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REVIEW ARTICLE

'*Kulagar*' – A Potential System to Conserve the Crop Diversity

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Goa and Konkan region of Maharashtra are parts of Western Ghats with huge diversity of flora and fauna. Hot-humid climate with heavy monsoon makes this area a biodiversity hotspot. Farmers of this region have a conventional, multitier, homestead system of gardening called *kulagar*, inherited from their ancestors, to cultivate and conserve the local crop plants near their household. It is an integrated system with the skeletal component as areca nut palms. Other types of crops included in the system are cash crops, plantation crops, spices, fruits, local vegetables, medicinal and aromatic plants and flower crops. Some of the *kulagars* include animal components to make the system cost effective and holistic. Bioresource conservation, crop diversification, recycling of the resources, value addition and processing and byproduct utilization are important features of a *kulagar*. Advanced crop production technologies are being incorporated in *kulagar* by the new generation farmers to make it sustainable and economically viable.

Key Words: Conservation, Crop diversity, Goa, Konkan, *Kulagar*

Western Ghat is a mountain range covering 1,60,000 sq. m area parallel to the west coast. It is one of the biodiversity hotspots and designated as one of the UNESCO world heritage sites. Goa and Konkan region of Maharashtra are blessed with the diversity of tropical flora and fauna due to the proximity to the Western Ghats. The hot humid climate and the presence of heavy monsoon have made this region a biodiversity hotspot with beautiful landscape. Western Ghat begins from the boarders of Gujarat and Maharashtra and ends in Kanyakumari, Tamil Nadu covering the states of Maharashtra, Goa, Karnataka, Kerala and Tamil Nadu. The region is home to 7,402 species of flowering plants, 1,814 species of non-flowering plants, 139 mammal species, 508 bird species, 179 amphibian species, 6,000 insects species and 290 freshwater fish species (Nayar *et al.* (2014)., Myers *et al.,* (2000), Dahanukar *et al*., (2004). Some of them are facing the threat of extinction and therefore need urgent conservation measures to protect them.

Farmers of Goa and Konkan region have a conventional homestead system of gardening inherited from their ancestors, called *kulagar,* to cultivate and conserve the local crop plants near their household. It is an integrated system which includes cash crops, plantation crops, spices, fruits, local vegetables, medicinal and aromatic plants and flower crops. Some of the *kulagars* include animal components and follow the integrated farming system. *Kulagar* has its own identity and culture. The Konkani word '*kull*' means family and '*aagar*' means store house (Khedekar, 2013).

Kulagar is a system to cultivate horticultural crops in plains, terraces and hill tops. The skeletal tree species are areca nut palms in every *kulagars.* Black pepper vines (*mirvel*) or betel vines (*paanvel*) are trailed on these palms. The interspaces are utilized for the cultivation of different crop species. A few groups of people (Bhat and Kulwadi and a few families of Baman) are maintaining the *kulagar* as heirloom gardens. Some of them belong to the Paddye in Ponda, Kepem, Kankon and parts of Sattari and Bicholim. In Ponda, *kulagars* maintained by the Baaman-Saraswat community are very common. The upper portion of the *kulagar* is known as *visol,* wherein regular watering is not provided (Khedekar, 2008). They are irrigated by the natural flow of the gravitational water. In local language it is called *aapune udak* (*water by summon*). This part is cultivated with plantation crops and fruit trees which require less water for growth. Cashew, bamboo, pineapple, mango, tamarind are some of the plant species grown in this region. The area near to the farm house is called *porsum,* where plants like turmeric, ginger, bread fruit *etc* are grown. The area of each *kulagar* is different from others. Generally a *kulagar* is 1-2 hectares. It is known as *daando* and a

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chain of *kulagars* is called *faall.* The total area under *kulagar* in Goa is approx. 15,000 hectares (Khedekar, 2013).

Features of *Kulagar*

Kulagar system has features of crop diversification, recycling of resources, organic production, water harvesting and soil and water conservation that makes it an exclusive, sustainable system for horticulture crop production. The cash crop component in a *kulagar* can be areca nut, coconut, cashew nut, betel vine *etc*. In Goa, mostly areca nut based (rarely coconut based) *kulagars* are common. Local tall type areca nut palms are nowadays replaced by the improved cultivars like Mangala, Sumangala and Mohit nagar. The landraces of coconut found in Goa are 'Benaulim' of South Goa and 'Calangute' of North Goa. These palms are trailed with black pepper and betel vines. Black pepper varieties commonly grown in Goa are Panniyur varieties, Karimunda and Thevam. 'Kalem' (Black/hard) and 'Dhavem' (white/soft) are the two types of betel vines grown in Goa. 'Kalem' is used for consumption and the 'Dhavem' is used for religious occasions as *vida*. In areca nut plantations, inter culturing with pineapple, banana, shade tolerant vegetables and tuber crops like elephant foot yam is commonly practiced.

'Mankurad' and 'Hilario' are two local goan mango varieties with sweet relishing flavor and enormous diversity in size, shape and quality. Apart from these two, a large number of mango varieties are available in different parts of Goa. Alfonsa, Babio, Baretto, Bemcorada, Bishop, Ball, Brindao, Carreira, Carreira branca, Culas, Colaco blanca, Costa, Dourado, Durbate, Fernandin, Furtad, Godgo, Japao, Jeronimo, Jose, Kapri, Madame, Malgesh, Massarrat Bardez, Mussaret Salcete, Malgoa, Nicolau Afonsa, Olieveria, Papel, Papel Branco, Rebello, Reynold, Rosa, Secretin, St. Antony, Salgada, Tanque, Toranja, Chimut, Udgo and Xavier are the mango varieties grown in Goa (Dhander *et al.,* 1997). Commonly cultivated banana varieties of Goa are Saldatti (AAB), Savarboni (ABB), Amti (AAB), Raspali (AAB), Sakkari (AAB), Velchi (AB), Myndoli (AAB) and Sugandi (AAB). Pineapple varieties Kew, Giant Kew, Queen and Red Spanish are locally grown in *kulagars* of Goa. Spice crops like nutmeg, cinnamon, clove and underutilized fruit crops like kokum, jack fruit (Firm flesh type–kappa and soft flesh type–rasal), acid lime, pummelo (red flesh type and white flesh type), bread fruit, karonda, sapota, flower crops like hibiscus, jasmine, marigold, crossandra (ratan aboli-unique type with dark red petals) and a large number of medicinal and aromatic plants are a part of this system. Multi-tier cropping assures the proper utilization of space and sunlight. The highest tier comprises of palms which are often trailed with betel vines and black pepper. The next tier has fruit trees like guava, banana, papaya, wax apple, kokum, jackfruit, bread fruit and spice crops like nutmeg, cinnamon etc. Lowest tier is pineapple, tuber crops, vegetables, shade loving flower crops, medicinal and aromatic plants. This assures the proper sunlight penetration and distribution inside the system through the canopy of different layers of the crops. The same kind of pattern can be seen in the root distribution also. The fibrous root system of palms spread to a maximum of two meter depth and the surrounding shallow rooted fruit crops like banana, pineapple, vegetables, tuber crops and ornamental crops will not compete with each other for moisture and nutrients.

Water Harvesting and Soil and Water Conservation

Kulagars are green throughout the year. Most of the *kulagars* consist of ponds, wells and canals which are naturally filled by the rains obtained during the abundant monsoons. They can provide water to the system throughout the year by water harvesting. The water is supplied in three different manners in the *kulagars* using the customary methods. Water from tank or *tallem* is used for irrigation during day and stops during night. Another method is from a *baand* created on a tributary also known as *vhall*. It is constructed usually in the middle region and it supplies water to both sides of the *kulagar*. Sometimes water is stored in the mud tank known as *ushen*. It is placed at high altitude and at the lower level; a hollow trunk of the areca nut tree is used as a pipe, which is fixed into the wall. During the night, this pipe is closed with the putrefied banana stem. When the mouth of the trunk pipe is opened, water flows into the *kulagar*. It is splashed onto the roots manually with the help of a curved wooden channel called *kallem*. The main channel of *kulagar* is known as *paat*. It runs from the top of the *kulagar* to the bottom. For the conservation of soil and protection from leaching and erosion, terraces, trenches and contour bunds are made in the *kulagars*. Stone wall parchments are made in the terraces. The pathways are also pitched with stones in some places. For the convenient movement to the higher areas, there are uneven flights of steps made in *kulagars*. At every

Table 1. Crop diversification in *Kulagars*

Name	Scientific name	Family
Plantation crops		
Areca Nut	*Areca catechu*	Arecaceae
Coconut	*Cocos nucifera*	Arecaceae
Spice crops		
Betel vine	*Piper betle*	Piperaceae
Black pepper	*Piper nigrum*	Piperaceae
Cardamom	*Elettaria cardamomum*	Zingiberaceae
Cinnamon	*Cinnamomum zeylanicum, Cinnamomun verum*	Lauraceae
Clove	*Syzygium aromaticum*	Myrtaceae
Curry leaf	*Murraya koenigii*	Rutaceae
Ginger	*Zingiber officinale*	Zingiberaceae
Nut meg	*Myristica fragrans*	Myrsticaceae
Tamarind	*Tamarindus indica*	Fabaceae
Turmeric	*Curcuma longa*	Zingiberaceae
Fruit crops		
Acid lime	*Citrus aurantifolia*	Rutaceae
Ambada	*Spondias pinnata*	Anacardiaceae
Aini	*Artocarpus hirsutus*	Moraceae
Aonla	*Phyllanthus emblica*	Euphorbiaceae
Banana	*Musa* sp.	Musaceae
Ber	*Ziziphus mauritiana*	Rhamnaceae
Bilimbi	*Averrhoa bilimbi*	Oxalidaceae
Bread fruit	*Artocarpus altilis*	Moraceae
Carambola	*Averrhoa carambola*	Oxalidaceae
Custard apple	*Annona squamosa, Annona muricata*	Annonaceae
Fig	*Ficus carica*	Moraceae
Guava	*Psidium guajava*	Myrtaceae
Jack fruit	*Artocarpus heterophyllus*	Moraceae
Jamun	*Syzygium cuminii*	Myrtaceae
Karonda	*Carissa carandas*	Apocynaceae
Kokum	*Garcinia indica*	Clusiaceae
Lemon	*Citrus limon*	Rutaceae
Malabar tamarind	*Garcinia gummigutta*	Clusiaceae
Mango	*Mangifera indica*	Anacardiaceae
Monkey jack	*Artocarpus lakoocha*	Moraceae
Papaya	*Carica papaya*	Caricaceae
Passion fruit	*Passiflora edulis*	Passifloraceae
Pineapple	*Ananas comosus*	Bromiliaceae
Pummello	*Citrus grandis*	Rutaceae
Sapota	*Manilkara achras*	Sapotaceae
Wax apple	*Syzygium samarengense*	Myrtaceae
Vegetable crops		
Chilli	*Capsicum annuum, Capsicum frutescence, Capsicum chinensis, Capsicum baccatum*	Solanaceae
Brinjal	*Solanum melongena*	Solanaceae
Bhindi	*Abelmoschus esculentus*	Malvaceae
Amaranthus	*Amaranthus tricolor, Amaranthus viridis*	Amaranthaceae
Melons	*Cucurbita pepo*	Cucurbitaceae
Pumpkin	*Cucurbita maxima*	Cucurbitaceae
Agathi	*Sesbania grandiflora*	Fabaceae
Tomato	*Lycopersicon esculentum*	Solanaceae
Drumstick	*Moringa oleifera*	Moringaceae
Elephant foot yam	*Amorphophallus paeoniifolius*	Areceae
Basella	*Basella alba, Basella rubra*	Basellaceae

Contd.

Name	Scientific name	Family
Colocasia	*Colocasia esculenta*	Areceae
Tapioca	*Manihot esculenta*	Euphorbiaceae
Chekkurmanis	*Sauropus androgynus*	Euphorbiaceae
Flower crops		
Bougainvillea	*Bougainvillea spectabilis*	Nyctaginaceae
Clitoria	*Clitoria ternatea*	Papilonaceae
Crape jasmine	*Tabernaemontana divaricata*	Apocynaceae
Crossandra	*Crossandra infundibuliformis*	Acanthaceae
Golden champa	*Michelia champaca*	Magnoliaceae
Indian Oleander	*Nerium oleander*	Apocyanaceae
Ixora	*Ixora coccinea*	Rubiaceae
Jasmine	*Jasminum sambac, Jasminum grandiflorum, Jasminu miltiflorum*	Oleaceae
Marigold	*Tagetes erecta*	Asteraceae
Medlar	*Mimusops elengi*	Sapotaceae
Night jasmine	*Nyctanthes arbor-tristis*	Oleaceae
Rangoon creeper	*Quisqualis indica*	Combretaceae
Shoe flower	*Hibiscus rosa-sinensis*	Malvaceae
Trumpet flower	*Tecoma stans*	Bignoniaceae
Medicinal and aromatic plants		
Adhatoda	*Adhatoda vasica*	Acanthaceae
Aloe vera	*Aloe barbadensis*	Liliaceae
Ashoka	*Saraca asoca*	Caesalpiniaceae
Asparagus	*Asparagus racemosus*	Liliaceae
Basil	*Ocimum sanctum* (Holy basil), *Ocimum basilicum* (Sweet basil)	Lamiaceae
Calotropis	*Calotropis gigantea*	Asclepiadaceae
Coleus	*Coleus aromaticus*	Lamiaceae
Costus	*Costus speciosus, Costus igneus* (Insulin plant)	Zingiberaceae
Davana	*Artemisia annua, Artemisia pallens, Artemisia vulgaris*	Asteraceae
Henna	*Lawsonia inermis*	Lythraceae
Insulin Plant	*Costus igneus*	Zingiberaceae
Kalmegh	*Andrographis paniculata*	Acanthaceae
Long pepper	*Piper longum*	Piperaceae
Medicinal yam	*Dioscorea floribunda*	Areceae
Mint	*Mentha arvensis*	Lamiaceae
Periwinkle	*Catharanthus roseus*	Apocynaceae
Red flowered leadwort	*Plumbago indica*	Plumbaginaceae
Serpent wood	*Rauvolfia serpentina*	Apocynaceae
Sweet flag	*Acorus calamus*	Acoraceae
Vetiver	*Vetiveria zizanioides*	Poaceae

terrace, there are cross channels. Each channel has two or three pits called *fondi.* In order to divert the water from main stream to another channel, a *Banne* is placed at different spots. *Bann*e is a decomposed banana stem which act as a water tight arrangement to prevent water leakage. Farmers are well versed to operate the *banne* with their legs. This is practiced till the *ushen is* empty. On every third day plants are watered in the *kulagars* and this is called *pairo* (Khedekar, 2013).

Recycling of the Resources and Organic Production

The resources generated in the *kulagars* are recycled inside the system itself by *in situ* composting. Some farmers have incorporated vermi composting units in the system to utilize the biomass waste. Cows and Buffaloes contribute to the compost and biogas production in the system. The animal manures are mixed with the water source and are diverted to the *paat*. The annual task of *aallem* is performed by removing the roots of areca nut and coconut by clearing the soil. Dried leaves and plant derbies are collected from surrounding regions and mixed with cow manure and mulched on the root portion of the plants. Microclimate created due to the close spacing, diversity and moisture cause the infestation of pests and diseases in the *kulagar*. Some serious issues related to pest and diseases are black pepper wilt, damping off

of vegetables, root rots, cashew stem borer, banana pseudo stem weevil, banana skipper butterflies, mealy bugs, scales, nematodes and viral diseases. In order to overcome this problem, farmers follow eco friendly measures like neem cake application, sprinkling of ash and salt in the field.

Advanced Production Technologies

Advanced crop production technologies like sprinkler and drip irrigation has been established in some of the *kulagars* recently. Some have included shade net houses for the production of quality planting materials and for incorporation of commercial crops. Mechanization for farm activities and storage facilities are other important aspects that can be incorporated in this system to enhance the sustainability. Introduction of modern agro production technologies, exotic plant and animal species, mechanization and irrigation facilities in the *kulagar* helps to improve its productivity.

Future Perspectives of *Kulagar*

The existing *kulagars* can be well utilized for the year round income generation activities which assures financial security to the farmer or the farm family. It is an excellent opportunity for employment generation. Rural youth can be trained for skilled activities and can be engaged in the system for maintenance. Along with this, it can be converted into a system for conservation of local genotypes and traditional crop production strategies. The future perspectives of a *kulagar* system of cultivation are the following.

Value Addition, Processing and Byproduct Utilization

Diversified products and year round production is the potential of each *kulagar*. Farmers can assure income from the direct sales of the produce or the value addition of the available produce. Minimal processing and value addition has lots of scope in the rural areas. Jack fruit, which is often considered as an under exploited fruit can be well utilized for a diverse array of products like papad, halwa, ice cream, chips, seed powder *etc*. Similarly, farmers can produce, squashes, juices, RTSs and other beverages from kokum, bilimbi and carambola. Pickling of mango is another potential area. Most of the mango varieties present in Goa are small, sour type which is suitable for pickle making. Jam, jellies and marmalades are another set of products which can easily prepared at homestead levels with underutilized and underexploited fruit crops.

The fiber extracted from the coconut and coconut shell can be utilized for the production of different types of hand crafts. Coconut fiber mats, mattresses and ropes can also be prepared from this. Areca nut leaf sheath is used for the production of plates, bowls etc. Bags, crafts, mats, saris etc are prepared from the banana fibers. The large quantity of biomass generated in the system can be converted into vermi compost which fetches good price in the market due to popularity of organic farming.

Agro-ecotourism

Goa and Konkan regions are considered as one of the most preferred tourist spots of India. Annually more than 10 lakhs foreign and domestic tourists visit this region. Agro-ecotourism centers (AET) with *kulagars* are one of the hotspots in all tourist packages. Agro-ecotourism is a perfect blend of agriculture and tourism. It helps the visitors to understand the farm, farm related activities and rural life and rural culture. The concept of on-farm conservation also can best fit into this agro-ecotourism models, where the *kulagars* are being converted into the agro-ecotourism units. The basic principles of agro-ecotourism are 'something for the visitors to see, something for the visitors to do and something for the visitors to buy' (Barbuddhe and Singh, 2014). While converting a *kulagar* as an agro eco tourism centre, the basic objectives like harmonious integration of diversified farming activities for sustainable economic returns, local employment generation, aesthetic goods and services, environment protection and management, ecotourism industry development, infrastructure development and socio economic transformation should be considered (Desai, 2016). Foreigners as well as urban tourists and students find it interesting to visit such units. The relevance of these indigenous plants and its traditional uses can be spread to the society through agro ecotourism ventures.

On-farm Conservation of Genetic Resources

Farmer have pivotal role in conservation of genetic resources and there is a need to sensitize them about the effect of genetic erosion and the significance of biodiversity conservation and utilization. They should be encouraged and supported by providing various inputs to continue cultivating and conserving as much plant diversity as possible. An understanding of what and why farmers do, in a two way process would help the researchers and policy makers to help farmers effectively and extend the practice to other farmers

also (Dhillon *et al.,* 2004).The farmers are routinely conserving the local genotypes and landraces in the *kulagars.* Awareness can be provided to them for the relevance of the conservation of these local resources. Appreciation for the plant genetic conservation can be provided to them in the form of awards. In this way, *kulagars* can be considered to be a very effective system to collect, conserve and utilize the local genetic resources and spread awareness to the people regarding the local resources by show casing it.

Conclusion

Kulagar is an ancestral system of cultivation of horticulture crops in Konkan and Maharashtra region. Integrated farming system is one of the peculiar features of the system. It conserves traditional crops and technologies. New generation farmers introduce advanced production technologies to this system and take it to new dimensions like value addition and processing, agro ecotourism and on farm conservation of genetic resources.

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