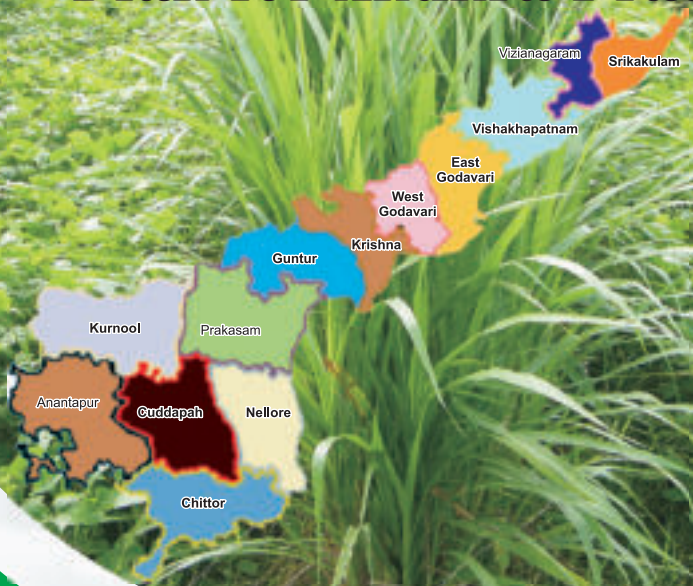
Fodder Resources Development Plan for Andhra Pradesh



ICAR- Indian Grassland and Fodder Research Institute
Jhansi-284 003 (UP) India

An ISO 9001:2015 Certified Institute
Sardar Patel Award for Outstanding ICAR Institute (Large) for 2015

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ICAR

Fodder Resources Development Plan for Andhra Pradesh

ICAR- Indian Grassland and Fodder Research Institute
Jhansi-284 003 (UP) India

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त्रिलोचन महापात्र, पीएच.डी.
सचिव एवं महानिदेशक
TRILOCHAN MOHAPATRA, Ph.D.
SECRETARY & DIRECTOR GENERAL

सत्यमेव जयते

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भारतीय कृषि अनुसंधान परिषद
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MESSAGE

Andhra Pradesh is one of the well performing States in country as far animal husbandry is concerned. It ranks 4th among the leading milk and meat producing States. About 70% of the small and marginal farmers and agricultural laborers are dependant on livestock rearing. The dry fodder deficiency ranges from 31.4% in West Godavari District to 76.9% in Prakasham District with an average deficiency of 56.5% (34.96 lakh tonnes). For ensuring the sustainable supply of fodder in the state, there is a need for exploring various options. The holistic Fodder Resources Development Plan for Andhra Pradesh developed by the ICAR-IGFRI, Jhansi highlights technological options to complement the efforts of the State to address the issue of fodder scarcity.

I appreciate the efforts made by ICAR-IGFRI in bringing out this important document.

(T. Mohapatra)

Dated the 24th March, 2021
New Delhi

Fodder Resource Development Plan developed as part of

National Initiative for Accelerating Fodder Technology Adoption (NIAFTA)

ICAR - Indian Grassland and Fodder Research Institute, Jhansi

Themes of NIAFTA

A. Developing State Fodder Resources Development Plan
B. Disseminating fodder production technologies for enhanced productivity and improved management.
C. Promoting alternate land usage
D. Focusing fodder based rationing
E. Utilizing fodder processing technologies for value addition.

Coordination Team

- Dr VK Yadav, Director — Chairman
- Dr. Purushottam Sharma, PS — Nodal Officer

Members

- Dr. AK Roy, Project Coordinator, AICRP on FC&U
- Dr. AK Mishra, Head, Plant Animal Relationship Division
- Dr. Sunil Kumar, Head, Crop Production Division
- Dr. RV Kumar, Head, Grassland & Silvipasture Management Division
- Dr. PK Pathak, Head, FMPHT Division
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- Dr. Shahid Ahmad, Head, Crop Improvement Division

Andhra Pradesh State Fodder Resources Development Plan Committee

- Dr. RV Kumar, Coordinator
- Dr. BG Shivakumar, Chairman
- Dr. K Sridhar, Member
- Dr. NS Kulkarni, Member

Document Formatting and Cover Design

Mr. KP Rao, Chief Technical Officer

Acknowledgement

Fodder plan is area specific strategy to be adopted to overcome deficiency of green and dry fodder of the region and also to provide executable plan for the state government and other agencies involved in livestock related policy and planning. The fodder resource development plan provides technological options available for enhancing production, conservation and value addition of fodder resources of the state.

Looking into shortage of green and dry fodder in the country the idea and vision of the development of state wise fodder plan for different states of the country was visualized by Dr. Trilochan Mohapatra, Hon'ble Secretary DARE and Director General, ICAR. During his visit to IGFRI-SRRS, Dharwad on 17th June 2019, he advised to develop state wise fodder resource development plan which covers the broad areas as per requirement of the state. We are highly grateful to him for his insight guidance, encouragement, continuous support and suggestions in preparation of this document. We are also thankful to Deputy Director General (Crop Science), ADG (FFC) and other officers of the ICAR who extended their support during the development of fodder plan of Andhra Pradesh.

We express our sincere thanks to Government of Andhra Pradesh, especially to Sh. H. Arun Kumar, Commissioner of Agriculture & Project Director, APDMP, Government of Andhra Pradesh who inaugurated the interactive workshop held online on 6th July 2020 in collaboration with Directorate of Animal Husbandry, Andhra Pradesh. We also extend our thanks to Dr. Srinivas, Director of Animal Husbandry, Government of Andhra Pradesh, Dr. Giridhara Krishna, Director of Research, ANGRAU, Hyderabad for their support in organizing interactive workshop and showing keen interest in developing plan for augmenting forage and livestock sector in the state with special focus on pasture development on waste lands and impart training to state government officers. We also thank to other participants including officials of state government, scientists of ICAR institutes, ANGRAU, KVK personnel, veterinary officials, etc., who actively participated in the workshop and provided their valuable suggestions for the improvement of plan.

The efforts made by our team from ICAR-IGFRI, Jhansi in preparation of fodder plan for the state and organizing interactive workshop are praise worthy. This fodder plan is prepared as a part of the activities of our programme 'National Initiatives on Accelerating Fodder Technology Adoption (NIAFTA)', whole team of the programme; and Coordinator, Dr. B.G. Shivakumar, Principal Scientist, and Nodal Officer, Dr. Purshottam Sharma, Principal Scientist, deserves special appreciation.

(Vijay K Yadav)
Director (Acting)
ICAR-IGFRI, Jhansi

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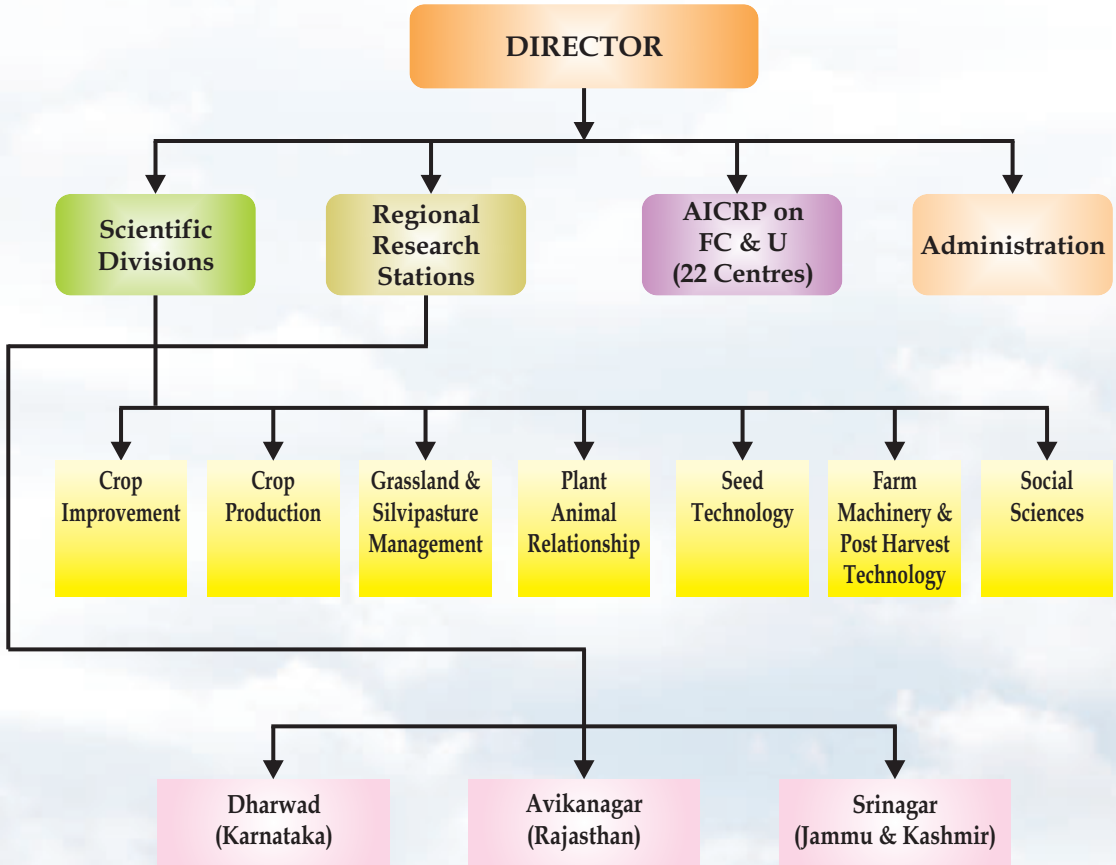
Organogram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ICAR-IGFRI - A Profile

ICAR-Indian Grassland and Fodder Research Institute, Jhansi (U.P) India

The ICAR-Indian Grassland and Fodder Research Institute (ICAR-IGFRI), Jhansi, was established in 1962 to conduct organized scientific research on grasslands and fodder production, conservation and their utilization. On 1 April, 1966, it became part of the Indian Council of Agricultural Research (ICAR). Subsequently All India Coordinated Research Project on Forage Crops and Utilization was started in 1972 with ICAR-IGFRI, Jhansi as head quarter for multi-location testing of forage varieties and technologies in different agro climatic zones of the country through 23 coordinating centers and 15 as volunteer centre's at various State Agricultural Universities/NGO/ICAR under the National Agricultural Research System. The institute consists of seven multi-disciplinary division *viz.*, Crop Improvement, Crop Production, Farm Machinery and Post-Harvest Technology, Seed Technology, Social Science, Grassland and Silvipasture Management and Plant Animal Relationship. It also has five units *viz.*, PME, HRD, ATIC, ITMU and AKMU and facilities like Library, Central Research Farm, Dairy and Central Instrumentation Lab. The institute has three regional stations located in Avikanagar (Rajasthan), Dharwad (Karnataka) and Srinagar (Jammu & Kashmir) to conduct focused forage research on arid, semi-arid and temperate climatic conditions, respectively and a grassland center at Palampur (Himachal Pradesh).

Mandate

- Basic strategic and adaptive research on improvement, production and utilization of fodder crops and grasslands.
- Coordination of research on forages and grasslands for enhancing productivity and quality for enhancing livestock productivity.
- Technology dissemination and human resource development.

The institute has successfully served the country for 58 years achieving several milestones in generation of fodder technologies. Institute was conferred with "Sardar Patel Outstanding ICAR Institution Award in the year 2015" for his remarkable progress and contributions in the field of forage research, capacity building and infrastructure development. Institute is an ISO 9001: 2015 certified institute. The institute is endeavoring in basic and applied research in both cultivated as well as range species in the fields of intensive fodder production systems, alternative fodder sources, grasslands, silvi and horti-pasture systems, seed production technology, farm mechanization, post-harvest conservation and utilization, livestock feeding and

management, etc. Institute is striving through numerous research projects at various levels like institute, inter-institute, externally funded national and international collaborative projects to address the persistent problems of fodder shortage and lack of quality forages. The institute is undertaking several new initiatives in forage research in new frontier areas.

Proven Technologies of Institute

- No. of forage varieties released: >300
- Climate resilient forage production systems under rainfed situation
- Round the year fodder production system (Irrigated situation)
- Round the year fodder production system (Rainfed situation)
- Fodder on Field boundary/Bunds/Channels
- Alternate land use systems
- Silvo-pasture model for highly degraded/ waste lands
- Horti-pastoral model for higher income in rainfed ecosystem
- Azolla as supplement feed for livestock
- Silage for sustenance of livestock production
- Community pastureland development
- Fodder production in mango orchards
- Improved varieties of grasses and cultivated fodder
- Seed production technology for all important forages
- Seed quality and field standards of forage crops
- DUS guidelines for forage crops.

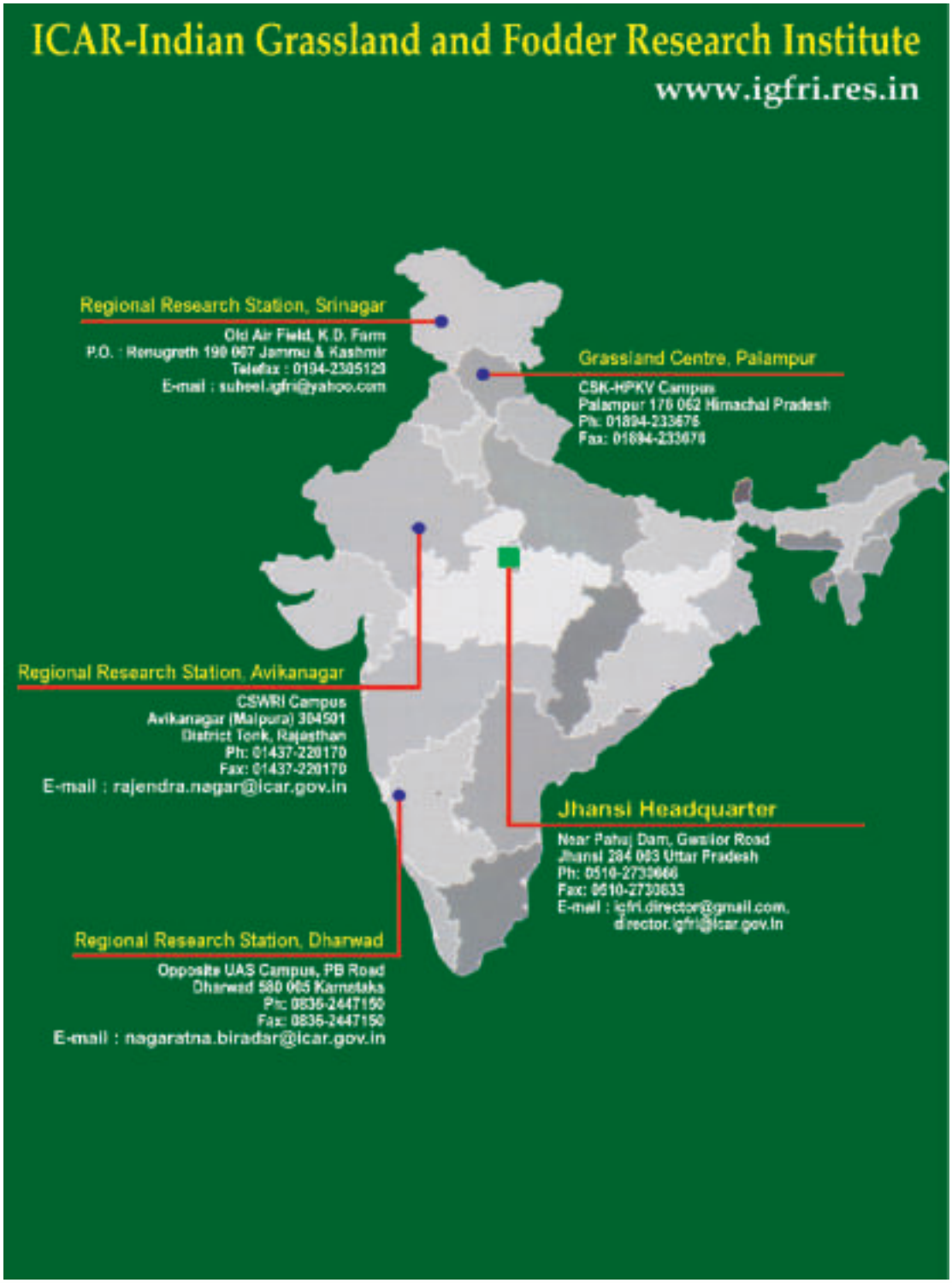
Accelerating Fodder Technology adoption

Transferring knowledge and skills are the essential component required for execution and implementation of resource conservation based projects in the country. The institute is organizing training and skill development programmes regularly of varying duration for farmers, students, state government officials, field functionaries in the field of soil and water conservation The research institutes has signed MoUs with more than 20 Gaushalas for transfer fodder production technologies. Field demonstration on validated technologies for resource conservation and productivity enhancement in red soils of Bundelkhand region are operating at full fledge. Several outreach programmes such as Adarsh Chara Gram A cluster of three villages, Mera Gaon Mera Gaurav (MGMG), National Initiative on Fodder Technology Demonstration (NIFTD), Network Project on Bhadawari Buffaloes, Participatory Fodder Production in Mango Orchards, Farmers FIRST Programme, NICRA, TSP, SCSP, NEH, DFI-Kisan Mitra and NIAFTA have been initiated and implemented.

ICAR has established in institute the Agri-Business Incubation Centre (ABIC) to provide technical knowhow to farmers, educated rural youth and develop entrepreneur.

NIAFTA: New Initiatives

Institute has initiated "National Initiative for Fodder Technologies Adoption (NIAFTA)" to formulate an implementable fodder resource development plan for each state/UT of the country suitable to specific niches which can utilize the potential of available resources to achieve self-sufficiency in fodder production and utilization. NIAFTA also aims for extension of latest research findings/technologies with the policy planners, management personnel and field level functionaries for enhancing country's fodder productivity, capacity building and skill enhancement of the fodder producers and livestock keepers on emerging technologies and also provide opportunity to interact with scientists and managers and impact assessment on fodder supply and farmers livelihood.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Part-I : Agriculture, Livestock and Fodder Scenario

A. Introduction

The state of Andhra Pradesh after carving out of Telangana on 2nd June 2014 is spread over an area of 1,60,205 km^2. It is located in the eastern coast of southern India neighbored in the north by the Telangana, Chhattisgarh and Odisha; Tamil Nadu in the south and Karnataka in the west (Figure 1). Andhra Pradesh lies between 12°41' and 19^0.07'N latitude and 77° and 84°40'E longitude. It has the second longest coastline (974 km) in India. Andhra Pradesh is the eighth largest state in India in terms area and tenth largest in terms of population. It has a population of 4.96 crores as per the 2011 census. Urbanization has been regarded as an important component for growth realization. The percentage of urban population to the total population in the State is 29.47 percent in 2011 as compared to 24.13 percent in 2001.The state has 13 districts. As per the forest records, the state ranks 9th in India having 36909.38 sq. km forest area which accounts for 23.04% of the total geographical area.

Figure 1. Geographical location of Andhra Pradesh

Climate

The climate of Andhra Pradesh is generally hot and humid. The summer season in this state generally extends from March to June. During these months the humidity level is quite high. The coastal areas have higher temperatures than the other parts of the state. In summer, the temperature generally ranges between 20°C and 40°C. At certain places the temperature will be as high as 45^0C during summer. The summer is followed by the monsoon season, which starts during June and continues till September. This is the season for heavy tropical rains in Andhra Pradesh. The major role in determining the climate of the state is played by South-West monsoons. About one third of the total rainfall in Andhra Pradesh is brought by the North-East monsoons around the month of October in the state. The winters in Andhra Pradesh are pleasant. October to February are the winter months in Andhra Pradesh. Since the state has quite a long coastline, the winters are comparatively mild. The range of winter temperatures is generally from 13°C to 30°C.

Land use scenario

The land utilization classification reveals that 37.29% of the state geographical area is net area sown (60.77 lakh hectares), 22.63 % is forest (36.88 lakh hectares) area, 9.18% is current fallow lands (14.96 lakh hectares), 12.57% is under non-agricultural uses (20.48 lakh hectares), 8.26% is barren and uncultivable land (13.46 lakh hectares) and remaining 7.18% is under other fallow land, cultivable waste lands like permanent pastures and other grazing lands (12.74 lakh hectares) and land under miscellaneous tree crops and groves are not included in the net area sown which is around 2.26% (3.69 lakh hectares) (Figure 2, Table 1, SES, 2017-18).

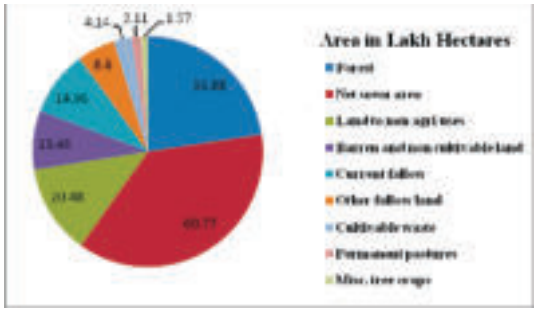

Figure 2. Land utilization in Andhra Pradesh in 2016-17

Table 1. Distribution of land holding in Andhra Pradesh (2010-11)

Size group	No. of holdings (in lakhs)	% to Total	Area (Lakh ha)	% to Total	Average size of holdings (ha)
Marginal	49.84	65.40	21.60	26.68	0.43
Small	15.91	20.88	22.51	27.80	1.41
Semi medium	7.96	10.44	21.00	25.94	2.64
Medium	2.30	3.02	12.82	15.83	5.57
Large	0.20	0.26	3.04	3.75	15.20
Total	76.21	100	80.97	100	1.06

General agriculture scenario

The State of Andhra Pradesh is basically an agro-based economy. Agriculture and allied sectors contribute more than 29% of the gross state domestic product (GSDP) as against 17% in all India gross domestic product (GDP). Ten major crops occupy 80% of the gross cropped area against 165 crops enumerated. Major 10 crops identified as growth engines to accelerate the growth of the agriculture economy through special focused strategies. Agriculture is back bone to the economy in achieving inclusive double digit growth as its impact spreads over to other sectors of economy such as manufacturing, trade and transport sectors. Agriculture and allied sectors is supporting about 60% of the population of the state of Andhra Pradesh. Two thirds of the area cultivated in the state is rain-fed. The gross area irrigated in the state was 35.82 lakh hectares and the net area irrigated was 27.19 lakh hectares in 2016-17. The cropping intensity for the year 2016-17 was 1.25.

Cropping pattern

Rice is the major staple food crop. Non-food crops constitute fibers, oilseeds, pulp and timber, drugs and narcotics including tobacco, fodder crops, green manure crops, aromatic plants, flowers and others. The area under different crops and their percentage to total cropped area during 2016-17 is presented in Table 2. Out of 74.18 lakh hectares of total cropped area in 2016-17, the area under food crops was 51.95 lakh hectares (Table 2).

Table 2. Area and share of different crops in Andhra Pradesh

S.No.	Crop	Average of preceding 5 years	% share in total cropped area	Area in lakh hectares
1	Paddy	23.46	29.72	21.05
2	Jowar	1.50	1.90	0.97
3	Bajra	0.41	0.52	0.42
4	Maize	2.95	3.74	2.50
5	Ragi	0.37	0.47	0.32
6	Millets	5.56	7.04	4.53
7	Pulses	12.53	15.88	14.13
8	Total food grain	41.55	52.64	39.70
9	Total food crops	53.93	68.32	51.95
10	Groundnut	10.24	12.97	10.13
11	Total oil seeds	14.25	18.05	13.32
12	Total non food crops	25.01	31.68	22.23
13	Total cropped area	78.94	100	74.18

Major forage sources

There are 3 categories of forage resources are identified in the state of Andhra Pradesh:

- Community grazing lands also called as *gocharas* in plain areas
- Trees having fodder values *viz.* prosopis/*khejri*, subabul, sesbania, glyricidia, ficus etc.
- Cultivated fodder crops *viz.* fodder jowar, fodder maize, stylosanthes, napier grass, para grass, *pillipesaru* (*Phaseolus trilobus*), cowpea etc.

In recent years, Bajra Napier hybrid, guinea grass, lucerne, perennial fodder sorghum etc. are becoming popular in assured irrigation areas.

Major sources of crop residues

The crop residues after the separation of economic portion of almost all the food crops

are used as fodder in many areas of the state. The type of crop and crop depend on the agro-climatic conditions prevailing in a given area. By and large the following crop residues are common in most of the areas:

Cereals: Rice straw

Millets: Jowar stover, bajra stover, maize stover, ragi straw etc.

Pulses: Greengram straw, bengal gram straw, red gram straw etc.

Commercial crop: Sugarcane top etc.

Oilseeds: Groundnut straw, soybean straw etc.

Miscellaneous: Mulberry twigs

Horticulture Scenario

Horticulture is one of the major enterprises of Andhra Pradesh agriculture. Due to varied agro-climatic conditions prevailing in the state, a variety of horticultural crops are grown. They include major fruit crops *viz.* mango, banana, guava, papaya, sapota etc. in all the districts and minor fruit crops in some districts *viz.* ber, orange, custard apple, jackfruit, pineapple, pomegranate, water melon, musk melon etc. The vegetable crops include beans, bitter gourd, bottle gourd, brinjal, cabbage, capsicum, carrot, cauliflower, cucumber, chilies, bhendi, onion, radish, pumpkin, sweet potato, tomato etc. Plantation crops include areca nut, cashew nut, cocoa, coconut, oil crop, oil palm, coffee etc. Spices and condiments include betel vine, black pepper, coriander, ginger, tamarind, turmeric etc. Flower crops include chrysanthemum, jasmine, marigold, rose, tuberose, crossandra etc. Aromatic crops include like chlorphytum, palma rosa, annota, lemon grass etc. Medicinal crops include like coleus, ashwaganda, citronella etc. (Table 3).

Table 3. Area, production and productivity of major horticulture crops (2018-19)

S.No.	Crops	Area (Lakh ha)	Production (Lakh MT)	Productivity (MT/ha)
1	Fruit crops	718912	17614672	24.50
2	Vegetable crops	260051	7092739	27.27
3	Plantation crops	496142	3370766	6.79
4	Spices	238737	1786132	7.48
5	Flower crops	28038	298646	10.65
6	Aromatic/Medicinal crops	6500	11003	1.69
	Total	1748380	30173958	17.26

B. Agro-climatic zones

The state of Andhra Pradesh comprises of both dry interior lands in south west to long coastal climate in the east and north east. It consists of broadly five different soil types

viz. red soil, alluvial soil, black soil, and peaty and marshy soils. Geographically, the state of Andhra Pradesh can be divided into two important regions *i.e.*, Rayalaseema and Coastal Andhra, and there are 6 agro-climatic zones (ACZs) (Figure 3) spread across 13 districts of Andhra Pradesh *viz.* High altitude zone, Krishna zone, Godavari zone, North coastal zone, Southern zone and Scarce rainfall zone (Table 4).

Table 4. Agro-climatic zones of Andhra Pradesh

S.No.	Zone	Districts	Rainfall (mm/ha)	Temperature	Soil type	Crops grown
1	North coastal zone	Srikakulam, Vizianagaram, Visakhapatnam	South-west monsoon 1,000-1,100 mm	Max. 29-42 °C Min. 18-27 °C	Red soils with clay base, pockets of acidic soils, laterite soils with PH 4-5.	Rice, groundnut, mesta, jute, sunhemp, sesamum, sorghum, pearl millet, blackgram and horticultural crops
2	Godavari zone	East Godavari, West Godavari	South-west monsoon 800-1,100 mm	Max. 29-42 °C Min. 16-24 °C	Deltaic alluvium, red soils with clay, black cotton soils, red loams, coastal sands and saline soils	Rice, groundnut, sorghum, pearl millet, tobacco, cotton, chilli, sugarcane and horticultural crops
3	Krishna zone	Krishna, Guntur, Prakasam	South-west monsoon 800-1,100 mm	Max. 29-42 °C Min. 16-24 °C	Deltaic alluvium, red soils with clay, black cotton soils, red loams, coastal sands and saline soils	Rice, groundnut, sorghum, pearl millet, tobacco, cotton, chilli, sugarcane and horticultural crops
4	Southern zone	Chittoor, Kadapa, Nellore	South-west monsoon 700-1,000 mm	Max. 28-40 °C Min. 13-27 °C	Red loamy soils, shallow to moderately deep	Rice, groundnut, cotton, sugarcane, millets and horticultural crops
5	Scarce rainfall zone	Kurnool, Anantapur	South-west monsoon 500-750 mm	Max. 32-40 °C Min. 13-28 °C	Red earths with loamy soils, red sandy soils and black cotton soils in pockets	Cotton, sorghum, millets, groundnut, pulses and rice
6	High altitude & tribal areas zone	High altitude & tribal areas of Srikakulam, Visakhapatnam, East Godavari districts	South-west monsoon >1,400 mm	Max. 17-35 °C Min. 6-24 °C	Hill slopes, undulating transported soils	Horticultural crops, millets, pulses, chilly, turmeric and pepper

In recent years, drought and other natural calamities have adversely affected the State's economy and its people. Since the calendar year 2010, the state has been affected by 13 natural calamities. The state has 5 chronically drought prone districts *viz*. Ananthapur, YSR Kadapa, Chittoor, Kurnool, and Prakasam out of 13 districts (Anon. 2015). There are various types of soils and the formation of a soil is primarily influenced by major factors *viz.* climate, altitude and composition of bedrock etc. Disproportion in the distribution of rainfall and excessive heat contribute special characters to the soils. Most of the soils in the state are made up of a combination of three basic types *viz.* sand,

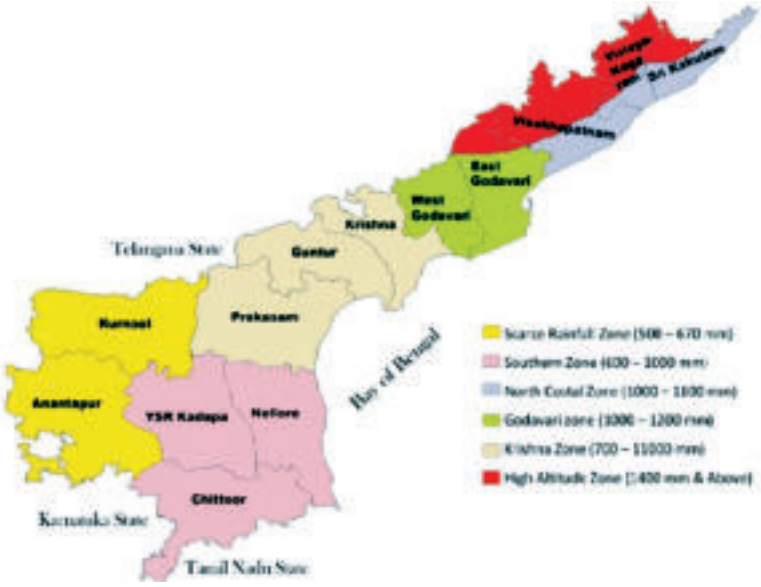

Figure 3. Agro-climatic zones of Andhra Pradesh

silt, and clay. Of the 22 categories of soils adding to the total geographical area of the state, six types are predominant and together account for over 88% of the area.

C. Interactive Workshop-IGFRI and State Department

An online interactive workshop on "Fodder Resources Development Plan for Andhra Pradesh" was held on 6th July 2020. Sh. H. Arun Kumar, Commission of Agriculture & Project Director, APDMP, Govt. of Andhra Pradesh inaugurated the workshop.

At the outset, Dr. V.K. Yadav, Director, ICAR-IGFRI, Jhansi welcomed all the participants to the meeting and briefly outlined the purpose of online workshop. He highlighted the significant contributions of the IGFRI Jhansi in catering to the fodder security in the country. In this direction he said this "Andhra Pradesh Fodder Resources Development Plan" is being developed and to elicit the opinion of different departments, this workshop is being organized.

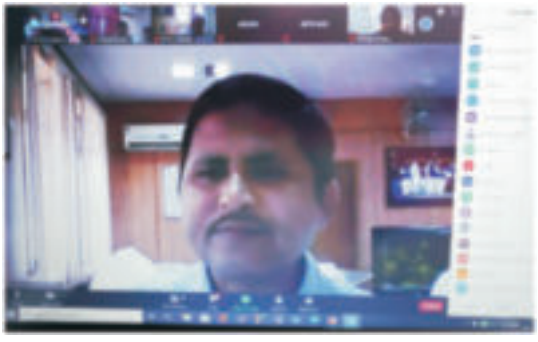

Figure 4. Dr. V.K. Yadav delivering inaugural address

Sh. H. Arun Kumar, Commissioner of Agriculture & Project Director, APDMP, Government of Andhra Pradesh briefed about the Andhra Pradesh state having large cattle population and milk production.

Dr. Srinivas, Director of Animal Husbandry, Govt. of Andhra Pradesh observed that Karnool, Kadappa, Prakasham and Ananthpur in Rayalseema area are main fodder deficit districts.

Dr. Giridhara Krishna, Director of Research, ANGRAU in his observations outlined the importance of fodder crops in the present scenario and opined that there is a need to establish fodder banks at each district level under state government departments.

From ICAR-IGFRI, Dr. B.G. Shivakumar, Principal Scientist & Officer-in-Charge, Southern Regional Research Station, Dharwad made a detailed presentation for fodder plan of Andhra Pradesh. Dr. A.K. Roy, Project Coordinator (Forage Crops & Utilization) made detailed presentation on improved forage varieties, fodder crops production and protection technologies suitable. Dr. K. Sridhar, Principal Scientist, Southern Regional Research Station, Dharwad made presentation on package of practices for the improved forage suitable varieties. Dr. R.V. Kumar, Head, Grassland and Silvi-pasture Management Division, made presentation on different silvi and horti pasture management and grassland management systems. Dr. Sunil Kumar Seth, Principal Scientist, made presentation on different horti-pasture systems. Dr. Sultan Singh, Principal Scientist, made a detailed presentation on fodder based rationing of farm animals.

Dr. C. Bala Subramanyam, Chief Operating Officer, APDMP, Govt. of Andhra Pradesh, Dr. Venkatesh, Department of Agriculture, Andhra Pradesh, Dr. Ramachandrudu, Principal Scientist, ICAR- Indian Institute of Oil Palm, Dr. Venkata Seshaiah, ANGRAU and Dr. Ananda Rao mentioned that fodder conservation of mainly paddy straw and maize stover through bale making is required.

Dr. Sunil Tiwari, Head, Crop Production Division, Dr. P.K. Pathak, Head, Farm Machinery and Post-Harvest Technology Division, Dr. Khem Chand, Head, Social Science Division, ICAR-IGFRI, Jhansi also presented their view points.

Dr. V.K. Yadav, Director, ICAR-IGFRI, Jhansi in his concluding remarks requested all the members to work in coordination to finalize the draft plan and to work together in future to implement this fodder plan for Andhra Pradesh state (Annexure I).

D. Livestock scenario

Andhra Pradesh is an important livestock rearing state in India. It had a total livestock population of 34.05 million with 4.58 million cattle, 6.22 million, buffaloes, 17.63 million sheep, 5.52 million goats etc. (BAHS, 2019; Table 5). Of late there is greater emphasis on improving the exotic/crossbred population of cattle and sheep. Andhra Pradesh ranks 4th in milk and meat production in the country with 15.04 million and 7.81 lakh tonnes, respectively. It also stands 9th in wool production (Table 6). Chittoor district leads in cattle population followed by Visakhapatnam, Srikakulam Anantapur and Vizianagaram districts. Prakasam district leads in buffaloes followed by Guntur, SPSR

Nellore, Krishna and West Godavari districts. Anantapur district leads in sheep followed by Prakasam, Kurnool, YSR Kadapa and Chittoor districts. Anantapur also leads in goat population followed by Kurnool, Chittoor, Prakasam and SPSR Nellore. Among the districts, Anantapur leads in total livestock population followed by Prakasam, Kurnool, Chittoor and YSR Kadapa (Table 7).The district wise indigenous, crossbreed/exotic and total cattle population; district-wise male, female, milking and - total population of buffaloes; district-wise indigenous, crossbred/exotic and total population of sheep and district-wise male, female and total goat population has been presented in Tables 8-11. There is more or less equitable distribution of livestock keeping among all sections of the society with a very large households and household enterprises owing different kind of animals in the state (Table 12). Livestock is contributing 6.75% of revenue to the Gross State Domestic Product (GSDP) and 46 lakh families depend on livestock farming in the state (DES 2015). Livestock farming is the mainstay of the rural economy and act as drought insurance. 70% of the small and marginal farmers and agricultural laborers depend upon livestock rearing. With the changing socio climatic environment, farmers are shifting from traditional agriculture to livestock farming as the livestock farming is providing more sustainable livelihood and supplementary income. In this scenario, the dairying is booming. However the shortage of fodder is limiting the progress. Unless measures to mitigate the fodder shortage are taken, the livestock production and dairying are going to be adversely affected.

Table 5. Livestock population of Andhra Pradesh

S.No.	Particulars	Number (million)	% population of India	Rank among states
1	Cattle	4.58	2.38	14
2	Buffaloe	6.22	5.66	6
3	Sheep	17.63	23.74	2
4	Goat	5.52	3.71	11
5	Total	34.05	6.09	6

(Source: BAHS, 2019)

Table 6. Milk, meat and wool production in Andhra Pradesh

S.No.	Particulars	India	Andhra Pradesh	% of India	Rank among states
1	Milk (million tonne)	187.75	15.04	8.01	4
2	Meat (Lakh tonnes)	81.14	7.81	9.62	4
3	Wool ('000 tonnes)	40.42	0.80	1.97	9

(Source: BAHS, 2019)

Table 7. District-wise livestock population in Andhra Pradesh

District	Cattle	Buffaloes	Sheep	Goat	Total
Anantapur	497,102	285,443	4,926,587	884,186	6,593,318
Chittoor	950,026	86,680	1,696,698	535,063	3,268,467
East Godavari	396,021	585,246	316,480	318,696	1,616,443
Guntur	95,927	882,347	704,863	196,153	1,879,290
Krishna	78,846	669,773	593,007	196,986	1,538,612
Kurnool	356,122	419,855	1,985,957	610,574	3,372,508
Prakasam	68,309	926,651	2,033,479	498,472	3,526,911
SPSR Nellore	107,858	745,829	1,370,812	453,820	2,678,319
Srikakulam	571,943	48,481	738,910	335,684	1,695,018
Visakhapatanam	648,743	318,846	371,430	435,620	1,774,639
Vizianagaram	490,989	135,858	540,336	271,205	1,438,388
West Godavari	201,102	627,909	478,551	207,067	1,514,629
YSR Kadapa	137,099	486,581	1,869,861	578,607	3,072,148
Total	4,600,087	6,219,499	17,629,996	5,522,133	33,971,715

(Source: BAHS, 2019)

Table 8. District-wise indigenous, crossbred /exotic and total cattle population in Andhra Pradesh

District	Exotic/crossbred	Indigenous	Total
Anantapur	225,895	271,207	497,102
Chittoor	829,852	120,174	950,026
East Godavari	90,027	305,994	396,021
Guntur	13,132	82,795	95,927
Krishna	10,267	68,579	78,846
Kurnool	17,203	338,919	356,122
Prakasam	10,384	57,925	68,309
SPSR Nellore	17,208	90,650	107,858
Srikakulam	411,067	160,876	571,943
Visakhapatanam	187,623	461,120	648,743
Vizianagaram	337,327	153,662	490,989
West Godavari	51,971	149,131	201,102
YSR Kadapa	60,273	76,826	137,099
Total	2,262,229	2,337,858	4,600,087

(Source: BAHS, 2019)

Table 9. District-wise male, female, milking and total population of buffaloes in Andhra Pradesh

District	Male	Female	Milking	Total
Anantapur	20,982	264,461	100,956	285,443
Chittoor	8,105	78,575	28,976	86,680
East Godavari	32,090	553,156	222,035	585,246
Guntur	57,892	24,455	291,477	882,347
Krishna	47,395	622,378	229,374	669,773
Kurnool	23,483	396,372	144,410	419,855
Prakasam	62,425	864,226	327,197	926,651
SPSR Nellore	58,104	687,725	249,185	745,829
Srikakulam	8,686	39,795	15,751	48,481
Visakhapatanam	39,919	278,927	108,867	318,846
Vizianagaram	18,849	117,009	42,566	135,858
West Godavari	41,523	586,386	224,535	627,909
YSR Kadapa	43,769	442,812	161,366	486,581
Total	463,222	5,756,277	2,146,695	6,219,499

Source: BAHS, 2019)

Table 10. District-wise indigenous, crossbred /exotic and total sheep population in Andhra Pradesh

District	Exotic/crossbred	Indigenous	Total
Anantapur	271,138	4,655,449	4,926,587
Chittoor	177,607	1,519,091	1,696,698
East Godavari	61,463	255,017	316,480
Guntur	23,194	681,669	704,863
Krishna	27,816	565,191	593,007
Kurnool	69,664	1,916,293	1,985,957
Prakasam	55,797	1,977,682	2,033,479
SPSR Nellore	78,522	1,292,290	1,370,812
Srikakulam	114,813	624,097	738,910
Visakhapatanam	25,045	346,385	371,430
Vizianagaram	100,173	440,163	540,336
West Godavari	20,854	457,697	478,551
YSR Kadapa	154,540	1,715,321	1,869,861
Total	17,626,971	3,025	17,629,996

(Source: BAHS, 2019)

Table 11. District-wise male, female and total goat population in Andhra Pradesh

District	Male	Female	Total
Anantapur	165,870	718,316	884,186
Chittoor	112,971	422,092	535,063
East Godavari	87,794	230,902	318,696
Guntur	31,042	165,111	196,153
Krishna	37,402	159,584	196,986
Kurnool	110,151	500,423	610,574
Prakasam	83,988	414,484	498,472
SPSR Nellore	58,789	395,031	453,820
Srikakulam	101,761	233,923	335,684
Visakhapatanam	135,976	299,644	435,620
Vizianagaram	77,649	193,556	271,205
West Godavari	40,807	166,260	207,067
YSR Kadapa	165,707	412,900	578,607
Total	1,209,907	4,312,226	5,522,133

(Source: BAHS, 2019)

Table 12. Number of households and household enterprises owning animals in Andhra Pradesh

District	Cattle	Buffaloes	Goats	Sheep
Anantapur	171926	99892	36939	61708
Chittoor	286879	23175	31005	39395
East Godavari	77738	198534	28462	11742
Guntur	41986	280751	10123	12823
Krishna	29103	207392	12139	16818
Kurnool	130711	118139	32708	50958
Prakasam	28100	267166	23382	34552
SPSR Nellore	29622	152694	18179	23512
Srikakulam	190407	17839	23178	40188
Visakhapatnam	134077	109846	45908	32570
Vizianagaram	116459	46679	19437	19481
West Godavari	43808	182716	19082	11310
YSR Kadapa	40126	109016	33595	35485
Total	2515801	2871654	740773	706538

(Source:BAHS, 2012)

The livestock sector has emerged as an alternative and dependable source of income generation even during the times of severe drought. Increase in the production of milk (13.53%), meat (13.68%) and egg (12.32%) resulted in an encouraging growth rate of 13.05% in the livestock sector. The fodder policy and timely interventions have helped the livestock sector, alone accounting for more than 28.96% per cent of the total agriculture sector GVA, to bypass the other entire sub sectors in the agriculture and allied group (SEO 2018) (Figure 5).

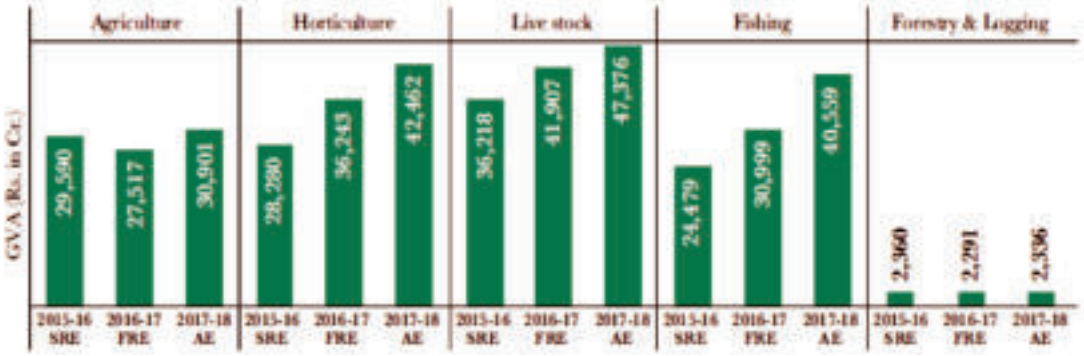

Figure 5. Subsector-wise gross value added (GSV) in agriculture and allied sector at constant prices (2011-12) (Source: SEO, 2018)

SRE: Second revised estimates **FRE**: First revised estimates **AE**: Advanced Estimates

E. Fodder scenario

There was about 2.13 lakh hectares of permanent pastures and other grazing lands. An area of 63,741 hectares of land was under fodder cultivation in 2014-15. The districts of Prakasham, Guntur and Chittor accounted for >50% of the area and about 13,365 hectares areas under irrigated conditions. The livestock sector has high inclusive growth potential. However, further growth of the sector is as much dependent upon the availability of fodder and breed improvement. It is the issues related to fodder that are a cause of concern (Table 13 & 14; Figure 5). This is despite the state's favourable agro-climatic conditions and availability of resources. One of the major challenges is huge shortage of fodder, more so during drought situations and summer. The total livestock units in the drought affected districts are 57.05 lakhs. The requirement of fodder is 61.94 lakh tonnes and the availability is 26.97 lakh tonnes. The estimated fodder shortage was estimated nearly at (-) 34.96 lakh tonnes (NIANP. 2012 & Anon, 2015). The animals require green, dry fodder and concentrate feed to exploit its genetic potential in order to yield more production. However, there is 41% shortage in green fodder, 42% shortage in feed concentrates and 20% shortage in dry fodder in the state. There is an urgent need to have a fodder policy in place, to increase production and to ensure faster growth of the livestock sector in the light of continuous reduction in grazing lands, on account of increased urbanization and as a result of which there is huge reduction in crop residue

availability and shortage of fodder, and this requires an appropriate comprehensive strategy to address (Govt. of Andhra Pradesh, 2015). The fodder security policy, having various components to provide quality feed and fodder to the livestock is being implemented through promotion of silage, hydroponics and azolla, total mixed ration, convergence with MGNREGS to match for material cost, ration balancing programme (RBP), fodder seed supply, fodder banks, feed and fodder supply, Oorura Pasu grass Kshetralu (OPGK), under *Kutumba Vikasam* programme etc.

The state government has approved fodder security policy to ensure fodder security to the animals. The government has targeted massive fodder production in 30000 acres under "Oorura Pashu Grasa Kshetralu" (OPGK) in the needy villages engaging the services of entrepreneurs interested to produce green fodder for the consumers who are willing to buy green fodder @ Rs. 1.00/kg from the entrepreneur. The state government is implementing the policy of distribution of feeding inputs @ Rs. 1.00/kg of green fodder, @ Rs. 2.00/kg silage, @ Rs. 3.00/kg of dry fodder, @ Rs. 3.50/kg total mixed ration and @ Rs. 4/kg concentrate feed to reduce the cost of production in order to make livestock enterprise viable to the farmers. The fodder security policy supports for propagation of world's best practices such as silage and total mixed ration feeding to the cattle in addition to the utilization of crop residues otherwise wasted in coastal districts for fodder management in summer season especially in Rayalaseema districts of Andhra Pradesh.

Table 13. District-wise area under fodder crops and gross sown area ('000 ha)

District	Area under fodder crops			Gross area sown			%Area under fodder area		
	2000-01	2008-09	2014-15	2000-01	2008-09	2014-15	2000-01	2008-09	2014-15
Anantapur	2.3	1.8	5.4	1102.9	1153.6	942.3	0.21	0.16	0.57
Chittoor	3.6	5.6	10.3	481.8	431.4	378.8	0.75	1.30	2.72
East Godavari	14.7	5.7	3.8	764.9	739.3	683.9	1.92	0.77	0.56
Guntur	50	32.4	16	864.5	831.8	809.7	5.78	3.90	1.98
YSR Kadapa	0.6	1.1	1.9	456.3	504.3	354.7	0.13	0.22	0.54
Krishna	6.9	10.9	5.1	714.9	756.2	677	0.97	1.44	0.75
Kurnool	0.6	0.9	0.3	991.8	993.7	998	0.06	0.09	0.03
SPSR Nellore	1.6	0.1	0.5	327.4	418	3946	0.49	0.02	0.01
Prakasam	25.6	20	18.1	6632.1	664.1	605.2	0.39	3.01	2.99
Srikakulam	0	0	0	419.9	432.2	419.1	0.00	0.00	0.00
Visakhapatnam	0.9	0.4	1.6	441.9	379.9	362.8	0.20	0.11	0.44
Vizianagaram	0	0.1	0	436.2	405.6	372.7	0.00	0.02	0.00
West Godavari	1.1	1.8	1.4	696.9	724.6	691.1	0.16	0.25	0.20
Total	107.9	80.8	63.7	8361.5	8434.7	7689.9	1.29	0.96	0.83

(Source: DES, 2016)

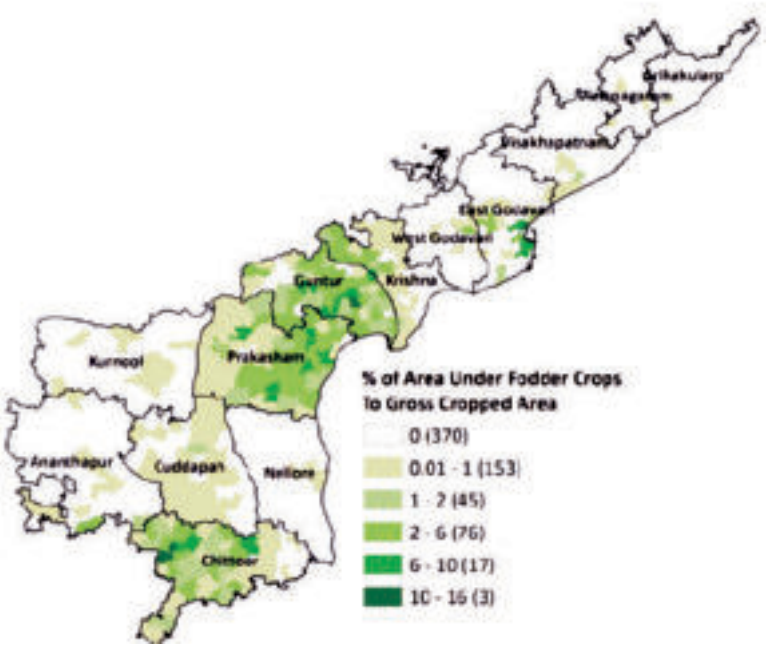

Figure 6. District-wise distribution of fodder crops in Andhra Pradesh
(Source: SAP, 2015-20)

Table 14. District-wise dry matter availability, requirement and balance in 2011('000 M T)

District	Availability	Requirement	Balance	% Deficiency
Anantapur	1783.2	3947.5	-2164.3	-54.8
Chittoor	1283.7	4153.8	-2870.1	-69.1
East Godavari	2475.1	5933.6	-3459.0	-58.3
Guntur	3812.4	7798.5	-3986.1	-51.1
YSR Kadapa	1347.9	4112.6	-2764.7	-67.2
Krishna	3245.3	6754.6	-3509.3	-52.0
Kurnool	2786.5	4100.0	-1313.5	-32.0
SPSR Nellore	1987.6	3976.1	-1988.5	-50.0
Prakasam	1963.4	8432.7	-6469.3	-76.7
Srikakulam	1120.8	3198.6	-2077.8	-65.0
Visakhapatnam	876.7	2987.6	-2110.9	-70.7
Vizianagaram	1241.8	2099.4	-857.6	-40.8
West Godavari	3045.3	4440.2	-1394.9	-31.4
Andhra Pradesh	26969.7	61935.2	-34966.0	-56.5

(Source: NIANP, 2012)

SWOT Analysis

In order develop any viable fodder resources developmental plan it is necessary to have a glance at the prevailing scenario. The strengths, weakness, opportunity and threats in the present situation in the state of Andhra Pradesh for fodder resources development plan has been presented in Table 15. There is wide scope for milk, meat and their byproducts in the state and it is like to grow in future. However, the fodder shortage is proving to be a major hurdle for further enhancing the animal products. We have to explore the ways and means of increasing fodder availability through different sources and resolving the hurdles by suitable measures.

Table 15. SWOT analysis and factors regarding fodder development in Andhra Pradesh

		Failure factor
Internal factor	**Strength** • Wide range of agro-climatic conditions is conducive for growing a large variety of fodder crops. • First in sheep, second in buffalo seventh in goat and eighth in cattle population in the country • 62.54 lakh (49.38%) households engaged in livestock / livestock related activities. • Livestock sector is an alternative and dependable source of income generation even during the times of severe drought. • Increase in milk (12.58%), meat (13.63%) & egg (11.66%) production resulted in growth rate of 12.18% in the livestock sector. • The state stands 4th in meat and milk production in the country • Of the total geographical area, 22.63% under forest (36.88 lakh hectares), 8.65% under current fallow lands (14.10 lakh hectares), 8.27% under barren and uncultivable land (13.47 lakh hectares), 7.63% (12.43 lakh hectares) is under other fallow, cultivable waste lands like permanent pastures and other grazing lands having high fodder supplying potential. • State receives bimodal rainfall both under south-west and north-east monsoons facilitating fodder cultivation during both *kharif* and *rabi* seasons.	**Weakness** • Decreasing size of agricultural land holdings and disproportionate allocation of land to fodder crop production • Continued dependence on the monsoon and irregular monsoon affecting the productivity of crops • Fodder production mostly under rainfed conditions and inadequate access to irrigation, imbalanced use plant nutrients. • Frequent droughts and cyclonic flood affecting the fodder crops • Non availability of suitable fodder crops, quality seeds and planting material. • Lack of fodder marketing facilities and confined to home consumption • Over dependence on natural niches for green fodder supply, crop residues as fodder sources and lesser emphasis on cultivated fodder crops. • Allocation of marginal and sub-marginal for fodder production and subsistence production systems • Regional imbalances in fodder production and availability
External factor	**Opportunity** • Growing demand for milk, meat and other livestock by-products indicating increasing prospects for livestock farming and thereof for fodder and feeds • Increasing number processing industries of livestock products creating attractive marketing prospects and profit margin for livestock keepers	**Threats** • Competitive land use system leading to displacement of fodder crops by other commercial and food crops • Fodder crop area encroachment by non-agricultural enterprises

External factor	Opportunity	Threats
	• Fodder security policy of government having various components to provide quality feed and fodder to the livestock • Scope for efficient use of crop residues as fodder for animals • Upcoming peri-urban dairy sector creating demand for green fodder and dry fodder markets • Prospects of growing of fodder trees in non-cropped areas, fallow lands and creating grazing lands • Value addition and conservation of fodder crops for realizing profits during lean periods • Generation of employment opportunity in dairy and meat processing sectors with increasing export potential • Prospects for fodder related research creating high yielding fodder crops under diverse agro-climatic conditions	• Opening of livestock sector to global players leading to stiff competition and reduction in profit margins and rendering the sector less remunerative • Lesser emphasis on scientific nutrient, water and pest management in fodder crops. • Fodder crops are not drought and flood proofed • Substance livestock farming and lesser emphasis on modernizing practices by the small livestock keepers • Greater proportion of indigenous breeds, lesser productivity and profits • More reliance on crop residues as dry fodder and natural vegetation as green fodder • Non-organized markets for remotely located livestock keepers making livestock keeping less remunerative

Part-II : Fodder Resource Development Plan

Development of fodder resources is an important issue in view of declining fodder availability to make livestock keeping more remunerative and sustainable in the State. The hitherto followed strategies of over-reliance on the natural fodder resources green fodder and crop residues for dry fodder may not be able to record the anticipated returns from the animal husbandry sector. The changing face of animal husbandry with greater thrust on increased milk and meat productivity and breed composition need a well calibrated nutritious green and dry fodder production systems proofed from climatic vagaries. It needs reforming the present fodder production and conservation systems to make sure continued fodder supply round the year to ensure good animal husbandry.

This may be possible only when all sources of fodder are used complementarily in tandem with various natural resources and agricultural production systems. The fodders may be grouped into various categories for understanding and efficient planning for better productivity *viz*. green fodders, dry fodders and crop residues. In fact, it is only green fodder in general are grown exclusively for feeding the animals in most of the situations. It is very rarely that the food crops are fed as green fodders in case of unforeseen failure of food crops due to drought or floods. Further, the crop residues after harvest and separation of economic part of food crops is conserved and used as dry fodder. In exigencies the tree lopping too is used as green fodder during lean periods. As per the estimate of the Govt. of Andhra Pradesh (2015), there is 41% shortage in green fodder, 42% shortage in feed concentrates and 20% shortage in dry fodder in the State. The requirement, availability and deficit of green fodder, dry fodder and feed are presented in Table 16.

Tale 16. Status of dry fodder, green fodder and concentrated feed in Andhra Pradesh

S.No.	Fodder/Feed	Requirement (Lakh MT)	Available (Lakh MT)	Net deficit (Lakh MT)	% deficit
1	Dry fodder	255.36	205.40	49.96	19.56
2	Green fodder	776.68	461.44	315.24	40.59
3	Concentrate feed	51.78	30.38	21.40	41.33

(Source: GoAP, 2015)

Strategies for enhancing fodder resources

The fodder crops are often considered as orphan crops. They are neither considered to be the domain crops of Department of Agriculture nor Animal Husbandry because of their peculiar utility. Farmers find it difficult to get proper advice and guidance

for the cultivation of these crops. Any planning to augment the fodder resources has to take various issues for consideration for good and efficient implementation. It should include estimation of natural resources of fodder *viz*. grasslands/grazing lands, forest areas, community lands, fodder availability from the agricultural/horticultural systems etc. Since the fodder has limited marketing potential, only the needy animal keepers may be interested in fodders. Therefore the planning may begin with the fodder requirement vis-à-vis the availability in a given location. First it should aim at exploiting the natural resources of fodder in the vicinity and then cultivation. Fodder crops often lose out to food and commercial crops in any farming system and hence, there should be emphasis on using the community land, non-cropped fallow lands, waste lands etc. Often the Panchayats, forest department etc. can join hands to create and develop community grazing lands to meet the fodder requirement of grazing animals. Fodder cultivation may be thought of as intercrop in horticultural crops, agro-forestry systems and mixed land use systems. Only when there is livestock rearing on commercial scale we can go for fodder cultivation as sole crop. It needs to work out the economics of production of fodder crops and its usefulness in enhancing the monetary returns in combination with animal husbandry as compared to food or commercial crops. If found to be remunerative, the farmers may be educated and encouraged with all modern fodder production technology making available quality fodder seeds, planting material and other inputs. This is more important in irrigated areas and agriculturally developed areas as the farmers often think food/commercial crops are more remunerative than growing fodder crops. Further sensitizing the farmers about the conservation of green fodder as silage or dry fodder as hay needs equal emphasis to ensure the fodder security.

A. Cultivated fodder resources

There are opportunities for cultivation of fodder crops in different parts of the state. The suitable fodder crops and their yield levels under different growing conditions have been furnished in Table 17. The selection of fodder crops also depends on the availability of fodder from other food crops, horticulture crops etc. Fodder crops may be cultivated on the basis of requirement of fodder as annual and perennial basis. The annual crops may be taken up to tide over the fodder shortages during the lean period of summer and when fodder scarcity arises out of failure of other crops. The continued supply of fodder to the livestock may be ensured by cultivation of perennial fodder crops where there is a need for fodder crops throughout the year as livestock keeping and dairying is considered as major economic activity under agriculture and allied activities. A large number of fodder crops both annual and perennial have been identified to be suitable for different agro-climatic conditions of the state. Some of the promising food-fodder based cropping systems have been listed below:

Promising food – fodder based cropping systems:

- Fodder Maize + Cowpea - Sorghum
- Fodder Sorghum + Pigeonpea-Maize
- Fodder Cowpea - Maize - Pigeonpea
- Fodder Bajra + Cowpea - Sorghum
- Fodder Pigeonpea + Pigeonpea - Maize
- Ragi + Fodder cowpea-Chickpea

The fodder crops *viz*. guinea grass, grazing guinea, signal grass, stylosanthes, hedge lucerne etc. may be grown on borders, tree basins, on field bunds, along the water courses etc.

Table 17. Fodder crops and their green fodder yield under different growing conditions

Fodder crops		Productivity	
		Rainfed	Irrigated
I, Annual fodders	Fodder maize	30-40 t/ha	40-50 t/ha
	Fodder sorghum	20-25 t/ha	25-30 t/ha
	Fodder cowpea	10-15 t/ha	25-30 t/ha
II. Perennial fodder	Signal grass	80-100 t/ha	-
	Guinea grass	80-100 t/ha	180-200 t/ha
	Bajra Napier hybrid	60-80 t/ha	200-250 t/ha
	Stylosanthes spp	35-40 t/ha	-
	Hedge lucerne	40-70 t/ha	-
	Setaria anceps	25-40 t/ha	
	Para grass	60-80 t/ha	80-100 t/ha
	Congo signal grass	35-40 t/ha	-
	Cenhrus cilaiaris	60-70 t/ha	90-100 t/ha
	Calapogonium mucunoides	20-25 t/ha	-
	Centrosema spp	25-30 t/ha	-

i. Fodder Production in non-arable areas

The undivided state of Andhra Pradesh had a total non-arable area excluding fallow of about 1.38 million ha accounting for 5.02% of the total geographical areas of Andhra Pradesh (including the present day Telangana State) (GOI, 2016). This area is often not used for cultivation of food crops/commercial crops. Hence there is a wide scope for cultivation of fodder crops in these areas. However, the nature of non-arable land

determines the kind of fodder grass suitable for cultivation. Under all circumstances, timely sowing coinciding with the start of rainfall and frequency of cutting in tune with the distribution of rainfall is imperative. The fodder crops suitable for non-arable lands along with the expected yield are presented in Table 18. Although annual crops could be grown in good rainfall areas, there is less likelihood of potential yield of these crops owing to varied constraints. Therefore perennial fodder crops are more suited for these lands.

Table 18. Fodder crops suitable for non-arable lands and their productivity

Fodder crop	Green fodder yield (t/ha)
Dinanath grass	25-30 t/ha
Perennial fodder sorghum	30-40 t/ha
Cenchrus spp.	25-30 t/ha
Grazing guinea	75-80 t/ha
Stylosanthes spp.	10-15 t/ha
Clitoria spp.	10-12 t/ha
Hedge lucerne	15-20 t/ha
Sehima grass	2-4 t/ha

ii. Fodder production in arable areas

Cultivation of fodder crops in arable areas is easier as compared to non-arable owing to assured rainfall and/or irrigated conditions in Andhra Pradesh. The farming community having already understood the importance of green fodder for animal husbandry is earmarking some good lands for production of fodder. It is possible to grow fodder both annual and perennial under rainfed and also irrigated conditions. The selection of suitable crops for a given area as to annual or perennial depending upon the need of the farmer is important for the success. The important fodder crops for different conditions/seasons and suitable varieties have been presented in Table 19. Besides growing these crops as sole crops, it is also suggested to grow them on bunds, in vacant space in orchards and also in the basins of tall trees particularly leguminous fodder crops like *Stylosanthes, Clitoria* etc.

Table 19. Fodder crops suitable for arable lands

Fodder crop	Crop	Varieties
Annual		
Kharif (Rainfed)	Fodder maize	African Tall, APFM 8
	Fodder sorghum	SSG 59-3, Pusa Chari 6, HC 136, Pusa Chari 9, Pusa Chari 23, SV-74, SSV-84,TSFB15-4 and TSFB-15-8

	Fodder bajra	Gaint Bajra, Raj Bajra Chari 2, CO-8, TNSC 1, AVKB 19, KHB 202, Moti Bajra
	Fodder cowpea	UPC 5286, Co 5, UPC 287, Bundel lobia 1, MFC 09-1, EC 4216
	Fodder horse gram	DFHG 1
	Rice bean	RBL 6
Rabi (Irrigated)	Fodder maize	African tall, APFM-8
	Fodder sorghum	SSG 59-3, Pusa Chari 6, HC 136, Pusa Chari 9, Pusa Chari 23, SV-74, SSV-84,TSFB15-4 and TSFB-15-8
	Fodder oat	Kent, HFO 212B, OS-6, OS-7, UPO 94, UPO 2012, No.2688, OL-9, IGFR-2688
	Fodder cowpea	UPC 5286, Bundel Lobia 1, Bundel Lobia 2, MFC 09-1, MFC-08-14, EC 4216, Vijaya
	Berseem	JB1, Vardan (S99-1), B.L.1,2,10, JB-2, UPB 110
	Fodder horse gram	VLG-19, VLG-15, A.K-21, A.K- 42
Summer (Irrigated)	Fodder maize	African Tall, APFM 8
	Fodder cowpea	UPC 5286, Bundel Lobia 1, Bundel Lobia 2, MFC 09-1, MFC-08-14, EC 4216, Vijaya
Perennial		-
Rainfed	Signal grass	Bassilisk
	Ruzi grass (Congo signal grass)	DBRS 1
	Grazing guinea	-
	Perennial fodder sorghum	COFS 29, COFS 31
	Dinanath grass	Bundel 1, Bundel 2, IGFRI 4-2-1, IGFRI 43-1, CO 1, TNDN 1
	Rhodes grass	Rhodes 10, Callide
	Stylosanthes spp	-
	Clitoria spp.	-
	Hedge lucerne	CO-2,TSHL-1
	Setaria anceps	Nandi, Narok and Kazungula
	Anjan grass	CO-2, Bundel Anjan 3
Irrigated	Bajra napier hbrid	NB 21, DHN 6, APBN 1 KKM 1, CO BN 5, COBN 6
	Guinea grass	PGG 13, PGG 14, Marathakam, Bundel Guinea 2, DDG 1
	Lucerne	RL 88, Anand 2, CO 1, Anand-11

iii. Fodder production modules for different Agro-climatic zones

The success rate of fodder production depends on the resources available for their cultivation and also on the climatic conditions prevailing in a given area. Appropriate fodder production plans based on the soil types, rainfall pattern, irrigation availability and cropping pattern determine the overall productivity of fodder. Hence the fodder production modules based on the agro-climatic conditions are deemed to be more rational and sustainable.

i. Krishna–Godavari Zones:

1. Exploring the utilization of local fodder resources and their enrichment like paddy straw major crop residue, groundnut haulms, stover of other legumes, local native grass from community lands etc. as supplement
2. Promote cultivation of short duration fodder crops like sorghum, bajra, maize etc. as rainfed crops and also as catch crops when main crops fail due to vagaries of monsoon.
3. Fodder production should be a part of National/State Agriculture Policy for enforcing NCA recommendations to bring 10% cultivable land under fodder cultivation. At each farm level, at least 10% of the land be allocated for fodder crops (annual/perennial) depending on the situation either rainfed or with limited irrigation
4. Growing of perennial fodder crops in interspaces of horticulture crops wherever feasible
5. Suitable niches like bunds, farm pond embankments, shaded areas, non-cultivable waste lands, unutilized land in the fields, kitchen backyards, etc. can be used for growing the suitable species fodder grasses and legumes
6. Peri-urban fodder production can be a viable option and a source for dissemination and adoption of fodder technologies in the region
7. Utilization of CPR's for growing fodder trees, range grasses and legumes
8. Formation of regional fodder working groups consisting people from NGOs, village institutions, researchers and concerned government agencies and networking of these groups

ii. North Coastal Zone:

1. Promote cultivation of short duration fodder crops like sorghum, bajra, maize etc.
2. Promoting non-conventional fodder and feed resources to support feeding situation.
3. Enriching of low nutritive material like paddy straw, stover and forest hay.
4. Promoting social fencing with fodder trees like glyricidia, sesbania, calliandra, moringa etc

5. Promoting fodder cultivation in embankments and on bunds to harness the residual moisture as a coping mechanism.
6. Creation of permanent feed and fodder banks in all villages
7. Chopping of fodder should be made mandatory in every village through supply and establishment good quality chaff cutters. It would minimize fodder wastage.
8. Establishment of silvi-pastoral systems, horti-pastoral systems in community lands.
9. Growing of perennial fodder crops in interspaces of horticulture crops wherever feasible

iii. Southern Zone:

1. Growing of perennial fodder crops in interspaces of horticulture crops wherever feasible
2. Enriching of low nutritive material like paddy straw, stover and forest hay.
3. Utilization of tree fodder and unconventional feed resources available
4. Suitable niches like bunds, farm pond embankments, shaded areas, non-cultivable waste lands, unutilized land in the fields, kitchen backyards, etc. can be used for growing suitable species of fodder grasses and legumes

iv. Scarce rainfall zone:

1. Promote cultivation of short duration fodder crops like sorghum, bajra, maize etc.
2. Promotion of perennial grasses like perennial sorghum, signal grass and grazing guinea in farmers' fields as per the niches available and needs of the farmers
3. Chopping of fodder should be made mandatory in every village through supply and establishment good quality chaff cutters. It would minimize fodder wastage.
4. Enriching of low nutritive material like paddy straw, stover and forest hay.
5. Utilization of community lands for growing fodder trees, range grasses and legumes

v. High altitude zone:

1. Growing of perennial fodder crops in interspaces of horticulture crops wherever feasible
2. Growing of fodder trees on boundaries for top feeds during the lean season
3. Utilization of CPR's for growing fodder trees, range grasses and legumes
4. Promoting social fencing with fodder trees like glyricidia, sesbania, calliandra, moringa etc.

5. Harvesting and collection of perennial local grasses, feed and fodder from community lands during monsoon and stall fed in order to reduce the energy requirements of the animals
6. Promoting non-conventional fodder and feed resources to support feeding situation.

Forage based crop intensification (Round the year forage production system)

In many areas having small land holdings, animal husbandry forms a predominant livelihood option for the rural folks. Under such conditions production of fodder crops is very important to meet the fodder requirement of livestock throughout the year. Thus forage based cropping system *viz*. intercropping, relay cropping or sequential cropping systems need to be planned and established to meet the balanced fodder requirement of the livestock. Here attention should be given to ensure the availability of both cereal and legume component to animals and also to sustain the soil productivity. Under assured irrigation facilities following fodder cropping systems may be taken up.

Fodder maize-fodder cowpea-fodder sorghum

Fodder sorghum-fodder cowpea-fodder maize

Fodder bajra-fodder cowpea-fodder maize

Fodder sorghum + fodder horse gram - fodder sorghum-fodder maize

Fodder maize + fodder horse gram - fodder sorghum-fodder cowpea

Fodder maize-lucerne (Annual)

Fodder sorghum-lucerne (Annual)

Fodder bajra- lucerne (Annual)

Fodder maize-fodder cowpea-fodder oats

Fodder sorghum-fodder cowpea-fodder oats

Further fodder crops may be included in the food grain or commercial cropping system without affecting the monetary returns from those crops in relay or sequential cropping systems.

B. Fodder production through horti-pasture and silvi-pasture systems

The orchard and plantation crops being wide spaced in planting geometry provide ample opportunities for introduction of fodder crops in the intervening spaces without affecting the performance of these crops. The fodder crops hardly pose any competition for resources to the orchard or plantation crops as fodder crops have different zones of extracting water, nutrients and solar radiation. On the contrary the fodder crops will help in *in situ* soil and water conservation and reduce the emergence of unwanted vegetation particularly weeds. The leguminous fodder crops like stylosanthes help in biological nitrogen fixation and improve the soil fertility status. The state of Andhra

Pradesh with diverse agro-climatic conditions has a large area under orchard and plantation crops. There are a large number fodder grasses and legumes that can be introduced in these orchards and plantation crops in different agro-climatic conditions. It can be sole cropping and mixed cropping or sequential cropping. Introduction of fodder crops besides providing the fodder, help in improving the soil organic carbon, bio-chemical properties which help in water holding capacity. Fodder crops also improve the soil micro-fauna and flora enhancing the soil productivity. Suitable fodder crops for inter-cropping in orchard and plantation crops under different agro-climatic conditions have been presented in Table 20. There is a great scope for introduction of fodder crops in horti-pasture system in many of the crops grown in Andhra Pradesh (Table 21). Further each of the districts of Andhra Pradesh has potential for fodder production under horti-pasture system mitigating the fodder scarcity (Table 22).

Table 20. Suitable perennial fodder crops for introduction in orchards and plantation crops in Andhra Pradesh

S.No.	Agro-climatic zone	Districts	Orchard/ Plantation	Perennial fodder crops
1	North coastal zone	Srikakulam, Vizianagaram, Visakhapatnam	Cashew nut, Coconut, Coffee, Papaya, Mango	**Grasses:** Guinea grass, bajra napier hybrid, *Brachiaria*, Nandi grass **Legumes:** *Clitoria ternatea, Stylosanthes* guianensis
2	Godavari zone	East Godavari, West Godavari	Cashew nut, Coconut, Cocoa, Papaya, Sapota, Mango	**Grasses:** Guinea grass, bajra napier hybrid, *Brachiaria*, Nandi grass, Grazing guinea **Legumes:** *Clitoria ternatea*, *Stylosanthes guianensis*, Lucerne
3	Krishna zone	Krishna, Guntur, Prakasam	Papaya, Sapota, Mango	**Grasses:** Guinea grass, bajra napier hybrid, *Brachiaria*, Nandi grass, Grazing guinea, Perennial fodder sorghum **Legumes:** *Clitoria ternatea*, *Stylosanthes guianensis*, Lucerne, Hedge lucerne
4	Southern zone	Chittoor, Kadapa, Nellore	Coconut, Tamarind, Papaya, Sapota, Guava, Mango, Lemon	**Grasses:** Guinea grass, bajra napier hybrid, *Brachiaria*, Grazing guinea, Perennial fodder sorghum, Rhodes grass **Legumes:** *Clitoria ternatea*, *Stylosanthes hamata*, Lucerne, Hedge lucerne

5	Scarce rainfall zone	Kurnool, Anantapur	Papaya, Sapota, Guava, Mango, Lemon	**Grasses:** Guinea grass, Brachiaria, Cenchrus grass, Dinanath, Grazing guinea, Perennial fodder sorghum, Rhodes grass **Legumes:** *Stylosanthes scabra*, Hedge lucerne
6	High altitude & tribal areas zone	High altitude & tribal areas of Srikakulam, Visakhapatnam, East Godavari districts	Papaya, Mango	**Grasses:** Guinea grass, bajra napier hybrid, Brachiaria, Nandi grass, Dinanath, Cenchrus grass. **Legumes:** *Clitoria ternatea, Stylosanthes guianensis*

Table 21. Expected fodder production under hortipasture systems with the introduction of fodder crops in orchards and plantations

S.No.	Orchard/ plantation	Area (ha)	Targeting 50% area (ha)	Targeting 25% area of 50% area (ha)	Expected green fodder production (t)	Expected dry fodder production (t)
1	Amla	800	400	100	2500	500
2	Ber	1503	752	188	4697	939
3	Lemon	34883	17442	4360	109009	21802
4	Orange	82887	41444	10361	259022	51804
5	Custard apple	1678	839	210	5244	1049
6	Guava	9528	4764	1191	29775	5955
7	Jackfruit	1197	599	150	3741	748
8	Mango	363002	181501	45375	1134381	226876
9	Pomegranate	9466	4733	1183	29581	5916
10	Sapota	10086	5043	1261	31519	6304
11	Areca nut	1916	958	240	5988	1198
12	Cashew nut	114439	57220	14305	357622	71524
13	Cocoa	26216	13108	3277	81925	16385
14	Coconut	99508	49754	12439	310963	62193
15	Oil palm	162692	81346	20337	508413	101683
16	Coffee	63210	31605	7901	197531	39506
17	Tamarind	6576	3288	822	20550	4110
	Total	989587	494794	123698	3092459	618492

Assumption: Average green fodder yield: 20-30 t/ha & dry fodder yield: 4-6 t/ha

(Source:http://horticulture.ap.nic.in/index.html)

Table 22. District wise expected fodder production under hortipasture systems

District	Area under hortipasture (ha)	Targeting 50% area (ha)	Targeting 25% area of 50% area (ha)	Expected green fodder production (t)	Expected dry fodder production (t)
Anantapur	114996	57498	14375	359363	71873
Chittoor	118609	59305	14826	370653	74131
East Godavari	172772	86386	21597	539913	107983
Guntur	6576	3288	822	20550	4110
Krishna	104737	52369	13092	327303	65461
Kurnool	15370	7685	1921	48031	9606
Prakasam	24759	12380	3095	77372	15474
Nellore	40296	20148	5037	125925	25185
Srikakulam	54058	27029	6757	168931	33786
Visakhapatnam	133186	66593	16648	416206	83241
Vizianagaram	73475	36738	9184	229609	45922
West Godavari	244206	122103	30526	763144	152629
YSR	49356	24678	6170	154238	30848
Total	1152396	576198	144050	3601238	720248

Assumption: Average green fodder yield: 20-30 t/ha & dry fodder yield: 4-6 t/ha

There is a possibility of fodder production through changed land use system *viz*. *horti-pasture* where fodder crops are introduced in the horticultural crops, *silvi-pasture* where fodder crops are grown in tree plantations, *silvi-horti-pasture* where fodder crops are grown in trees and horticultural crops grown together, for feeding the livestock. The selection fodder crops should be such that they should be able to tolerate the shade and meet their nutrient and water from soil and varied soil profile different from that of tree components. There should be a complementary relationship between the component trees and fodder crops. For example the tall growing trees should cast shadow on the shade loving fodder crops, while, fodder legumes should fix atmospheric nitrogen and spare some portion of it to benefit tree components. The fodder crops also help in *in situ* soil and water conservation, which will be beneficial to the tree crops. Further well planned systems will beside supplying fodder in scarcity areas will help in maintaining ecological balance in the nature. Further planting of multi-purpose trees will besides acting as source of fodder also meet the wood requirement of the farmers for farm implements, fire wood etc. These systems also protect the land from becoming barren in long run due to soil and water erosion.

C. Fodder production in permanent pasture/grazing lands

The state of Andhra Pradesh has a large area under permanent pasture and grazing

land and other category of lands where there is a scope for cultivation of fodder crops and enhancing the availability of fodder crops for livestock (Table 23).

Through careful planning and utilization of permanent pasture and grazing lands there is a possibility of production of 4.47 lakh metric tonnes of fodder. However, these lands are not properly looked after and grossly neglected. There is a need for removal of unwanted vegetation, planting and maintenance of crops having fodder value. Since these do not belong to individuals, they should be managed at community levels with the involvement of forestry, agriculture, horticulture and animal husbandry departments of the state government. These lands could be very useful sources of fodder for nomadic people, village community grazing lands and also for the wild herbivore animals. The most important interventions could be:

i. Grazing period and intensity
ii. Rotational and controlled grazing
iii. Removal of weeds, shrubs having no fodder value
iv. Periodic seeding and nutrient management
v. Erosion control
vi. Rejuvenation after heavy grazing period

Table 23. Land use pattern in Andhra Pradesh (2013-14)

Sl.No.	Category	Total Area (lakh ha)	% area of total area	Fodder area (lakh ha)	Expected fodder yield (lakh MT)
1	Forest	34.93	15	5.20	11.96
2	Barren and uncultivable land	13.41	50	7.15	16.45
3	Cultivable waste	3.92	75	3.59	8.25
4	Permanent pastures and other grazing lands	2.12	75	1.94	4.47
5	Current fallows	10.88	80	7.55	17.37
6	Other fallow lands	7.92	80	5.60	12.88
	Total	73.18		31.03	71.37

(Source: GoAP, 2015)

D. Fodder on non-competative lands

Bunds are commonly raised to demarcate the land boundaries by the farmers. Further they are used to conserve water in the field. Bunds are common irrespective of farming system and land holdings. In fact small land holders very rigorously maintain bunds to prevent encroachment from neighboring cultivators. The width of the bund varies from crop to crop and land gradient. They provide ample scope for planting of fodder crops on them. The perennial fodder crops guinea grass, Bajra Napier hybrid, *Sesbania* spp.

etc. are planted in single or double rows depending on the width of the bunds. They are also planted on the water canals/course in the field. The fodder crops on the bunds become quite useful during the peak crop growing seasons and lean period when the available fodders from the field dwindles. A well maintained fodder crop on bunds can give about 6-8 kg/m length/annum. The expected fodder production potential on the bunds, water courses and irrigation canals in Andhra Pradesh is presented in Table 24.

Table 24. Fodder production prospects on the bunds in Andhra Pradesh

Type of holding	No. of holdings (in lakhs)	Average Size of holdings (ha)	Total bund length (lakh km)*	Fodder production (lakh MT)**
Marginal (<1 ha)	49.84	0.43	6.61	4.63
Small (1-2 ha)	15.91	1.41	3.81	2.66
Semi Medium (2-4 ha)	7.96	2.64	2.62	1.83
Medium (4-10 ha)	2.30	5.57	1.07	0.75
Large (>10 ha)	0.20	15.20	0.19	0.14
Total	76.21		14.30	10.01

*Computed value **10% bund length used @7 kg/m length

E. Crop residues quality management

Indeed the crop residues constitute a major source of dry fodder for the livestock in the state of Andhra Pradesh. With a variety of food and commercial crops grown throughout the state, the residues after the separation of economic portion is conserved and used as dry fodder in many crops. Although these are rich in crude fiber and poor in quality, they are indispensible source of fodder in many areas irrespective of agro-climatic conditions. The major food crops, commercial crops grown and parts used as fodder and expected quantity is presented in Table 25.

Table 25. Area, production, yield and fodder yield of crops in Andhra Pradesh

S.No.	Crop	Area (lakh ha)	Production (lakh MT)	Yield (kg/ha)	Fodder part	Fodder yield (lakh MT)
Cereals						
1	Paddy	22.18	126.91	5722	Straw	126.910
2	Wheat	Negligible	Negligible	716	Straw	Negligible
3	Jowar	1.4	3.33	2382	Stover	4.995
4	Bajra	0.48	0.93	1927	Stover	1.395
5	Maize	3.36	23.26	6911	Stover	34.890
6	Ragi	0.35	0.44	1277	Straw	0.660
7	Samai	0.07	0.03		Straw	0.045
8	Korra	0.11	0.12	1075	Straw	0.180

9	Varagu	0.03	0.01	354	Straw	0.015
10	Arukulu	Negligible	Negligible	384	Straw	Negligible
					Total Cereals	**169.090**
Pulses						
11	Bengalgram	5.2	5.89	1132	Stover	13.743
12	Redgram	2.8	1.20	430	Stover	2.800
13	Greengram	1.39	0.93	661	Stover	2.170
14	Blackgram	4.03	3.71	921	Stover	8.657
15	Horsegram	0.39	0.22	573	Stover	0.513
16	Cowpea	0.14	0.10	736	Stover	0.233
17	Rajma	0.11	0.13	1220	Stover	0.303
18	Anumulu	0.02	0.01	529	Stover	0.023
					Total pulses	**28.443**
Oil seeds						
19	Groundnut	7.35	10.48	1426	Stover	24.453
20	Sesamum	0.40	0.11	274	Stover	0.257
21	Niger	0.06	0.02	413	Stover	0.047
22	Mustard	0.03	0.01	457	Stover	0.023
23	Linseed	Negligible	Negligible	482	Stover	Negligible
24	Soybean	Negligible	Negligible	1889	Stover	Negligible
					Total oil seeds	**24.780**
Other						
25	Sugarcane	0.99	77.83	78686	Top	8.648
					Grand Total	**230.961**

(**Source**: ASAG, 2018)

Often crop residues are not properly harvested and conserved by the farmers laying more emphasis on the economic part of the crop. Further due to mechanical harvesting and negligence in gathering the crop residues, a large portion is either lost in the field or spoiled due to improper storage. Except for the crop residues of crops like castor, all crop residues have fodder value. Due to high crude fiber, lesser content of crude protein and hardy nature make them less palatable to animals. It can be improved by value addition by treating with micro-nutrients, salt, jaggery and urea spray. Further chaffing of dry fodder before feeding reduces the energy loss by the animal in mastication and also reduces the wastage in feeding. Besides, the food crop residues, crop residues of vegetable crops after harvest constitute a very good green fodder for the animals particularly of gourds, cluster bean, tomato, brinjal etc. Detopped portion of maize after tasseling could yield a good quality green fodder without adversely impacting the grain productivity.

F. Alternative fodder resources

In spite of careful planning and use of all crop residues, fodder crops etc. there may be scarcity of fodder due to unforeseen failure of crops, decline in production, non-availability of fodder during peak crop growing seasons, lean period like summer etc. Hence we should also think of developing and utilizing alternative sources of fodder to tide over the scarcity period. These alternative sources could be non-conventional fodder trees like sesbania, moringa, subabul, *khejri*, glyricidia etc. Besides these, the modern techniques like azolla cultivation and hydroponics also provide cushioning in meeting the fodder requirement. Both azolla and hydroponics have proven to be successful in resource poor conditions both in rural and urban settings.

a. Loppings of fodder/dual purpose trees

The loppings of fodder or dual purpose trees *viz*. sesbania, moringa, subabul, *khejri,* glyricidia etc. will provide quality green fodder in-terms of foliage round the year in case of exigencies. However, the planting and maintenance of these trees should be done on long term basis as they cannot provide the fodder like fodder crops at a very short period of time. They can be planted on the boundaries, canal bunds, non-cropped areas without affecting the overall productivity of the farm. The loppings being rich in nutrients form a quality feed for the small ruminants. The cutting management, feeding practices could be tailored in conjunction with other sources of fodder and feed to the livestock. The trees like *khejri* are highly drought tolerant and rich in nutrients may be an excellent source of green fodder in drier areas of the state. The moringa being a popular vegetable also could be fit-in in many cropping systems. The sesbania too is a very nutritious and dual purpose fodder tree in many situations.

b. Azolla production

It is a floating water fern. It can be used as fodder plant. A variety of animals *viz*. cattle, buffalo, sheep, goat etc. can be fed with this. It can be cultivated in ponds, wetlands, even in standing rice. It prefers shade and requires about 30-50% of normal light for photosynthesis. It can be successfully grown in a temperature range of 20-35^{0}C. It multiplies very fast in 4-10 days period and yield about 8-12 t/ha in 4 months period depending on growing conditions. It is rich in protein, amino acids, vitamins, magnesium, calcium potassium and phosphorus. Azolla cultivation can be taken up in the farm as well as in the back yard of the livestock keeping area. It showed an overall increase of milk yield by 15–20% when 1.5–2.0 kg of Azolla was combined with regular feed.

Figure 7. Azolla cultivation in polythene pod
(Source: http://www.akmindia.in/azolla-cultivation**)**

c. Hydroponic fodder production

Hydroponic method of fodder production could be an ideal method of fodder production for land less farmers and urban based livestock keepers. As the name says it is cultivation of fodder in water culture. Hydroponic fodder production is probably best-suited to semi-arid, arid, and drought-prone regions of the state, suffering from chronic water shortages or in areas where irrigation infrastructure does not exist. Hydroponic fodder production is a boon for farmers whose soil is rocky and infertile. It is a viable farmer friendly alternative technology for landless farmers for fodder production. Fodders including maize, barley, oats, sorghum, rye, lucerne etc. can be produced by hydroponics. The low cost hydroponic systems consist of trays for facilitating sprouting seeds to grow as seedling with reasonable control of temperature, moisture, humidity etc. with lower cost of construction. The sprouted seedlings are used as fresh green fodder to the animals. This could be an ideal supplementary fodder for the animals but cannot be a substitute for the green or dry fodder produced and procured from the field. This is a quick method of fodder production system under landless condition or in areas where there is difficulty in producing fodder from the field due to limitations of soil or climate. In one of the demonstrations at Kurnool district to overcome the scarcity of green fodder in drought areas with limited source of water available hydroponics technology was utilized. A low cost unit was set up at a cost of Rs. 13000 and 12 kg hydroponically grown maize fodder along with 7 kg jowar straw was given every day. The results indicated that there was an increase of 8.11% milk yield with additional net income of Rs. 32 per day. It also reduced the requirement of concentrates thus lowering the cost of milk production (Table 26).

Table 26. Hydroponics fodder production in Kurnool

Particulars	Hydroponics	Farmers practice
Milk Yield (for 30 days) (l)	260	240
Gross income (Rs.)	7794	7209
Cost of concentrates (Rs.)	1430	1802
B:C ratio (Rs/Re)	5.5	4.0

Figure 8. Low cost hydroponics fodder production system
(Source: Prasad *et al.,* 2016**)**

G. Fodder conservation technologies - Hay, bales, silage, feed block

Fodder is a bulky and space consuming material. Due to these two attributes farmers often fail to gather and conserve the fodder to meet the future requirements. Further the notion that fodder may be met from subsequent crop harvest also makes farmers to overlook the process of conservation. The frequent droughts, floods, crop failures leading to fodder scarcity have highlighted the importance of fodder conservation. In earlier times only the crop residues were conserved as dry fodder in the form stacks. Due to unscientific stacking, the keeping quality has been very low often ending up as rotten farm yard manure in many areas. Hence in recent times, scientific conservation has been emphasized to enhance the keeping quality of fodder for longer period of time. The *hay* and *bale* making are common for dry fodder while, silage and feed block making for green fodder are common methods of conserving fodder.

a. Hay making:

Hay making is one of the oldest and most common methods of dry fodder conservation. Here the dry fodder or crop residues are dried to a moisture content of <15%, collected and stacked at a place where there is no water stagnation, often on elevated land and prepared floor to avoid seepage of water. The stacked dry fodder is often protected from rains, winds and insect pest and pathogens though protecting roof, to retain the good quality and aroma. The well prepared hay may be conserved for 2-3 years. This is most commonly seen in drier and low rainfall areas.

b. Bales

Due to bulky nature dry fodder occupies large space and incurs higher cost for transportation. Hence to reduce the space and facilitate ease of transportation, it is mechanically pressed to reduce volume in the form of circular bales or cubical bales. This can be done at the time of gathering by the tractor at farm or through bale makers at the threshing yards. Keeping moisture at <15% through sun drying will enhance the keeping quality and palatability. The palatability of both hay and bales may be enhanced through salt, mineral mixture and urea spray before feeding (Figure 4).

Figure 9. Fodder bales

c. Silage

Silage making is emerging as one of the most important practices for conservation of green fodder in case of excess production to use during the scarcity period. Silage is the conserved green fodder having moisture content in the range of 65 to 70 percent.

Fodder crops rich in soluble carbohydrates are incubated after chaffing for 45-50 days under anaerobic conditions. Sugars present in the fodder are converted to lactic acid, which acts as a preservative and a good source of readily fermentable sugars for the rumen microbes. The fodder crops, such as maize, sorghum, oats, pearl millet, and hybrid napier rich in soluble carbohydrates are most suitable for ensiling. Quality of silage can be improved with the use of suitable additives such as molasses, urea, salt, formic acid etc. Under proper storage condition, silage can be stored up to 2 years. Small silo bags are now very commonly used by the farmers for silage making. Even the tops of sugarcane can be used for silage making.

Chaffing of forage for ensiling Trench silage Stack of the silage

Figure 10. Silage preparation

d. Feed block

In order to reduce the volume and increase the keeping quality of the nutrient rich green fodders and composite mixtures, feed block making practice is gaining a lot of popularity. Here the materials to be converted into feed blocks are chaffed, mixed and run through a compressing machine under pressure. It will mould the feed block in desirable shapes, which upon drying become compact, light in weight and possess long keeping quality. There are several types of feed blocks from different base materials having varied shape and sizes have been developed at IGFRI Jhansi. These are

Figure 11. Feed block machine at IGFRI Jhansi

easy to transport from one place to another. They are rich in nutrients may substitute several feeds and concentrates fed to animals. Densification in the form of complete feed block in combination with concentrate mixture significantly increases the bulk density (200-544 kg/m3), reduces storage space by 3-8 times depending upon the chaff length. Complete feed blocks feeding increased live weight gain (35%) and milk yield (14-15%) at IGFRI Jhansi).

H. Development of fodder resource bases

In many areas fodder crops are grown in less resourceful lands *viz*. marginal and sub-marginal lands, undulated rocky terrain, lands affected by erosion, problematic soils etc. These lands are also deprived of irrigation facilities and nutrient application as in case of other food crops. The fodder crops by virtue of their hardy nature survive and provide some yield. If care is taken to ameliorate these soils through leveling, reclamation, development of irrigation facilities *viz*., watershed development, micro-irrigation facilities, productivity of the fodder crops can be substantially enhanced.

I. Rejuvenation of common property resources (CPRs)

One may observe community lands in many villages earmarked for grazing of the village animals. They are called "Grāma mēta bhūmi" in Telugu. These have become less productive due to overgrazing and lack of management practices to make them more productive. They are often infested with unwanted non-palatable vegetation rendering them unsuitable for the grazing animals. They may be enriched by planting suitable high yielding fodder crops, fodder trees on community basis involving village Panchayat, line department *viz*. forest department, animal husbandry, agriculture, horticulture etc. under the collective management of villagers for increasing the usefulness of these common property resources. Besides rejuvenation of waste lands, grasslands, fallow lands etc. may also be attended to improve their productivity.

J. Exploring newer niches

The focus on fodder resources development may get a greater thrust if new niches are identified in larger agricultural situation in the form of catch crops, intercrops, sequential crops, relay crops through suitable cropping systems / pattern. This without affecting the agriculture systems will help to accommodate fodder crops wherever possible. The rice fallow after harvest may be planted with fodder cowpea, rice bean etc. in assured irrigation facilities. Likewise adoption of annual fodder crops during delayed or early onset of monsoon when the normal cropping gets affected. The state of Andhra Pradesh having large rice area has a plenty of opportunity for growing fodder as catch crops in rice fallows. Further growing of fodder in the forest fringe areas will help meet fodder requirement without entering into forests. Maize is known to consume only 16-20 % of water than that of paddy

crop. Area under cultivation of maize is likely to increase in *rabi* from 3.3. lakh ha to 6.6 lakh ha in near future which can become a boon to dairy sector if a portion of grain maize is converted as silage and stover offered to farmers in the form of bales. The residue (stover) can be chaffed and converted in to blocks after fortification for utilization as fodder. Promotion of tank bed fodder cultivation in perennial drought prone districts is another area where there is scope for fodder production.

K. Custom hiring centre

Fodder related machineries often become limitations for efficient fodder harvesting chaffing, pressing machines. They may be broadly categorized into fodder harvesting machineries *viz*. cutter, chaffers and bale/feed block makers. The fodder crops are very dense and pose lot of difficulty for manual harvest. Therefore, the fodder harvesters in the field reduce the drudgery and increase the efficiency of harvest. There are a variety of machineries for harvest depending upon the nature of crops. These machines chaff and load to the trolleys. Further, for small live stock keeper, chafferers for cutting the green fodder plants in to pieces are also available. They can be either manual or power operated. These are basic for chaffing the fodder. This chaffing will improve the use efficiency of the fodder and palatability. The compressors and bale makers are useful for dry fodder conservation. These machineries may be expensive for the individual farmers to purchase and maintain. Hence purchase on community basis or custom hire centers providing these machineries to needy farmers may be helpful for the livestock keepers.

Table 27. Fodder production related machineries for custom hiring centers

Prime movers or general machines	Land preparation/ Tillage machine	Sowing/ Transplanting machine/ Intercultural machines	Harvesting machines
I. Tractors i. Tractors 2WD (20-40 HP) ii. Tractors 2WD (40-70 HP) iii. Tractors 4WD (20-40 HP) iv. Tractors 4WD (40-70 HP) **II. Power tillers** i. Power tillers (< 8 HP) ii. Power tillers (> 8 HP)	i. Disc plough ii. Cultivator iii. Disc harrow iv. Leveler blade v. Furrow opener vi. Ridge maker vii. Bund former viii. Rotovator	i. Seed cum fertilizer drill ii. Post hole digger iii. Raised bed planter iv. Ridge furrow planter v. Pneumatic planter vi. Poly-mulch laying machine vii. Weed slasher viii. Power weeder ix. Power sprayer	i. Tractor drawn reaper ii. Tractor drawn reaper cum binder iii. Tractor operated chopper iv. Automated seed separator v. Seed palleting machines

Part-III : Brief Action Plan

i. Identification of areas for propagating fodder production

Bench mark survey on the micro-climatic conditions, cropping systems and introduction of fodder crops may be initiated for identification of suitable fodder crops and their varieties and production potential vis-à-vis the farmers' acceptance and their satisfaction.

ii. Selection of villages in different agro-climatic zones based on livestock resources

Among six agro-climatic zones of the state, one district from each agro-climatic zone will be selected. Bench mark survey will be initiated in 2 clusters of 5 villages in each of the selected districts. It will fairly give an idea about the possible conditions for propagation of fodder crops under varied situations.

iii. Identification of fodder species/varieties suitable for different agro-climatic zones

Fodder crops and their varieties more suitable for different agro-climatic conditions prevailing in the state and will be outlined in the recommendations. The same may be used as guideline for identification of suitable fodder crops and varieties.

iv. Finalization of suitable package of practices for fodder crops

There are already well established package of practices for different fodder crops under various agro-climatic conditions. The same will be adopted as package of practices *mutatis mutandis* for successful cultivation of fodder crops in the state of Andhra Pradesh.

v. Master trainers training at IGFRI/NIANP?NDRI/SAUs/SVUs

The staff of Dept. of Animal Husbandry, Veterinary, Agriculture, Horticulture, Forestry etc. from the Govt. of Andhra Pradesh having aptitude to work for augmenting fodder resources will be identified through their superiors in the first stage as master trainers. And they will be offered intensive need based training programme. The number of participants, the duration of the training programme and the topics of training programme will be finalized after discussion with the Head of the line departments, Govt. of Andhra Pradesh.

vi. Creating awareness among farmers and other stakeholders and promoting production of forage crops

The Krishi Vigyan Kendras (KVKs) operating in the state of Andhra Pradesh will be roped in to identify the needy farmers for training on fodder crops. Other stake holders like milk co-operatives, non-governmental agencies (NGOs) and progressive farmers will also be made partners in the process of creating awareness about fodder production.

vii. Conduction of frontline demonstration and training

After bench mark survey and identification of suitable places for propagating awareness about the fodder crops, sufficient number of front line demonstrations in each of the selected village will be conducted in the farmers' field to make them aware of the fodder production technology and motivate them to go for cultivation of fodder as per the needs. In addition tailor made training programmes will be organized through KVKs for the benefit of the interested farmers on the topics of their interest in fodder crop production, livestock production and dairying.

viii. Strengthening of forage seed production chain

The non-availability of quality seeds and planting material of suitable fodder crops is one of the major hindrances for the cultivation of fodder crops. Therefore efforts will be made to estimate the quantum various fodder crops' seeds and planting material well in advance and an institutional mechanism will be put in place to ensure the availability of different category of fodder seeds and planting material so that the non-availability does not become an issue for fodder cultivation.

ix. Adoption of holistic approach- fodder production, conservation and utilization

The fodder cultivating farmers will be doing so out of their dire requirement of fodder for their livestock. And hence the fodder production will be need based and there is no way of facing any problem thereafter. However, all efforts will be made to interlink the activities of fodder production, conservation either in the farm of silage (for green fodder) or hay (for dry fodder), and its scientific utilization will be ensured through creating awareness on all these aspects and ensuring the compliance by the master trainers, trained farmers and other stake holder in the process.

x. Enhance acreage and productivity in non-conventional areas

Efforts will be made to bring non-conventional areas for production of fodder crops. In the process all efforts will be made for:

a. Production of fodder in non-arable land, wasteland and non-cropped areas.

b. Production of fodder in problematic soils.

c. Enhancing fodder production through grassland, rangeland and grazing land management.

d. Enhancing fodder production through alternate land use management such as horti-pasture, silvi-pasture etc.

xi. Conservation of forage resources to mitigate calamities and ease of transport

In many areas, in spite of having a large chuck of crop wastes having fodder value, it cannot be used due to faulty agricultural practices or lack of foresight and or lack of machinery etc. Hence conservation of fodder resources for future use during lean periods and at time of natural calamities like famine, high rainfall etc. will be

highlighted. Further as fodder is bulky in nature accounting for huge expenditure in transportation, bale making of dry fodders, silage in poly-bags of convenient sizes for transportation will be promoted and popularized among the livestock holders.

xii. Establishment of fodder banks

At times livestock holder are faced with fodder scarcity owing to natural calamities, unforeseen failure of crops and it poses a great threat to sustainable animal husbandry and dairying. To tide over such situation of fodder scarcity, efforts will be made to educate the policy makers, heads of line departments to establish fodder banks at cluster village for ensuring the supply of minimum quantity of fodder to livestock keeper so that the animals are not forced to go hungry. In addition, establishment of fodder ware houses with enriched dry fodder or silage bins will also be popularized.

xiii. Networking through ICAR-DAHD-SAUs-Milk Federations

Any isolated efforts to augment fodder resources may not be sustainable in long run owing to some unforeseen situations in future. And hence, networking of fodder producers, fodder entrepreneurs, heads of line departments will be made for foreseeing at the grass root level. Likewise, networking of ICAR Institutions *viz*. IGFRI, NIANP, NDRI, IVRI, IIVR, IIPR, IISR, etc., Department of Animal Husbandry and Veterinary Services of the state and central govt., Milk Federations and Dairy owners etc., will be established to supervise and evolve a mechanism to attend to the problems associated with technologies and emerging issues in future.

xiv. Public-Private-Partnership (PPP) mode of operation

Although the initial stage of programme is hovering around the government agencies involved in various aspects of fodder production, processing, conservation, utilization, rationing, policy making, etc. the ultimate end user will be common farmers. Further there are several private players *viz*. dairy owners, veterinary pharma industries, feed manufactures, NGOs involved in livestock production and dairying etc. They will all be brought together under Public-Private Partnership (PPP) mode in more transparent, efficient and economical way for all the partners.

xv. Impact analysis of technology adoption

The objectives of the programme also aim at seeing the perceptible changes that are going to occur though the implementation of the proposed project. Hence, base line data on various parameters will be collected before the start of the project and after the project implementation at regular interval. The findings will be used for impact analysis of the technology demonstrated through this project. Midterm corrections needed if any will be identified through this impact analysis study.

Part-IV : Road Map

This project is a multi-task, multi-partner and multi-year activity. Hence a proper road map is necessary for making it more practical and result oriented one. The following road map has been proposed under this project. There are several actions points to be carried out in the process of implementation by several agencies (Table 28).

Table 28. Road map for the implementation of the proposed activities

Sl. No.	Action Point	Agencies involved
1	Breeder seed production of the identified varieties	IGFRI, Jhansi/ SAUs
2	Foundation seed production	RFS/ DAHD /SAHD
3	Production of TFL/certified seeds	SAUs/Milk unions/ NSC / SSC
4	Demonstration, Training of farmers, Field trials at farmers field, package of practices	District KVK /milk unions/SAHD
5	Extension activities and development of fodder warehouse	Milk Unions / State Animal Husbandry Department
6	Dry fodder processing, value addition and fodder management (chaff cutter, Fodder block, Baling, grinding)	District level milk union/Animal Husbandry Dept.
7	R & D activity (Evaluation of fodder quality, food-feed crops, Hydroponics etc.,)	ICAR Institutes / SAUs / SVUs
8	Capacity building of stake holders	ICAR-IGFRI/SAUs

The programme implementation plan aims to complete the activities in time in a logical way. It has been presented in Table 30.

Part-V : Implementation of Pilot Programme

The Pilot Programme will be implemented in the selected areas to assess the acceptability, impact of technology and also refinement in technologies and methodologies, if required. Pilot Programme will be implemented in selected villages of identified districts of each agro- climatic zone. The list of selected/identified districts in different agro-climatic zones of Andhra Pradesh is given in the Table 29. The detailed plan for implementation of pilot project is presented in the Table 30.

Table 29. Agro-climatic zone wise selected/identified district

S.No.	Zone	Farming situation	Identified Districts
1.	North coastal zone	Rainfed	Visakhapatnam
2.	Godavari zone	Irrigated	West Godavari
3.	Krishna zone	Irrigated	Guntur
4.	Southern zone	Rainfed	Kadapa
5.	Scarce rainfall zone	Rainfed	Anantapur
6.	High altitude & tribal areas zone	Rainfed	Srikakulam

Table 30. Implementation level plan for pilot project

Sl.No.	Activity	Action points
1	Target area selection	◆ Selection of 6 districts (1 from each agro-climatic zone) of Andhra Pradesh ◆ Selection of 2 cluster of 5 villages in each district total 12 clusters for 6 districts ◆ Selection of 2 ha in each cluster for technology demonstrations ◆ Bench mark survey
2	Training	◆ Training of master trainers- 20 master trainers per batch and 1 batch from each district at IGFRI, Jhansi Training of farmers; 10 from each village; 600 farmers in first year (12 training program for farmers of each cluster) ◆ Exposure visit of progressive farmers and master trainers at IGFRI, Jhansi and other ICAR institutes, NIANP and NDRI, Bengaluru, SV Veterinary University, Tirupathi/ NDDB, Anand.

3	Technology Demonstrations	◆ Selection of crop and varieties will be done after identifying suitable districts and village clusters both under annual and perennial crops for different seasons *viz. kharif*, *rabi* and *zaid* ◆ Silage making will be encouraged ◆ Value addition of dry fodder, bale and hay making, fodder bank etc
4	Suitable silvi- pasture/ horti-pasture system demonstrations	◆ In existing orchard- 5 ha ◆ Popular and potential fodder trees ◆ Moringa as fodder tree in upland areas
5	Development of fodder trees blocks	◆ In tribal and rainfed districts of state in 1 ha on forest / community lands with grasses
6	Need based Watershed/ micro irrigation facility development	◆ Suitable fodder species to check soil and water erosion and enhancing water retention will be highlighted.
7	Rejuvenation of grazing lands/ CPRs	◆ The related activities will be taken up during post rainy season
8	Tapping rice fallow and other fallow areas for fodder production	◆ Suitable annual fodder crops *viz.* fodder cowpea etc. will be grown on residual moisture to ensure fodder supply during the succeeding season
8	Input supply	◆ Inputs *viz.* seeds/rooted slips, fertilizers, insecticides etc. chaff cutters, improved sickles etc. will be supplied to farmers
9	Custom hiring centre in each village cluster	◆ Exploring and facilitating the farmers with chaff cutter, dry fodder urea enriching machinery, baling of paddy straw, dry fodder etc, complete feed block making machine, regular farm implements including tractors, harrow, seed drill etc.

Funding arrangements

Project proposals will be routed through Govt. of Andhra Pradesh and Govt. of India for funding under state and central schemes like RKVY etc. ICAR- IGFRI will provide technical support for formulation of such fodder development proposals for funding. The fund requirement for the implementation of pilot project is presented in Table 31.

Table 31. Approximate budget requirement for the implementation of pilot programme

(Rs. in Lakhs)

S.No.	Activity	Amount (Rs. In Lakhs)					
		Ist yr.	IInd yr.	IIIrd yr.	IVth yr.	Vth yr.	Total
1	Training of master trainers, farmers and exposure visit	10	12	14	6	6	48
2	Annual cultivated fodder crops	36	40	24	24	20	144
3	Perennials Fodder crops	12	12	2	2	2	30
4	Suitable silvi-pasture/ Horti-pasture system demonstrations	6	6	3	3	3	21
5	Need based Watershed/ micro- irrigation facility development to check soil and water erosion, enhancing water retention	60	60	45	45	45	255
6	Rejuvenation of grassland/pasturelands/ CPRs	3	3	3	3	3	15
7	Tapping Rice fallow and other fallow areas for fodder production	6	6	6	4	4	26
8	Multi-utility centre in each village cluster	120	3	3	3	3	132
9	Human resource (Trained)	30	30	30	30	30	150
	Total	**283**	**172**	**130**	**120**	**116**	**821**
	Contingency 5%	**14.15**	**8.6**	**6.5**	**6**	**5.8**	**41.05**
	Grand Total	**297.15**	**180.6**	**136.5**	**126**	**121.8**	**862.05**

(Rupees eight hundred sixty two lakhs only)

Part-VI : Modalities

This Programme is proposed to enhance the fodder production, conservation and utilization on sustainable basis in different fodder deficit districts of Andhra Pradesh. The ICAR-IGFRI will take a lead in technological support in collaborating with other public and private sector agencies in this regard. The modalities of executing this programme are as follows:

- ICAR- IGFRI will be knowledge partner and will help in providing all technical backup, technological support, seed procurement, sources etc.
- ICAR-IGFRI will provide all the technological and technical support in implementation of fodder action plan
- ICAR-IGFRI will also supply the seeds/planting material or else will facilitate for the same from reliable sources in case of non-availability locally.
- ICAR-IGFRI would help in seed procurement on buy back arrangement in cases where seed production activities are involved in the programme
- Line Departments *viz*. Dept. of Agriculture, Dept. of AH & VS, Dept. of Horticulture, Dept. of Forestry etc, Govt. of Andhra Pradesh along with KVKs, NGOs, Milk Federation etc. will implement the programme at field and farmers level.

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Annexure-I

Proceedings of the online workshop on "Andhra Pradesh State Fodder Resources Development Plan" held on 6th July 2020

At the outset, Dr. V.K. Yadav, Director, ICAR-IGFRI, Jhansi welcomed all the participants to the meeting and briefly outlined the purpose of calling this meeting. He highlighted the significant contributions of the IGFRI Jhansi in catering to the fodder security in the country. In the present fodder scenario there is a need for emphasis on the development of fodder resources to augment the fodder availability through exploring various options, addressing problems, educating the farming community involving all the stake holders. The "Andhra Pradesh Fodder Resources Development Plan" is being developed and to elicit the opinion of different departments, this workshop is being organized.

Sh. H. Arun Kumar, Commissioner of Agriculture & Project Director, APDMP, Government of Andhra Pradesh briefed about the Andhra Pradesh state, its cattle population and milk production. He elaborated that 5-6 districts have fodder shortage due to drought and transportation of fodder from surplus areas to the deficit areas is being done. He highlighted the importance of making available the quality fodder seeds and root slips through different stake holders. He felt that the machineries required for fodder production and conservation can be met from Government of India projects on Animal Husbandry. He highlighted about the uniqueness of the Andhra Pradesh state having 11,000 village secretariats or gram *Panchayats* for dissemination of knowledge in agriculture and same may be exploited for promoting the fodder production in the state. He further requested all the participants to share their knowledge for the benefit of Andhra Pradesh.

Dr. Srinivas, Director of Animal Husbandry, Government of Andhra Pradesh observed that sufficient fodder is available in most parts of Andhra Pradesh except districts like Kurnool, Kadapa, Prakasham and Ananthpur in Rayalseema area. He informed that dry fodder mostly paddy straw is transported from surplus to deficit areas. He observed that recently in Rayalseema area, more area under horticultural crops is coming up leading to the shortage of crop residues. In Chittoor district there is high density of cross bred cattle but there is a shortage of 15 lakh MT fodder. This deficiency is somewhat met by the use of concentrated feed. Due to increased cost of concentrated feed, milk cost is also increasing. Thus he opined popularizing annual forage crops as well providing cheap concentrated feed is a real challenge in these districts. He requested all the members to come forward with some productive outcome and recommendations through this meeting.

Dr. Giridhara Krishna, Director of Research, ANGRAU in his observations outlined the importance of fodder crops in the present scenario and opined that there is a need to establish fodder banks at each district level under state government departments. He expressed the optimism that this workshop will pave the way for developing an ideal

fodder resources plan for augmenting fodder availability in the state and further enhance the animal husbandry activity in the state. He further opined that there is a need to establish AICRP (FCU) Center at ANGRAU as there is no regular center here. Dr. A.K. Roy, PC (FC), ICAR-IGFRI, Jhansi suggested him to send a proposal through VC, ANGRAU to DDG (CS) and it may be considered in 2021 plan.

Dr. B.G. Shivakumar, Principal Scientist & Officer-in-Charge, ICAR-IGFRI, Southern Regional Research Station, Dharwad made a detailed presentation highlighting the agricultural, horticultural and animal husbandry scenario in the state Andhra Pradesh. He outlined the fodder scenario of dry fodder, green fodder, availability of crop residues, opportunities for augmenting fodder production in different newer niches like introduction of fodder crops in orchard and horticultural crops, farm bund and non-cropped areas with various fodder crops and improved varieties suitable for the state of Andhra Pradesh. He briefly narrated the proposed fodder resources development for Andhra Pradesh state with action plan, linkages and modalities.

Dr. A.K. Roy, Project Coordinator (Forage Crops & Utilization) ICAR-IGFRI, Jhansi made detailed presentation on improved forage varieties, fodder crops production and protection technologies suitable for the state of Andhra Pradesh.

Dr. K. Sridhar, Principal Scientist, ICAR-IGFRI, Southern Regional Research Station, Dharwad made presentation on package of practices for the improved forage varieties suitable for Andhra Pradesh state.

Dr. R.V. Kumar, Head, Grassland and Silvi-pasture Management Division, ICAR-IGFRI, Jhansi made presentation on different silvi and horti pasture management and grassland management systems suitable for Andhra Pradesh state.

Dr. Sunil Kumar Seth, Principal Scientist, ICAR-IGFRI, Jhansi made presentation on different horti-pasture systems and how they can be exploited for augmenting the fodder production in Andhra Pradesh.

Dr. Sultan Singh, Principal Scientist, ICAR-IGFRI, Jhansi made a detailed presentation on fodder based rationing of farm animals.

Dr. C. Bala Subramanyam, Chief Operating Officer, APDMP, Govt. of Andhra Pradesh, mentioned that 4500 ha area is identified for fodder production under MNREGA in AP state this year.

Dr. Venkatesh Department of Agriculture, Andhra Pradesh, opined that there is a need to identify native fodder tree species for top feeding.

Dr. Ramachandrudu, Principal Scientist, ICAR- Indian Institute of Oil Palm, mentioned that there is around 1.65 lakh ha area under oil palm in Andhra Pradesh and cattle grazing inside oil palm orchard is very common. He shared that of the several fodder crops tried for intercropping in oil palm, 2 bajra napier hybrid and 3 grazing guinea varieties were found suitable. Varieties released by IGFRI-SRRS, Dharwad viz., bajra napier hybrid var. DHN 6, signal grass var. DBRS-1 and guinea grass var. DGG-1 were found highly suitable to grow under oil palm orchards. He opined, in future, if planting material is made available, horti-pasture under oil palm orchards may come in a big way.

Dr. Venkata Seshaiah, ANGRAU mentioned that tank bunds needs to be introduced for fodder production and integrated land and water resources are important. Fodder banks as well as fodder fences in the fields mainly by growing sesbania and moringa found useful.

Dr. Ananda Rao, mentioned that fodder conservation of mainly paddy straw and maize stover through bale making is required.

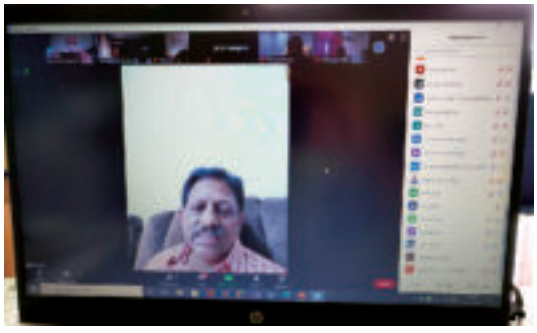
Dr. Gangaraju, informed that waste land improvement though fodder cultivation is essential. Super napier hybrid cultivation is coming up in Chittoor area for dairy animals. Similarly sheep rearing is also coming in Chittoor area and hence making available of suitable seed/planting material of fodder crops like hedge lucerne and other fodder shrubs and trees is needed.

From ICAR-IGFRI, Jhansi, Dr. Sunil Tiwari, Head, Crop Production Division, mentioned that intensive fodder production, value addition, production in different niche areas, utilizing alternate land use systems, training to those engaged in fodder production, making the availability of seed/ planting material are needed now for encouraging fodder production. Dr. P.K. Pathak, Head, Farm Machinery and Post-Harvest Technology Division, opined that establishing fodder banks, paddy straw bale making can help in meeting the off season dry fodder requirement. Dr. Khem Chand, Head, Social Sciences Division, opined that through MNREGA program fodder development can be taken up and small equipments like chaff cutters can be made available to forage growing farmers on subsidy basis though state government schemes.

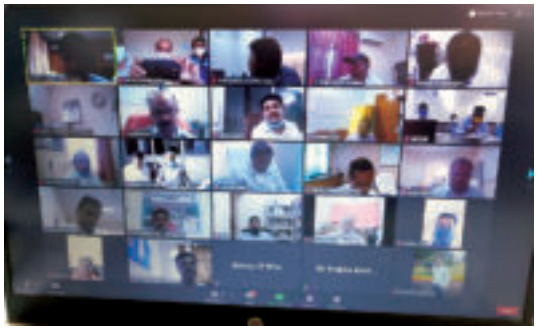
Dr. V.K. Yadav, Director, ICAR-IGFRI, Jhansi in his concluding remarks requested all the members to work in coordination to finalize the draft plan and to work together in future to implement this fodder plan for Andhra Pradesh state.

Dr. Purushottam Sharma Principal Scientist, ICAR-IGFRI, Jhansi and Dr. B.G. Shivakumar, Principal Scientist & OIC, ICAR-IGFRI, SRRS, Dharwad thanked all the participants for attending the meeting and valuable suggestions.

Glimpses of Interactive Workshop



Dr. Srinivas, Director of Animal Husbandry giving his remarks



An overview of participants

Annexure-II

List of participants in the online Workshop on "Andhra Pradesh State Fodder Resources Development" held on July 6th, 2020

1. Dr. Vijay Kumar Yadav, Director, ICAR-IGFRI, Jhansi, Uttar Pradesh
2. Sh. H. Arun Kumar, Commissioner of Agriculture & Project Director, APDMP, Govt. of Andhra Pradesh
3. Dr. Srinivas, Director of Animal Husbandry, Govt. of Andhra Pradesh
4. Dr. T. Giridhara Krishna, Director of Research, ANGRAU, Guntur, Andhra Pradesh
5. Sh. Bala Subramanyam, Chief Operating Officer, APDMP, Govt. of Andhra Pradesh, Guntur, Andhra Pradesh
6. Dr. A.K. Roy, Project Coordinator, AICRP (FCU), IGFRI, Jhansi, Uttar Pradesh
7. Dr. B. Singh, Director, RSFPD, GOI, Hyderabad, Telangana
8. Dr. T.V. Srirama Murthy, Joint Director of Agriculture, Prakasam District, Andhra Pradesh
9. Dr. G. Krishna Reddy, Principal Scientist (Agronomy), RARS, ANGRAU, Tirupati, Andhra Pradesh
10. Dr. S. Tirumala Reddy, Scientist (Agronomy), RARS, ANGRAU, Tirupati, Andhra Pradesh
11. Dr. M. Anuradha, Programme Coordinator, ICAR-CTRI-Krishi Vigyan Kendra, Kandukur, Prakasham District, Andhra Pradesh
12. Dr. Ramachandrudu, Principal Scientist, ICAR-Indian Institute of Oilpalm Research, Eluru, Andhra Pradesh
13. Dr. Rathna Kumar Akula, ADAH, Ananthapur, Andhra Pradesh
14. Dr. Ch. Venkata Seshaiah, Professor, College of Veterinary Science, Gannavaram, Andhra Pradesh
15. Dr. D.V.B. Ramana, Principal Scientist, ICAR-CRIDA, Hyderabad, Telangana
16. Dr. Venkatesh, G. Principal Scientist, ICAR-CRIDA, Hyderabad, Telangana
17. Dr. P.K. Pankaj, ICAR-CRIDA, Hyderabad, Telangana
18. Dr. K. Ananda Rao, Sri Venkateswar Veterinary University, Tirupati, Andhra Pradesh
19. Dr. B. Sanyasirao, JDAH, Ananthapur, Andhra Pradesh
20. Dr. Anju Basera, RSFPD, GOI, Hyderabad, Telangana
21. Dr. Martin Luther, Head, Department of Agronomy, ANGRAU, Bapatla, Andhra Pradesh
22. Dr. B. Sahadeva Reddy, Professor of Agronomy, ANGRAU, Rajahamundry, Andhra Pradesh

23. Dr. Koneru Lakshman, Scientist (Agronomy), ANGRAU, Bapatla, Andhra Pradesh
24. Dr. G.S. Haritha, SMS (Veterinary), KVK, Darsi, Prakasam District, Andhra Pradesh
25. Ms. Nymisha, A., ANGRAU, Guntur, Andhra Pradesh
26. Deputy Director, NLM, Animal Husbandry Department, Govt. of Andhra Pradesh
27. Deputy Director, NRM, Animal Husbandry Department, Govt. of Andhra Pradesh
28. Sri. B. Singhaiah, PD, DPMU, Ongole, Andhra Pradesh
29. Sri V Thirumaleswara Reddy, PD, DPMU, Kurnool, Andhra Pradesh
30. Sri N. Rama Mohana Reddy, PD. DPMU, Kadapa, Andhra Pradesh
31. Smt. A.D. Jyoti, PD, DPMU, Chittoor, Andhra Pradesh
32. Dr. P. Srinivasarao, JDAH, West Godavari, Andhra Pradesh
33. Dr. G. Gangaraju, Principal Scientist, Livestock Research Station, SVVU, Palamner, Tirupati, Andhra Pradesh
34. Dr. R.V. Kumar, Head, Division of Grassland and Silvi-pasture Management, ICAR-IGFRI, Jhansi, Uttar Pradesh
35. Dr. Sultan Sing, Principal Scientist, Division of Plant Animal Relationship, ICAR- IGFRI, Jhansi, Uttar Pradesh
36. Dr. P. Sharma, Principal Scientist and Nodal Officer, NIAFTA, ICAR- IGFRI, Jhansi, Uttar Pradesh
37. Dr. Sunil Kumar, Principal Scientist, Division of Grassland and Silvi-pasture Management, ICAR- IGFRI, Jhansi, Uttar Pradesh
38. Dr. Sunil Kumar, Head, Division of Crop Production, ICAR- IGFRI, Jhansi, Uttar Pradesh
39. Dr. Prabha Kant Pathak, Head, Division of Farm Machinery and Post Harvest Technology, ICAR- IGFRI, Jhansi, Uttar Pradesh
40. Dr. Khem Chand, Head, Social Sciences, ICAR- IGFRI, Jhansi, Uttar Pradesh
41. Dr. Edna Antony, Senior Scientist, IGFRI SRRS, Dharwad, Karnataka
42. Dr. Vinod Kumar, Principal Scientist, IGFRI SRRS, Dharwad, Karnataka
43. Dr. R.P. Nagar, Principal Scientist & Officer-in-Charge, ICAR-IGFRI, Western Regional Research Station, Avikanagar, Rajasthan
44. Dr. S.S. Meena, PS, IGFRI WRRS, Avikanagar, Rajasthan
45. Dr. N.S. Kulkarni, Principal Scientist, ICAR-IGFRI, SRRS, Dharwad, Karnataka
46. Dr. K. Sridhar, Principal Scientist, ICAR-IGFRI, SRRS, Dharwad, Karnataka
47. Dr. B.G. Shivakumar, Principal Scientist & Officer-in-Charge, ICAR-IGFRI, SRRS, Dharwad, Karnataka
48. Dr. Saialankrutha Ramayanam
49. Dr. Dharanidhar Pradhan
50. Dr. B. Sarkar

Developed Fodder Crop Varieties from ICAR-IGFRI, Jhansi

Crop	Varieties	GFY (t/ha)	Recommendation for cultivation	Year of release
Berseem	Wardan	65-70	Whole country	1981
	Bundel Berseem 2	65-80	Central, NW zone	1997
	Bundel Berseem 3	68-83	NE Zone	2000
	JBSC-1	38-40	North west zone	2017
Lucerne	Chetak	140-150	North west central	1975
Oat	Bundel Jai 822	44-50	Central zone	1989
	Bundel Jai 851	40-50	Whole country	1997
	Bundel Jai 99-2	40-50	North West Zone	2004
	Bundle Jai 2004	50	North east and north west zone	2002
	Bundel Jai 2009-1	53-62	Central zone	2016
	Bundel Jai 99-1	35-40	Hill Zone	2007
	Bundel Jai 2010-1	27-34	South Zone	2015
	Bundel Jai 2012-2	33-37	South Zone	2017
	Bundel Jai 2015-1	25-30	Hill Zone	2018
Cowpea	Bundel Lobia 1	25-30	Whole country	1992
	Bundel Lobia 2	25-30	North Zone	1992
	Bundel Lobia 4	23-26	North-eastern Zone	2012
Guar	Bundel Guar 1	25-35	Whole country	1993
	Bundel Guar 2	30-40	Whole country	1994
	Bundel Guar 3	30-40	Whole country	1999
Field bean	Bundel Sem 1	25-35	Whole country	1993
Anjan grass	Bundel Anjan 1	30-35	Whole country	1989
Cenchrus	Bundel Anjan 3	30-35	Whole country	2006
ciliaris	Bundel Anjan-4	35-37	Whole Zone	2019
Dhaman grass *Cenchrus setigerus*	Bundel dhaman -1	13-15	Western part of country	2019
Dinanath grass	Bundel Dinanath 1	55-60	Whole country	1987
	Bundel Dinanath 2	60-65	Whole country	1990

BN hybrid	Swetika	100-120	Central, northern and north eastern areas	1983
Bajra-squamulatum hybrid	BBSH-1	30-33	Western and northern part of country	2019
Butterfly pea	Bundel clitoria-1 (JGCT-2013-3)	25	All India	2017
Bajra	AVKB-19 JHPM-05-2	50-60 70-80	Whole country Whole country except south zone	2007 2008
Guinea grass	Bundel guinea 1	40-50	Punjab, HP, Central UP, Maharastra, Tamilnadu	2004
	Bundel guinea 2	50-55	Rainfed conditions in semi-arid, tropical, sub-tropical and humid tropics	2008
	Bundel guinea 4	75-81	All guinea grass growing areas	2012
Sehima	Bundel Sen Ghas -1	18-20	Semi-arid, tropical and sub-tropical areas across the country	2007
Chrysopogon	Bundel Dhawalu Ghas-1	26-30	Rangelands under rainfed condition across the country	2007
Heteropogon	Bundel Lampa Ghas-1, IGHC-03-4	25-30	Rangelands under rainfed condition across the country	2007
Dichanthium	Bundel Marvel Grass-2013-2 (JHD- 2013-2)	35-45	NWZ particularly for Punjab and Rajasthan	2017

Contact Us :

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