Forage Resources of Telangana State and Research Technology for Enhancing Fodder Production

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Abstract

Livestock are an important asset and livelihood option for poor people in rain fed areas, but poor feed quality and dry season feed shortages are a serious limitation for sustainable livestock production. The cattle and buffaloes are normally fed on the fodder available from cultivated crops, supplemented to a small extent by harvested grasses and top feeds (tree leaves). While small ruminants usually depend on grazing and top feeds, either browsed or lopped from shrubs and trees. Better feeding could be achieved by ensuring the adequate supply of good quality forage from better varieties and improved cultural practices. Fodder production and its utilization depend on the cropping pattern, climate, socio-economic conditions and type of livestock. Keeping this in view the Forage Research scheme *i.e.* AICRP on Forage Crops, PJTSAU, Hyderabad has been formulated the mandate areas of research such as development of improved cultivars and contributed technologies for improving fodder production of various cultivated fodder crops. Since its inception six varieties were developed and released for cultivation in state of Telangana and Andhra Pradesh. The Bajra Napier hybrid APBN-1 released from the centre is very popular even in the state of Gujarat with commendable area under cultivation. Many fodder production technologies were developed and were adopted by farming community.

Keywords: Livestock, Fodder, Technology, Telangana, Production

1. Introduction

Agriculture plays a pivotal role in the economy of the state. Livestock rearing is an important supplementary occupation of Telangana farmers. The share of agriculture to state GSDP in 2014-15 is 9.3% in which livestock sector contributes 4.86% at current prices. About 55.5% of the State's population is dependent on some form or the other on farm activity for livelihoods. In the State, 62.0% of the holdings are marginal (less than 1 ha) and the Percentage of smallholdings (1 to 2 ha) is 23.9%. Thus, marginal and small holdings constitute about 85.9% of total agricultural holdings in the State. Now a days due to the fluctuations in rain fall only the live stock sector offers a secured lively hood to the rural people being a source of income and employment, but poor feed quality and dry season feed shortages are a serious limitation for sustainable livestock production. Feeding cost alone constitutes 70% of total milk production cost. Therefore green nutritious forages are essential for economic production of animal products.

2. Live Stock population in State of Telangana

Telangana state has very rich livestock resources. The total livestock population of the state is 267.7 lakhs in which 50.3 lakhs cattle, 41.9 lakhs buffaloes, 128.7 lakhs sheep and 46.7 lakhs goats (Table 1).The milk production status in Telangana state is 42.1 lakhs tonnes and meat production is 5.1 lakhs tonnes. The state is not self sufficient in meeting the demand of milk.

3. Main Breeds Under Each Livestock Species in The State

- ✓ Cattle: Deoni, Ongole, Crossbreed – HF, Jersey (Jersey + Sahiwal), Non-descript
- ✓ Buffaloes: Graded Murrah, Non-descript
- ✓ Sheep: Deccani, Nellore brown, Nellore Jodipe, Non-descript
- ✓ Goat: Osmanabadi, Mahaboobnagar, Non-descript

Table 1: Live Stock population in State of Telangana(Source: Quinquennial animal census 2012)

Sl. No.	District	Cattle	Buffaloes	Sheep	Goat	Total livestock
1.	Mahabubnagar	824326	414370	3730689	687066	5656451
2.	Ranga Reddy	316822	265259	660582	422482	1665145
3.	Hyderabad	17913	27737	13657	39913	99220
4.	Medak	440885	437031	1072380	573931	2524227
5.	Nizamabad	334648	399917	920548	477681	2132794
6.	Adilabad	1009575	318406	695125	588340	2611446
7.	Karimnagar	413313	471685	1641547	409605	2936150
8.	Warangal	586118	489540	1749429	446768	3271855
9.	Khammam	592260	580308	486073	495818	2154459
10.	Nalgonda	498249	790063	1905189	533700	3727201
	Total	5034109	4194316	12875219	4675304	26778948

(Source: PVNRT Veterinary University, Hyderabad)

4. Forage Resources of Telangana State

Cattle and buffaloes are largely fed with crop residues and grazing to an extent with cultivated fodder. The most common sources of fodder for livestock are Crop residues 52%, forages from common property resources (CPRs) like forests, pastures and grazing lands 43% and cultivated fodders 5% (Figure 1). Sheep and goats are generally not given any hand feeding

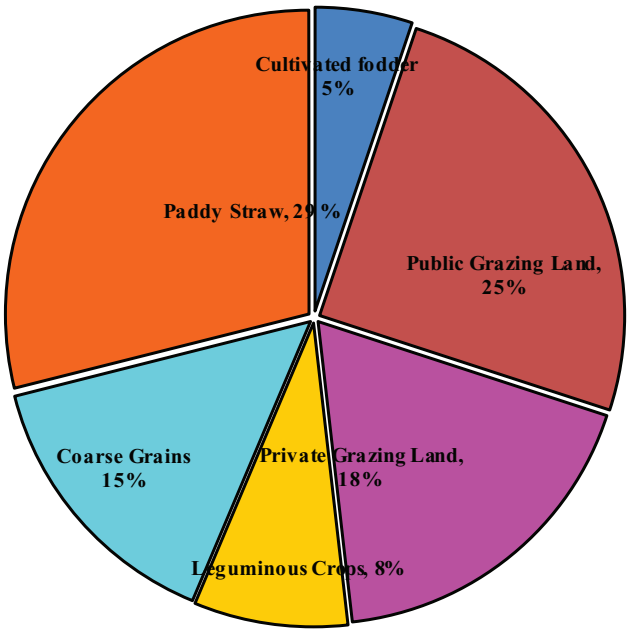

Figure 1

since they are reared only on grazing. Tree fodders often called multipurpose tree species (MPTS) also meet the fodder needs some extent during lean periods. The annual requirement and availability of fodder and feed in Telangana for the year 2016 as per the assessment of National Institute for Animal Nutrition and Physiology, Bangalore (NIANP) is present in table 2.

Paragrass (*Bracharia* spp.), forage sorghum (mostly multicut), Maize, Napier Bajra hybrid, Guinea grass, Anjan grass, Stylo, Lucerne, Pilli Pesara (grown in rice fallows with residual moisture) and to some extent Cowpea are popular forage crops cultivated in the state of Telangana.

Table 2: Statement showing the annual requirement and availability of fodder in Telangana

Sl. no	Particulars	Green fodder	Dry fodder
1.	Total Fodder requirement (1000 t)	6374	12748
2.	Total availability of fodder in the State (1000 t)	2377	15008
3.	Fodder Deficit (1000 tones) (% Deficit)	3997 (62%)	-

Source: National institute for animal nutrition and physiology, bangalore (nianp)

5. Forage Production Technologies

The system of forage production vary from region to region, place to place and farmer to farmer, depending upon the availability of resource and inputs, namely fertilizers, irrigation, insecticides,

pesticides, etc. An ideal forage production system is that which gives the maximum output of digestible nutrients per hectare, or maximum livestock products from a unit area, and should ensure the availability of succulent, palatable and nutritious fodder throughout the year for livestock. Legumes usually maintain their quality better than grasses even at maturity, and being rich in protein, enhance the forage value, and also

add substantially the much-needed nitrogen to the soil. The grass-legume mixtures also improves the physical conditions of the soil, check soil erosion, resist the encroachment of weeds and withstand the vagaries of weather better than pure stands. The beneficial effect of grass legume mixture over pure stand is well established (Agarwal et al., 1993. Keeping this in view the Forage Research scheme i;e AICRP on Forage Crops, PJTSAU,Hyderabad has been contributed technologies for improving fodder productivity of various cultivated fodder crops.

6. Technologies Generated

A) Varieties/Hybrids : Varieties developed and released for cultivation in state of Telangana so far by AICRP on Forage Crops, PJTSAU,Hyderabad is presented in Table 3.

Table 3 : varieties developed

Sl. No.	Crop	Variety	Year of Release	Zone	Features
1.	Fodder Bajra (single cut)	APFB 09-1 (NEZ)	2016	North Eastern zone	The variety has recorded highest mean green fodder yield (302 q ha^{-1}) in single cut. Tall growing (220.0 cm), high tillering (5 no's) with high leaf stem ratio (0.40). Early in flowering i.e., 50 days to 50% flowering. Crude protein content 9.6 %.
2.	Fodder Cowpea	Vijaya	2016	State of Telangana	Variety has Green Fodder yield potential of 300.2 q ha^{-1} and dry fodder yield potential (42.0 q ha^{-1}). Early in 50% flowering i.e., 54 days and has got high Crude protein content of 15% with high Seed production potential of 8 q ha^{-1}. Crop is erect growing, hence suitable for inter cropping. Plant height is 140.5 cms with leaf stem ratio of 0.72.
3.	Fodder Bajra (multi cut)	Moti Bajra	2015	State of Telangana	Average green fodder yield is 811 qha-1in 3 cuts. Seed yield potential is 21.0 qha-1. Variety is tall growing (220.0 cms) high tillering (5 no's) with high leaf stem ratio (0.40). Early in flowering: i.e., 50 days to 50% flowering. It has Crude protein content of 9.6 %. Most suitable for summer season with minimum irrigations.
4.	BN Hybrid	APBN – 1	1997	Andhra Pradesh & Telangana	Hybrid grows to a height of 380 cm with wide and long leaves compared to CO 1 and CO 2 coupled with medium stem thickness and yields around 250 to 300 t ha^{-1} $year^{-1}$ each cut at an interval of 45 days
5.	Fodder Bajra	APFB-2	1997	Andhra Pradesh & Telangana	Grows to a height of 160-180 cm, non-lodging types and is fertilizer responsive and gives 250 q ha^{-1} green and 55 q ha^{-1} dry fodder under rainfed conditions.
6.	Fodder Maize	APFM-8	1997	Andhra Pradesh & Telangana	A medium duration variety with non-lodging nature and matures in 90-95 days (Seed to seed) in *Kharif* and 105 to 110 days in *Rabi / winter* and gives 350 q ha^{-1} green fodder and 75.2 q ha^{-1} dry fodder at 50% tasselling .

B) **Production and Protection technologies developed**.

❖ Application of vermicompost @ 10 tha-1 along with 75% recommended dose (100:40:30) of NPK fertilizer (75:30:23) gave higher green and dry fodder yield of maize. However, it was on par with application of 75% recommended NPK dose+ FYM @ 10 t ha^{-1}. Hence it was recommended that 25% of recommended dose of NPK can be supplemented by FYM and vermicompost (Table 4) q ha^{-1}

❖ Hybrid Bajra Napier+cowpea/Berseem sequence was found to be highly remunerative over other cropping systems viz., Sorghum + redgram(S) – tomato system , maize (G)-lucerne (F) - lucerne (S)system and Sunflower (G) – cowpea (S) – multicut sorghum (F) systems.). Laxmi et al., 2002 also reported similar trend of results that the treatment combination involving hybrid napier+stylosanthes hamata produced the highest tonnage of green fodder and dry matter. They also mentioned that the annual legume, cowpea was found to be the best inter crop for hybrid Napier (Table 5).

❖ Under year round fodder production system, higher GFY, DMY, CPY and Benefit cost ratio was recorded with NB hybrid + cowpea – Lucerne system followed by Baby corn + cowpea – Oat – Fodder maize + cowpea system. However, net returns

Table 4 : Effect of Vermicompost on forage yield of maize (Mean of 3 years 1998 – 2000)

Sl. No.	Treatments	GFY (q ha^{-1})	DFY (q ha^{-1})
1.	Control (No. NPK)	280.9	57.6
2.	100 rec.dose (100:40:30 kg. NPK ha^{-1}) through ferti.	406.6	71.5
3.	Vermicompost @ 10 t ha^{-1}	384.0	72.0
4.	FYM @ 10 t ha^{-1}	332.7	66.1
5.	75% rec. dose through fertilisers	367.3	68.3
6.	75% rec.dose through fertilisers + vermicompost @ 10 t ha^{-1}	455.6	89.1
7.	75% rec. dose through fertilisers + FYM @ 10 t ha^{-1}	424.2	70.8
8.	50% rec. dose through fertilisers	351.0	69.0
9.	50% rec. dose through fertilisers + vermicompost @ 10 t ha^{-1}	408.1	81.0
10.	50% rec. dose through fertilisers + FYM @ 10 t ha^{-1}	359.0	74.4
	CD (p=0.05)	47.3	7.4
	CV%	6.9	6.7

Table 5 : Effect of dates of sowing and cutting management on fodder yield of multicut Sorghum variety SSG 59 – 3

Sl. No.	Treatments	GFY (q ha^{-1})	DFY (q ha^{-1})	Days to harvest		
				I cut	II cut	III cut
1.	9th January, 1997	83.6	30.2	73	52	48
2.	24th January, 1997	100.3	38.9	70	55	45
3.	8th February, 1997	110.2	41.7	77	50	50
4.	24th February, 1997	108.8	43.1	78	51	49
5.	11th March, 1997	104.1	41.7	78	53	45
6.	26th March, 1997	100.8	40.9	75	50	47
7.	10th April, 1997	76.9	28.2	78	55	--
8.	25th April, 1997	61.2	23.6	76	55	--
General Mean		93.3	35.9			
CD (p=0.05)		7.2	2.4			

were higher with Baby corn + cowpea - Baby corn – Baby corn + cowpea system(Table 6). In periurban areas, growing of either baby corn or sweet corn is profitable for both cobs and green fodder. Maize can be grown round the year and hence can supply green fodder. Misra et al, 2007 also narrated that the overlapping system evolved by taking advantage of the growth periods of different species, which ensures a uniform supply of green fodder throughout the year.

❖ In berseem, 10% salt treatment of berseem seed for 3-5 minutes and removal of all floating seed was found to be more economical and practical in controlling weeds, particularly chicory. Application of Butachlor @ 2 kg ai/ha too was found effective in reducing the density and dry weight of weeds.

❖ Sowing multi-cut sorghum, SSG-59-3 during first week of February gave significantly higher green fodder yields rather than sowing at later dates.

Table 6: Evaluation of forage production potential of maize grown for Baby corn and Green cob (Complete sequence) (2007-08)

Sl. No.	Treatment	Cob yield (q ha^{-1})	G.F.Y. (q ha^{-1})	Net returns (₹ ha^{-1})	B:C ratio
1.	NB Hybrid+ Cowpea -Lucerne	0.0	2037.91	111372.00	18.56
2.	Maize(baby corn) +Cowpea - maize(baby corn) - maize(baby corn)+ Cowpea	176.64	631.47	158993.00	11.12
3.	Maize(baby corn)+Cowpea -Lucerne	102.81	525.09	158615.00	16.16
4.	Maize(baby corn)+Cowpea-Oat -Maize(baby corn) +Cowpea	147.68	873.71	157048.00	12.34
5.	Maize(baby corn) +Cowpea-Oat-Maize (F) +Cowpea	87.64	791.29	101497.00	9.19
6.	Maize(baby corn)+Cowpea-Maize (green cob) - Maize(green cob)+Cowpea	103.23	759.66	83898.00	7.27
7.	Maize(green cob) + Cowpea -Lucerne	62.73	495.77	89189.00	12.50
8.	Maize(green cob) +Cowpea-Oat – Maize(green cob)+Cowpea	158.19	891.98	73320.00	8.13
9.	Maize(green cob) + Cowpea - Oat – Maize (F)+Cowpea	50.54	813.79	46893.00	7.06
10.	Maize(grain)(K)+ Cowpea–Lucerne (fodder) – Lucerne(seed)(S)	43.68	282.20	59045.00	11.04

❖ In APBN-1(Table 7), the ideal time of cutting interval was found out to be at 45 days after planting as the crude protein yield was highest compared to other cutting intervals.

Table 7: Effect of planting methods and cutting frequencies on green and dry fodder yield (q ha^{-1}) of Napier Bajra Hybrid

Sl. NO.	Treatments Main plots:	Green fodder yield (q ha^{-1})		Dry fodder yield (q ha^{-1})	
		2005	2006	2005	2006
M1	Single budded stem cuttings in furrows	437.64	311.77	76.53	63.39
M2	Two budded stem cuttings slanting on ridge	497.48	362.95	91.13	80.41
M3	Two budded stem cuttings in furrows	483.02	349.53	86.57	78.13
	SEm±	34.1	11.71	5.48	4.75
	CD (*p*=0.05)	NS	32.5	NS	13.2
Sub plots:					
C1	30 Days	249.5	193.24	43.56	37.28
C2	40 Days	347.9	277.91	53.88	54.11
C3	45 Days	467.8	324.70	78.60	70.67
C4	50 Days	559.9	404.55	95.68	88.36
C5	60 Days	738.4	506.68	151.98	119.46
	S E m +	35.5	9.16	9.00	2.8
	C.D.(0.05)	103.5	18.9	26.17	5.79
	Interaction:				
	SEm±	43.4	15.86	11.0	4.86
	CD (*p*=0.05)				
	NS	NS	NS	NS	

❖ Among all the small millets evaluated for forage quality and yield (Table 8), Korra varieties viz., Krishnadevaraya, Srilakshmi, Lepakshi, Narasimharaya and Prasad along with Ragi varieties Maruti and Godavari performed well under Hyderabad climatic conditions compared to Variga and Arika.

❖ In INM (Table 8.1), 25% of inorganic nitrogen can be substituted with organic manures like Poultry manure or FYM for dual purpose sorghum – forage cowpea sequence to achieve the same level of seed, green and dry fodder yields.

❖ Market rate: Sorghum seed: ₹ 550/ q^{-1}. Stover: ₹ 250 t^{-1}.

Cowpea green fodder: ₹ 600 t^{-1}.

Cost Of cultivation: For T1 (No NPK) ₹ 6730/-.

Table 8 : Evaluation of forage production and quality of small millets and popular varieties of small millets (pooled data of 2006-07& 2007-08)

Sl. No.	Treatments	Green fodder yield (q ha^{-1})	Dry fodder yield (q ha^{-1})
1.	Ragi Var. Maruthi	112.29	60.35
2.	Ragi Var. Godavari	108.18	63.46
3.	Ragi Var.VR 923	81.09	48.95
4.	Ragi Var.Champavathi	92.29	57.78
5.	Ragi Var.Ratnagiri	90.39	50.61
6.	Ragi Var.VR 914	93.38	52.67
7.	Ragi Var.VR 762	79.51	47.03
8.	Ragi Var.847	110.87	62.53
9.	Korra Var. Krishna devaraya	136.28	68.64
10.	Korra Var.Sri lakshmi	120.23	66.63
11.	Korra Var.Lepakshi	122.13	68.74
12.	Korra Var. Narasimharaya	122.94	67.09
13.	Korra Var.Prasad	118.00	66.13
14.	Andakorra	93.61	53.03
15.	Varigalu	82.39	50.83
16.	Arikalu	78.54	47.03
	SEm±	6.54	3.97
	CD (*p*=0.05)	18.87	11.46
	CV %	11.15	14.90

❖ Evaluation of performance of multicut sorghum and multi cut bajra as sole crops as well as inter crop with cowpea during Rabi season under limited irrigation(Table 9) revealed that and multicut bajra in combination with cowpea gives good green fodder yield during summer season.

❖ Higher seed yield of maize African Tall (26.00 q ha^{-1}) and higher seed yield of Lucerne (2.09 q ha^{-1}) and higher net returns of the entire sequence (Rs. 27081 ha^{-1}) were obtained with application of 10 kg Zn/ha every year through $ZnSO_4$ or 20 kgS ha^{-1} every year through gypsum (25.75 q ha^{-1}, 2.10 q ha^{-1} and Rs. 25823 ha^{-1}, respectively) as mentioned in Table 10. The similar results in favour of green fodder and dry fodder yields were observed by Dadhich and Gupta (2003) for pearl millet with application of 40 kgS ha^{-1} and 10 kg Zn ha^{-1}.

❖ Creepers like *Cissampelos pareira,* and *Coccolus hirsutus* and *Bryonia palmate have good fodder value and* are promising in their nutritive potential with 10.94, 10.50 and 16.9 % crude protein, respectively. Among top feeds *Canthium parviflorum, Albizzia lebbeck, Lawsonia ineremis, Moris alba, Bauhinia racemosa, Cordia dichotoma, Moringa indica, Ficus bengalensis, Luceana leucocephala, Phoenix farinifera, Acacia*

Table 8.1: Integrated Nutrient Management in food (sorghum) grain – forage (cowpea) based system

Sl. No.	Treatments	Sorghum		Cowpea	Net returns ('000 ₹ ha^{-1} $year^{-1}$)	B:C Ratio
		Seed yield (q ha^{-1})	Stover yield (q ha^{-1})	GFY (q ha^{-1})		
1.	Control	12.78	88.45	85.72	7.65	2.13
2.	100% NPK through Inorganic form.	25.96	135.97	154.78	18.23	3.09
3.	75% NPK through inorganic form + 25%N through FYM.	27.88	141.11	171.50	19.65	3.07
4.	50% NPK through inorganic form + 50%N through FYM.	26.61	141.91	180.96	18.83	2.85
5.	100% NPK through FYM.	28.57	129.94	148.40	16.76	2.51
6.	75% NPK through inorganic fertilizer + 25% N through Poultry Manure.	29.00	144.90	173.01	20.45	3.15
7.	50% NPK through inorganic fertilizer + 50% N through Poultry Manure.	27.79	130.44	177.77	19.01	2.86
8.	100% NPK through Poultry manure.	29.33	138.13	150.00	17.48	2.57
9.	100% NPK through Poultry Manure + VAM	29.13	142.46	157.94	20.26	3.30
SEm±		2.01	9.86	13.97		
CD (*p*=0.05)		1.91	9.75	23.25		
CV %		13.15	12.55	15.50		

Table 9 : Evaluation of *Rabi* forage crops under limited irrigation in south zone (Pooled data of 2006-07& 2007-08)

Sl. No.	Treatments	GFY (q ha^{-1})	DFY (q ha^{-1})	CPY (q ha^{-1})
1.	Multicut Sorghum (var. COFS-29)	476.89	105.07	6.96
2.	Multicut Sorghum (var. SSG 59-3)	507.72	124.96	10.00
3.	Multicut Bajra (var. CO-8)	623.95	134.54	12.41
4.	Multicut Bajra (var. Gaint Bajra)	663.95	147.46	9.55
5.	Lucerne (var. Anand-2)	114.93	20.94	7.65
6.	T_1+Cowpea(Co-8)	375.19	72.80	8.28
7.	T_2+Cowpea(Co-8)	362.22	78.66	10.74
8.	T_3+Cowpea(Co-8)	498.33	96.24	11.90
9.	T_4+Cowpea(Co-8)	591.39	117.31	10.18
SEm±		39.08	8.78	1.60
CD (*p*=0.05)		117.15	26.34	4.02
CV %		14.55	15.20	21.50

nilotica, Ficus religiosa are some of the promising tree species.

❖ The fodders grown in and on the banks of Musi are laden with traces of organochloro pesticide residues especially PPDDD and Dichlorvas and fortunately their channelization into fodder was negligible thus leaving the cultivated forages of Musi safe for animal consumption in Hyderabad. Prasad and Chhabra, 2001 analysed few green fodders such as maize, oat, sorghum, berseem and Lucerne collected Karnal, Haryana for organochlorine pesticide residues and found that total HCH content was abnormally high ranging from 15-44 mg kg^{-1} DM basis, lowest in Lucerne and highest in Maize. However Deka et al 2004 found that no detectable residues of any pesticides in grasses like setaria, guinea, Dinanath, para grass, hybrid napier and fodder cowpea.

❖ The concentration of heavy metals in Musi waters is quite alarming. The waters even after passing out of sewerage treatment plant showed toxic levels of cobalt and cadmium and milk collected from cattle different places in Hyderabad which are fed with Musi fodder showed toxic concentration of heavy metals viz., Cu, Co, Ni, Cd and Pb.

❖ The per cent dead hearts due to shoot fly and stem borer was less when sorghum was intercropped with leguminous fodders like cowpea, cluster bean, lablab bean, moth bean, soybean and pillipesara compared to sole crop of sorghum

❖ Lucerne crop can be protected from pea aphid, spotted alfalfa aphid and rust disease by taking control measures like seed treatment with carbendazim @ 3 g kg^{-1} seed, application of carbofuran 3 G @ 3 g $meter^{-1}$ row and spraying 3% neem seed kernel extract.

❖ Seed treatment with either neem seed powder @ 50 g kg^{-1} of seed or *Tricchoderma viridi* 5 g kg^{-1} seed followed by spraying of neem seed extract @3% at 30 and 45 days after sowing was found to reduce the pest and disease incidence in both sorghum and cowpea crops with increased green fodder yields.

Table 10: Optimization of Sulphur and Zinc levels for enhancement of seed production of forage based cropping systems (Maize + Cowpea – Lucerne)

Sl. No.	Treatments	Maize		Cowpea	Lucerne		Net returns ('000 ₹ ha^{-1} year^{-1})	B: C Ratio
		Seed yield (q ha^{-1})	Stover yield (q ha^{-1})	G.F.Y. (q ha^{-1})	G.F.Y. (q ha^{-1})	Seed yield (q ha^{-1})		
1.	Control (No S& Zn)	26.66	138.32	73.08	87.26	1.34	9.97	1.34
2.	10 kg S/ha through Gypsum (EY)	28.17	158.62	80.22	72.47	1.56	12.53	1.43
3.	10 Kg S/ha through Gypsum (AY)	27.50	161.05	63.57	84.84	1.78	13.94	1.48
4.	20 Kg S/ha through Gypsum (EY)	36.04	182.60	74.61	87.38	2.32	18.90	1.65
5.	20 Kg S/ha through Gypsum (AY)	31.49	164.43	71.43	88.17	2.47	19.43	1.67
6.	5 Kg Zn /ha through Zn Cl 2 (EY)	31.59	164.93	81.76	95.21	1.97	17.85	1.60
7.	5 Kg Zn /ha through Zn Cl 2 (AY)	29.47	150.97	78.57	87.30	2.14	14.37	1.50
8.	10 Kg Zn /ha through Zn Cl 2 (EY)	32.22	179.89	67.46	84.55	2.10	18.05	1.60
9.	10 Kg Zn /ha through Zn Cl 2 (AY)	30.01	166.19	91.27	85.00	2.18	15.99	1.55
10.	5 Kg Zn /ha through Zn SO 4 (EY)	33.52	185.01	71.51	75.80	2.26	19.70	1.67
11.	5 Kg Zn /ha through Zn SO 4 (AY)	32.60	176.90	79.37	81.03	2.17	19.25	1.66
12.	10 Kg Zn /ha through Zn SO 4 (EY)	37.71	186.44	81.75	84.91	2.38	23.64	1.80
13.	10 Kg Zn /ha through Zn SO 4 (AY)	34.43	176.81	77.75	91.21	2.21	21.57	1.74
SEm±		1.76	6.66	6.49	5.55	0.10		
CD (p=0.05)		5.09	19.34	10.67	NS	0.28		
CV %		9.05	6.95	14.00	17.30	7.55		

❖ Seed treatment with either *Trichoderma harzanum* @5 g kg^{-1} seed or *Trichoderma viridi* @ 5 g kg^{-1} seed or carbendazim @ 2 g kg^{-1} seed or foliar application of neem seed kernel extract @ 3% will reduce the pest infested plants with flea beetle and aphids along with virus disease to a lower level along with higher yields in cowpea.

❖ The pest and disease incidence in lucerne was reduced when integrated pest management module was adopted followed by spraying of neem seed kernel extract @ 5%. The module in which seed treatment with *Trichoderma viridi* @ 5 g kg^{-1} seed , soil application of FYM @ 5 t ha^{-1}, spraying of NSKE5% at late winter season and spraying of deltramethrin@ 0.0075%+ carbendazim@ 0.1%during rainy season gave higher yields with lower pest incidence.

❖ The IPM module consisting of spraying of *Bacillus thuringenensis* @ 1 kg ha^{-1} at flowering stage, release of *Trichogramma chilonis*@1,00,000 parasites/week synchronizing the first release with the appearance of *Helicoverpa armigera* larvae, spraying of HNPV @250 lEha^{-1}, one week after the release of *Trichogramma para*sites, and installation of bird perches @ 15 acre^{-1} and spraying of Mancozeb @ 0.2% at the initiation of disease was found to be effective in management of Lucerne pest complex.

❖ Seed treatment with *Trichoderma viridi* @ 5 g kg^{-1} seed + soil application of FYM @ 4 t ha^{-1}, followed by foliar spraying of NSKE @ 3% at 30 and 45 DAS crop was found to be the effective treatment for the management of sorghum and cow pea pest complex with higher yields.

3. Future Strategies

❖ Enrichment of germplasm for forage crops mandatory to the centre and their evaluation and documentation.

❖ Development of improved forage varieties for mandatory forage crops with high biomass production, multicut nature and dual purpose types.

❖ Quality seed production of popular improved varieties suitable to the region.

❖ Development of forage protection technologies based on IPM approach.

❖ Research for development of suitable production technologies for the new genotypes evolved and fodder based cropping systems for intensive agriculture and intercropping systems

❖ Evaluation of forage for quality traits

❖ Introduction of non-traditional forage crops and

❖ Transfer of technology of fodder production and protection technologies, to the farming community.

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