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Research Paper

Dynamics of Cropping Pattern in Cotton Growing Districts of Maharashtra

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ABSTRACT

Shifts in cropping pattern were analyzed with reference to cotton in major cotton growing districts of Maharashtra with the help of Markov chain analysis. The analysis revealed that in 14 among the 19 cotton growing districts, cotton area increased during the study period (2000-01 to 2017-18) while 5 districts experienced decrease in cotton area. Cotton crop was found to have high retention capacity in almost all the districts with a probability ranging from 0.53 to 0.98 among the cotton growing districts. The main crops that lost their area to cotton were pigeon pea, maize, black gram, soybean and other *kharif* pulses. Castor, small millets, groundnut and sunflower also lost their area to cotton. Crops like soybean, maize, pigeon pea, black gram and green gram also got area from cotton in some districts but the probability was very less. Stable and good prices, stable yield and easy to market are the reasons for preferring cotton over other crops. High cost of cultivation and non availability of labour are the major reasons for not preferring cotton crop.

HIGHLIGHTS

- Cotton area increased in 14 district and decreased in 5 districts during the study period (2000-01 to 2017-18).
- Cotton crop was found to have high retention capacity.
- Pigeon pea, maize, black gram, soybean and other *kharif* pulses lost their area to cotton.
- Stable prices and yield as well as easy to market are the reasons for preferring cotton over other crops.

Keywords: Cotton, cropping pattern, Markov analysis

The cropping pattern of a particular area is largely determined by agro-climatic factors such as soil, temperature and rainfall distribution etc. Each region adopts some popular cropping pattern according to its agro climatic characters referred as "traditional cropping''. Other factors like economic, technical as well as policy related also influence the traditional cropping pattern and lead to these fluctuations. These changes will be directed towards high value crops (Narain 1977; Mouzam *et al.* 2015) more remunerative crops in place of cereals (Sharma *et al.* 1996; Ram & Tripathy 1996), coarse cereals to finer cereals (Johl & Sidhu1988), at the expense of one crop another (Kelley & Rao 1993). These changes are influenced by changes in economic, technological, institutional and policy-induced factors (Gulati & Kelley 1999).

Cotton is an important commercial crop of India with an area of about 120 lakh ha. Cotton was found to be one of the most stable crops of the country which competes with food and other crops for area (Aravind Kumar & Basvaraja 2012, Dayakar Rao 2005, Madhuri and Nagpure 2017). Among the states, Maharashtra is the most important state following a traditional cropping pattern dominated

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by cotton. It ranks first in cotton area and second in production. In Maharashtra cotton is grown on 43.51 lakh ha producing 83.35 lakh bales of lint with an average productivity of 325.7 kg/ha (2017-18). Cotton area increased from 30.77 lakh ha in 2000-01 to 43.51 lakh ha in 2017-18 with an average area of about 34 lakh ha. It fluctuated widely from a minimum of 27.7 lakh ha to 43.51 lakh ha during 200-01 to 2017-18. These fluctuations will have important implications for the supply-demand balances of not only cotton but also the competing crops. Shifts in crop areas will lead to deficit of particular crop in the domestic market and pressures for increased imports. These changes will also lead to inefficiency in resource use or distortions in cropping patterns. If the processes underlying the crop use shifts are quantified, then future adjustments in land use can be projected. Further, specifications of the underlying shifts in land use that makes it possible for resource economists to provide policy makers with economic intelligence concerned by the variables that influence future use of the land resource, or alternatively, suggest changes in economic, social, or institutional variables to insure that desired future land use is realized. A large no of researchers studied the cropping pattern changes at various levels. Most of the studies on cropping pattern changes are quite general (Narain, 1977; Johl and Sidhu, 1988; Kelley and Rao, 1993; Ram and Tripathy, 1996; Sharma *et al.* 1996; Gulati and Kelley, 1999; Ardeshna and Shiynai, 2013; Sunita *et al.* 2016). These studies do not make a mention of the shifts of the area under a particular crop and transactions of its area with other crops. There is no such study at district level about the cropping pattern changes with reference to cotton crop. In this study an attempt was made to answer the questions such as how the area of cotton crop is affected with reference to the competing crops and what are the reasons behind these changes in crop area with reference to cotton.

Methodology

The Markov process was used to study the shifts in cropping pattern and thereby gain an understanding about the dynamics of the changes. A transition probability matrix was constructed for each district using Markov chain analysis. It is assumed that the combined influence of the individually systematic forces approximates to a stochastic process and the propensity of farmers to move from one crop state to another differs according to the crop state involved. With these assumptions the process of cropping pattern change may be described in the form of a matrix '*P*' of first order transition probabilities. The element of 'P_{ij}' of the matrix indicates the probability of a farmer in crop state '*i*' in one period will move to crop state '*j*' during the following period. The diagonal element 'P_{ij}' measures the probability that the proportional share of j^{th} category of the crop will be maintained.

$$Y_j = X_j P_j + (U_j - V_j)$$

Where Y_j = (T×1) vectors of observations reflecting the proportion in cropping pattern '*j*' in time '*t*'.

X_j = (T×r) matrix of realised values of the proportion in cropping pattern '*i*' in time (t–1),

P_j = (r×1) vector of unknown transition parameters to be estimated, and

(U_j–V_j) = vector of random disturbance

P_j is estimated by minimization of μ_j by solving the following linear programming model

$$Minimize\ Z = u_j - v_j$$

Subjected to,

$$\sum X_{ij} P_{ij} + (U_j - V_j) = X_i + 1_j$$

$$X_{ij} \geq 0, \sum P_j = 1$$

Data

The data on crop areas were collected from the website of Ministry of Agriculture and Farmers Welfare, Govt of India (https://aps.dac.gov.in/APY/Index.htm). There are 19 important cotton districts in Maharashtra. These districts include Ahmednagar, Akola, Amravati, Aurangabad, Beed, Buldhana, Chandrapur, Dhule, Hingoli, Jalgaon, Jalna, Nagpur, Nanded, Nandurbar, Nashik, Parbhani, Wardha, Washim and Yavatmal. The data on all the crops grown in these districts were collected for the period 2000-01 to 2017-18. Primary data were collected from 150 cotton farmers of

selected districts namely, Aurangabad, Amravati and Ahmadnagar and analysed to know the reasons of switchover of crops by farmers.

RESULTS AND DISCUSSION

Changes in cotton area

Many changes occurred in cotton cultivation during the last 15 years. Bt cotton as well as other production and protection technologies were introduced and got popular. Prices of inputs as well as output got subjected to many changes. All these changes had an impact on cotton area in Maharashtra. To know the changes that occurred in cotton area in the selected districts, average cotton area of triennium ending (TE) 2000-01 was compared with that of TE 2017-18.

Among the 19 cotton growing districts, cotton area increased in 14 districts during the study period (Table 1) while cotton area decreased in another 5 districts. Increase in cotton area was highest in Aurangabad followed by Beed and Dhule. In Aurangabad cotton area increased from 148167 ha in TE 2000-01 to 495284 ha in TE 2017-18. There was an increase of 358884 ha in cotton area in this district. In Beed and Dhule an extent of 251436 ha and 141833 ha was added to the cotton area respectively during the study period. Cotton cultivation was extended to more than 1 lakh ha in each of Jalna and Chandrapur districts. Similarly Ahmednagar, Wardha, Nanded, Jalgaon, Nandurbar and Nagpur districts added about 60000 to 100000 ha to their cotton area during the same period. Highest decrease in cotton area was observed in Amravati followed by Washim and Akola. In Amravati cotton area decreased from 304233 ha to 202586 ha. In Washim and Akola decrease in cotton area was 77849 ha and 73183ha respectively.

Changes in crop pattern

Aurangabad, Beed, Dhule, Jalna, Chandrapur, Ahmednagar, Wardha, Nanded, Jalgaon, Nandurbar, Nagpur, Nashik, Yavatmal and Parbhani, are the 14 districts in which area of cotton increased during the study period. Along with the cotton the area of soybean, maize and pigeon pea also increased. Major crops that lost area include bajra, sorghum and green gram. In Amravati, Washim, Akola, Buldhana and Hingoli cotton area decreased. Along with the cotton area of sorghum and green gram decreased during the study period. In these districts the area of soybean, pigeon pea and maize increased.

Table 1: Changes in the cotton area in major cotton growing districts of Maharashtra

District	TE 2000-01	TE 2017-18	Increase/Decrease	%
Aurangabad	148167	495284	358884	263
Beed	101467	341336	251436	280
Dhule	75867	208200	141833	214
Jalna	157033	277346	130580	89
Chandrapur	54233	161580	103913	180
Ahmednagar	14267	112933	99600	747
Wardha	135500	238321	96121	68
Nanded	274133	338748	95314	39
Jalgaon	394167	493367	93867	23
Nandurbar	29600	99567	67267	208
Nagpur	63667	136023	61156	82
Nashik	5167	51800	46033	798
Yavatmal	446467	441300	11967	3
Parbhani	250533	208320	8553	4
Hingoli	108900	82058	-26842	-25
Buldhana	247867	171596	-31137	-15
Akola	275900	154183	-73183	-32
Washim	112800	18784	-77849	-81
Amravati	318667	202586	-101648	-33

Table 2: Probability of transaction of other crops area to cotton

Other crops to cotton	Cotton	Pigeon pea	Other *Kharif* pulses	Castor seed	Maize	Black gram	Small millets	Groundnut	Green gram	Soyabean	Sunflower	Sesamum	Rice	Bajra	Sorghum
Aurangbad	0.810	0.610	0.000	0.000	0.340	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Beed	0.850	0.390	0.000	0.000	0.800	0.000	0.000	0.000	0.000	0.230	0.000	0.000	0.000	0.000	0.000
Jalna	0.880	0.130	0.000	0.920	0.430	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000
Dhule	0.840	0.990	0.000	0.000	0.230	0.000	0.000	0.000	0.000	0.300	0.000	0.000	0.120	0.010	0.000
Hingoli	0.640	0.000	0.000	0.000	0.000	0.196	0.000	0.000	0.640	0.082	0.000	0.000	0.000	0.000	0.000
Jalgaon	0.950	0.000	0.000	0.000	0.100	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.200
Nanded	0.940	0.090	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.060	0.000	0.000	0.000	0.000	0.000
Ahmednagar	0.920	0.000	0.000	0.000	0.050	0.380	0.000	0.000	0.120	0.010	0.000	0.000	0.000	0.000	0.000
Nandurbar	0.870	0.000	0.000	0.000	0.270	0.000	0.000	0.000	0.000	0.070	0.000	0.000	0.000	0.000	0.080
Chandrapur	0.960	0.110	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Parbhani	0.840	0.490	0.920	0.000	0.000	0.320	0.000	0.610	0.000	0.040	0.000	0.000	0.000	0.000	0.000
Wardha	0.980	0.000	0.610	0.000	0.000	0.000	0.000	0.150	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Nashik	0.060	0.000	0.000	0.000	0.140	0.000	0.000	0.000	0.000	0.230	0.000	0.000	0.120	0.000	0.000
Nagpur	0.530	0.520	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.170	0.000	0.000
Yavattmal	0.960	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.030	0.000	0.000	0.000	0.000	0.050
Buldhana	0.710	0.580	0.000	0.000	0.240	0.000	0.000	0.000	0.160	0.000	0.780	0.730	0.000	0.000	0.000
Washim	0.810	0.040	0.000	0.000	0.000	0.110	0.000	0.000	0.000	0.000	0.000	0.250	0.000	0.000	0.000
Akola	0.830	0.030	0.990	0.000	0.000	0.990	0.150	0.000	0.210	0.020	0.080	0.000	0.000	0.000	0.000
Amravati	0.890	0.000	0.120	1.000	0.000	0.860	1.000	0.220	0.000	0.050	0.000	0.000	0.000	0.330	0.000
Average	0.804	0.209	0.202	0.183	0.153	0.150	0.072	0.065	0.059	0.059	0.057	0.052	0.026	0.021	0.017

Table 2 shows the transaction probabilities of cotton gaining area from other crops. Pigeon pea is the major crop which lost its area to cotton. Aurangabad, Beed, Dhule, Parbhani, Nagpur and Buldhana are the major district where cotton gained area from pigeon pea. Maize is another crop which lost its area to cotton in Aurangabad, Beed, Jalna, Dhule, Nandurbar and Buldhana. Cotton also got area from other *kharif* pulses in Nanded, Parbhani, Wardha and Akola. Similarly black gram lost its area to cotton in Ahmednagar, Parbhani, Akola and Amravati. Soybean is another crop from which cotton gained area in Beed, Dhule and Nashik. The other cops which lost its area to cotton include castor, small millets, groundnut and sunflower.

The results revealed that cotton has a high retention capacity in almost all the districts. The probability of retention ranged from 0.53 to 0.98 among cotton growing districts with an average of 0.84. Highest retention probability was observed with Wardha (0.98) followed by Chandrapur (0.96) and Yavatmal (0.96). Similarly lowest retention probability is observed with Nagpur (0.53) followed by Nashik (0.60) and Buldhana (0.71).

Major crops getting area from cotton include soybean, maize, pigeon pea, black gram and green gram (Table 3). If we examine the transaction probabilities of Amrawati, Akola and Washim where cotton area got decreased over the analysis period, it is clear that black gram, green gram and pigeon pea gained the area from cotton. In other districts the crop which got area from cotton includes soybean, maize, pigeon pea, black gram and green gram.

Reasons for preferring/ not preferring cotton crop

A survey was conducted in Aurangabad, Ahmednagar and Amravati to know the reasons for increase/ decrease in cotton area and the ranks of each reason is given Table 4.

The reasons due to which farmers are preferring cotton over other crops includes stable and good

Table 3: Probability of transaction of cotton area to other crops

Cotton to other crops	Pigeon pea	Bajra	Castor	Cotton	Groundnut	Sorghum	Maize	Green Gram	Rice	Small millets	Soybean	Black gram
Aurangabad	0.058	0.012	0	0.813	0.004	0	0.113	0	0	0	0	0
Beed	0.037	0.018	0.001	0.852	0	0	0.004	0	0	0.004	0.065	0.018
Jalna	0.042	0.008	0	0.878	0	0	0.029	0.017	0	0	0.025	0
Dhule	0.007	0.017	0	0.84	0	0	0.12	0	0.007	0	0.009	0
Jalgaon	0.005	0	0.001	0.951	0	0	0.014	0.007	0	0.001	0	0.021
Nanded	0.013	0	0	0.939	0	0.027	0	0.002	0	0.002	0	0.017
Ahmednagar	0.009	0	0	0.92	0	0	0.067	0	0	0	0	0
Nandurbar	0	0	0.002	0.866	0	0.095	0.003	0	0.034	0	0	0
Chandrapur	0.04	0		0.96	0	0		0	0	0	0	0
Parbhani	0.09	0	0.002	0.835	0	0.01	0.004	0	0	0.001	0.039	0.016
Wardha	0.017	0	0	0.981	0	0.002		0	0		0	0
Nashik	0	0	0	0.064	0	0	0.349	0	0	0.005	0.582	0
Nagpur	0.271	0	0.001	0.529	0	0	0	0	0		0.195	0.005
Yavatmal	0.041	0	0	0.959	0	0	0	0	0		0	0
Buldhana	0.089	0.008	0.001	0.711	0.001	0.012	0.04	0.021	0	0	0.11	0.005
Washim	0	0	0	0.806		0	0	0.082	0	0	0	0.112
Akola	0	0	0	0.831		0	0	0.107	0	0	0	0.062
Amravati	0.026	0	0.002	0.892	0.002	0	0	0.055	0.004	0	0	0.02
Hingoli	0.012	0.000	0.000	0.640		0.146	0.003	0.000	0.000	0.000	0.177	0.023
Average	0.8035	0.0633	0.0439	0.0398	0.0157	0.0154	0.0153	0.0039	0.0028	0.0008	0.0006	0.0005

Table 4: Reasons for preferring/ not preferring cotton crop

Reasons for preference	Rank	Reasons for non-preference	Rank
Stable and good price	I	High cost of cultivation	I
Stable yield	II	Non availability of labour	II
Easy to market	III	More no of sprayings	III
Less crop losses	IV	Ease of cultivating other crops	IV
Better performance in drought conditions	V		
Cash crop	VI		

prices, stable yield, easy to market, less crop losses, better performance during drought and minimum guaranteed income. Stable and good price is the major and foremost reason for the performance of cotton over other crops. Cotton price over the years remained above ₹ 4500/- per q and the coefficient of variation (CV) is lowest when compared with the other competing crops (table 5).

Stable yield: Stable yield of cotton crop is another reason for the performance of cotton over other crops. Average yield of cotton remained at 14.4 q per ha with a standard deviation of 2.4 during the period of analysis coefficient of variation of cotton yield was 39 for this period. CV of the yield of other competing crops was more than the CV of cotton yield except that of *bajra*.

Marketing of cotton is comparatively easy. It is not perishable commodity and the market for cotton is available at any time in the village itself or nearby town. It can be readily marketed at any point of time and can be converted into money.

Crop losses and yield reduction due to various reasons are less in cotton when compared with its competing crops. It will also perform better during

Table 5: Variation in income, yield and price of various crops in Maharashtra, (2006-07 to 2015-16)

Crop	Gross income			CV of Yield	CV of Price
	₹/ha	SD	CV		
Pigeon pea	57989	33253	57	29.3	48
Bajra	23663	5715	24	15.2	30
Cotton	53105	20823	39	16.7	27
Groundnut	47606	22075	46	30.6	31
Sorghum	26586	7873	30	22.0	32
Green gram	21496	6471	30	27.3	38
Ragi	7198	11703	163	161.1	163
Soyabean	31543	10931	35	20.7	35
Sunflower	18860	13956	74	61.1	59
Black gram	20292	5489	27	26.8	41

the drought conditions as it is a drought resistant crop. It will provide minimum guaranteed income. Whereas the other crop there is no such guarantee and the losses may go to any extent. Due to all these reasons farmers in the study area prefer cotton over other crops. Farmers are more concerned with the economics and ease of marketing. Cotton has advantage of both stable yield and price.

Major reasons for not preferring cotton crop in the districts where cotton area decreased include high cost of cultivation, non availability of labour, cumbersome spraying for pests and ease in cultivating other crops. To cultivate one hectare of cotton about ₹ 70000/- is needed. Most of the small and marginal farmers are poor and do not have sufficient investment. Hence they prefer crops with less investment. Cotton is a long duration crop requiring about 100 to 120 man days of labour during the crop season. Shortage of labour during peak periods like weeding and harvesting prohibits the farmer to take up cotton cultivation. Cotton needs more sprayings of chemicals than other competing crops. This combined with the above three reasons makes the farmers to prefer other crops which are comparatively easy to cultivate.

CONCLUSION

Findings of this study indicate that cotton is very stable crop with respect to area and its area increased during 2000-01 to 2017-18 at the cost of food crops like pigeon pea, maize, black gram and soybean. Comparatively stable yield along with stable and higher prices of cotton over the period made the farmers to prefer it over the other crops. Such shift in cotton area needs to be given attention and policies should be devised to make the other crops also competitive and preferred by the farmers so that the balance will be maintained.

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