Agri- horticultural and Horti pastoral Systems for Alternate Land Uses in Drylands of Indian Sub Continent

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Abstract: Horticultural crops cover about 6.8% of the total area contributing 18% of gross agricultural output. The choice of Horticulture crops as one of the alternate land use systems in drylands depends on the type of lands available for cultivation, fertility status of the soils, rainfall pattern and the economic conditions of the farmer. In India fruit crops are grown on 4.54 m • ha of land yielding 48m • tonnes of fruits making it as the World's largest producer of fruits. The vegetables are grown in an area of 51.2 m • ha yielding 80.8m tonnes. Due to the development of large number of varieties/hybrids coupled with matching production technologies, the area and productivity have been increasing fast. Generally on lands with gentle to moderate slopes and on deep soils with poor fertility, the farmer prefers to plant horticultural species. The extent of land required for such purpose is normally more than that for agricultural use. Given the required inputs and initial capital, an enterprising farmer can establish a small horticultural garden in the drylands by adopting the appropriate production technologies, some of which are highlighted below.

1 Introduction

1.1 Rainfall pattern

An analysis of seasonal rainfall data of Hayatnagar Research farm of CRIDA at Hyderabad during the last 25 years indicated that about 30% of the annual rainfall occurs during off-season (October-May). This amount of rainfall could successfully be utilized by the fruit species enabling better establishment of the seedlings and growth in subsequent years.

With regard to the production of vegetables in dryland agriculture, the dryland regions can be grouped into three zones (1) areas having average yearly rainfall more than 300mm (2) areas with 200mm—300mm rainfall and (3) areas having less than 200mm rainfall. In an area having more than 300mm rainfall bottle gourd, ridge gourd, sponge gourd, round gourd, bitter gourd, long melon, snap melon, okra, guar, amaranth and cowpea can be successfully grown. All these vegetables can be grown if the monsoon starts at least in the first week of July. If the monsoon is delayed till the middle of July or 1st week of August, choice has to be restricted to crops having shorter span. In 200mm—300mm rainfall zone if monsoon begins in July, snap melon and round gourd can be taken. If the rains are further delayed and is less than 200mm in such situations, a watermelon cultivar, Mateera is grown on flat sandy soils on conserved moisture.

1.2 Soils

A representative soil of North Telangana plateau in Andhra Pradesh has hot, moist semi-arid eco-sub region soilscapes having moderately to gently sloping Patancheru series of Udic Rhodustalfs and Kasireddipalli series of montmorillonitic. Typic Pellusterts, are the predominant red and black soils in the region. Kasireddipallli soils are the representative soils in Medak district. While Patancheru series are extensively found in parts of Medak and Ranga Reddy districts and the adjoing areas. The texture of Patancheru series vary from sandy loam to loamy sandy with heavy and compact sub soil horizon due to increased clay content and mild acidic nature. The problems are presence of gravel and high bulk density, poor moisture availability and frequent drought

conditions .The soils of Kasireddipalli series are very deep, very dark grey strongly alkaline and calcareous with high and uniform clay content in the pedon. These are imperfectly drained, highly susceptible to erosion with high shrink –swell potential.

Table 1 Physical and chemical properties of few representative soils in India

Depth(cm)	Clay(%)	pH(1∶25)	Ec(dS • m^{-1})	OC(%)	$CaCO_3$(cmol(p+)kg^{-1}
Udic Rhodustalf (Patancheru Series)					
0—25	18.2	6.5	-	0.8	8.2
25—50	33.5	6.7	-	0.8	14.3
50—100	39.5	7.8	-	0.5	18.3
Typic Pellusterts (Kasireddypalli Series)					
0—25	53.7	8.8	0.1	2.0	0.7
25—50	58.4	9.4	0.1	9.5	0.5
50—100	67.4	9.4	0.4	20.0	0.3

Deccan plateau hot arid ecoregion comprises of mixed red and black soils. Red loams represented by Garnimitta series comprising Typic Rhodustalfs and the black soils are represented by Raichur series comprising Typic Pellusterts. They are highly susceptible to erosion and frequent drought. Sub soils is very hard when dry and acts as hard pan for root penetration and infiltration of water. Representative soils of Garnimitta sandy loams are slightly acidic to neutral with depth and clay content abruptly increases in the sub-surface layer. The Raichur soil series are very deep, dark Grey and moderately alkaline in soil reaction.

2 Choice of fruit tree

Farmers normally prefer to grow a multipurpose tree species to cater their domestic needs apart from tree fodder during the off-season. However, when the size of the holding is large they prefer to grow fruit trees on large area. The fruit trees not only provide additional income, employment and nutritious food material required for a balanced diet, but also help in harvesting the side branches etc. , which will supplement the fuel needs of the farmers. Fruit trees ensure efficient use of land and water, keep production costs low and higher profits per unit area. The tree species must be fast growing, multipurpose, tolerant to drought and extremes of temperature and must propitiate easily. Some of the promising fruit species that can successfully be cultivated under poor (500mm) and moderate (500mm—750mm) annual rainfall distribution patters are:

2.1 Establishment of fruit species

Identification of site specific problems for different fruit species and evolving suitable production technology is critical for establishing orchards in drylands. Some of such aspects are discussed below:

2.1.1 Microsite improvement

It is preferable to plant the fruit trees with the onset of monsoon in well prepared and filled in pits at suitable distances. Most of the above fruit species respond well in closed spacing except tamarind, goose berry, syzygium and mango which prefer a wider spacing. The pits should be of one cu.m. dimension, filled with equal quantities of tank silt, well decomposed compost or Farm yard Manure and the good soil from the site,100 g DAP and 50 g of BHC dust. Before filling the pit, dried leaves may be burnt in the pit to kill any germs inside. Application of 10 kg bentonite at the bottom of pit enhance availability of moisture to the root system.

Table 2

Spacing / botanical name	Common name	Variety
5m × 5m:		
Annona squamosa	Custard apple	Balanagar selection, Etimoya, Washington
Psidium guajava	Guava	Allahabad safeda Lucknow-49 (sardar)
Morus alba	Mulberry	Kohin safeda, Selection-8, Safed Jam
Ziziphus mauritiana	Ber	Gola, Seb, Umron, Kaithli, Ponda
Punica granatum	Pomegranate	Ganesh, Jalore Seedless, Muscat, Bassein Seedless, Jodhpur Red, Jyothi
Carrissa carondas	Karonda	American Red / Green
Grewia subinequalis	Phalsa	Tall type, Dwarf type
10 × 10m :		
Tamarindus indica	Tamarind	Pratisthan, PKM-1
Emblica officianalis	Amla	Chakaiya, Banarasi, Krishna Kanchan, Anand-1, Anand-2
Syzygium cuminii	Jamun	Francis Varanasi
Mangifera indica	Mango	Amarapali, Mallika, Kesar, Baneshan, Dashehari, Pedda Rasalu, Neelam, Totapari, Chinna Rasalu, Ratna, Suvarna Rekha.
Moringa oleifera	Drumstick	PKM-1

2.1.2 Fruit plant management

In the initial years of establishment of the tree seedlings, it may be required to pot water the plants during off season to protect them from drought and also some shade may be essential to guard against heat. A pitcher of 8—10 lit capacity with a wick of about 1/3 ht from bottom can supply water to young plants for 5—6 days even in summer season. Mulching of the basins with locally available materials like paddy husk, gravel or used straw will help in reducing surface evaporation, weed growth, canopy temperature, etc. since the weeds would establish fast and try to dominate the three seedlings and depress their growth, 3—4 ring weedings / year may be essential for the first two years before the tree species strike deep roots and grow vigorously minimizing the competition with under crops for moisture and nutrients.

2.1.3 Nutrient management

Young fruit plants should be manured during rainy season every year. A dose of 50 kg FYM should be incorporated in the basin with the onset of monsoon. Depending upon the age of plants canopy development, soil moisture availability, chemical fertilizers should be applied in 2—3 splits after a rainfall incidence or watered. An estimate of fertilizer to be applied to different fruit plants is given below:

Table 3 Fertilizer schedule for fruit plants (N, P_2O_5 and K_2O in g / plant)

Fruitcrop	1—3years	4—6years	7—10years	>10years
Guava	50-25-75	100-40-75	200-80-150	300-120-150
Pomegranate	300-250-250	500-300-300	700-400-400	900-500-500
Custardapple	100-100-100	150-150-150	250-250-250	350-300-300
Ber	200-200-200	300-300-300	400-300-300	500-400-400
Mango	350-150-150	700-300-300	1000-2000-5000	1000-2000-5000
Aonla	100-75-100	200-150-200	300-800-1000	400-1000-1200

2.1.4 Intercropping annual crops under fruit trees

The establishment of an orchard involves heavy investment and high recurring maintenance expenditure particularly under dryland conditions. Since the land is not fully covered during the initial 5-6 years of the plantation, it is remunerative to encourage intercropping with suitable annual crops like groundnut, cowpea and greengram. This will help in meeting the initial expenditure on the plantation besides generating more employment.

2.1.5 Effect on soil characters

There was a marked increase by 25% in soil aggregates of more than 2.0 mm size with *Stylosanthes hamata* under guava and custard apple while with *Cenchrus ciliaris*, the increase was only 10%.

2.1.6 The crops must complete their growth and fruiting well in the moisture availability period like in guava, ber, custard apple, aonla etc. Crops like guava and pomegranate should be encouraged to bear fruits in rainy season (mrigbahar). Ever, the grafted plants start bearing from third year onwards. The flowering in the initial 3 years should not be encouraged so as to develop good canopy architecture

2.1.7 Plant protection

In drylands, normally the pest problem is not intense on fruit unlike in irrigated areas. However, need based plant protection measures particularly in ber, pomegranate etc. should be adopted as per regional recommendations.

2.1.8 Horti - pastoral systems in drylands

The choice of horti - pastoral system as one of the alternate land use systems in Dryland Alfisols depends on the type of lands available for cultivation, fertility status of the soils and the economic condition of the farmer. Generally on lands with gentle to moderate slopes and soils with poor fertility, the farmer prefers to plant horticultural species. The extent of land required for such land use is normally more than that for agricultural use. Given the required inputs and initial capital, an enterprising farmer can establish a small horticultural garden in his drylands by adopting the appropriate production technologies, some of which are highlighted below.

2.1.9 Essential features of the pasture component

(1) It should be tolerant to drought and extremes of temperature
(2) It should be able to grow well and be compatible with other forage crops
(3) A non – seeding type of species should propagate vegetatively and establish quickly
(4) Must be prolific seeder

(5) The fodder should be highly palatable and nutritive
(6) Should conserve soil, water and nutrients
(7) Should be able to withstand over – grazing and trampling

2.1.10 Choice of fruit trees

The choice of farmer is normally towards growing a multipurpose tree species to cater his domestic needs apart from tree fodder during off-season. However, when the size of the holding is large, there is a scope for cultivation of fruit trees in a sizeable portion of the land. The fruit trees not only provide for a balanced diet, but also help in pruning the side branches, etc. which will try to supplement the fuel needs of the farmers. The tree species must be fast growing, multipurpose tolerant to drought and extremes of temperatures and must propagate easily. Some of the promising fruit trees that can be successfully cultivated under poor (500 mm) and moderate (500 mm to 750 mm) annual rainfall distribution patterns are:

Annona squamosa	Custard apple
Psidium guajava	Guava
Tamarindus indica	Tamarind
Zizyphus mauritiana	Ber
Moringa oleifera	Drumstick
Grewia subinequalis	Phalsa
Emblica officinalis	Amla (Aonla)
Carissa carondas	Karonda
Sizygium cuminii	Jamun
Mangifera indica	Mango
Punica granatum	Pomegranate

In undulating shallow red soils of Hyderabad, buffel grass (Cenchrus ciliaris) and Stylo legume (Stylosanthes hamata) were established in guava and custard apple plantations. Buffel grass yielded dry forage of 7.0 t/ha with 17.5 % of crude protein. Stylosanthes hamata self seeding during the first year. In the second year, it yielded 5.57 t/ha of dry fodder. The growth of custard apple was significantly reduced when raised along with buffel grass. The survival and growth of guava fruit trees was very poor with grass association than with stylo.