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Intercropping in Traditional Farming Systems

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ABSTRACT

Though largely neglected by researchers and planners, intercropping is a key element of traditional farming systems. Its superiority over sole cropping has been shown in terms of higher and dependable gross returns per hectare as well as per unit of peak period labor use. Its potential for greater employment is also revealed. Studies show that intercropping is largely a system of small and unirrigated farms. A significant implication of this finding is that any breakthrough in intercropping technology will help poor farmers more than the rich. Increased research resource allocation to intercropping will thus serve the equity goals better.

Traditional intercropping is found to be highly complex and diverse because the farmer attempts to achieve his multiple objectives simultaneously through intercropping. Researchers cannot and need not generate equally complex new intercropping system. Instead, this could concentrate on generating simple system which satisfies key objectives like profitability and stability without completely ignoring the other objectives which underlie traditional intercropping system.

INTERCROPPING IN TRADITIONAL FARMING SYSTEMS

N.S. Jodha*

INTRODUCTION

Intercropping or growing crops in mixture is one of the important features of farming in developing countries. Depending on local agroclimatic variations, 50 to 80 percent of rainfed crops are planted as intercrops in different parts of the developing countries (Aiyer 1949; Mathur 1963; Norman 1974; and Jodha 1977). Viewed from different angles, the practice of intercropping reflects farmers' traditional wisdom or rationality as applied to his cropping decisions (Norman 1974; Jodha 1977). However, notwithstanding its vast coverage and the strong rationale behind it, intercropping has received scant attention from the standpoint of research, policy, and planning. National and international reports of agricultural statistics seldom include details about intercrops; plan documents do not contain programs for intercrops, even at development block level; agricultural growth models seldom recognize intercropping as one of the variables. Researchers engaged in technology generation for agriculture have for the most part shown indifference to intercropping and consequently all high-yielding varieties were developed largely as sole crops. Extension activity for spreading new

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technology generally place little emphasis on intercrops. One reason is perhaps a general lack of awareness about its spread and potential.

Whatever limited documented evidence on intercropping is available at present suggests that intercropping gave higher and more dependable per hectare gross returns than did sole crops in Vidarbha region of India (Mathur 1963) and northern Nigeria (Norman 1974; Norman *et al.* 1978). It gave higher gross returns per unit of labor employed during labor scarcity period in northern Nigeria. Intercropping was found to ensure greater as well as a more even spread of employment of labor in Vidarbha (Mathur 1963). Intercropping was found negatively associated with farm size in three agroclimatic zones of peninsular India (Jodha 1977) as well as corn growing areas of Columbia (Colmenares 1975). Traditional intercropping systems were found to be characterized by very high degree of complexity and diversity as indicated by the numerous crop combinations that may be involved in a single village. Norman *et al.* (1978) identified as many as 230 different crop mixtures in study villages of northern Nigeria. Mathur (1973) reported more than a hundred crop combinations of mixed crops in Vidarbha region. Jodha (1977) reported 60 different combinations characterizing intercropping in a single village.

Viewed in relation to the extent of its practice and its enormous complexity, the effort devoted to actual study of intercropping is at best insignificant. No doubt the diversity and complexity make its study extremely difficult. But its understanding alone may meaningfully explain farmers' decision behavior regarding crop choice. This in turn can generate information directly usable to those engaged in generating and spreading new agricultural technology.

INTERCROPPING IN PENINSULAR INDIA

This paper discusses only a few dimensions of intercropping as practised in six SAT villages—two in each of three agroclimatic zones in peninsular India--where ICRISAT has conducted village level studies since May 1975. My presentation is based on plotwise details of cropping pattern of sample farmers for 3 agricultural years (1975 - 1978).[1] Important characteristics of the villages and the extent of intercropping therein are summarized in Table 1.

As shown in Table 1, the extent of intercropping as a proportion of gross cropped area varied from about 18 to more than 83 percent in the six villages. This fairly wide variability of intercropping is due to local differences of agroclimatic and related conditions. Conditions varying in vastly different degrees in different villages were extent of postrainy season cropping, extent of irrigation, and extent of HYVs as well as extent of some crops like paddy, castor bean, etc. (rarely grown as mixed crops), all of which for one or another reason discourage intercropping. Tables 2 and 3 clearly illustrate that the above factors lead to greater emphasis on sole cropping.

To elaborate, reducing the weather-induced instability of farming through irrigation reduces the need for intercropping as a crop-diversifi-

[1]For methodology and other details of ICRISAT Village Level Studies see Jodha *et al.* (1977).

Table 1. Extent of intercropping and related details in six villages in SAT India[a]

Village	Rainfall: Annual average	Rainfall: Variability (C.V.)	Soil type	Situation on sample farms (3-yr. average)[b]: Gross cropped area/ha	Proportion of GCA having: Intercropping	Irrigation	HYVs[c]	Specific crops[d]	Net sown area planted in: Post-rainy season	Rainy season
	(mm)	(%)			(%)	(%)	(%)	(%)	(%)	(%)
Kanzara (Akola Dist. Maharashtra)	820	27	Medium deep Vertisols	6.5	72.7	4.9	15.6	1.5	1.7	94.7
Kinkheda (Akola Dist. Maharashtra)	820	27	"	6.6	83.1	3.8	6.6	1.8	3.1	91.2
Kalman (Sholapur Dist. Maharashtra)	690	29	Deep and Medium deep Vertisols	9.0	47.4	10.4	1.0	3.5	60.8	31.5
Shirapur (Sholapur Dist. Maharashtra)	690	29	Deep Vertisols	6.7	17.6	13.3	0.2	6.7	67.5	21.2
Aurepalle (Mahbubnagar Dist. Andhra Pradesh)	710	28	Shallow and medium deep Alfisols	4.5	34.9	21.0	11.7	53.5	5.2	80.7
Dokur (Mahbubnagar Dist. Andhra Pradesh)	710	28	"	3.2	20.9	60.1	43.9	49.8	18.1	69.2

[a] Based on the details from sample farms in six villages. Village level studies have been conducted in these villages since May 1975 (Jodha *et al.* 1977).

[b] Number of sample farms selected in May 1975 was 30 in each village.

[c] High Yielding Varieties of crops include mainly hybrid sorghum and cotton in Akola villages and HYV paddy in Mahbubnagar villages.

[d] Includes crops like sugarcane, paddy and castor bean which are seldom grown as mixed crops. See Table 3.

Table 2. Proportions of postrainy season net sown area (NCA), gross irrigated area, and high yielding varieties (HYVs) area devoted to sole cropping in six SAT villages in India during 1975-76 to 1977-78.[a]

Village	Proportions of sole cropping in the total of:		
	Postrainy season NCA	Gross irrigated area	HYVs' area
	(%)	(%)	(%)
Kanzara	98.9	100.0	76.7
Kinkheda	100.0	73.7	73.3
Kalman	64.7	83.4	61.4
Shirapur	78.9	90.1	100.0
Aurepalle	100.0	93.8	100.0
Dokur	98.7	99.6	100.0

[a]Based on details from sample farms in six villages. Village level studies have been conducted in these villages since May 1975 (Jodha *et al.* 1977).

cation strategy against risk. Unlike rainy season (kharif) cropping, postrainy season (rabi) planting begins with a known state of soil mosture, and hence the need for intercropping to adjust to eventual fluctuation in moisture situation becomes less important. The HYVs requiring higher input costs do not fit well to the farmers' intercropping systems. The farmer does not want to divert costly inputs meant for HYVs by interplant-

Table 3. Proportion of individual crop areas devoted to intercropping in six SAT villages in India during 1975-76 to 1977-78[a].

Crops	Proportion of individual crop's area devoted to intercrops in village:[b]					
	Kanzara	Kinkheda	Kalman	Shirapur	Aurepalle	Dokur
	(%)	(%)	(%)	(%)	(%)	(%)
Sorghum (HYV)	46.7	33.6	15.0	-	0.0	0.0
Sorghum (Local-K)[c]	96.4	99.4	-	-	88.4	41.4
Sorghum (Local-R)[d]	-	-	35.4	21.6	-	-
Pearl millet (Local)	100.0	-	100.0	-	99.3	-
Wheat (HYV)	0.0	3.7	0.0	0.0	0.0	-
Wheat (Local)	0.0	11.2	72.6	49.5	40.0	0.0
Paddy (HYV)	-	-	-	-	0.0	0.0
Paddy (Local)	62.2[e]	63.2[e]	35.3[e]	4.1	0.0	0.0
Maize (HYV)	-	-	26.1	-	-	-
Maize (Local)	-	-	59.2	32.1	-	-
Cotton (HYV)	44.6	84.4[e]	-	-	-	-
Cotton (Local)	91.1	94.6	-	-	-	-
Sugarcane	0.0	-	6.6	9.0	-	-
Pigeonpea	100.0	98.7	94.6	23.2	100.0	100.0
Mungbean	93.2	94.2	97.2	85.4	-	-
Chickpea	29.2	5.3	68.2	26.9	-	0.0
Groundnut	81.8	61.8	41.0	8.8	13.3[e]	41.4
Safflower	0.0	0.0	100.0	85.7	18.3	-
Castorbean	-	-	-	-	9.9	-

[a]Based on details from sample farms in six villages. Village level studies have been conducted in these villages since May 1975 (Jodha *et al.* 1977).

[b]For calculating proportions, the area of the concerned crop grown as sole as well as all mixtures containing the concerned crop irrespective of its actual share in the mixture was considered.

[c]Local-K = Local variety of (kharif) rainy season crop.

[d]Local-R = Local variety of (rabi) postrainy season crop.

[e]Actual area under these crops was too insignificant to warrant meaningful comparison.

ing non-HYV crops with HYVs.[2] Moreover, till recently very little research was done on different aspects of intercropping involving HYVs. The phenomenon of unwillingness to divert costly inputs to unwanted crops also prevents mixing other crops with high water-requiring high payoff crops like paddy and sugarcane. Besides, the lack of technical complementarity of crops like paddy, castor, and sugarcane with other crops discourages intercropping and the villages with a high proportion of these crops (Table 4) correspondingly had a lower extent of intercropping. On the other hand, the villages with higher extent of crops like pigeonpea, groundnut, cotton, and rainy season sorghum (largely grown as intercrops, Table 3,4), had higher extent of intercropping.

INTERCROPPING AND FARM SIZE

An important phenomena related to the risk-minimizing potential of intercropping is the popularity of this system with small farmers who (unlike large farmers) have neither enough capacity to take risk nor enough land to conveniently diversify cropping by putting different sole crops on several plots. Table 5 further confirms the results reported by Jodha (1977) indicating the decline in intercropping with increase of farm size. This was the case in all villages except in Dokur and Shirapur, where small farmers were better endowed than large farmers in terms of the factors (proportion

[2]The difficulty of incorporating HYVs into intercropping system could be one of the factors responsible for limited spread of HYVs in the areas as well as farming groups (i.e., small farmers) where intercropping gets higher priority (see Table 5).

Table 4. Proportion of important crops/crop mixtures in gross cropped area (GCA) in six SAT villages in India during 1975-76 to 1977-78.[a]

Crops/Crop mixtures	Proportion of crops/crop mixtures[b] in GCA in villages					
	Kanzara	Kinkheda	Kalman	Shirapur	Aurepalle	Dokur
	(%)	(%)	(%)	(%)	(%)	(%)
Sorghum[c]	9.0	2.3	38.1	42.7	4.0	6.3
Sorghum mixtures[c]	18.4	35.6	20.3	11.8	30.0	7.6
Wheat	2.7	3.4	1.4	2.4	0.1	0.4
Paddy	1.1	1.0	2.5	1.7	16.6	48.1
Other cereals	0.1	-	1.6	2.1	0.3	4.4
Pigeonpea	-	0.8	1.2	6.8	-	-
Pigeonpea mixtures	-	-	19.4	0.5	-	-
Chickpea	2.0	4.9	2.3	4.6	-	1.2
Other pulses	1.0	1.4	1.5	8.7	1.1	1.6
Groundnut	2.1	1.5	1.6	2.1	0.7	17.0
Groundnut mixtures	9.1	2.1	0.8	0.2	0.1	12.0
Castor bean/cotton[d]	7.7	2.3	-	-	33.2	-
Castor bean/cotton mixtures[d]	45.9	43.6	-	-	3.7	-
Other crops	0.8	0.6	2.4	10.3	8.1	0.6
Other mixtures	0.1	0.5	6.9	6.1	2.1	0.8

[a]Based on details from sample farms in six villages. Village level studies have been conducted in these villages since May 1975 (Jodha *et al.* 1977).

[b]The crop mixtures have been named after the prominent crop of the mixtures.

[c]Sorghum crop and its mixture in Kalman and Shirapur villages are postrainy season crops.

[d]Castor bean and castor bean mixtures relate to Aurepalle village; cotton and cotton mixtures relate to Kanzara and Kinkheda villages.

Table 5. Extent of intercropping and related details on small and large farms in six SAT villages in India during 1975-76 to 1977-78[a]

Village	Farm size groups	Proportion of gross cropped area devoted to intercropping				3-yr. average	
		1975-76[d]	1976-77	1977-78	Average	Irri-gated area[b]	Postrainy season cropping[c]
	(ha)	(%)	(%)	(%)	(%)	(%)	(%)
KANZARA							
Small	0.21-2.25	83.1	85.6	92.6	87.3	6.1	1.8
Large	>5.60	68.6	65.6	75.2	69.7	5.4	1.6
KINKHEDA							
Small	0.21-3.00	92.0	79.2	100.0	90.7	4.4	2.1
Large	>5.60	79.6	78.4	85.4	91.8	4.6	2.7
KALMAN							
Small	0.21-6.00	65.6	44.1	67.1	59.5	7.1	65.8
Large	>10.75	34.5	41.0	46.5	41.1	10.7	58.6
SHIRAPUR							
Small	0.21-2.50	3.1	14.1	15.7	11.2	21.9	77.1
Large	>6.00	16.7	20.7	19.0	19.0	10.4	70.5
AUREPALLE							
Small	0.21-2.50	49.3	27.4	57.2	44.4	4.5	5.4
Large	>5.25	44.1	25.4	26.2	33.7	25.2	6.6
DOKUR							
Small	0.21-1.00	12.3	0.0	0.0	5.1	74.0	7.9
Large	>3.00	20.2	21.4	22.1	21.2	59.0	18.8

[a] Based on details from sample farms in six villages. Village level studies have been conducted in these villages since May 1975 (Jodha *et al.* 1977).

[b] Gross irrigated areas as proportion of gross cropped area.

[c] Net area sown during postrainy season as proportion of total net sown area.

[d] The figures indicating proportion of intercropping on small and large farms differ slightly from those indicated by preliminary analysis (Jodha 1977) due to recategorization of farm size groups. See Ghodake and Asokan (1978).

of area irrigated, postrainy season net cropped area) which discouraged intercropping. The proportion of intercropping was consistently higher on small farms during all 3 years. The small and large farm differences in the proportion of intercropping were found statistically significant at one percent level of confidence.

Another reason for higher proportion of intercropping on small farms is the fact that the small farmer has to satisfy all his profit-oriented as well as his subsistence-oriented requirements from the same small piece of land. Intercropping according to the small farmers is relatively convenient means to serve this purpose well.

A significant implication of this result is that any break-through in intercropping technology will benefit less-endowed farmers more than the relatively better-endowed farmers. This offers a unique opportunity of explicitly incorporating equity considerations in agricultural research strategy by means of allocating greater resources to intercropping research.

TRADITIONAL INTERCROPPING SYSTEMS

As mentioned earlier, complexity and diversity is another important feature of a traditional intercropping system. Table 6 provides an illustration. The number of sole crops grown in six villages ranged from 17 (in Dokur) to 44 (in Shirapur), but the number of crop combinations used for intercropping exceeded the number of sole crops in most of the villages. Within intercrops, two-crop mixtures were popular in most villages but mixtures involving five to eight crops were not uncommon. The proportion of gross cropped area occupied by two-crop mixtures ranged from more than

Table 6. Number of sole crops, crop combinations in crop mixtures, and their (%) share in gross cropped area in six SAT villages in India during 1975-76 to 1977-78[a]

Village	Sole crop	Intercrops with mixture of 2 crop	3 crop	4 crop	5-8 crop	Total
	(no)	(no)	(no)	(no)	(no)	(no)
Kanzara	22 (27.5)[b]	17 (25.8)	13 (23.8)	11 (18.8)	4 (4.1)	67 (100.0)
Kinkheda	19 (16.9)	15 (23.8)	14 (41.2)	11 (17.3)	1 (0.8)	60 (100.0)
Kalman	34 (52.7)	40 (24.6)	28 (14.7)	13 (6.3)	3 (1.7)	118 (100.0)
Shirapur	44 (82.4)	23 (15.2)	3 (1.6)	1 (0.8)	-	71 (100.0)
Aurepalle	21 (64.3)	4 (5.5)	2 (9.8)	- (1.5)	11 (18.9)	38 (100.0)
Dokur	17 (79.3)	4 (5.3)	3 (2.1)	2 (6.8)	1 (6.5)	27 (100.0)

[a]Based on details from sample farms in six villages. Village level studies have been conducted in these villages since May 1975 (Jodha *et al.* 1977).

[b]Figures in parentheses indicate the percentage share of crop/crop combination in gross cropped area during the 3-year period.

5 to about 26 percent of gross cropped area in these villages. The corresponding proportions of three and four crop mixtures ranged from 2 to 41 percent and 2 to 19 percent, respectively. Of course, viewed from their share in gross cropped area, the most important mixtures (identified by number and not type of crops involved) were different in different villages.

Furthermore, in terms of seed rates and distribution of rows of different crops in the mixtures no uniform pattern was found to prevail in all the villages. However, intercropping by mixing seeds (as against putting different rows of different crops) was not very common except in the case of minor components of the mixtures.

The inter-village differences (Table 6) could be further elaborated with the help of details in Table 3, 4, providing additional information on cropping patterns in six villages. Cotton-dominated mixtures followed by sorghum-dominated mixtures were prominent in villages of Akola district (Table 4).[3] In the remaining villages (except Dokur), sorghum-dominated mixtures were most important. In Dokur, groundnut-led mixtures were dominant. As reflected in Table 3, the bulk of the pigeonpeas, pearl millet, mungbean, and safflower were grown as mixed crops in most of the villages; but being subsidiary crops of the mixtures, they do not figure explicitly in most villages in Table 4.

The complexity of traditional intercropping discussed above is partly an outcome of farmers' informal experimentation with crops which satisfy their requirements and also fit the agricultural environment of the region In developing countries, the farmer is engaged in agriculture with multiple objectives. Since a single crop or a group of similar crops (because of their physiological, economic and other characteristics) have compara-

[3] Mathur (1963) also reported the similar phenomena for that region.

tive advantage in satisfying specific objectives, and in densely populated countries the farm size is not large enough to permit growing of sole crops to meet all these objectives, the farmer resorts to intercropping in order to satisfy his multiple objectives simultaneously.

For instance his profitability objective can be satisfied best with high-value cash crops like cotton and groundnuts while his subsistence requirements are best served by sorghum, pigeonpea, etc. While the maintenance of soil fertility is best achieved by leguminous crops, fodder requirements of farmers' animals are served better by crops like sorghum and pearl millet having enough crop byproducts. Similarly, while trying to have highest output from his crop enterprises, a farmer has to guard against possible midseason droughts. Crops like pigeonpeas with greater drought resistance, and sorghum having higher salvage value (i.e., in the event of crop failure, at least fodder is available) satisfy his security requirements better. Similarly, despite the broad regional suitability of soils for particular crops, each part of a land parcel operated by a farmer is not uniformally suited to the same crop. Patches of plots characterized by salinity, depressions having accumulation of fine silt or potential for seasonal stagnation of water, and gravelly infertile soil are not uncommon. In order to adjust to these specific features, farmer undertakes "patch cultivation,"[4] raising different crops on different patches within a small

[4]It may be noted that technically speaking 'patch cultivation' is not intercropping. However, in most of the situations they do serve the broad objectives served by planned intercropping.

plot. "Patch cultivation" also takes place through "midseason" corrections in the cropping pattern when part of the crop in a small plot fails because of insect attack or excess or lack of timely post-sowing rainfall. Despite overall excess availability of manpower in agriculture in countries like India, labor (because of time-specific crop operations) does prove a bottleneck especially at harvest season. Raising of crops with distinctly different maturity periods (e.g. sorghum versus pigeonpea) as sole or mixed crops helps in more even spread of labor requirement. But the objectives of having maximum cropped acreage without subsequent labor bottlenecks and maximum gainful employment for family workers along with the gains in terms of risk reduction and technical complementarities of crops are achieved better through intercropping of crops with different growth cycles.

To the extent that different crops can complement each other in satisfying farmers' multiple requirements, the intercropping of these crops serves as most rational cropping strategy on the part of the farmer.[5]

To illustrate the points mentioned above, crop mixtures in the study villages were classified into six categories on the basis of crops (having specific characteristics) included in each crop combination of intercrops. Their brief description is as follows:

[5]This paper does not refer to technical complementarities of crops when grown as intercrops. For a detailed review, see Willey (1978).

Category A : Mixtures or crop combinations involving crops planted in order to use patches of problem-soils (saline soils, depressions, etc.) within the plot. Combining of paddy crop with sorghum or pigeonpea is one illustration of such mixtures. This category of crop mixture is intended to satisfy the objective of adjusting crops to features of the land-resource base.

Category B : Mixtures involving crops like seasonal vegetables, tobacco fiber crops, and (in some cases) minor millets, pulses, and oilseeds, raised mostly for 'self provisioning requirements' of the family. Their insignificance is indicated by very low seeding rate when compared with the seeding rate of other component crops of the mixture in a plot. Most of these crops--especially vegetables--are seldom harvested systematically. Leaves and fruits are picked up if and when need arises and time permits. These crops are different from other subsistence crops (e.g. sorghum, pigeonpea, etc.) raised as major component of mixtures and, depending upon their production, are marketed.

Category C : Mixtures involving crops with different growth periods facilitating spread of peak- (harvest) period labor requirement. Combination of sorghum or pearl millet and pigeonpea is an example.

Category D : Mixtures involving drought-resistant and drought-sensitive or less drought-resistant crops such as pearl millet and groundnut or pigeonpea and cotton to at least partially guard against drought risk.

<u>Category E</u> : Mixtures involving crops conventionally described as cash crops and food-grain crops. Groundnut and pearl millet, or cotton and sorghum, or castor bean and pigeonpea are examples of this mixture designed to satisfy both profitability and subsistence requirements.

<u>Category F</u> : Mixtures involving legume and nonlegume crops to maintain soil fertility without sacrificing nonlegume crops and also fulfil crop-rotation requirements.

It may be noted that above categories of crop mixtures are not mutually exclusive.

The proportions of mixtures qualifying for the above categories in different villages are presented in Table 7.

Accordingly, the extent of intercropping (Category A) induced by need for adjustment to features of the land-resource base through patch cultivation was important only in Kalman and Shirapur villages. These villages belong to the region having the highest extent of heterogeneity of resource base created by types of soils, bunding, and very erratic rainfall in two phases.

Intercropping induced by "self-provisioning requirements" (different from subsistence requirements) ranged from 9 to 36 percent of total area under intercrops.[6]

[6]The highest extent of intercropping of Category B in Aurepalle and Dokur was partly due to the ritual that every farmer should plant nine crops in at least one of his plots. This practice known as *Nava Dhanyam* (nine grains) is guided by a belief that it is duty of every farmer to preserve the germplasm, which nature has provided. This practice--prevalent in several parts of the country--is now fast disappearing due to more and more specialized farming.

Table 7. Proportions of different categories of crop mixtures in the total area of intercropping in six villages in SAT India (average of 1975-76 to 1977-78)[a]

Crop mixture categories[b]	Proportion of different categories of crop mixtures in total area of intercropping in					
	Kanzara	Kinkheda	Kalman	Shirapur	Aurepalle	Dokur
	(%)	(%)	(%)	(%)	(%)	(%)
A	2.1	3.4	15.4	12.2	2.6	1.8
B	9.4	11.2	18.4	14.1	35.9	28.7
C	58.1	83.9	46.1	32.4	71.1	79.0
D	71.9	80.6	17.7[c]	24.6	12.5[c]	40.5
E	72.7	59.2	44.2	60.6	53.2	50.3
F	87.5	77.2	58.5	39.8[d]	84.4	37.7[d]

[a]Based on details from sample farms in six villages. Village level studies have been conducted in these villages since May 1975 (Jodha *et al.* 1977).

[b]The crop-mixture categories are not mutually exclusive. The basis of crop-mixture categorization is as follows:

Category A : Mixture resulting from adding to the main crop of the plot a few other crops in order to adjust to the physical factors like patches with salinity, depressions, infertile gravelly soil, etc. (e.g., paddy combined with sorghum or pigeonpea).

Category B : Mixtures having some crops like seasonal vegetables, tobacco, fiber crops, etc., seldom grown for the purpose of final harvests. They are harvested as and when family "self-provisioning" demands.

Category C : Mixtures involving crops with different growth periods facilitating spread of peak (harvest) period labor requirement (e.g., sorghum and pigeonpea).

Category D : Mixtures involving drought resistant and drought sensitive (or less drought resistant) crops (e.g., groundnut and pearl millet).

Category E : Mixtures involving cash crops and foodgrain crops (e.g., sorghum and cotton, castor bean, and pigeonpea).

Category F : Mixtures involving legumes and nonlegumes (e.g., sorghum, pigeonpea, or greengram).

[c]Bulk of the other mixtures consisted of only drought-resistant crops.

[d]Bulk of the other mixtures consisted of only legumes.

Crop mixtures under category C, involving crops with different peak labor-requirement periods accounted for 32 to 83 percent of acreage under intercrops in different villages. However, in predominantly postrainy season cropping villages, the proportion of crop mixture of Category C was relatively low as the cropping season did not offer enough scope for crops with vastly different maturity periods. Lack of mixtures of Category C in postrainy season crops influenced the overall proportion of these mixtures in both Kalman and Shirapur.

The lower extent of mixture Category D (involving drought-resistant and less drought-resistant crops) in the above two villages was also partly due to the impact of postrainy season intercrops. Crops in this season are grown on the basis of moisture stored in deep Vertisols and one does not have to plan crop mixtures that will guard against impact of likely drought. Mixing of drought-resistant crops only also reduced the extent of mixture Category D in Kalman and Aurepalle villages.

Intercropping induced by need for combining cash and subsistence crops as well as combining legume and nonlegume crops was also very substantial in most of the villages, as revealed by crop-mixture categories E and F (Table 7).

While the analysis of data to quantify the extent to which farmer could actually achieve his goals through six categories of crop mixtures is still in progress.[7] The above picture convincingly demonstrates that

[7]The biggest problem faced in such analysis is that of decomposing the mixture and judging the contribution of each component of the mixture in fulfilling different objectives.

traditional intercropping system is complex and varied because it embodies conscious and rational attempt of farmer to adjust his cropping pattern according to his need and resource base.

However, a closer look at traditional intercropping raises an important question. Can one generate new intercropping technology which can satisfy multiple goals of the farmer? The honest answer is "no". In the first place it is not possible for researchers to clearly perceive the diverse and multiple objectives of the farmer in raising intercrops. Secondly, even if the objectives are clearly understood, their incorporation into research strategy is more difficult, notwithstanding the availability of multilocation and multiseason trial facilities.

Indeed it could be argued that it is not necessary that scientists generate an intercropping system as complicated and diversified as witnessed in traditional agriculture. The best strategy lies in evolving only a few simple intercropping systems which satisfy at least key objectives like profitability and stability (i.e. risk reduction). However, the dominance of crop mixture categories C, D, E, and F (Table 7) indicates that fertility maintenance and labor-peak problems also need to be incorporated. Hence, while profitability and stability should perhaps get the main focus, the side conditions of labor use and soil fertility also need to be kept in view while developing intercropping technology. This itself may not be very difficult because a particular mixture may fall in perhaps all the categories. To make itself superior to the traditional one, the new intercropping system should incorporate new agrobiological components, such as HYVs, and new knowledge about land and water management. If the new simple intercropping options prove viable, the farmer would be induced to adopt them. If he finds it more useful to incorporate new elements to them, he--through informal experimentation--can very well make them more complex to serve his multiple objectives as has been the case in the past.

CONCLUSIONS

Though neglected by both researchers and agricultural planners, intercropping is an important feature of traditional farming systems. It embodies traditional wisdom of the farmer as it relates to his crop decisions. The available documented evidence shows the superiority of intercropping over solecropping in terms of gross returns per hectare as well as per man day used during labor scarcity period of crop season. Intercropping ensures greater and even distribution of employment of labor.

The present paper has highlighted two important features of traditional intercropping system having significant research and policy implications. Firstly, intercropping is less important on large farms as well as on irrigated farms compared to small farms and rainfed farms respectively. Thus, any break through in intercropping technology will help the poorly endowed farmers more than the well endowed farmers. This suggests a unique opportunity to incorporate equity-bias in research resource allocation by way of increased allocation to intercropping research.

Secondly, the traditional intercropping system is highly complex and diverse as indicated by a multiplicity of combinations in crop mixtures. The farmer does so in order to satisfy his multiple objectives simultaneously. The researchers cannot and need not try to generate equally complex new intercropping systems. They should concentrate on generating simple intercropping systems which satisfy at least a few key objectives like profitability and stability without completely ignoring other objectives which underlie the traditional intercropping system.

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