PN-AAJ-872

c.1

Economics Program
Progress Report - 21

Crop Failure and Intercropping in the Semi-Arid Tropics of India

R.P. Singh

ICRISAT

International Crops Research Institute for the Semi-Arid Tropics
ICRISAT Patancheru P.O.
Andhra Pradesh 502 324, India

May 1981

PROGRESS REPORTS are informal communications about ongoing research, or thoughts of ICRISAT staff members, which are designed to stimulate thinking and comments of professional colleagues within and outside the Institute. These reports are not to be considered as formal publications bearing the endorsement of the Institute. Progress reports were earlier referred to as Occasional Papers/Discussion Papers.

BEST AVAILABLE DOCUMENT

Crop Failure and Intercropping in the Semi-Arid Tropics of India

R.P. Singh*

Crop failure is a typical phenomenon of SAT India where rainfall is generally low and irrigation facilities are less developed. Farmers take some precautionary measures to minimize the risk of crop failure. Intercropping† is one such important strategy practiced by the farmers for many centuries. In Africa it has been found not only to reduce crop failure but also to provide dependable higher gross returns and more regular employment (Norman 1974, Norman et al. 1978, and Abalu and D'Silva 1979). This paper presents a descriptive analysis of crop failure mainly in relation to intercropping in SAT India.

Crop failure can be of two types (1) complete crop failure where all the crops grown in a plot fail and (2) partial crop failure where either one or more crops fail in an intercrop. In this study, failure implies that grain yield is nil from the plot; therefore, much of the analysis focuses on complete crop failure. The data used in the paper relate to three agroclimatic regions of SAT India, viz., Akola and Sholapur (in

---

* Economist, Economics Program, ICRISAT. The author wishes to thank Drs. Thomas S. Walker, James G. Ryan, and M. von Oppen for their valuable comments and suggestions for the improvement of paper. The author is thankful to D. Jha for his encouragement and constant help in preparing this paper from the beginning. The author would also thank Mr. C. Krishnagopal for his help in computer work and Mr. Mahendran and Mr. V.B. Ladole for their help in processing and analysis of the data.

† Intercropping refers to growing two or more crops simultaneously in the same plot in different but proximate stands. Mixed intercropping is the growing of two or more crops simultaneously intermingled in the same plot with no distinct row arrangements. In this paper, intercropping refers to both row and mixed intercropping.

Maharashtra state) and Mahbubnagar (in Andhra Pradesh state) and cover five cropping years from 1975-76 to 1979-80.

The main objectives of this paper are to examine the incidence of crop failure in different agro-climatic regions and to study the factors responsible for crop failure. The following hypotheses are analyzed:

i) the extent of crop failure is higher for sole cropping compared with intercropping;

ii) the extent of crop failure is lower in post-rainy season (rabi) crop areas compared with rainy season (kharif) crop areas;

iii) the extent of crop failure is higher on large farms compared with small farms;

iv) the extent of crop failure is higher on soils with poor moisture retention capacity, i.e. shallow soils.

EXTENT OF CROP FAILURE

In Sholapur region, total crop failure is a relatively frequent event as about 11% of the cropped area suffered from complete failure, while in Mahbubnagar and Akola regions the extent of complete crop failure is very low at around 3% (Table 1).

---

* For a description of ICRISAT's Village Level Studies, see Jodha et al. (1977)

Table 1. Percentage of plots and area suffered from complete crop failure under sole and intercrops in different agroclimatic regions (Average of 1975-76 to 1978-79).

(Percentages)

Village/region	Plots			Area		
	Sole crop	Inter-crop	Total	Sole crop	Inter-crop	Total
Aurepalle	14.4	3.3	6.2	4.6	2.6	3.9
Dokur	2.4	5.6	2.7	1.7	6.1	2.5
Mahboobnagar	4.7	3.9	4.6	3.4	3.5	3.4
Shirapur	21.5	11.2	19.6	18.0	8.5	15.6
Kalman	12.9	9.3	11.4	8.1	6.1	7.1
Sholapur	17.5	9.8	15.1	13.4	6.8	10.9
Kanzara	6.1	3.9	4.9	4.5	2.6	3.1
Kinkheda	5.3	1.9	2.9	5.1	2.0	2.6
Akola	5.8	2.9	4.0	4.7	2.3	2.8

Complete crop failure is generally higher in sole cropping compared with intercropping (Table 1, Figure 1). In Sholapur region where the extent of intercropping is 31% (Table 2), crop failure varies from 18% in sole cropping to 10% in intercropping. Intercropping is prevalent (62%) in Akola region and the incidence of crop failure is substantially less. In Mahbubnagar region where the practice of intercropping is not very common (20%), failure in both sole crops and intercrops is around 4%. The data in Tables 1 and 2 tend to support the hypothesis that farmers of the SAT, whose farming is dependent mainly on rainfall, take the precautionary measure of growing a number of crops in each plot as a strategy to safeguard against crop failure.

Within the villages of the same region, greater crop failure in sole crops compared with intercrops is clearly visible (Tables 1 and 2). In Sholapur region, there is quite a large difference in the average extent of crop failure between Shirapur and Kalman, but the same fiding applies that failure is higher in monoculture. Only for Dokur does this generalization not hold, and Dokur is primarily an irrigated villages planted to sole-cropped paddy (Figure 2 and Appendix Table 1).

The data in Table 3 and the graphs in Figure 3 suggest that large farmers suffer from a higher incidence of crop failure than small farmers. A X^2 test indicates that the mean difference in crop failure among farm-size classes is significant at the 5% level. One reason for more frequent crop failure on larger farms stems from a greater reliance on sole cropping on larger farms (Table 2 and Figure 4). For example, the

Fig. 1. Incidence of complete crop failure in different villages of SAT India (1975-76 to 1978-79).

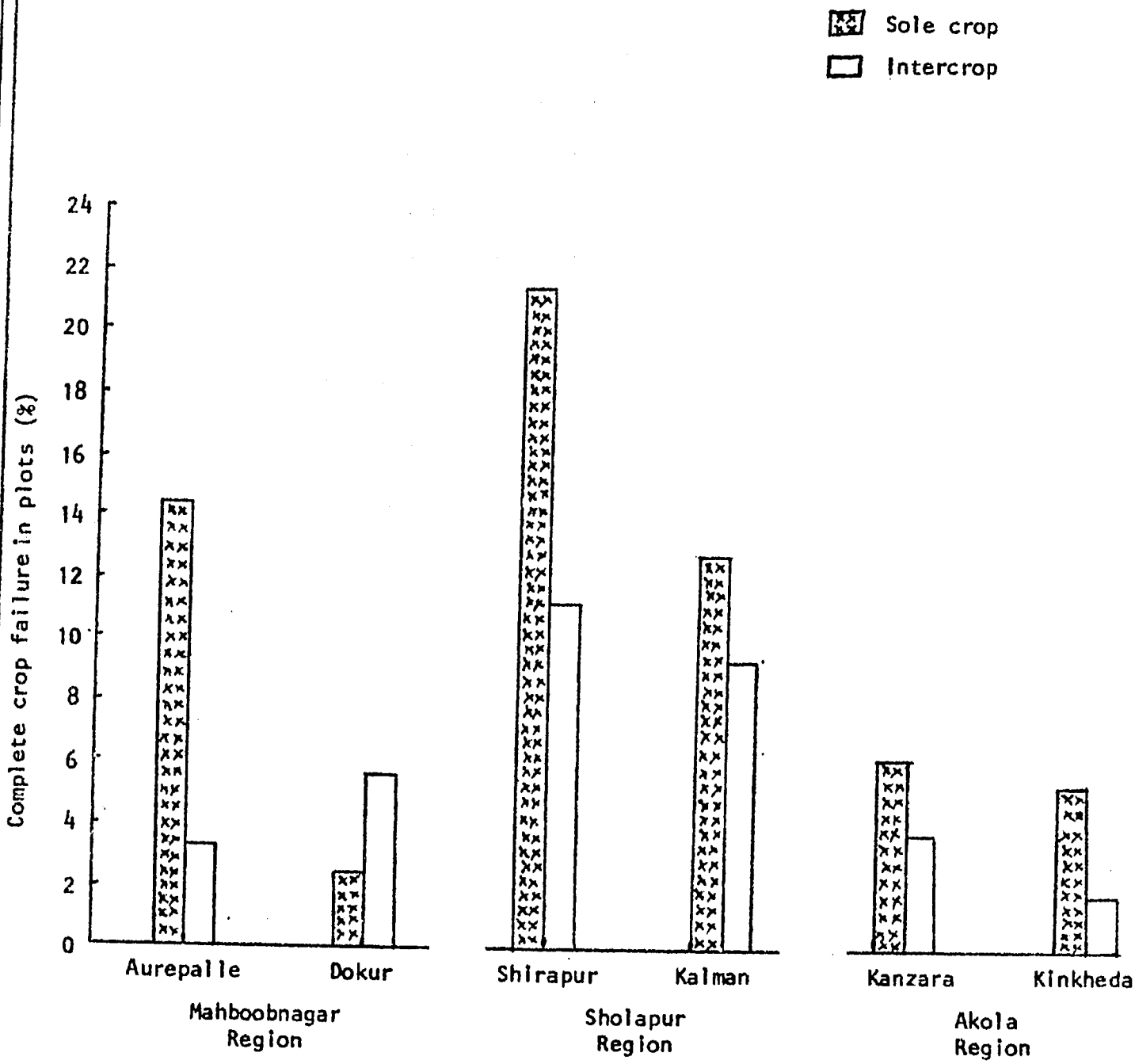


Table 2. Extent of intercropping in different village according to land holding class (average of 1975-76 to 1978-79).

Village/region	Percentage number of plots and cropped area under intercropping							
	Small		Medium		Large		All	
	Plot	Area	Plot	Area	Plot	Area	Plot	Area
Aurepalle	46	46	35	42	19	31	27	35
Dokur	3	3	14	21	13	20	11	19
Mahboobnagar	25	32	24	34	16	27	20	29
Shirapur	13	18	22	19	18	27	19	25
Kalman	48	59	39	54	40	44	42	49
Sholapur	36	47	32	42	24	36	31	38
Kanzara	79	85	64	80	47	70	54	73
Kinkheda	78	88	80	85	65	76	70	81
Akola	78	87	72	82	55	75	62	77

Fig. 2. Extent of Intercropping in different villages of SAT India. (1975-76 to 1978-79)

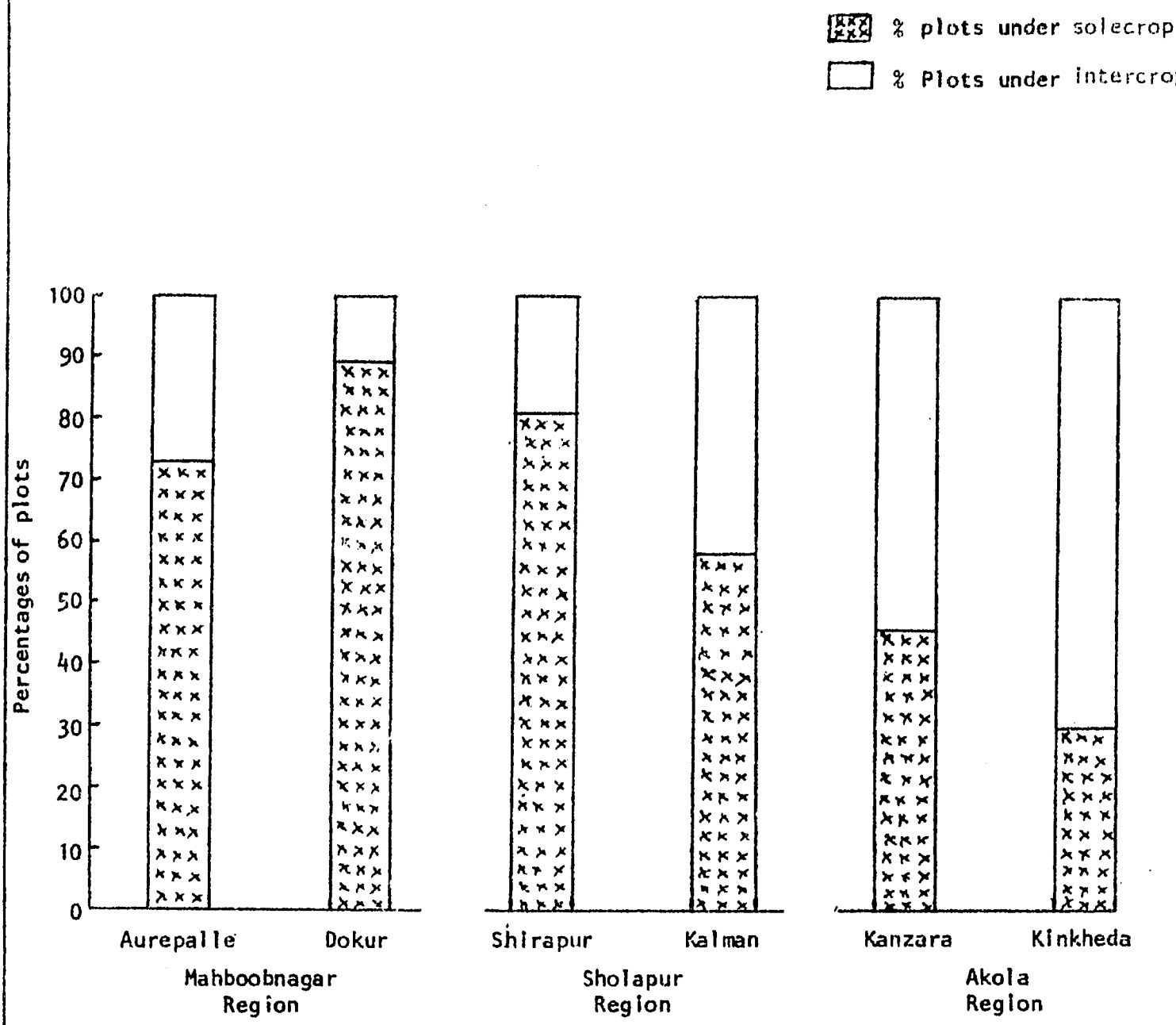


Table 3. Extent of crop failure (complete) in different regions according to land holding class (average of 1975-76 to 1978-79).

Village/region	Percentage area failed* in sole and intercropping											
	Small			Medium			Large			All		
	Sole crop	Intercrop	Total	Sole crop	Intercrop	Total	Sole crop	Intercrop	Total	Sole crop	Intercrop	Total
Aurepalle	6.6	-	3.5	6.0	-	3.4	4.2	4.3	4.2	4.7	2.6	4.0
Dokur	-	-	-	1.5	1.6	1.5	2.0	7.7	3.2	1.7	6.1	2.5
Mahboobnagar	3.5	-	2.4	3.9	0.4	2.7	3.3	5.3	3.8	3.3	3.5	3.4
Shirapur	19.2	1.9	16.0	16.9	5.3	14.7	18.2	9.5	15.8	18.0	8.5	15.6
Kalman	3.4	4.0	3.8	11.3	5.3	8.0	7.8	6.8	6.9	8.1	6.1	7.1
Sholapur	10.1	3.8	7.1	13.9	5.3	10.2	13.7	7.8	11.2	13.4	6.8	10.9
Kanzara	-	-	-	8.5	3.5	4.5	4.1	2.7	3.1	4.5	2.6	3.1
Kinkheda	-	-	-	20.9	1.9	4.7	2.3	2.3	2.3	5.1	2.0	2.6
Akola	-	-	-	14.0	2.6	4.6	3.4	2.5	2.7	4.7	2.3	2.8

*Percentage failure has been estimated separately for sole, and intercropping. Percentage area failed under sole cropping indicates the area failed under sole cropping divided by total area under sole crops multiplied by 100. Similarly failure in intercropping has been expressed area failed divided by total cropped area under intercropping multiplied by 100.

Fig. 3. Complete crop failure according to size of farms in different villages of SAT India (1975-76 to 1978-79)

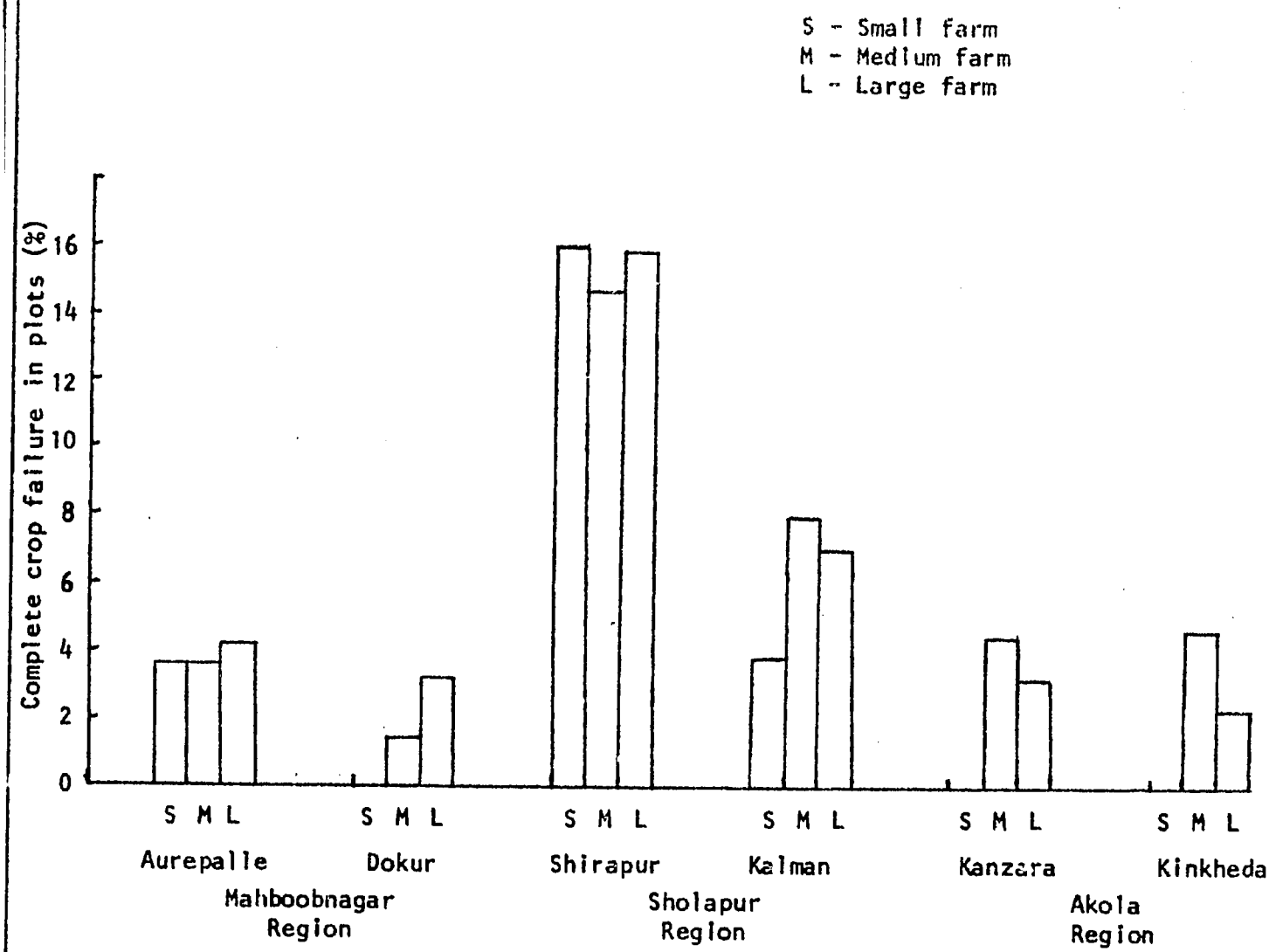
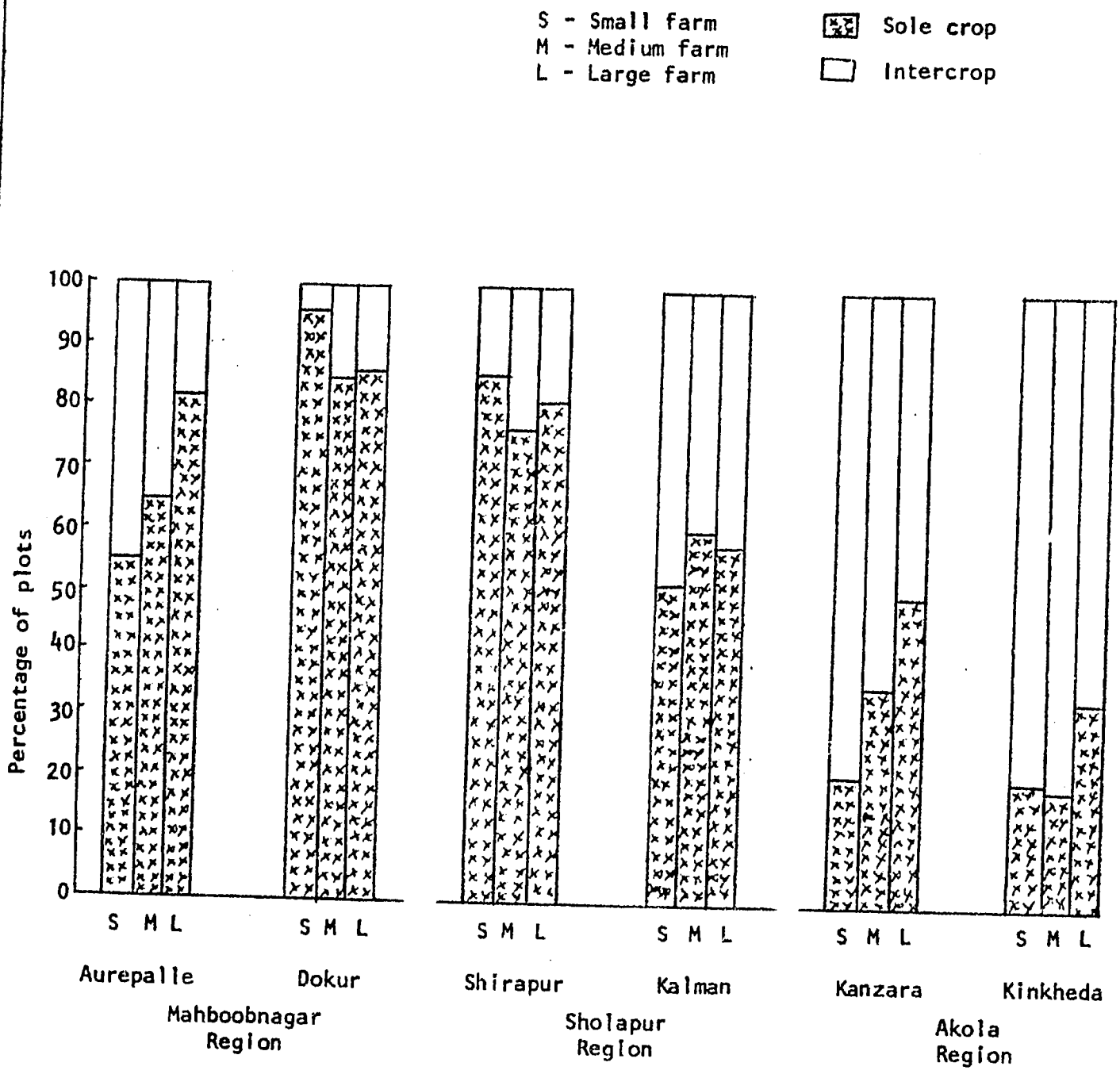


Fig. 4. Extent of intercropping according to size of farm in different villages of SAT India. (1975-76 to 1978-79)



extent of intercropping in the Akola region is very high (78%) and small farmers grow intercrops on 87% of their cropped area compared with 82% for medium farmers and 75% for large farmers (Figure 4). Small farmers in the Akola region did not suffer from complete crop failure. In contrast, crop failure was more frequent on medium and large sized farms where intercropping is not as intensively practiced. In Kinkheda failure in sole cropping was fairly common for large farmers at 21%.

Another measure of how crop failure varies across farm-size classes compares shares in cropped area to those for total crop failure (Table 4). It is interesting to note that, except in Akola region, the percentage share of crop failure for small and medium farmers was smaller than their share in gross cropped area.

The incidence of higher crop failure on larger farms compared with smaller holdings further supports the hypothesis that small farmers grow intercrops as a strategy to guarantee them minimum production. Intercropping is a relatively convenient means of attaining this goal (Jodha 1975). This conclusion is consistent with other findings and is based on long experience of the farmers (Norman 1974 and Jodha 1977).

INCIDENCE OF CROP FAILURE IN INTERCROPPING

Table 5 shows the probabilities of failure for different crops in intercropping combinations. The incidence of failure of the dominant or first crop is quite low at 3% while the possibility of failure of the second crop is nearly three times (9%) as great. Similarly, the probability

Table 4. Percentage share of different categories of farmers in total cropped area and area failed (average of 1975-76 to 1978-79).

Village/region	Percentage share in total cropped area and area failed								Area failed as % of cropped area
	Small		Medium		Large		All		
	Cropped area	Area failed	Cropped area	Area failed	Cropped area	Area failed	Cropped area	Area failed	
Aurepalle	10.86	9.57	20.72	17.85	68.33	72.58	1256.07 (100)	50.15 (100)	4.0
Dokur	8.36	-	21.76	12.77	69.88	87.23	776.10 (100)	19.66 (100)	2.5
Mahboobnagar	9.92	6.87	21.12	16.42	68.96	76.71	2032.17 (100)	69.81 (100)	3.4
Shirapur	7.05	7.30	17.53	16.50	75.42	76.30	1986.72 (100)	310.40 (100)	15.6
Kalman	14.55	7.86	27.52	31.57	57.93	60.57	2524.01 (100)	176.76 (100)	7.0
Sholapur	11.25	7.44	23.12	21.96	65.63	70.60	4510.73 (100)	487.16 (100)	10.8
Kanzara	7.74	-	17.50	25.27	74.76	74.73	1782.[illegible]8 (100)	55.20 (100)	3.1
Kinkheda	8.79	-	20.15	36.80	71.06	63.20	1786.82 (100)	46.20 (100)	2.6
Akola	8.27		18.83	30.52	72.90	69.48	3569.30 (100)	101.40 (100)	2.8

Table 5. Probabilities* of failure of dominant crops in crop mixtures of more than three crops in different agroclimatic regions (average of 1975-76 to 1977-78).

Villages/region	1st crop only	2nd crop only	3rd crop only	1st & 2nd crops	2nd & 3rd crops	1st & 3rd crops	All three crops
Aurepalle	0.8	4.2	9.2	-	3.3	0.8	3.3
Dokur	2.1	12.5	2.1	4.2	22.9	-	-
Mahbubnagar	1.2	6.5	7.1	1.2	8.9	0.6	3.0
Shirapur	2.1	21.0	2.1	9.1	1.4	1.4	0.7
Kalman	6.0	13.2	4.5	8.7	3.2	0.6	3.2
Sholapur	5.1	15.0	3.9	3.8	2.8	0.8	2.6
Kanzara	1.1	3.8	5.5	2.3	2.3	-	1.1
Kinkheda	2.4	2.7	4.1	0.7	-	-	1.1
Akola	1.8	3.9	4.9	1.4	1.1	-	1.1
Average	3	5	5	3	3	-	2

*Probabilities of failures are estimated by dividing the number of plots failed by total number of plots grown with different crop combinations.

of failure of only the third crop is also less (5%) but slightly higher than the failure of first crop in a mixture. Failure of both first and second crop gives a joint probability of 5%.

With regard to partial crop failure, principal crops failed at a rate of about 20% in the Sholapur region, and 6% in Mahbubnagar and Akola regions. Considering the two most important crops, the severity of the crop failure becomes higher. In Sholapur region nearly half of the crop area suffered from partial crop failure, whereas, in the Akola and Mahbubnagar regions partial crop failure accounted for about 12% of planted area. In different villages, partial crop failure varied from 9 to 52%, being generally lowest in Kinkheda village of Akola region and highest in Shirapur of Sholapur region.

There is a large variation between in the cropping pattern in intercropping in the six villages. Despite this variation, the probability of the first crop failing in a mixture is low for all six villages. This result further suggests that farmers generally grow more stable species as the dominant crop. Table 5 raises some definitional questions on what we mean by crop failure and points to the need for an in-depth analysis of crop failure in intercropping.

INCIDENCE OF FAILURE BY CROP

Pearl Millet

For pearl millet which is rarely grown as a sole crop in the three regions, the probability of failure is quite high if grown as sole crop. It is generally grown as a second-and third-most important crop in crop mixtures

in Maharashtra villages and as the first-and second-most important crop in Aurepalle in Mahbubnagar regions. In Dokur, where rainfall is relatively reliable and irrigation facilities are more developed, farmers do not grow pearl millet and give more preference to cash crops like paddy and wheat. In Maharashtra villages, the likelihood of failure is higher if it is grown as a third crop compared to a second crop. But in Aurepalle though it is mainly grown as the dominant and second important crop in a mixture the expectation of failure is low.

Sorghum

Farmers generally grow local sorghum in Sholapur as a sole crop. HYV sorghum is grown in a smaller area in both the Maharashtra villages. In Mahbubnagar region, it is rarely planted as a sole crop. In Maharashtra villages, both local and HYV sorghum are grown mainly as sole crops or as the dominant species in a mixture. The possibilities of failure in the sole crop is quite high in Akola villages (Kanzara and Kinkheda) as compared with the Sholapur villages. In intercropping, the percentage of failure as the first and second crops is relatively higher in the Sholapur villages than in the other villages. In Dokur, the area planted to sorghum is small and the possibilities of failure are quite high. Similarly, the probability of failure is high in Kalman where HYV sorghum is rarely grown.

Pigeonpea

Pigeonpea is grown as a sole crop in Shirapur, while in Kalman it is planted as a dominant crop mixed with other crops. In the Akola region, it gets less preference and is grown as a second important crop, whereas

In Aurepalle and Dokur it is planted mainly as the third important crop in a mixture. In Mahbubnagar and Akola villages it is grown as second and third crop and the possibilities of failure are quite high if grown as a first and second crop in a mixture. But in Shirapur failure in intercrop is negligible and even low if cultivated as a sole crop.

Chickpea

Chickpea is rarely grown in Mahbubnagar either as a sole crop or intercrop. It is fairly common as sole crop in Maharashtra and is more prevalent in Sholapur than in Akola. It is a relatively risky crop in Kalman if grown as a second and third crop in a mixture whereas it did not fail once in Shirapur from 1975-76 to 1978-79.

Cash Crops

In the case of paddy and wheat, which are mostly planted in local cultivars, the probability of failure in Kalman is quite high if grown as a second or third crop in a mixture. For groundnut, cotton, and castor the chances of failure are negligible. Farmers probably plant their best land to these crops and choose management practices to ensure that they do not fail.

These observations hint that the cropping behavior of farmers who grow these crops is not arbitrary and is based on their experience. This further suggests that whenever a farmer chooses to grow a sole crop he takes much care to reduce the risk of crop failure.

INCIDENCE OF CROP FAILURE OVER TIME

Yearwise analysis of crop failure shows that the extent of crop failure in Sholapur region was high in all the years as compared to other regions; in 1977-78 it reached 21%. While in the same year in Mahbubnagar and Akola regions failure was merely 3 and 7% respectively (Appendix Tables 2 and 3). The extent of failure was highest in Sholapur and Akola regions in 1977-78 while in Mahbubnagar region incidence was highest in 1976-77. The intensity of crop failure varies from year to year depending upon rainfall. Because of confounding variables such as the extent of intercropping, simple tabular comparisons do not provide a clear picture of how rainfall conditions crop failure. There is some indication of an increasing tendency of intercropping in those areas (Akola and Sholapur), where it was already very high, while in Mahbubnagar region it shows the reverse trend, (Appendix Tables 4 and 5). The data on sole and intercropping over years and across villages further show the importance of intercropping as an important strategy in minimizing the risk of crop failure (Apendix Tables 6 and 7).

REGRESSION ANALYSIS

The extent of crop failure has been analyzed in relation to intercropping but there are other determinants which also potentially contribute to crop failure. Some other important factors affecting crop failure are soil type, seasonal cropping pattern, soil moisture, and rainfall pattern over the crop period.

Regression analysis is used to measure the relative influence of some of these factors. One linear regression is estimated using data from 1975-76 to 1977-78 for the six villages. The dependent variables is percent crop failure by household by year. On average about 30% of the households experienced crop failure on one or more plots in any given year.

Descriptive information on the independent variables is provided in Table 6. An increase in irrigated, intercropped, bunded, and rabi cropped area should reduce crop failure. Rabi crops are planted in the postrainy season when disease and pest incidence is less and when soil moisture is known at planting. Shallow soils and larger gross cropped areas characteristic of larger farms are expected to enhance the odds of crop failure. It is also expected that location effects expressed in the village dummy variables will have a significant impact on crop failure.

The signs of the estimated coefficients are consistent with expectations but only irrigated area, intercropped area, and rabi cropped area are significant in Table 7. The impact of changes in these variables on crop failure is small. For instance a ten percent increase in any of the three variables results in less than a one percent decrease in crop failure. Locational effects are stronger. Shifting from Kinkheda to Shirapur enhances the incidence of crop failure by 15%. Year effects are also significant. The first cropping year 1975-76 was particularly favorable relative to 1977-78.

Table 6. Specification of the variables in the regression analysis.

Variable	Description	Mean value	Range	Expected sign
GROSAREA	Gross cropped area in acres	14.75	0.40-91.67	+
IRRAREA	Percent GROSAREA irrigated	18.84	0.00-100.00	-
INTCROP	Percent GROSAREA intercropped	49.57	0.00-100.00	-
SHALAREA	Percent GROSAREA in Shallow soils	28.83	0.00-100.00	+
BUNDAREA	Percent GROSAREA bunded	53.18	0.00-100.00	-
RABIAREA	Percent GROSSAREA Rabi cropped	29.93	0.00-100.00	-
CROPFALL	Dependent variable: Percent GROSAREA completely failed	6.26	0.00-100.00	
VILLDUM 1-5	Village dummy; 1-Aurepelle 2-Dokur, 3-Shirapur, 4-Kalman, 5-Kanzara; Kinkheda is the reference village.			
YEARDUM 1-2	Year dummy: 1-1975-76, and 2-1976-77; 1977-78 is the reference year.			

Table 7. Estimated regression coefficients of pooled data for all the villages from 1975-76 to 1977-78

	Variable	Regression coefficient
X_1	GROSAREA	0.0307 (0.72)
X_2	IRRAREA	-0.0656 (-2.11)
X_3	INTCROP	-0.0879* (-3.49)
X_4	SHALAREA	0.0347 (1.41)
X_5	BUNDAREA	-0.0003 (-0.01)
X_6	RABIAREA	-0.0985* (-2.91)
X_7	VILLDUM 1	1.3801 (-0.38)
X_8	VILLDUM 2	-0.0276 (-0.01)
X_9	VILLDUM 3	15.1289* (4.10)
X_{10}	VILLDUM 4	10.6008* (3.75)
X_{11}	VILLDUM 5	-0.3278 (-0.16)
X_{12}	YEARDUM 1	-3.4178* (-2.34)
X_{13}	YEARDUM 2	-0.8853 (0.60)
	Intercept	10.9413
	$\bar{R}^2$	0.146

* Significant at 5% level with 516 d.f.
(figures in parenthesis are t-values)

The estimated regression explains only about 15% of the total variation in crop failure. This low explanatory power is due to the preponderance of zero observations--seventy percent of the values are zero--in the dependent variable. This points to the need for a dichotomous variable approach using plotwise data.

CONCLUSIONS AND DIRECTIONS FOR FUTURE RESEARCH

Crop failure is a complex phenomenon. These results suggest that complete crop failure is conditioned by environmental factors and is also influenced by management practices such as the choice of cropping pattern. In particular, both the tabular and regression analysis strongly suggest that crop failure is reduced in intercropping compared with sole cropping. Rabi cropping and irrigation also diminish the likelihood of crop failure.

Future research will address partial crop failure in intercropping, crop failure on a plotwise basis, and the use of improved statistical techniques to understand crop failure. The prospects for modeling drought stress with the available data will be explored to see whether such estimates can account for village, year, and planting date effects. Since crop failure is only one event in a probability distribution, attention will also be directed at understanding the shape of yield and net return distributions to measure objective risk from historical data.

REFERENCES

Abalu, G.O.I., and D'Silva, B. 1979. Socio-economic analysis of existing farming systems and practices in Northern Nigeria. Pages 125-136 in Proceedings of the International Workshop on Socioeconomic Constraints to Development of Semi-Arid Tropical Agriculture, 19-23 February 1979, Hyderabad, India. ICRISAT, Patancheru, A.P., India.

Jodha, N.S., Asokan, M., and Ryan, J.G. 1977. Village study methodology and resource endowments of the selected villages. ICRISAT Economics Program Occasional Paper No. 16, Patancheru, A.P., India.

Jodha, N.S. 1977. Resource base as a determinant of cropping patterns. ICRISAT Economics Program Occasional Paper No. 14, Patancheru, A.P., India.

Jodha, N.S. 1979. Intercropping in traditional farming systems. ICRISAT Economics Program Progress Report 3, Patancheru, A.P., India.

Norman, D.W. 1974. Rationalizing mixed cropping under indigenous conditions. The example of Northern Nigeria. The Journal of Development Studies, 11:3-21.

Norman, D.W. 1978. The small farmer in Hausa land. Michigan State University, Michigan, U.S.A.

Appendix Table 1. Proportion of plots grown and failed under sole and intercrops in different agro-climatic regions (Average of 1975-76 to 1978-79).

Village/region	Proportion of plots				Total no. of plots	
	Grown		Failed			
	Sole crop	Intercrop	Sole crop	Intercrop	Grown	Failed
Aurepalle	73	27	85	15	551	34 (6.2)
Dokur	89	11	[illegible]	23	475	13 (2.7)
Mahboobnagar	80	20	83	17	1026	47 (4.6)
Shirapur	81	19	89	11	1155	226 (19.6)
Kalman	58	42	66	34	1397	159 (11.4)
Sholapur	69	31	80	20	2552	385 (15.1)
Kanzara	46	54	56	44	651	32 (4.9)
Kinkheda	30	70	53	47	512	15 (2.9)
Akola	38	62	55	45	1163	47 (4.0)

(Figures in parentheses are percentage of plots failed to total number of plots where crops were grown.)

Appendix Table 2. Incidence of complete crop failure in different agro-climatic regions according to landholding class 1975-76 to 1978-79 (sole and intercropped both).

(In percentage)

Region	Year	Size of farm						Average	
		Small		Medium		Large			
		Plot	Area	Plot	Area	Plot	Area	Plot	Area
Mahbubnagar	1975-76	-	-	8.33	4.62	7.00	4.27	5.56	3.36
	1976-77	9.30	10.80	9.52	5.64	7.78	7.22	8.27	7.14
	1977-78	-	-	4.26	1.18	3.14	1.46	2.72	1.24
	1978-79	-	-	-	-	0.90	0.90	0.50	0.56
Sholapur	1975-76	16.39	13.31	11.35	13.16	17.87	13.13	15.37	13.18
	1976-77	18.81	12.08	12.87	8.40	15.28	11.48	15.09	10.79
	1977-78	9.00	5.27	15.29	11.54	26.65	14.31	20.59	13.01
	1978-79	3.74	0.72	15.11	7.16	9.21	7.36	9.59	6.47
Akola	1975-76	-	-	-	-	2.12	1.77	1.33	0.55
	1976-77	-	-	5.71	8.80	4.35	1.96	4.13	3.14
	1977-78	-	-	12.31	7.24	7.04	5.75	7.26	5.51
	1978-79	-	-	5.08	2.71	3.33	2.05	3.27	2.00

Appendix Table 4. Extent of intercropping in different regions according to landholding classes during 1975-76 to 1978-79.

(In percentage)

Region	Year	Size of farm: Small		Medium		Large		Average	
		Plot	Area	Plot	Area	Plot	Area	Plot	Area
Mahboobnagar	1975-76	28.89	30.37	22.08	31.84	19.11	35.02	20.83	33.92
	1976-77	20.93	25.87	26.98	38.73	18.56	23.61	20.50	26.78
	1977-78	31.25	42.43	29.79	40.94	13.84	23.64	19.84	29.33
	1978-79	27.91	32.96	19.57	22.87	13.39	24.37	17.73	25.04
Sholapur	1975-76	34.43	43.25	26.20	38.58	22.26	28.24	25.82	33.69
	1976-77	31.68	36.15	34.65	42.49	27.98	38.11	30.48	38.96
	1977-78	49.44	60.65	39.41	40.39	37.00	39.75	39.62	41.55
	1978-79	30.84	45.86	32.37	44.57	28.73	36.53	29.92	39.21
Akola	1975-76	73.33	89.22	75.76	87.57	50.80	72.60	59.67	77.19
	1976-77	65.79	77.18	71.43	75.83	52.66	71.30	58.41	72.57
	1977-78	89.74	94.41	67.70	85.06	59.80	79.88	65.35	82.09
	1978-79	86.1	88.5	71.20	79.77	55.33	71.40	63.67	75.54

Appendix Table 3. Incidence of complete crop failure (both sole and inter-crop) in different villages according to landholding class during 1975-76 to 1978-79.

(In percentage)

Village	Year	Size of farm						Average	
		Small		Medium		Large			
		Plot	Area	Plot	Area	Plot	Area	Plot	Area
Aurepalle	1975-76	-	-	13.9	5.4	10.6	6.0	14.0	5.5
	1976-77	15.4	14.3	9.8	6.1	10.0	8.0	10.8	8.1
	1977-78	-	-	-	-	1.2	0.6	0.8	0.4
	1978-79	-	-	-	-	-	-	-	-
Dokur	1975-76	-	-	-	-	1.5	1.3	0.7	0.9
	1976-77	-	-	9.1	4.3	4.5	6.0	4.5	5.3
	1977-78	-	-	7.4	2.8	5.1	2.5	4.8	2.4
	1978-79	-	-	-	-	1.8	2.4	1.0	1.5
Shirapur	1975-76	21.1	21.7	13.4	15.9	20.8	15.7	18.5	16.6
	1976-77	26.2	22.0	8.3	9.3	20.[illegible]	15.0	17.9	14.2
	1977-78	23.3	15.5	16.2	17.2	29.5	20.6	26.0	20.0
	1978-79	7.4	1.7	17.0	18.4	15.7	10.2	15.1	10.6
Kalman	1975-76	2.3	8.7	10.2	12.0	15.0	[illegible]	13.4	11.2
	1976-77	3.6	7.7	16.1	7.9	[illegible]	9.1	13.3	8.7
	1977-78	3.2	2.2	14.6	8.1	19.6	5.6	13.5	5.7
	1978-79	2.5	0.4	13.9	2.6	1.8	3.8	5.0	2.97
Kanzara	1975-76	-	-	-	-	0.9	0.3	0.6	0.2
	1976-77	-	-	3.0	1.7	4.0	1.0	3.5	1.1
	1977-78	-	-	12.4	10.3	10.8	8.9	11.2	8.5
	1978-79	-	-	8.8	6.2	3.4	4.0	4.2	2.3
Kinkheda	1975-76	-	-	-	-	3.8	1.2	2.2	0.8
	1976-77	-	-	3.1	14.0	4.8	2.9	4.9	5.1
	1977-78	-	-	3.7	3.0	2.3	2.6	2.2	2.4
	1978-79	-	-	-	-	3.2	2.4	1.9	1.6

Appendix Table 5. Extent of intercropping according to landholding calsses in different villages during 1975-76 to 1978-79.

(In percentage)

Village	Year	Size of farm: Small		Medium		Large		All	
		Plot	Area	Plot	Area	Plot	Area	Plot	Area
Aurepalle	1975-76	55.55	49.25	41.67	47.75	24.47	44.93	32.43	45.85
	1976-77	34.61	35.42	26.83	38.24	18.00	22.07	22.75	26.64
	1977-78	50.00	55.81	45.00	48.53	12.35	24.60	25.95	34.29
	1978-79	44.44	45.88	30.00	32.54	20.70	32.04	28.57	34.07
Dokur	1975-76	11.11	10.44	4.88	9.71	11.11	18.84	8.57	15.68
	1976-77	-	-	27.27	39.87	19.40	26.17	17.12	26.92
	1977-78	-	-	18.52	30.00	15.38	22.51	13.49	22.60
	1978-79	-	-	11.54	11.13	5.56	10.27	6.12	9.48
Shirapur	1975-76	2.38	2.80	9.76	8.22	9.60	18.68	8.11	13.81
	1976-77	16.67	18.22	22.62	13.71	18.18	30.01	19.24	24.96
	1977-78	23.08	40.04	29.73	21.12	16.74	28.96	20.18	28.31
	1978-79	22.22	22.76	28.30	33.80	25.76	30.79	25.90	30.64
Kalman	1975-76	58.57	66.61	35.37	51.48	30.41	35.04	36.98	45.32
	1976-77	42.37	44.05	42.22	59.26	35.29	43.87	38.69	48.09
	1977-78	60.32	66.75	46.88	53.36	86.96	55.46	64.94	56.49
	1978-79	33.75	52.42	34.88	48.77	32.16	43.82	33.23	46.67
Kanzara	1975-76	76.19	83.10	62.86	76.96	40.54	68.40	49.70	71.32
	1976-77	66.67	72.53	69.70	80.02	43.55	67.75	50.58	70.03
	1977-78	80.95	87.99	57.89	83.26	50.45	74.60	55.88	77.27
	1978-79	90.00	95.67	67.65	80.10	57.95	72.89	64.79	75.92
Kinkheda	1975-76	70.83	93.43	90.32	96.83	65.38	76.42	72.18	82.36
	1976-77	65.22	79.86	72.97	72.92	66.27	75.17	67.83	75.05
	1977-78	100.00	100.00	81.48	87.41	71.59	85.17	77.44	87.07
	1978-79	81.25	81.3	76.00	79.52	51.61	69.55	62.14	72.93

Appendix Table 6. Incidence of complete failure in sole cropping in different villages according to landholding classes (1975-76 to 1978-79).

(In percentage)

Village	Year	Size of farm						All	
		Small		Medium		Large			
		Plot	Area	Plot	Area	Plot	Area	Plot	Area
Aurepalle	1975-76	-	-	23.8	10.3	11.3	6.9	13.0	7.1
	1976-77	23.5	22.1	13.3	9.9	8.5	7.2	11.6	8.9
	1977-78	-	-	-	-	1.4	0.8	1.0	0.6
	1978-79	-	-	-	-	-	-	-	-
Dokur	1975-76	-	-	-	-	1.8	1.7	0.8	1.1
	1976-77	-	-	6.2	4.6	1.8	0.6	2.2	1.1
	1977-78	-	-	9.1	4.0	5.1	3.2	5.5	3.1
	1978-79	-	-	-	-	2.0	2.7	1.1	1.7
Shirapur	1975-76	21.6	22.3	13.5	19.0	21.2	16.1	18.9	17.3
	1976-77	28.6	25.3	10.8	11.2	24.4	19.8	20.8	18.0
	1977-78	30.0	26.1	17.3	17.4	29.6	22.6	27.2	22.0
	1978-79	10.0	2.2	23.7	27.9	17.7	12.7	18.0	13.1
Kalman	1975-76	13.8	7.1	9.5	13.6	15.6	10.5	13.1	11.2
	1976-77	14.7	6.0	23.9	12.9	13.3	10.1	16.4	10.2
	1977-78	-	-	19.6	13.6	58.3	3.4	19.3	5.3
	1978-79	1.9	0.4	17.9	4.5	42.7	6.5	5.8	5.0
Kanzara	1975-76	-	-	-	-	1.5	1.0	1.2	0.8
	1976-77	-	-	-	-	7.1	3.1	5.9	2.6
	1977-78	-	-	25.0	22.8	7.3	6.8	10.7	8.6
	1978-79	-	-	9.1	15.5	8.1	6.5	8.0	7.6
Kinkheda	1975-76	-	-	-	-	11.1	5.9	8.1	5.4
	1976-77	-	-	20.0	46.0	10.7	2.9	10.9	12.9
	1977-78	-	-	-	-	-	-	-	-
	1978-79	-	-	-	-	-	-	-	-

Appendix Table 7. Incidence of complete crop failure in intercropping in different villages according to landholding classes (1975-76 to 1978-79).

(Percentage)

Village	Year	Size of farm						All	
		Small		Large		Medium			
		Plot	Area	Plot	Area	Plot	Area	Plot	Area
Aurepalle	75-76	-	-	-	-	8.7	4.7	4.2	3.3
	76-77	-	-	-	-	16.7	10.6	7.9	6.2
	77-78	-	-	-	-	-	-	-	-
	78-79	-	-	-	-	-	-	-	-
Dokur	75-76	-	-	-	-	-	-	-	-
	76-77	-	-	16.7	4.0	15.4	21.2	15.8	16.8
	77-78	-	-	-	-	-	-	-	-
	78-79	-	-	-	-	-	-	-	-
Shirapur	75-76	-	-	12.5	3.3	16.7	14.0	14.3	11.9
	76-77	14.3	7.8	-	-	3.3	0.7	3.6	1.0
	77-78	-	-	13.6	15.8	28.9	15.5	21.2	14.6
	78-79	-	-	-	-	9.8	5.8	6.9	4.8
Kalman	75-76	9.8	8.7	11.5	10.4	16.9	12.9	13.2	11.0
	76-77	12.0	9.8	5.9	4.4	9.0	7.8	8.4	9.6
	77-78	-	-	8.9	3.9	13.8	8.5	10.4	5.4
	78-79	3.7	0.5	6.7	0.6	1.8	0.3	3.6	0.4
Kanzara	75-76	-	-	-	-	-	-	-	-
	76-77	-	-	4.4	2.1	-	-	1.2	0.4
	77-78	-	-	13.6	8.2	14.3	9.6	11.6	8.4
	78-79	-	-	8.7	3.9	-	-	2.2	0.7
Kinkheda	75-76	-	-	-	-	-	-	-	-
	76-77	-	-	6.7	12.0	1.8	2.9	2.1	3.1
	77-78	-	-	5.6	5.1	3.2	3.1	2.9	2.8
	78-79	-	-	-	-	6.3	3.5	3.1	2.3