University of Agricultural Sciences
Bengaluru

Glimpse of Forage Research at UAS, Bengaluru

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Directorate of Research
AICRP on Forage Crops & Utilization
ZARS, V.C. Farm, Mandya – 571 405

2017

Sheep Exhibition at Hebbal farm in 1910

Forage Crops Demonstration at Hebbal in 1915

Dr. K. Krishnamurthy, Director of Research explaining on fodder crops to
Shri. G Ramegowda, Hon'ble Minister, Animal Husbandry, Govt. of Mysore

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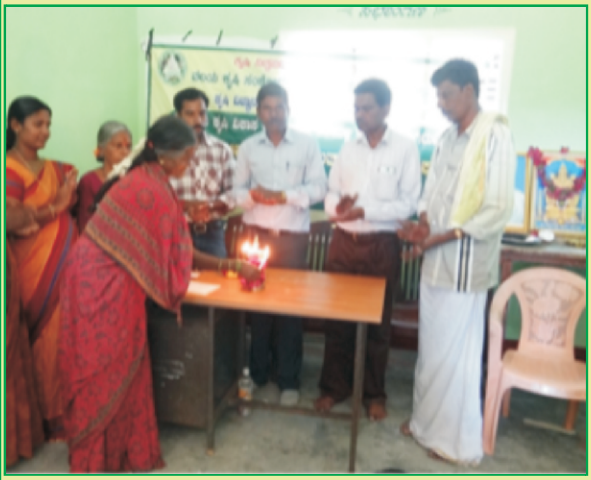
Distribution of Fodder Seeds by ADR, ZARS, V C Farm, Mandya


Field day on Multicut fodder Sorghum Variety CoFS-29




Training Programme on Fodder Production Technologies

Accreditation Team visit to forage crop exhibition

Visit of Project Coordinator, IGFRI, Jhansi to FTD-Forage Crops

Visit of Director of Research to FTD-Forage Crops

Dr. H. SHIVANNA
Vice-Chancellor

UNIVERSITY OF AGRICULTURAL SCIENCES, BENGALURU
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FOREWORD

India being the world's largest milk producer, with 18% global production having a livestock population of 512.05 million (19th livestock census-2012), the productivity of milk and meat appears to be low when compared to developed countries. Though we have above one fourth of total world livestock population, low productivity is due to under nutrition besides low genetic potential of the animals. However, the overall contribution of livestock sector to India's total GDP is 4.11 per cent. Urbanization has brought a marked shift in the lifestyle of people in feeding habits towards milk products, meat and eggs with resultant increase in demand for livestock products. Strong farm-gate prices and rising demand for value-added products due to increasing consumer income are stimulating increased milk production in India. The animal husbandry and livestock sectors are critical for the rural economy, especially the small and marginal farmers. They not only contribute to their income but also their best insurance against any natural calamity.

The area under cultivated fodder is only 8.4 million hectares and has been static during last two decades. The scope for further increase seems to be very low due to demographic pressure for food crops. The recent crop diversification where commercial crops replacing the traditional cereal crops especially the coarse cereals is likely to have an impact on the availability of crop residues for animal production. Seed availability of forage crops is just 15-20% of national requirement and much of it is under the unorganized seed market. Forage crops in general and range grasses and legumes in particular are shy seed producers. Nucleus and Breeder seed production are the major bottleneck to be addressed by forage research network. The issues related to the development of remunerative forage based cropping system, livestock based integrated farming systems for efficient resource use and enhancing farm productivity, forage based contract farming and cooperative farming, utilization of problematic soils, waste lands, current fallows and marshy lands for fodder production and standardizing seed research needs to be given utmost importance. Further, there is scope to increase the fodder production through hydroponics fodder production and silage making besides popularizing fodder tree species to meet the lean season fodder requirement and fodder scarcity.

This technical bulletin gives the glimpse of research accomplishments and issues related to the research strategies to be required for meeting the challenges. The authors have made sincere efforts in compiling information generated on research activities carried out on different facets of forage research in our university in the last five decades. I complement them for bringing out this publication to serve as a guide to researchers and policy makers.

Bengaluru
September, 2017

(H. SHIVANNA)
Vice-Chancellor

Y.G. SHADAKSHARI
Director of Rresearch

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PREFACE

Livestock being a key source of supplementary income and livelihood, specially for small and marginal farmers and landless rural poor. Nearly 70 per cent of India's milk production comes from small and marginal farmers who depend on home grown fodder. Ensuring an adequate supply of reasonable quality feed and fodder is major challenge which Indian livestock sector is facing currently. Of late cultivation of forage crops has gained increasing importance due to rapid degradation of natural fodder resources and growing concern among the farmers for sustainable agricultural production and integrated dairy farming. The low productivity of Indian livestock is a matter of concern, which can be improved by providing quality forage in adequate quantity.

The challenges before us is to bridge the gap between a demand of 1060 mt, 589mt and 130 mt of green fodder, dry fodder and concentrates respectively against the present supply of 395 mt , 451 mt, and 48 mt of green fodder, dry fodder and concentrates respectively.

Realizing the importance of quality green fodder production to boost livestock production, UAS, Bengaluru initiated research work on fodder crops in a small scale at Main Research Station, Hebbal, Bengaluru. The crop improvement on forage crops was also initiated in the Department of Genetics and Plant Breeding at College of Agriculture, GKVK, Bengaulru and Agricultural Research Station, Nagamangala in Mandya district and Naganahally in Mysuru district. Realizing the importance of dairy farming and providing quality fodder to dairy cattle in Karnataka, ICAR sanctioned All India Co-ordinated Research Project on Forage Crops during 1987-88 at Zonal Agricultural Research Station, Tiptur and later during the year 2004-05, the centre was shifted to Zonal Agricultural Research Station, Vishsweswaraiah Canal Farm, Mandya. Since its inception, the centre has developed and adopted several high yielding fodder varieties and released to the state for cultivation. The centre also developed several production technologies like nutrient management, grass legume mixtures, remunerative forage based cropping system and cultivation of forage crops in problematic soils for higher yield and quality fodder production. I appreciate the efforts of scientists who were instrumental in developing these technologies.

I sincerely thank the ICAR for its continuous financial support to the AICRP centre, functioning at ZARS, V.C. Farm, Mandya.

I hope information covered in this bulletin will serve as a sense of direction for researcher and policy makers for strengthening research on forage crops in unexploited areas and making suitable policies.

Bengaluru
September, 2017

(Y.G. SHADAKSHARI)
Director of Rresearch

CONTENTS

1. Introduction

Indian agriculture is bestowed with a lot of plant and animal diverse resources for food and nutritional security of the country. Agriculture and livestock farming evolved together as an integrated and sustainable livelihood options for centuries with inter-dependence and perfect balance among human, plant and animal life from nomadic state to settled form of agricultural evolution in India. In the changed scenario, agriculture and livestock farming intensified with advent of high yielding more responsive crop variety / hybrids and improved cross breeds in the country during green revolution and white revolution in agriculture and livestock farming respectively. During this period, efforts were made to improve green fodder availability for livestock and to reduce the deficiency of green fodder due to depletion of available natural resources like grazing/pasture lands and peripheral forests by intensive agricultural practices and population explosion. Natural feed and fodder resources became scarce to support growing livestock population, many grass and tree / shrubs species with high forage value were introduced to India in 1960's and 1970's under Indo-Danish project and International Development Agency (IDA) by establishment of National Dairy Development Board and Indian Dairy Corporation in 1970 in the country. Development of livestock farming technologies started only after 1970 with scientific management of animal rearing with improved breeds, supply of balanced feed and nutritious fodder and technologies for animal health coverage. Meantime, Napier and Guinea grasses were introduced under Indo-Swiss project in 1967. Fodder potentialities of these genotypes were demonstrated in selected farmers including military dairy farms in different states.

Dairying and animal husbandry activities got a good support from the erstwhile visionary ruler Maharaja of Mysuru, Sri Krishnaraja Wodeyar ever since he adorned the throne of Mysuru kingdom in the year 1902. His sincere efforts of alleviating poverty through several agricultural and rural development initiatives under the democratic principles yielded fruitful results which were well appreciated all over the country.

The first initiative of the Maharaja was grant of land and establishment of experimental farm at Hebbal, Bengaluru in the year 1899 with an area 20 acres of wetland and 60 acres of dry land. Initially three sections were established with Agricultural School in the year 1913 along with Veterinary hospital and Hebbal dairy for promotion of livestock farming. Hebbal was the main centre for all agricultural research including dairy and fodder development activities in the state. A herd of cross bred (Merino x Local) sheep were also maintained in the farm. In the year 1920, a separate livestock section was created and Mr. Davison was appointed as livestock expert. A sheep farm was also opened at Yelachihalli in the Mysuru district. Mysuru Agricultural College was established in 1946 under the

jurisdiction of University of Mysuru with initiative of Mr. Srinivasan as a Minister for Agriculture in the Mysuru state.

A land mark in Karnataka dairy development has been the establishment of the Karnataka Dairy Development Corporation (KDDC) Ltd., in December 1974 with the financial assistance from the International Development Agency of World Bank, Geneva. One of the objectives of this programme entrusted to the university was on applied forage research and demonstration in the KDDC command area of southern Karnataka for increasing milk production by changing production potential of dairy cattle through organizing effective and improved management and feeding systems by educating farmers through applied research and demonstration on practical problems of forage crops. A number of field experiments were conducted on various forage species and genotypes, plant density, nutrient requirements, weed control, yield components and herbage yield.These experiments were mainly concentrated at MRS, Hebbal with attached fodder demonstration and dairy farm.Some research works were also conducted in other research stations of UAS, Bengaluruin order to evaluate forage crops in relation to the yield and yield components under different agro climatic conditions. Simultaneouslythey focused on nutritional aspects of some fodder crops and fodder trees / shrubs and their requirement for different categories of livestock. This programme helped dairy farmer to get better level of nutritious green fodder yield which resulted in the reduction of cost of production ofmilk and also enhanced the milk yield and prolonged lactation period in their milch animals. The university also introduced high yieldingLucerne varieties “Wairau and Saranac” which were introduced from Australia, New-Zealand and Hungary into irrigated fertile soils in the command area.The University was entrusted with the responsibility of establishing forage demonstration farms at different milk unions in all the eight districts.These demonstration farms served as an extension education model tools for popularising the forage technologies among dairy farmers.

Realising the importance of dairy farming in the state and role played by the University in enhancing the forage production & to support livestock farming in Karnataka, ICAR, New Delhi sanctioned All India Coordinated Research Project on Forage Crops & it was established in the year 1987 at Tiptur (Zone 4) and later shifted to Mandya (Zone 6) in the year 2004 with following objectives.

2. Mandate & Objectives of the centre

- Development of high yielding varieties with desired quality parameters in different forage crops (Mandate crops: Maize and cowpea)
- Identification of sustainable and remunerative forage based cropping system

- Integrated nutrient management in food-forage cropping system for sustainability
- Intensive forage production in coconut/dry land orchard based cropping system
- Intensive forage production through grass-legume mixtures
- Forage Production based on watershed approach
- Intensive forage production through Silvi / Horti - pasture system
- Dissemination of scientific information to the Extension personnel and through technology demonstrations and trainings
- Supply of seeds & planting material and technical know how to the farming community
- Quality fodder seed production of improved varieties

The emphasis for Animal husbandry and dairying activities was hastened due to severe drought in 1966-67 which led to more focussed research on livestock rearing as an alternate source of income for the farmers under drought situations. High yielding improved breeds of cows and buffaloes were introduced to support Animal husbandry with improved fodder genotypes and production technologies. Many demonstrations on improved varieties and production technologies for different fodder crops were conducted in both farmers fields and research stations of the University.

They also achieved a significant breakthrough in development of cows and buffalos of high genetic potential of milk production, feed them economically with adequate quantity of green nutritious fodder and feeds of adequate quality. In this way a record milk production of 33 M tons was achieved in 1982 from hardly 21 M tons in 1970 in the country.

3. Fodder Research Network established between 1975 -1982

A) Crop Improvement

i) Main Research Station, Hebbal, Bengaluru

- Varietal evaluation
- Seed Production
- Forage crops under different cropping systems
- Hybridisation
- Mutation work started in Bajra, Napier, Green Panic grass and Congo signal grasses.

Development of Improved Napier Bajra Hybrid-BH-18

Dr. G. Shivashankar & co-workers developed a promising Bajra Napier hybrid grass variety **BH-18** and a promising non-arrowing mutant of green panic grass in the year 1981. The University had earlier released "**Kamadhenu**" (Dharwad hybrid Napier-2) variety looking to the needs of dairy industry which was a derivative of interspecific hybridization programme involving Elephant grass (*Pennisetum purpureum*) and Bajra (*Pennisetum typhoides*) var Golgeri-1. However, the same was withdrawn by the University since it was very susceptible to leaf blight disease caused by *Helminthosporium*. Realising the gravity of the situation, new interspecific hybridization programme was undertaken using resistance source of Tift-23A (MS) with elephant grass. BH-18 is a hybrid derived from the above cross. The triploid F_1 plant (BH-18) has been observed to be superior in many respects, besides resistant to *Helminthosporium* (leaf blight) disease.

Non-Flowering Mutant of Green Panic Grass

Green panic (*Panicum maximum* var. trichoglume), is one of the best palatable nutritious and succulent grasses very much relished by the dairy animals. However, its major drawback is its profuse flowering thus depleting its foliage both in quantity and quality. Through gamma irradiation, a non-arrowing mutant was isolated (at 40 kR treatment) which had yield potential of 75 t/ha (22% more over its flowering type) which is mainly attributable to the increased number of tillers and leaves besides good rejuvenation capacity. The proximate analysis has shown that the mutant had 6.04% crude protein and 0.5% Calcium content.

Project entitled "Development of non flowering mutants with increased fodder productivity in guinea grass by Gamma irradiation" was sanctioned by BARC, Mumbai during 1992-94 was headed by Dr. M. Byregowda. The Gamma rays with a dosage of 80 kR appeared to be optimum for inducing desirable mutants in guinea grass. The selected desirable mutants were used and maintained for further evaluation.

Varieties evaluated during the period

- ✓ **Hybrid Napier Grass:** NB-21,BH-18,BH-2 & Kamadhenu selection
- ✓ **High Yielding grasses:** Guinea, Rhodes, Green Panic, Blue Panic, Congo signal, Para, Dallis, Giant star, Molasses and Dhavalu.
- ✓ **Fodder Maize:** Deccan hybrid, South African tall, Pioneer hybrids
- ✓ **Teosinte:** Teo Maize
- ✓ **Oats:** Kent

- ✓ **Fodder Sorghum :** Hybrids :Pioneer x 988, Pioneer x 410 E

  Varieties: J-Set-3, S-136, S-1049, MP-Chari and 2219-A.
- ✓ **Lucerne:** Composite-3, Composite-5, Anand-2, T-7, Sirsa-8, Sirsa-9, Wairsu and Sarnac.
- ✓ **Forage Cowpea :** EC-4216, C-152 and IGFRI Varieties.
- ✓ **Subabul:** Salvadorensis, Peru, Hawaiian types, Cunningham, Carriedo and Hawaiian Giant strains.
- ✓ **Forage Bajra :** Deenabandhu 49A

Production technologies developed

- ❖ Production technologies for both irrigated & rainfed conditions have been developed.
- ❖ Conducted animal nutrition studies at Hebbal dairy.
- ❖ Forage crops were tested on Bunds, waste lands, marginal range lands & ravines through silvipastoral methods.
- ❖ Demonstrated growing top feed tree species along the avenues & field roads.
- ❖ Experiments conducted on tropical and temperate forage legumes like Lucerne in the command area

ii) RRS V.C. Farm, Mandya

- ❖ Identified and introduced most suitable grasses like Napier Bajra Hybrid, Green Panic, Rhodes, Congo Signal and tropical forage legumes, top feed trees species and seasonal forage crops.
- ❖ All the cultivable waste lands, field bunds were utilised for cultivating top feed trees namely Shevri, Subabul, Agase, Hariwana and Dasharath grass.
- ❖ The centre acted as a main source of the quality seed production.
- ❖ Involved in Transfer of forage technologies to the MPCS Union, Mandya & Mysore

iii) ARS Naganahalli, Mysore

- ✓ Identified most suitable grasses like Napier Bajra Hybrid, Green Panic, Rhodes, Congo Signal grasses and Lucerne under irrigated situation and *Sirratro* and Subabul under rainfed condition.
- ✓ Evaluated different forage crops in Coconut garden under rainfed conditions.

- ✓ Involved in Transfer of forage technologies to the MPCS Union, Mysore

iv) ARS Madenur, Hassan

- ✓ Identified most suitable grasses like Napier Bajra Hybrid, Green Panic, Rhodes, Congo Signal grasses and Lucerne under irrigated situation and *stylo, sirratro* and *subabul* under rainfed condition.
- ✓ Involved in Transfer of forage technologies to the MPCS Union, Hassan

v) ARS Arasikere. Hassan

- ✓ Evaluated different forage crops in Coconut garden under rainfed conditions.
- ✓ Introduced Subabul on field bunds of sub marginal, range lands, waste lands.
- ✓ Involved in transferring the technology to the MPCS Union, Tumkur in cultivating the forage crops.

vi) ARS Chintamani, Kolar

- ✓ Evaluated drought tolerant/resistant varieties of different forage crops.
- ✓ Identified and introducedmost suitable grasses like Napier Bajra Hybrid, Green Panic, Rhodes, Anjan grass, Congo Signal and Sudan grasses and tropical forages *viz., Sirratro, Stylo, Shevri, Subabul, Agase* and Dasharath species under rainfed conditions.
- ✓ Involved in Transfer of forage technologies to the MPCS Union, Kolar

vii) RRS Mudigere, Chikkamangaluru

- ✓ Identified and introduced most suitable grasses like Napier Bajra Hybrid, Green Panic, Rhodes, Congo Signal, spear grass and *Paspalum sp* and forage legumes like *Centrosema*, *Sirratro*, Subabul, Calopo and Valvet bean under high rainfall conditions.

B) Crop Production

Production technologies generated (1977-1987)

- ✓ The maximum biomass yield of 89.2 t/ha with Anjan grass+ *Stylo* when fertilized at 40:40:20 kg NPK/ha in 9 cuttings under rainfed conditions. They also recorded highest green fodder yield (136.5 t/ha) at a clipping interval of 40 days in green panic mutant grass. They also observed highest yield with 200:100:60 kg NPK/ha (130.3 t/ha).
- ✓ In Fodder maize, application of Sulphur at 20 ppm enhanced GFY over control (33.5 t green fodder/ ha), which accounts 31.3% improvement in yield where soils are deficit in available sulphur content under rainfed conditions.

- ✓ The significant improvement in grain yield of African Tall fodder maize due to one spray of triacontanol (Grinit) (1 ml/ 2 litre water) at 55 days after sowing.
- ✓ The highest green fodder yield (79.4 t/ha) by Multi cut fodder Jowar CV. Pioneer at 100 kg seeds with 150:75:75 kg NPK/ha.
- ✓ Cowpea and Horsegram as intercrops in fodder maize gave better yields than rice bean under rainfed conditions.
- ✓ NB hybrid grass, BH-18 in association with legume fodders like mimosa and Calapagonium gave higher combined yield than in association with *Stylo*/ Lucerne/ under irrigation.
- ✓ Use of poultry waste (10t/ha) in NB Hybrid grass gave highest fodder yield (56.2 t/ha in 3 cuts) while recommended NPK or use of water hyacinth (20t/ha) gave an yield of 52.1 t/ha only under rainfed conditions.
- ✓ Superior performance of 49-A fodder Bajra (Check Variety) with 24.2 t green fodder/ha as compared to UUJ-1 (21.6 t/ha)
- ✓ APLP-1 and JLP-4 of Fodder Fieldbean varieties recorded high GFY (31.0 and 32.5 t green fodder/ha) as compared to local (23t/ha).
- ✓ Napier Bajra Hybrid, BH-18 gave maximum green fodder (56.5 t/ha/year in 2 cuts) as compared to Kamadhenu selection (53.7 t/ha/year).
- ✓ Fodder Legumes like Calapogonium and Axillaris gave higher fodder yields (30.3 and 32.8 t/ha/year) than *Siratro* (27.8 t/ha) and *Stylo* (9.4 to 14.9 t/ha).
- ✓ Among *Stylo* species, *S. hamata* and *S. scabra* gave equal fodder yield (10.8 t/ha/year) and were superior to *S. quinensis* cv. Cook (8.4 t/ha) and cv. Graham (7.6 t/ha) under rainfed conditions
- ✓ Pure crop of Signal and Anjan grasses gave higher fodder yield (6.5 & 4.7 t/ha) than grass + legumes mixtures (Signal + *Centrocema* - 6.0 t/ha, Signal +*Siratro* - 4.2 t/ha while Anjan + Centrocema -3.6 t/ha and Anjan + Siratro-3.4 t/ha) under rainfed conditions.

C) Transfer of technology (1975-1982)

SI. No.	Crop & Varieties	No. of Demonstrations conducted	Area covered (ha)
1.	Lucerne (Sirsa-9, Anand-2, PV, Sirsa-8, T7 ,T9)	2596	110.75
2.	Hybrid Napier Bajra	7069	1082.5
3.	Guinea grass	4000	796.29
4.	Subabul	8792	58.46
5.	African tall	281 tonnes seeds produced and distributed	
6.	Fodder Sorghum (J-Set -3, Pioneer x 988, Pioneer x 422 E)		
7.	Fodder Cowpea		

4. Research Accomplishments after establishment of AICRP

A) Crop Improvement

Productivity of following Fodder crops & varieties were evaluated at Zonal Agricultural Research Station in Tiptur under Irrigated & Rainfed conditions between1987-2004

Sl. No.	Fodder crops	Green fodder yield (t/ha) promising varieties		check varieties yield(t/ha)	
1	**CEREAL FODDERS**				
	Forage Maize (RF)	GBM-84-1 GBM-84-2 GBM-84-3	: 45-60	African tall:	45-58
2.	Forage Jowar (RF)	855-F MF6H-9	45-55	SSG-59-3:	45-52
3.	Rabi Maize(irrigated)	FML-15 GBM-84-2	55-65 45-60	African tall :	45-52
4.	Oats (irrigated)	AKS-8 Kent OL-8 OL-125	: 22-34 24-36		
5.	Bajra (Multicut) (irrigated)	APFB-2 FMH-3 UUJ-2	85-90	Giant Bajra: UUJ-IV (M) :	65-70

Sl. No.	Fodder crops	Green fodder yield (t/ha) promising varieties		check varieties yield(t/ha)	
II.	**LEGUME FODDERS**				
	1. Cowpea (RF)	IFC-901 UPC-8801 UPC-9102	30-36	UPC-287 : UPC-5286	30-34
	2. Fieldbean (RF)	JLP-4 JLP-31-3	: 25-30	High worth :	25-28
	3. Lucerne (Irrigated)	RLS-88,CO-1	: 80-85	LLC-3 :	55-60
III.	**PERENNIAL GRASSES**				
	1 a) Napier Bajra hybrids (Irrigated)	CN-7 CN-8 : IGFRI-10	120-130	NB-21 :	110-115
	b) Napier Bajra hybrids (RF)	RBN-9 : IGFRI-10 :	34-36	BH-18 :	34-36
	2 a) Guinea grass (Irrigated)	PGG-14 : PGG-316	120-130	Hamil : Maccuni:	80-100
	b) Guinea grass (RF)	PGG-202 : PGG-489	25-30	PGC-9 : Maccuni :	18-22
IV.	**PASTURE GRASSES**				
	1. Anjan grass	CAZRI-1228 : CAZRI-1414 :	20-25	CAZRI-75 :	18-20
	2. Dhaman grass	CAZRI-76 :	15-18	CAZRI-1 :	10-12
	3. Marvel grass	IGFRI-1978 : IGFRI-1994	15-20I	GFRI-225 :	13-15
	4. Dinanath grass	JHP-2 :	18-20		
V.	**PASTURE LEGUMES**				
	1. *Stylo*	*S. scabra*:	18-20	*S. hamata*:	6-8
	2. Others	*Clitoria ternatia* :	12-16		

Status of PGR (SOURCE)/exploration/collection

Crop	Germ-plasm no	Source
Forage Cowpea	235	AICRP Arid Legumes, GKVK, Bengaluru Channarayapattana local, Goa local, Tiptur local, Kadur local Patrehalli local.
Maize inbreeds and Resistant donors	69	AICRP(Maize), ZARS, V.C.Farm Mandya
Forage Sorghum	25	Locals collections from, Kollegala, Gunlupet, Chamarajanagar, Malavalli
Forage Fieldbean	65	AICRP on Pigeonpea, GKVK, Bengaluru and Farmers fields of Karnataka, Tamilnadu and Andhra Pradesh
Forage Horsegram	48	AICRP on Arid Legumes, GKVK, Bengaluru
Guinea grass	06	IGFRI, Jhansi, AICRP centres & Local collections
Hybrid Napier Bajra	13	
Anjan grass	08	
Cenchrus spp	10	
Stylosanthes spp	03	
Agase (*Sesbenia spp*.)	02	Introductions
Subabul	02	Introductions
Ricebean	15	AICRP on Potential crops, UAS, GKVK, Bengaluru
Erythrina	03	Local collections
Crotolaria	07	Local collections from Western Ghats of Karnataka
Hedge Lucerne	03	TNAU, Coimbatore
Total	**515**	

Varieties developed /Adopted:

1. **Forage Cowpea**

- **KBC-2:** Developed by gamma rays induced mutations of variety V-16 & released in the year 2009. KBC-2 is superior in green forage yield (253.9 q/ha) over best check UPC-9202 (199.7q/ha) with high seed yield (7.50 q/ha) as compared to checks and possesses resistance to rust, high dry matter content(20-21%), crude protein content (15.6%) and leaf to stem ratio(0.8) (Fig.1).
- **MFC-08-14:** Developed at Mandya centre. It is derived from the cross KBC-2 x Bundelobia-1 & released at national level in the year 2015. This variety is superior in green forage yield (200.43 q/ha) over best check UPC-9202 (182.27 q/ha). High seed yield (7.40 q/ha) compared to checks & possesses resistance to rust, dry matter content(18-20 %), crude protein content (20-22%) and leaf to stem ratio(0.68)(Fig.2).
- **MFC-09-1:** Developed at Mandya centre. It is derived from the cross KBC-2 x COFC-8 & released for South India in the year 2016. **MFC-09-1** is superior in terms of green forage yield (301.60 q/ha), dry matter yield (43.4 q/ha) and crude protein yield (7.5 q/ha) over the national check UPC 5286, moderately resistant to rust, long pods and high seed yield (10.54 q/ha) as compared to check (Fig.3).

2. **Forage Maize**

- **African Tall**: It is a composite variety derived from the cross combination of 7 genotypes (H-611, H-611, H-611(R),C3, K-III, X EC-573(R12), C3, Ukiri comp A(F)C5 x Ukiri Comp A(F)C3, Chitedge composite A and Ilonga composite.) through modified mass selection techniques from MPKV Rahuri & released in the year 1982. This variety was adopted for Karnataka in the year 1985.This composite is a tall plant type (255-265 cm) with vigorous & sturdy growth & more leafy with well developed stalk roots, with leaf stem ratio of 0.45 it is white grained bold & semi grain texture, with average GFY of 60-65 t/ha, DMY 15-18 t/ha & seed yield 18-20 q/ha (Fig.4).

3. **Forage Sorghum**

- **MP Chari (Multicut):** It is a cross between Sudan grass (K-49) & Sorghum (J-57) at Jawaharlal Nehru Agricultural University Jabalpur, and released at national level in the year 1978 & it was adopted for the state of Karnataka for cultivation. It is having GFY potential of 60-65 t/ha & DMY of 12-15 t/ha (Fig.5).

- **SSG 59-3 (Multicut):** It is a cross between Non sweet Sudan grass & Sweet Jowar (JSA 263) at CSS Haryana Agricultural University Hisar & released at National level in the year 1978. The variety produces 75 t/h green fodder and 22 t/ha dry fodder (Fig.6).
- **Sudex chari (Multicut):** It is a cross between Sorghum (2077 A) & Sudan grass (SGL-87) at PAU, Ludhiana, released at national level in the year 1991. It is a multi cut variety having quick regenerability with thin & juicy stem with sucrose content of 6.8 %. The green forage yield 110-115 t/ha in 4 cuts& DMY of 22.0-25.0 t/ha (Fig.7).
- **CoFS-29 (Multicut):** It is a cross between TNS 30 & Sudan grass at TNAU, Coimbatore & released for south India in the year 2011. It is adopted for southern Karnataka in the year 2011.It is having GFY potential of (65-75 t/ha) & Dry matter content of (35.55%) with crude protein content (8.38%) (Fig.8).

4. Forage Bajra

- **Deenbandhu 49-A:** This variety is selected from the local at UAS, Dharwad & it is tolerant to drought with early maturity (65-70 days) with green forage yield of 40-45 t/ha under rainfed conditions & 60-65 t/ha under irrigated conditions and ratoon yield of 20-25 t/ha GFY. Live stock preferred this variety more due to its thin, soft & juicy stem (Fig.9).
- **Giant Bajra:** It is derived from the cross between Australian Bajra & Local Bajra from Dhule district at Maharastra this variety is developed at MPKV Rahuri released at National level in the year 1985. It is taller (250-300 cm) with profuse tillering & high leafiness at boot stage. It has crude protein content 8-9 %. The average yield of this variety GFY (30-35 t/ha) & DMY (7-8 t/ha). It is good for both green & silage making (Fig.10).
- **BAIF Bajra-1:** It is developed at BAIF, Urulikanchan, Pune and released in the year 2009. It is with average green forage yield of 38-40 t/ha under irrigated conditions & 15-20 t/ha under rainfed condition. It has good quality of fodder with dry matter of 24.47% & crude protein content (7.15%) with moderate leaf stem ratio (0.24) (Fig.11).

5. Forage Oat

- **OS-6:** It is a cross between HFO-10 x HFO 55 P-2 done at CCSHAU, Hisar. & released at National level in the year 1981.It is adopted for the state of south Karnataka in the year 2011.This variety is superior in green forage yield (27-30 t/ha), high dry matter content (20-25 %) high crude protein content (8.7%) and leaf to stem ratio (0.43%) with high seed yield (15 q/ha) (Fig.12).

6. Lucerne:

- **RL-88:** It is a selection from the Ahmednagar local and developed at MPKV-Rahuri, Maharastra. It is recommended for release at National level during the year 1995.The green forage yield potential of 85-100 tons/ha/year with 9-10 cuts. DMY (20-22 tons/ha/year) & crude protein content (20-22 %).It is suitable for year round fodder production (Fig.13).

7. Hybrid Napier Bajra

- **BH-18:** It is an improved Hybrid Napier grass derived from the triple cross between Elephant grass & Bajra Variety Golgeri-1. Further it was crossed with TIF 23 A to derive *Helminthosporium* resistant Triploid F_1 plant which was released as BH-18 i.e, Bangalore Hybrid-18. Besides being resistant to *Helminthosporium* (leaf blight) disease, the clone has the potential to yield 120-130 tons/ha/year of green fodder in 7-8 cuttings in irrigated conditions & 40-50 tons/ha under rainfed conditions (Fig.14).
- **NB-21:** It is a cross derived from the Napier i.e, Elephant grass & Bajra. It was developed at PAU, Ludhiana & released at National level during the year1979. It is having low Oxalic acid content and average green forage yield of 50-60 tons/ha in rainfed conditions & 140-150 t/ha in irrigated conditions (Fig.15).
- **Co-3**: It is a cross derived from Bajra (PT-1697) x *Pennesitum purpurium*(Merkeson) at TNAU, Coimbatore & released at National level in the year 1997. The University adopted this variety for southern Karnataka in the year 2009.This variety has Profuse tillering, high green forage yield (160-170 t/ha/year) & DMY (65-70 tons/ha/year) under rainfed conditions, high leaf stem ratio (0.94), drought tolerant, sparse flowering, quick regeneration after each cut and highly palatable (Fig.16).
- **BNH-10:** It is a cross derived from BAIF Bajra-1 & Napier grass (BRN-2) at BAIF Foundation, Urulikanchan, Pune & it is released for south zone during the year 2015, Long & soft leaves with no hairs on the margin, high crude protein content 6.84 % with high leaf stem ratio of 0.76, yield potential of 120-130 t /ha GFY & 55-65 t/ha DMY(Fig.17).

8. Guinea grass

- **JHGG-08-1:** It is clonal selection from Bundel collection & developed from IGFRI, Jhansi & released for the southern state of Karnataka in the year 2015. It is having good regenerability after every cut & high crude protein (12.01%) with average green forage yield of 80-120 t/ha/year (Fig.18).

Entries nominated for All India Co-ordinated Evaluation from Mandya centre

Year	Crop &Entries	
	Forage Cowpea	Forage Maize
2007-08	KBC-2	
2008-09	MFC-08-14	
2009-10	MFC-09-1	
2011-12	MFC-09-5	
2012-13	-	
2013-14	MFC-09-9	MFM-6, MFM-4
2014-15	MFC-09-23, MFC-09-13 & MFC-09-4	MFM-5, MFM-8
2015-16	MFC-09-3, MFC-09-13,MFC-09-15 & MFC-09-23	
2016-17	MFC-09-16, MFC-16-4 & MFC-16-5	MFM-2

Research on other local important forage crops

✓ **Screening of Horsegram for fodder types and resistant to powdery mildew and yellow mosaic virus disease**

One hundred Horse gram germplasm were evaluated during Rabi 2016 to identify promising fodder types with high biomass and resistant to PM and MYMV diseases. The following genotypes found promising for further evaluation.

1. IC-202781 2. TCR 1675 3. TCR 1593
4. TCR 1517 5. IC-71814 6. TCR 1789

✓ **Screening of Dolichos (Fieldbean) germplasm for fodder types**

One hundred twenty three, Local field bean germplasm collected from AICRP on Pigeon pea, UAS, GKVK, Bengaluru, Which were collected previously from the states of Karnataka, Maharastra, Tamilnadu and Andrapradesh were screened for Fodder traits during Kharif 2016 in an augmented design at "I" Block ZARS, V.C. Farm, Mandya. Out of them the following germplasm lines found promising for further evaluation.

GL 392, GL 537, GL 332, GL 558, GL 564, GL 511, GL 573, GL 375, GL 324, GL 556, GL 481, GL 366, GL 423, GL 458, GL 482, GL 7, GL 53, GL 54, GL 45, GL 57, GL 22 and GL 9.

B) Crop Production

Technologies developed

- ✓ Anjan grass intermixed with *Stylosanthes hamata* (3:1) as a sustainable forage cropping system under rainfed conditions.
- ✓ Germination in *Stylosanthus hamata* can be improved by scarification with rubber sheets followed by overnight soaking in hot water as compared to control.
- ✓ Cultivation of Forage Maize + Forage cowpea at 3:1 ratio recorded higher green forage yield of 531.2q/ha as compared to the sole crop of maize (475.3q/ha).
- ✓ Hybrid Napier intercropping with Horsegram followed by Lucerne during rabi recorded higher Hybrid Napier equivalent yield (254.54 t/ha) followed by Forage soybean (250.81 t/ha) and *Centrocema* (248.28 t/ha) over sole crop of Hybrid Napier (156.20 t/ha).
- ✓ The green fodder and dry matter yield of Forage maize was statistically on par with the crop when supplied with 50% recommended fertilizers + 50% FYM or vermicompost (5t/ha) as compared to 100% recommended fertilizers under irrigated conditions.
- ✓ Application of 50% RDF through inorganic + vermicompost (10 t/ha) significantly recorded higher green forage yield (341.7 q/ha) over 100% RDF (269.0) under rainfed situation
- ✓ The Perennial Guinea grass was evaluated for seed and fodder production. The first cut was harvested for seed and remaining cuts for fodder resulted higher seed (143.8kg/ha) and green fodder yield (464q/ha). The application of nitrogen at 150 kg/ha recorded significantly higher green fodder yield (530.4 q/ha) as compared to 100 N kg/ha (477.5 q/ha).
- ✓ Row proportion of Guinea and Lucerne at 2:1 spaced at 30 cm apart, recorded higher Guinea grass equivalent yield (47.9 t/ha).
- ✓ Bajra x Napier hybrid as perennial forage found remunerative for central dry zone of Karnataka, which recorded higher forage equivalent yield (121.4 t/ha) and net monetary returns (53153 Rs/ha/yr).
- ✓ Nutrient levels of 120:60:40 kg NPK/ha is found optimum for Bajra x Napier hybrid under rainfed condition in central dry zone of Karnataka.
- ✓ Application of 50% NPK through inorganic fertilizers + 50% N through FYM significantly recorded higher green forage yield (575.67 q/ha) and cowpea seed yield (17.22 q/ha).

- ✓ Among the varieties Giant Bajra recorded higher green forage (191.02q/ha)and seed yield (11.23q/ha). Application of 100 kg N /ha significantly recorded higher green forage (208.53 q/ha) and seed yield (10.93 q/ha).
- ✓ Nutrient Levels of 75% RDF appeared to be optimum for fodder maize + cowpea with a seed rate of 80 kg maize + 20 kg cowpea / ha under rainfed conditions in central dry one of Karnataka
- ✓ Application of 50 % recommended nitrogen as basal, 25% nitrogen at 30 DAS and 25% nitrogen after first cut appears to be better as it gave numerically higher cumulative green fodder yield under rainfed situation in central dry zone of Karnataka.
- ✓ The silvi-pastoral system of *Albizia amara* at 4m x 4m spacing intercropped with Anjan grass recorded higher green fodder yield (71.6 q/ha from Anjan and 43.0 q/ha from *Albizia amara*). Similarly, Subabul at 4m x 2m spacing intercropping with Guinea grass also yielded higher Green fodder yield (58.2 q/ha from guinea and 63.8 q/ha from Subabul). In addition, fuel wood was realized from both the systems. The combination provided to be a viable alternative for year round supply of green fodder in addition to providing grazing land with quality forages, under rainfed situation.
- ✓ In Bajra x Napier hybrid intercropping with cowpea *(Kharif)* followed by Lucerne *(Rabi)* as intercrop recorded significantly higher green forage yield (147.17 t/ha), dry matter yield (31.04 t/ha), crude protein (3.3 t/ha).
- ✓ In Coconut garden cultivation of Cowpea followed by Lucerne recorded significantly higher green forage yield (65.0 t/ha), dry matter yield (14.9 t/ha) and crude protein (2.6 t/ha).
- ✓ Among planting geometry 60 cm X 45 cm recorded significantly higher green forage yield (119.3 t/ha). Application of 150% recommended dose of fertilizer recorded higher green forage yield (123.3 t/ha) which was on par with 100% RDF (116.3 t/ha). Based on results 60 cm x 45 cm with 100% RDF (200:50:25 NPK kg/ha) found optimum and economical.
- ✓ Application of 50% NPK through inorganic fertilizers + 50% N through FYM significantly recorded higher green forage yield (521.20 q/ha) and fodder sorghum equivalent yield (531.63 q/ha).Where as 100% RDF through inorganic fertilizer + VAM recorded higher cowpea seed yield (16.30 q/ha), net monetary returns (43,999Rs/ha) and nutrient use efficiency (100.7%) in food-forage cropping system.
- ✓ Among different forage based cropping system, cultivation of forage Maize + Cowpea -Sunflower (Grain) – Finger millet (Grain) found remunerative which, recorded higher

net monetary returns (65487 Rs/ha/yr) compared to Finger millet (Grain) –Fieldbean (Grain) - Sunflower (Grain) (49389 Rs/ha/yr) and perennial Hybrid Napier Bajra (58026 Rs/ha/yr).

- ✓ The Napier Bajra Hybrid- Lucerne recorded higher green fodder yield (1488.3 q/ha). Whereas Maize for green cob +Cowpea (fodder) round the year recorded higher net monetary returns (1,58,715Rs/ha/yr) followed by Maize grown for Baby corn + Cowpea (fodder) round the year (1,25,365Rs/ha/yr) as compared to perennial fodder source of hybrid Napier Bajra + Cowpea- Lucerne (64,148Rs/ha/yr) and most adopted cropping system of Maize + Cowpea (Fodder) – Sunflower (grain) –Finger millet (grain) (65487 Rs/ha/yr).
- ✓ In alkali, soil application of Rec. NPK + FYM (10 t ha^{-1}) + $ZnSO_4$ 20 Kg ha^{-1}+ Gypsum (100 % GR) recorded significantly higher green fodder (252.48 q ha^{-1}), dry matter yield (68.02 q ha^{-1}). Crude protein yield (4.62 qha^{-1}) & Net monetary return (8335 Rs. ha^{-1}).The higher B:C ratio was obtained with Rec. NPK + press mud (10 t ha^{-1})(1.60). It was observed that 51.96 Per cent increase in green forage yield over existing production package (199.64 q/ha).
- ✓ In rice fallows, application of 100% recommended dose of nitrogen (RDN) to different forage crops recorded significantly higher green fodder (363.77 q ha^{-1}), dry matter (86.46 q ha^{-1}) and crude protein yield (7.49 q ha^{-1}) and fetched higher net monetary returns (17119 Rs. ha^{-1}) and benefit cost ratio (2.54). The maize + cowpea cropping system supplemented with 100% RDN produced significantly higher green forage (465.16 q ha^{-1}) and dry matter yield (113.51 q ha^{-1}).
- ✓ During lean period under limited moisture conditions, cultivation of fodder maize recorded significantly higher green forage yield (393.12 q ha^{-1}), where as pearl millet recorded maximum water use efficiency (14.69 q ha^{-1}cm). Irrigating the crop (IW/CPE ratio of 1.0) recorded significantly higher green forage yield (373.18 q ha^{-1}). Whereas maize harvested for baby corn recorded higher net monetary returns (Rs.46576 /ha) and B: C ratio (3.65).

Packages of Practices developed

A. Fodder Cowpea:

- ✓ KBC-2: Spacing of 30 x 10cm with seed rate of 35 kg/ha & NPK levels of 25:50:25 kg/ha recorded higher green forage yield (25 t/ha), dry matter yield (4.5 t/ha) and crude protein (0.8 t/ha).

- ✓ MFC-08-14: Spacing of 30 x 10 cm with seed rate of 35 kg/ha and nutrient levels of 25:50:25 NPK kg/ha found optimum and economical.
- ✓ MFC-09-1: Spacing of 30 x 10 cm with seed rate of 35 kg/ha and nutrient levels of 25:50:25 NPK kg/ha found optimum and economical.

B. Bajra X Napier Hybrid

- ✓ Co-3: Spacing of 90 x 60 cm with nutrient levels of 180:120:80 NPK kg/ha recorded higher green forage yield (128.93t/ha) with maximum net returns of Rs. 46063/ha.
- ✓ BNH-10: Planting at 90 cm x 60cm recorded significantly higher green forage yield (149.57 t/ha) over others. Application of 150% recommended dose of fertilizer recorded higher green forage yield (148.4 t/ha). Whereas, B:C ratio was higher with 100% Recommended Dose of Fertilizer (3.17). Based on the results spacing of 90cm X 60CM with 100% RDF (180: 120: 80 NPK Kg/ha) found optimum and economical.

C. Multi cut Fodder Sorghum

- ✓ CoFS-29: Planting geometry of 30 x 10 cm with seed rate of 10 kg/ha and nutrient levels of 90:50:40 NPK kg/ha recorded higher green forage yield (577.54, 570.44 & 562.26 q/ha, respectively).

D. Fodder Oat

- ✓ OS-6: Sowing of Fodder oat during second fortnight of october with seed rate of 100 kg/ha, spacing of 25cm between rows & NPK levels of 100:60:40 kg/ha recorded higher green forage yield (27.5 t/ha), dry matter yield (5.25 t/ha) and crude protein (0.41 t/ha).

E. Guinea grass

- ✓ JHGG-08-1: Planting geometry 60 cm x 45cm recorded significantly higher green forage yield (119.3 t/ha). Application of 150% recommended dose of fertilizer recorded higher green forage yield (123.3 t/ha) which was on par with 100% RDF (116.3t/ha). Based on results 60 cm x 45cm with 100% RDF (200:50:25 NPK kg/ha) found optimum and economical.

F. Anjan grass

- ✓ CAZRI-75 and IGFRI-3108: Spacing of 45 x 30cm with seed rate of 5 kg/ha & NPK levels of 40:30:0 kg/ha found optimum and economical.

C) Seed Production

Year	Crop	Variety	Quantity produced (q)				
			NS	BS	FS	CS	TL
2006-07	Maize	African Tall		8.50			
2007-08	Maize	African Tall		7.50		540.0	
2008-09	Maize	African Tall		10.0			
	Cowpea	KBC-2	0.80	10.0			
2009-10	Maize	African Tall		10.0			
	Cowpea	KBC-2	0.60	2.0			
2010-11	Maize	African Tall		11.50			
	Cowpea	KBC-2	1.20	4.80			
2011-12	Maize	African Tall		12.00	98.96	200.0	200.0
	Cowpea	KBC-2	0.60	2.00			
2012-13	Maize	African Tall		37.00	60.00	90.0	4.0
	Cowpea	KBC-2	2.00	13.35			
	Cowpea	MFC-08-14	0.20	1.60			
2013-14	Maize	African Tall		12.0			
2014-15	Maize	African Tall		12.00			
	Cowpea	MFC-08-14	0.30	1.28			
	Cowpea	KBC-2	0.80	6.25			
2015-16	Cowpea	MFC-08-14	0.30	3.00			
	Cowpea	MFC-09-1	0.20	2.00			
2016-17	Maize	African tall		3.0	50.0		
	Cowpea	MFC-08-14	1.30	0.5			
	Cowpea	KBC-2	0.20	5.0			
	Cowpea	MFC-09-1	0.50				
Total			**9.00**	**175.28**	**208.96**	**830.0**	**204.0**

NS: Nucleus Seed, BS: Breeder Seed, FS: Foundation Seed, CS: Certified Seed, TL: Truth full Seed.

IV. Seeds / roots slips/stem cuttings distributed to farmers (2007 to 2017)

Crop	Variety	Roots Slips/stem cuttings distributed (No.)	Seeds distributed (Kgs)
Bajra x Napier Hybrid	Co-3 & BNH-10	212000	-
Guinea grass	JHGG-08-1, Maccunii & Reversdale	50000	-
Rhodes grass	Callide	30000	-
Signal grass	Congo Signal & DBRS-1	25000	-
Fodder Maize	African Tall	-	17280
Fodder Sorghum	MP Chari, Sudex Chari, CoFS-29 and PC-23	-	2788
Fodder Bajra	BAIF Bajra-1	-	300
Fodder Oat	OS-6	-	100
Lucerne	RL-88	-	100
Fodder Cowpea	KBC-2, MFC-08-14 & MFC-09-1	-	1028
Stylosanthes hamata	Local	-	50
Siratro	Local	-	3
Centrocema	Local	-	5
Hariwana	Local	-	2.5
Agase	Local	-	10
Gliricidia	Local	-	2

D) Transfer of Technology

- ❖ Introduction of high yielding Bajra x Napier Hybrid (BNH-10 & Co-3)
- ❖ Introduction of high yielding Guinea grass (Reversedale, Maccunii and JHGG-08-1)
- ❖ Introduction of high yielding perennial Multicut Forage Sorghum (CoFS-29 & CoFS-31)

- ❖ Introduction of high yielding Forage Cowpea varieties (KBC-2, MFC-08-14 & MFC-09-1)
- ❖ Introduction of high yielding Forage oat varieties (Kent & OS-6)
- ❖ Introduction of high yielding Forage pearl millet variety (BAIF Bajra-1)
- ❖ Introduction of high yielding Forage Lucerne variety (RL-88)
- ❖ On farm demonstration of Forage legumes as inter crop with Napier Bajra Hybrid
- ❖ Cultivation of forage legumes (Cowpea-Lucerne / Stylo / *Centrocema* / *Sirratro* / *Glycine*) in coconut garden.
- ❖ Silage Making and enrichment of dry fodder

I) Forage Technology Demonstrations conducted onfarmers field

SI. No.	Crop	Variety/ Technology Demons-trated	Num bers	GFY (q/ha)%		Improvement over Farmers practice
				Farmers practice	Improved Practice	
	2009-10: Kharif					
1	Bajra x Napier Hybrid	Co-3	15	1223.0	1387.0	13.41
2	Forage cowpea	KBC-2	8	289.0	335.0	15.92
3	Guinea grass	Maccuni	2	898.0	922.0	2.67
4	Forage maize	African Tall	5	486.0	535.0	10.08
5	Lucerne	Co-1	5	756.0	862.0	14.02
	2009-10: Rabi					
1	Lucerne	Co-1	5	791.0	847.0	7.08
	2010-11 : Kharif					
1	Bajra x Napier Hybrid	Co-3	7	1322.0	1426.0	7.87
2	Forage Cowpea	KBC-2	2	284.0	317.0	11.62
3	Guinea grass	Maccunii	3	819.0	937.0	14.41
4	Forage Sorghum	CoFS-29	5	775.0	864.0	11.48

	2010-11: Rabi					
1	Lucerne	Co-1	5	812.0	898.0	10.59
	2011-12: Kharif					
1	Hybrid Napier Bajra	CO-3	5	1326.0	1512.0	14.03
2	Guinea grass	JHGG-08-1	5	796.0	864.0	8.54
3	Forage cowpea	KBC-2	5	299.0	333.0	11.37
	2012-13 :Kharif					
1	Forage oat	OS-6	5	285.0	323.0	13.33
2	Lucerne	RL-88	5	782.0	863.0	10.36
3	Hybrid Napier Bajra	CO-3	7	1269.0	1463.0	15.29
4	Multicut Forage Sorghum	CoFS-29	5	756.0	886.0	17.20
5	Forage Cowpea	KBC-2	5	273.0	312.0	14.29
6	Guinea grass	Maccuni	3	715.0	801.0	12.03
	2013-14 :Kharif					
1	Forage maize	African Tall1	0	438.0	517.0	18.04
2	Forage cowpea	MFC-08-14	10	302.0	346.0	14.57
3	Guinea grass	JHGG-08-1	10	697.0	788.0	13.06
	2013-14 :Rabi					
1	Forage Lucerne	RL-88	10	789.0	846.0	7.22
2	Forage Oats	OS-66	10	294.0	331.0	12.59
	2014-15: Kharif					
1	Guinea Grass	JHGG-08-1	10	769.0	826.0	7.41
2	Cowpea	MFC-08-14	10	313.0	359.0	14.70
3	Maize	African tall	10	435.0	509.0	17.01
	2014-15: Rabi					
1	Lucerne	RL-88	10	743.0	861.0	15.88

2	Forage Oats	OS-66	10	268.0	306.0	14.18
	2015-16: Kharif					
1	Guinea grass	JHGG-08-1	10	824.0	896.0	8.74
2	Forage Cowpea	MFC-08-14	10	310.0	346.0	11.61
3	Forage Maize	African tall	10	531.0	587.0	10.55
4	Bajra	BAIF Bajra	10	351.0	387.0	10.26
5	Bajra x Napier Hybrid	Co-3	10	1362.0	1465.0	7.56
	Total		**257**			

ii) Dissemination of Technology:

The training programmes field days, TV and radio talks were organised for dissemination of technologies to farmers at various levels.

Under training programmes, more emphasis was given for quality forage production technologies, quality milk production, Forage crop production techniques and enrichment of dry fodder, silage making & making of Forage blocks using dry fodder.

5. Future thrust of Research

i. Improvement and evaluation of forage crops with tolerance to various stress conditions.

ii. Exploration, collection, and evaluation of germplasm of different forage crops

iii. Development of appropriate production technologies for sustaining productivity of problematic soil through forage grasses / legumes and to add to the feed resources

iv. Scope of organic farming practices in quality forage production

v. Developing production cum conservation strategies for availability of forages during lean period.

vi. Introduction of forage crops into existing cropping system for intensive forage production

vii. Forage farming system based on water shed approach

viii. Promotion of fodder trees on farm bunds -(*Sesbania*, *Glyricidia*, *Erythrina* and Drumstick*)*

ix. Intensive forage production in rice based cropping system

x. Development of suitable varieties and forage production technologies for marginal/waste/uncultivable/degraded lands.

6. Linkages/Collaborations established.

i. Central / State Governments: Departments of Animal Husbandry & Veterinary Science, Agriculture & water shed, Government of Karnataka.

ii. NGOs: Vikasana, Mandya; Vijaya Bank Self Employment Training Institute, Mandya; Krishika Trust, Mandya, Dharmastala Grameena Abhiruddhi Samsthe Mandya.

iii. Farmers groups: Banuli Krishi Balaga (KVK, Mandya and AIR, Mysore)

iv. Others: Women Self Help Groups (Mandya district)

v. Co-operatives: Karnataka milk federation

7. Publications

A. Research papers

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F. Books / Chapters

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List of Forage Scientists and Technical Staff at UAS, Bengaluru (1975-2017)

Sl. No.	Name		Designation
A. University Forage Research Programme (1975-1986)			
1	Dr. K. Krishnamurthy	:	Director of Research & Co-ordinator
2	Dr. G. Shivashankar	:	Senior scientist (Genetics & Plant breeding)
3	Dr. R. S. Kulkarni	:	Research Assistant
4	Dr. Rafeeq Nazarath	:	Research Assistant
5	Dr. M. Byregowda	:	Agrostologist
6	Dr. B. N. Patil	:	Agrostologist
7	Mr. M. Gopala Reddy	:	Agronomist
8	Mr. M. K. Mune Gowda	:	Agronomist
9	Mr. M.K. Jagannath	:	Asst. Biometrician
10	Mr. H. Sridhara	:	Asst. Biometrician
11	Mr. S.R.S. Murthy	:	Asst. Agril. Economist
12	Mr. B.V. Venkateshaiah	:	Research Assistant
13	Mr. Ramakrishnappa	:	Research Assistant
14	Mr. S. Puttaswamy	:	Research Assistant
15	Dr. H.S. Satyanarayana	:	Research Assistant
16	Mr. B.V. Jayakumar	:	Research Assistant
17	Dr. V.S. Janakiram	:	Research Assistant
18	Mr. Laxminarayana	:	Research Assistant
19	Mr. C. Visweswaran	:	Research Assistant
20	Mr. Hanumanthappa	:	Research Assistant
21	Mr. T.N. Anand	:	Research Assistant

B. AICRP on Forage Crops, ZARS, Tiptur (1987-2003)			
22	Mr. Abdul Jabbar	:	Senior scientist (Genetics & Plant breeding)
23	Dr. S. Ramesh	:	Senior scientist (Genetics & Plant breeding)
24	Dr. S. Purushotham	:	Scientist (Agronomy)
25	Mr. T.N. Krishnappa	:	Scientist (Agronomy)
26	Dr. H.K. Basavaraju	:	Scientist (Agronomy)
27	Dr. N. Krishnamurthy	:	Scientist (Agronomy)
28	Dr. G.K. Girijesh	:	Research Assistant
29	Mr. Gangadharaiah	:	Research Assistant
30	Dr. K. Umesh	:	Research Assistant
31	Dr. R. Siddaraju	:	Research Assistant
32	Mr. K. Nagaraja	:	Technical Assistant
33	Mr. G.V. Narayanaswamy	:	Technical Assistant

C. AICRP on Forage Crops & Utilization, ZARS, V.C. Farm, Mandya(2004 -2017)			
34	Dr. N. Shivakumar	:	Senior scientist (Genetics & Plant breeding)
35	Dr. H.C. Lohithaswa	:	Senior scientist (Genetics & Plant breeding)
36	Dr. M.R. Krishnappa	:	Senior scientist (Genetics & Plant breeding)
37	Dr. P. Mahadevu	:	Senior scientist (Genetics & Plant breeding)
38	Dr. B.G. Shekara	:	Scientist (Agronomy)
39	Mr. Nagesh Chikkarugi	:	Technical Assistant
40	Mrs. Manasa	:	Technical Assistant
D. Main Research Station, Hebbal, Bengaluru			
41	Dr. V. C. Reddy	:	Agrostologist
42	Dr. Nanjundappa	:	Agrostologist
43	Dr. Lingappa	:	Agrostologist
44	Dr. A. P. Nagaraju	:	Agrostologist
45	Dr. Jayaramegowda J	:	Agrostologist