
TRENDS OF DIFFUSION

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1. Introduction :

The process of agricultural diffusion is the spread of new varieties of seeds and implements in space over time. Agriculture is an operation of the cultivation of farm and the production of crops from land. The process of cultivation and production requires the help of human labour, irrigation and pesticides, Innovation is a change in the established methods of agricultural practices, culture, ideas, etc., with the help of private institutions and the government machineries.

The favourable climatic conditions, deep and highly fertile soils in river valleys, development of irrigation facilities, have led Kolhapur district as one of the prosperous districts for cane cultivation in Maharashtra. Tractor plays an important role in the farm technology, which is very popular in sugarcane cultivated areas due to its multiple uses. After knowing the diffusion process in previous chapter, here an attempt is made to present the trend of adoption of tractor over a period of time in a various tahsils of Kolhapur district in general.

2. <u>Methodology</u> :

The spatio-temporal data collected for the diffusion of tractors in Kolhapur district (tahsilwise), was tried to show by linear method. But it was found that the trends were non

linear for each of the tahsils and all curves are either convex or concave having an upward trend. And therefore, have decided to use-nonlinear regression for this study. Of the nonlinear regressions one forms of exponentials i.e. Second Degree Curve is used for the present study, where a straight line indicates a constant amount of increase or decrease a second degree curve involves increasing or decreasing amount of increase or decrease. Almost all the tahsils meet this condition of second degree curve by having increasing amount of adoption of tractors. The second degree curve involves merely addition of cx^2 to the equation of a straight line giving :

$$Xc = A + BX + CX^2$$

Where A, B and C are constant and X is the time variable. The least square equation for estimating the parameters A, B and C are described in Appendix II. The second degree curve is fitted to the data of adoption of tractors for all the tahsils from the starting year of adoption upto 1982. For Karveer tahsils the years 1969 and 1970 have X values as -1 and +1 respectively. While the remaining tahsils except Gaganbavada and Bhudargad tahsils have X values as -1 and +1 respectively, for the year 1971 and 1972. Whereas for Bhudargad tahsil the years 1972 and 1973 have X values as -1 and +1 respectively, and Gaganbavada tahsil the years 1973 and 1974 have X values as -1 and +1 respectively.

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3. Diffusion trends (tahsilwise) :

a) Karveer tahsil

The Karveer tahsil is located in the central part of the district. It has a total population of 6,05,931 (1981) giving a density of 903 persons per sq.kilometer. More than 71% of the total area is cultivated. The average yearly rainfall amounts to 1071 mm. The tahsil is also well served with means of irrigation. The main sources of irrigation are wells and lifts, irrigating about 25.3% of the net sown area. About 25% of net area sown is under sugarcame.

The adoption of tractor took place in Kolhapur city in the year 1957. During this year the number of adopted tractors was only 4, but upto 1982 it has increased upto 634, mainly because of the fertile soils in river valleys, developed irrigation facilities, increased area under sugarcane and growth of sugar factories during last two and half decades. The comparative study of actual values and trend values of second degree curve reveals that both values are much closer to each other (Table 4.1).

It is also evident that the actual curve more or less follows the second degree curve (Fig.4-1A). In other words the diffusion of tractors in the Karveer tahsil has followed the trend of second degree curve.

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	Karveer	tahsil	Hatkanga	ale tahsil	Panhala	tahsil
Year	Actual adoption	Trend values	Actual adoption	Trend values	Actual adoption	Trend values
400 ANA 440 ANA 486 ANA 499 B		و میرود میرود وروی میرود میرود میرود م		an Gair ann Afric sin Ghi Ann ann Ann A	u dili abi din ana gan ank any any any	ی در با
1957	4	13.4	-	-	-	-
1958	15	12.6	-		-	-
1959	20	15.6	-			
1960	32	19.4	-	-	-	-
1961	40	25.0	23	30.6	4	7.3
1962	41	32.6	29	29.1	5	7.8
1963	43	41.9	29	28.9	6	8.7
1964	45	52.9	34	30.0	8	9.9
1965	54	65.9	38	32.6	12	11.6
1966	56	80.8	42	36.3	15	13.6-
1967	61	97.2	44	41.5	10	16.0
1968	101	115.6	48	47.8	20	18.9
1969	177	135.9	60	55.6	32	22.0
1970	206	181.7	74	64.7	35	25.6
1971	224	207.3	81	75.0	40	29.6
1972	245	234.9	92	9 9. 9	41	34.0
1973	263	264.1	108	114.2	43	39.2
1974	292	295.3	130	129.8	44	44.6
1975	330	328.3	147	146.8	47	50.5
1976	361	363.0	159	165.2	53	56.7
1977	410	399.6	180	184.8	56	63.3
1978	431	438.0	204	205.7	68	70.1
1979	445	478.3	218	228.0	79	77.6
1980	488	520.3	245	251.6,	93	85.4
1981	587	563.2	285	276.5	103	93.4
1982	634	609.9	313	302.7	118	101.9

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Table 4.1 Actual number of tractors and second degree curve trend values.

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Source : Compiled by the author.

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b) Hatkangale tahsil

Hatkangale tahsil located in the north eastern part of the district, covers an area of 60,937 hectares including 45,924 hectares as cultivated land. The total population according to 1981 census is 4,27,648 giving a density of 702 persons per sq.kms. The annual rainfall is low (525 mm) and highly variable. But lifts and wells provide the water to 21.2% of the net area sown.

In this tahsil the first tractor was adopted in the year 1961. Table 4.1 reveals the rapid increase in the number of tractors, from 23 tractors in 1961 to 313 in 1982. Increase in the land under sugarcane, availability of sugar factory which provide the financial assistance to the farmers for adoption of tractors resulted in the diffusion of tractor in Hatkangale tahsil. It is also clear that the actual values are close to the trend values of second degree curve.

Fig.4-1B indicates that the actual curve follows much more to second degree curve. Hence, it is evident that the general trend of the diffusion of tractors in the tahsil follows the second degree curve.

c) Panhala tahsil

This tahsil covers an area of 56,871 hectares, including 30,092 hectares as cultivated land. It has 1,70,823 population (1981) of which nearly 98.5% belongs to rural areas. The density

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of population per sq.km. is 245. The normal rainfall is 2082 mm. Lift irrigation is the main source of irrigation. Nearly 13.9% of the net sown area is irrigated.

The Table 4.1 reveals that in 1961 the number of tractors were only 4. Which increased to 118 in 1982. Upto year 1968, the rate of adoption was very low but after 1968 there is a remarkable increase in adoption of tractors. The actual values and the trend values of second degree curve are much closer to each other. Also the actual curve more or less follows the second degree curve (Fig.4-2A)

d) Shirol tahsil

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Shirol tahsil lying in the north eastern part of the district, covers an area of 50,793 hectares. About 83% of the total area is cultivated. Total population according to 1981 census is 2,46,277 giving a density of 485 persons per sq.kms. As compared to other tahsils of the district the average rainfall is less (i.e. 522 mm) and uncertain. But ample water from river Panchanganga irrigates about 30.27% of net sown area.

Table 4.2 shows that in the year 1961, the adopted tractors were only 11 and upto 1971 the **rate** of diffusion was not more, but after 1972 the rate of tractorazation increased and in 1982 it goes upto 312 tractors. This can well attributed to the developed irrigation facilities, increased area under cane cultivation, and establishment of sugar factory (1973-74). The actual curve more or less follows the second degree curve (Fig.4-2B).

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Table 4.2 Actual number of tractors and second degree curve

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, AND	Shirol t	ahsil	Kagal ta	hsil	Gadhingla	j tahsil
Year	Actual adoption	Trend values	Actual adoption	Trend values	Actual adoption	Trend values
1961	11	22.5	4	3.4	3	8.5
1962	23	18.0	4	3.5	3	5.2
1963	- 13	15.0	4	4.1	3	2.7
1964	['] 17	13.8	4	5.3	3	0.8
1965	, 22	14.0	6 '	7.0	з.	0.12
196 6	25	15.9	8	9.3	3	0.5
196 7	26	19.4	9	12.0	3	0.1
1968	30	24.4	12	15.4	3	1.0
1969	39	31.0	21	19.3	3	3.0
1970	46	39.0	23	23.7	7	5.5
1971	51	48.9	32	28.6	8	9.0
1972	61	73.0	34	40.1	11	13.4
1973	79	87.5	43	46.7	13	18.9
1974	106	103.6	49	53.8	29	25.3
1975	120	121.3	65	61.5	39	32.4
1976	139	140.5	72	69.7	50	40.1
1977	155	161.3	79	78.4	57	48.7
1978	176	183.6	81	87.7	58	58.0
1979	196	207.7	97	97.5	63	68.0
1980	233	233.0	107	107.8	92	78.9
1 981	261	260.3	122	118.7	98	90.3
1982	312	288.9	132	130.2	106	102.6
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trend values.

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Source : Compiled by the author.

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e) Kagal tahsil

This tahsil is located on the central eastern part of the district, and covers an area of about 54,754 hectares including 41,784 hectares as net area sown. Annual rainfall ranges from 800 mm to 1100 mm and is highly variable. It supports a population of 1,83,028. The per sq.km. density of population is 334.

Table 4.2 shows that in 1961 the number of tractors ware only 4, which was constant upto 1964. After 1964, the number of tractors increased slowly and reached upto 132 in the year 1982; because of development in irrigation facilities, increased area under sugarcane and growth of sugar factories in the tahsil. It is evident that the actual values are close to the trend values of second degree curve.

Fig.4-3A indicates that the actual curve follows much more the second degree curve. However, it may be concluded that the general trend of the diffusion of tractors in the tahsil follows the second degree curve.

f) Gadhınglaj tahsil

Gadhinglaj is the smallest tahsil of the district, with an area of about 48,115 hectars including 40,837 hectare as cultivated, and this is the highest proportion to total area in the district. The annual rainfall in normally more than 960 mm. The total population of the tahsil is 1,74,760 (1981). Lift and



wells are the major sources of irrigation, irrigating 8.9% of the net area sown.

The adoption process of tractors was started in 1961, when the total number of tractors was three. But there was no increase in the adoption of tractor upto 1968. The process of adoption spread up after 1973 and presently there are 106 tractors in operation.

From a comparative study of actual values and trend values of second degree curve, it is clear that, the trend values of second degree curve are much closer to actual degree curve except the years from 1963 to 1968. During this period the trend values of second degree curve are below the actual values. Fig.4-3B also indicates that the actual curve follows much more to second degree curve except the years from 1963 to 1968.

g) Shahuwadi tahsil

This tahsil located in the north western corner of the district covers an area of 1,04,352 hectares. Arealy it is the largest tahsil in the district, supporting a population of 1,38,490 (1981), giving a density of 133 persons per sq.kms. Due to undulating nature of the surface only 30% of the total area is under cultivation. Lifts and wells are the main source of irrigation and about 11.9% of the net area sown is irrigated. The average rainfall is more than 3000 mm.

The adoption process started in the year 1961 with one

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tractor, and there was no increase in it upto 1964. Then sudden rise is observed from the year 1974 (38). Presently there are 104 tractors. The growth cycle is more or less in accordance with the trend values of second degree curve.

Fig.4-4A clearly indicates that the actual curve moves very close to the second degree curve. It is a clear indication of the fact that the trend of diffusion of tractors in the tahsil follows second degree curve.

h) Radhanagari tahsil

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Radhanagari tahsil covers an area of about 84,232 hect. It is the third largest tahsil of the district. Of the total geographical area about 33.9% areaes is under cultivation. It supports a population of 1,50,915. The average annual rainfall is more than 4000 mm. The tahsil is well served with means of irrigation. Lifts and wells are the main source of irrigation, which irrigates 16% of the net sown area.

Adoption of tractor started firstly in the year 1961 with only one tractor, but in the first four years the number of tractor was constant. Since the year 1973 the rate of diffusion increased rapidly due to increase in area under sugarcane cultivation. The number of tractor increased from one in 1961 to 116 in 1982. This fact represented in Fig.4-4B reveals that the actual curve follows the second degree curve from the year 1963. A comparative study of the observed values and the Table 4.3 Actual number of tractors and second degree curve • trend values.

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Year	Shahuwadi tahsil		Radhanagari tahsil		Chandgad tahsil	
	Actual adoption	Trend values	Actual adoption	Trend values	Actual adoption	Trend values
1961		03	1		1	, ,
1060	-	0.5	1	-4	1	0.7
1962	1	0.9	1	-2	1	0.5
1963	1	0.9	1	0.1	1	0.2
1964	1	0.6	1	2.6	1	0.4
1965	2	0.4	4	5.5	2	1.0
1966	2	1.9	4	8.8	2	1.8'
1967	11	3.9	6	12.4	2	2.8
1968	12	6.4	8	16.3	2	3.9
1969	15	9.4	31	20.5	2	5.2
1970	17	13.0	34	25.0	3	6.7
1971	19	17.0	4 9	29.9	6	8.3
1972	20	26.7	49	40.5	9	12.0
1973	24	32.4	58	46.3	17	14.1
1974	38	38.5	60	52.5	22	16.4
1975	44	45.2	71	59.0	24	18.8
1976	49	52.4	73	65.6	24	21.4
1977	60	60.0	76	72.7	25	24.1
1978	65	. 68.3	76	80.2	29	27.0
1979	-73	77.0	82	87.9	30	30.0
1980	86	86.4	85	95.9	30	33.3
1981	9 9	96.1	105	104.3	` 34	36.7
1982	104 ´	106.4	116	113.0	42	40.2

Source : Compiled by the author.

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trend values of second degree curve shows that there is accordance in these figures from 1963 to year 1982. The diffusion curve follows the second degree curve in Radhanagari tahsil also.

i) Chandgad tahsil

The Chandgad tahsil lying in the southern part of the district covers an area of about 96,542 hectares including 44,192 hectares as net area sown. Annual rainfall ranges from 2700 mm to 3000 mm only 503% of the net area sown is irrigated. It supports a population of 1,34,936 giving a density of 140 persons per sq.kms. Already this is the second largest tahsil in the district.

In this tahsil adoption of tractor took place in the year 1961. Table 4.3 reveals that the rate of adoption was very slow upto the year 1972 mainly due to less development of irrigation facilities which has limited the cane cultivation. Adoption of tractor then slightly increased and reached upto 42 tractors in year 1982. The comparative study of actual values and trend values of second degree curve reveals that both values are much closer to each other. It is also evident that the actual curve more or less follows the second degree curve (Fig.4-5A).

j) Ajara tahsil

The total geographical area of Ajara tahsil is 54,888 hectares including 33,578 hectares as cultivated land. The total population is 94,499 giving a density of 172 persons per

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sq. kms. Irrigation facilities are not developed because of rough terrain. Only 3.5 of the net area sown is irrigated in the tahsil. The annual rainfall is more than 3000 mm.

Though the adoption of tractor took place in the year 1961, the number of tractors remained the same upto 1972. The rate of adoption increased after 1972, and at present there are thirteen tractors (Table 4.4). This fact represented in Fig.4-5B, reveals that actual curve moves very close to the second degree curve. The trend of diffusion of tractors in the tahsil follows second degree curve.

k) Bhudargad tahsil

Bhudargad tahsil located in the south western part of the district, covers an area of 64,446 hectares including 30,651 hectares of cultivated land. The total population of 1,08,061 belongs to rural areas only. Average annual rainfall is roughly 1500 mm.

The adoption of tractor took place in the year 1963. During this year the number of adopted tractor was only one. The rate of diffusion of tractors is very slow upto the end of the year, 1982. The undulating topography, shallow coarse soils, less development of irrigation facilities, limited cane cultivation; the combine effect of all these factors has restricted the diffusion of tractor in Bhudargad tahsil. There are only 11 tractors at present. The comparative study of actual values and

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Table 4.4 Actual number of tractors and second degree curve

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	Ajara tahsil		Bhudarga	d tahsil	Bavada	tahsil
Year	Actual adoption	<pre>、Trend values</pre>	Actual adoption	Trend values	Actual adoption	Trend values
1961`	1	1.2	-	-	-	-
1962 [`]	1	0.8	-	-	-	-
1963	1	0.6	1	0.4	-	-
1964	1	0.3	1	0.6	-	-
1965	1	0.3	2	0.9	1	1.0
1966	1	0.3	2	1.3	2	1.4
1967	1	0.4	2	1.6	2	1.7
1968	1	0.5	2	2.0	2	2.1
1969 ·	1	0.7	2	2.4	3	2.5
197 9	1	1.0	2	2.8	4	2.9
1971	1	1.4.	2	3.2	. 4	3.4
1972	1	2.4	3	3.4	4	3.8
1973 ,	2	3.0	6	4.6	4	4.3
1974	4	3.7	6	5.1	4	5.4
19 7 5	5	4.5	6	5.7	5	5.9
1976	7	5.4	7	6.2	6	6.4
1977	7	6.3	7	6.8	8	7.0
1978	7	7.3	8	7.4	9	7.6
1979	7	8.4	8	8.0	9	8.2
1980	11	9.6	9	8.6	9	8.9
1981	12	10.8	9	9.3	10 '	9.5
1982	13 ·	12.2	11	9.9	11	10.2

trend values.

Source : Compiled by the author.



Fig. 4.6

trend values of second degree curve reveals that the trend values of second degree curve are much closer to actual values (Table 4.4)

1) Gaganbavada tahsil

This tahail located at the western part of the district, ' covers an area of 69,863 hectares including 17,538 hectares as cultivated land. It supports a population of 70,962 giving a density of 102 persons per sq.kms. Nearly 6.9% of the net area sown is irrigated. This tahsil receives maximum rainfall (more than 6000 mm).

The first tractor adopted in this tahsil was in the year 1965. The diffusion of tractor is very slow in the tahsil. The undulating topography, less fertile soil, cultivation limited to the river banks have limited the cane cultivation in this tahsil. The combine effect of all these factors has restricted the diffusion of tractor in Gaganbavada tahsil. At present there are only 11 tractors in the tahsil. The comparative study of actual values and the values of second degree curve (Table 4.4) indicates that the values are very close to each other. Also the Fig.4-6A indicates that the actual curve follows much more the second degree curve.

4. Summary :

It is quite obvious from the study that the trend of diffusion of adoption of tractor is highest in Karveer tahsil, followed by Hatkanagle, Shirol and Panhala. In the beginning



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the rate of diffusion was very slow upto year 1968, but after 1969 the rate of diffusion increased rapidly. This can be well attributed to the fertile soil, developed irrigation facilities, Sugar increased area under cultivation and growth of sugar factories in these tahsils. In the case of tahsils like Ajara, Bhudargad and Gaganbavada, the rate of diffusion is very slow, mainly because of the undulating nature of the surface, unsuitable for cane cultivation. In general the trend of diffusion of all the tahsils follow the second degree curve.

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