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CONDITIONS OF CROPPING INTENSITY

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Whether there has been a steady or decelerated growth rate since 60 [1], the point that firmly stands out is that overall growth rate of ricultural production has failed to get accelerated [2] although there has en a step up of growth rates of few foodgrain items like pulse and coarse reals between 1965 and 1975 [3]. One of the important factors of this non celeration is the slow down in the expansion of cropped area. The near haustion of scope for expansion of net cropped area, a constraint imposed geographical conditions has not been adequately compensated by increase in oss cropped area through higher cropping intensity. Following the component alysis of agricultural growth, [4] it is quite clear that important sources agricultural growth are (i) expansion of area, (ii) change in cropping ttern towards a high value crop and (iii) higher yield rates. Expansion area can further be decomposed into net sown area and cropping intensity. nce exploitation of new land for cultivation is almost over, raising the

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(a) See C.H. Hanumantha Rao, Technological change and Distribution of Gains in Indian Agriculture, The Macmillan Company of India Ltd., Delhi, 1975.

(b) Vaidyanathar, A. "Performance and Prospects of crop production in India" Economic and Political Weekly Special number, August 1977

(c) Srinivasan, T.N. "Trends in agriculture in India 1949-50 - 1977-78" Economic and Political Weekly Special Number, August 1979.

Dharam Narain, "Growth of Productivity in Indian Agriculture" Indian Journal of Agricultural Economics vol. XXXII, No.1, 1977.

Dasgupta, R. Nutritional Planning in India, unpublished Ph.D. thesis, Delhi University, 1982 (pp 102)

(a) Minhar, B.S. & Vaidyanathan, A. "Growth of crop output in India, 1951-54 to 1958-61", Journal of the Indian Society of Agricultural Statistics, vol. 18, No.s, 1965.

(b) Dharm Narain, op.cit.

intensity of cropping seems to be the only answer for expansion of area While there has been a lot of studies on economics of supply response of individual crops which gives insight for change in cropping pattern, there has practically been no work on aspects of cropping intensity. Although Bhardwaj 5/ has shown the relationship between cropping intensity and size holding, she has not tried to find out any techno-economic conditions of cropping intensity. We would like to explore these aspects in our present study.

A level of cropping intensity which is generally taken as ratio of gross cropped area and net sown area 6/ is dependent on both technical and economic conditions. Whereas technical conditions may be taken as necessary conditions so that double cropping may not be feasible without certain aspects, economic parameters may be viewed as sufficient condition in the absence of which there may not be any inclination for increasing the cropping intensity. Dynamics of cropping intensity thus depends upon a few technical and economic aspects. Whereas some of the former aspects are almost fixed most of the later aspects may vary with time.

Most important natural inputs of cultivation are water, soil and climate. Water although almost a free good for human being is quite a scarce input for agricultural activity. Water required for cultivation can be met through either rain or irrigation. In India rain water is

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5/ Bhardwaj, K. Production Conditions in Indian Agriculture. Cambridge University Press, London, 1974.

6/ Alternatively one can consider time concept. Cropping intensity may be taken as $\sum A(i)\ t(i)/A.12$, where $A(i)$ is the area of crop, $t(i)$ is the duration of crop i the field i.e., total period between sowing and harvesting, and A is net sown area.

available in few months of the year only, and proportion of irrigated area is around 25 per cent. This of course varies among states - around 60 percent in Delhi and 10 percent in Gujarat. Annual rainfall too varies from 250 cm. in Assam to less than 60 cm. in Rajasthan. We therefore expect to find variations in cropping intensity across the states. More specifically we expect to find a positive correlation between cropping intensity and irrigation and rainfall. Increase in cropping intensity arises because of multiple cropping - same plot cultivated more than once in the same agriculture year. If irrigation system is available so that water can be drawn at any time - more crops can be grown depending upon the profitability cultivation. Even in the absence of irrigation more crops may be grown if rainfall is assured at different cultivation seasons. Distribution of rainfall alongwith absolute amount of rainfall is therefore equally important for higher cropping intensity. Soil is another factor contributing to yield. Generally when a crop is raised, it extracts nutrients from the soil. The land is then kept fallow for the replenishment of those nutrients through nature. Use of fertilisers may overcome this constraint. But there are so many micronutrients which can't be supplied through fertiliser or manure. Land is therefore kept fallow. However, this is more necessary for less fertile land. More fertile land may be cultivated more than once without being kept idle for a long period. This fertility depends upon the variety and texture of soil. We have generally four types of soil (i) red, (ii) black, (iii) laterite and (iv) alluvial. We again expect variations in cropping intensity depending upon the quality of soil. Climate is another necessary condition for agriculture. Climate is a composite index of temperature, humidity, wind etc. Cropping intensity will be more if climatic condition is favourable in more than one point of time during a year.

So far we have been discussing the technical aspects which are necessary conditions for cultivation, and also for cropping intensity. But these are not sufficient conditions in themselves so that cultivation will be done or cropping intensity will be increased only because of presence of these technical conditions. A farmer is the agent of cultivation. He requires some incentives to carry out cultivation. He can't do without it. If he is cultivating for home consumption, he is doing because of the subsistence need of his family. If there was no word like 'hunger' nobody would have toiled to cultivate. Similarly, if one is cultivating for more than home consumption that is for selling to market, he needs price for his extra effort. He takes price as the reward or compensation for his vigorous cultivation, multiple cropping, and all other efforts to sell more output. If he thinks that price he gets is not enough to compensate his labour and other costs, he may rather go for leisure. Price is therefore the most important incentive for inducing the farmers to go for multiple cropping. This is the sufficient condition for cropping intensity from our point of view. Unless both necessary and sufficient conditions are met multiple cropping can't take place. We would like to examine the above propositions with the help of Indian data through regression equations in the following section.

II

We have extensively used the agricultural statistics compiled by Ministry of Agriculture, Government of India to estimate cropping intensity, proportion of area under different crops, proportion of irrigated area and irrigation by different sources for all the years from 1956-57 to 1971-72 for different states. Number of states however vary from year to year either because of non availability of data or because of division of one state into two to three states. Harvest prices of different crops have been collected from Agricultural prices in India compiled by Directorate of Economics and statistics, Ministry of Agriculture and Irrigation, Government of India. Prices are available from 1956-57 to 1973-74 for seventeen states excluding Orissa. The same source gives the index number of fertiliser price for all India which is taken here in our study as an indicator of variation in cost of cultivation. Proportion of each type of soil in each area is given in Dasgupta.7/ Rainfall date either normal or actual has been taken from Statistical Abstract, source being Meteorological Department, Ministry of Tourism & Civil Aviation, Government of India. Actual rainfalls are annual rainfall for each year for a particular state - where as normal rainfalls have been taken month wise - for all twelve months.

Table 1 gives results in connection with water conditions. Rainfall whether actual or normal is very weakly correlated with cropping intensity. Beta co-efficients although have positive signs in most of the cases are always insignificant. As we have already mentioned distribution of rainfall is supposed to be equally important for multiple cropping.we have therefore used another variable which is a ratio of rainfall in two seasons Kharif and Rabi.8/ If the ratio is high, rainfall is concentrated in one season, if it's low rainfall is spread over both the seasons. Cropping intensity is therefore supposed to vary inversely with the above ratio - more where rainfall is available in both seasons. Again, as expected we find proper sign that is negative, but the T values are quite insignificant.

7/ Dasgupta, R. op.cit (pp 204-232)

8/ If rainfall is higher in Rabi season, Rabi rainfall is taken as numerator otherwise Kharif rainfall is taken as numerator.

Our next set of water variables are irrigation levels. Proportion of either net irrigated area to net sown area or gross irrigated to gross cropped area is moderately positively correlated with cropping intensity. In some of the later years such as 1970-71 and 1971-72 they are however strongly correlated, T values being significant at 5 per cent level. But if we instead use intensity of irrigation as our variable which is a ratio of gross irrigated area to net irrigated area we observe a strong correlation in almost all the years. This is an important observation, we think. Mere irrigation does not help cropping intensity much. It depends upon how intensively it can be used. This indicates that quality of irrigation is more important. We have taken sources as indicators of quality. What is observed from Table 1 is that proportions of area irrigated with either canals or tanks are negatively correlated. In case of canals T values are generally insignificant, but in case of tanks they are at most of the years significant at 5 to 10 per cent levels. Tubewell irrigation although shows negative correlation in initial years, has perhaps become efficient system of irrigation in later years as it bears a positive correlation in later years to the extent that T values become significant at later years. But what is interesting is that irrigation from other sources has been strongly correlated with cropping intensity in all these years. May be, as they are of indigenous nature each system being different in each state, they have been perfected over a number of generations through the experiences of local farmers. On the other hand canal irrigation system has not been efficient. Water might not have been supplied proportionately to all the farmers because of political pressures and since

Table 1: Regression results with cross sectional data and single explanatory variable

(Water variables)

Year / Dependent variable	Degree of freedom	Actual rain-fall	Normal rainfall	Kharif Rain / Rabi Rain	Proportion of Net irrigated area	Proportion of Gross irrigated area
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1959-60	15	.02	.04	-.07	16.6	23.07
		(.32)	(.59)	(.61)	(.88)	(.73)
1960-61	16	.03	.04	-.006	45.9	43.7
		(.51)	(.7)	(.54)	(1.78)	(1.5)
1961-62	16	.01	.03	- .007	40.2	36.11
		(.16)	(.55)	(.64)	(1.45)	(1.2)
1962-63	16	.03	.05	-.009	37.2	37.37
		(.60)	(.9)	(.78)	(1.4)	(1.3)
1963-64	16	.05	.04	- .01	40.2	36.9
		(.86)	(.78)	(.86)	(1.5)	(1.3)
1964-65	16	.03	.04	- .01	44.4	38.6
		(.46)	(.68)	(.87)	(1.6)	(1.3)
1965-66	16	.07	.07	- .01	29.3	28.5
		(1.17)	(1.3)	(.7)	(1.3)	(1.2)

(Continued)

Table 1: Regression results with cross sectional data, and single explanatory variable

(Water variables)

Year	Dependent variable: Gross irrigation / Net irrigation	Proportion of canal irrigation	Proportion of tank irrigation	Proportion of tube well irrigation	Proportion of irrigation through other sources
	(8)	(9)	(10)	(11)	(12)
1959-60	.19 (1.39)	- .12 (.72)	- .47 (2.5)	- .19 (1.07)	.41 (4.2)
1960-61	.39 (2.48)	- .02 (.12)	- .38 (1.02)	- .19 (1.4)	.36 (3.3)
1961-62	.45 (2.87)	- .05 (.33)	- .41 (2.09)	2.7 (1.12)	.35 (3.2)
1962-63	.52 (3.86)	- .07 (.44)	- .3 (.5)	1.34 (1.21)	.39 (3.9)
1963-64	.48 (3.33)	- .05 (.29)	- .31 (1.47)	.94 (.89)	.38 (3.6)
1964-65	.47 (3.13)	- .01 (.03)	- .35 (1.72)	.87 (.85)	.34 (3.04)
1965-66	.53 (3.94)	- .09 (.53)	- .24 (1.16)	.86 (1.08)	.39 (4.6)

(Continued)

Table 1: Regression results with cross sectional data, and single explanatory variable
(Water variables)

1	2	3	4	5	6	7	8	9	10	11	12
1966-67	17	- .03	.02	- .009	37.4	36.8	.44	- .03	- .18	.82	.33
		(.39)	(.2)	(.78)	(1.8)	(1.8)	(3.71)	(.17)	(.94)	(1.4)	(2.9)
1967-68	17	.01	.02	- .01	39.5	39.4	.22	- .02	- .36	.63	.4
		(.09)	(.35)	(.98)	(1.6)	(1.8)	(2.73)	(.14)	(1.53)	(1.35)	(3.1)
1968-69	17	.04	.03	- .01	27.3	21.99	.16	- .11	-.26	.35	.28
		(.49)	(.37)	(.85)	(1.4)	(1.2)	(1.6)	(.69)	(1.06)	(1.09)	(2.9)
1969-70	17	.06	.04	- .01	35.8	31.5	.56	- .05	-.59	.47	.42
		(.93)	(.69)	(.94)	(1.7)	(1.5)	(3.8)	(.27)	(2.09)	(1.6)	(3.4)
1970-71	17	.02	.02	- .009	46.6	42.6	.52	- .13	-.67	.51	.41
		(.28)	(.44)	(.88)	(2.4)	(2.1)	(3.1)	(.74)	(2.35)	(2.1)	(3.1)
1971-72	17	-.07	-.03	-.01	58.9	47	.56	- .1	- .78	.57	.37
		(1.3)	(.57)	(.86)	(2.8)	(2.3)	(3.3)	(.56)	(2.4)	(2.5)	(2.5)

Figures in parenthesis in Tables 1, 2, 4, 5, 6, & 7 are T values.

cropping intensity is correlated with structural relationship - inversely related with landholding size,[9] cropping intensity is lower in those areas. Or the low rate of water utilisation of the canal waters may be due to the inadequate development of a network of feeder channels and drains to make the water reach the individual farmers's plots.[10]

Just as water, soil fertility itself is important for intensive cultivation for the reasons mentioned earlier. We find from Table 2 that cropping intensity is more where proportion of alluvial soils are more Beta co-efficients being positive. For red and black soil we find a negative correlation. Correlations although not vary strong are moderately high. These results are not at all unexpected as alluvial soils are highly fertile, and as we have discussed earlier intensive use of land is more plausible here. Opposite is the case with red or black soils. Black soils are however good for cotton cultivation. Cotton being a long duration crop other crops may not be grown so that cropping intensity in terms of gross cropped area and net sown area is not high although land utilisation in terms of time may be high.

As we have already said climate is a composite index of few variables like temperature, humidity etc. it is difficult to obtain such indices with the present state of knowledge. Not only that, climatic conditions interect with other variables like soil fertility, landscape, water conditions etc.

9/ Bhardwaj, K. op.cit (pp 18)

10/ Rudra.A "Organisation of agriculture for rural development- the Indian case" Cambridge Journal of Economics, December, 1978.

is therefore quite difficult if not impossible to capture the influence climatic condition on cropping intensity through above variables. We we therefore used an indirect method. Cropping pattern in particular gion to our mind is an indicator of climatic conditions of that region d their interactions with other technical variables. Wheat is mostly own in northern and western region - only because climatic conditions those places are favourable to wheat cultivation. Otherwise technolo- cal revolution in wheat seed would have made inroads to southern states o. Similarly maize and bajra are cultivated in specific areas. Quite pposite is the case with paddy cultivation. It is grown almost everywhere India. Paddy cultivation is therefore not supposed to capture the limatic variation whereas proportion of wheat, maize or bajra area are upposed to serve that purpose. It is clear from Table 2. We find a trong positive correlation between cropping intensity and either proportion f wheat area or maize area. It is negative although not highly significant or bajra area. Contrary to this signs of beta co-efficients for rice area luctuate over years. Also, they are not significant. What we therefore ould like to infer is that cropping intensity at a particular place depends pon the climatic condition of that area.

Table 2: Regression results with cross sectional data, and single explanatory variable
(Soil and climatic variable)

Dependent variable / Year	Degrees of freedom	Proportion of Red soil	Proportion of Black soil	Proportion of Alluvial soil	Proportion of Wheat area	Proportion of Maize area	Proportion of Bajra area	Proportion of Rice area
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1959-60	15	- .28 (2.8)	- .19 (1.43)	.16 (1.73)	1.87 (3.3)	1.08 (3.1)	- .39 (.81)	- 7.2 (.44)
1960-61	16	- .28 (2.6)	- .17 (1.3)	.18 (1.9)	.89 (3.6)	1.04 (3.1)	- .55 (1.3)	- .58 (.04)
1961-62	16	- .29 (2.96)	- .14 (1.06)	.001 (1.35)	.97 (4.1)	.95 (2.7)	- .41 (.89)	- 6.8 (.44)
1962-63	16	.3 (3.0[illegible])	- .2 (1.13)	. 1 (1.38)	.84 (3.4)	.93 (2.9)	- .63 (1.4)	1.2 (.08)
1963-64	16	- .3 (3.3)	- .2 (1.12)	. 11 (1.37)	.9 (3.9)	1.03 (3.3)	- .65 (1.5)	-.34 - (.02)
1964-65	16	- .32 (3.34)	- .15 (1.12)	.16 (1.59)	.92 (4.3)	.98 (2.9)	- .5 (1.2)	-.13 (.01)
1965-66	16	- .30 (3.48)	- .10 (.79)	.13 (1.36)	.69 (2.9)	.76 (2.5)	- .6 (1.7)	7.97 (.5)

(Continued)

Table 2: (Continuation)

Regression results with cross sectional data, and single explanatory variable
(Soil and climatic variables)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1966-67	17	- .33	- .08	.14	.75	.76	- .5	2.97
		(3.62)	(.61)	(1.45)	(3.2[illegible])	(2.2)	(1.3)	(.19)
1967-68	17	- .36	- .14	.19	.86	.87	- .35	-3.5
		(3.61)	(.92)	(1.78)	(3.6)	(2.1)	(.7)	(.2)
1968-69	17	- .35	- .12	.14	.56	.98	- .63	8.3
		(3.54)	(.84)	(1.27)	(2.7)	(2.9)	(1.8)	(.53)
1969-70	17	- .38	- .16	.19	.69	.89	- .5	4.8
		(3.74)	(1.04)	(1.69)	(3.1)	(2.3)	(1.2)	(.28)
1970-71	17	- .36	- .27	.23	.83	.86	- .35	- 6.2
		(3.22)	(1.88)	(2.11)	(4.1)	(2.3)	(.8)	(.36)
1971-72	17	- .34	- .2	.21	.88	.78	- .4	- 7.4
		(3.8)	(1.6)	(1.6)	(4.7)	(1.9)	(.7)	(.4)

Figures in parenthesis are T values

So far we were discussing how few technical variables are important in explaining a particular level of cropping intensity. But most of the above variables other than irrigation level are almost static over time. They therefore can't explain the variations in cropping intensity over time. In fact they should not - as we have already discussed. Amount of marketable surplus will depend upon price of crop in relation to cost of cultivation. This price however, is what the farmer expects in future say in harvesting time. This price cost expectation determines the marketable surplus which in turn determines the total supply of land for cultivation and cropping intensity. Following Nerlovian[11/] model of special case, expected price is an weighted average of prices of two previous periods. In general case it is an average of prices of all the previous periods. But importance of previous prices decline as we go back in time. Recent prices are therefore of more importance.

Expected price Pt at period t can be taken as

$$P_t = aP_{t-1} + (1-a)\,P_{t-2}$$

(i) When a = 1, $P_t = P_{t-1}$ that is expected price is the observed price at previous year.

We call it lag 1 or L1 model.

(ii) When a = 0, $P_t = P_{t-2}$ that is expected price is the observed price of period two years earlier. We call it lag 2 or L2 model.

11/ Nerlove, M. The Dynamics of supply, The johns Hopkins Press, Baltimore, 1958 (pp-199)

Table 3: Three important cereal crops of each state, and proportion of of their area in 1971-72

	Name			Proportion of Area (percent)		
	Crop I	Crop II	Crop III	Crop I	Crop II	Crop III
Andhra Pradesh	Paddy	Jowar	Bajra	24	20	4
Assam	Paddy	Maize	Wheat	69	4	1.4
Bihar	Paddy	Maize	Wheat	51	7	13
Delhi	Jowar	Bajra	Wheat	9	14	44
Gujarat	Jowar	Bajra	Maize	5	10	17
Himachal Pradesh	Paddy	Maize	Wheat	10	28	36
Jammu & Kashmir	Paddy	Maize	Wheat	25	33	21
Karnataka	Paddy	Jowar	Ragi	11	21	10
Kerala	Paddy	-	-	30	-	-
Maharashtra	Paddy	Jowar	Bajra	16	74	16
Madhya Pradesh	Paddy	Jowar	Wheat	22	9	18
Punjab	Paddy	Maize	Wheat	8	9	41
Rajasthan	Jowar	Bajra	Wheat	6	30	9
Tamilnadu	Paddy	Jowar	Bajra	36	10	6
Utter Pradesh	Paddy	Maize	Wheat	21	7	27
West Bengal	Paddy	Wheat	-	69	6	-

(iii) When $a = 0.5$, $P_t = .5P_{t-1} + .5\ P_{t-2}$ that is expected price is simple average of observed prices of two previous years. We call it intermediate model 1 or I1 model.

(iv) When $a = 2$, $P_t = P_{t-1} + (P_{t-1} - P_{t-2})$, that is expected price is the observed price of previous year plus difference between previous year's price and price of two years earlier. We call it intermediate model 2 or I2 model.

All these have been discussed in detail by Nerlove.[12/] Nerlove was however concerned with the acreage of a particular crop in question so that his P_t was price of that crop in question, and that of competit crops. In our case there is no one crop in question. It is an index of price which a farmer receives. It therefore should be an weighted average of prices of all the agricultural commodities. Or we can consid prices of few important crops of a particular state. We have chosen the second alternative for some specific reasons. Among the crops we have identified few important foodgrain crops depending upon the proportion of area of these crops. We have not taken account of commercial crops because generally they remain in the field for a longer period. If the price of these crops increase, there will be a shift in favour of these crops, so that multiple cropping may not be possible in those areas. In that case cropping intensity as defined by us may decline and we will not get a proper result. This also is the reason for not estimating a composite price index which farmer receives. Different prices of that basket will have a diverging effect on cropping intensity. To circumvent this

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12/ Nerlove,M. op.cit (pp-46-65, 186-200) problem, one can however define cropping intensity in terms of land utilisation with respect to time.

Three important crops along with their percentage share in total area for each state are given in Table 3. Orissa and Haryana have been excluded from our analysis. Price data of Orissa was not available, and that of Haryana because of her recent origin was available for only 5 to 6 years. Results of three models L1, L2 and I1 have been reported in Tables 4, 5 and 6 respectively. I2 model has not been considered as this does not give meaningful results.

In most of the states, we find a positive regression co-efficient for those important crops mentioned earlier. Some of those show high correlation since those co-efficients are significant at lower level of significance. Some however show weak correlation as they are significant at 20 per cent or higher level of significance only. In Bihar however we find consistently negative correlation with highly significant T values. In Tamilnadu for paddy, and in Madhya Pradesh for all the three crops, we again find negative correlation although they are insignificant. Even with respect to time, those states show negative trends for cropping intensity (see Table 7). Perhaps some necessary conditions lack there. They may be in the nature of technical variables what we have discussed earlier or some structural or political problems which we have not discussed.

The prices that we have used in our exercise are the price of a crop at each year deflated by the price of that crop for the year 1960-61. One however can argue that instead of these almost nominal price, crop price should be deflated by some aggregate price index say wholesale

Table 4: Timeseries Regression Results with single explanatory variable

Model L1

States	Degrees of fraction	Crop price I	Crop price II	Crop price III	Crop price deflated by fertiliser price I	II	III
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Andhra Pradesh	14	.054	.04	.048	.07	(.03)	(.03)
		(4.31)	(3.02)	(3.09)	(2.8)	(1.34)	1.3
Assam	11	.052	-	-	.062	-	-
		(3.2)			(3.8)		
Bihar	14	-.014	-.023	-.04	-.02	-.03	-.05
		(1.6)	(1.4)	(1.9)	(1.8)	(2.6)	(1.9)
Delhi	14	.0002	.02	.06	.03	.002	.05
		(.004)	(.6)	(1.96)	(.6)	(.04)	(.06)
Gujarat	10	.02	.012	.013	.012	-.0015	.006
		(3.2)	(1.4)	(2.3)	(1.07)	(.14)	(.7)
Himachal Pradesh	14	.045	.04	.04	.03	.04	.04
		(3.2)	(3.7)	(3.8)	(1.6)	(2.1)	(2.1)
Jammu & Kashmir	14	.034	.038	.08	.015	.04	.01
		(1.5)	(2.2)	(1.65)	(.48)	(1.39)	(.17)
Karnataka	14	.016	.02	.011	.011	.014	.007
		(3.7)	(4.5)	(3.11)	(1.76)	(1.94)	(1.5)

(Continued)

Table 4: (Continuation)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Kerala	14	.079 (7.4)	-	-	.074 (4.3)	-	-
Maharashtra	10	.0006 (.188)	.005 (1.34)	0 (.004)	.003 (.98)	-.001 (.17)	-.004 (1.09)
Madhya Pradesh	14	-.012 (.82)	-.011 (.79)	-.013 (.98)	-.04 (1.8)	-.04 (2.03)	-.04 (2.1)
Punjab	14	.087 (2.8)	.06 (2.9)	.075 (4.1)	.036 (.7)	.036 (.21)	.06 (1.93)
Rajasthan	14	.014 (1.4)	.008 (.74)	.01 (1.44)	.01 (.48)	-.004 (.25)	.007 .69
Tamilnadu	14	-.004 (.3)	.005 (.6)	.006 (.74)	.003 (.025)	-.005 (.48)	-.006 (.54)
Uttar Pradesh	14	.025 (2.5)	.02 (1.92)	.03 (3.2)	.02 (1.3)	.012 (1.3)	.02 (1.52)
West Bengal	14	.07 (5.2)	.08 (3.8)	-	.08 (3.2)	.03 (1.92)	-

Table 5: Time series Regression Results with single explanatory variable
Model L2

States	Degrees of freedom	Crop Price I	Crop Price II	Crop Price III	Crop price deflated by Fertiliser price I	Crop price deflated by Fertiliser price II	Crop price deflated by Fertiliser price III
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Andhra Pradesh	13	.062	.06	.05	.09	.05	.04
		(6.2)	(4.7)	(3.4)	(5.8)	(2.8)	(2.06)
Assam	10	.05	.032	.01	.07	.04	.01
		(16)	(7.8)	(.84)	(8.5)	(5.9)	(.43)
Bihar	13	-.01	-.01	-.03	.01	-.02	-.03
		(.68)	(.82)	(1.2)	(.71)	(.9)	(1.2)
Delhi	13	.03	.06	.07	-.05	.04	.05
		(.75)	(1.7)	(1.99)	(1.09)	(1.01)	(1.13)
Gujarat	9	.023	.023	.02	.02	.014	.015
		(4.8)	(3.38)	(3.8)	(2.17)	(1.3)	(1.9)
Himachal Pradesh	13	.05	.05	.04	.045	.057	.04
		(3.4)	(4.5)	(3.5)	(2.2)	(3.2)	(2.5)
Jammu & Kashmir	13	.045	.028	.11	.03	.02	.07
		(1.9)	(1.4)	(2.29)	(1.1)	(.6)	(.99)
Karnataka	13	.017	.021	.013	.013	.016	.01
		(4.18)	(4.52)	(3.7)	(2.26)	(2.18)	(2.1)

Table 5: (Continuation)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Kerala	13	.073 (13.4)	-	-	.086 (7.8)	-	-
Maharashtra	9	.003 (.84)	.008 (1.5)	.003 (.9)	-.0004 (.1)	0 (.004)	0 (.009)
Madhya Pradesh	13	-.006 (.39)	-.008 (.52)	-.011 (.79)	-.023 (1.04)	-.03 (1.48)	-.03 (1.8)
Punjab	13	.118 (4.3)	.066 (3.2)	.08 (4.11)	.094 (2.03)	.051 (1.81)	.07 (2.36)
Rajasthan	13	.011 (1.02)	.015 (1.4)	.008 (1.03)	.004 (.27)	.009 (.69)	0.8 (.425)
Tamil Nadu	13	.01 (.68)	-.002 (1.7)	-.003 (.319)	.02 (.94)	.002 (.21)	-.005 (.39)
Uttar Pradesh	13	.028 (3.2)	.029 (3.3)	.023 (2.5)	.023 (1.84)	.025 (1.9)	.015 (1.21)
West Bengal	13	.08 (8.01)	.09 (5.1)	-	.09 (4.4)	.08 (2.61)	-

Table 6: Time series Regression Results with single explanatory variable

Model I:

State	Degrees of freedom	Crops Price I	Crops Price II	Crops Price III	Crop price deflated by fertiliser price I	Crop price deflated by fertiliser price II	Crop price deflated by fertiliser price III
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Andhra Pradesh	13	.059 (5.03)	.05 (3.61)	.05 (3.19)	.087 (3.8)	.045 (1.93)	.039 (1.6)
Assam	10	.05 (13.83)	.03 (12)	.031 (1.85)	.07 (5.44)	.05 (8.3)	.025 (1.03)
Bihar	13	-.012 (1.2)	-.02 (1.2)	-.039 (1.63)	-.017 (1.28)	-.028 (1.3)	-.05 (1.8)
Delhi	13	-.025 (.48)	.05 (1.2)	.08 (2.06)	- .05 (1.003)	.026 (.51)	.06 (1.2)
Gujarat	9	.0[illegible] (4.52)	.02 (2.5)	.016 (3.2)	.02 (1.74)	.01 (.54)	.012 (1.3)
Himachal Pradesh	13	.05 ([illegible].5)	.053 (4.2)	.05 (3.9)	.05 (1.92)	.06 (2.7)	.05 (2.5)
Jammu & Kashmir	13	.038 (1.52)	.032 (1.7)	.12 (2.01)	.02 (.57)	.024 (.78)	.035 (.38)
Karnataka	13	.018 (4.3)	.021 (4.74)	.013 (3.5)	.014 (2.11)	.016 (2.06)	.01 (1.8)

(Continued)

Table 6: (Continuation)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Kerala	13	.074 (11.1)	-	-	.084 (5.8)	-	-
Maharashtra	9	.002 (.705)	.009 (1.83)	.002 (.66)	.002 (.41)	.001 (.11)	-.002 (.43)
Madhya Pradesh	13	-.01 (.76)	-.011 (.76)	-.015 (1.06)	-.035 (1.64)	-0.04 (1.93)	-.04 (2.3)
Punjab	13	.12 (3.82)	.07 (3.17)	.08 (4.1)	.08 (1.5)	.05 (1.6)	.07 (2.1)
Rajasthan	13	.013 (1.16)	.012 (1.01)	.01 (1.2)	.005 (.31)	.002 (.14)	.01 (.5)
Tamil Nadu	13	-.01 (.54)	-.004 (.47)	-.01 (.6)	-.01 (.5)	-.01 (.4)	.01 (.53)
Uttar Pradesh	13	.027 (2.8)	.028 (2.6)	.03 (2.9)	.02 (1.44)	.019 (1.2)	.019 (1.39)
West Bengal	13	.07 (6.29)	.08 (4.44)	-	.09 (3.6)	.08 (2.2)	-

price index to obtain the change in real price of that crop. We have however deliberately not done this exercise for some reasons which can be traced from our earlier discussions. If the aggregate price index consists of all the prices, then some of them or more specifically relative prices of agricultural commodities which the farmer receives will have tendency to increase cropping intensity. On the contrary relative price of non agriculture commodity to agriculture commodity which a farmer pays will have negative impact on cropping intensity. Since we don't have any price index number which consists of only those items which are non agricultural, and which are bought by farmers we couldn't deflate our price. One however can construct that.

We have instead deflated the crop price by the fertiliser price which is an input of cultivation. This may give some idea about the change in real price of a crop. Again we find positive correlations (Tables 4, 5, 6) with T Values significant at different levels - for all states except Bihar, Madhya Pradesh and Tamilnadu. One can still argue that more important variable responsible for the change in cropping intensity over time is not price but more attractive variable like irrigation facility or a compulsion variable like population pressure. We don't rule it out altogether. Subject to favourable demand position and profit margins cropping intensity is to be raised through irrigation facility. But this than should be viewed as a necessary condition. Irrigation variable indeed shows a positive correlation (see Table 7) with cropping intensity overtime in many states. But even in few states such as Assam, Haryana, Jammu & Kashmir, Orissa and West Bengal irrigation level has shown negative impact on cropping intensity although cropping intensity has a positive

Table 7: Time series results with single explanatory variable

States	Degrees of freedom	Gross Irrigation / Cross area	Time
(1)	(2)	(3)	(4)
Andhra Pradesh	14	1.22 (2.25)	.39 (4.75)
Assam	11	-.149 (1.5)	.7 (9.9)
Bihar	14	-.66 (2.1)	-.41 (2.1)
Delhi	14	.124 (.6)	.48 (1.03)
Gujarat	10	.368 (5.8)	.27 (4.6)
Haryana	4	-.77 (1.1)	.82 (.4)
Himachal Pradesh	14	2.02 (2.2)	.55 (3.9)
Jammu & Kashmir	14	-1.04 (2.6)	.6 (4.1)
Karnataka	14	.45 (8.6)	.19 (7.02)
Kerala	14	4.9 (3.1)	1.13 (8.7)
Maharashtra	10	.19 (1.7)	.05 (1.38)
Madhya Pradesh	14	-.51 (.85)	-.123 (1.01)
Orissa	11	-3.7 (3.7)	1.06 (1.6)
Punjab	14	.2 (4.9)	.56 (3.5)
Rajasthan	14	-.14 (.6)	.02 (.25)
Tamil Nadu	14	.02 (.09)	-.03 (.55)
Uttar Pradesh	14	.272 (3.0)	0.45 (5.8)
West Bengal	14	-3.2 (1.8)	0.91 (6.37)

Table 8: Partial correlation co-efficient between cropping intensity and crop price with irrigation as controlled variable

State	Crop I	Crop II	Crop III
Andhra Pradesh	.627	.497	.386
Assam	.845	.921	.628
Bihar	-.292	-.296	-.58
Delhi	-.08	.004	.031
Gujarat	-.46	-.44	-.35
Himachal Pradesh	.261	.376	.383
Jammu & Kashmir	.564	.684	.45
Karnataka	-.1	-.2	-.2
Kerala	.694	-	-
Maharashtra	-.59	.09	-.16
Madhya Pradesh	-.31	.06	-.22
Punjab	-.0004	.872	-.36
Rajasthan	.2	-.1	-.003
Tamil Nadu	-.18	-.48	-.5
Uttar Pradesh	.22	.21	.12
West Bengal	.88	.83	-

trend in these states. Price has definitely some impact on cropping intensity at least in these few states. To be more sure about impact of price in other states we have computed partial correlation coefficient (Table 8) between price of a crop and cropping intensity with constant irrigation level. Again we generally find a positive correlation. There are few negative correlations too, but they are generally insignificant. So far as population pressure is concerned this itself does not generate more agricultural production or indirectly cropping intensity. It is the demand generated by them which induces more production. This demand in turn depends upon income level along with income distribution. Since majority of Indian population is poor, bulk of the population increase too takes place among them who generally don't create much demand. Among them who are marginal farmers get impoverished because of population rise, and lease out their lands to large size prosperous landowners.[13] These large size landowners would produce more only if they can sell their products at favourable price. Negligible role of population pressure is quite evident from Table 9, where we have growth rates of population and cropping intensity between 1961 and 1971 for different states. States with higher growth rate of cropping intensity did not necessarily experience large growth in population. Correlation co-efficient between these variables is merely 0.11.

13/ Nadkarni, M.V. "Tenants from the dominant class. A developing contradictions in land reforms" Economic and Political Weekly, December 25, 1976.

Table 9: Growth rates - 1961-71

(Percent)

State	Decenial growth of population	cropping intensity annual compound
Andhra Pradesh	20.9	0.4
Assam	34.7	0.6
Bihar	21.3	-0.3
Gujarat	29.4	0.3
Himachal Pradesh	23.1	0.5
Jammu & Kashmir	29.7	0.3
Karnataka	24.2	0.3
Kerala	26.3	1.2
Madhya Pradesh	28.7	-0.2
Maharashtra	27.4	0.00
Orissa	25.1	0.7
Punjab	21.7	0.7
Rajasthan	27.8	0.2
Tamil Nadu	22.3	-0.1
Uttar Pradesh	19.8	0.5
West Bengal	26.9	1.0

IV

To summarise the whole exercise we have tried to trace out the role of technical and market variables on cropping intensity. We have in our discussion observed that rainfall and its distribution, soil fertility, climatic condition and irrigation facilities are important necessary conditions for cropping intensity. But they are not enough. Farmers require incentive in the form of higher price for their crops for higher level of cropping intensity. We have also discovered in our discussion that to answer certain set of issues present definition of cropping intensity in terms of gross cropped area and net sown area is not adequate. One should consider land utilisation with respect to time.