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DR. MANGALA RAI TAKES OVER AS SECRETARY, DARE AND D.G., ICAR

The ENVIS Centre on Desertification and CAZRI, Jodhpur extends hearty congratulations to Dr. Mangala Rai, for taking over the charge as Secretary DARE and Director General, Indian Council of Agricultural Research (ICAR), New Delhi. Born on June 30, 1947 Dr. Rai has served the Council in various important positions. As Assistant Director General (Policy & Perspective Planning), he was instrumental in drawing up a blue-print of NATP. As ADG (Seeds) for nearly six years (1989-94), Dr. Rai organised the seed research in the country and thus strengthened the basic link in agricultural production chain. The country witnessed multifold increase in the production and distribution of Breeder and Certified seeds. He was OSD (Oilseed Technology) in the TMOP and his vision planning and execution of the mission resulted in doubling of oilseed production in the country that was recognised as 'Yellow Revolution'. Dr. Mangla Rai, served the Council as Dy. Director General (Crop Science) for a period of nearly six years (1997-2002) and during that period he developed many new varieties of crops and increased country's export in many folds.

Dr. Rai worked as Chairman of Central Sub-committee of Crop Standards and Varietal Release and Notification of Government of India. Dr. Rai is also on the Board of Directors, National Seeds Corporation of India and on the Board of Management of three State Agricultural Universities, Indian Agricultural Research Institute, New Delhi and National Academy of Agricultural Research Management (NAARM). Considering his managerial capabilities Dr. Rai was given the assignment as Local Secretary of the 88th Indian Science Congress held in January, 2001.

A renowned expert in agriculture, Dr. Rai has traveled extensively to over 20 countries and represented the country at several international meetings and provided leadership on genetic resources and intellectual property rights. He served as Consultant to FAO and International Development Research Centre, Canada and as Chairman SAARC Agricultural Information Centre and Technical Committee of SAARC on Agriculture. Recently, he has been elected as Chairman of Asian Maize Biotechnology Network and is now on the Board of Trustees of CIMMYT, Mexico.

He was elected to the Presidency of several important scientific societies including Indian Society of Genetics & Plant Breeding, Plant Genetics & Plant Breeding, Plant Genetic Resources, Oilseeds Research, Plant Physiology, Seed Technology, Allelopathy, Agrotechnology and Bioenergy. Dr. Rai is elected fellow of National Academy of Agricultural Science and has been conferred D.Sc. (Degree) Honoris Causa by C.S. Azad University of Agriculture and Technology, Kanpur, India.

With his rich experience in research, planning and implementation, able management and administrative capabilities and having special interest in seeds and seed technology, Biotechnology, Biodiversity and IPR in agriculture, ICAR in particular and Indian Agriculture in general will certainly move forward to achieve all round development.

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GUAR - A FORMIDABLE CROP FOR INDIAN ARID ZONE

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Harnessing agricultural production from arid habitats has been a challenging task before the agriculturists and agricultural scientists due to obvious hostilities and adversities inherited with the arid eco-system. Nevertheless, this system has been fortunate also due to availability of field crops with characteristic development of required elasticity and plasticity in their genomes for time memorial exposure, rendering therefore, exemplary specific adaptations to these situations only. The field crops of the zone are rated unparallel in adaptation; tolerance to drought, heat and nutritional deficiencies; exhibiting less incidence of diseases and insect-pests, with improved WUE and being photo synthetically effective, therefore providing high biomass production in such unprecedent situations. Citing of the crops, viz., pearl millet, guar, moth bean, cowpea etc., amply justifies the same, looking synonyms to Indian arid zone due to perhaps matching or encroching the unpredictable intensity and extent of aridity. Of these valuable field crops, guar known as cluster bean (*Cyamopsis tetragonoloba* L. Taub) has been grown in Indian arid zone for past many decades and is probably the most ancient legume, dates back its introduction to Botanical Gardens in Calcutta during 1768. Acquired morpho-physiological attributes by this legume for acclimation to its short and long range environmental fluctuations have contributed to its confinement to arid zone, particularly, with less inputs and little after care, the situation in which majority of the crops may wipe out.

Area and Production :

Guar is mainly grown in dry habitats of Rajasthan, Haryana, Gujarat and to limited extent in parts of Punjab, Uttar Pradesh and Madhya Pradesh. Besides, India, guar is also grown as cash crop to some extent in other parts of the world, viz., Australia, Brazil, South Africa, North Texas. In India it is grown in 23.30 lakh ha area. The maximum contributions of these states in respect of area is shared by Rajasthan (18.1 lakh ha) followed by Gujarat (2.27 lakh ha), Haryana (1.27 lakh ha) and Punjab (0.14 lakh ha). In other words, Rajasthan alone contributes 83.0% area and produces hardly 59% with only 231 kg ha^{-1} productivity. The important uses of this drought hardy legumes are as follows :

1. Green manuring: Guar is used for green manuring in canal command areas. It has potential to tolerate moisture content upto 75-80% and has ability to decay in the soil even with minimum soil moisture. As a green manuring crop it can provide 50-60 kg N ha^{-1}.

2. Soil health: Broad leaves and their complete sheding upto maturity may add to soil organic carbon. Deep root system which decays after harvest of the crop may conserve the soil. Being legume it can fix 30-40 kg N ha^{-1} from the roots, through bacterial nitrogen fixation common to the leguminous plants ultimately leading to soil health.

3. Human consumption: Young green pods are very good source of delicious vegetable from late summer to mid rainy season. On an average basis guar crop can give 37 (Pusa Sadabahar) to 160 q ha^{-1} (Sharad bahar) green pods in 50-90 days under irrigated conditions and almost half of it under rainfed conditions. The pods can be cooked as those of *Phaseolus* bean pods. Guar pods are very good source of vitamin A (65.3 IU), Calcium (57 mg), Iron (4.5 mg), Phosphorus (57 mg) and Ascorbic acid (49 mg) which add to its nutritive value.

4. Medicinal purpose: It has medicinal values for curing some diseases. Leaves are eaten for curing night blindness. Boiled guar seeds are used as poultices against plagues, extended liver and swelling due to broken bones. Guar seeds are used as chemotheraputic agents against luxative and small pox. It suppresses the hunger, hence can be used in slimming aids.

5. Guar meal :

(a) Germ and seed coat together form guar meal for animals which constitutes 40-42% protein, is good for livestock feed and known as protein concentrate. Guar meal can completely replace protein supplements, like groundnut oil cake in ruminants. Lower concentration of guar meal in the diet has been found useful for poultry while higher percentage may decrease feed efficiency.

(b) Protein concentrate prepared from guar meal is free from beany flavour and used to fortify the biscuits which are more lasting and crispy than "Vitamino" biscuits developed by CFTRI, Mysore. This has opened new avenues for utilization of guar meal for human consumption and will have bearing on economic and viability of guar industry.

6. Fodder: Guar is a source of nutritive fodder to the livestock. The green forage on dry matter basis contains 16% crude protein, 46% TDN, 11-12% DCP and 60% dry matter digestibility. It is adviseable to feed guar at flowering stage. Guar is nutritive and makes good silage when mixed with wheat straw.

7. Source of foreign exchange: A natural polysaccharide galactomannan guar gum obtained from protein free splits of endosperm is a source of foreign exchange. For instance, guar gum to the tune of 1,10,000 metric tones, costing Rs. 814.0 crore was exported to Western countries in 1999-2000. India is a largest source of gum in the world enabling its export to 65 countries.

8. Source of employment: It provides sizeable number of employments in Indian arid zone through guar gum industries numbering more than 50 in Northern Western parts. It also generates employments through world trade to the order of 1,20,000 ton annually, of which India alone contributes almost 75%.

9. Adaptive tolerance: Under acute soil moisture deficit situations encountered with highly irratic rains, soils and nutritional deficient being moderately saline with characteristic transpirational cooling this crop can certainly give some production. Guar being the immediate choice for augmenting production, therefore, helping combat desertification and degradation of soil environment on arid environment due to retaining canopy in wake of high temperature and soil movement.

Industrial uses: Guar seed endosperm which is rich in galactomannan polysaccharide gum, called guar gum is an important product worthy of industrial uses in many ways. Guar gum acts as a binder, thickner or stabilizer; in other words, its use can be envisaged in all system where water is an important factor. The main industrial uses are as follows:

1. Food uses

(i) In frozen food: Due to water holding properties and ability to inhibit ice crystal formation, guar gum is used as a binder and stabilizer in many frozen food preparations; like, ice cream, ice pop, water-ice, lollies, sherbets and iced deserts. Guar gum together with sugar, fat and water-free milk components provides a suitable mixture for the preparation of ice cream, milk shakes and alcoholic milk drinks.

(ii) In baked food: Guar gum is used as a moisture-retention agent. It increases shelf-life in industrial bread making. Guar improves the elasticity of the bread. Generally guar gum is used 0.1-0.2 % of the total weight of the dry ingredients.

(iii) In processed cheese: Guar gum improves the texture in cold pack cheese products. It works as a moisture distribution control agent. When guar gum is incorporated, yield of the curd solid increases. Without use of whey, guar improves the texture of the final product.

(iv) In dairy products: Guar gum, when used alone or combined with other water soluble gums such as locust bean gum, xanthan gum, gelatine or modified starches becomes an excellent stabilizer for dairy desserts and acidified dairy products such as yoghurt, kefir and quarg.

(v) In instant mixes: Many hydrocolloids are used as a stabilizer and gelling agent in packaged food mixes but guar gum offers more functional advantages than others. It brings body and mouth-feel to instant milk deserts, puddings and chiffon pies. Guar gum is a fast, cold dispersible thickening and texturing agent used in instant sauces, a cold or hot thickening and suspending agent for powdered chocolate mixes, instant beverage preparation.

(vi) In meat products, canned meats: Guar gum acts as a binder and lubricant in the manufacture of a variety of meat products such as saucages, stuffed meat products, sliced meat products and canned meat such as corned beef, luncheon meat, pet foods and baby foods. The cold water solubility add hydration of guar gum permits easy processing while absorbing and binding excess water. The resulting meat is firmer and consistency in the can is better.

(vii) In beverages: Guar gum is used as a viscosity control and suspending agent in fruit beverages and fruit nectars. It improves mouth-feel in sugar less low calorie drinks. Guar gum is useful to resist the breakdown during sterilization in low pH condition. As it is cold water soluble, it can be used in beverage processing plants.

(viii) In pharmaceutical industry: Guar gum is used as a binder or dispersant agent in various pharmaceuticals and cosmetic preparations. Guar is also used as medicine in the antidiabetics formulation drug and dietery control.

2. As textile thickners

(i) Depolymerised guar gum, made by chemical modification, is suitable to use as textile thickners for sizing, printing and finishing of cotton, rayon silk, polyester, polyamide, polyacetate, acetate, triacetate and wool.

(ii) In textile printing, suitable modified guar product is required which runs through machine without any trouble and has compatibility with all chemical auxillaries colours used and during printing process. Modified guar gum is also easily washable from printing cloth after fixation of colour.

(iii) Modified guar gum used in printing gives good printing finishing, evenness in printing, penetration of colour as well as, it gives good colour yield and brightness. The guar product should be suitable with a variety of dyestuffs normally used for synthetic fabrics, such as dispersed, acid, metal complex and basic dyestuffs. Carpet printing is done by various methods and the gum requirement varies with the method. All these methods require a gum thickner, and the thickner must have special characteristics for optimum performance. The thickner should be low in insoluble content, high in viscosity, easily dispersible to a lump-free paste, extremely soluble for easy washout, produce good apparent colour value, and be compatible with auxiliary chemicals and dyes being used.

3. In paper industry

(i) The gum added to the pulp suspension before the paper sheet is formed on either a fourdriner machine (on endless wire) or a cylinder machine. The pulping process, which is designed to remove lignin and produces a fibrous cellulose pulp, also removes the large parts of hemicelluloses normally present in the wood. Guar replaces or supplements the natural hemicellulose needed in paper bonding.

(ii) One of the properties of guar is its hydrogen - bonding effect, an effect which is known to be one of the major factors affecting fibre-fibre bonding.

(iii) Guar gum is also used as an additive in size press or calender operations in many paper industries. Guar gum increases the viscosity of the paste which is made from starch or modified starch and controls the pick up. There is a chance of gelation with naked starch but addition of guar prevents gelation.

4. In mining industry :

(i) In mining industry, guar gum can be used as depressant and auxiliary reagent, flotation agent, as foam stabilizer and also as filter aid.

(ii) Guar gum is also used as an settling agent. Normally large tanks or thickeners are used to effect settling. By adding guar gum to the thickener, faster settling of the suspended solids can be achieved. This reduces the amount of thickener required to settle a given amount of solids.

(iii) Guar gum has good application as a filter aid in mining. Filters are required to remove suspended slimes or clay particles. But these small particles have a tendency to form a very compact filter cake which traps water within itself and plugs the filter surface. The addition of guar gum to a pulp gives settling of suspended particles and these large flocks no longer have a tendency to blind the filter screen and at the same time, they allow a quicker channeling of liquid through the filter cake.

5. Oil well drilling:

(i) Like many other water soluble gums, guar is used widely in the production of crude oil. In this case, the main use is as an oil exploration and drilling agent. In oil and gas production, drilling fluids are employed in various processes for fracturing and drilling operations. Addition of guar gum/ modified guar gum gives many advantages. Water loss control, viscosity control, frictions reduction, lubrication and drilling of the drill bit, suspension aids and mobility control to carry out of the well bore cuttings and chips.

(ii) Drilling fluids and spacers exploit the viscosifier property of guar gum to suspend weighing materials. Guar gum with its high molecular weight and nearly straight chain configuration reduces the friction pressure in turbulent flow.

6. In explosive industry

Guar is a water proofing agent for ammonium or sodium nitrate stick explosives. The gum is used as gelling agent when reticulated in association with cationic metal with slurry explosives. Guar also absorbs the free water which is produced during reaction.

7. In tobacco industry

Guar is used as a binder for fragmented tobacco fines in the manufacture of reconstituted tobacco sheet. Tobacco fines are moisturized, guar gum and a humectant are passed between roller presses as a film of appropriate thickness which after drying is stripped in continuous sheets. The flexible sheets thus, obtained can be further blended with tobacco leaves.

8. Fire fighting

Water for fighting fires can be handled faster and at a lower energy cost if friction reducing aids such as guar gum are added. In addition to providing a greater flow or less pressure drop in a fire fighting line, the jet from a nozzle tends to be more resistant to break-up by the wind and to concentrate the stream on a small area, all of which are important factors in fire-fighting.

Main Challenges: Gaur has been facing certain challenges which affect its average productivity and shattering quantum of export also. Some of the critical challenges are out lined below :

1. Technical :

(a) Poor and unstable productivity

(b) No variety for summer sowing

(c) Longer maturity

(d) Susceptibility to region specific diseases

2. Socio-economic:

(a) Marginal status

(b) Second choice of the farmers

(c) Planting on neglected soils with poor fertility

3. Support price:

Area and production fluctuating due to crash in price.

4. Nutritional quality:

(a) Guar protein low in containing amino acids

5. Alternate source of gum content:

Biggest challenge guar crop facing is the availability of alternate sources of galactomannan gum or the hydrocolloids. For instance, *Sesbania bispinosa, Sesbania sesban, Cassia accidentails, Cassia sophera, Cassia tora.* Abundant availability and comparative gum quality in these legumes are causing serious threat to guar as an industrial crop. For instance, gum content higher in these legumes range from 33.0 (*C. tora*) to 37% (*S. bispinosa*) against 32.5% of guar. High viscosity desired for export purpose was also considerably higher in *S. sesban* (3160) and *S. bispinosa* (3800) than 2800 in guar (*C. tetragonoloba*).

Moreover, India's nearest and immediate competitor for guar gum in international market is Pakistan, whose gum has by and large been of better quality than ours.

Resume

Thus, clusterbean commonly known as guar at the national and international level is very important and valuable plant material for Indian arid zone due to its wide

uses: soil health, fixation of atmospheric nitrogen, green vegetable, medicinal purpose, fodder, guar meal, source of foreign exchange, providing employment and used in a number of industries; and inherited adaptive tolerance. The crop is however pitted against non-traditional legumes having the source of alternate glactomannan gum content. The content and quality of gum contained by these legumes is improved that guar. However, guar crop can compete well with these crops (*S. bispinosa, S. sesban, C. tora, C. sophera*) if yield productivity of guar crop is increased from present level of 231 kg ha^{-1} in Rajasthan and are of this crop is increased in other states of Gujarat, Haryana and Punjab where productivity is higher.

DRYLAND LIVELIHOODS IN INDIA

Strategies for coping with change in semi-arid India have been studied by researchers from India and the UK, with the aim of examining differences between drier drought prone areas (DP), and non-drought prone (NDP) areas of the country to draw comparisons and see how things have been changing over time. The research provides interesting insights of broader relevance to many African dryland settings.

In general, DP areas rely less on agriculture for livelihoods and are more dependent on migration than NDP areas; population densities are lower as is the share of agriculture as a source of employment while urbanisation rates are higher in drought prone regions. Poverty is increasingly concentrated in cities and towns as people seek to earn in living off the land. A smaller proportion of cropped area is irrigated than in NDP regions, but there is a clear trend towards intensification of farm production and increased use of purchased inputs. While holding sizes are still almost twice as large as those in non-drought prone areas, average farm size is falling rapidly, land distribution is becoming more inequitable, and landlessness is rising.

Water shortages present a major and growing threat. Water availability is decling, especially where surface and groundwater is being sought by other users, such as mining in and around Udaipur. The supply of water to industry and urban areas is using up rural water sources, urban water needs being sourced from wells hitherto devoted to agriculture.

Most diversification is out of the farming sector. Poor households tend to diversify into casual, unskilled wage labour, while the better off, having some education, can often gain higher paid work and salaried employment. Hence diversification seems to be sidening income disparities in India. Neevertheless, all of those interviewed considered that their standard of living had improved over the last 20-30 years.

Use of common property resources used to from an essential component in livelihood strategies, especially in drought years, such as 2000, but many such resources have disappeared, having been encroached on by farmers for cropping, allocated to commercial contractors, and privitised. The experience of cotton and groundnut farmers shows how liberalisation and globalisation can bring damaging consequences for small holders. A combination of low profitability, crop failures, high input costs and heavy indebtedness has led to several hundred suicides and landlessness.

Household livelihood and coping strategies in semi-arid India; Adapting to long-term changes. Czech Conroy et al, Research Report - Society for Promotion of Wastelands Development, Delhi. spwd@vsnl.com. Also available from NRI +44.1634.880066

(HARMATA : Bulletin of the drylands : People, Politics, Programmes. No. 42 year 2002)

DROUGHT MITIGATION AND POVERTY ALLEVATION THROUGH TREE PLANTATIONS IN ARID REGIONS

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The arid and semi-arid regions are characterized by hostile environmental conditions such as low and erratic rainfall, intense solar radiation and high wind velocity. Almost during the whole year, the evapotranspiration far exceeds precipitation. Besides, the productivity potential of the land is also usually low. The soils are immature, structure less and very coarse in texture with low water holding capacity and poor nutrient status. Under such agroclimatic conditions crop production is a gamble if not impossible. The results of the last 100 years of rainfall data revealed that out of 100 more than 30 years were drought years and productivity of the crop was abysmally low. In the recent past, during 1982-1987 and 1997-1999 the region faced the severe droughts and again last year (2002) the situation became most worst when it rained only 50.6 mm.

The droughts not only affect the crop production but also the ground water level because of poor recharge. The lowering of ground water is not only due to low recharge but also because of excessive use of water for irrigation, and therefore, in last couple of years, most areas have been declared as dark zone, gray zone by the Ground Water Department.

In view of the above and to mitigate the recurring drought situation the farmers may be advised to concentrate on multipurpose tree plantation. Though the farmers of the desert region are already growing multipurpose trees using traditional techniques, in association with the crops to get some tree products in the lean period it needs to be supported by the scientific approach.

In this paper an attempt has been made to add some value addition in the tree products so as to improve the farmer's economy.

Minor Forest Producing Trees: There are many trees/shrubs growing in the regions are capable of yielding products of economic importance (Table-1). Exploitation of these plants would ensure steady income for subsistence level of tribal farmers and improve the economic conditions of other farmers too.

(i) Gum producing trees: *Acacia senegal, A. nilotica, A. jaquimontii, Cordia rothii, Commiphora wrightii* and *Prosopis cineraria* have a great potential to exude gum. Besides, *Acacia tortilis* and *Prosopis juliflora*, an introduced plants also have very high potential to exude gum. But so far they have not been exploited for commercial gum production. The farmers/tribal people collect the gum exude and sold in the market. These plants naturally exude only 5-10 gm gum/tree which is very low in production.

Recently some efforts have been made to increase the gum production without any adverse effect on the tree growth. Khan and Harsh (1994) and Harsh et al (2000) used the Ethephon - a plant growth regulator to enhance the gum production from different trees (Table-2) . By the use of ethephone, the gum production has increased from 10 gm/tree to 500 gm/tree in *A. senegal*. The cost of treatment of per tree is not more than Rs. 10/- while the produced gum fatches more than Rs. 100/- per tree. The exudation of gum from each tree can be done more than six years. *A. senegal* is wildly growing tree in the arid western Rajasthan with a varying density (10-30 trees/ha). By applying the gum exudation technique the farmers may increase their income to Rs. 1000 to 3000 / year besides crop harvest and tree seeds (Photo-1).

Table 1 : Tree/shrub species, their uses and distribution

Name of spp	Uses	Rainfall (mm)	Land form
Prosopis cineraria	Leaf fodder, green pods as vegetable, dry pods fruits, fuel wood etc.	150-450	Soil loam, sandy
P. juliflora	Pods as cattle feed, wood as small lumber and gum and fuelwood	100-1000	All types of land form except frost prone areas
Acacia senegal	High quality gum, seed as vegetable, leaves as fodder, fuel wood	100-450	Sandune systems rocky refractory site and sandy loam soils
A. tortilis	Gum, leaves and pods as fodder, timber, farm equipment, tannins, fuelwood etc.	350-1000	Sandy loam, clay loam etc.
Salvadora Sp.	Fruit, edible oil and fuel wood	250-500	Saline soils, sand loam
Anogeissus rotundifolia	Leaves as fodder, fuel wood, gum	400-750	Rocky, gravelly refractory site
A. latifolia/ pendula	Edible gum (gum ghutti) fuel wood, also low quality timber	500-1000	Rocky, gravelly refractory site
Pongamia glabra	Non-edible oil, fuel wood, avenue plantation	350-750	Sandy loam
Capparis decidua	Fruits for vegetable, medicinal uses, etc.	150-400	Shallow calcarious soils, sandy alluvial soils
Azadirachta indica	Non-edible oil, medicines and pesticides, etc.	350-1000	All types of soil except saline, frost prone areas
Acacia jaquimontii	Small wood for farm implements, soil conservation and gum	150-350	Sand dunes, sandy plains

Table 2 : Induced gum production from different tree species

Species	Ethephon content in ml/plant	Time of application	Gum production/plant (gm)
Acacia senegal	600 mg/4 ml	Feb. end to April end	100-3000
Anogeissus rotundifolia	400 mg/4 ml	March 1st wk to April end	500-3000
Boswellia serrata	400 mg/4 ml	Dec.-Feb.	500-1500
Acacia jaquimontii	600 mg/4 ml	April-May	100-600
Acacia tortilis	600 mg/4 ml	Feb-April	100-700
Acacia nilotica	600 mg/4 ml	April end to May	50-250
Eucalyptus camaldulensis	600 mg/4 ml	March	0-1200

(Gum Exudation in *Acacia senegal* by application of Ethephon)

Similarly *Acacia tortilis* an exotic tree which was introduced in 1958 from Israel at CAZRI, Jodhpur and till now (2002) it has been planted on more than 1,00,000 ha in arid western Rajasthan, specially for sand dune stabilization, village fuel wood plantation on common lands as well as on road side plantation.

This plant also has great potential for gum exudation but it was not exploited for this purpose. Recently some of the trees were treated with ethephon and they profusely exude gum (ranged 100-700 gm / tree). So far this tree was mainly used for soil conservation and also as fuel wood, but according to the new research if it is being explored for gum production, then it may change the economy of the region.

Similarly, it is also observed that if its wood is seasoned and treated with insecticides than it can be used for preparation of low cost furniture.

Aacacia jaquimontii, locally called Bhoo Bavali, commonly growing on the sand dunes in Bikaner, Jaisalmer and Jodhpur is mainly used for making baskets. It also produces the gum and sold in the market at the rate of Rs. 500-600/kg in the market of Bikaner, but natural production of gum is very low. However, by the application of ethephon the gum production can be increased from 100-600 gm/tree. Therefore, from such trees we may plan to change the economy of the farmers. Besides, there are number of trees viz. *Anogeissus rotundifolia, Boswellia serrata*, and *Commiphora weightii* which can be exploited for gum/oleoresins production and they also have responded to etheral .

(i) Trees for fodder: In desert area mainly *Prosopis cineraria* (Khejri) is used as fodder. The tree lopped in the month of December and dry leaves (called Loong) are used as fodder for sheep and goat. In the double cropped area it is being lopped twice a year (May-June and October). The lops and tops done in the month of May-June are used as feed for animals as green fodder. By lopping Khejri, each tree can produce 10-15 kg dry loong per tree, in a normal rainfall but during drought year about 30-40% reduction was recorded. If a farmers maintains 30-50 tree/ha, he can rare 1-2 sheep/goat round the year.

In the recent past some other trees viz. *Colophospermum mopane Hardwickia binata* and *Ailanthus excelsa* are also used as fodder. By lopping *H.*

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Similarly, it is also observed that if its wood is seasoned and treated with insecticides than it can be used for preparation of low cost furniture.

Aacacia jaquimontii, locally called Bhoo Bavali, commonly growing on the sand dunes in Bikaner, Jaisalmer and Jodhpur is mainly used for making baskets. It also produces the gum and sold in the market at the rate of Rs. 500-600/kg in the market of Bikaner, but natural production of gum is very low. However, by the application of ethephon the gum production can be increased from 100-600 gm/tree. Therefore, from such trees we may plan to change the economy of the farmers. Besides, there are number of trees viz. *Anogeissus rotundifolia, Boswellia serrata*, and *Commiphora weightii* which can be exploited for gum/oleoresins production and they also have responded to etheral .

(i) Trees for fodder: In desert area mainly *Prosopis cineraria* (Khejri) is used as fodder. The tree lopped in the month of December and dry leaves (called Loong) are used as fodder for sheep and goat. In the double cropped area it is being lopped twice a year (May-June and October). The lops and tops done in the month of May-June are used as feed for animals as green fodder. By lopping Khejri, each tree can produce 10-15 kg dry loong per tree, in a normal rainfall but during drought year about 30-40% reduction was recorded. If a farmers maintains 30-50 tree/ha, he can rare 1-2 sheep/goat round the year.

In the recent past some other trees viz. *Colophospermum mopane Hardwickia binata* and *Ailanthus excelsa* are also used as fodder. By lopping *H.*

binata, and *C. mopane* on an average 5-7 kg/tree dry leaves can be harvested and thus farmer can maintain their livestock during lean period.

The areas where irrigated crops are in practice, *Ailanthus excelsa (Ardu)* and *Acacia nilotica Vr. Cupressiformis* can be grown in association with crops. Ardu leaves are used freshly and most liked by the sheep and goat. By lopping a 15 years old tree about 2-4 ql of leaves can be harvested and which may fatch approximately Rs. 200 - 400. Since 1985 large scale plantation of Ardu has been done by the farmers in Sikar and Jaipur districts of Rajasthan to meet their fodder requirement. Similarly *A. nilotica Vr Capressiformis* is also used as lean period fodder in Pali and Sirohi districts of Rajasthan.

During the current year (2002) due to failure of monsoon rains, even grasses failed to resprout and, therefore, farmers of the region are maintaining their animals on above said tree species. Not only their leaves are used as fodder but also the pods of some plant species are used as livestock feed and human food.

Pods as livestock feeds: *Prosopis juliflora's* ripened pods are very much liked by sheep, goat and buffalo. Presently they are grazed as such without any processing which may cause fatality in the livestock. But if they are systematically collected, grounded and 20% flour is mixed with cattle feed, then milk yield of cattle can be increased and uneven distribution of seeds through cattle rumen can be checked. In Gujarat VRTI and other private entrepreneurs are preparing cattle feed by *P. juliflora* pods. Gujrat State Forest Development Corporation (GSFDC) has collected 2000 mt of pods and has processed. It has also been estimated that from the north western arid zone of Gujarat two million tones of pods can be collected and used as cattle feed. If in the same way, if Forest Department of Rajasthan collects the pod of *P. juliflora* and processes than the wide gap of feed can be reduced.

Similarly the pods of *A. tortilis* are the major source of feeds for camel, sheep and goat. The livestock consume the fallen pods. If these pods collected systematically than from one tree average 20 kg pods can be harvested. Till date 100,000 ha area have been planted by *A. tortilis* with a spacing of 5 x 5 m and if 50 per cent plantation considered productive than 400,000 t of pods can be collected from planted trees.

Pods as human food: There are number of desert trees, whose pods/seeds are used as vegetable by the desert dwellers. *P. cineraria* pods (unripned locally called *Sangari*) is the main constituent of Panchkuta - a famous vegetable being consumed by the desert dwellers. From one tree 5-10 kg pods may be collected and if they are collected in a organized way than from the existing population of *Khejri* approximately 1,13,000 t of *Sangari* can be collected.

In *Khejri*, pod can only be produced provided trees are not lopped for leaf fodder (Loong). Therefore, it is proposed that ¼ tree canopy should not be lopped to produce the pods, so that farmers can get at least 4-5 kg pod/plant and can earn Rs. 1000/- additionally.

Similarly *A. senegal* seeds (Kumat) are also used as vegetable. But if semi-ripened pods and seeds at green stage are harvested and processed, than green kumat (like heena pea) can be sold in the market and farmers may fatch four to five times more money than dried seeds.

P. juliflora pods are now a days also used for human consumption in Latin America, Arizona and Texas. The pod flour is used in making biscuits, cookies, coffee, syrup etc. In India, at CAZRI, Jodhpur biscuits and syrup were prepared. Therefore, *P. juliflora* pod for human consumption requires to be explored.

Trees as minor timber: *Tecomella undulata* (Rohida - a Marwar Teak) is only the tree, which has a high commercial timber value. *A. nilotica* is another tree whose wood is mainly used for construction of door frames, agricultural equipment etc. However, the use of *P. juliflora* wood has not been explored for minor timber as yet. Recently its wood has been explored for use in preparation of small articles such as tables and stools and in flooring. The wood quality is comparable to Shisham or Indian rose wood and Indian Teak wood (Table 3 a & b). In fact, *P. juliflora* wood equals or surpasses the physical and mechanical properties of other common recognized fine hardwood of India. If wood can be sold at the rate of Rs. 200-400 cubic feet where as a fuel wood is fetching Rs. 70-100 per quintal.

Table 3 a. : Some physical and mechanical properties of *P. juliflora*, *Shisham*/ Indian rose wood (*Dalbergia lantifolia*) and teak (*Tectona grandis*)

Property	*P. juliflora*	*D. lantifolia*	*T. grandis*
Density (kg/m^3)	721	850	641
Bending strength (MOE* x 10^3)	97	125	102
Shrinkage (%) Volumetric	4.7	8.5	7.0
Tangential	2.2	5.8	5.8
Radial	2.6	2.7	2.5
Side Hardiness	1059	1437	453

*MOE : Modulus of elasticity

Table 3b : Suitability indices of *P. juliflora* with respect of Teak as 100

Property/Use	P. *Juliflora*
Weight at 12% M.C.	125
Strength as beam	97
Stiffness as beam	76
Suitability as post or strut	90
Shock resisting ability	150
Retention of shape	133
Shear	146
Hardness	157
Refractoriness	73

Ailanthus excelsa (Ardu) is mainly used for leaf fodder and also for making toys etc. But recently its wood has been explored for making veneer and matchsticks. In Jaipur and Sikar districts it has been planted on the large scale and farmers after 10 years of plantation fetching Rs. 75/ql green wood and second rotation was only after five years. Therefore, besides fodder for cattle, they are earning huge amount by sale of wood. In Sikar district, more than 10 industries have come up only on Ardu. In Karnataka, again this plant is used in ply wood industries as well as in match industries (Photo-2).

(Ailanthus Excelsa Wood used in plywood Industries as well as in match stick Industries)

There are many more such plants which have not been explored properly. Therefore, it concludes from the ongoing discussion that plantation of forest trees on the farm boundaries along with the crops, does not require much input to farmer. By planting multipurpose trees on the farmers field than the Government can tame the desert and economy of farmers can be improved.

प्राणिनां प्राणहिसायां ये नरा निरताः सदा ।
परनिन्दारता ये चते वै निरयगामिनः ।।
कूपारामतड़ागानां प्रापानां च विदूषिकाः ।
सरसां चैव भेत्तारो नरा निरयगामिन : ।।

A person who is engaged in killing creatures, polluting wells, gardens and tanks, ponds certainly goes to hell.

FEEDING MANAGEMENT OF LIVESTOCK DURING DROUGHT IN ARID ZONE

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In arid zone traditional rural wisdom prefers livestock based agricultural practices as compared to crop farming. Most of the research findings with holistic perception in the field of agriculture and animal husbandry also confirms it. Arid zone is facing continuous drought since last four years. However, the recent drought (2002-03) is the severe most due to cumulative effects of preceeding years. When crop fails, livestock serves as a ready source of revenue for the livlihood of arid farmers. Thus livestock is the backbone of rural economy in the Thar desert.

As per the latest livestock census (1997), Rajasthan state harbours 54.38 million livestock, out of which arid zone (12 districts) livestock population is 28.60 million. The native livestock breeds of arid zone have inherited through generations adaptability to adverse climatic conditions of the hot desert.

The major livestock breeds in the region are:

Cattle: Tharparker, Rathi, Nagori and Kankrej.

Sheep: Marwari, Jaisalmeri, Chokla, Nali, Pugal and Sonadi.

Goat: Marwari, Kutchi and Parbatsari.

Camel: Bikaneri and Jaisalmeri.

Broadly scientific Animal Husbandary has three major components :

1. Feeding
2. Breeding
3. Health

During drought the first and foremost branch which need utmost attention is animal nutrition- or the feeding management.

FEEDING MANAGEMENT :

Due to the acute scarcity of feed and fooder during drought the utmost importance is given to the feeding component. Dried roughages provides bulk to the belly and meets 70-80% supply of dry matter and total digestible nutrients (TDN) required by cattle, sheep and goats. Failure of the monsoon is the main reason responsible for drought in the country. Arid areas where mostly rainfed agriculture is practiced are more prone to fodder scarcity than others.

Traditionally, the arid zone farmer conserve and store the bajra straw, grasses etc., sometimes blended with legume crop byproducts of mung and moth in a typical dom shape storage, called "Bhanwariya" in local language. The walls are constructed using less edable crop byproducts and vegetation. These fodder stores are opened during drought to maintain the livestock for few months. During present continuous drought situation livestock keepers have already exhausted stocks long back and have nothing to feed to the livestock.

Under such condition meeting of fodder demand by transportation of wheat straw or paddy straw from neghbouring states becomes a major task. Morever, the roughages like wheat/paddy straw are of very poor nutritive value in terms of digestible crude protein (DCP) and total digestible nutrients (TDN). These straw as such are unable to meet even the maintenance requirement of livestock, and thus lead to higher rates of nutrition related health problems. Similarly, the conventional concentrate feeds like oil cakes, legume and cereal grain or their byproducts are available at unaffordable high prices and becomes out of reach. During this period resources like unconventional feeds, non protein nitrogen and mineral mixture will play an important role when utilized

judisiously.

Therefore, during drought following techniques for livestock feeding will be beneficial for the well being of animals.

1. Preparation of ration with urea-molasses for immediate feeding (Per cattle/day)

(a) Wheat/paddy straw 3.0 Kg.

(b) Molasses 300 Gms.

(c) Urea 30 gms.

(d) Vitamin Mineral Mixture 20 gms.

(e) Common salt 20 gms.

Procedure of Feeding :

In a container dissolve 30 gms urea in half litre of water and add 300 gms molasses, stir it with a stick homogenously. Now spray evenly this urea molasses solution on straw, and then also spray on straw vitamin mineral mixture with common salt. Finally using both hands mix the ingredients with straw throughly. Ration is ready to be fed to livestock. For making ration of 100 kg straw we require one kilogram urea and ten kilogram molasses. This ready to fed ration is very palatable to animal and is consumed immediately.

2. Urea treatment of Straw:

Wheat and paddy straw is crop residues left after harvesting the grains from crops. These straw forms the main bulk of roughages for cattle during drought. These cereal roughages are poor in nutritive value, with almost 0% digestible crude protin. Due to high lignin content the palatability is also low. High oxalic acid content in paddy straw affect calcium absorption. So when as such dry straw is fed to cattle the maintenance requirement is not met with. Therefore, with dry straw either some green fodder or grain/cake is mixed and offered to cattle. But under drought circumstances, these are not available with livestock keepers. Keeping this in view the alternative to be adopted is 3% urea treatment of the poor quality straw with 50% moisture level and stored under cover for 21 days. This urea treated straw can meet the maintenance requirement of the animal to a large extent.

Procedure of urea treatment of straw :

Material required: For 100 kg straw we require: 3.0 kg urea, 40-50 litre water, buckets, Polythene sheet or used empty polythene bags.

(Sprinkling Urea-Water Over Straw)

Treament:

Provide vitamin A injection at bimonthly interval and/or in ration add vitamin A containing mineral mixture.

5. Cheaper and balanced concentrate for laclating animals :

Tumba (*citrullus colocynthis*) seed cake of arid zone has been evaluated as feed to provide protein and some minerals. This is available in market at about one forth price of the conventional cakes. Tumba seed cake can be incorporated in concentrate, upto 25% level, reducing cost of concentration by 20%. To this 15-20% grinded *prosopis juliflora* (English babool) pods can be added as energy source which are also very cheap and available locally.

6. Addition of leguminous crop byproducts:

Feeding of wheat/rice straw by mixing with leguminous straw e.g., gram straw, groundnut crop byproduct or masoor straw will improve nutrient availability and digestion of the livestock.

7. Chopping of straw:

For feeding livestock always offer chaffed fodder. Chopping improves digestibility and avoids nutrient wastage.

8. Mineral bricks and common salt:

Feeding managers of animals should have mineral bricks and common salt, so that deficiency of minerals and common salt may not occur.

9. Deworming:

Animal should be dewormed with broad spectrum anthementic thrice yearly. In case of ectoparasites: spray/ dusting should be done at regular intervals with ectoparasiticide. These simple treatment will increase the availability of nutrients to livestock.

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