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IMPACT OF ECOLOGICAL AND ECONOMIC FACTORS ON RICE FARMING: A CASE STUDY OF KANYAKUMARI DISTRICT

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ABSTRACT

Farming, particularly rice farming is adversely affected by unfavourable changes that happened in ecological and economic conditions of a region. Kanyakumari district is not an exception to this. Rice is the staple food of people of the district. The district was once called 'the Rice Granary' of erstwhile Travancore State. However, the present situation is completely different. Per year decline in the area under rice cultivation is 532.76 hectares between 1957-'58 and 1991-'92 and 1328.80 hectares between 1999-'00 and 2008-'09. If this tendency continues, there will be no rice cultivation in the district after 2025. Ecological factors make the income from rice farming uncertain and economic factors make rice cultivation non-profitable. So farmers quit rice cultivation; already 62 per cent quitted rice farming and 60 per cent of the remaining are ready to quit.

Introduction

Rice farming is much affected not only by ecological factors but also by economic factors. Ecological factors like changes in climate i.e., rainfall, temperature and wind direction and speed, soil quality, water quality, intensity of light and moisture content in the atmosphere, rainfall and temperature are the most influencing factors. Hence, it is reported that climate change influences every economy by delayed monsoon, unexpected rains, heavy downpours and rising temperature {Cramer (2008) Dar (2009) Joseph (2009) Krugman (2009) Middletonne (2009) Monbiot (2009) Panda (2009) Sample (2009) Sanwal (2008)}. Factors such as net return, cost of input, price of output, availability of farm labourers and finance and marketability of produce are the main economic factors influencing the area under rice cultivation and thereby the production of rice.

In Kanyakumari district also these factors play a key role in deciding the cultivation of rice which is the staple food of people of the district. This article is prepared to estimate the impact of rainfall and temperature on the area under rice cultivation and productivity and the consequent effect on production and to identify the various economic factors influencing rice cultivation in the study area.

Methodology

This research article made use of both primary and secondary data. The secondary data regarding rainfall and temperature, area under rice and production and productivity of rice were

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collected for the last 18 years from various published and unpublished sources. The main sources are G – Returns, Season and Crop Reports, Statistics at a Glance, Economic Survey and records available in Meteorological Department, Chennai, District Statistical Office, Nagercoil and various libraries. Details regarding cost of production, gross income and net income are collected from the offices of Joint Director of Agriculture and Deputy Director of Horticulture. Primary data were collected directly from field experts. The oldest farmers' society called Kumari Mavatta Vivasaygal Sangam (Kanyakumari District Farmers' Development Society) was selected for identifying farmers. Out of 1045 registered members of the society, 105 were selected at random. Information regarding the influence of rainfall, temperature, net return, availability of farm workers and finance, occurrence of pests and diseases, disturbance of wild animals, irrigation problems, and reasons for shifting crops and future plan of farmers was collected from field experts through a scientifically prepared interview schedule. The collected data were processed, analysed and interpreted with the help of mathematical tools such as percentage and rate and statistical tools such as correlation coefficient, coefficient of determination and multiple regression and testing tools were also used wherever necessary.

Rice Cultivation in Kanyakumari District – Trend and Tendency

The district was once called 'the Rice Granary' of erstwhile Travancore State and 'Nanjil Nadu'. 'Nanjil' means 'plough' and 'Nadu' means 'region'. Kanyakumari district is the region where the main occupation is associated with plough. In the district, for many years, more than 50 per cent of the total geographical area is under cultivation and this puts the district's primary occupation as farming and farm-based avocations. In the district, on the basis of area under cultivation, rice topped the list among crops up to 2002-'03 and in 2003-'04, it was pushed to the third place due to deficiency in rainfall in the previous year, 2002-'03. In 2003-'04, first place goes to coconut with an area of 23664 hectares, rubber occupies second place with 18296 hectares and rice third with 17320 hectares. In 2004-'05, as there was an increase in the area under rice, rice was placed in the second place. After 2007-'08, rice once again occupied the third place. It is sure that it cannot occupy the lost glory as the area under rubber has continuously been increasing from 1997-'98 (18063 hectares) and area under coconut from 1979-'80 (15461 hectares) and conversion of rice field into rubber estate and coconut grove takes time and conversion of the opposite is a huge waste. The Table given below shows the area under rice cultivation in Kanyakumari district in different decades.

Table 1 : Rice Cultivation in Different Decades in Kanyakumari District

(in hectares)

Crop	1957-'58	1960s	1970s	1980s	1990s	2000s
Rice	58686	58167	53265	42124	34847	21909

Source: Calculated from Various Season and Crop Reports.

The above Table shows that the area under rice cultivation is declining decade after decade. The average area under cultivation of rice decreased from 58167 hectares in the sixties to 21909 hectares in the 2000s. The year-wise data show that the area under rice decreased from 58686 hectares in 1957-'58 to 18187 hectares in 2008-'09 and rice production decreased from 95300 tonnes in 1957-'58 to 83657 tonnes in 2008-'09. The productivity also shows a fall in nine years i.e., half of the period taken for analysis. The yearly data of area, production and productivity of rice from 1991-92 to 2008-'09 are given in Table 2.

Table 2 : Area Production and Productivity of Rice in Kanyakumari District From 1991-'92 to 2008-'09

Year	Area (in hectare)	% Change*	Production (in tonnes)	% Change*	Productivity (in kg)	% Change*
1991-92	40572	-1.59	143220	12.05	3530	13.86
1992-93	38794	-4.38	118920	-16.97	3065	-13.16
1993-94	38541	-0.65	139260	17.10	3613	17.87
1994-95	37565	-2.53	151650	8.90	4037	11.73
1995-96	36020	-4.11	148730	-1.93	4129	2.28
1996-97	33659	-6.55	138930	-6.59	4128	-0.04
1997-98	31244	-7.17	118640	-14.60	3797	-8.00
1998-99	32004	2.43	152800	28.79	4774	25.73
1999-00	31475	-1.65	149480	-2.17	4749	-0.53
2000-01	28594	-9.15	135000	-9.69	4721	-0.59
2001-02	28229	-1.28	121390	-10.08	4300	-8.92
2002-03	26052	-7.71	98469	-18.88	3780	-12.10
2003-04	17320	-33.52	52897	-46.28	3054	-19.20
2004-05	22016	27.11	86486	63.50	3928	28.62
2005-06	21709	-1.39	82523	-4.58	3801	-3.23
2006-07	21406	-1.40	94130	14.07	4397	15.68
2007-08	20349	-4.94	90210	-4.16	4433	0.81
2008-09	18187	-10.62	83657	-7.26	4599.82	3.76

Source: Season and Crop Reports *Calculated figures.

The figures given below show both the linear (A & A) and the exponential (B & B) trend lines drawn both for area and production of rice. It is easy to understand from the graph that the rate of change of area per year is – 1377.7 hectares ($R^2 = 0.94$), and the rate of change of production per year is – 4295.5 tonnes ($R^2 = 0.58$). The rate of change of productivity per year is very small (0.37 quintals per year) and the R^2 value is also very small (0.14) and so details are not presented in diagram.

Figure 1
Area Under Rice in Kanyakumari District

(A) **(B)**

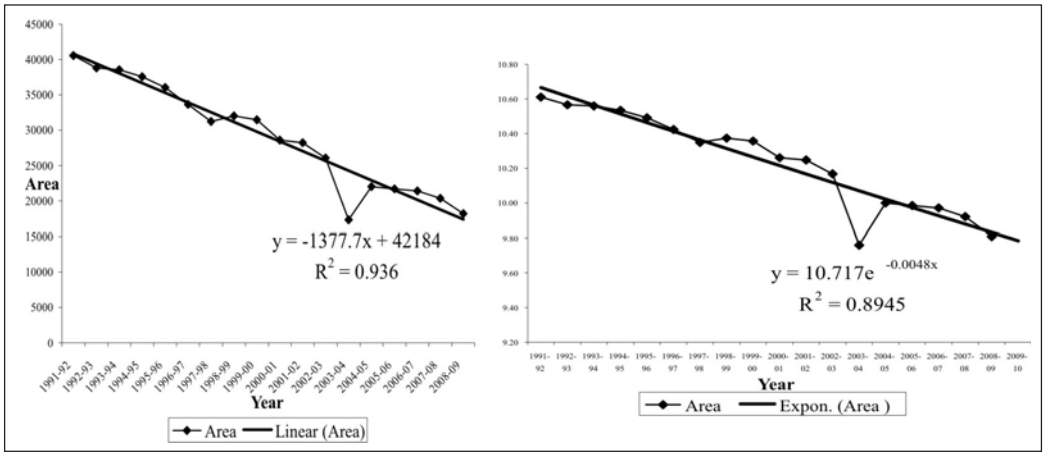
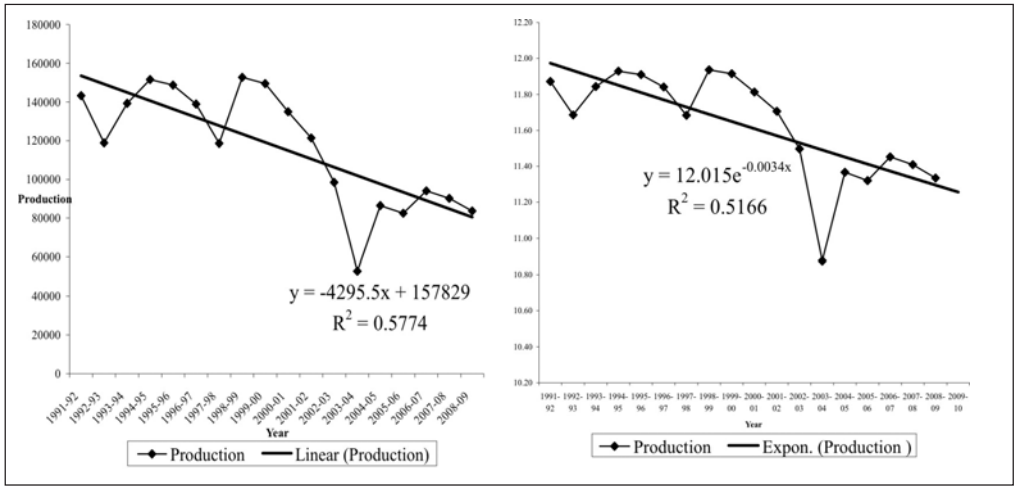


Figure 2
Production of Rice in Kanyakumari District

(A) **(B)**



Calculation of growth rates is helpful for scientific analysis and so the growth rates are calculated and presented in Table 3.

Table 3 : Growth Rates of Area, Production and Productivity of Rice

Growth Rates	Area (%)	Production (%)	Productivity (%)
Exponential	–0.48	–0.34	–0.15
Average Annual	–3.07	–2.31	1.68
Per Year Fall/ Rise	–3.06	–3.25	1.68

Source: Calculated from Table 2.

It is obvious from Table 3 and figures that the area under rice cultivation declined at a rate of 0.48 per cent between 1991-'92 and 2008-'09. The same pattern can be observed in exponential growth rates for production and productivity. While the average annual growth rates show a fall of 3.07 and 2.31 respectively, for area and production, productivity shows a rise of 1.68. Reduction for one year in the area under rice is 3.06 per cent and it is 3.25 for the decline in the production of rice between 1991-'92 and 2008-'09. Productivity increases at a rate of 1.68 per cent for the same period.

It is better to find the falling pattern of area under rice at different periods of time. The overall per year reduction of area under rice is 1.35 per cent between 1957-'58 and 2008-'09, while the per year reduction is 0.91 per cent between 1957-'58 and 1991-'92, 3.16 per cent between 1995-'96 and 1999-'00 and 4.45 per cent between 2001-'02 and 2008-'09. It means that the decrease in area under rice between 2001-'02 and 2008-'09 is about 5 times more than the rate of decrease between 1957-'58 and 1991-'92. In absolute terms, per year reduction of area under rice is 532.76 hectares between 1957-'58 and 1991-'92, 794.09 hectares between 1957-'58 and 2008-'09, 1316.76 hectares between 1991-'92 and 2008-'09 and 1328.80 hectares between 1999-'00 and 2008-'09, for the last 10 years. It means that there will be no rice cultivation in the district after 2025. It is further confirmed by the block-wise data of area under cultivation, which are presented in Table 4. The cultivation of rice in Thiruvattar block is completely stopped and is almost stopped in Melpuram, Munchirai, Killiyoor and Thuckalay blocks. On the other hand, rice production in the district increased up to 1998-'99 i.e., from 95300 tonnes in 1957-'58 to 152800 tonnes in 1998-'99, a per year rise of 1.44 per cent. After 1998-'99, rice production decreased and reached 83657 tonnes in 2008-'09, a per year fall of 4.25 per cent. The productivity also moves in the same manner, a per year rise of 3.94 per cent between 1957-'58 and 1998-'99 and a per year fall of 0.33 per cent between 1998-'99 and 2008-'09. Between 1998-'99 and 2007-'08, production decreases at a rate of 4.25 per cent while productivity decreases at a rate of 0.33 per cent. It means that rice production decreases much due to the fall in the area under rice.

Table 4 : Block-wise Cultivation of Rice in Kanyakumari District

(Area in hectares)

Year	Thov-alai	Agastees-waram	Rajakkam-angalam	Kurunth-encode	Thuc-kalay	Thiru-vattar	Mel-puram	Killi-yoor	Munch Irai
1997-98	7787	7180	4634	4313	3914	495	853	1257	811
1998-99	7980	6988	4868	4816	3843	556	857	1276	826
1999-00	8277	7565	4506	4460	3438	207	878	1315	822
2000-01	8322	6652	4178	4390	2270	124	651	1170	837
2001-02	8145	6246	4190	4467	2280	130	690	1218	864
2002-03	8291	5662	3546	3870	1971	113	647	1138	814
2003-04	5539	3797	2363	2393	1298	56	443	863	568
2004-05	7319	4916	2993	2810	1796	114	473	968	627
2005-06	7317	5149	2897	2805	1302	87	461	1022	669
2006-07	7280	5081	2906	2736	1303	78	402	977	521
2007-08	7281	4889	2867	2606	1079	20	305	831	471
2008-09	6551	4681	2608	2327	896	0	210	538	377
2009-10	6718	4443	2608	2202	686	0	103	306	241

Source: Various issues of 'G' Return.

Table 5 shows how the use of land for agricultural purposes decreases and non-agricultural purposes increases in the district.

Table 5 : Area Under Agricultural and Non-Agricultural Uses

(in hectares)

Year	Food - crops	Non – food crops	Total cultivated area	Area under non-agricultural use
1991-92	67386 (40.30)	42433 (25.38)	109819 (65.68)	15923* (9.52)
1992-93	66721 (39.91)	42442 (25.38)	109163 (65.29)	16579* (9.92)
1993-94	65576 (39.22)	43149 (25.81)	108725 (65.03)	17017* (10.18)
1994-95	64568 (38.62)	43795 (26.19)	108363 (64.81)	17379* (10.39)
1995-96	61411 (36.73)	45148 (27.00)	106559 (63.73)	19183* (11.47)
1996-97	58520 (35.00)	42801 (25.60)	101321 (60.60)	24421* (14.61)
1997-98	57696 (34.51)	41422 (24.77)	99118 (59.28)	25073 (15.00)
1998-99	59065 (35.33	41588 (24.87)	100653 (60.20)	25089 (15.01)
1999-00	58747 (35.14)	42300 (25.30)	101047 (60.44)	25095 (15.01)
2000-01	55362 (33.11)	43086 (25.77)	98448 (58.88)	25163 (15.05)
2001-02	55137 (32.98	43187 (25.83)	98324 (58.81)	25313 (15.14)
2002-03	51389 (30.74)	42985 (25.71)	94374 (56.44)	25435 (15.21)
2003-04	43528 (26.03)	44276 (26.48)	87804 (52.51)	26287 (15.72)
2004-05	46795 (27.99)	44712 (26.74)	91507 (54.73)	26337 (15.75)
2005-06	45982 (27.50)	45825 (27.41)	91807 (54.91)	26890 (16.08)
2006-07	46113 (27.58)	46439 (27.77)	92552 (55.35)	28178 (16.85)
2007-08	43593 (26.07)	47407 (28.35)	91000 (54.43)	28255 (16.90)
2008-09	41105 (24.58)	47687 (28.52)	88792 (53.11)	28331 (16.94)

Source: Various issues of 'G return' and Season and Crop Reports.

* Estimated figures. Figures in parentheses are their respective percentages.

From the above Table, it is very easy to understand that the share of area under food crops shows a sharp fall while the share of area under non-agricultural purposes shows a sharp rise. The decrease in area under food crops is 39 per cent against a rise of 78 per cent for the area under non-agricultural purposes. It means that within a short period of time all the area under food crops may be used for non-agricultural purposes or for cultivating some other crops. In the district the number of cultivators also decreased considerably. In 1961, there were 72865 cultivators and in 1991, there were only 61547 cultivators. The number further decreased to 13434 in 2001 (Census Reports).

Table 6 shows the share of rice to total geographical area, to total cultivated area and to area under food-crops from 1991-'92 to 2008-'09 in the district.

Table 6 : Share of Area Under Rice to the Total Geographical and Cultivated Area in the District

(in percentage)

Year	Share to total geographical area	Share to total cultivated area	Share to area under food-crops
1991-92	24.27	36.94	60.20
1992-93	23.20	35.54	58.14
1993-94	23.05	35.45	58.77
1994-95	22.47	34.67	58.17
1995-96	21.54	33.80	58.65
1996-97	20.13	33.22	57.51
1997-98	18.69	31.52	54.15
1998-99	19.14	31.80	54.18
1999-00	18.82	31.15	53.57
2000-01	17.10	29.04	51.64
2001-02	16.88	28.71	51.19
2002-03	15.58	27.61	50.69
2003-04	10.36	19.73	39.79
2004-05	13.17	24.06	47.04
2005-06	12.98	23.65	47.21
2006-07	12.80	23.13	46.42
2007-08	12.17	22.36	46.67
2008-09	10.88	20.48	44.24

Source: Calculated figures.

The share of area under rice cultivation to total geographical area decreased from 24.27 per cent in 1991-'92 to 10.88 per cent in 2008-'09, i.e., nearly 14 per cent fall within a period of 18 years. In the same way, the share of area under rice to total cultivated area decreased from 36.94 to 20.48 per cent in the same period, i.e., nearly 17 per cent decline within 18 years. The share of area under rice to area under food-crops also shows a decline, 60.20 per cent in 1991-'92 to 44.24 per cent in 2008-'09, nearly 16 per cent decline. All these details are available in Table 6.

The per capita production of rice is the best indicator of real situation of rice production

as population is increasing while rice production goes on decreasing. In Kanyakumari district, population increased from 1591174 in 1991 to 1825746 in 2011. Production of rice decreased from 143220 tonnes in 1991-'92 to 83657 tonnes in 2008-'09. So a comparison of per capita rice production in the district is made with the national per capita availability and consumption of rice and is presented in Table 7.

Table 7 : Per capita Rice Production in Comparison with the National Per Capita Availability of Rice During 1991, 2001 & 2008

Year	Per capita net availability of food-grains in India (kg)	Per capita net availability of rice in India (kg)	Population in KK district	Rice production in KK district (Tonnes)	Per capita rice production in KK district ✿ (kg)	% Share to national food-grains ✿	% Share to national rice✿
1991	171.1	79.2 (46.29)	1591174	143220	90.01	52.61	113.65
2001	180.4	83.5 (46.29)	1676034	13500	80.55	44.65	96.47
2008	162.1	68.8 (42.44)	1795774◆	83657	46.59	28.74	67.72

Source: Statistics at a Glance 2010-11.

◆ Calculated from Census Figures ✿ Calculated Figures.

It is very clear from Table 7 that Kanyakumari district, which produced nearly 14 per cent excess rice in 1991, produced 32.28 per cent less than the national average in 2008. Its share to national availability of foodgrains also decreased from 52.61 per cent in 1991 to 28.74 per cent in 2008 just like the per capita production of rice, which decreased from 90.01kg to 46.59 kg in the same period. It is already observed that in 2000, 74 per cent of arrivals of rice to the Kottar market, the main purchasing centre for the whole district, is out-station purchases made by the local merchants and in the near future every grain must be purchased from other districts and States.

Influencing Factors of Rice Cultivation

To avoid the situation of no-rice cultivation in the near future in Kanyakumari district, one must know the reasons. Otherwise the problem cannot be solved. Here, an attempt is made to find out the real reasons for the decrease in the area under cultivation and production of rice in the study area.

Ecological Factors

There are many ecological factors. But rainfall and temperature are the two recognised ecological factors causing disturbances in crop cultivation. Table 8 shows the rainfall pattern and the average of the highest maximum temperature prevailing in the district from 1991-'92 to 2008-'09.

Table 8 : Rainfall and Temperature in Kanyakumari District from 1991-'92 to 2008-'09

Year	Rainfall (in mm)	Temperature (in °C)
1991-92	1882.0	32.94
1992-93	1744.3	32.85
1993-94	1877.4	32.93
1994-95	1776.7	33.33
1995-96	1343.8	32.96
1996-97	1519.3	33.43
1997-98	1656.0	33.50
1998-99	2248.4	33.58
1999-00	1535.3	33.22
2000-01	1750.5	33.62
2001-02	1526.5	33.93
2002-03	1207.0	33.47
2003-04	1208.2	34.10
2004-05	1436.9	33.34
2005-06	1694.8	33.31
2006-07	1553.5	33.11
2007-08	1795.3	33.58
2008-09	1551.3	33.40

Source: Records, Assistant Director, District Statistical Office, Nagercoil & Meteorological Department of Tamil Nadu, Chennai.

Figure 3 : Rainfall in Kanyakumari District

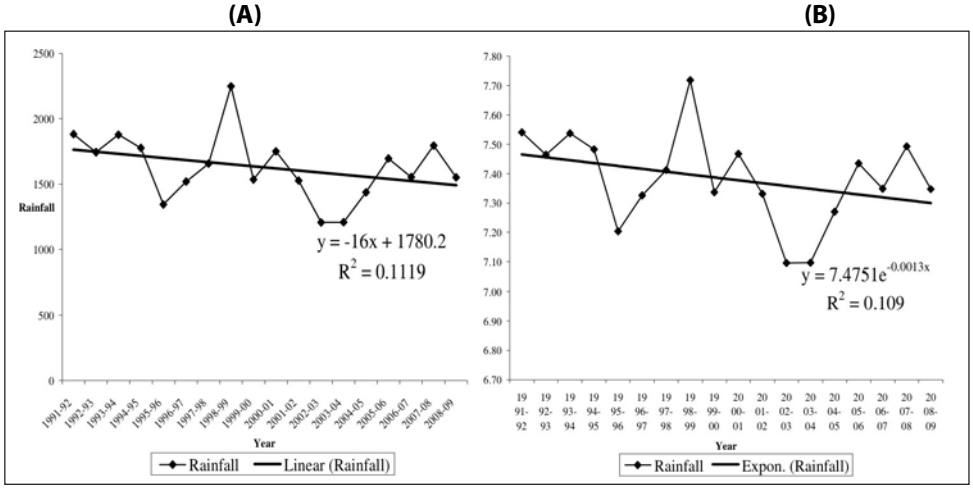
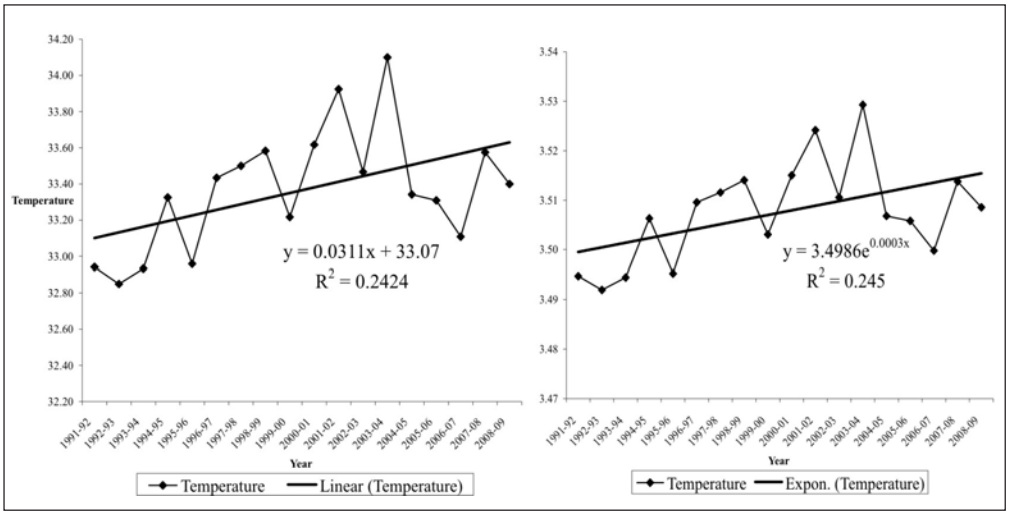


Figure 4 : Temperature in Kanyakumari District

(A) **(B)**



It is easily understandable from Table 8 and Figures 3 and 4 that rainfall has a falling trend while temperature shows a small but steady increase. Hence, the standard deviation for rainfall is 255.34 mm and for temperature it is only 0.34°C. The rate of change for rainfall per year is –16 mm (R^2 = 0.11) and the rate of change of temperature is 0.03°C (R^2 = 0.24). The exponential growth rate calculated for rainfall is – 0.13 (R^2 = 0.11) per cent while for temperature it is 0.03 (R^2 = 0.25).

Economic Factors

Quantifiable information available regarding economic factors is only the minimum support price offered by the Central government. The minimum support prices (MSP) are available from 2000-'01 to 2010-'11. And so comparison is made only for nine years as data for other factors are available only up to 2008-'09. The cost of production and net income are available only for 1987-'88 and 2004-'05, with which one can compare the net return as there is enough distance between two years. The MSPs offered by the Central government are illustrated in Table 9.

Table 9 : Minimum Support Prices Offered from 2000-'01 to 2010-'11 (in ₹)

Year	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11
MSPC	510	530	530	550	560	570	580	850	850	950	1000
MSPA	-	-	-	-	590	600	610	880	880	980	1030

Source: Economic Survey 2010-11, MSPC = MSP for common varieties, MSPA = MSP for 'A' Grade.

From the above Table it is easy to understand that support prices increase very slowly.

To understand the impact of one factor on another, anyone, who has a limited knowledge in Statistics and Econometrics, can depend on correlation and regression coefficients. Hence, correlation coefficients between area under rice cultivation and rainfall, temperature and MSP (A = f (R,T,MSP), between production of rice and rainfall, temperature, productivity and MSP (P = f ((R, T, Pt, MSP) and between productivity and rainfall, temperature and MSP (Pt = f (R, T, MSP) and multiple regression coefficients have been calculated. Table 10 explains the correlation existing between area, production and productivity of rice and climate factors and MSP.

Table 10 : Correlation Between Rainfall, Temperature and Area, Production and Productivity of Rice

Factors	Area	Production	Productivity
Rainfall	0.42^{NS}	0.50*	0.25 ^{NS}
Temperature	–0.58*	–0.41 ^{NS}	0.16 ^{NS}
MSP	–0.57*	–0.26	0.39 ^{NS}

Source: Calculated figures, * Significant at 5% level NS = Not Significant.

From the above Table, it is very clear that there is significant positive correlation between rice production and rainfall and significant negative correlation between area under rice and temperature. The correlation between area under rice and rainfall is 0.42 and between production and temperature is – 0.41, both are not significant. The correlation between productivity and rainfall as well as temperature shows only very poor relation. The correlation between area under rice and MSP is significant, –0.57 and between production and MSP is insignificant, –0.26. The correlation between productivity and MSP is also not significant. The two main inferences drawn from the above data analysis are; area under rice cultivation decreased significantly due to rise in temperature, and rice production decreased significantly due to fall in rainfall. Simply saying, the two climate factors played a dominant role in affecting rice cultivation adversely. However, MSPs have only negative impact on both the area under rice and production of rice.

As the rainfall and the MSP in a particular season/year have their impact on the dependent factors for the coming season or year, Lag and Lead correlation is calculated to know this effect. The Lag and Lead correlation also shows the same trend except a small variation in the size of the number. The correlation values between rainfall and area under rice cultivation, rainfall and production and production and MSP show a rise from 0.42 to 0.48, from 0.50 to 0.58 and –0.26 to 0.54, respectively. The productivity value for rainfall and MSP also shows a rise. However, other values show a small fall. Details are given in Table 11.

Table 11 : Lag and Lead Correlation Between Rainfall, Temperature and Area, Production and Productivity of Rice

Factors	Area	Production	Productivity
Rainfall	0.48*	0.58*	0.35 NS
Highest Maximum Temperature	–0.53*	–0.38 NS	0.16 NS
MSP	–0.18 NS	0.54 NS	0.87 *

Source: Calculated * Significant at 5% level, NS = Not Significant.

The regression equations given below show the contribution of each factor to the variation in dependent factors, area under rice, production and productivity of rice.

$A = -20672.17^{NS} + 0.47^{NS}X_1 - 0.098^{NS}X_2 - 0.73^{**}X_5,\ R^2 = 0.49^{NS}$

$P = -300507.06^{**} + 0.038^{NS}X_1 + 0.086^{*}X_2 + 0.62^{**}X_3 + 0.54^{**}X_4 - 0.12^{*}X_5,\ R^2 = 0.99^{**}$

$P_{t} = -11855.18^{NS} + 0.63^{NS}X_1 - 0.18^{NS}X_2 + 0.12^{NS}X_5,\ R^2 = 0.57^{NS}$

** = Significant at 1% level, *=Significant at 5% level, NS= Not significant

A = Area. P = Production, Pt = Productivity

X_1 = Rainfall, X_2 = Temperature, X_3 = Area, X_4 = Productivity, X_5 = MSPC.

From these regression equations it is clear that the area under rice is influenced neither by rainfall nor by temperature but by MSPC, while the production is affected by temperature, area, productivity and MSPC. However rainfall, temperature and MSPC have no influence on productivity. Simply saying, the important climate factor, rainfall, has no impact not only on the area under rice, but also on the production and productivity of rice. The primary data collected from field experts show a different picture (Refer Table 13) and they opined that less rainfall is one of the main reasons for the fall in the area under rice cultivation. For example, the area under rice declined sharply in 2003-'04, from 26052 in 2002-'03 to 17320 hectares in 2003-'04 due to less rainfall in 2002-'03, from 1526.5 mm in 2001-'02 to 1207.02 mm in 2002-'03 (Refer Tables 2 and 8). It confirms the view of farmers.

Another factor influencing rice cultivation is the cost of production, which rises at a very high speed. For example, the cost of production of rice per tonne (common variety) increased from ₹ 1450 in 1987-'88 to ₹ 13540 in 2004-'05. The increase in cost of production is 833.79 per cent between 1987-'88 and 2004-'05, a per year increase of 49.05 per cent. However, the increase in the support price is only 96.07 per cent, a per year rise of only 8.73 per cent between 2001-'02 and 2010-'11. It is reported by Swaminathan (2011) that the cost of production of rice is ₹ 1270 and the minimum support price is only ₹ 1080. The cost of production of rice calculated by farmers' societies (ranges between ₹ 15500 and 18300) is also much higher than the cost calculated by the agricultural department. The share of net income to total cost of production for all crops except common rice and banana of ordinary variety increased from 1987-'88 to 2004-'05, for tapioca from 63 to 186 per cent, for coconut from 90 to 106 per cent, for banana (Nendran) from 57 to 116 and rice (HYV) from 50 to 52 and for rubber from 220 to 256 per cent. The net return decreased for rice (common) from 46 to 42 per cent and for banana (ordinary) from 105 to 80 per cent in the same period. The net return over the cost of production for rubber increased from 220 in 1987-'88 to 256 per cent in 2004-'05 while for rice it decreased from 46 to 42 for common variety (as per the calculation

of farmers' societies it ranges from 10 to 29 per cent), though the net return for high-yielding variety increased from 50 to 52.

Details regarding cost of production, gross income, net income and percentage of net income to the cost of production are portrayed in Table 12.

Table 12 : Cost of Production, Gross Income and Net Income of Important Crops in Kanyakumari District in 1987-'88 and 2004-'05

(in ₹ per hectare)

Crops		1987-'88				2004-'05			
		Cost	GI	NI	% to cost	Cost	GI	NI	% to cost
Rice	HYV	1838	2757	919	50	13265	20130	6865	52
	Common	1450	2120	670	46	13540	19240	5690	42
Banana	Common	3120	6400	3280	105	25000	45000	20000	80
	Nendran	6120	9600	3480	57	37000	80000	43000	116
Tapioca	1640	2660	1020	63	7000	20000	13000	186	
Coconut	2625	5075	2450	90	14125	29140	15015	106	
Rubber	2250	7200	4950	220	22500	80000	57500	256	

Source : Joint Director of Agriculture, & Deputy Director of Horticulture, Nagercoil.
Note: GI = gross income NI = net income.

The net return from rubber is the highest in comparison with other crops. It is the nature of all human beings to go after the highest net revenue yielding project. Hence, there is no wonder in moving of farmers towards rubber cultivation. Farmers cultivate rubber whenever and wherever possible. In five blocks of Thiruvattar, Melpuram, Munchirai, Killiyoor and Thuckalay, which are suitable to cultivate rubber also, farmers shifted to rubber from rice. In other blocks they shifted to coconut or banana or used rice fields for non-agricultural purposes. Further, rice is highly labour intensive and it is reported that in 2001 nearly 70 per cent of production cost of rice was labour cost. Though the net income of coconut is not much, farmers prefer coconut as it is a less labour-intensive crop. It means that economic factors also have a significant role in reducing area under rice cultivation and rice production.

There are other reasons also for farmers to quit rice cultivation. To know the other reasons, primary data were collected directly from field experts. The oldest farmers' society called Kumari Mavatta Vivasaygal Sangam (Kanyakumari District Farmers' Development Society) was selected for identifying farmers. Out of 1045 registered members of the society, 105 were selected at random for collecting information regarding the influence of rainfall, temperature, net return, availability of farm workers and finance, irrigation problems, and reasons for shifting crops. The various reasons for changing crops by farmers are available in Table 13.

Table 13 : Reasons for Changing the Crop

Reasons for Shift	No. of Respondents
Rainfall	12
Non-remunerative price	20
Rainfall and low price	47
Low profit and labour shortage	28
Disturbance of wild animals	6
Irrigation problem	12
Less involvement of other members of family	7
Diseases	2

Source: Primary Data.

The main economic factor that affects rice cultivation adversely is the non-remunerative price existing in the market in comparison with the cost of production. It is indicated by the farmers' opinion that 20 farmers have expressed the low price as the sole reason whereas 47 farmers attributed to rainfall and low price as the reasons and 28 farmers pointed out that low profit and labour shortage as the reasons for shift in cultivation. The other factors that have some influence in bringing down the area under rice are irrigation problem and labour shortage. Hesitation of other members of the family to engage in cultivation is also one of the reasons for the reduction in the area under rice cultivation. Table 14 shows how many family members are involved in rice cultivation in the surveyed households.

Table 14 : Age Group and Number of People Engaged in Agriculture

Age Group	No. of People Engaged in Agriculture					
	1		2		3	
	No. of respondents	Percen-tage	No. of respondents	Percen-tage	No. of respondents	Percen-tage
21 – 40	10	15.62	3	9.37	0	0
41 – 60	28	43.75	16	50	7	77.78
61 – 80	26	40.63	13	40.63	2	22.22
Total	64	100	32	100	9	100

Source: Primary Data.

Note: 1 - Only the respondent was engaged in agriculture.

2 - The respondent and one family member had participation in agriculture.

3 - Three members were engaged in agriculture.

From the above Table, it is observed that only in nine households two other family members, in 32 households one more family member and in 64 households only the respondent, were involved in rice farming. In the age group of 21 – 40 years, there are only 10 respondents in the first group and three respondents in the second group. In total, only 13 members (12.38 per cent) below the age of 40 are involved in cultivation. It means that future generation is not ready to involve in farming. Details of the present crop and the previous crop are depicted in Table 15.

Table 15 : Present and Previous Crops of the Respondents

Present crop	Previous crop	No. of Respondents
Rice	Rice	35
Banana	Rice	7
Tapioca	Rice	8
Rubber	Rice	15
Coconut	Rice	11
Coconut and rubber	Rice	6
Banana and tapioca	Rice	4
Banana and coconut	Rice	8
Rice and coconut	Rice	6
Total		100*

Source: Primary Data.

* Five farmers are excluded as they frequently change their crops from rice to banana or tapioca and vice versa.

It is very clear from the above Table that 65 farmers changed their crops out of 105 surveyed and all from rice crop to some other crops. The period, when they shifted to other crops from rice is presented in Table 16.

Table 16 : When the Respondents Changed Their Crops

Before (in years)	No. of Respondents	Percentage
30	4	6.15
25	3	4.62
20	5	7.70
15	9	13.85
10	8	12.30
6	7	10.77
5	11	16.92
2	13	20.00
1	5	7.69
Total	65	100

Source: Primary Data.

The above Table shows that out of 65 farmers who changed their crops, 44 (67.69 per cent) farmers shifted their crops within 10 years. The reasons for having the present crop are presented in Table 17.

Table 17 : Reasons for Having the Present Crop

Reasons	Rice	Banana	Tapioca	Coconut	Rubber	Total
More profit	–	–	–	–	5	5
Less labour-intensive	–	–	5	2	–	7
More profit and less labour-intensive	-	15	4	21	18	58
Others	35	-	-	0	0	35
Total	35	15	9	23	23	105

Source: Primary Data.

As it is clear from the above Table, 35 farmers cultivate rice because they do it traditionally and to meet the rice requirement of their families and fodder needs of their cattle. Fifty five per cent of farmers (58) cultivate those crops that give more profit but at the same time less labour-intensive.

To know whether the farmers will continue in the cultivation of the same crop or change their crop in future, opinion is sought from them and information provided by them is presented in Table 18.

Table 18 : Future Plan of the Respondents

Future Plan	No. of Respondents	Percentage
Rice	14	13.33
Banana	9	8.57
Tapioca	4	3.80
Coconut	16	15.23
Rubber	21	20.00
Coconut and Rubber	2	1.90
Banana and Tapioca	5	4.76
Banana and Coconut	5	4.76
Non-agricultural	29	27.61
Total	105	100

Source: Primary Data.

It is very sad to observe that only 14 farmers (13.33 per cent) are ready to continue with rice cultivation in the future and 29 farmers (27.61 per cent) have the intention of using their land for non-agricultural purposes.The remaining 62 farmers (59.04 per cent) are ready to continue

with cultivation but crops other than rice. It is further observed that 21 farmers out of 35 (60 per cent), who are cultivating rice, are ready to quit rice cultivation. It means that the district is moving away from self-sufficiency.

From the above analysis, it is easy to conclude that ecological factors make the income uncertain, while economic factors make rice cultivation non-profitable and so farmers are quitting rice farming. Area under rice cultivation is not much adversely affected by rainfall but by temperature. Rainfall affected rice production significantly. Temperature significantly influenced area under rice but only insignificantly affected production of rice. Area under rice strongly influenced production, while productivity was affected neither by rainfall nor by temperature.The economic factors affecting rice cultivation are low price in comparison with cost of production, non-availability of inputs particularly labour,irrigation problems particularly in tail-end farms and disturbances of wild animals mainly in farms adjacent to forest area. The minimum support prices offered by governments are also not attractive. All these factors finally have an adverse impact on the area under cultivation and thereby rice production. Hence, suitable steps should be taken on a war footing way to increase the area under rice cultivation and rice production.

Policy Implications

The following ideas may help authorities overcome the adverse impact of ecological and economic factors on rice farming.

Farmers can produce more, and more area can be brought under cultivation if proper steps are being taken by the government. As told by Swaminathan (2010), through integrated measures, soil health can be enhanced by improving organic matter and macro and micro-nutrient content as well as the physics and the micro-biology of the soil.The programme of soil health cards can be introduced in all States as it is in Gujarat.

In water scarce area, promotion of water harvesting, conservation and efficient and equitable use of water by empowering gram 'sabhas' to function as 'Pani Panchayats' will benefit the farming community, which in turn ensures high per capita availability of rice in the district.

Immediately credit reforms and insurance literacy must be initiated. Universal coverage of farmers by crop insurance favours farmers who are at the risk of crop failures due to fluctuations of rainfall, drought and flood, and temperature. Steps should also be taken to mitigate the challenges of ecological factors particularly the falling rainfall and rising temperature.

The decrease in production of rice can be overcome by increasing the productivity.To increase the productivity, the growing gap between scientific know-how and field level do-how should be bridged.

One of the main reasons for quitting rice farming is the non-remunerative price that the rice farmers get.The reason for non-remunerative price is middlemen who exploit both producers and consumers. It was reported that farmers got only 10 to 15 rupees while consumers paid 80 to 100 rupees per kg of onion in 2009-'10. As farmers shift from less remunerative to more remunerative crops, it is the duty of the government to make rice also remunerative either by fixing a high support price or by giving subsidy as it is in the USA and in some other countries. In the USA, Japan and France, subsidies given are more than what the farmers produced. In India, agricultural subsidies stood at about 3 to 6 per cent of the total output, whereas it was 72 per cent in Japan, 37per cent in EU and 27per cent in the USA (Sharma 2004).

The minimum support price offered by the government did not cover even the cost. And so the minimum support price must be increased to cover the cost of production as well as a sumptuous margin.

Another reason for the decline in the area under rice cultivation is labour shortage and in turn it leads to high wage rate. Hence steps should be taken to remove labour shortage. It can be attained by mechanising all the processes of rice cultivation and also by making the youth involve in agriculture.

The conversion of land meant for food crops into housing plots and shopping complexes and other non-agricultural purposes should be curbed. Steps should also be taken to control the disturbance of wild animals.

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