CROPPING SYSTEMS DISCRIMINATION IN TERMS OF GROUNDWATER EXTRACTION

INDEX

5.1 Overview

Since groundwater extraction was observed to be significantly varying across the wells in the watershed in terms of the cropping systems irrigated by these wells, it was presumed that the cropping systems practiced in the watershed were, in a way, discriminated by the groundwater extraction pattern on individual wells. Farmers seemed to be aware of the volume of groundwater that could be extracted from their wells and, therefore, decided the crops and cropping pattern to be taken in the command area of their wells.

5.2 Hypothesis

It was examined whether groundwater extraction by different cropping systems discriminate the cropping systems practiced in the watershed in terms of water use. It was hypothesized that,

a) the cropping systems were discriminated in terms of groundwater extraction
b) a large percent of discrimination in the crop systems practiced was explained by the groundwater extraction over and above the variance accounted for by control variables,

5.3 Technique used

Discriminant function analysis was used to examine the hypothesis. This analysis is used to determine whether two or more groups are significantly different from each other with regard to the mean of a particular variable. If the means for a variable are significantly different in different groups, then this variable discriminates between groups.

5.3.1 Discriminant Function Analysis

Discriminant analysis has two steps: (1) an F test (Wilks' lambda) is used to test if the discriminant model as a whole is significant, and (2) if the F test shows significance,

then the individual independent variable is assessed to see which variable differ significantly in mean by group and these is used to classify the dependent variable. Discriminant analysis shares all the usual assumptions of correlation, requiring linear and homoscedastic relationships, and untruncated interval or near interval data. It also assumes proper model specification (inclusion of all important independents and exclusion of extraneous variables). Discriminant analysis gives pair-wise group comparisons which display the distances between group means of the dependent variable in the multidimensional space formed by the discriminant functions. The pair-wise group comparisons gives an F test of significance, based on Mahalanobis distances, of the distance of the group means, enabling the determination if every group mean is significantly distant from every other group mean. The eigen value, also called the characteristic root of each discriminant function, reflects the ratio of importance of the dimensions which classify cases of the dependent variable. The unstandardized discriminant coefficients are used in the formula for making the classifications in Discriminant Aanalysis, much as b coefficients are used in regression in making predictions. The constant plus the sum of products of the unstandardized coefficients with the observations yields the discriminant scores. That is, discriminant coefficients are the regression-like b coefficients in the discriminant function.

Multiple Groups Discrimination Analysis was performed with groundwater extraction as independent variable against the cropping systems as grouping variable (dependent variable).

5.4 Results

Box's test of equality of covariance matrices was performed on the data to examine the suitability of the discriminant analysis for the existing data set. The discriminant analysis assumes the homogeneity of group variances and co variances,

though, it could still be robust even with violation of this assumption. Moreover, the present analysis was performed to test the hypothesis about the discrimination in cropping system by the mean groundwater extraction and larger percentage of variance in the crop system groups being explained by the groundwater extraction over and above the variance accounted for by control variables.

The test of homogeneity of cropping system covariance worked out to be significant (Tables 5.1 through 5.3), confirming that the covariances do not differ. This was, however, interpreted in combination with log determinants, which interprets about group's covariance. The larger the log determinant, the more that group's covariance matrix differs. However, examination of log determinants for individual cropping systems revealed that during the year 2003-04, only a couple of cropping systems; pure cotton, cotton-fennel had larger determinants and pure sunflower had much smaller determinants than the rest of the cropping systems. The other systems had about similar log determinants. Similarly, during the year 2004-05, except for summer pearl millet, wheat-paddy and pure castor, the log determinants of other crop systems did not differ much. During 2005-06, in fact, despite significance of box's M ($P = 0.03$), all the cropping systems had about same log determinants. Therefore, despite significance of box's M, a closer look at log determinants suggested that discriminant analysis could still be used to the data set for examining the significance of discrimination of cropping systems in terms of the groundwater extraction.

The hypothesis about the equality of mean levels of groundwater extraction was tested (Table 5.4) and it was revealed that the cropping systems significantly differed in terms of the mean groundwater extracted for all the years, irrespective of the rainfall. The pooled data analysis for the three years also confirmed this observation. In the ANOVA table, the smaller the Wilks' Lambda, the greater is the importance of the independent

variable, groundwater extraction, to the discriminant function. The Wilks' Lambda varied between 0.06 to 0.16 during 2003-04 to 2005-06. This was, however, significant in all the individual years as well as in pooled data, indicating importance of groundwater extraction in discriminating cropping systems. In other words, a sizeable proportion of discrimination among the cropping systems was accounted for, by the groundwater extraction. The F statistics also confirmed the significance of the discrimination functions during the three years under study.

5.4.1 Canonical discriminant functions

Further, the eigen value of canonical discriminant functions and the canonical correlations re-affirmed the observations of the analysis as explained in the previous section.

The eigen value, which is the characteristic root of the discriminant function explained the variance in the cropping system explained by the function. The eigen values for all the years turned out to be significant as revealed by the Wilks' Lambda. Also, the squared canonical correlation, which is the percent of discrimination in the cropping systems explained by the groundwater extraction, showed that more than 90 per cent variation in the dependent variable was discriminated. The low values of eigen value and canonical correlation in the pooled data of the three years can be explained by the high variability of the rainfall parameter in the pooled data set. Particularly, the year 2005-06 was an exceptionally high rainfall year, while the years proceeding it was just about the normal.

5.4.2 Pair wise comparison between cropping systems

This explains the distance between the means of cropping systems in terms of the groundwater extraction. The 'F' test based on Mahalanobis distances was used to test the significance of the distances of cropping system means.

Cotton mono crop and cotton-based cropping systems were observed to have a significant mean distances from most of the non-cotton based cropping systems as well as among themselves (Tables 5.6 to 5.8). During the year 2003-04, cotton mono crop had significant distance from most of the cotton based systems except when combined with fennel, wheat and sunflower (Table 5.6). Further, cotton mono crop also had significant distances from most of the other mono cropping systems like paddy, castor, fennel, wheat and summer pearl millet mono crops. On the contrary, non-cotton based cropping systems were, by and large, not significantly discriminated from each other.

During 2004-05, while observations about cotton and cotton based cropping systems were about similar (Table 5.7), some of the other mono crops like fennel, cumin and summer pearl millet were also significantly different from cotton based cropping systems.

During the year 2005-06, the same observations were made on cotton based cropping systems. Cotton mono crop, however, was not significantly discriminated against the mono crop like fennel (Table 5.8). As also observed elsewhere, this year received a very high rainfall and the resultant groundwater recharge, hence mono cropping was not much practiced. The cotton based cropping systems had significant difference among themselves as well as other non-cotton based cropping systems as in previous years.

The analysis revealed distinct groups in terms of significant discrimination.

a) Cotton and cotton based cropping systems formed one distinct group during all the years.

b) Non-cotton based cropping systems formed another distinct group as during 2004-05.

c) Among mono crops, cotton mono crop and others such as paddy, castor, fennel, cumin and summer pearl millet mono crops individually formed distinct groups.

d) The non-cotton mono crops taken together did not form one distinct group as these were not significantly different among themselves.

Table 5.1: *Box's test of equality of covariance matrices, 2003-04*

CROPS	Rank	Log Determinant
Year: 2003-04		
Cotton alone	1	12.140
Paddy alone	1	9.602
Castor alone	1	8.626
Cotton-fennel	1	11.529
Cotton, castor	1	8.747
Fennel alone	1	8.390
Cotton, maize	1	5.727
Sunflower alone	1	-25.969
Summer bajara alone	1	5.483
Pooled within-groups	1	11.673
Box's M		82.822
F	Approx.	12.326
	df1	8
	df2	186.919
	Sig.	0.00

Table 5.2: *Box's test of equality of covariance matrices, 2004-05*

CROPS	Rank	Log Determinant
Cotton, castor	1	12.018
Cotton-cumin	1	10.957
Cotton pure	1	10.908
Cotton- fennel, cumin	1	9.811
Cotton, castor-wheat	1	9.197
Cotton-fennel	1	10.331
Cotton-summer bajara	1	8.403
Summer bajara alone	1	7.633
Paddy-wheat	1	5.973
Castor alone	1	-23.928
Pooled within-groups	1	11.143
Box's M		51.800
F	Approx.	5.613
	df1	9
	df2	188.34
	Sig.	0.00

Table 5.3: *Box's test of equality of covariance matrices, 2005-06*

Cropping system code	Rank	Log Determinant
Cotton alone	1	12.599
Cotton-fennel, cumin	1	14.645
Cotton-fennel	1	13.623
Cotton, castor-fennel	1	15.694
Cotton-cumin	1	15.293
Fennel alone	1	11.740
Cotton, castor- summer bajara	1	14.788
Cotton-summer jowar	1	15.187
Cotton, castor-fennel, cumin,wheat, isabgol-summer bajari	1	14.711
Cotton, castor-fennel-summer bajara	1	15.662
Cotton-fennel-summer bajara	1	14.209
Pooled within-groups	1	14.522
Box's M		23.756
F	Approx.	2.015
	df1	10
	df2	228.546
	Sig.	0.03

Table 5.4: *Test of equality of group means*

	Wilks' Lambda	F	df1	df2	Sig.
Year : 2003-04					
Groundwater extraction	0.16	11.02	18	39	0.00
Year: 2004-05					
Groundwater extraction	0.06	20.56	22	31	0.00
Year: 2005-06					
Groundwater extraction	0.16	7.22	26	36	0.00
Year: 2003-04 to 2005-06					
Groundwater extraction	0.60	4.60	28	183	0.00

Table 5.5: *Canonical Discriminant functions*

Period	Eigen value	Wilks' Lambda	Chi-square	Df	Significance probability	Canonical correlation
2003-04	5.09	0.164	84.89	18	0.00	0.91
2004-05	14.59	0.064	112.62	22	0.00	0.96
2005-06	5.22	0.161	87.70	26	0.00	0.91
2003-04 to 2005-06	0.66	0.60	99.24	28	0.00	0.63

Table 5.6: *Pair wise comparison among cropping systems, 2003-04*

Cropping system	castor-Cot+Urad	paddy pure	cotton+ castor + fennel	castor pure	Cotton + fennel	Cotton + castor	Castor + fennel+ wheat + paddy	cotton+ wheat+ paddy	fennel pure	cotton+ sunflower	cotton+ maize	cotton+ castor+ cumin	sunflower pure	sunflower+ drumstick	wheat pure	sunflower+ fennel	summer bajari pure	S. bajari + vegetables
cotton pure	8.634	37.343	1.385	17.552	7.262	8.573	.067	.307	17.580	2.407	26.657	4.246	18.928	.126	11.942	2.175	49.364	12.022
	0.006	0.000	0.246	0.000	0.010	0.006	.797	.583	.000	.129	.000	.046	.000	.724	.001	.148	.000	.001
Castor-Cot+Urad		.073	8.820	.005	16.210	17.707	3.739	6.353	.139	10.499	.428	13.015	.028	3.474	.139	1.115	.037	.146
		.789	.005	.945	.000	.000	.060	.016	.711	.002	.517	.001	.869	.070	.711	.297	.848	.705
paddy pure			16.210	.063	42.012	39.678	7.374	11.956	.920	19.081	.333	23.357	.013	6.902	.041	2.577	.021	.045
			.000	.804	.000	.000	.010	.001	.343	.000	.567	.000	.910	.012	.840	.116	.886	.832
cotton+castor+fennel				12.238	.151	.606	1.074	.202	10.653	.073	16.674	.407	12.925	1.223	11.177	3.663	16.655	11.233
				.001	.699	.441	.306	.656	.002	.788	.000	.527	.001	.275	.002	.063	.000	.002
castor pure					26.889	27.440	5.299	8.877	.319	14.520	.513	17.933	.014	4.934	.131	1.660	.023	.138
					.000	.000	.027	.005	.575	.000	.478	.000	.906	.032	.719	.205	.881	.712
cotton+ fennel						.306	2.749	.882	26.685	.003	35.644	.154	28.252	3.040	20.102	7.468	47.182	20.194
						.584	.105	.353	.000	.954	.000	.697	.000	.089	.000	.009	.000	.000
cotton+castor							3.901	1.684	26.762	.218	35.459	.002	28.696	4.226	21.522	8.931	43.122	21.611
							.055	.202	.000	.643	.000	.966	.000	.047	.000	.005	.000	.000
castor+fennel+wheat+paddy								.344	3.979	1.707	8.334	2.802	5.754	.005	5.323	.770	7.422	5.361
								.561	.053	.199	.006	.102	.021	.945	.026	.386	.010	.026
cotton+wheat+paddy									7.363	.518	12.705	1.182	9.463	.431	8.374	2.144	12.198	8.423
									.010	.476	.001	.284	.004	.515	.006	.151	.001	.006
fennel pure										12.924	1.822	16.361	.483	3.645	.690	.846	.817	.707
										.001	.185	.000	.491	.064	.411	.363	.372	.405
Cotton+sunflower											19.321	.135	15.267	1.894	13.058	4.770	19.670	13.119
											.000	.715	.000	.177	.001	.035	.000	.001
cotton+maize												23.230	.357	7.875	.050	3.510	.527	.045
												.000	.553	.008	.825	.069	.472	.832
cotton+castor+cumin													18.762	3.041	15.849	6.510	24.168	15.915
													.000	.089	.000	.015	.000	.000
sunflower pure														5.373	.070	1.919	.000	.076
														.026	.792	.174	.995	.785

CROPS	castor-Cot+Urad	paddy pure	cotton + castor + fennel	castor pure	Cotton +fennel	Cotton +fennel+ castor wheat+ paddy	castor+ wheat+ paddy	cotton + fennel pure	cotton+ sunflower	cotton + maize	cotton + castor+ cumin	sunflower pure	sunflower + drumstick	wheat pure	sunflower + fennel	summer bajari pure	bajari+vegetables
sunflower+drumstick														5.005	.652	6.932	5.043
														.031	.424	.012	.030

The figures in a cell are 'F' statistics and the significance probability.

Table 5.7: *Pair wise comparison among cropping systems, 2004-05*

Cropping system	cotton, castor	cotton, cumin	cotton pure	cotton, fennel, cumin	cotton,castor , wheat	cotton, castor, cumin, wheat	cotton,fennel	cotton,castor,fennel,wheat,paddy	cotton,castor,fennel,cumin,wheat,paddy	cotton,castor,fennel	cotton,drmstick	cotton,wheat, s.bajari	fennel	cumin
cotton, castor		.396	9.503	.641	5.582	.002	2.678	6.507	6.873	.291	193.455	1.914	17.834	41.324
		.534	.004	.429	.025	.965	.112	.016	.013	.594	.000	.176	.000	.000
cotton, cumin	.396		2.977	.082	6.602	.144	.871	7.526	7.896	.717	180.946	.933	13.274	28.794
	.534		.094	.777	.015	.707	.358	.010	.009	.404	.000	.341	.001	.000
cotton pure	9.503	2.977		.976	17.684	1.879	.205	15.218	15.780	3.500	236.040	.005	8.617	22.419
	.004	.094		.331	.000	.180	.654	.000	.000	.071	.000	.945	.006	.000
cotton, fennel,cumin	.641	.082	.976		6.116	.301	.260	7.326	7.659	.951	155.798	.462	9.756	19.354
	.429	.777	.331		.019	.587	.614	.011	.009	.337	.000	.502	.004	.000
cotton,castor,wheat	5.582	6.602	17.684	6.116		2.162	10.358	.473	.560	1.090	109.469	7.283	26.447	47.228
	.025	.015	.000	.019		.152	.003	.497	.460	.305	.000	.011	.000	.000
cotton,castor,cumin,wheat	.002	.144	1.879	.301	2.162		.970	3.492	3.692	.136	106.799	1.132	10.115	17.146
	.965	.707	.180	.587	.152		.332	.071	.064	.714	.000	.296	.003	.000
cotton,fennel	2.678	.871	.205	.260	10.358	.970		10.716	11.142	2.065	186.099	.101	8.470	18.574
	.112	.358	.654	.614	.003	.332		.003	.002	.161	.000	.753	.007	.000
cotton,castor,fennel,wheat,paddy	6.507	7.526	15.218	7.326	.473	3.492	10.716		.003	2.248	71.667	8.600	25.493	39.672
	.016	.010	.000	.011	.497	.071	.003		.958	.144	.000	.006	.000	.000
cotton,castor,fennel,cumin,wheat,paddy	6.873	7.896	15.780	7.659	.560	3.692	11.142	.003		2.409	70.778	8.911	26.027	40.442
	.013	.009	.000	.009	.460	.064	.002	.958		.131	.000	.005	.000	.000
cotton,castor,fennel	.291	.717	3.500	.951	1.090	.136	2.065	2.248	2.409		99.302	2.054	12.600	20.860
	.594	.404	.071	.337	.305	.714	.161	.144	.131		.000	.162	.001	.000

Cropping system	cotton, castor	cotton, cumin	cotton pure	cotton, fennel, cumin	cotton,castor ,wheat	cotton,castor,c umin,wheat	cotton,fennel	cotton,castor,fenn el,wheat,paddy	cotton,castor,fenn el,cumin,wheat,p addy	cotton,castor,fe nnel	cotton,drmstick	cotton,wheat, s.bajari	fennel	Cumin
cotton,drmstick	193.455	180.946	236.040	155.798	109.469	106.799	186.099	71.667	70.778	99.302		129.918	182.647	258.371
	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000		.000	.000	.000
cotton,wheat,s.ba jari	1.914	.933	.005	.462	7.283	1.132	.101	8.600	8.911	2.054	129.918		4.480	8.482
	.176	.341	.945	.502	.011	.296	.753	.006	.005	.162	.000		.042	.007
fennel	17.834	13.274	8.617	9.756	26.447	10.115	8.470	25.493	26.027	12.600	182.647	4.480		.219
	.000	.001	.006	.004	.000	.003	.007	.000	.000	.001	.000	.042		.643
cumin	41.324	28.794	22.419	19.354	47.228	17.146	18.574	39.672	40.442	20.860	258.371	8.482	.219	
	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.007	.643	
cotton,isabgol	.519	.116	.359	.012	4.529	.324	.083	5.945	6.205	.882	118.896	.244	6.816	12.132
	.477	.735	.553	.914	.041	.573	.776	.021	.018	.355	.000	.625	.014	.001
cotton,s.bajari	7.551	4.177	.984	2.317	15.961	3.210	1.341	15.598	16.082	4.920	188.367	.317	3.537	8.278
	.010	.050	.329	.138	.000	.083	.256	.000	.000	.034	.000	.577	.069	.007
S.bajari	59.463	38.884	33.240	24.460	58.595	20.179	24.601	45.978	46.857	24.447	294.089	10.171	.356	.016
	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.003	.555	.900
wheat,paddy	33.626	23.018	16.766	15.266	40.706	13.980	14.218	34.772	35.493	17.351	245.614	6.303	.004	.242
	.000	.000	.000	.000	.000	.001	.001	.000	.000	.000	.000	.017	.947	.626
castor, wheat,paddy	4.801	2.985	.783	1.890	11.519	2.775	1.114	12.493	12.868	4.142	144.005	.362	2.294	4.916
	.036	.094	.383	.179	.002	.106	.290	.001	.001	.050	.000	.552	.140	.034
cotton,sunflower,f ennel	.487	.102	.387	.008	4.448	.306	.095	5.865	6.123	.851	118.536	.261	6.903	12.265
	.490	.751	.539	.929	.043	.584	.761	.021	.019	.363	.000	.613	.013	.001
castor pure	17.767	11.345	6.171	7.124	26.441	7.443	5.830	23.872	24.470	9.951	214.952	2.249	.892	2.993
	.000	.002	.019	.012	.000	.010	.022	.000	.000	.004	.000	.144	.352	.094

The figures in a cell are 'F' statistics and the significance probability.

Table 5.8: *Pair wise com arison amon cro in stems, 2005-06*

Cropping system	cotton, castor, fennel, cumin	cotton pure	cotton, fennel, cumin	cotton, fennel	cotton, castor, fennel	cotton, cumin, wheat, s.bajari	cotton, cumin	cotton, castor	cotton, paddy, s.bajari	cotton, castor, fennel, cumin, s.bajari	fennel pure	cotton, groundnut, potato	cotton, castor, s. bajari	cotton, s. bajari	cotton, castc ennel, cum wheat, s.baj , isab
cotton,castor,fennel,cumin		16.774	3.732	8.145	.038	1.006	7.514	10.776	2.190	7.679	14.522	3.498	1.276	4.577	.3
		.000	.061	.007	.846	.322	.009	.002	.148	.009	.001	.070	.266	.039	.5
cotton pure	16.774		9.839	9.577	62.541	7.523	1.467	.109	4.410	61.343	.025	2.476	14.132	1.466	30.1
	.000		.003	.004	.000	.009	.234	.743	.043	.000	.874	.124	.001	.234	.0
cotton,fennel,cumin	3.732	9.839		1.313	8.152	.494	1.523	4.363	.014	28.363	7.062	.129	.861	.474	3.6
	.061	.003		.259	.007	.487	.225	.044	.906	.000	.012	.722	.360	.496	.0
cotton,fennel	8.145	9.577	1.313		30.443	2.223	.256	2.581	.711	43.813	4.907	.098	4.316	.003	12.6
	.007	.004	.259		.000	.145	.616	.117	.405	.000	.033	.756	.045	.958	.0
cotton,castor,fennel	.038	62.541	8.152	30.443		1.249	14.841	16.827	3.034	14.625	35.091	5.075	2.060	6.787	.4
	.846	.000	.007	.000		.271	.000	.000	.090	.001	.000	.030	.160	.013	.5
cotton,fennel,cumin,wheat,s.bajari	1.006	7.523	.494	2.223	1.249		2.505	5.196	.227	14.246	6.668	.752	.001	1.291	.4
	.322	.009	.487	.145	.271		.122	.029	.636	.001	.014	.392	.977	.263	.5
cotton,cumin	7.514	1.467	1.523	.256	14.841	2.505		1.101	1.065	35.295	1.306	.338	3.895	.073	8.6
	.009	.234	.225	.616	.000	.122		.301	.309	.000	.261	.565	.056	.788	.0
cotton,castor	10.770	.109	4.303	2.581	16.827	5.196	1.101		3.250	36.649	.044	1.995	7.080	1.307	11.7
	.002	.743	.044	.117	.000	.029	.301		.080	.000	.835	.166	.012	.260	.0
cotton,paddy,s.bajari	2.190	4.410	.014	.711	3.034	.227	1.065	3.250		18.072	3.993	.152	.335	.435	1.5
	.148	.043	.906	.405	.090	.636	.309	.080		.000	.053	.699	.566	.514	.2

Cropping system	cotton, castor, fennel, cumin	cotton pure	cotton, fennel, cumin	cotton, fennel	cotton, castor, fennel	cotton, cumin, s.bajari	fennel, wheat,	cotton, cumin	cotton, castor	cotton, paddy, s.bajari	cotton, castor, fennel, cumin, s.bajari	fennel pure	cotton, groundnut, potato	cotton, castor, s. bajari	cotton, s. bajari	cotton, ennel, wheat,	casto cumi s.baj , isab
cotton,castor,fennel,cumin,s.bajari	7.679	61.343	28.363	43.813	14.625	14.246		35.295	36.649	18.072		51.909	21.543	18.745	24.114		15.8
	.009	.000	.000	.000	.001	.001		.000	.000	.000		.000	.000	.000	.000		.0
fennel pure	14.522	.025	7.062	4.907	35.091	6.668		1.306	.044	3.993	51.909		2.311	10.921	1.417		20.7
	.001	.874	.012	.033	.000	.014		.261	.835	.053	.000		.137	.002	.242		.0
cotton,groundnut,potato	3.498	2.476	.129	.098	5.075	.752		.338	1.995	.152	21.543	2.311		1.061	.072		2.8
	.070	.124	.722	.756	.030	.392		.565	.166	.699	.000	.137		.310	.789		.0
cotto, castor,s.bajari	1.276	14.132	.861	4.316	2.060	.001		3.895	7.080	.335	18.745	10.921	1.061		1.798		.5
	.266	.001	.360	.045	.160	.977		.056	.012	.566	.000	.002	.310		.188		.4
cotton,s.bajari	4.577	1.466	.474	.003	6.787	1.291		.073	1.307	.435	24.114	1.417	.072	1.798			4.1
	.039	.234	.496	.958	.013	.263		.788	.260	.514	.000	.242	.789	.188			.0
cotton,cumin,s.jowar	2.885	3.259	.022	.298	4.112	.483		.608	2.510	.048	19.977	2.995	.030	.691	.194		2.2
	.098	.079	.883	.588	.050	.491		.441	.122	.828	.000	.092	.865	.411	.662		.1
cotton,s.jowar	4.910	4.169	.280	.113	9.391	1.118		.414	2.480	.257	29.330	3.413	.003	1.769	.065		4.9
	.033	.049	.600	.739	.004	.297		.524	.124	.615	.000	.073	.955	.192	.800		.0
cotton,fennel,wheat	1.642	5.607	.131	1.239	2.195	.077		1.592	4.006	.039	16.422	5.025	.347	.122	.736		.9
	.208	.023	.719	.273	.147	.783		.215	.053	.844	.000	.031	.560	.729	.396		.3

Cropping system	cotton, castor, fennel, cumin	cotton pure	cotton, fennel, cumin	cotton, fennel	cotton, castor, fennel	cotton, cumin, wheat, s.bajari	cotton, cumin	cotton, castor	cotton, paddy, s.bajari	cotton, castor, fennel, cumin, s.ba'ari	fennel pure	cotton, groundnut, potato	cotton, castor, s. bajari	cotton, s. bajari	cotton,cast ennel,cu wheat,s.baj , isab
fennel,s.ba jari	6.720	.360	1.546	.447	10.229	2.526	.064	.477	1.238	28.768	.404	.521	3.473	.205	6.6
	.014	.552	.222	.508	.003	.121	.802	.494	.273	.000	.529	.475	.071	.653	.0
cotton,cast or,fennel,c umin,whea t,s.bajari, isabgol	.346	30.183	3.612	12.602	.437	.410	8.607	11.782	1.500	15.856	20.773	2.899	.596	4.130	
	.560	.000	.065	.001	.513	.526	.006	.002	.229	.000	.000	.097	.445	.050	
cotton,cast or,fennel,s. bajari	.720	47.436	12.832	27.564	2.348	4.028	19.330	21.522	6.541	5.528	35.510	9.050	5.871	11.017	3.5
	.402	.000	.001	.000	.134	.052	.000	.000	.015	.024	.000	.005	.021	.002	.0
wheat, paddy	9.057	.001	3.077	1.526	14.021	4.025	.539	.075	2.340	33.416	.016	1.298	5.501	.757	9.5
	.005	.970	.088	.225	.001	.052	.468	.786	.135	.000	.901	.262	.025	.390	.0

The figures in a cell are 'F' statistics and the significance probability.