tonnes	12500	37500	25000
			Total	**29000**	**77500**	**48500**

2. Lakshmikanth S/o Timmaiah

Survey no : 27
Farm pond dimension : 20x12x2 (l m x b m x d m)
Water storage capacity : 480 Cu.m
Total area : 3 acre
Area used : 1.5 acre

Sri Lakshmikanth is a marginal farmer of D.Nagenahalli village. He has 3 acre of dryland with slight slope. The land is low in fertility where he normally cultivated one crop during kharif season. Due to high variability in southwest monsoon, he had difficulty in meeting his family requirement. Under NICRA interventions, his 3 acre land was leveled and divided into

compartments. Besides a farm pond measuring 20 m x 12 m x 2 m was dug to harvest the runoff. His cropping intensity has now tripled as he is able to take 3 crops by utilizing harvested rainwater from his 480 cu. m dug out pond. He uses portable 1 hp motor sprinkler to irrigate the crop. He cultivates tomatoes, Aster and Brinjal on his small farm by irrigating the small compartments. He produced 2.5 tons of tomatoes from 0.25 ac and earned Rs. 12900. Additional Rs.16300 earned by producing 1200 kg aster flower from another 0.50 ac. Besides, he also cultivated brinjal during post rainy season in 0.5 ac land earned about Rs.18900 (Table 14).

Table 14: Details of impact of new farm pond in Sri Lakshmikanth farm

Crop	Variety	Area (Acre)	Yield (q)	Gross Cost (Rs.)	Gross Return (Rs.)	Net Return (Rs.)
2010-11 (Before NICRA)						
Paddy	Local	0.5	8	6500	10500	4000
Aster	Local	0.25	6	2500	9500	7000
			Total	**9000**	**20000**	**11000**
2012-13 (After NICRA)						
Paddy	Local	1.0	20	12500	20500	8000
Aster	Local	0.5	13.5	5500	21500	16000
			Total	**18000**	**42000**	**24000**
Rabi						
Tomato	Lakshmi	0.25	25	5500	18400	12900
Aster	Local	0.5	12	6100	22400	16300
			Total	**11600**	**40800**	**29200**
2013-14						
Paddy	Local	1	19	13300	22800	9500
Aster	Local	0.5	10.5	7200	24400	17200
			Total	**20500**	**47200**	**26700**
Rabi						
Brinjal	Local	0.5	38	6500	22400	18900
Aster	Local	0.5	13	7500	27500	20000
			Total	**14000**	**52900**	**38900**

3. Nagarajaiah S/o Narayanappa

Survey no	:	97
Farm pond dimension	:	15x8x1
Water storage capacity	:	120 Cu.m
Total area	:	2 acre
Area used	:	1.0 acre

Sri Nagarajaiah is farmer with 2 acre of farm land. He faced water shortage from his field. NICRA team met him and decided to dug out new farm pond. The water storage capacity of his farm pond is 120 cu.m, to provide supplementary irrigation to the crops during critical stages. He uses portable 1 hp motor sprinkler to irrigate the crop. He grows Ragi, Ground nut and Tomato in his farm. During the first year even though monsoon was not good he still managed to get sufficient yield. It was possible due to the farm pond. He had cultivated Tomato in 0.75 ac farm. The yield of Tomato was 8 tons with additional income of Rs.37400 (Table 15).

Table 15: Details of impact of new farm pond in Sri Nagarajaiah farm

Crop	Variety	Area (Ac)	Yield	Cost (Rs.)	Gross benefit (Rs.)	Net benefit (Rs.)
2010-11 Before NICRA						
Tomato	Local	0.5	1.3 ton	4000	11000	7000
Ragi	Local	0.25	3 q	1000	3500	2500
			Total	**1000**	**3500**	**2500**
2011-12 After NICRA						
Tomato	Arka Meghali	0.75	8 ton	14100	51500	37400
			Total	**14100**	**51500**	**37400**
2012-13						
Ground nut	Local	0.38	2.6 ton	8000	41500	33500
Tomato	Lakshmi	0.5	2.1 ton	5500	31000	25500
			Total	**13500**	**72500**	**59000**
2013-14						
Tomato	Lakshmi	0.5	2.1 ton	6000	32500	26500
Fodder maize	Local	0.25	-	Used for animal feeding		
			Total	**6000**	**32500**	**26500**

4. Narasimha Murthy K S/o Karigiriyappa

Survey no : 39
Farm pond dimension : 35x12x1 (l m x b m x d m)
Water storage capacity : 420 Cu.m
Total area : 3 acre
Area used : 1 .5 acre

Sri Narasimha Murthy is farmer with 3 acre of farm land in low lying area. He faced water shortage from his field. NICRA team met him and decided to dug out new farm pond. The water storage capacity of his farm pond is 420 cu.m to provide supplementary irrigation to the crops during critical stages. He grows paddy in his farm initially in 0.4 ac. During the first year even though monsoon was not good he still managed to get sufficient yield. It was possible due to the farm pond. He had cultivated paddy in 0.8 ac farm with 100% cropping intensity. The yield of paddy was 40qt during 2011-12 with additional income of Rs.26500. (Table 16).

Table 16: Details of impact of new farm pond in Sri Narasimha Murthy farm

2010-11 Before NICRA						
Crop	**Variety**	**Area (Ac)**	**Yield**	**Cost (Rs.)**	**Gross benefit (Rs.)**	**Net benefit (Rs.)**
Paddy	Local	0.4	20 q	6000	18000	12000
				6000	**18000**	**12000**
2011-12 After NICRA						
Paddy	Local	0.8	40 q	9500	36000	26500
				9500	**36000**	**26500**
2012-13						
Paddy	Local	0.8	30 q	7000	27000	20000
Fodder maize	Local	0.2	-	Used for animal feeding		
				7000	**27000**	**20000**
2013-14						
Paddy	Local	0.5 acre	20 q	4000	20000	16000
Fodder maize	Local	0.25 acre	-	Used for animal feeding		
				4000	**20000**	**16000**

5. Kampliah S/o Mudduramiah

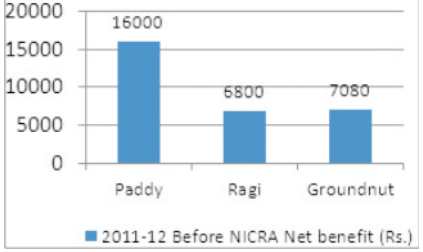
Survey no : 26
Farm pond dimension : 40x12x3 (l m x b m x d m)
Water storage capacity : 1440 Cu.m
Total area : 3 acre
Area used : 1 acre

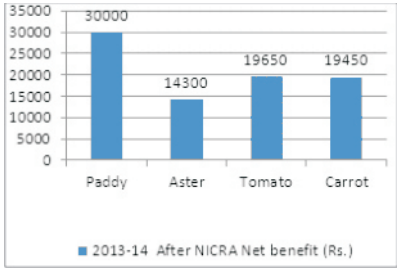
Farm pond of size 40m x 12m x 3m with water storage capacity of 1440 cu m had been excavated in the farm of

Kampliah to face water scarcity and delayed monsoon. He cultivates Paddy, Ground nut and Ragi. He had cultivated ground nut in 0.75 acre and Ragi in 1.0 acre and paddy in 0.75 acre. During the dry spells he watered the crop every 3 days from farm pond to minimize the loss in crop yield. The yield of the ground nut is 3.8 quintal and Ragi is 8 quintal before NICRA interventions. After NICRA interventions he benefitted with recharge of open well by farm pond. The crop diversity has been increased by adopting 3-4 high valued crops per year. He produced 8.5 q of aster flower from 0.40 acre and earned Rs.14300. He also produced 1.7 tons of tomato from another 0.4 ac and earned Rs.19650. Besides, he also cultivated carrot during post rainy season in 0.20 ac land and earned about Rs.19450 during 2013-14. He got additional income of Rs. 53520 (Table 17).

Table 17: Details of impact of new farm pond in Sri Kampliah farm

2011-12 Before NICRA						
Crop	**Variety**	**Area**	**Yield**	**Cost (Rs.)**	**Gross benefit (Rs.)**	**Net benefit (Rs.)**
Paddy	Local	0.75 acre	25 q	4000	20000	16000
Ragi	Local	1.0 acre	8 q	5200	12000	6800
Groundnut	Local	0.75 acre	3.8 q	2800	9800	7080
				12000	**41800**	**29880**
2012-13 After NICRA						
Crop	**Variety**	**Area**	**Yield**	**Cost (Rs.)**	**Gross benefit (Rs.)**	**Net benefit (Rs.)**
Paddy	Local	1 acre	32 q	4500	30000	25000
Tomato	Local	0.5 acre	2.0 t	6200	28000	21800
				10700	**58000**	**46800**
2013-14						
Crop	**Variety**	**Area**	**Yield**	**Cost (Rs.)**	**Gross benefit (Rs.)**	**Net benefit (Rs.)**
Paddy	Local	1 acre	33 q	5000	35000	30000
Aster	Local	0.4 acre	8.5 q	6100	20400	14300
Tomato		0.4 acre	1.7 t	5850	25500	19650
Carrot		0.2 acre	1.2 t	4550	24000	19450
				21500	**104900**	**83400**





6.2.3 Percolation ponds:

Percolation ponds were dug to reduce the velocity of runoff from the fields and to recharge the groundwater. Thirteen percolation ponds were dug in appropriate places across the fields in the village. The rainwater storage capacity of these ponds is 1750 cu m which is benefitting over 20 farmers.

Percolation ponds

6.2.4 Recharge of bore wells:

Recharge of bore wells were constructed for diverting runoff water into less yielding bore wells. The water flowing in the channel was made to pass through a filter media before entering

into recharge structure to avoid accumulation of silt. Study of bore wells at the beginning of the project indicated a very low water table 700-800 ft. Continuous drought over the years had rendered many of the bore wells with zero yield or very low yield. Due to this reason even farmers with irrigation facilities were forced to reduce the cropping area especially in summer. However due to this intervention and also overall impact of NRM activities in the village, the borewells have been rejuvenated and started yielding good amount of water for cultivating crop continuously.


Recharge of Borewell

6.2.5 Check dams:

Check dam is a type of structure which dams up a small nallahs in order to break flow of water during the monsoon and allows it to seep into the soil. It helps in ground water recharge of the area. Recharge of water helps in raising the water table in the area. Around 5 check dams were constructed in the D. Nagenahalli village. The water storage capacity developed is 6570 cu m in total. Around 11 farmers benefited due to this intervention (Table 14).


New Checkdam

Table 18: Details of Check dams:

Sl.No.	Beneficiary	Survey No.	Year of Construction	Dimension of the Structure (l m x b m x d m)	Storage Capacity (Cu m)
1	Chikkamuddaiah	16	2012	30 x 8 x 1.5	360
2	Chandrashekhariah	56	2012	20 x 6 x 1.5	180
3	Narasimhamurthy K	64	2012	20 x 8x 1	160
4	Chandranna	23	2012	40 x 50 x 3	6000
5	Kemparaju	36	2012	15 x 3 x 1	45
				Total	**6745**

In one of the success stories considered for this study, farmer Sri Chandranna who benefitted from one check dam of size 40 m x 50 m x 3 m. He earlier used to cultivate only one crop (Ragi) in one acre farm during monsoon, later grew vegetables like tomato in 2013-14 from his 0.75 acre land, supported by a check dam water of 6000 cu m capacity. The yield of tomato was 5 tonnes and which provided an income of Rs.43000, owing to the supplemental irrigation from his check dam (Table 19).

Table 19:Details of impact of check dam constructed in Sri Chandranna's farm

Crop	Variety	Area acre	Yield	Cost (Rs.)	Gross benefit (Rs.)	Net benefit (Rs.)
2012-13 Before NICRA						
Ragi	Local	1.0	6 q	2100	7500	5400
			Total	**2100**	**7500**	**5400**
2013-14 After NICRA						
Tomato	Lakshmi	0.75	5 tonnes	7500	50500	43000
			Total	**7500**	**50500**	**43000**

6.2.6 Water storage structure:

Farmers in this village stored water in earthen tanks at a higher elevation by pumping water from bore/open wells when power supply is there to irrigate limited area down the line by gravity. This led to significant seepage losses. The project promoted lining of the earthen tanks by cementing/ plastic lining to prevent large amount of seepage loss. Four water storage tanks have been lined with either cement or plastic sheets in a participatory mode. This has helped improve groundwater use efficiency thereby extending the area under irrigation through gravity fed tanks by 1.6 ha. (Table 20).

Table 20: Details of water storage structures

Sl.No.	Beneficiary	Year of Construction	Dimension (l m x b m x d m)	Storage Capacity (Cu m)	Increased Area under irrigation (ha)
1	Dwarakanath.L.P	2012	18 x 6 x 2.5	270	0.5
2	Lokesh S/o Venktaramaiah	2013	12 x 11 x 2	264	0.5
3	Ranganath S/o Shrirangappa	2013	15 x 6 x 2	180	0.4
4	Govindappa S/o Mudlappa	2013	8 x 6 x 1	48	0.2
			Total	**762**	**1.6**

Table 21: Effect of lining with plastic film on seepage and percolation losses in soil.

Intervention	Total area irrigated	Drop in depth per day by cm			
		Red Sandy soil	Percent reduction in water loss	Red clay soil	Percent reduction in water loss
lining with Plastic film	4 ha	10.2	70.85	9.4	38.2
Without lining with plastic film	1.8 ha	35		15.2	

- Reduction in water losses through percolation and seepage to the maximum extent (38-71 %)
- Lining with plastic film has benefited reduction of water loss in red sandy soil (70.85 %) compared to that of red clay soil (38 %).
- Judicious utilization of stored water for the purpose for fish culture and to provide supplementary irrigation during crop critical stages.


Unlined earthen storage structure (left) and cemented storage structure


Plastic lined storage structure

6.2.7 Desilting and widening of catchment channels and blocking of leakage of D.Nagenahalli tank:

About 1200 m of runoff channels of D.Nagenahalli village tank was desilted and widened. This tank was recharged by runoff catchment channels and runoff water is diverted in to the tank. There was a leakage in between two pipes installed near the sluice gate and hence the water harvested in this tank was going waste without making itself available for cropping. The leakage was blocked during the process.

The tank has a total command area of 16 ha, but only 3 ha were used to cultivate paddy during kharif season before the blocking of leakage. Blocking of leakage increased additional 1,45,600 cu m rain water storage capacity and farmers are planning to cultivate more area utilizing this water.

Community inspects damaged sluice gate of village tank

6.2.8 Desilting and widening of defunct farm ponds and Check dams:

The water storage capacity is increased by desilting and widening of defunct water harvesting structures. Fifteen farm ponds were desilted and widened with water storage capacity of 7500 cu m. and eight check dams were desilted and widened with water storage capacity of 10,700 cu m.

Renovation of defunct check dams

6.2.9 Rejuvenation of community tanks

Two tanks with substantial water storage capacity constructed long ago have become defunct due to neglect, non maintenance and silting up. Due to neglect of community tanks, surplus rainfall (runoff) during kharif is not being stored properly and used. Hence, due to prolonged dry spells at critical stages, crop failures are experienced in some years and production is seriously affected. Rainfed crops in Rabi experienced soil moisture deficit which resulted in low productivity. Two community tanks were desilted and widened and increased the additional water storage capacity of 5500 cu m (Table 22).

Table 22: Details of water storage capacity of community tanks.

Sl.No.	Beneficiary	Year of Construction	Dimension (lm x bm x dm)	Storage Capacity (Cu m)
1	Mandara katte	2013	25 x 25 x 3	1875
2	Small tank	2012	30 x 40 x 3	3600
3	Village tank	2012	130 x 160 x 7	145600

6.2.10 Drip irrigation for vegetables, areca nut and mango crops:

In drip irrigation a part of soil in the vicinity of plant roots is only wetted and kept close to field capacity. It provides ideal moisture regime for high yield and quality and produce especially in vegetables and horticultural crops. Around 1.2 ha vegetables, 1.2 ha areca nut, 0.6 ha mango plot were installed with drip system that benefited 8 farmers. It has been observed that crop under drip gave higher yield, good quality produce and hence fetched higher returns.

6.2.11 Sprinkler irrigation for flower crops:

Sprinkler methods ensures high degree of water control and enables judicious utilization of even small water flow on undulated and shallow soils. It gives overall irrigation efficiency as high as 80-82 % as correspond to 30-50% in surface irrigation. Sprinkler irrigation adopted for 0.4 ha in flower crops and 0.6 ha in vegetables crops. It has been observed that vegetables and flower crops gave higher yields good quality produce and greater water economy when irrigated by sprinklers.

6.3 Crop intervention

6.3.1 Growing of ML-365 Ragi to cope with early season drought

Ragi (Eleusine coracana) is the staple food crop and made indelible impact in the food habit of people residing in the village. Farmers are getting low yield due to uneven rainfall (May- June), poor management and due to non availability of quality seeds. During kharif season the early season drought occurred due to delay in the monsoon rains. NICRA team has introduced Ragi variety ML-365 released by UAS, GKVK,

Bengaluru, to cope up with delayed monsoon. Seventy farmers have been provided ML-365 seeds.

The specific characteristics of the variety are

- Short duration (about 105 days)
- Medium plant height
- High yielding (Grain and fodder)
- Resistant to leaf spot, neck blast disease and lodging
- Good cooking quality
- Suitable for dryland agriculture and late sowing

The finger millet cv ML365 has been promoted in the Nagenahalli village in 50 ha and benefited the 110 farmers. The performance of the variety is significantly superior over its local variety. While the local variety was wilting due to moisture stress, ML 365 was full fingers with grains in milky stage. The Farmer Muddahanumiah had cultivated Ragi ML-365 in 0.5 ha farm. The yield of Ragi ML365 is 42.5 Quintal/ha compared to that of local Ragi 35.5 Quintal/ha. The yield of the Ragi ML365 could be increased to an extent of 19.7 %. The farmer was benefitted with additional yield of 7 q compared to local and an additional income of Rs. 10500.

6.3.2 Introduction of Redgram BRG 2 to cope with delayed monsoon:

The BRG-2 variety has been introduced in the village as a large scale in 20 ha. Nearly 113 farmers were provided the seeds. BRG 2 variety is a short duration, high yielding and suitable for dry land and late sowing variety. The performance of the variety is excellent compared to local variety. The demonstration of Red gram BRG 2 was conducted in the 1 ha field of farmer Shri Nagrajaiah. The performance of the Red gram BRG 2 (12.6 q/ha) was found superior to the local variety of Red gram (10.2 q/ha). The yield of Redgram increased to an extent of 23.5 %. The farmer got benefitted with additional yield of 2.4 q compared to local and an additional income of Rs. 10440.

6.3.3 Addressing drought vulnerability by Aerobic Paddy MAS-26 cultivation

Rice *(Oryza sativa L.)* is the most important cereal crop of India. In Karnataka, about 55–60 % of the rice is grown under puddled system and the rest is under a rainfed situation. Traditional rice cultivation method is well- suited to countries

and regions with low labour cost and high rainfall, as it is very labour-intensive. Irrigated rice is typically transplanted into puddled paddy fields, which includes land preparation with 4-6 inches of standing water and this method of cultivation requires large quantities of water and is labour intensive. Because of increasing water scarcity, Aerobic Paddy cultivation was demonstrated in the village which require less water.

The main advantages of the drought tolerant aerobic paddy MAS 26 are: direct sowing, no need of puddling, resistance to pest and diseases, reduces the pollution, medium duration, 60 tillering per seed and 50% water saving along with 80% seed saving. The demonstration of aerobic paddy MAS-26 was conducted at farmer field Sri Mahesh.N.M, in 0.5 ha. The performance of the aerobic paddy MAS-26 (37.5 q/ha) was found to be superior to the local variety of paddy (29.8 q/ha). The yield of aerobic paddy MAS-26 increased to an extent 12.4 %. The farmer got benefitted with additional yield of 2 q compared to local and an additional income of Rs. 3600.

6.3.4 Vegetable crops

Tomato and Chilli:

The tomato variety Arka Meghali and Chilli variety Arka Lohit were introduced in the village in 3.5 ha and benefited 20 farmers in the village. The yield was significantly superior to local variety. The Chilli variety Arka Lohit is a higher yielding open pollinated variety yielding 8-10 tonnes/ha of green Chilli in dry land. The variety has performed well in dry land. The net income from cultivation of this variety is 25% higher than local variety, thereby an average farmer can get Rs.24000/- net profit per hectare.

Plastic mulching for promoting higher production:

Plastic mulching was promoted in tomato and chilli cultivation in the village for ensuring higher yield and better quality tomato and chilli production. Initial trial was laid out in tomato 1 acre and 0.5 acre of chilli. The results were very encouraging. The yield of plastic mulched tomato and chilli were to the tune of 10 tonnes and 15 tonnes respectively.

6.3.5 Cropping system intervention

Four cropping system interventions were introduced in the village which are as follows :

Inter cropping system	No. of farmers	Area covered (ha)
Ragi + Redgram (4:1/8:2)	30	10
Maize+ Redgram (2:1)	09	3.5
Groundnut + Redgram (3/4:1)	60	08
Ragi + Dolichos (3:1)	20	04

Ragi + Redgram (4:1/8:2):

Sri Muddahanumaiah has practiced Finger millets + Red gram (8:2) system, which gave finger millet yield 23.5 q/ha and Red gram yield 1.2 q/ha with net return of Rs.17400/ha. Whereas mono cropping system gave total net return of Rs.12800.The farmers got and additional income of Rs.4600.

Maize+ Redgram (2:1):

Sri Ashwath has adopted this cropping system, which gave Maize yield 35 q/ha and Red gram yield 1.1 q/ha with net return of Rs.36000/ha. Whereas mono cropping system gave total net return of Rs.31200.The farmers got and additional income of Rs.4800.

Groundnut + Redgram (3/4:1):

Sri Ramanjaneya has adopted this cropping system, which gave Ground nut yield 17.4 q/ha and Red gram yield 1.3 q/ha with net return of Rs.38600/ha. Whereas mono cropping system gave total net return of Rs.33500.The farmers got and additional income of Rs.5100.

The cropping system best utilizes the natural resources like soil, rain water and serves as a crop insurance against weather aberrations. These inter cropping system have helped the farmes in the village to harvest higher yields per unit area besides high net results per unit area as compared to solo cropping.

Mono cropping

Intercropping (Ragi + Red gram)

(Maize + Red Gram)

(Groundnut + Red Gram)

6.4 Livestock:

Name of intervention undertaken	No of animals under taken	No of farmers covered / benefitted	Remarks
Preventive vaccination	403	44	Improved Animal health and Increased animal components and there by increased milk and meat production
De-worming of animals	65	32	Improved Animal health
Animal health check-up	403	44	Improved Animal health and Increased animal components and there by increased milk and meat production
Fodder production	20	20	To make green fodder available during the late rabi and summer months

6.5 Institutional arrangements to be encouraged / made:

The farmers of the village have constituted the committees to address the challenges due to climate change and to take up the project activities by calling a Grama Sabha meeting. The following committees have been constituted in the village.

1. Village Climate Risk Management Committee (VCRMC)
2. Farm Machinery Custom Hiring Centre (FMCHC)
3. Village Seed Bank

6.5.1 Village Climate Risk Management Committee (VCRMC):

An innovative institutional mechanism was put in place at the village level for management of the custom hiring centre for farm machinery. Village Climate Risk Management Committee (VCRMC) was constituted comprising of 12-20 villagers with

nominated members as President, Secretary and Treasurer. A bank account is opened in the name of VCRMC and is operated by any two signatories. The committee fixes the charges for hiring for different implements and hiring rates are to be displayed prominently. Farmers' contributory share towards inputs like seeds, fertilizer, animals etc., is also deposited in the bank account. The revenue and expenditure details must be shared with the general body periodically.

Table 24. Village Climate Risk Management Committee (VCRMC)

Name of farmers	Designation	Type of land holding
Chandraiah	President	Small
Yogesh	Vice President	Medium
Mahesh	Secretary	Small
Vishwesharaiah	Member	Medium
Sharadamma	Member	Marginal
Sahabjan sab	Member	Medium
Rupa	Member	Small
Gangaraju	Member	Marginal
Papanna	Member	Marginal
Jayarangaiah	Member	Medium
Mylarappa	Member	Marginal
Suresha	Member	Large
Siddalingappa	Member	Marginal
Laxmamma	Member	Marginal
Radhamma	Member	Marginal

6.5.2 Farm Machinery Custom Hiring Centre (FMCHC):

A Custom Hiring Centre was established in the village to facilitate time farm operation and also to help the poor farmers to carry out ordinary farm operations. The D.Nagenahalli village has been doing well in maintaining and running the Custom Hiring Centre which is equipped with the need based agricultural machineries. The centre has the following equipments (table. 26) which are in high demand in the farming community.

An area of around 184 ha was serviced by the equipments of the custom hiring centre where in the cost saving on account of labour ranged between 30 – 50%.

Table 25: Committee for managing the Custom Hiring Center in the village:

Name of farmers	Designation	Size of holding
Lokesh	President	Medium
Ashwath	Vice President	Medium
Chikkamuddaiah	Secretary	Small
Mardhan sab	Member	Medium
Prakash	Member	Medium

Table 26: List of Farm machineries equipments under CHC.

Sl. No	Name of Farm implements and Machineries Equipments
1	Weed cutter with accessories
2	Trencher
3	Land leveler
4	Furrow opener
5	Heavy duty Disc plough
6	Disc harrow
7	Chaff cutter 3 hp
8	Portable 4 stroke Power sprayer
9	Water tanker 4000 lt
10	Power weeder 1 hp
11	Water pumping diesel engine 5 hp
12	Tamarind deseeder
13	Chisel plough
14	Amla deseeder
15	Chain Saw 2.5 HP Petrol

Water pumping Diesel Engine

Water Tanker

Table 27: Use of equipments by farmers

Implements	No. of Farmers	Area, ha	Mechanization Capacity output /hr	Conventional Capacity output /hr	% labour saving
Disc plough	28	12	2ha	0.3 ha	85
Brush cutter	25	10	0.75 ha	0.1 ha	86
Water Tanker	100	75	4ha	0.8 ha	80
Disc Harrow	8	20	2.5 ha	0.4 ha	84
Amla -deseeder	1	2	180 kg	10 kg	94
Land leveler	10	15			
Water pumping	75	50	0.75 ha	0.1 ha	86
Diesel engine			6000 lit	580 lit with pot	90

Custom Hiring Centers: Early Lessons

- Water saving devices especially drip and sprinkler sets are very popular in areas predominant with horticulture crops.
- Use of water tank and diesel engine for watering tree seedlings is in great demand.
- This implements helped to improve the fertilizer use efficiency, as fertilizer placement particularly urea, DAP was appropriate. This has implication in reducing nitrous oxide emissions.
- Deployment of power weeders in CHCs helped timely weed control, which improved the water and nutrient use efficiency
- Broad bed furrow technology for vegetables helped in controlling damage due to excess soil moisture by aiding quick drainage and avoiding water stagnation.

6.5.3 Village Seed Bank:

Seed shortages of suitable crop varieties are an important limitation faced by farmers to implement contingency plan to tackle aberrant rainfall situations. The farmers tend to dispose off the entire produce as grain and depend on external source for seed supply in the next season. Early season drought and need for re-sowing will only exacerbate the hardship faced by farmers. Seeds of certain contingency crops like minor millets are sometimes left out of normal seed supply chain.

Participatory village level seed production of short duration Ragi ML 365, Red gram BRG 2 and Aerobic Paddy MAS 26 were taken up in the village. Breeder seed and foundation seed were sourced from research farms for multiplication in farmer's field and the seeds so produced were used in the village and nearby villages.

6.6 Farm level value addition.

1. Value addition to Amla

Sri Mahesh.N.M has 0.2 ha of Amla farm (which yields 8300 kg per annum) faced marketing problem of the produce before NICRA intervention. NICRA team visited him and suggested for value addition of Amla and given training on Amla squash and Amla candy preparation.He produced 1800 liter Amla squash and 960 kg Amla candy and earned Rs.4.68 Lakh in 2013-14.

2. Value addition to Ragi

Established Ragi processing unit viz., Ragi cleaning, polishing and powdering machine in the village in collaboration with

Karnataka State Marketing Board (KSMB) and given training on branding and packing of Ragi malt, Ragi biscuit and Ragi powder.

7. Concrete recommendations arising out of the project work: their acceptability and adoption by the target users

Table 28: The following concrete recommendations have emerged from the work done by the nominees:

Recommendations	Acceptability	Adoption in the target area of work	Up-scaling possibilities
Establishment of village level custom hiring center for timely sowing	Facilitates timelines s in farm operations and efficient use of inputs	More than 184 ha of area serviced by CHC equipments and 247 farmers utilized CHC equipments	NGOs like Aware, Aviskar and SKRDP are establishing custom hiring centers in village in collaboration with state govt.
Demonstration of trench cum bunding to arrest soil erosion	Served as reserved for soil moisture and recharge of underground water	More than 107 ha of area were covered and 182 farmers adopted this technology	This technology can be up scaled through NHM and other schemes of Agriculture and Horticulture Departments and also through MNREGS
Land survey, Soil health card and mapping of village to identify potential areas	Based on survey, soil depth, soil and water erosion, soil slope and runoff characteristics were identified	Entire D. Nagenhalli village was surveyed and around 180 soil health cards were distributed	Scope to survey in village level and preparation of maps and soil health card by soil survey department
Water harvesting structures like farm pond, percolation pond, check dam and renovation of tanks to increase water storage capacity	Acceptability is moderate. High capital cost is a major limitation.	More than 1,96,560 cubic meter water storage capacity was created and 178 farmers benefitted from this interventions	Convergence of MNREGS and state agriculture department through watershed programmes can successfully upscale this technology to combat drought
Short duration drought tolerant and pest and disease resistant crop interventions (Ragi-ML365, BRG-2, Aerobic paddy and Dry land horticulture crops)	75 % of the farmers in the village accepted this technology	More than 60 ha of the area and 228 farmers adopted this crop interventions	Up scaling can be done through agriculture departments, NGOs, NSC and KVKs.
Tree based farming was taken up in degraded land and on bunds to improve soil and water conservation and increase organic carbon sequestration	44% of the farmers accepted the this practice	120 farmers adopted tree based farming system in 50 ha area	This can be up scaled through agriculture departments, NGOs, ATMA and KVKs

8. Lessons learnt:

- Almost all the farmers in village are keen to own farm ponds provided support is extended by the government and willing to part sizeable area of land holding plus small contribution in terms of cash/kind.
- Lining is essential in light textured soils like Alfisols. However, it can be avoided where the pond is fed by sub-surface flow.

- Lining is not required in locations having high ESP and high pH.
- Farm ponds of greater depths (>3.0m) are required for reducing evaporative and seepage losses for creating similar storage capacity.
- It is not always possible to dig the water storage structures manually; hence machines are needed for digging to greater depths as it is cost-effective, reduces drudgery and execution time.
- The low cost pump sets are now available readily for lifting water and can help in up-scaling of the technology which was earlier observed to be a big constraint.
- Irrespective of total annual rainfall, there is always scope for rainwater harvesting due to high intensity rainfall events which is going to occur more frequently in the changing climatic scenario.
- There is a high potential of up-scaling farm pond technology in semi-arid India as it can prevent both droughts and floods.
- Availability of heavy duty tractor (45-60 hp) will improve the use efficiency of CHC equipments.

Adoption and execution of the technique(s) developed through research and development by the department, NGOs, Farmers, and its extent of spread, as can be accessed from official reports, surveys, media reports, etc

For up scaling the technology demonstrated in the NICRA site, media meet was conducted and the details of all the demonstrated technologies were published in the local papers. Video of the demonstrated technology was broadcasted by Doordarshan. The dignitaries from ICAR institutes, SAUs, KVKs and line department visited NICRA sites and assured to include the successful technologies for up scaling in their respective department schemes. The delegates from 9 countries like Ghana, China etc., visited NICRA demonstration site and appreciated the efforts and showed keenness to adopt these technology in their countries. NGOs of AWARE, AVISKAR and SKRDP team visited NICRA site and adopted technologies in their project areas.

Field days on drought tolerant Ragi ML-365, Aerobic Paddy MAS-26, tree based farming system, rain water harvesting technology and Amla and Ragi value addition were conducted and the news was covered by the local news papers to spread these technologies to the other villages.

Dr. S.Ayyappan DG, ICAR

Dr. A.K.Singh DDG (NRM) and Dr.B.Venkateswaralu, Director, CRIDA, Dr.Sreenath Dixit, Coordinator TDC NICRA

Delegates from Ghana visited NICRA site

Delegates from China visited NICRA site


Delegates from different nations (9 countries) visited NICRA site


Media meet visited NICRA sites


Farmers and other institution persons visited NICRA sites


Evaluation team visited NICRA site


Agri. line dept. visited NICRA site


Farmers from different areas visited NICRA site

9. Actual impact of the recommendations on improving the production, productivity and profitability of the relevant dry land farming systems

- The entire village is in drought prone areas due to variable rainfall pattern and no perennial source of irrigation. The water scarcity and land degradation were the major constraints to agricultural productivity in the village D.Nagenahalli before implementation of natural resource management under NICRA. Water harvesting structures were initiated in the village during 2011 which are crucial in building resilience against climate variability. Farm pond

and check dam help farmers for supportive irrigation to crops, recharge the underground water and increase the cropping intensity. Only single crops are used to be cultivated during kharif season before interventions. After NICRA project, the cropping intensity was doubled in many cases. The overall water storage capacity of water harvesting structures in the village is increased to 1,96,560 Cu m. Seventeen out of 32 open wells and 11 out of 29 bore wells were recharged due to water harvesting structures and created protective irrigation potential in 24 ha. Perceptible changes were observed in areas under irrigation, cropping pattern and intensity along with diversification of crops. Over a period of time water storage capacity increased significantly, covering more area under irrigation and enhancing the cropping pattern, intensity and productivity of several crops. During rabi around 58 farmers cultivated tomato, carrot and flower crops in 22.5 ha of land. Both per capita cultivable land and yield increased drastically in the village. Water resource management improved the socioeconomic status of D.Nagenahalli farmers.

Table 29. Impact of Rain water harvesting structures

Name of the Intervention	No. of Units	No. of farmers benefited	Water Storage Capacity (Cu m)	Protective irrigation potential created* (ha)	Increase in cropp ing intensity%
New farm pond	72	85	18000	16	100
Percolation pond	13	13	1750	Indirect impact on ground water recharge.	
New check dam	05	11	6750	1.5	100
Water storage structure	04	04	760	02	100
Rejuvenation of farm pond	15	20	7500	05	100
Rejuvenation of check dam	08	15	10700	5.5	100
Rejuvenation of community tank	02	12	5500	03	150
Desilting and widening of catchment channel for the village tank (1200 m)	01	18	145600	07	150
		Total	**196560**	**24**	

** Two protective irrigations at a depth of 5 cm per irrigation*

- The soil management practices such as leveling and making of the compartments, Trench cum bunding, Tank silt application, Deep Ploughing and contour bunding, Crop mulching, Stubble mulching and Compost pit improves the soil moisture content and soil organic carbon content consequently helped better yield in ran fed areas.
- Other promising water harvesting technologies like Percolation ponds, recharge of bore wells and check dams,

water storage structure, desilting and widening of catchment channels and blocking of leakage village tank and drip irrigation proved to be the best practices for the good rainwater harvesting.

- Adoption of contingent crop plans depending on rain is an insurance against total crop loss. It is a resilient agriculture for aberrant weather in dry areas. Introduction of best practices viz., growing of ML-365 Ragi to cope with early season drought, Introduction of Redgram (BRG 2) to cope with delayed monsoon, Addressing Drought Vulnerability by Aerobic Paddy MAS-26 Cultivation, Plastic mulching for promoting higher production, Cropping system intervention and Tree based farming system are the other best methods to fight against unexpected delayed and failure of monsoon.
- In addition to that, more than 32,000 different fruits and forest seedlings were planted. Tree planting was also initiated on degraded lands in the village to slow down the siltation of water bodies, improves the microclimate and soil organic carbon sequestration. It also supplies fodder to goat and sheep in rainfed areas.

Over view of NICRA site

10. Quality of publication arising out of the research project

Popular Articles:

- *Launching of National Initiative on Climate Resilient Agriculture Project, 2011.* Prajavani, Tumakuru District, Kannada daily.
- *New Programme at D.Nagenahalli: Farmers are Happy, NICRA Scheme from Krishi Vigyan Kendra, 2011.* Vijaya Karnataka, Kannada daily.
- *Uses of mixed tree based farming system on climate resilient to agriculture 2011,* Vijaya Karnataka, Prajavani, Kannada daily.
- *Management of micronutrient in Ragi, 2011.* Prajavani, Praja Pragati, Kannada daily.

- *Drought tolerant Ragi ML-365 for delayed monsoon, 2011.* Vijaya Karnataka, Kannada daily.
- *Adoption of climate resilient interventions at D.Nagenahalli, 2011.* Prajavani, Praja Pragati, Vijaya Karnataka, Kannada daily.
- *Use of Biofertilizer and its importance, 2011.* Prajavani, Kannada daily.
- *D.Nagenahalli farmers turn barren land fertile, The NICRA scheme has come in handy for drought hit village, 2012.* Kannada Prabha, Prajavani, Praja Pragati, Vijayavani, Hosadiganta, Tumakuru daily, Kannada daily and Deccan Herald.
- *Introduction on drought tolerant, water saving Aerobic Paddy MAS-26, 2012.*
- *Use of Arka Microbial Consortium, a Bio fertilizer for sustainable agriculture production, 2013.* Vijaya Karnataka, Kannada daily.

Booklet:

- *Climate Change, 2011.* Krishi Vigyan Kendra, Hirehalli, Tumakuru.
- *Land Resource Assessment of Durgada Nagenahalli (A NICRA adopted Village, in Karnataka) for Integrated Development, April 2012.* National Bureau of Soil Survey and Land Use Planning (NBSS & LUP) and KVK (IIHR) Hirehalli.
- *Venkateswarlu, B., Shalander Kumar, Sreenath Dixit, Srinivasa Rao, Ch., Kokate, K.D. and Singh, A.K. 2012. Demonstration of Climate Resilient Technologies on Farmers' Fields Action Plan for 100 Vulnerable Districts. Central Research Institute for Dryland griculture, Hyderabad. 163 p.*
- *Venkateswarlu, B., Kokate, K.D., Gopinath, K.A., Srinivasarao, Ch., Anuradha, B. and Sreenath Dixit (Eds.). (2013). Coping with Climate Variability: Technology Demonstration on Farmers' Fields in Vulnerable Districts. Central Research Institute for Dryland Agriculture, Hyderabad. 160 p.*
- *Prasad, YG., Maheswari, M., Dixit, S., Srinivasarao, Ch., Sikka, AK., Venkateswarlu, B., Sudhakar, N., Prabhu Kumar, S., Singh, AK., Gogoi, AK., Singh, AK., Singh, YVand Mishra, A. 2014. Smart Practices and Technologies for Climate Resilient Agriculture. Central Research Institute for Dryland Agriculture (ICAR), Hyderabad. 76 p.*

Publication:

- Ramesh PR, Jagadish KN, Prasanth JM and Naik LB, *2013.* Technology demonstration component of D.Nagenahalli NICRA village, Farmers First, Soil and Water Conservation. National Conference (FFSWC) held at Hebbal UAS Bangalore 14-16th March.
- *Loganandhan N, Naik, LB Ramesh PR, Prasanth JM, Jagadish,KN, and,2013.Adoption of Climate Resilient Technologies in a Drought Prone Village in Tumakuru District, Karnataka,* 2013. International conference on climate change and its implications for water resources and nutrition security, ILSI India and Center for integrated

Modeling of Sustainable Agriculture and Nutrition Security (CIMSANS), Washington DC at Hotel Pride, Bangalore on 15-16th November.

- *Ramesh PR, Hanumanthegowda B, Praveenkumar, Loganandhan N and Naik LB, 2014. Water resource management to combat climatic vulnerability: A case study of D. Nagenahalli, Tumakuru, Karnataka. Accepted for National Seminar on "Climate Change and Agrarian Economy: An Indian perspective to be held at University of Agricultural Sciences, Dharwad from January 22-23, 2015.*

- *Loganandhan N, Ramesh PR, Jagadish,KN, Prasanth JM, and Naik, LB,2014. Three years, seventy farm ponds, eighteen thousand cubic meters capacity– A success story from a NICRA village in Tumakuru district of Karnataka. Accepted for International Conference on Natural Resource Management for Farming Systems and Rural Livelihood to be held at Soil Conservation Society of India, New Delhi from 10-13 February, 2015.*

Video documentation:

- *Technology Demonstration Component NICRA KVK Hirehalli, 2011, released by Dr.Ayyappan (DG).*
- *Demonstration of drought mitigation technologies at D.Nagenahalli, 2012,* documented by Doordarshan.
- *Documentation of Rabi crops and climate resilient interventions at D.Nagenahalli, 2013,* documented by CRIDA.