Popular Kheti
Volume -1, Issue-2 (April-June), 2013
Available online at www.popularkheti.com

ISSN:2321-0001

Fruit Crop-Based Cropping System: A Key for Sustainable Production

Mahesh Kumar Dhakar*, Brij Bihari Sharma and Kailash Prajapat
Indian Agricultural Research Institute, New Delhi - 110012
***Email of corresponding author: mahesh2iari@gmail.com**

Subsistence farmers who often face famine condition would like to adopt a technology which would produce at least some yield to run livelihood even in the worst year of agriculture. Fruit based cropping system is one of such types of technologies which can provide the farmers an appreciable amount of economic return even under unfavourable agro ecological situations. This is very difficult to achieve by growing only seasonal or forage crops which often fail under abnormality of weather but fruit trees are efficient to be productive even such conditions.

Introduction

Fruit based cropping system can be defined as a planting system comprising combinations of plants with various morpho-phenological features to maximize the natural resource use efficiency and enhanced total factor productivity. The system comprising of a combination of perennial and annual plant species as different components in the same piece of land arranged in a geometry that facilitates maximum utilization of space in four directions (length, width, height and depth) leading to maximum economic productivity of the system.

To ensure high returns from the underutilized and stressed lands and improve the soil characteristics, perennial fruit plant based production system have been found successful under semi arid and dry land conditions. Storing carbon (C) in vegetation and soils is one of the strategies accepted by the United Nations for mitigating high atmospheric concentrations of carbon dioxide (CO_2) that causes global warming. These multispecies plant associations are speculated to have high carbon sequestration potential (CSP) due to their forest-like structure and composition, particularly in accumulating C in the soil. The ecological process by which trees contribute to such higher amounts of C in stable form is believed to be mediated *via* litter fall and decomposition, and root activity especially decomposition of sloughed-off roots.

Components of Fruit Based Cropping System

The system consists of three main components *viz*. main crop, filler crop and inter crop.

A. Main Crop: Main crops are the fruit species having a larger canopy size and prolonged juvenile as well as productive phase. Generally the crops utilize the entire land after 20-25 years, whereas only 25-30 per cent of land is effectively used up by the main crop up to 10 years. These plants are planted at wider spacing.

Criteria for selecting of main crops are:

1. Xeric characters such as deep tap root system, high bound water in tissues, sunken stomata, waxy coating, thick cuticle and pubescence.
2. Ability to complete maximum vegetative and reproductive phase during the period of moisture availability.
3. Root system and root growth should be able to exploit deeper soil layers than those tapped by the under and ground storey crops.
4. Branching habit that allows light penetration to the under storey crops.
5. Species should be strong coppicer and should respond to pruning.
6. Leaf fall during the growth period of the ground crops and the rate of litter fall and decomposition should have positive effect on soil fertility.
7. Resistant to pest and diseases.

Suitable Varieties of Different Fruits Crops

Mango	Bombay Green, Himsagar, Zardalu, Krishna Bhog, Langra, Maldah, Dashehari, Chausa, Mallika, Amrapali
Litchi	Shahi, Ajhauli, Rose Scented, Trikolia, Swarna Roopa, China
Aonla	Narendra Aonla-7, Kanchan
Sapota	PKM-1, Kalipatti, DHS-1, Cricket Ball
Jack fruit	Khajva, Swarna Poorti, Swarna Manohar
Guava	Sardar, Allahabad Safeda, Arka Mridula
Custard apple	Balanagar, Arka Sahan
Papaya	Pusa Dwarf, Pusa Nanha
Lime	Kagzi

B. Filler Crops: The filler crops are the fruit species which are precocious in nature, prolific bearer having short stature. These plants are planted with the purpose to generate additional income from the land during the juvenile and initial bearing stage of the main crops. The plants generally hardy in nature and have shorter economic life than main crop and planted within the main crop at a closer spacing. The filler plants can be removed after the main crops attain effective canopy size for yielding economically.

Guava, being a prolific and precious bearing fruit plant and dwarf stature canopy can very well be fitted as second storey crop for additional income at least in the initial years of the orchard. Papaya, Banana, Pomegranate and Phalsa etc. are also used as filler crop.

C. Inter Crop: The inter crop occupy the lower most layer of the system and are grown in the remaining unused land. Generally the inter crops are the location specific annual crops, selected as per the climatic and socio-economic suitability. During the initial years any crop can be taken, whereas at later stage shade tolerant crops can be grown as inter crops.

Criteria for selecting of inter crops are:

1. Early maturing.
2. Should have shade tolerance suiting the amount of available solar radiation.
3. Should not compete with the perennial companion crop.
4. Should not be more susceptible than the main crop to diseases they have common.

5. Should not require mechanized harvesting or other operations that would damage the main crop or induce soil erosion or damage soil structure.
6. Should not have economic life longer than that of main crop.
7. Should suit the local agro climatic, labour, irrigation and market/processing facilities.
8. Leguminous ground storey crops that have nitrogen fixing capacity should be preferred.

Leguminous crops have been reported to be the most remunerative intercrops in fruit based cropping system during the initial 7-10 years. Scientists have also advocated monocot grass spp. (*Cenchrus ciliaris*) under stress conditions of arid region. Many tropical Medicinal and Aromatic Plants are well adapted to partial shading, moist soil, high relative humidity and mild temperatures, allowing them to be intercropped with timber and fuel wood plantations, fruit trees and plantation crops. Some well known medicinal plants that have been successfully intercropped in India, include *safed musli* (*Chlorophytum borivilianum*), rauvolfia (*Rauvolfia serpentina*), turmeric (*Curcuma longa*), wild turmeric (*C. aromatica*), *Curculigo orchioides*, and ginger (*Zingiber officinale*) etc.

Allelopathy Effect in Fruit Based Cropping System

The term allelopathy, was introduced by Molisch in 1937, and is derived from the Greek words allelon 'of each other' and pathos 'to suffer' and means the injurious effect of one upon the other. In 1996 The International Allelopathy Society defined allelopathy as follows: *"Any process involving secondary metabolites produced by plants, micro-organisms, viruses, and fungi that influence the growth and development of agricultural and biological systems (excluding animals), including positive and negative effects"*. Chemicals released from plants and imposing allelopathic influences are termed allelochemicals or allelochemics. Allelochemicals can be present in several parts of plants including roots, rhizomes, leaves, stems, pollen, seeds and flowers. Generally, there are four processes by which allelopathic substances are released into the environment: volatilization, leaching, decomposition of plant residues, and root exudation. When susceptible plants are exposed to allelochemicals, germination, growth and development may be affected. Allelopathy occurring among individuals of the same species is termed autotoxicity. Autotoxicity is known for example in *Medicago sativa* (alfalfa), *Trifolium* spp. (clovers) and *Asparagus officinalis* (asparagus). A number of crops and vegetables are known for their allelopathic activities such as corn, sunflower, sorghum and tomato. Tomato seed germination, seedling growth and dry weight were very sensitive to aqueous extract of most tested plants [okra (*Hibiscus esulentus* L.); sorghum (*Sorghum bicolor* L. subspecies *tichnicum)*; sunflower (*Helianthus annuus* L.); pepper

(*Capsicum frutescens* L.); and tomato (*Lycopersicon esculentum* L.)]. This means that compatibility will not occur between tomato and these interacted plants under mixed cropping. In the same time okra plants was less susceptible to the aqueous extracts of all tested plants except that of sorghum. This means that okra exhibits more resistance toward phytotoxic substances from other intercropped plants and can grow together at the same time.

Black walnut is considered as the most notorious of allelopathic trees. It has long been recognized that the principal chemical responsible for walnut allelopathy is a phenolic compound called juglone (5-hydroxy-1,4- naphthoquinone). However, installation of polyethylene root barriers proved to be efficient in preventing juglone from getting into the alley where associated crop species are normally planted. This implies that management practices such as root pruning, fertilizer injection, or root discing can be used to limit the impacts of juglone.

Fruit Crop-Based Cropping Systems

A. Fruit based diversified cropping system for arid region developed by Central Institute for Arid Horticulture (CIAH)

1) Ber Based System

In-situ budded ber cultivar Gola as overstorey component and groundnut-wheat, clusterbean-mustard and Indian aloe as ground storey component were integrated into the system. Among different crop combinations, the highest fruit yield of ber was recorded with Indian aloe while with groundnut-wheat and clusterbean-mustard, the yield level was almost at par and minimum yield was recorded under sole plantation. The highest B:C ratio (3.67) was obtained in ber + clusterbean-mustard system.

2) Aonla (*Emlica officinalis*) Based Cropping System

The tree canopy of aonla allows filtered light and permit intercropping even after it has made full growth. Two models have been developed-

(i) M_1 = Aonla – Ber – Brinjal – Mothbean – Fenugreek.

(ii) M_2 = Aonla – Prosopis – Suaeda – Mothbean – Mustard.

Highest gross return (25662 Rs ha^{-1}) was obtained under M_2 model.

3) Khejri [*Prosopis cineraria* (L.) Druce] Based System

Main crop: Khejri (*Prosopis cineraria*),

Filler crops: Ber (*Ziziphus rotundifolia)*, Lasora (*Cordia myxa)*, pilu (*Salvadora oleoides*) and ker (*Capparis deciduas*)

Inter crops: Jawar (*Sorghum bicolor*), pearl millet (*Pennisetum typhoides*), mothbean (*Vigna aconitifolius*), clusterbean (*Cyamopsis tetragonoloba*) and sesame (*Sesamum indicum*).

4) Cordia Based System

Cordia myxa has been observed to be a suitable tree in association with several crops like-

In Rainfed: Pearl millet (*Pennisetum typhoides*), clusterbean (*Cyamopsis tetragonoloba*), taramira *(Eruca sativa)* and vegetables.

In Irrigated: Rapeseed and mustard (*Brassica spp.*), wheat (*Triticum aestivum*) and green gram (*Vigna radiata*).

B. ICAR research complex for eastern region at Ranchi recommended following system.

1) In the locations having comparatively better soil conditions and facilities of supplemental irrigation, litchi (*Litchi chinensis*) based models with guava (*Psidium guajava)* as filler crop can be grown with intercropping of French bean (*phaseolus vulgaris*) and cowpea (*Vigna sinensis*) during initial eight years.
2) For location having no supplemental irrigation with sloppy land, mango + gamhar (*Gmelina arborea*) + *Stylosanthes hamata* (Gass) model will be more effective.
3) On the highest part of watersheds having gravelly land or coarse soil formations, aonla based system can be most effective.

C. Directorate of research on women in agriculture, Bhubaneshwar (Orrisa) developed horticulture based cropping models like mango based, guava based, minor fruit based, coconut based, cashew nut based and hortisilvipastural models were laid out. More than 25 intercrops, including vegetables, short duration fruit crops, flowers, aromatic plants, fodder crops and root crops were planted among these crops. These model helps in generating 6F's of sustainability – food, fodder, fuel, feed, fibre and finance.

D. National Research Centre for Agroforestry, Jhansi has been working on *aonla* (*Emlica officinalis*) based agroforestry systems since 1989-90 in very poor soil having very shallow depth and low moisture holding capacity, known as *rakkar* soil of the Bundelkhand region. NRC for Agroforestry initiated a field trial during 1989 with 4 varieties of aonla *viz*. Chakaiya, Kanchan, Krishna and NA-7 as fruit trees, subabul (*Leucaena leucocephala*) as multipurpose tree and blackgram (*Vigna mungo*) as intercrop in rainfed areas. The subabul was planted on both sides of the fruit trees at 2m distance. The aonla was planted at 10 x 6m and 5 x 6m spacing but 10 x 6m spacing proved to be ideal spacing among these. Fruit bearing in aonla started 4 years after plantation. At the age of 6 years, on an average the fruit yield from a plant was up to 93 kg. Besides fruit yield of aonla, 256 kg grain (on an average) was obtained from blackgram every year. Introduction of *Leucaena* in the system provides organic matter in form of leaf litter and it also fixes atmospheric nitrogen in the soil. *Leucaena* was cut twice a year and it provided on an average 1325 kg fuel wood and 799 kg leaves ha^{-1} every year. The leaves of *Leucaena* were utilized as mulch to minimize moisture loss from soil during summer, which is very

beneficial in alfisols in rainfed areas. Besides fuel and fodder yield from *Leucaena*, it also helped in improving soil fertility. In this system, organic carbon increased after 9 years up to 28.1 per cent from original value (0.32 per cent).

Conclusion

Fruit based cropping system is a very good option for minimization of crop failure risk at a farm due to anomaly of weather.

A variety of crops in the system has been found to be productive however, research still need to be carried out with respect to validation of the different systems in different agro ecological situations, inclusion of more horticultural crops and their planting pattern with other food crops for maximum possible economic benefits.

For more information

CIAH / TECH / PUB. / No. 25. Fruit Based Diversified Cropping System for Arid Regions, Bikaner, Rajasthan.