

CROP DIVERSIFICATION, CHEMICAL POLLUTION AND ENDOSULPHAN TRAGEDY OF KASARAGOD DISTRICT IN KERALA

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Abstract

Kasaragod district in Kerala is basically an agro-based region and a major portion of the labour force is working in agriculture and related activities. The statistical data clearly revealed crop diversification. Diversification of crops and application of chemical fertilizers and pesticides heavily result in the depletion of nutrients of the soil and resulted in chemical pollution. There is wide difference in suggested and actual application of chemical fertilizers and pesticides. The Endosulphan tragedy of the district is the worst case of environmental tragedy that Kerala ever experienced. This pesticide caused serious health hazard to the people including, cancer, mental retardation, cerebral palsy and locomotors. The economic backwardness of victims, low health infrastructure, high medical expenses, absence of proper identification of their needs, etc. demands special attention from authorities to the tragedy and is still a burning social issue.

Keywords:

Crop Diversification, Chemical Pollution, Endosulphan Tragedy, Kasaragod

1. INTRODUCTION

Kasaragod in Kerala is an agriculture oriented district and the leading crops are rice, coconut, arecanut, rubber, pepper, cashewnut, tapioca, ginger, banana and other plantains. They accounted about 92 percent of the gross cropped area [7]. At present, the dominant crops are coconut, rubber, arecanut, cashewnut and pepper. Coconut, rubber and arecanut together constituted 80 percent of the total cropped area. Rubber is the second important crop while rice is in the sixth position. This transformation has demonstrated a shift from subsistence cropping to commercial cropping and leads to diversification in agriculture [4].

The filling of paddy lands, expansion of rubber [15], ever-widening supply gap in food grains [12] and the increasing conversion of paddy lands are main threat to the ecology of the state which is experiencing today. Diversification of crops and the continuous application of chemical fertilizers and pesticides lead to depletion of inherent nutrients of the soil and problems of deterioration of groundwater [10]. Hence an analysis of diversification of crops, chemical pollution, Endosulphan issues and its consequences on the farm sector and the health of the farmers of Kasaragod district of Kerala are attempted in this study.

The main objectives of the study include:

- (i) An analysis of crop diversification and chemical pollution in the Kasaragod district in Kerala and
- (ii) Endosulphan caused issues and its consequences on the farm sector and the health of the farmers of Kasaragod district of Kerala.

2. REVIEW OF LITERATURE

Crop diversification signifies a shift from less profitable to more profitable crop and reflects changes in the cropping pattern of a region [5]. It is one of the major tools of policy, which drew widespread attention in India in the recent past in the face of stagnant growth. Diversification and the tremendous application of chemical fertilizers and pesticides created depletion of soil fertility [3][9] and the direct effect of the extensive use of chemical fertilisers and pesticides in agricultural sector leads to chemical pollution of water resources also. Concern on the deterioration of groundwater quality and quantity is also reported in Kerala [11][15]. Jayadeven, et al. [8], Binu Kumar, et al. [2], Asha Embrandhiri, et al. [1] and Karunakaran [13] analyzed the consequences of chemical pollution on the health sector of the people and discussed the effects of aerial spraying of Endosulphan on cashew plants of Kasaragod. They studied the impact of Endosulphan on living beings and mankind and ultimately to environment. The toxic residues of it impair development and harmful functioning of the hormone dependent process in flora and fauna was also analysed. The studies pointed out that in the recent past there has been concern to address the declining trends and deteriorating ecological elements and their functions in productive agricultural landscapes. The efforts to revive the ecological functions needs multiple scale approach, which include scientific understanding, time dependent restorative activities and incorporation of wisdom of the stakeholders. Conservation initiatives linked to precision farming is an apt mechanism to minimize the loss of natural resources of agricultural landscapes to maintain the complex stabilizers of ecological functions. Such an effort must address the scientific evaluation of the farm as "ecologically sustainable unit" with due consideration to social construction at local to regional level.

3. MATERIALS AND METHODS

The study is based on primary and secondary data. The primary data were collected from 60 Endosulphan affected person's houses through personal interview and questionnaire, Endosulphan field workers, members of local self-governments and authorities related to relief and remediation activities. To know whether there is over use of chemical fertilizers and pesticides in the district, data on the difference between suggested dose and actual used doses of chemical fertilizers to various crops (paddy, coconut, arecanut, cashewnut, rubber and banana) were also collected using primary data. In the district six panchayaths were selected for data collection: Vorkady panchayath for paddy, Panathady panchayath for coconut, Karadka panchayath for arecanut, Enmakaje panchayath for cashewnut, West-Eleri panchayath for rubber and Mangalpady panchayath for banana;

where these crops were largely cultivated. A total number of 210 farmers were interviewed to get information on the total quantity of NPK fertilizers used, lime used, pesticides applied and organic manure consumed in their respective farms or plants and also to get information on various health issues due to Endosulphan use. On the basis of this average actual dose of chemical fertilizers (NPK), lime and organic manures applied by farmers for paddy, coconut, arecanut, cashewnut, rubber and banana plants were worked out.

The major sources of secondary data are various published reports of the Department of Economics and statistics and State Planning Board, Government of Kerala, Thiruvananthapuram. The secondary data were also collected from various printed and electronic sources include books, journals, pamphlets, newspapers and websites.

Table.1. Land use pattern in the Kasaragod District

Classification of Area	In percentage
Total Geographical Area	100.00
Forest	2.82
Land put to non-agricultural use	13.7
Barren and uncultivated land	3.97
Land under miscellaneous tree crops	0.30
Cultivable waste	5.09
Fallow other than current fallow	0.93
Water logged area	0,01
Social forestry	0.07
Still water	2.06
Net Area Sown	71.27
Area sown more than once	1.49
Total Cropped Area	72.76

Source: Computed from Agricultural Statistics (2013-14), Department of Economics and Statistics, Govt. of Kerala, Thiruvananthapuram.

Herfindahl Index (HI) is used to measure the extent of crop diversification and is calculated by taking sum of squares of acreage proportion of each crop to the total cropped area.

$$HI = \sum_{i=1}^N P_i^2$$

where, N is the total number of crops and P_i represents acreage proportion of the i^{th} crops to total cropped area. Herfindahl Index (HI) is a measure of concentration and Diversification Index (DI) = $1 - HI$.

Proportional Morbidity Ratio and Average Monthly Health Cost and Benefit Ratio were also used in the study. Proportional Morbidity Ratio is in percentage terms and is calculated by dividing the particular number of ill affected persons with total number of victims. The average monthly health cost and health benefit ratio per individual level is calculated by dividing per monthly health benefit with average monthly health expenditure of each victim.

Table.2. Rank of each crop in the Total Cropped Area in the Kasaragod district

Crops	1985-86	1990-91	1995-96	2000-01	2005-06	2013-14
Rice	3	4	5	5	6	6
Coconut	1	1	1	1	1	1
Arecanut	6	5	4	4	4	3
Rubber	4	3	3	2	2	2
Pepper	5	6	6	6	5	5
Cashewnut	2	2	2	3	3	4
Tapioca	7	8	8	8	8	8
Ginger	9	9	9	9	9	9
Banana and other plantains	8	7	7	7	7	7

Source: Computed from (i) Statistics for planning (various issues), Department of Economics and Statistics, Govt. of Kerala, Thiruvananthapuram. (ii) Economic Review (various issues), State Planning Board, Govt. of Kerala, Thiruvananthapuram.

4. RESULTS, ANALYSIS AND DISCUSSION

Kasaragod is endowed with rich natural resources, ravishing rivers, hills, green valleys and beautiful beaches. Of the total farmers, 84% constitute marginal farmers, 11% small farmers and the rest other farmers. The results, analysis and discussion of study is summarised in three heads as follows:

4.1 CROP DIVERSIFICATION IN THE KASARAGOD DISTRICT

Diversification is an integral part of structural transformation [16] and in agriculture it implies any of the three situations: (i) a shift from farm to non-farm activities, (ii) a shift from less profitable crop to more profitable crop, and (iii) using resources in diverse but complementary activities.

Crop diversification is mainly due to competition among the growing crops in a region; higher the competition keener the magnitude of crop diversification and vice versa [14]. To analyze the extent of crop diversification in the district, the status of land utilization pattern and rank of each crop in the total cropped area are examined and is shown in Table.1 and Table.2.

Table.3. Crop Diversification Indices for Kasaragod district

Year	Crop Diversification Index
1985-86	0.848 (0.152)
1990-91	0.858 (0.142)
1995-96	0.861 (0.139)
2000-01	0.863 (0.137)
2005-06	0.866 (0.134)
2009-10	0.869 (0.131)
2012-13	0.872 (0.128)
2013-14	0.874 (0.126)

Figures in bracket shows Herfindahl Index

During 1985-86 the order of the first five crops was coconut, cashewnut, rice, rubber and pepper, in the descending order of shares to the total cropped area changed to coconut, rubber, arecanut, cashewnut and pepper. Rubber came to the second position by pushing rice to the sixth. The Table.4 shows the difference between suggested and actual applications of Fertilizers to various crops in the Kasaragod District.

Table.4. Difference between suggested and actual applications of Fertilizers to various crops in the Kasaragod District

Crops Item	Paddy	Coconut	Arecanut	Rubber	Banana	Cashewnut
Lime	(-) 50.00	(-) 1.00	(-) 0.500	(-) 0.700	(-) 0.350	(-) 0.700
Deviation (in %)	(-) 16.67	(-) 66.67	(-) 71.43	(-) 100.00	(-) 58.33	(-) 100.00
NPK total	(+) 12.00	(-) 0.365	(-) 0.05	(+) 1.226	(+) 1.598	(+) 0.200
Deviation (in %)	(+) 7.36	(-) 15.43	(-) 11.11	(+) 158.40	(+) 113.98	(+) 25.00
Organic manure	(-) 1250	(-) 5.00	(-) 14	(-) 8.00	(-) 8.00	(-) 8.00
Deviation (in %)	(-) 50.00	(-) 20.00	(-) 58.33	(-) 80.00	(-) 80.00	(-) 80.00

In Kg per hectare for paddy and Kg per plant for other crops

Source: Primary Data

The Table.2 clearly shows shift from food crops, mainly rice and tapioca, in favour of tree crops such as rubber, arecanut and coconut in the district, which was supported by the diversification index shown in Table.3. The figures show less diversification in the initial years and higher values in the later years, indicating more diversification.

4.2 CHEMICAL POLLUTION IN THE DISTRICT

The Table.4 shows the overuse of NPK chemical fertilizers in the rubber plantations compared to suggested dose which revealed that crop diversification and expansion of rubber creates pollution in the soil of the district.

4.3 ENDOSULPHAN CAUSED HEALTH ISSUES OF THE DISTRICT

In the different parts of the district, aerial spraying of Endosulphan on cashew plantations had begun from 1976 onwards located in panchayaths namely, Kallar, Ajanur, Kumbadaje, Badiyadka, Kayyoor-Chemeni, Panathady, Enmakaje and Pullur-Periya.

The pesticide mixed with air, water and soil had polluted the environment which caused multiple health issues to human beings and animals and was first reported from Enmakaje Grama panchayath. Health problems which are complex, rare and no way to deal by local health facilities had been reported. It includes cancer, cerebral palsy, locomotors disabilities, mental retardation, deaf and dumb, vision problems, skin disorders and other anomalies (Table.5).

Table.5. Number of Health cases identified due to Endosulphan spray in the Kasaragod District

Name of Panchayath	Health problems												Total
	1	2	3	4	5	6	7	8	9	10	11	12	
Badiyadka	59	4	30	4	0	2	3	0	14	15	1	13	145
Bellur	24	4	36	16	9	15	2	2	7	25	7	13	160
Muliyar	42	6	23	7	5	17	1	19	11	9	11	15	166
Karadka	76	4	37	18	8	21	5	8	37	14	17	29	274
Kallar	88	4	32	4	31	18	13	19	34	21	36	102	402
Ajanur	74	3	15	6	17	15	2	10	14	10	23	59	248
Kayyoor-Chemeni	33	7	18	65	58	29	10	12	28	25	26	100	411
Panathady	113	0	36	11	30	4	8	30	35	15	17	52	351
Kumbadaje	54	1	25	22	9	7	1	27	9	14	6	26	201
Pullur-Periya	49	6	51	26	14	15	1	4	13	18	9	13	219
Enmakaje	56	23	61	35	12	10	1	6	28	11	9	7	259
Total	668	62	364	214	193	153	47	137	230	177	162	429	2836

Note: Health problems (1. Mental retardation, 2. Cerebral Palsy, 3. Locomotors Disabilities, 4. Multiple disabilities, 5. Other anomalies, 6. Mental illness, 7. Cancer, 8. Infertility, 9. Deaf and Dump, 10. Vision Problems, 11. Skin disorders, 12. Others).

Source: Govt. of Kerala (2010), Health department, Kasaragod district.

Table.6. Growth of Endosulphan affected persons from 2010 to 2014 in one panchayath in Kasaragod district (Enmakaje Panchayath)

Disease category	2010	2014	Growth in Percentage
Mental retardation	56	88	57
Cancer	1	31	3000
Cerebral Palsy	23	38	65
Locomotors disabilities	61	84	37
Multiple disabilities	35	57	63
Other anomalies	12	23	92
Mental illness	10	21	110
Infertilities	6	18	200
Deaf and Dumb	28	31	11
Vision problem	11	19	73
Skin disorders	9	16	78
Others	7	30	329
Total	259	466	80

Source: (1) Govt. of Kerala (2010), Health department, Kasaragod district and (2) Enmakaje Endosulphan field worker report, 2014.

To analyze the severity of the issue among farmers, one panchayath in the Kasaragod district, where Endosulphan pollution is very high is used for detailed analysis. The Table.6 shows that in 2014 there are 466 Endosulphan affected persons with many health issues identified compared to only 259 in 2010 (an increase of 80 percent).

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Among 466 persons, 60 Endosulphan affected persons (34 female and 26 male) mainly from the households of agricultural sector were identified and analysed. The Table.7 gives the proportional morbidity ratio among these persons.

The Table.7 revealed that both mental retarded and locomotors cases combine 44 percent of total illness. The Table.8 revealed the age wise composition of Endosulphan affected persons. 17 out of 60 are below the age of 15 indicates, 17 victims of children includes 7 mentally retarded, three locomotors, three vision problems, two cerebral palsy and two mentally ill. 5 cancer patients out of total 8 are in between the age of 30 to 60 and locomotors cases have been reported from all the age groups.

The Table.8 shows that half of the Endosulphan affected persons are in the category of 15 to 60 ages and are mainly farmers. This badly affects their ability to work, earn, consume and save [6]. The rare and complicated health issues also create huge increase in health expenditure of these families. The unavailability of adequate regular health benefit and increased nature of monthly health expenditure are the two problems identified from Table.9.

This is particular in the case of chronic illness like cancer. From Table.9, it is evident that out of 8 cancer victims of Endosulphan, 2 have no health benefit and 4 of them fail to meet their rising health cost with low health benefit. This increased health cost and exclusion from attainment of health benefit is present in all diseases mentioned in Table.9 in connection with Endosulphan aerial spray and continuous chemical pollution in the district.

Table.7. Proportional Morbidity Ratio among Endosulphan affected persons

Category of Disease	Endosulphan affected persons	Proportional morbidity ratio (in percent)
Mental retardation	11	18.33
Cancer	8	13.33
Cerebral palsy	7	11.66
Locomotors disabilities	16	26.66
Multiple disabilities	5	8.33
Mental illness	4	6.66
Deaf and dumb	2	3.33
Vision problem	4	6.66
Skin disorders	3	5.00
Total	60	100.00

Source: Primary data

Table.8. Age Wise Group of Endosulphan affected persons

Age group (in years)	Category of health problem									Total
	1	2	3	4	5	6	7	8	9	
0-15	7	0	3	2	0	3	2	0	0	17
15-30	0	2	2	0	0	0	3	1	0	8
30-60	3	5	6	2	2	1	0	1	2	22
above 60	1	1	5	0	0	0	2	3	1	13
Total	11	8	16	4	2	4	7	5	3	60

Note: Health problems (1. Mental retardation, 2. Cancer, 3. Locomotors disabilities, 4. Mental illness, 5. Deaf and dumb, 6. Vision problems, 7. Cerebral palsy, 8. Multiple disabilities, 9. Skin disorders).

Source: Primary data

Table.9. Average monthly health finance of Endosulphan affected persons in the study area based on morbidity

Category of disease	No. of victims have no health benefit	No. of victims who bears more health cost	No. of victims who bears more health benefit	Currently no treatment cases	Total
Mental retardation	3	6	2	0	11
Cancer	2	4	1	1	8
Locomotors	4	5	5	2	16
Multiple disability	2	2	1	0	5
Mental illness	2	0	2	0	4
Cerebral palsy	2	2	3	0	7
Deaf and dumb	0	0	1	1	2
Vision problem	0	0	2	2	4
Skin disorder	1	0	1	1	3
Total	16	19	18	7	60

Source: Primary data

Crop diversification analysed in terms of chemical pollution, revealed certain important results and findings in the agricultural sector of Kasaragod district.

- i. Rubber and cashewnut farmers were not using lime for their plants; for coconut, arecanut and banana the usage was below 50 percent and paddy farmers used 83 percent of the lime as suggested.
- ii. Rubber and banana farmers are using over dosage of NPK chemical fertilizers. Cashewnut farmers were using 20 percent more; paddy cultivators a margin of 12 Kg per hectare more; coconut and arecanut farmers approximately the same amount of fertilizers as suggested.

- iii. All farmers are using organic manures in the form of cow-dug, ashes, green leaf and readymade organic manures. Paddy cultivators were using 50 percent of the suggested dose; coconut cultivators 80 percent and arecanut farmers 42 percent; whereas rubber, cashewnut and banana cultivators 20 percent of the suggested dose.
- iv. Among the crops rubber and banana cultivators used overdose of chemical fertilizers and under use of organic manures and lime compared to other crops.

The aerial spraying of Endosulphan on cashew plantations mixed with air, water and soil had polluted the environment which caused multiple health issues to human beings and animals like cancer, cerebral palsy, locomotors disabilities, mental retardation, deaf and dumb, vision problems, skin disorders and other anomalies. The analysis revealed the severity of the issue among farmers in the Kasaragod district.

5. CONCLUSION

Kasaragod is mainly an agro-based district and a major portion of the labour force is working in agriculture and related industries. During 1985-86 the order of the first five crops in Kasaragod district was coconut, cashewnut, rice, rubber and pepper, in the descending order of shares to the total cropped area; but in 2013-14, it is changed in the form of coconut, rubber, arecanut, cashewnut and pepper. This change in cropping pattern reflects shift from subsistence cropping to commercial cropping. It is also observed that the diversification Index were lower in the initial years and more diversification in the later years.

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