Enhancing livestock production through increased fodder availability : IGFRI perspective

R. V. Kumar

Director

ICAR-Indian Grassland and Fodder Research Institute

Jhansi - 284003

हर कदम, हर डगर
किसानों का हमसफर
भारतीय कृषि अनुसंधान परिषद

Status of Livestock and fodder availability

Facts of Indian Livestock sector

Agriculture & allied sector share in Total GDP (%)	17.32
Livestock contribution to Agriculture GDP (%)	**25.6**
Growth rate of Agriculture sector in 12th Plan (%) (in first 4 years)	**1.60**
Growth rate of Livestock in 11th Plan (%)	**4.80**
Milk production (2015-16) in million tonnes	**155.50**
Per capita milk availability in India (2015-16) in gms/day	**337.00**

**Economic survey 2015-16

Livestock population (million)

Category	2007	2012	% change
Cattle	199.07	190.90	-4.1
Buffalo	105.34	108.70	+3.2
yak	83.00	77.00	-7.64
Sheep	71.56	65.07	-9.07
Goat	140.54	135.17	-3.82
Camel	0.52	0.42	-22.6
Mithun	264.00	298.00	+12.9
Total livestock	529.70	512.06	-3.33

** Source: Livestock Census 2012, Department of Animal Husbandry

Demand and supply estimates of dry and green forages (million tonnes)

Year	Demand		Supply		Deficit		Deficit as %	
	Dry	Green	Dry	Green	Dry	Green	Dry	Green
2010	508.9	816.8	453.2	525.5	55.72	291.3	10.95	35.66
2020	530.5	851.3	467.6	590.4	62.85	260.9	11.85	30.65
2030	568.1	911.6	500.0	687.4	68.07	224.2	11.98	24.59
2040	594.9	954.8	524.4	761.7	70.57	193.0	11.86	20.22
2050	631.0	1012.7	547.7	826.0	83.27	186.6	13.20	18.43

** Source: IGFRI Vision 2050

Grazing resources in India

Resources	Area (million ha)	Percentage
Forests	69.41	22.70
Permanent pastures, grazing lands	10.90	3.60
Cultivable wasteland	13.66	4.50
Fallow land	24.99	8.10
Fallow land other than current fallows	10.19	3.30
Barren uncultivable wastelands	19.26	6.30
Total common property resources other than forests	54.01	17.70

Low productivity of Livestock

Average yield of milk and meat: 20-60% lower than world average

Responsible Factors:

- **Feed & Fodder deficiency (50.2%)**
- **Breeding & reproduction (21.1%)**
- **Diseases (17.9%)**
- **Management (10.5%)**

Fodder issues

- Competition with food crops
- Stagnant area under cultivation
- High yielding food crop varieties with low crop residues
- Diversion of crop residues for other purposes
- Lack of authenticated crop wise and region/state wise data.
- Agricultural loan for forage cultivation?

Seed issues

- Huge gap between demand and supply of seed
- Less seed production in forage crops particularly grasses
- Poor seed chain /Indenting system through DAHD/lifting of Breeder seed
- Lesser interest of private sector
- Preference of farmer for fodder harvest
- Mechanization for grass seed harvesting
- Lack of seed production subsidies

Grassland issues

- Lack of proper policy for management and utilization of CPRs/degraded/wastelands
- Increasing urbanization
- Overgrazing leading to denudation of grasslands
- Diversion of grazing lands for other purposes – Industry, social welfare schemes
- Social conflicts
- Lack of national level mission mode programmes
- Lack of inventorization of grassland resources

Policy issues

- Poor linkages among stakeholders
- Diversified responsibility for fodder and fodder seed production
- Lack of fodder expert at district or block level
- Lack of organized forage and forage seed market
- Lack of MSP for fodder seed
- Policy to discourage burning
- Mechanization for optimum recovery of crop residues.

IGFRI Technology

Forage production from

- # Arable land
- # Non arable land

Production Technology
(Arable land)

Fodder production in Irrigated Arable land

Annual based : Sorghum (multi-cut)+ Cowpea – Berseem)

Production potential: 172.0 t/ha/year green fodder (32.3 tDM/ha)

Adoption area: Whole India (except south India)

Clientele group: Periurban and milkshed areas

Water requirement: 1820 mm

Livestocks support: 5-6 ACU

B:C Ratio: 1.67

Fodder production in Irrigated Arable land

Perennial based : N-B hybrid + (cowpea - berseem)

Production potential: 273 t/ha/year green fodder (44.3t/DM)

Adoption area: Whole India except south India

Clientele group: Periurban and milkshed areas

Water requirement: 1090 mm

Livestocks support: 7-8 ACU

B:C Ratio: 2.41

Mechanized production system

Manual production system

Fodder production in Rainfed Arable land

Annual based: Sorghum (Grain) + cowpea (Fodder)

Production potential: Grain- 2.5 t/ha, Green fodder – 17 t/ha

Adoption area: Semi arid region
Clientele group: Small and medium farmers

Targeted area: up to 500 mm rainfall (UP, MP, Maharastra, Gujarat)

Livestock support: 2-3 milch animals

B:C Ratio: 1.57

Fodder production in Rainfed Arable land

Perenial based: Subabul + Tri-specific hybrid (*Pennisitum purpureum X P. squamulatum X P. glaucum*) - sorghum (fodder) + pigeon pea (grain)

Production potential: 53.3 t/ha green fodder grain -0.4 t/ha

Adoption area: Whole India

Clientele group: Small and medium farmers

Targeted area: up to 500 mm rainfall

Livestock support: 2-3 milch animals

(Green fodder- 30t, Silage – 15t)

B:C Ratio: 2.59

Production Technology
(Non-Arable land)

Fodder production in non arable lands

Silvi - Pasture System

Pakar (*Ficus infectoria*) + Guinea grass & Stylo

Zone : Semi arid
Forage : 12.3 t/ha DM/ha
ACU : 3 – 4/ha

Green forage (79 %) : July-Nov (9.7 t)

Tree leaves (21 %) : 2.6 t

(Pakar & Mahua) : Dec- Jan

(Subabul) : Feb-Apr

(Subabul, Pakar & Babul): May- Jun

Conserved forage (Subabul leaf meal & grass)

"Hay": (2.6 t + 4.7 t= 7.3 t) for remaining 7 months

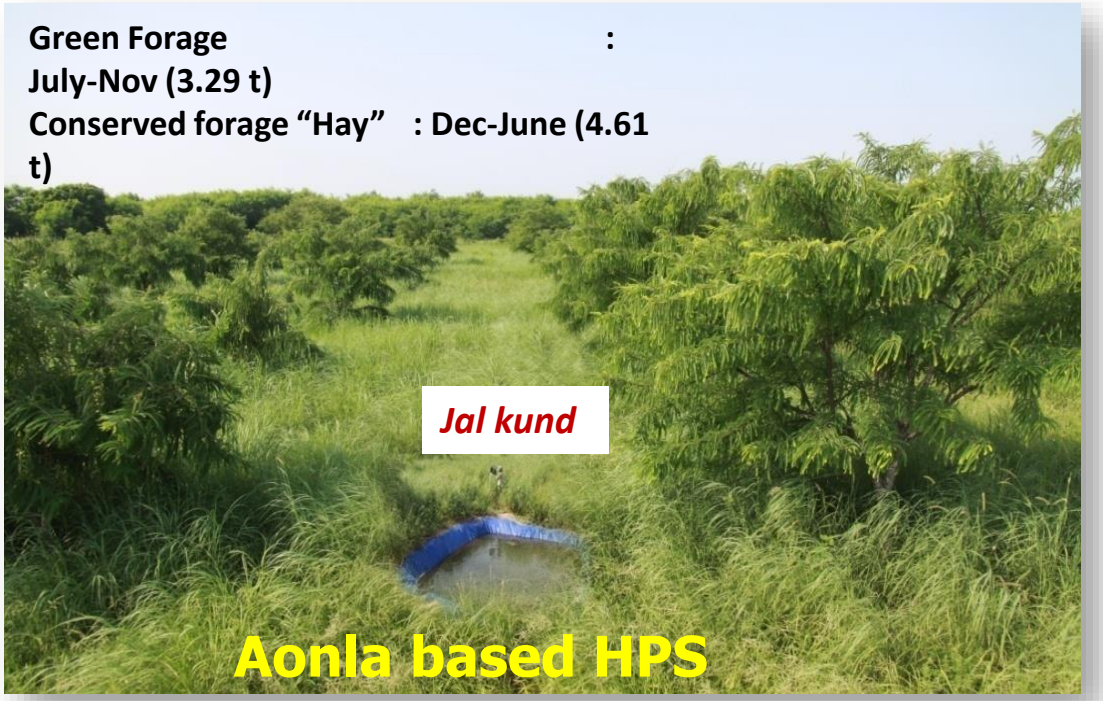
Fodder production systems in non arable lands

Hardwickia binata + Anjan based Silvipasture system

Rainfall	**:**	**300-400 mm**
Productivity	**:**	**5-7 t DM/ha**
SWC measure	**:**	**Staggered trenches**
Carrying capacity	**:**	**2.0 ACU/ha**
Grazing period	**:**	**Aug to Jan**
B:C	**:**	**1: 1.5**

Green forage : July-Nov (2.5 to 3.5 t)
Tree leaves & Grass Hay (2.5 to 3.5 t) : Dec-June

Fodder production in non arable lands



Horti-pasture System

Aonla + Anjan Grass avg. of 10 years

Replicated in Adarsh chara gaon

Zone : Arid to semi arid

Fruit : 8-10 t fruit

Forage : 7.9 t DM/ha

ACU : 2 – 2.5/ha

B:C ratio: 1:3.7

Contour Staggered trenches : 63% reduction in soil loss and 51% runoff loss

Fodder production in non arable lands

Horti-pasture System

Guava + Anjan Grass avg. of 10 years

Zone : Semi arid

Fruit : 6.8 t and

Forage : 7.9 t DM/ha

ACU : 2- 2.5/ha

B:C ratio: 1:4.9

Green Forage (42 %) : July-Nov (3.29 t)

Conserved forage "Hay" (58 %): Dec-June (4.61 t)

Model suitable for 700-800 mm rainfall with staggered trenches

Fodder availability from three tier silvipasture system

For small ruminants

Out of total system productivity of 10t/yr percentage of different component

Fodder availability month during Year

Tree	Shrub	Grass/legume
Jan. to June	Feb. to April	July to Dec. (Green fodder) March- April (Grazing)
21%	15%	64%

Model grassland development in IGFRI

Original site

Loam to sandy in texture, 0.613% OC

Productivity- Fresh wt. 5 t/ha

Carrying capacity - 0.55 ACU/ha

Improved Grassland

Range grasses and legumes:
Anjan, Dhaman, Dhawalu, Sen, Lampa, Phulkara, Stylo, Clitoria, Siratro

Productivity- Fresh wt. 17t/ha

Carrying capacity - 2 ACU/ha

Apple based hortipasture system, IGFRI-RRS, Srinagar

Layout of Apple based hortipasture

Dactylis glomerata in the interspaces of apple orchard

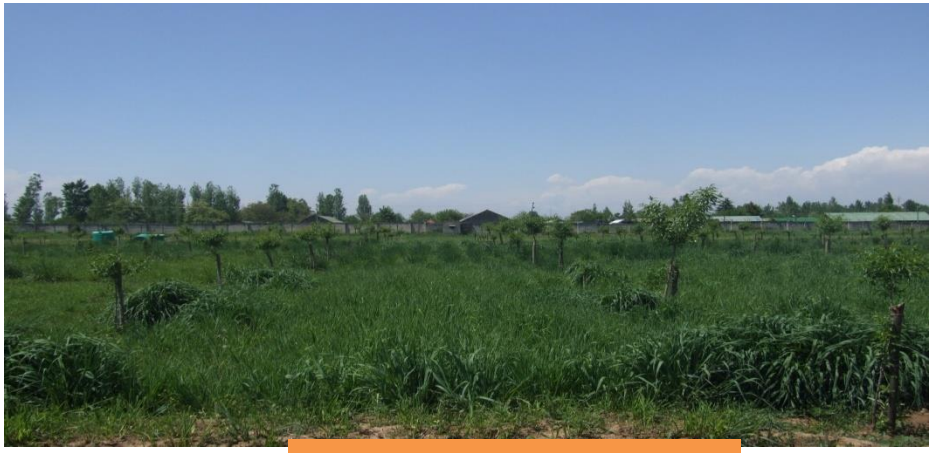
Orchard grass + white clover intercropping
Green fodder yield: 23.65 t/ha

Red clover intercropping
Green fodder yield: 16.50 t/ha

Almond bases hortipasture system, IGFRI-RRS, Srinagar

Planting of almond saplings

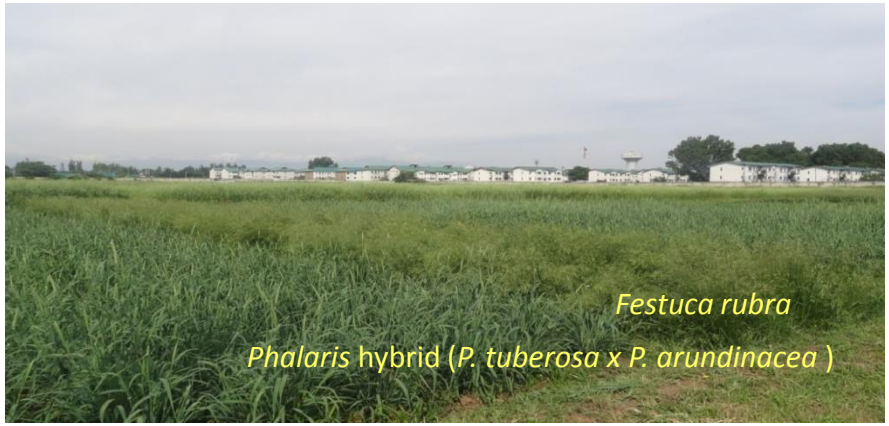
Orchard grass + Almond
Green Fodder Yield: 22.47 t/ha



Phalaris hybrid + almond
Green Fodder Yield: 27.54 t/ha

Tall fescue + Almond
Green Fodder Yield: 23.57 t/ha

Pastoraleum (Live Museum/Forage Cafeteria) at IGFRI, RRS Srinagar



Different views of the Pastoraleum/Forage cafetaria

Sainfoin-an important perennial forage legume
GFY: 21.65 t/ha

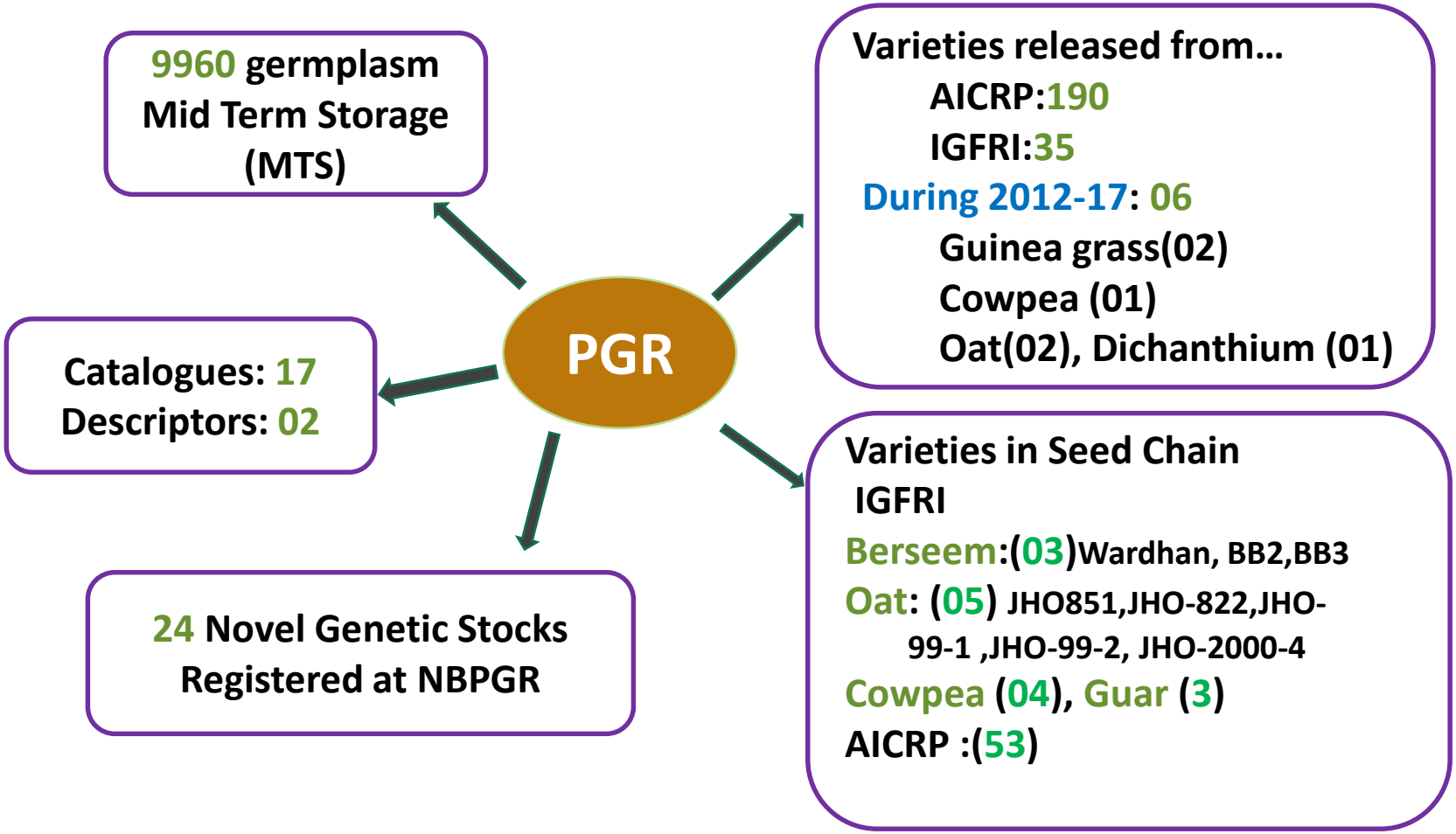
Orchard grass-an important perennial forage grass. **GFY: 24.76 t/ha**

Glimpses of mango and sapota based horti-pastoral system, RRS, Dharwad

Fodders on village tank bunds,
village- Kanakikoppa, Dharwad, Karnataka

Preparation and sowing of grasses and Establishment of grasses

Crop improvement


9960 germplasm
Mid Term Storage
(MTS)
Varieties released from…
AICRP:190
IGFRI:35
During 2012-17: 06
Guinea grass(02)
Cowpea (01)
Oat(02), Dichanthium (01)
PGR
Catalogues: 17
Descriptors: 02
Varieties in Seed Chain
IGFRI
Berseem:(03)Wardhan, BB2,BB3
Oat: (05) JHO851,JHO-822,JHO-99-1 ,JHO-99-2, JHO-2000-4
Cowpea (04), Guar (3)
AICRP :(53)
24 Novel Genetic Stocks
Registered at NBPGR

190 varieties released so far…..
high biomass

Last 5 years Focus towards

Moisture stress
Maize

Biotic Stress
Cowpea
Lucerne

Sugar content
Cenchrus ciliaris

Biofortification
Oat

Drought tolerance
Pennisetum
Sorghum

Quality (CP)
Berseem
Pennisetum

Salinity tolerance
Guinea grass

Crops and varieties suitable for saline/problem soils

Crops	Varieties	Green fodder yield (t/ha)
Sorghum	HC-136, HC-171, SSG-59-3	35-50
Teosinte	Improved teosinte, TL-1	30-40
BN hybrid	IGFRI-3, IGFRI-6, IGFRI-10, CO-1, CO-3	70-110
Cowpea	EC-4216, UPC-5286	25-35
Lucerne	T-9, RL-88	60-80
Oat	JHO-851, Kent, JHO-822	35-40
Lathyrus	Local	20-25
Karnal grass	Selection	25-30
Guinea grass	Gutton	45-60
Rhodes grass	Selection	20-25
Desmanthus	Selection	35-55

Crops and varieties suitable for sodic soils:

Crops	Varieties	Green fodder yield (t/ha)
Sorghum	MP chari, PC-6, PC-9, UP chari-2, UP chari-3	35-40
Pearl millet	Giant bajra, RCB-2	35-45
BN hybrid	IGFRI-6	80-100
Oat	Kent, JHO-822	35-45
Berseem	Mescavi, BB-3, Wardan	60-80
Karnal grass	-	25-30
Shaftal	SH-48	50-70
Guinea grass	Gutton	45-60
Rhodes grass	-	20-25
Desmanthus	-	35-55

Crops and varieties suitable for acidic soils

Crops	Varieties	Green fodder yield (t/ha)
Cowpea	EC-4216, UPC-5286, UPC-4200	25-30
Ricebean	K-1, K-16, Bidhan-1, Bidhan-2	20-25
BN hybrid	NB-21, IGFRI-3, IGFRI-6, CO-2, CO-3	90-120
Oat	Kent, JHO-851, JHO-99-1, JHO-99-2	35-45
Maize	African Tall	30-35
Thin napier	Selection	40-60
Guinea grass	Hamil, PGG-9, PGG-14	80-90
Setaria	Nandi, Narok, PSS-1, Kazungula	70-90

Forage crops and their varieties suitable for waterlogged soil

Soil condition	Suitable crop
Standing water	Almon grass (*Echinochloa polyptachya*), Para grass, coix sps., *Iseilema laxum*, *Chloris gayana*, signal grass, karnal grass, congosignal grass
Shallow water table	Teosinte (*Zea mexicana*), shevary (*Sesbania sesban*)
Temporary water logged soil drained in rabi season	Sasuna (*Medicago denticulata*), teera (*Lathyrus sativus*), chatarimatri (*Vicia sativa*), oats and berseem
Riverine flood waterlogging	Sorghum (PC-6), Teosinte (TL-6)
Saline water logged	Casuriana and Populus

Developed high tillering maize (Interspecific crosses through Teosinte)

Evaluation of maize for water logging tolerance

- 24 lines (along with African tall and Teosinte (*Z. mexicana*), CML lines and pre-breeding lines (Maize x Teosinte crosses) evaluated under natural water logging.
- **2 lines** MWL-7 and MWLT-5/5/22 tolerant (vegetative to reproductive stage)

5 cm water level upto 20 Days

40-50 cm water level upto 45 Days

Biofortification of Oat for Zinc

- **150 Oat germplasm evaluated for Zn content in fodder.**
- **Six lines (37.5 to 48 mg/Kg) selected.**

Control (untreated) **Zn Treated**

Future Work:

- **Partitioning studies for mechanisms of nutrient transport and mobilization**
- **High Zn lines for breeding (popular varieties with enhanced Zn)**

Development of novel genetic variants in Berseem through Interspecific Hybridization

T. alexandrinum* X *T. apertum

Embryo rescue

F_1

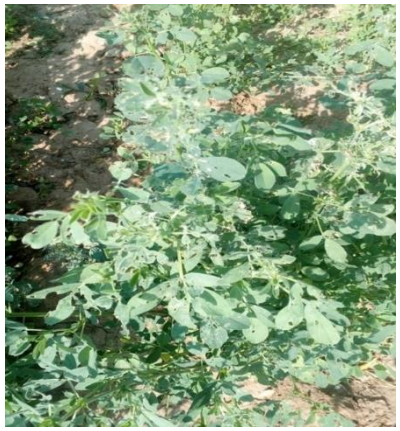
Repeated selfing

***T. alexandrinum* (Fahli)** X **Novel black seeded penta foliate**

Development of weevil resistant breeding populations in Alfalfa

- **Four polycross breeding populations for weevil tolerant parental lines developed.**

- **Moderate resistance at natural and under artificial epiphytotic conditions.**



Weevil susceptible

Resistant

NIANP- IGFRI collaborative project

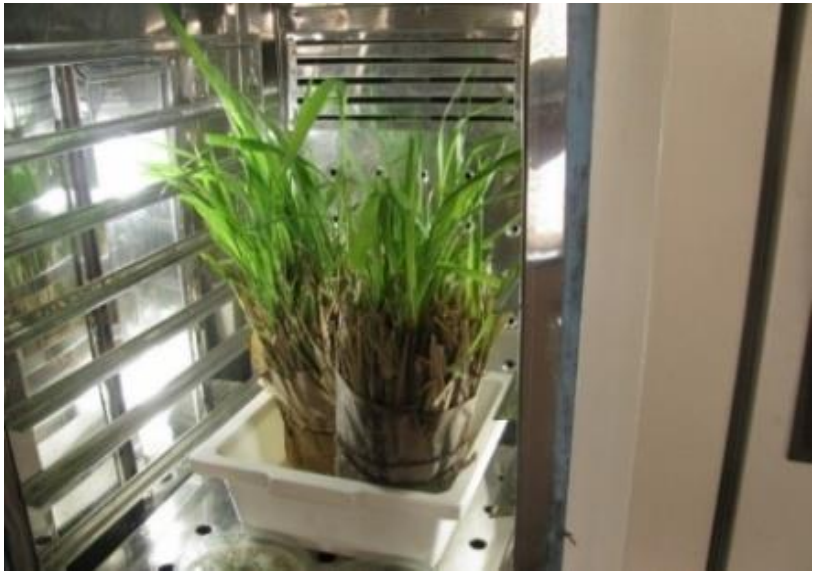
Cenchrus accession having more sugar and high biomass

91 genotypes evaluated (Min. sugar for silage making >7%)

Accessions	Sugar (mg/g)		DMY (Q/ha)
	1st cut	2nd cut	
	101.47		196.51
IG96-358	(10.1%)	77.71 (7.7%)	
IG96-96	97.92 (9.8%)	80.76 (8.1%)	182.67
IG96-50	84.59 (8.5%)	72.98 (7.3%)	232.79

Seed technology

High Density Nursery & Low cost *in-vitro* planting material production in NxB Hybrid



In vitro maturation of grass seed

Interventions to enhance seed setting in range grasses

Methodology:

- ***Panicum maximum*:** IAA @ 100 ppm.
- ***Cenchrus ciliaris*:** IAA & kinetin 100 ppm.
- ***Chrysopogon fulvus*:** Kinetin 100 ppm.
- ***Sehima nervosum***: TIBA 200 ppm.

Benefits:

- Seed setting increased by 15-50% in different grasses.
- Enhanced germination.

Seed coating enhances seed performance in cowpea and berseem

Naked seed

Synthetic polymer

New nutrient mix

Useful PGRs

Pesticides

Methodology:

Seed coating with polymer in combination with nutrient mixture (N- 0.613%, P- 12.5%, K- 1.4% and other micronutrients in minute concentration), PGR (GA_3 @100 ppm) and Malathion and Bavistin (2g/kg of seed).

Benefits:

It enhances seed storability by one year.

Coating with above mixture enhanced seedling vigour.

Effect of nanoparticles (NPs) on seed germination

- Enhance germination and vigour
- Reduce seed borne fungal infection

Crop	Germination(%)		
	Control	CuO	ZnO
Oat	89	100	100
Sorghum	87	97	95
Berseem	92	93	97
Cowpea	83	96	95

Antimicrobial property of nanoparticle

IGFRI Initiative- Participatory Seed production- 300 quintals in 2016-17

- Initiated participatory seed production

1. Oat
2. Berseem
3. Stylo

- Guidelines for buy back of seed produced by farmers prepared and implemented

जई बीज, बिहार (approx 39 ha)

Stylo seed production at Dharwad

Oat seed (JHO 822), Jhansi

Berseem-Chicory seed separator (collaboration with CIPHET, Ludhiana)

1st Machine: Aspirator grader

Optimum wind velocity, m/s : 13.8
Capacity, kg/h : 18
Cleaning efficiency, % : up to 67

2nd Machine : Inclined flat belt draper

Belt inclination : 21°
Draper speed, rpm : 50
Belt speed, m/s : 0.26
Capacity, kg/h :13.8
Cleaning efficiency,% : 99

Technology Impact

IGFRI activities on Grasslands

Improved grassland site at IGFRI

Site at Zeema farm, N. Sikkim

Pasture development site in Ladakh

Pasture development site in Arunanchal

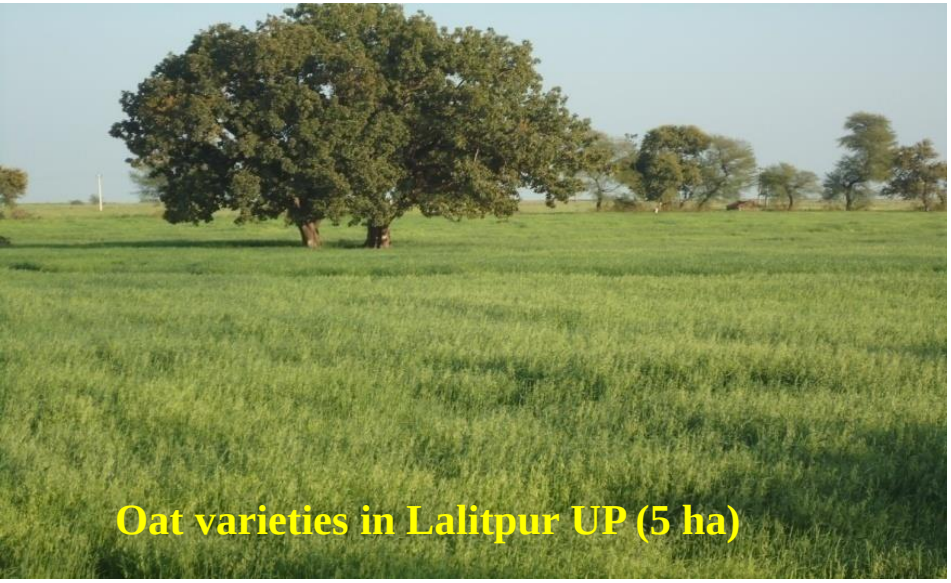
Amelioration of temperate/alpine pastures for livelihood support to pastoral communities

- **Temperate pastures established at 3 places in Arunachal Pradesh & 5 places in N Sikkim**
- **In total 108 yak farmers sensitized for pasture development and fodder conservation**

Impact of IGFRI Forage Seeds
Bihar, UP – 460 farmers (2012-13)

Oat varieties in Bihar (approx 170 ha)

Berseem variety in Lalitpur UP (4 ha)



Oat varieties in Lalitpur UP (5 ha)

Berseem variety near Jhansi (4 ha)

Participatory fodder production in Mango orchards in Karnataka (2013-14)



189 farmers trained : **31 acres covered**

Crops Introduced: **Irrigated : Bajra Hybrid (DHN-6), Guinea (BG-2), Cowpea , Lucerne**

Dryland: Perennial fodder sorghum (CoFS-29), S. hamata

MODEL GRASSLAND DEVELOPMENT (Outreach)

35 ha Grassland Development, Bundelkhand

A total of 35 ha Gochar land at three locations Palinda, Bachawali and Bangra of Jhansi district has been developed during the year. About 50 ha forest land already developed in pasture production at Orchha and 70 ha at soda village of Rajasthan

Developed site:

Gochar land of Palinda village

Area :7.5 ha

Grass sowing

Developed site

NB hybrid transplanting

Developed site:

Grassland development: Soda village, Rajasthan (70 hectare)

View of natural grassland (High infestation of Vilayati Babool)

Impact (Total Budget : 39.4 lakh)

- Production increase: 1.5 t/ha to 4.5 t/ha
- Green forage available upto November
- Feed cost for dairy animals decreased by 25-30% due to saving on Dry fodder
- Increased Milk yield by 20- 25 percent
- Villages/ Farm families benefitted: Soda, Jaisinghpura, Dholi- 03/525
- Removal of Vilayati Babool and protection led to good growth of pods on already existed 03 thousands babool trees and small ruminants benefitted during summer season

View of improved grassland and seed collection

Proposal submitted for Grassland development in eight states with stakeholders and DAHD & F funding

Collaboration: IGFRI & *Jal Grahan Samiti*, Soda, IIRD, NGO

Pasture development in Himachal Pradesh

Pasture land development Chainpura, Rajasthan (developed 20 ha)

Fodder technology development in 34 Gaushalas in India

- Rajasthan (20), Karnatak (1), Madhya Pradesh(6) and Uttar Pradesh (7)

Seed picking from Kali anjan grass, Srikrishna Gaushala, Sikar, Rajasthan

Panchvati Akka Mahadevi Gaushala, Sogal, Belgaun, Karnataka

Kamdhenu Gausahala, Sakrar, Jhansi

Opportunities during drought and lean period

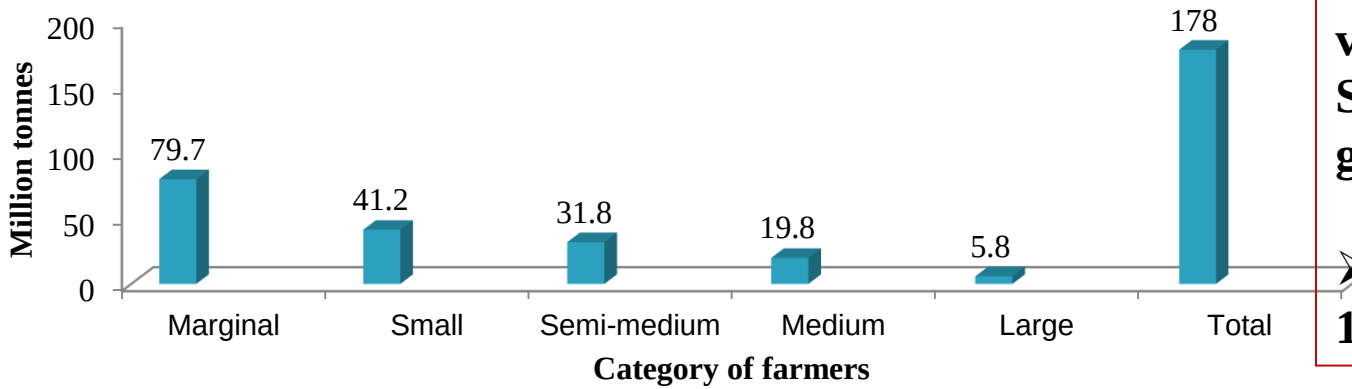
Fodder on Bunds

Total bund length available in India

Category of farmers	No. of holdings (million)	Total bunds length (million meter)
Marginal	92.4	11391
Small	24.7	5886
Semi-medium	13.8	4543
Medium	5.9	2832
Large	1.0	834

Fodder on bund

Projected Fodder Production Potential (million tonne)



- **Perennial grasses viz., NB hybrid, TSH, Setaria and Guinea grass.**
- **7-11 q green fodder / 100 m bund / year.**

If 10 % Farm Bunds utilized: 17.8 mt green fodder production/year

Sugarcane

Sugarcane crop

Sugarcane tops

Bagasse

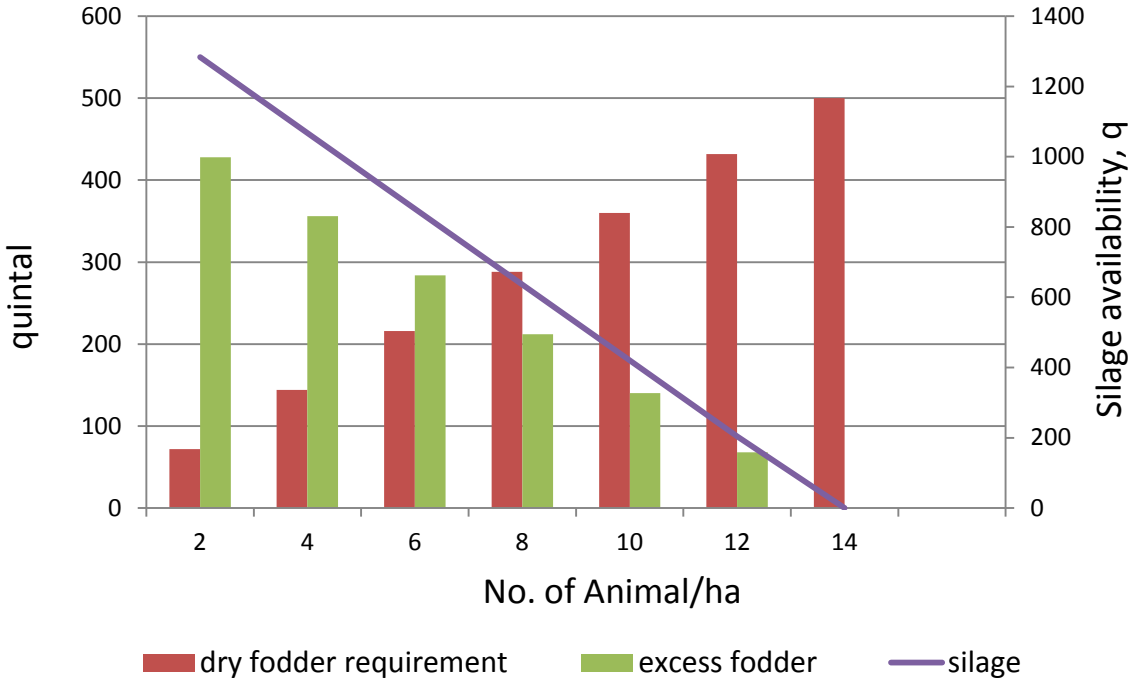
In Lakh tonnes

Particulars	U.P.	Bihar	Mah.	TN	India (2013-14)
Sugarcane tops (SCTs) (25 % of sugarcane production)	333	31	188	94	875
Bagasse (30% of sugarcane production)	400	37	226	113	1050
Surplus Bagasse (4% of total bagasse production)	16	1.5	9	5	42

- Only 15-20 % of available green SCTs is used as feed supplements
- Silage making is to be promoted in sugarcane growing areas
- 90- 95 % bagasse is used as fuel by sugar mills/factories
- Improving the digestibility (30 % to 60 %) of bagasse as feed by steam treatment (14kg/cm2 for 5 minutes)

Fodder Conservation: Silage

Surplus fodder availability in intensive fodder production system for silage/ha/year (Dry matter based)



Potential Agencies for Adoption:

- Milk cooperative societies
- Organized dairy farms
- Progressive farmers
- NGOs
- Govt. Farms/organizations
- Private industries

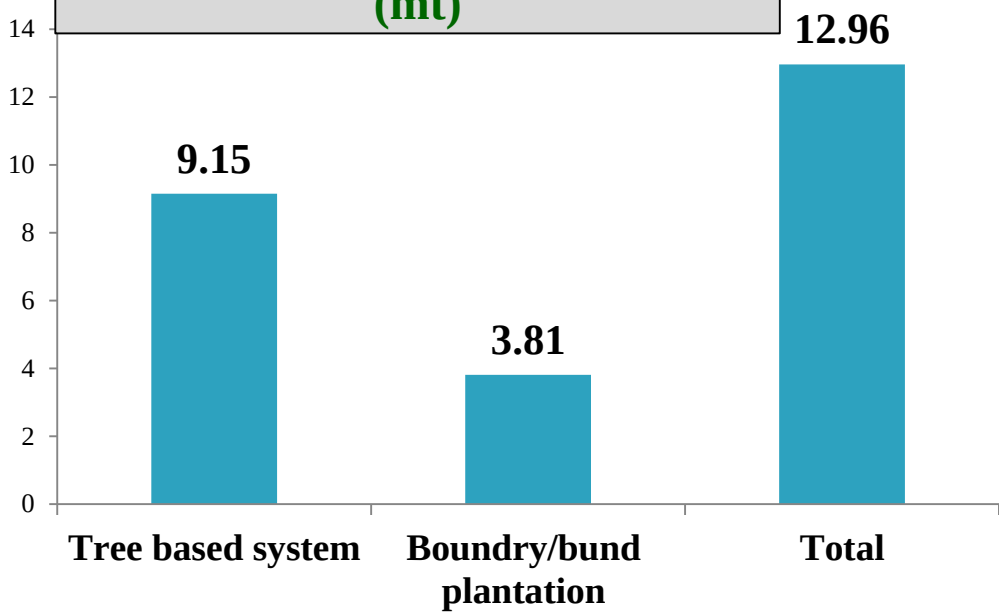
Fodder Trees

Important fodder trees and productivity

Area	Name of tree	Fresh leaves / tree (kg)
Hills	*Ailanthus altissima*	8-10
	Grewia optiva	12-30
	Populus spp.	20-22
	Elaeagnus angustifolia	8-10
	Robinia pseudoacacia	5-8
	Salix spp.	29-30
Plain	*Prosopis cineraria*	23-24
	Acacia spp.	15-16
	Ailanthus excelsa	23-25
	Leucaena leucocephala	15-16
	Moringa oleifera	8-10
	Gliricidia sepium	2-3
	Ficus spp.	150-200
	Morus spp.	8-10

❖Protein content in leaves:14 - 28%

Estimate of Tree leaves production (mt)



❖10 % of total area under each system

❖40 - 50 trees /ha under boundary/bund plantation

❖100 - 150 trees/ha under tree based system

Alternate forage resource - Cactus

Components and activities

ICARDA- 14 + 3 accessions, Italy-8, Brazil- 10

- **Promotion in farm boundaries in semiarid region (outreach programmes of IGFRI- Adarsha Chara Gram/NICRA sites).**
- **Regular/Alternate hedge rows in degraded land use management systems (Silvipasture /hortipasture).**
- **Tissue culture for fast multiplication.**
- **Conservation and utilization for livestock production**

Crude Protein	8.3%
NDF	28.5%
ADF	20.1%
Ash	28.0%
Dry matter digestibility	52.0%
Protein content:	**4.5 - 5.5 %**
Moisture content:	**88 - 94 %**

Potato haulm (*Solanum spp.*)

Crude Protein	12.07%
NDF	50.08%
Crude Fiber	1.65%
Ash	5.97%
Dry matter digestibility	53.69%

Potato haulm – Early harvest

Fodder Sugarcane

Crude Protein	10.95%
NDF	64.96%
ADF	37.07%
Ash	9.66%
Dry matter digestibility	65.69%

Moringa

Crude Protein	22.0%
N D F	16.8%
A D F	14.2%
Ash	7.29%
Dry matter digestibility	60.2%

Moringa


Indian Grassland & Fodder Research Institute
THANK YOU