Fruit Based Agroforestry Systems for Drylands

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Crop production on drylands in general and marginal rainfed lands in particular results in low and unstable, and often times uneconomic yields because of aberrant monsoon behavior. Poor management of marginal lands results in land degradation. It is estimated that nearly 65 m.ha out of 98 m.ha under rainfed cultivation are facing some kind of land degradation or the other. These marginal lands are not able to sustain arable crops particularly during the drought years. Therefore there has been thinking to develop some alternate land use systems for these lands. Tree component in dryland agriculture increases production and income, besides imparting stability to the farming system. Fruit trees, apart from the above advantages also yield valuable bye products like fodder, and fuel wood, through their annual prunings and fruits, which are supposed to improve and maintain good health of human beings.

Among the alternate land use system developed, dryland horticulture and agri-horticulture system (fruit based agroforestry systems) are readily picked up by the farmers due to cash benefits derived from these system.

Agri-horticulture system or horti-pastoral system is one form of agroforestry where the tree component is a fruit tree. Agroforestry is a collective term for systems of land use in which woody plants (trees and shrubs) are deliberately combined on the same land management unit with herbaceous crops in some form of spatial arrangement.

Advantages of Fruit based agro forestry systems

This system mainly focuses on higher income per unit area. Well-maintained and established orchards bring better returns than field crops from the same piece of land. The farmer can practice intercropping during the early stages of the fruit trees. The system is helpful in generating more employment especially during this off-season when the crops are not cultivated.

Fruit growing also provides scope for ancillary industries like fruit processing, canning, preservation, dehydration, essential oils, package transport and refrigeration. Fruits are protective foods, necessary for the maintenance of human health. Many fruits are a rich source for energy giving carbohydrates. Besides, fruits are valuable source of minerals, vitamins and enzymes, which are required for better functioning of human body and for fighting diseases. Many fruits are also known to possess specific medicinal values. Pectin and cellulose found in several fruits stimulates intestinal activity in human body.

Fruit trees are deep rooted and hardy. These provide minimum guaranteed returns even in drought years (atleast fodder and wood) when arable crops fail. Trees utilize off-season rainfall in addition to the rainfall during the cropping season.

Some of the key elements for successful raising of dryland fruit trees are as follows.

Selection of fruit species: Success of fruit trees on rainfed land depends on selection of fruit species for a given soil and climate. Fruit tree species like

(1) Custard apple (*Annona squamosa*) (Varieties, Balanagar): It prefers dry climate. It can withstand mild frost. The root system is confined to relatively shallow layers and therefore, these do not require deep soils. However, it needs well-drained soil. The trees withstand high amounts of lime found in calcareous soils. It is one of the most drought tolerant fruit trees in India. It is grown in rocky soils. Fruits contains up to 16.5% sugar. Custard apple is free from pests and diseases except mealy bugs.

(2) Aonla (*Emblica officinalis*): Amla is becoming a commercially important fruit crop. It is also known as amla, amlaki and usiri. It is rich in vitamin C. The fruits are made into murrabba, sauce, candy, dried chips, jellies, pickles and powder. Used extensively in Ayurvedic and Unani medicines. Important varieties are NA 10 (Balwant); NA 7 (Neelam), NA 6 (Amrit), NA 4 (Kanchan), Chakaiya, & Banarasi.

(3) Ber – (*Zizyplus mauritiana*): It is drought hardy tree and can be grown purely as rainfed crop. It can even tolerate alkalinity and slight water logging. It has very good nutritious value, comparable to that of apple. It yields sufficient fodder and fuel every year. Processed products viz. candy, juice, squash, jam & jellies. Varieties: Gola, Seb, Umran. Umran has better keeping quality over others.

(4) Tamarind (*Tamarindus indica*): Known for their drought resistance and services as insurance trees for the marginal and poor farmers in dry tracts. Bears heavily in alternate years like upto 80 years. The seeds are rich in protein and a good source of tannins. Varieties: PKM –1, Pratishthan and Anantapur local)

(5) Jamun (*Syzygium cumini*): Varieties: Erkad and Rajmany.

All the five fruit species can be grown successfully in moderately deep soils (100 cm soil depth) with an annual rainfall of 600-750 mm. The other fruit species like guava (Allahabad safed, Lucknow 49) Pomegranate (Ganesh, Muskat, Jyothi and Dolka) Mango (Amrapali, Dassheri, Kesari, Neelam and Benishan), Phalsa (Long & dwarf) and cashewnut can be planted in soils with 150-200 cm depth in regions receiving annual rainfall above 750-1100 mm.

Planting time: Procure seedling / grafts for respective fruit species either from Government nurseries or approved reputed plant nurseries. Planting of fruit seedlings / grafts has to be in early rainy season (July) when soil profile gets charged fully. Seedlings should be healthy, uniform in size and of good quality. After correct root placement good compaction of soil around the seedling has to be done to eliminate air pockets.

Establishment Techniques: The planting site for fruit trees should be good in soil depth and well drained. Clear the site from wild bushes and make weed free with appropriate tillage. Align key lines of 0.1 m^2 cross section across the slope. The distance between key lines varies with slope and type of species to be planted. Normally fruit trees like custard apple, ber are to be planted at 5-6 m from plant to plant within and also in between rows. Mango, Amla & Jamun are to be planted at 8-10 m distance. Put sticks along the key line at a point where sapling is to be planted. On hilly or undulating lands

planting fruit trees along the contour is desirable. Beyond 6% slope contour trenches with mild gradient is useful.

Pit size and filling: Pits of 60 cm diameter and 60 cm depth are to be dug in summer seasonally. Burn the dried leaves in pit to destroy the egg masses of termites and root grubs.

Microsite improvement: Rainfed lands generally cannot support high biomass associated with fruit tree cultivation. But this can be overcome to some extent by microsite improvement. The planting site has to be improved by suitable amendments. This involves mixing of tank silt or black soil, FYM and native soil in 1:1:1 ratio by volume in case of red soils. About 100 g of DAP and 100 g of 10% Lindane powder per pit are to be added for controlling root grub attack. Placing bentonite clay upto 10-15 cm from bottom of the pit is useful to increase water holding capacity of the site. The amendments are filled in the pit and sticks are placed where sapling is to be planted.

In-situ moisture conservation: The survival of fruit seedlings can be improved by shaping the surface in immediate vicinity of fruit tree to collect the runoff into the root zone.

- On leveled flat lands, 'Saucer' shaped depressions of 15 cm depth at center and 1.0 m diameter are to be made.

- On mild slopy lands (2-4%) 'V' shaped depression with 15 cm depth and 1.0 m dia are to be made. The seedlings has to be planted near the apex of 'V'.

- On slopy lands (4-6%) series of ridges are to be constructed with varied shapes (horse shoe or half moon or fish bone on gentle gradient to intercept and store rain water.

Mulching with small stone pebbles or paddy husk on the surface of the basin with 5-10 cm thickness will be useful to reduce moisture losses and better weed control.

Water Management: There is need to protect the fruit seedlings during summer for better survival atleast in the first year through protection irrigation. The limited water collected from runoff in ponds or in other sources can be effectively utilized through pitcher and portable drip system.

Pitcher system of irrigation: Earthen pots of 8-10 lit capacity having a vick in a hole made above bottom of the pot have to be placed at 30 cm depth and 15 cm away from the seedling in the basin at the time of planting the seedling. After filling with water, cover the pot with lid. Water drops near to the root dropwise through the vick, which will be useful for the growth of the seedling. The refilling of water in the pot can be done at interval of 7-10 days in summer.

Management practices: Two weedings in a year are essential to improve the survival and growth of fruit seedlings. Staking with sticks in rainy season is desirable to avoid wind damage and also for straight growth of seelings. Tillage on subsequent summer monsoon shower facilitates better moisture conservation and weed control. Application of manure and fertilizer as recommended are to be followed regularly for maintaining fruit trees in healthy condition.

Agro forestry system with fruit trees: Fruit trees have long gestation period of 4-5 years to get income. Till they develop canopy, the interspaces can be conveniently used for cultivation of surface crops like, groundnut, greengram, blackgram, cowpea, clusterbean, horsegram. The yield from intercrops (400 – 500 kgs) in an additional income and can be obtained upto 2-3 years.

The systems are to be chosen as per land capability i.e. arable and non-arable lands.

For arable lands, the best suited is Agri-Horticulture system

Agri.Horticulture system: This is food-cum-fruit system.
Fruit trees: Custard apple, Ber, guava, Mango, Jamun and Amla.
Spacing: 5-6 m (custard apple, Ber, Guava) 8-10 cm (Mango, Jamun, Amla)
Under crops: Horsegram, clusterbean, greengram, blackgram, cowpea, groundnut
Yield obtained: 400 – 500 kg/ha/year.
Fruit trees: Yield fuel wood of 1 to 1.1 tons from prunings in case of Ber.

Nutrient Management: Fruit trees are to be provided with plant nutrients on annual basis.

1) Custard apple: These plants are to be given @ 250 g N + 125 g P_2O_5 + 125 g K_2O per plant per year for good growth and yield.
2) Ber: Annual fertilizers are to be applied. Nitrogen dose may be supplied through organic and inorganic forms 50% each as follows

Fertilizer schedule for ber

Year	Fertilizer (kg/tree)			
	FYM	N	P	K
1st year	10	100	50	50
2nd year	20	200	100	100
3rd year	30	300	150	150
4th year	40	400	200	200
5th year	50	500	250	250

3) Guava: A five year old guava plant needs about 50 kg FYM + 210 g N + 160 g P_2O_5 + 300 g K_2O per tree per year. Applied in two splits i.e. once in June-July & January – February.
4) Mango: for adult trees i.e. above 5 years

N 1-2 kg per/year
P_2O_5 2-4 kg "
K_2O ½ - 1 kg "
For young 1 year old trees, apply 1/8 of the dose.
2 year " ¼ "
3 year " ½ "
4 year " ¾ "
5 year Full dose

5) Jamun: For grown up trees: 500 g N + 600 g P_2O_5 + 300 g K_2O

6) Amla : At young stage apply: 680-900 g N + 160-200g P_2O_5 +
900-1000 g K_2O/plant/year + FYM 15-20 kg.
For mature plants, FYM 30-40 kg in two split doses i.e.
April-May & Sept. – October

Undercrops: All the crops mentioned are leguminous crops. Apply 10 kg N + 30 kg P_2O_5/ha.

The recommended varieties may be same as per the spacing recommended. Intercultivation and weeding operations are to be carried out and plant protection as required i.e. crop management as in its sole crop cultivation.

Plant protection

Custard apple: No serious pests except mealybug. This does not harm the quality of the fruit.

Amla : Seriously damaged by bark borer and Mealybug.

Jamun: Bark borer: The excreta of the larva may be removed with sharp instrument and cleaned with brush followed by sprayings Nuvan @ 1 ml/1 litre or Endosulphan @ 2 ml / 1 lit water.

This is very serious on Amla. To control, the pest, (1) summer ploughing (2) prune the branches touching the ground (3) apply 2% folidol dust in the basin of the tree (4) roll alkathene sheet/400 guage on the trunks of the tree upto 1 foot in the months of Nov-December (5) spray carbaryl 50 W.P. @ 4 g/litre of water or chlorpyriphos @ 2.5 ml/litre of water on tree trunks, branches, twigs thoroughly.

Horti-Pastoral system: Two tier model fruit-cum-fodder based agroforestry system.

Fruit-Trees: 1) Tamarind, jamun, amla, wood apple (8-10 m)
2) Custard apple, ber (5-6 m)

Pastures: *Stylosanthes hamata*, horsegram, *Stylosanthes scabra*, *Cenchrus ciliaris*, *Cenchrus setigerus*.

Management of fruit trees

Tamarind: Trees are known for their drought resistance and serve as insurance for the marginal and poor farmers in dry tracts. These can be planted in non-arable lands. Trees bear heavily in alternate years and live up to 80 years. The seeds are rich in protein and good source of tannins. Sweet & sour types are available. Yield between 250-1000 kg of ripe pods in year.

Wood apple: This is one of the slow growing trees found mostly in forests. Propagated by seedlings. Trees attain 40 feet height in ten years. This is drought tolerant tree. Wood apple has excellent keeping quality.

Pastures:

Stylosanthes hamata: A legume pasture.

Seeding & Fertlization of Stylo hamata: Good soil working leading to thorough seed bed preparation would ensure excellent results. However good results are obtained by light soil working or merely scratching the soil with any light agricultural implement. A seed rate of 4-6 kg/ha mixed with wet soil 10 times of its volume would ensure good establishment when broadcast with the onset of monsoon. Though it establishes and grows well in poor marginal soils, it responds well to the application of single superphosphate (30 kg P_2O_5/ha or 187.5 kg of single super phosphate per ha) normally recommended and should be broadcast before sowing). It is non-specific in rhizobium requirement and nodulates freely with wide range of cowpea rhizobium strains.

Stylosanthus scabra is a shy germinator and scarification of seeds is must. Scarification could be done by rubbing the seeds with coarse river sand.

Both the stylo species viz. *S. hamata* and *S. scabra* grow successfully in association with *Cenchrus ciliaris*, *C. setigerus* etc.

Seeding and fertilization of *Cenchrus ciliaris*

In a well ploughed soil, a seed rate of 5-6 q/ha is broadcast just before the start of monsoon rain. *C. ciliaris* can also be successfully established through transplantation of root slips at 50 cm x 50 cm on a rainy day during monsoon season. It responds well to fertilization. Highest yield is obtained with 40 kg N + 20 kg P_2O_5 /ha applied once before the establishment.

Fruit trees recorded better survival and growth in association with stylo-cenchrus.

Yields: Stylo 6.0 t /ha – Cenchrus 6.6 t/ha.

Thus these fruit based systems are useful in stabilizing income of the dryland farmer. Through this system food-fruit-pasture are obtained.