Proven Technologies of IGFRI, Jhansi (Uttar Pradesh)

Technology- I: Round the year fodder production system (Irrigated situation)

Perennial based : N-B hybrid + cowpea

Dimension: The system comprises of raising seasonal legume fodder crops, inter-planted with perennial grasses (hybrid napier / guinea grass). Hybrid Napier based cropping system (Hybrid Napier + (Cowpea - Berseem + Mustard) has green fodder production potential of 273 t/ha and dry fodder potential of 44.3 t/ha per year under assured water supply (water requirement 1090 mm).

Target area: The system is suitable for large scale dairy farmers in Peri-urban and Milkshed areas of whole India except tropical region.

Impact: Technology can supply round the year good quality fodder (Cereal: legume, 67:33) which can sustain 8-10 ACU per ha (1 ACU= 350 kg bodyweight). The technology is being demonstrated in farmer's field in Bundelkhand.

States suitable for adoption of this technology: J&K, HP, Punjab, Haryana, Uttarakhand, UP, MP, Maharastra, Bihar, Jhankhand, Odisa (Other than coastal area), CG, Telangana, West Bengal

Package of practices

Crops (Varieties): NB hybrid (IGFRI-6, 10 and NB 21). Intercrop with Cowpea (BL 1 & 2) during kharif season and Berseem (Wardan, BB 2 7 BB 3) during rabi season.

Sowing/ planting time:

NB hybrid: Mid February – July

Cowpea: April –May after the harvest of Berseem

Berseem: October

Seed rate and spacing (cm)

NB hybrid: 20000 rooted slips/ha (1 rooted slip per hill) are planted at a spacing of 100 x 50 cm and due to perennial in nature, up to 4-5 years there is no need of further planting and only gap filling and tussock dressing is required)

Cowpea: 20-25 kg seed per ha two lines between two rows of N-B hybrid

Berseem: 15-20 kg seed per ha should be sown in between two rows of NB hybrid

No. of irrigations: During spring & summer 8-9 irrigations and a total of 12-15 irrigations: 8-10 days interval during autumn and 12-15 days interval during Spring

Nutrient management

NB hybrid: Basal: 50 + 50 + 50 kg NPK/ha and top dressing: 50 kg N/ha after each cut

Cowpea: No separate fertilization is required

Berseem: Basal: 20+80 kg NP/ha

Harvesting schedule

NB hybrid: 1st cut: 75 – 80 days after planting (DAP) and subsequent cuts: 30– 40 days after previous harvest (DAH)

Cowpea: Only one cut: 60-65 days after sowing (DAS)

Berseem: 1st cut : 50 – 55 DAS and subsequent cuts: 30 – 35 DAH

Per ha/ per unit cost of production and returns: Cost of production Rs 29 per quintal green fodder and Net return Rs 1,93,000 per ha with BC ratio of 2.41.

Targeted farmers: Large scale commercial dairy farmers

Days for which fodder will be available: Whole year except Oct-Dec. (300-310 days)

Possibility of seed production and quantity: Some area of berseem after march may be kept for seed production (45-50 kg seed) and 2nd year onward 50,000 nos rooted slips of NB hybrid

Estimated expenditure per demonstration (Specify the unit area of demonstration): Rs 16,000 per 0.20 ha demonstration

Availability of planting material for supply:

1. ICAR-Indian Grassland and Fodder Research Institute, Jhansi-284003
2. Centers of AICRP on forage crops in different SAUs and ICAR Institutes.
3. Central and State Agriculture Universities

Other sources like KVKs, BAIF, etc.

Technology- II : Round the year fodder production system (Rainfed situation)

Perenial based: Subabul + Trispecific hybrid - sorghum (fodder) + pigeon pea (grain)

Dimension: The Institute has developed Subabul + Trispecific hybrid - Fodder sorghum + Pigeonpea based fodder production system for rainfed conditions. In this system, the *Pennisetum* Trispecific Hybrid (TSH) is planted in paired rows at 0.75 m x 0.5 m spacing. Subabul is planted at 50 cm plant to plant spacing in between pairs of TSH. The 3 m space between such two alleys is utilized for fodder sorghum + pigeonpea cropping system in 2:1 ratio at 30 cm.

Target area: Rainfed farmers of semi arid region (up to 500 mm rainfall)

Impact: This system has green fodder production potential of 53.3 t/ha and 13.28 t dry fodder besides producing 0.4 t/ha pigeon pea grain and 0.8 t/ha dry sticks having fuel value. Technology can sustain 2-3 ACUs with quality fodder. It also provides nutrient rich pulse for human consumption and fuel wood. It is also capable of prolonging the fodder availability up to May (dry period)

States suitable for adoption of this technology: Maharastra, Karnataka, Punjab, Haryana, AP, Telangana,UP, MP, Gujrat, Bihar, Jhankhand, Odisa CG, West Bengal

Package of practices

Crops (Varieties):

Pennisetum trispecific hybrid + leucaena (K-8)

Fodder sorghum (PC 6 & 9) + Pigeonpea (Bahar, BDN 708, Vipla)

Sowing/ planting time:

Pennisetum trispecific hybrid + leucaena (K-8): July- August and Mid February – March

Fodder sorghum + Pigeonpea: June - July

Seed rate and spacing (cm)

TSH should be planted at 75 cm spaced in paired row; one row of *Leucaena* is planted 50 cm away from TSH followed by another set of TSH grass, each set is planted at 3.0 m spacing and 12000-15000/ha rooted slips of TSH planted and 1.5- 2.0 kg leucaena seed required and due to perennial in nature, up to 4-5 years there is no need of further planting and only gap filling and tussock dressing is required

Fodder sorghum + Pigeonpea: 12-14 kg Sorghum +1.5-2.0 kg pigeon pea in 30 cm apart lines (in 3.0 m wide alleys)

No. of irrigations: Not Applicable

Nutrient management

Pennisetum trispecific hybrid: 20 t FYM and 20: 30:30 kg NPK/ha as basal and top dressing: 20 kg

N/ha after each cut if coincides with rain

Fodder sorghum + Pigeonpea: 30+30 kg NP/ha as basal dose

Harvesting schedule

Pennisetum trispecific hybrid: 1st cut: 75 – 80 days after planting (DAP) Subsequent cuts: 30– 40 days after previous harvest (DAH)

Fodder sorghum + Pigeonpea: Sorghum is harvested at 55-60 days after sowing and pigeon pea is harvested for grain in April

Per ha/ per unit cost of production and returns: Cost of production Rs 38 per quintal green fodder and Net return Rs 52500 per ha with BC ratio of 2.59.

Targeted farmers: Small and Medium

Days for which fodder will be available: In north India 275 days and in south India whole year.

Possibility of seed production and quantity: Pigeon pea 4.0 q/ha and 2nd year onward 50,000 rooted slips of TSH

Estimated expenditure per demonstration (Specify the unit area of demonstration): Rs 5000 per 0.20 ha demonstration

Availability of planting material for supply:

1. ICAR-Indian Grassland and Fodder Research Institute, Jhansi-284003
2. Centers of AICRP on forage crops in different SAUs and ICAR Institutes.
3. Central and State Agriculture Universities

Other sources like KVKs, BAIF, etc.

Technology-III : Fodder on Field boundary/Bunds/Channels: Non competitive land use

Dimension: Among different perennial cultivated grasses, Napier - bajra hybrid is most suitable for bunds of irrigated areas and Tri-specific hybrid (TSH), guinea grass, anjan grass and nandi grass are suitable under rainfed conditions.

Target area: All categories of farmers specially marginal and small farmers in different agro climatic regions of India

Impact: Fodder yield recorded from different farm demonstrations indicated 1.75 to 2.50 kg green fodder per meter per cut and on an average in 4 cuttings 7.0- 11.0 q green fodder per 100 metre bund length is possible in a year. Besides additional farm productivity, it also works as a guard crop for main crop, reduces runoff loss of water and controls soil erosion. Now this technology has been disseminated in 600 farmers field in different rural parts of country through Adarsh Chara Gaon (100), Mera Gaon Mera Gaurav (200) and NGOs (50), Gaushalas (10) , NIFTD programme (National Initiative on fodder technology demonstration) and KVKs (240) etc.

States suitable for adoption of this technology: All states of India

Package of practices

Crops (Varieties): NB hybrid (IGFRI-6, 10 and NB 21) / Guinea grass (BG-1, 2 & 3, Hamil)

Sowing/ planting time: Mid February – July

Seed rate and spacing (cm): 400 rooted slips per 100 meter length of field boundary with a spacing of 50 x 50 cm and due to perennial in nature, up to 4-5 years there is no need of further planting and only gap filling and tussock dressing is required)

No. of irrigations: As per irrigation to main crop.

Nutrient management: Additional fertilization not required

Harvesting schedule: 1st cut: 75 – 80 days after planting and subsequent cuts at 30– 40 days after harvesting

Per ha/ per unit cost of production and returns: Cost of production Rs 35 per quintal green fodder and Net return Rs 1800 per bund area of 1 ha with BC ratio of 1.8.

Targeted farmers: All category of farmers

Days for which fodder will be available: During whole crop growing period of the year in south India and except winter months in north India.

Possibility of seed production and quantity: 2nd year onward 15000 rooted slips of perennial grass

Estimated expenditure per demonstration (Specify the unit area of demonstration): Rs 1000 per demo

(400 metre running length of bund).

Availability of planting material for supply:

1. ICAR-Indian Grassland and Fodder Research Institute, Jhansi-284003
2. Centers of AICRP on forage crops in different SAUs and ICAR Institutes.
3. Central and State Agriculture Universities

Other sources like KVKs, BAIF, etc.

Technology- IV: Azolla as supplement feed for livestock

Azolla demonstration at farmers fields in Jharkhand

Dimension: Azolla farming, in general, is inexpensive and it can be multiplied in natural water bodies for production of biomass. Biomass productivity is dependent on time and relative growth rate and efficiency of the species. Azolla is very rich in proteins, essential amino acids, vitamins (vitamin A, vitamin B12, Beta Carotene), and minerals including calcium, phosphorous, potassium, ferrous, copper, magnesium. On a dry weight basis, Azolla has **25-35% protein**, 10-15% mineral content, and 7-10% comprising a combination of amino acids, bio-active substances and biopolymers. During lean/ drought period it provides sufficient quantity of nutrients and acts as a **feed** resource.

Target area and suitable states : It can successfully be grown round the year in southern states like Karnataka, Kerala, Goa, Tamil Nadu and Maharashtra and during monsoon and summer months in states of Punjab, Haryana, Delhi, U.P., Bihar, M.P., Rajasthan, Gujarat, and Chhattisgarh. In North East and North West hilly states where winter is pronounced, azolla can be grown in monsoon and summer months.

Cultivation methodology

The biomass production under natural condition i.e. in rice field is only 50 g/ sq.m/day as against optimum production of 400 g/sq.m/day. The production efficiency can be increased by growing azolla in pits lined with synthetic polythene sheet in courtyard /back yard preferably in open space or on terrace where availability of sunlight is adequate. Production of azolla is good in nursery plots. Even the water bodies, ditches in the vicinity can also be used for production of azolla.

The methodology for cultivating *Azolla* by the livestock farmers economical is described here under:

- A water body of 2 x 1.5 x 0.4 m is dug and leveled to maintain uniform water. It should be lined with a silpauline sheet or any other polythene sheet. Silpauline is a polythene tarpaulin which is resistant to the ultra violet radiation in sunlight. Width of the bed is maintained at 1.5 m to enable the cultural operation from both sides.
- About 10 – 15 kg of sieved fertile soil is uniformly spread (depth of soil layer should be about 10 cm) over the silpauline sheet which will provide nutrient to the azolla plant. Slurry made of 5 kg of pre-decomposed (2 days) cow dung and 30 g of super phosphate mixed in 10 litres of water, is poured onto the sheet. More water is poured on to raise the water level to about 20-25 cm.
- About 0.5 – 1 kg of fresh and pure culture of a*zolla* is inoculated in the water of the pit. This will grow rapidly and fill the pit within 10 – 15 days. From then on, 500 – 600 g of a*zolla* can be harvested daily. Biomass should be removed at regular interval to avoid overcrowding or else

growth is restricted.

- A mixture of 20 g of super phosphate and about 1 kg of cow dung should be added once every 5 days in order to maintain rapid multiplication of the a*zolla* and to maintain the daily yield of 500 g.
- A micronutrient mix (about 40 g of nutrient mix made by mixing 10 kg rock phosphate, 1.5 kg magnesium salt and 500 g of murate of potash) containing magnesium, iron, copper, sulphur can also be added at monthly intervals to enhance the mineral content of a*zolla*. This not only takes care of the micronutrient requirement of azolla but also the cattle when it is fed with the azolla.

Impact: Azolla is a highly productive plant. It doubles its biomass in 3–10 days, depending on conditions and it can yield upto 37.8 t fresh weight/ha (2.78 t DM/ha dry weight). It has been demonstrated in more than 50 farmers' field of country through Adarsh Chara Gaon (20), Mera Gaon Mera Gaurav (10) NGOs (10) and KVKs (10). A farmer can realize a net profit of over Rs. 4000 per annum from the additional milk yield and reduced usage of concentrates' feeding for livestock.

Days for which fodder will be available: Six months in a year

Estimated Expenditure on demonstration: The cost involved in setting up Azolla plot varies between Rs 1500 to Rs 2000 for a structure of 5x2 sq m. The primary cost is in the form of manual labour, which can be contributed by the family labour. While estimating the cost of Azolla plot, two units of Azolla beds have been considered to maintain regular yield of azolla fodder.

Per unit cost: The cost of producing *Azolla* with above method will be Rs1.0 to 1.5 per kilogram.

Source of inoculums:

- Blue Green Algae Facility , IARI, NewDelhi
- IGFRI, Jhansi
- Natural Resources Development Project-NARDEP
  Technology Resource Centre Kanyakumari Tamil Nadu

Technology-V: Silage for sustenance of livestock production

Silage making in farmers fields in Garera, Datia, MP

Dimension: Silage is the fodder which is conserved by reducing pH through natural anaerobic fermentation and is used for feeding during scarcity period, drought or floods and for Utilizing surplus forage. The suitable crops are sorghum, maize and oat etc. During lean period feeding of silage acts as a green fodder and maintains livestock productivity.

Target area: All areas where farmers face problem in providing round the year fodder to the animals.

States suitable for adoption of this technology: Sorghum and maize growing states UP, MP, Punjab, Haryana, Rajasthan, Gujarat, Karnataka, Tamil nadu, Maharashtra etc. In rabi season, oat growing states can adopt this technology.

Process in silage making

1. **Selection of forage crops and their maturity stage**

   The optimum dry matter for crop harvesting for silage depends on the stage of harvesting (Table 1). Most of crops are harvested at 50% flowering to dough stage when the moisture content varies between 18-22%. After overnight wilting the dry matter content become 30-35% which is proper dry matter content for ensiling.

   Table 1: Optimum stage for crop harvesting

Common forage crops	Stage of harvest
Maize	50% flowering to dough stage
Sorghum	50% flowering to dough stage
Bajra	50% flowering to dough stage
Oat	Boot to dough stage

2. **Steps in silage making**

   Silage making involves four major steps viz., harvesting and transportation, chaffing, filling and compaction and covering of silo.

   1. ***Pit making***: Firstly, a silage pit has to be dug for storing silage. The pit size may be determined based on the amount of silage to be stored. A pit with a dimension of 1 metre wide X 1 metre length

X 1 metre depth can store 500 kilograms of silage. The location of pit should be free from water stagnation. The pit should be surrounded on all sides with thick plastic sheet. Pit can also be constructed using bricks and cement.

2. ***Preparation of fermentation mixture*:** For preparing 1 ton silage, the following materials are required.
    - Jaggery or Molasses - 1 Kg
    - Salt - 1 Kg
    - Mineral Mixture - 1 Kg
    - DCP (Di-Calcium Phosphate) - 1 Kg
    - LAB (Lactic Acid Bacteria)
    - Urea - 1 Kg
    - Mix all of the above into a drum by adding water.

3. ***Harvesting and transportation of crop (ensiling)***: Harvesting at proper stage but delay in transportation may lead to loss of excess moisture results in haylage (DM 70-80%).
4. **Chaffing**: It has to be chaffed into small pieces preferably 2-4 cm length using a chaff cutter. This improves the packing density which favours the growth of lactic acid bacteria, naturally present in crops. Add the fermentation mixture in small quantities as the fodder is loaded to chaff cutter. Position the chaff cutter so the chaffed fodder directly falls into the silage pit. Level the chaffed pieces evenly and press it hard so that all air comes out. Pressing and removing air is very important.
5. ***Filling of silo and compaction***: Chaffed material should be spread evenly over entire surface of silo (the structure) and then compacted through trampling (in case of small silo). In case of large silo (trenches) the compaction can be done using tractor. It helps in rapid evacuation of air from the silo, thus checks the aerobic respiration and nutrient loss.
6. ***Properly sealing and covering of silo pit***: It should be done in such a way that neither air enters in to the silo nor the gas comes out from the silo. It is better to use polythene sheet but care should be taken that entire surface of polythene sheet should be covered with straw or any other dried material up to 6-8 inch thickness to avoid the damage of polythene sheet by dog, cat or other animals. Make sure water does not enter the pit during rains.

   The silage will be ready in 45 to 60 days, depending on the types of material used. The silage of thin stem crop like oat becomes ready in 45 days while thick stem crops like maize, sorghum and bajra become ready in 60 days. Ideal silage is golden yellowish green colour with good aroma.

   After completion of incubation period the silo is opened for feeding. The whole silo should not be disturbed and it should be opened from one place/corner to avoid the loss of moisture and nutrients. Depending on the type of animal, stage of production and availability of silage it can be supplemented in the ration (5-25 kg per animal) of animal during lean period. After opening the pit, silage should be used within 30 days.

Impact: Sustain/Increase the livestock production by 10-15 % during the scarcity of green fodder**.**

Days for which fodder will be available: In general two lean periods are encountered when it can be fed. These include 1) November-December and 2) April- June (2 + 3 = 5 months).

Target farmers: All categories of farmers, having excess fodder over daily need

Operational cost of silage: Kaccha pit-Rs. 60-80/q
Pakka pit- Rs. 40-50 /q
Polythene bag- Rs. 300-400/q

Per unit cost of silage preparation (excluding the cost of fodder): Rs. 150-160/q (This includes cost of harvesting, transportation, chaffing, filling and covering)

Expected expenditure per demo (specify the unit area): For katcha pit (Rs. 1500/ demo of 1 m^3 and For Pakka pit (Rs. 4000/demo of 1 m^3)- These include cost of pit digging, polythene, bricks, cement, sand, labour etc, (at approximate value).

Technology- VI: Silvo-pasture model for highly degraded/ waste lands

Ficus infectoria with grasses and legumes species

Hardwickia binata with grasses and legume species

Morus alba with grass and legume species

Acacia nilotica with grass and legume species

Dimension: Rainfed/ arid regions of the country have degraded land and constraints in arable farming. Animal husbandry is the main occupation of farmers after rainfed crops cultivation in these areas. Livestock is dependent on forage produced in rangeland areas**.** In such areas large scale grazing of animals results in quite low pasture production restriciting availability during monsoon only. To solve the above said problem Silvipasture models (MPTS + Pasture) have been developed that produce higher forage per unit area per unit time as well as round the year than open pasture.

Target area: Forest area, degraded lands under rain-fed situation in semi-arid region of India (Rainfall 400-700 mm).

Impact: Degraded lands of India have constraints of soil and moisture making arable farming quite difficult. Different models of **S**ilvo-pasture systems developed at IGFRI have good production potential of forage from 5-10 t DM/ha on degraded /rangelands of the country. Silvi-pasture systems can serve the purposes of forage and firewood production and ecosystem conservation. This system support 2-4 ACU /year depending upon species of tree, pasture combinations and agro-climatic conditions. It also conserves soil moisture and reduces soil erosion as well as builds up soil in long

rotation. This technology is being disseminated with line departments of forestry, soil water conservation, NGOs, Gaushalas , KVKs through NIFTD programme (National Initiative on fodder technology demonstration) etc.

States suitable for adoption of this technology: A.P., Karnataka, Tamilnadu, Telangana, Uttarakhand, Bundelkhand part of M.P and U.P. Maharashtra, Chattisgarh, Jharkhand, H.P. and J&K, etc.

Establishment cost of the system: 25,000-30,000/ha.

B:C ratio: Over the period of 10 years:1.5-2

Forage production:5-10 t Dry Matter /ha/year

ACU supports: 2-4/year

1. **Ficus based silvipasture** **Zone :** Tropical &Semi arid **Rainfall:** 600-700 mm/annum **Forage :** 12.3 t/ha DM/ha **ACU :** 3 – 4/ha Grass- *Chrysopogon fulvus, Cenchrus ciliaris* and *Panicum maximum* Legume- *Clitoria ternatea* and *Stylosanthes seabrana* **Fodder availability** From grasses and legume- July to December (65-70 %) Tree leaves- March to June (30-35 %)	**2. Hardwickia based Silvi-pasture** **Zone :** Semi arid **Rainfall:** 600-700 mm/annum **Forage :** 7-9 t DM/ha **ACU :** 2- 2.5/ha Grass- *Chrysopogon fulvus, Cenchrus ciliaris* and *Panicum maximum* Legume- *Stylosanthes seabrana* **Fodder availability** From grasses and legume- July to December (85-90 %) Tree leaves- March to June (10-15 %)
3. Morus based Silvipasture **Zone :** Semi arid **Rainfall:** 600-700 mm/annum **Forage :** 11-13 t DM/ha **ACU :** 3-4/ha Grass- *Chrysopogon fulvus, Cenchrus ciliaris* and *Panicum maximum* Legume- *Clitoria ternatea* and *Stylosanthes seabrana* **Fodder availability** From grasses and legume- July to December (65-70 %) Tree leaves- March to June and September to November (30-35 %)	**4. Acacia based silvipasture** **Zone :** Semi arid **Rainfall:** 600-700 mm/annum **Forage :** 9-11 t DM/ha **ACU :** 2.5-3/ha Grass- *Chrysopogon fulvus, Cenchrus ciliaris* and *Panicum maximum* Legume- *Clitoria ternatea* and *Stylosanthes seabrana* **Fodder availability** From grasses and legume - July to December (92-95 %) Tree leaves- November to December (5-8 %)

Technology package (Silvo-pasture model for highly degraded/ waste lands)

<table>
<tr><td>Field preparation & digging</td><td>Pre monsoon, 45X45x45 cm</td></tr>
<tr><td>Tree Spacing

Planting of tree saplings</td><td>5 x 5 m (For tractor based operation)

During the monsoon</td></tr>
<tr><td>Sowing/Planting of grasses and legume

Weeding</td><td>Interspaces intercropped with pasture combinations at 50 cm row- to- row and legume between 2 rows of grasses.

One weeding beneficial for establishment of pasture</td></tr>
<tr><td>Fertilizer to tree</td><td>
<table>
<tr><td>Tree</td><td>N (g)</td><td>P (g)</td><td>K(g)</td><td>FYM (Kg)</td></tr>
<tr><td>1</td><td>50</td><td>25</td><td>50</td><td>10</td></tr>
</table>
</td></tr>
<tr><td>Fertilizer to grass

Harvesting

Lopping /Pruning of tree</td><td>20 Kg N, 30 Kg P and 30 kg K /ha. Application of Nitrogen in split during July and August

Harvesting of pasture 2-3 time(From September to December) as per monsoon and growth of pasture up to initial 5 years follow cut and carry system. After attaining growth of tree allowed grazing of small ruminant

After 3rd year during lean period- 20-40 % lopping-

Varieties of Grass and Legume
<table>
<tr><td>Grass</td><td>Variety</td></tr>
<tr><td>Chrysopogon fulvus</td><td>GAUD-1</td></tr>
<tr><td>Cenchrus ciliaris</td><td>Bundel Anjan-1, CAZRI-75</td></tr>
<tr><td>Panicum maximum</td><td>Hamil,Bundel Guinnea-1, Bundel Guinne-2, IGFRI-10.</td></tr>
<tr><td>Legume</td><td></td></tr>
<tr><td>Clitoria ternatea</td><td></td></tr>
<tr><td>Stylosanthes hamata</td><td></td></tr>
<tr><td>Stylosanthes seabrana</td><td></td></tr>
</table>
</td></tr>
</table>

Technology- VII : Horti-pastoral model for higher income in rainfed ecosystem

Aonla with *Cenchrus ciliaris and Stylosanthes seabrana*

Guava with *Cenchrus ciliaris and Stylosanthes hamata*

Dimension: Hortipasture system integrates pasture (grass and /or legumes) and fruit trees to fulfill the gap between demand and supply of fruit, fodder and fuel wood through utilizing moderately degraded land. IGFRI has developed Aonla and Guava based hortipasture systems for higher productivity. The range grasses used in the system are *Cenchrus ciliaris*, *Stylosanthes seabrana* and *Stylosanthes hamata*.

Target area: Well suited for poor soil with soil depth of 80-150 cm and annual rainfall of 700-800 mm.

Impact: During a period of 10 years it gives B:C ratio of 4-6 and supports 2-3 ACU/ha in a year. The technology is gaining acceptance among rainfed farmers in Bundelkhand, Maharashtra and Karnataka region and area is increasing in fruits particularly ber, aonla guava , sapota etc.

Impact:

The arable farming on degraded land in the country is difficult due to soil and moisture constraint. Guava, ber, aonla etc based Horti-pasture systems developed at IGFRI have good production potential of forage from 6.5-12t DM/ha on degraded land of rainfed areas. Horti-pasture systems can serve the purposes of forage, fruit, fuel wood and ecosystem conservation along with arresting the soil loss and conserve moisture. After a long rotation it improves the soil fertility and microbial activities. This system supports 2-4 ACU /year. This technology is being disseminated with farmers under NICRA, Adarsh Chara Gram, Farmers of different state with KVKs under NIFTD programme (National Initiative on fodder technology demonstration), joint forest management and social forestry, NGOs, Gaushalas , etc.

States suitable for adoption of this technology: A.P., Karnataka, Tamilnadu, Telangana, Utarakhand, Bundelkhand part of M.P and U.P. Maharashtra, Chattisgarh, Jharkhand, H.P. and J&K, etc.

Establishment cost of the system: 40,000-50,000/ha.

B:C ratio: Over the period of 10 years:4-6

Forage production:7-12 t Dry Matter /ha/year

ACU: 2-4/year

Technology package (Horti-pastoral model for higher income in rainfed ecosystem)

<table>
<tr><td>Time of pit preparation</td><td>During May- June to expose the soil and pits to heat for disinfection</td></tr>
<tr><td>Spacing</td><td>6 x 6 m</td></tr>
<tr><td>Size of pits</td><td>1 m^3</td></tr>
<tr><td>Planting of trees & grasses</td><td>One year old grafted fruit plants of improved cultivars planted in the center of pits. Rooted slips of grasses planted at 50cm x 50 cm under the interspaces of plantations and legume sown in line between 2 rows of grasses.</td></tr>
<tr><td>Fertilization to tree</td><td>
<table>
<tr><td>Tree age(Yr)</td><td>N (g)</td><td>P (g)</td><td>K(g)</td><td>FYM (Kg)</td></tr>
<tr><td>1</td><td>100</td><td>50</td><td>100</td><td>10</td></tr>
<tr><td>2</td><td>200</td><td>100</td><td>200</td><td>20</td></tr>
<tr><td>3</td><td>300</td><td>150</td><td>300</td><td>30</td></tr>
<tr><td>4</td><td>400</td><td>200</td><td>400</td><td>40</td></tr>
<tr><td>5</td><td>500</td><td>250</td><td>500</td><td>50</td></tr>
<tr><td>6</td><td>600</td><td>300</td><td>600</td><td>60</td></tr>
<tr><td>7</td><td>700</td><td>350</td><td>700</td><td>70</td></tr>
<tr><td>8</td><td>800</td><td>400</td><td>800</td><td>80</td></tr>
</table>
Same dose of 8th year to be continued till fruiting
</td></tr>
<tr><td>Fertilizer to grass</td><td>30 Kg N, 20 Kg P and 20 kg K /ha. Application of Nitrogen in to split during July and August</td></tr>
<tr><td>Life saving Irrigation</td><td>Initial 2 year- as and when required (from April – onset of monsoon)</td></tr>
<tr><td>Cultivar</td><td>Aonla-NA-7, Krishna, Kanchan, Chakaiya. (10% plants of other cultivar must be incorporate in a orchard for pollination) . Guava- Lalit, Shweta and Allahabad Safeda
<table>
<tr><td>Grass</td><td>Variety</td></tr>
<tr><td>Chrysopogon fulvus</td><td>GAUD-1</td></tr>
<tr><td>Cenchrus ciliaris</td><td>Bundel Anjan-1, CAZRI-75</td></tr>
<tr><td>Panicum maximum</td><td>Hamil,Bundel Guinnea-1,</td></tr>
</table>
</td></tr>
</table>

		Bundel Guinne-2, IGFRI-10.Co-1, Co-2
	Legume	
	Clitoria ternatea	
	Stylosanthes hamata	
	Stylosanthes seabrana	
Harvesting of Pasture	Harvesting of pasture 2-3 time(From September to December) as per monsoon and growth of pasture. Always follow cut and carry system.	
Harvesting of fruit	In grafted plant fruiting started 3 year in Guava and 4th year in Aonla. Aonla harvested -Mid December – mid January. Guava harvested -Mid January –end of February.	

Technology- VIII: Community pastureland development

CPR development at SODA Rajasthan

Dimension: Indian subcontinent is characterized by tropical monsoon climate having degraded forests and under seasonal protection; grasses grow and produce a typical monsoonal savanna with low productivity levels. In this, the active growth of grasses in grazing land occurs only during monsoon season. The grazing intensity in such type of natural grassland is as high as 12.6 ACU/ha compared with 0.8 ACU/ha in developed countries. Productivity can be increased by developing model grass land with minimum input and management.

Combination of range grasses and legumes : *Cenchrus ciliaris, Cenchrus setigerus, Chrysopogan fulvus, Sehima nervosum, Heteropogon contortus, Dichanthium annulatum, Bothriochloa intermedia , Stylosanthes seabrana, Stylosanthes hamata, Clitoria ternatea, Macroptilium atropurpureum*

Target area: Degraded land, community land and forest land available with different state governments in India

Impact: Rangelands are extensive areas which are unfit for arable farming and are mostly under natural vegetation where animals graze. The vast arid and semi arid tracts including the great Indian desert, the Himalayan rangelands involving the seasonal pattern of animal migration and other forest grazing areas depict the true nature of Indian rangelands. These vast areas could be developed as model grassland with increasing production potential with rich genetic diversity of forage plant species in different eco-climatic conditions and a variety of habitats and niches.

As an impact it has been well taken by different stakeholders as a successful model in 70 ha area in Soda **(Rajasthan**) and 25 ha forest area in Orcha, Madhay Pradesh **(Bundelkhand)** . Many stakeholders are coming forward to establish this model in their areas.

States suitable for adoption of this technology: A.P., Karnataka, Tamilnadu, Telangana, Utarakhand, Bundelkhand part of M.P and U.P. Maharashtra, Chattisgarh,Jharkhand, H.P. and J&K, etc. states of India

Establishment cost of the system: Rs.25,000-30,000/ha.

B:C ratio: Over the period of 10 years:1.5-2

Forage production: 6-8 t Dry Matter /ha/year

ACU: 2-2.5 ACU/ha, availability period of fodder from July to December.

Technology package (Community pastureland development)

Field preparation & bush cleaning	1 Disc ploughing and 2 ploughing by cultivator
Fertilizer application	20 kg N, 20 kgP/ha as basal doze and 20 kg N after one month as top dressing.
Seed rate	3-5 kg (grass+ legume mixture)
Method of sowing	1) Through Seed- Line Sowing/Broadcasting or
	2) Through Rooted Slip-Nursery raising of grass: 20 beds for one ha , bed size 8x 1.5 m
Source of seed : ICAR-IGFRI, Jhansi, ICAR-CAZRI, Jodhpur, Rajasthan DADF, New Delhi AICRP on Fodder Crops, Jhansi and its centers	

Technology- IX: Fodder production in mango orchards

Perennial sorghum in mango orchard

Napier Bajra hybrid in mango orchard

Dimension: In Karnataka, the common mango planting distance followed is 10 m by 10 m giving minimum 7-8 m inter space for introducing fodder crops. Karnataka has an estimated 90,000 ha in prime fruiting mango crop which if put under fodder crops (Bajra Napier Hybrid, Guinea, Perennial fodder sorghum) is estimated to produce 39.5 lakh tons of green fodder in a year meeting more than 7 lakh livestock's green fodder requirement round the year.

States suitable for adoption: Mango (prime fruiting stage, above 4 years) based farming system in Karnataka, Maharashtra, Andhra-Pradesh, Uttar Pradesh, West Bengal, Bihar

Cost of production and returns (Per ha):

Irrigated system with propagation by rootslips
Cost: Rs.29400.00 Returns: Rs. 175200.00

Rainfed system with propagation by seeds
Cost: Rs.12500 Returns: Rs.72000

Targeted farmers: All categories of mango growers

Minimum number of days for which fodder will be available:

Irrigated system: 240 days
Rainfed system: 90 days

Possibility of seed production and quantity:

Irrigated system: Rootslips multiplication is possible. Upto 390000/ha
Rainfed system: Seed production is possible. 70 to 80 kg/ha

Impact: It can provide green fodder of 146 t/ha/year with the gross value of Rs.175200=00 in irrigated condition. Besides it results in indirect economic benefits like saving cost of feed by 47%, increase in milk yield by 0.93 litres/ACU and labour saving by 0.91 mandays. **Till now 28 ha (70.07 acre) area has been covered and 84 farmers are benefitted.** Lesson learnt from this success story is being replicated in other fruits and plantation crops like sapota, coconut, areca nut in Karnataka state from June 2016.

Estimated expenditure per demonstration :
Unit of demonstration: Acre
Cost of demonstration:
Irrigated system: Rs.9760/acre
Rainfed system: Rs.3000/acre

Package of Practices
Crop varieties used: Bajra Napier Hybrid (var DHN-6), Guinea (var BG-1 and BG-2), Perennial fodder sorghum (CoFS-29), Cowpea (BL-1 and BL-2)

Source of planting material and seeds: IGFRI SRRS, Dharwad

Planting material /Seeds required: 20000 rootslips per ha (Bajra Napier hybrid and Guinea)

Seeds: 8 to 10 kg/ha (Perennial fodder sorghum)

Time of sowing/planting: Monsoon season is best. If irrigation is present any time of the year except peak winters

Planting/Sowing: Planting of grasses 1.5 m away from main crop (Mango); 60 cm X 60 cm row to row and plant to plant

For seeds: 45 cm row to row and 10 cm from plant to plant

Fertilizer application (ha): FYM: 5 tons per ha, NPK 100:70:45; after every 2 cuts, 50 kg nitrogen under irrigated condition. For rainfed system 5 tons FYM.

Inter-cultivation: First inter-cultivation after 20 to 25 days of planting, later after every two cuts

Irrigation: In winter once in every 15 days; in summer once in 10 days

Harvest: First cutting after 60 to 70 days of planting/sowing; subsequent cuts for every 40 to 45 days. First year 5 cuts and in subsequent years 6 cuts/year in irrigated condition. In rainfed 3 cuts in a year

Green fodder yield: 80 to 100 tons per ha in rain fed condition; 180 to 220 tons/ha in irrigated conditions

Annexure I

Table 1: Promising drought tolerating varieties of grasses and cultivated fodder

Crop	**Varieties**
Sorghum	Pusa Chari-1, CO-27, SSG 59-3 (Meethi Sudan), CSH-20MF (UPMCH- 1101), PAC 981, CSV–15
Bajra	Avika Bajra Chari (AVKB-19), Raj Bajra Chari-2, CO-8, APFB-2, PCB-164
Maize	Pratap Makka Chari 6
Oat	FOS-1/29, Bundel Jai-822, Bundel Jai 992 (JHO 99-2), JHO-2009-1
Cowpea	Bundel Lobia-1, Bundel Lobia-2 , S 450
Guar	Durgajay, Durgapura Safed, HFG-119, Bundel Guar- 1, Bundel Guar- 2, Bundel Guar- 3
Sem	Bundel Sem-1
NB hybrid	CO-1, NB-37
Dinanath grass	Bundel-1, Bundel-2, COD-1
Sudan grass	Meethi Sudan, Sweet Sudan Grass, Punjab Sudex Chari-1 (LY-250)
Guinea grass	Bundel Guinea-1 (JHGG-96-5), Bundel Guinea-2 (JHGG 04 –01)
Anjan grass	Bundel Anjan-1, CO-1 , Bundel Anjan-3
Motha dhaman grass	CAZRI-76, Marwar Dhaman (CAZRI-175)
Black spear grass	Bundel Lampa Ghas -1