SUSTAINABLE CROP PRODUCTION THROUGH CROPPING SYSTEM MANAGEMENT

In all the major spheres of human influence, sustainability has emerged as the most appropriate paradigm of development. In sustainable developent, progress in any sector is gauged from the quatitative as well as qualitative angle.

When sustainability is applied to agriculture, the development is evaluated not only in terms of the crop and live stock outputs but also in terms of the social, economic and eclological appropriateness of the production processes adopted. While increase inagricultural production is important, the farming system as a whole will also have to satisfy the parameters of sustainability such as social acceptance, local adaptability, economic viability and ecological soundness.

It is well supposed that India has attained self-reliance in food production. However, to feed the ever growing up of country's food production. The highest priority should be given to raise the production to 250 million tones per annum during next five years. Due topopulation flush and decline in per capita availability of land, it seems that there hardly remains any scope for horizontal expansion of land for food, feed, fuel, fodder and fibre production. Only verticalexpansin is possible by intensifyling the production both in time and space, by developing appropriate and the efficient crops and cropping systems for rained agriculture.

Corpping system is an important component of farming system. It denotes the cropping patterns used on a farm and their interaction with farm resources, other farm enterprises and available technology which determine their make up. Thus it represents the yearly sequence and spatial arrangement of crops and fallows in an area.

Corpping system is are planned on the basis of soil type, climate and water resources, taking into account farmers requirements for the maximum production. Most of the dryland areas in India are molo-cropped , however, cropping intensity may be increased by adopting the suitable intercopping and double cropping systems with improved management practices. Similarly waste lands and uncultivated fallows can be well utilized by adoping different alternate land use system according to land use capability classification.

I. POTENTIAL CROPPING SYSTEM IN RELATION TO RAINFALL AND SOIL TYPE

The concepts of rainfall pattern, effective growing season and soil type have been put fourth for deciding the cropping systems in differnt agro-climatic zones as given bellow:

Potential cropping system in relation to rainfall and soil type

Rainfall (mm)	Soil Type	Water Availibility	Potential cropping period (week) systems

350 - 600	Alfisols & shallow	20	Single kharif
350 - 600	verisols Aridisols &	20	cropping Single
	Entislos		cropping in kharif or
350 - 600		20	rabi
600 - 750	Deep vertisols Alfisols and	20 - 30	Single rabi cropping
750 - 900	Entisols Entisols, deep	More than	Intercropping
	vertisols,	30	Double
900	alfisols, inceptisols	More than	cropping with
	Entisols, deep vertisols,	30	monitoring
	deep inceptisols		Double cropping

Rainfed land are generally monocropped, more so those cosvered by Aridiso Alfisols, Depending upon the soil type and rainfall distribution, the crop is grown either the monsoon season (June – September) or on conserved soil moisture during the post season (October-March). It has been established that, in region receiving 350 – 600 of rainfall and 20 weeks effective growing season, only single cropping is post Generally, the alfisols or red soils are kharf croppe, while in vertisols, the cropping done either during kharif or rabi. In unimodel rainfall region (mean annual rainfall 750 m is the any season cropping which dominates, whereas the bimodal rainfall regions concentrated with post-rainy season cropping on conserved (residual) siol moi Obviously, the productivity of monosoon crops fallows the distribution of rainy seasons ra while that of post-rainy season crops remains low because it has to grow on receding moisture and also faces moisture deficiency during maturity phase.

Alternate Efficient Crops Suggested for Various Dryland Regions.

Sr. No	**Regions**	**Traditional Crops**	**Alternative crops**
1.	Deccan rabi region Malwa Plateau	Cotton Wheat Rice	Safflower Safflower,
2.	Upland of Bihar plateau and Orissa		Chickpea
3.	South – East Rajasthan N – Madhya	Maize Kali Tur	Finger milletw, Blackgram
	Pradesh E – Uttar Pradesh	Wheat	Groundnut
4.	N – W - India (sicrozem)	Wheat	Sorghum Soybean Chickpea
5.			Mustard, Turmeric
6.			
7.			

(Source : Singh and Singh,19)

1. **Forms of Cropping Systems:** Depending on the reources and the technologies available, different types of crops system are as mentioned below.

2. **Monocropping :** It refers to growing onnly one crop on a land year after year. The rea of monocropping is climatological and soci- economic condition or specialization of far in growing that particular crop. Under rainfed conditions, groundnut, cotton or sorghum are grown as mono crops due to limitations as rainfall, Paddy is grown in canal irrga area under water logged condition because it is not posssible to grow other crops there.

3. **Intercropping :** Intercropping is an art of growing two or more crops simultaneously the same piece of land with a definite row pattern. Thus the cropping intensity in sp

demension is achieved. In intercropping, when one crop is grown with 100 % of recommmended population sole crop known as base crop and another crop cal intercrop is introduced in the base crop by adjusting or changning crop geometry. The stteamed as additve series. In the replacement series both the crops are cal comoponent crops. Hence another component crop is introduced by scarifying cer proportion of population of one component crop. Mixed simultaneously interming without any row arrangement. In thus, the seed of different crops are mixed in cer proportion and then sown. The main object of mixed cropping is to meet the fam requirements of cereals, pulses and vegetables. The introduction of short duration and high yield varities of crops has opened up a new arrey of inter cropping posibilities (Narwal and malik, 1986) among the different plant geomentry and row proportion 3:3 (Additive) series recorded significantily higher productivity (Singh *et al.*1991), (Halvankar *et al.*2000).

Major Intercropping System Along with Crop Line Raito

Sr.No.	**Cropping System**	**Croplines ratio**
1.	Sroghum + Greemgram Sroghum +Blackgram	3:3
2.	Sroghum + Pigeonpea pearl millet + Pigeonpea	3:3
3.	Pigonepea + Greengram Pigonepea +Blackgram	3:3
4.	Pigonepea + Soybean	2:1
5.		1:2
6.		1:2
7.		1:2
Sr.No.	**Cropping System**	**Croplines ratio**
8.	Pigeonpea + Sesamum Cotton + Greengram	1:2
9.	Cotton + Blackgram	1:1
10.	Cotton + Soybean Cotton + Pigenopea	1:1
11.		1:1
12.		6:2

Across many rainfall situtions, efficient utilization of resources and stability in yields are best achieved through intercroping system. Further, in terms of land use, the practice of intercropping is more productive than growing them peparately. However, the additional productivity due to intercsropping system is mainly depends on complementarly of component crops. In order to achieve maximun land use efficency, the dryland research centres developed efficent intercopping system for differnt agro – climatic zones.

4. **Double Cropping :** It is defined as growing of two or more, crop in sequence on the same land a farming year. Thus depending on the number of crops grown in a year, it is called as double, triple and quadruple cropping, invlving two, three or four crops respectively. Relay cropping is another system in which succeeding crop is planted before harvest of processding crops. Whereas ratoon crop or rationing refers or raising a crop with regrowth coming out of roots or stalk after harvest or crop.

Factors such as total rainfall, soil type adn water avaiabiliuty decide a particular cropping pattern i a place region. Cropping system for differnt regions as suggested from the reults of AICARP (1970) are given below. (Normally only one crop is grown under dryland condtion and cultivation is restricted during the rainy seasons. Howere, the intensity of cropping can be increased through sequetial or intercropping depending on the rainfall adn moisture storage capacity of soils).

5. Cropping System for Differnt Regions of India Under Drylands:

Rigon / Soil types	**Crops**	
	Kharif	**Rabi**
Nothern regioon Samba (Jammu)	Maize Greengram Cowpea Sunflower Groundnut Pearl millet Sorghum Maize	Wheat Barley Wheat Wheat / Barely Barley Bengalgram Wheat Wheat / Potato / Barley
Punajab Hissar (Haryana) Arid soils (Sierozemic Soils) Central region Dehram(UP)	Pearl millet (Monocropping is the rule)	Cluster bean / Chickpea
Eastern region Ranchi (bihar)	Maize Rice (upland) Gram Pearl millet Rice Rice	Wheat Wheat / Bengalgram Mustard Chickpea / Barly Chickpea / Mustard Chickpea / Linseed / Barrley
Altisols (Red soils) Bhubaneshwar Madhyapradesh Rawa Vertisols (Black soils) Jhansi Vertisols Indore	Maize Rice Rice Sorghum Sorghum Pearl millet Blackgram Maize	Repessed / Bengalgram Linessed / Mustard Chickpea / Lentil Bengalgram / Wheat Bengalgram Bengalgram Safflower
Western region Udaipur (Rajastan) Vertisols	Greengram Sorghum Maize Pearl millet Greengram Sorghum	Chickpea Safflower Bengalgram Wheat
Anand (Gujarat) Akola (Maharashtra) Vertisols solapur (Maharashtra) Vertisols Southern region Anantpur (AP) Alfisols	Greengram Pearl millet Sorghum Pearl millet Greengram Cowpea Pearl millet Sorghum Greengram Cowpea Groundnut Cotton	Wheat Safflower Safflower Safflower Bangalgram Safflower / Horsegram Cowpea Pearl millet Pearl millet Cowpea
Hyderbad Bijapur Vertisols Bangalore (Karnatak) Mysore Bellary	- -	Greengram / Blackgram Sorghum / Safflower Finger millet Sorghum Sorghum

Kovilpatti (TN) Vertisols		Cotton, Sorghum Pearl millet, Cowpea

II. SOIL FERTILITY AND CORPPING SYSTEMS

Under intensive cropping, deffernt crops with varying roooting patterns are cultivated This heps to explore the soiil profile effectively for moistre and nutrients and prevent formation of compact sub-soil layers. Which often append in monculture. Adoping intensive cultivation in the marginal soils without adequate fertilizer may deplete the osil in course of time and decrease its productivity. Inter cropping and sequential cropping do not cause great varition in soil available N status. Continuous N application in cereal - basal system do not but up N status o soil. In most of the intercopping, the quatity of added P through fertilizer is greater than the quantity removed. Hence there may be built up in P statua.But this may not reflected in the available P staus, sa most of the adsP is rapidly converted to insoluble form. In rice based cropping system, soluble P increases due to submergence and high temperature.

Hence in rice- wheat system rice is found to make bette4r use of residual P than wheat. Hence a application is adovocated to what.

Majority of soils in India are well supplied with K. There is hardly sandy noticeble impact on soil avilable K even in continuous cropping. Because there exists equilibrium in various form of soil K. Even after depletion , the other forms release K slowly. But in coarse sols, with growing of high yielding varieties there maay be decline K.

III. LEGUMES EFFECT

Legumes have a long standing histrory of being soil fertility restores due to thir ability to obtain N from the atmosphere in symbiosis with Rhizobaium and have cpacity to leave behind a good amount of N for the use of succeeding crop. It has been stimated that 0.668 million tonnes of N can be saved through the inclusion of legumes in the cropping systems and of the order of 0.746 million tonnes with intercropping by legumes. the clears that 1.414 million tonnes of nitrogen could be hrnessed by this way (Saraf et al. 1990).

The N economy through various pulses is given below. The carry over N for succeeding crop (cereal) may be 20-60 kg in different kharif and Rabi pulses. Thus pulses crop plays a vital role of using as a source of renewable applied of N in pulse based cropping system.

Residul effect of proceeding legume on the folowing cereals.

Preceding legume	Following cereals	Fertilizer N equivalent (kg N/ha)	Precending legume	Following cerals	Fertilizer N equivalent (kg N/ha)
Chickpea	Maize Pearl	60 – 70	Lathyrus	Maize Pm	36 – 48
Cowpea	millet Pearl	60	Pigeonpe	Pm Maize	30
Chickpea	millet Pearl	40	a	Maize	30

Lintil Peas	millet Pearl	40	Greengra	Maize	20 – 49
Pigeonpea	millet Wheat	40	m		20 – 32
		40	Pigeonpe		18 – 30
Kharif			a Peas	Wheat	
Plgeonpea	Wheat		Lentil	Wheat	
Greengram	Wheat	20			20
Blackgram	Wheat	20			60
		20	Cowpea	Maize	
Rabi Chlokpea			Cowpea	Maize	
Lentil	Maize (G-5)		(F)		10
	Maize (G-5)	60			40
Summer		20			
Cowpea (F)			Pear		
Greengram	Maize (G-5)		Lathyrus		
	Maize (G-5)	40			
		15			

IV. ALTERNATE LAND USE SYSTEM

Increasing emphasis is being placed on alternate land use system, viz, agro – forestry, agri – horiculture and silvi-pastoral system to stabilize and sustain the productivity of drylands.

1. **Alley Cropping :** Alley cropping is essentially an agro-forestry system in which crops are grown in alleys formed by hedge rows of trees or shrubs. The tree component in n alley cropping system provides both leaves for fodder and green manure for component crops and addtionally serves as vegetative barriers for the conservation of moisture. Alley corpping has three versions viz, forage alley cropping, forage cum mulch alleycropping and forage cum pole alley cropping . The hedge rows are cut bck at planting and pruned during the cropping season to prevent shedding and also to reduce competition with food crop.The alley cropping experiments conducted at CRIDA with Jeucaen Iucocephas indicated that

    - Short duration cereals or millets are more compatible compared with long duration crops like caster and Pigeonpea
    - wider alley with 7-8 m spacing and Leucaena paired at 60 cm is better for semi-arid tropics compared with narrow alley width of 3.6 m
    - nulching of leucaena leaves is better than using it as fodder iv) frequent cutting of leucena during the cropping period at a 15 cm cutting height is shpperior to a 60 m cutting hiegh.

2. **The Studies of Agro – Horticulture System :** Comduted at CRIDA indicated that about 40 kg fruit / tree is possible to release from ber trees in addtion to get bonus yield of Greengram or Cowpea or Horsegram or 250, 450 and 1000 kg/ha, respectively. This ensures that fruit based alley cropping systems are essential for stabilizing income in drylands.

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