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Research Paper

Trends and determinants of crop diversification in Chikkaballapur District of Karnataka: An Economic Analysis

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ABSTRACT: *Crop diversification ensures greater security for the food nutrition, income and employment to a wider section of rural mass. Crop diversification is a tool to enhance agricultural output, in turn a rises in State and National GDP. Crop pattern and diversification has been systematically analysed in the Chikkaballapur district of Karnataka. The area under cultivation in Chikkaballapur district changed over the time. Over the decade there is a significant change in crop pattern and district adopted more vegetables, fruits and oil seed crops compared to the commercial crops, spices, flowers and others. The present study has analysed the crop pattern and crop diversification at the taluk level and under different agro-climatic conditions. In the district the trends and determinants and factors influencing crop diversification in the area has been studied with Herfindahl index, Simpson's index, Entropy index and Gini index indicating that there is a shift in crop diversification in Chikkaballapur district.*

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I. INTRODUCTION

In Karnataka, the agriculture sector contributes 8.2% to the Net State Domestic Product (NSDP) by providing around 60% of employment to the rural agriculture labours. A change in cropping pattern of agriculture implies a change in the proportion of area under different crops from remunerative crops to more remunerative crops, which in turn raise income levels of rural people, who depend on agriculture and allied activities. Dinesh Kumar Nayak [4] in his study district-wise analysis in Odisha agriculture diversification showed that productivity can be increased by increasing technological factors and promoting crop diversification. Birthal.*et.al.*,[3] how shown that the growing of high value crops in an agricultural diversification environment will accelerate the overall growth of the agriculture sector and benefit a large number of poor marginal farmers.

Crop diversification is a technique adopted to maximize effective use of fertile land and by minimum use of water and other resources for overall agricultural development. It gives farmers with viable options to grow different grams in a limited land diversification is adopted in different districts of Karnataka to avoid the risk and uncertainty in climate conditions. Crop diversification minimize adverse effects effect of current system better resource use reduction of risk and uncertainty to maintain better soil conditions.Acharya.*et.al.*,[1] have reported that crop diversification provides and cropping intensity generate Rural Employment commercialization of farming mitigates migration of rural flocks to the urban areas and involvement of women in income generation activities in their study of diversification crop analysed at the state level observed that there is a need to study at micro level.

The present study has analysed the trends and determinants of crop diversification at the all taluks of Chikkaballapur district. It has identified the factors influential for crop diversification

II. DATA AND METHODOLOGY

For analyzing the economics of crop diversification the chosen study area is Chikkaballapur district of Karnataka which is undergoing agricultural diversification. In the district all 6 taluks were selected for the study. The district Chikkaballapur was formed in 2007 after craving out of Kolar district. The district is situated in the south-eastern part of Karnataka in the eastern dry and semi-arid climate zone and characteristized by tropical weather with hot summer and mild winters. The soil and climate is favourable for growing cereals, pulses, oil seeds, and horticulture crops. For analysis of crop pattern and diversification, the secondary data related to study areas under different crop groups were borrowed from the published sources of Directorate of Economics and Statistics Bangalore Karnataka [6] and District Statistical Office, Chikkaballapur District [5] for the period of 10 years from 2010-11 to 2019-20. The data pertaining to crop area, production of different crops, crop wise area under cultivation, season wise crops, net cultivated area, area under multiple crops, gross cropped area, annual and month wise rainfall, fertilizers consumption, area size of land holding, farm harvest prices and other facilitating Infrastructures like regulated markets, number of Agricultural populations, proportion of rural populations, per capita income, net state development domestic product.

Time series data relating to the cultivated land production and productivity of horticultural crops were collected and analysed for the same period. The data is analysed for the period of 10 years for measuring crop diversification with the use of different indices i.e. Herfindahl index, Simpson's index, Gini index and Entropy index were used for assessment of Crop diversification.

The crop diversification or concentration(specialisation) offer crop activities over time and space is analysed with the different methods to examine the nature and extent of Crop diversification with the different crop groups within all groups of cultivated land. Different indices were assessed for different crop groups such as several pulses, oil seeds, commercial crops, spices and horticulture crops.

Herfindahl index (HI) is the sum of square of proportion of acreage under each crop to the total cropped area

$$HI = \sum_{i=0}^{N} A_i^2$$

Where A_i represents acreage proportion of i[th] crop and *N* is number of crops in total cropped area. HI takes the values between 0 and 1, If HI takes one when there is a crop concentration is a specialisation and if HI approaches to zero, when there is a perfect diversification.

Simpson's index (SI) is used to measure diversification of crops in a specific geographical land

$$SI = 1 - \sum_{i=0}^{N} S_i^2$$

Where $S_i = \frac{Ci}{\sum Ci}$ is the ratio of C_i, proportion of i[th] crop to the particular crop in a specified geographical land.

If SI is equal to 0 indicates cultivated land is particular crop. If SI is equal to 1 then cropped land is fully diversified.

Gini index (GI) is measure of crop distribution within the total cultivated land. If GI is zero then the cultivated region is a single crop. If Gini index or Gini coefficient is 1 represents crop is perfectly diversified.

$$GI = \frac{A}{A+B}$$

Where A is the area above the Lawrence curve, B is the area below the Lawrence curve.

Entropy index (EI) is the direct measure of diversification with the inverse logarithmic character

$$EI = -\sum_{i=0}^{N} A_i log A_i$$

Where A_i represents acreage proportion of i[th] crop to the total cultivated land

III. RESULTS AND DISCUSSION

Growth in the area under different crop groups all six taluks of Chikkaballapur dist

The growth of area under different crop groups over the period of 10 years from 2010-11 to 2019-20 analyzed using exponential growth function. The result shows (Table 1) that there is a positive growth in average area of cultivation of 0.781 percent in cereals, 15.71 percent in the pulses, and 18.55 percent in oil seeds annually. Commercial crops of cotton and sugarcane that cultivated in an area decreased at -0.36 percent annually. In case of Horticulture crops of fruits, vegetables, Spices, medicinal and aromatic crops and flowers in the district grow annually at the rate of 0.86 percent during that period.

Table 1. Growth of area of different crop groups in the Chikkaballapur district for the period 2010-11 to 2019-20 (in percent)

Crop group	Taluks	Chikkaball

	Bagepalli	Chikkaballapur	Chintamani	Gauribidanur	Gudibande	Sidlaghatta	apur Dist
Cereals	-0.139	-2.378	11.885*	-2.739	-3.406	1.465*	0.781
Pulses	22.705*	5.118*	10.664*	34.082*	2.730*	18.940*	15.706*
Oil seeds	2.134*	15.646*	1.655*	29.499*	14.631*	47.753*	18.553*
Commercial Crops	58.214*	0.000	-2.347	8.846*	-72.464	5.600*	-0.358
Horticulture	5.865*	-3.487	-2.107	-4.588	11.915*	-2.421	0.863

*Note:** denotes significance at 5 percent level

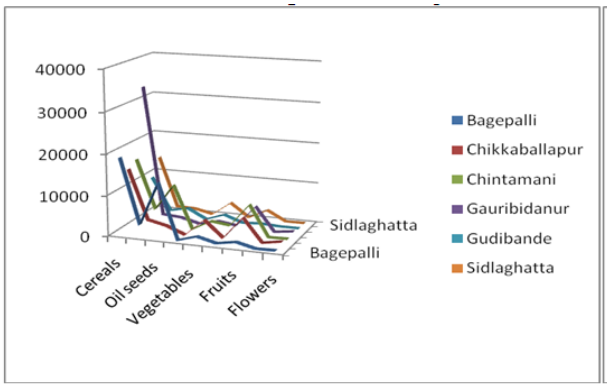

Figure 1 Growth of area of different crop groups for the period 2010-11

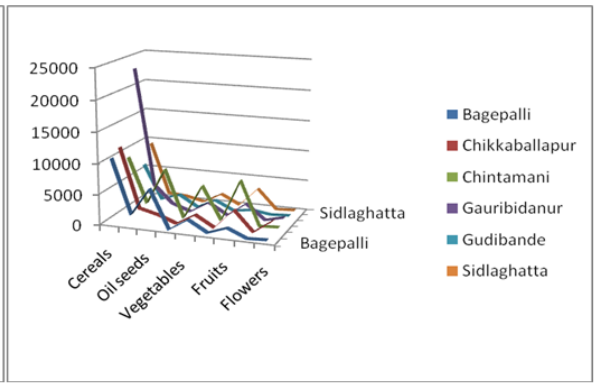

Figure 2 Growth of area of different crop groups for the period 2019-20

In all the six taluks of Chikkaballapur district, there is increase in area under cultivation of the pulses and oil seeds. In Bagepalli and Gudibanda taluks there is positive growth in area under cultivation of Horticulture crops. In Chintamani and Sidlaghatta cereals crops have shown a positive growth in area of cultivation.

Crop pattern and diversification in Chikkaballapur District

The crop pattern of Chikkaballapur district for the period of 10 years 2010-11 to 2019-20 were analysed for all taluks of Chikkaballapur district. In Bagepalli taluk there is an increase in area share of cultivation in pulses and horticulture crops from 6.91 hectare to 12.12 hectare and 8.59 hectare to 12.31 hectares respectively. In case of area share of cereals and commercial crops there is slight decrease in area of cultivation. In Chikkaballapur taluk share in area of cultivation of crops of cereals, pulses and oilseeds crops increased in area from 48.84 to 50.95, 8.26 to 11.45 percent and 5.12 to 7.36 percent respectively. Simultaneously in horticulture crops there is decrease in area of cultivation from 37.78 to 33.25 percent.

In Chintamani taluk area share of cultivation of cereals and pulses have shown an increase from 32.01 to 44.25 and 8.27 to 9.54 percent respectively. But other crop groups such as oilseeds, commercial crops and horticulture crops show a decline in area share of cultivation of 24.08 to 16.37, 0.16 to 0.04 percent and 35.47 to 29.79 percent respectively. In Gauribidanur taluk area share of cultivation of pulses and oilseeds shown high level of growth from 3.62 to 13.31 and 2.80 to 9.92 percent respectively, whereas the other crops cereals, commercial crops and horticulture crops have decline in area share of cutivation from 72.18 to 61.27, 0.32 to 0.20, and 21.07 to 15.30 percent respectively. In Gudibanda taluk area share of cultivation of oilseeds and horticulture crops show a slight increase from 14.41 to 16.69 and 7.03 to 17.78 percent, and other crops cereals, pulses and commercial crops have shown decline in area share of cultivation.

In Sidlaghatta taluk area share of cultivation of cereals pulses oilseeds have shown that gradually increase in area share of crops from 55.73 to 58.48, 4.6 to 9.23 and 3.98 to 5.39 percent respectively. Commercial crops and horticulture crop cultivation decrease from 0.17 to 0.04 and 35.5 to 26.86 percent.

In overall Chikkaballapur district pulses have increase in area share of crop cultivation. though cereals is the major crop group in the district, other crop groups such as oil seeds, commercial crops and horticulture crops, vegetables, fruits, spices and medicinal and aromatic crops and flowers have report to slight decrease in area of cultivation. In Chikkaballapur district pulses crop cultivation is increased from 6.63 to 10.93 percent due to major input demand in the market place, and it is also to be noted that Government of India has launched NSFM-pulses and accelerated pulses production program(A3P) in major pulses growing States of Madhya Pradesh Rajasthan, Karnataka, Maharashtra and Uttar Pradesh(Rimal *et.al* [8]).

As a result, there has been an increase in production of pulses in these districts which also includes Gadag (Venkatesh,[9]).The positive impact of A3P on increased pulses productivity and production was also

observed in other pulses-growing major states of Madhya Pradesh, Rajasthan, Maharashtra, Uttar Pradesh and Karnataka (Rimal *et.al* [8]).

The area share of medicinal and aromatic crops, fibre crops, flower crops and spice crops was less in the total cropped area (except spices) and decreased over the years. In the case of fruits and vegetables, their share to the total cropped area increased significantly from 0.10 per cent and 4.66 per cent to 0.25 per cent and7.80 per cent, respectively. This clearly reflects the role of high-value horticultural crops and the emphasis laid on this sector by way of promotion of this sector by the Horticulture Department of Karnataka

Share of crops in all the taluks of Chikkaballapur

The share of change in the cropping pattern for the period 2010-11to 2019-20 were analysed in Chikkaballapur district. The finding results show that the share in the area of cereals, oilseeds and commercial crops had a decline in Chikkaballapur district.

Table 2: Share of crop groups in all taluks of Chikkaballapur district

	Bagepalli Taluk					Chikkaballpur Taluk					Chintamani Taluk				
Year	Cereals	Pulses	Oil seeds	Commercial Crops	Horticulture	Cereals	Pulses	Oil seeds	Commercial Crops	Horticulture	Cereals	Pulses	Oil seeds	Commercial Crops	Horticulture
2010-11	52.16	6.91	32.20	0.14	8.59	48.84	8.26	5.12	0.00	37.78	32.01	8.27	24.08	0.16	35.47
2011-12	48.64	7.49	35.03	0.16	8.69	49.03	9.28	5.92	0.00	35.77	34.61	9.09	22.73	0.17	33.40
2012-13	47.69	7.61	33.52	0.01	11.18	51.49	9.18	2.31	0.00	37.01	43.36	8.65	15.45	0.15	32.39
2013-14	52.04	6.35	29.10	0.00	12.51	53.15	5.77	2.73	0.00	38.34	49.00	7.64	11.68	0.27	31.43
2014-15	56.59	2.96	28.53	0.01	11.91	48.89	7.76	2.15	0.00	41.19	50.53	10.46	8.45	0.05	30.51
2015-16	57.14	6.33	24.35	0.03	12.15	53.18	7.74	1.23	0.00	37.85	44.88	11.10	15.96	0.10	27.95
2016-17	41.86	12.43	33.86	0.11	11.73	52.06	6.72	1.07	0.00	40.15	45.83	8.92	20.82	0.17	24.25
2017-18	67.88	4.91	14.82	0.01	12.39	50.20	9.79	1.78	0.00	38.23	51.36	8.92	13.88	0.03	25.80
2018-19	59.34	6.88	24.64	0.00	9.12	50.95	9.37	5.59	0.00	34.09	30.10	5.98	25.46	0.00	38.47
2019-20	47.31	12.12	28.25	0.02	12.31	47.94	11.45	7.36	0.00	33.25	44.25	9.54	16.37	0.04	29.79

	Gauribidanur Taluk					Gudibanda Taluk					Sidlaghatta Taluk				
Year	Cereals	Pulses	Oil seeds	Commercial Crops	Horticulture	Cereals	Pulses	Oil seeds	Commercial Crops	Horticulture	Cereals	Pulses	Oil seeds	Commercial Crops	Horticulture
2010-11	72.18	3.62	2.80	0.32	21.07	68.55	9.84	14.41	0.16	7.03	55.73	4.62	3.98	0.17	35.50
2011-12	72.60	3.23	2.48	0.18	21.51	67.03	9.87	16.59	0.00	6.51	61.17	5.48	4.75	0.20	28.40
2012-13	76.02	2.43	1.59	0.42	19.53	72.63	8.53	7.54	0.16	11.14	61.95	6.83	1.74	0.19	29.29
2013-14	74.73	4.59	1.85	0.15	18.68	68.83	9.34	8.66	0.13	13.04	62.26	6.42	2.33	0.10	28.89
2014-15	75.14	3.18	3.18	0.22	18.28	71.74	3.32	15.09	0.00	9.85	63.59	4.43	0.69	0.09	31.20
2015-16	67.81	11.91	2.85	0.36	17.07	76.35	5.87	8.13	0.00	9.65	55.92	6.99	3.37	0.16	33.56
2016-17	61.83	15.70	8.11	0.27	14.08	62.25	7.77	20.99	0.00	8.98	52.92	8.72	5.03	0.02	33.31
2017-18	68.59	11.07	5.89	0.30	14.16	62.67	8.50	18.47	0.00	10.35	55.26	8.79	3.44	0.02	32.49
2018-19	61.39	10.60	13.61	0.30	14.09	60.65	6.73	16.80	0.00	15.82	56.37	5.50	4.07	0.04	34.02
2019-20	61.27	13.31	9.92	0.20	15.30	58.03	7.47	16.69	0.02	17.78	58.48	9.23	5.39	0.04	26.86
2019-20	61.27	13.31	9.92	0.20	15.30	58.03	7.47	16.69	0.02	17.78	58.48	9.23	5.39	0.04	26.86

	Chikkaballapur Dist				
	Cereals	Pulses	Oil seeds	Commercial Crops	Horticulture
2010-11	53.14	6.63	14.68	0.17	25.38
2011-12	53.48	7.14	15.52	0.13	23.73
2012-13	57.36	6.86	11.35	0.17	24.27
2013-14	59.25	6.40	9.90	0.12	24.33
2014-15	60.29	5.70	9.82	0.08	24.11
2015-16	57.12	9.00	10.21	0.13	23.54
2016-17	51.71	10.76	15.69	0.13	21.71
2017-18	59.43	8.77	9.34	0.08	22.39
2018-19	52.10	7.86	16.16	0.09	23.80
2019-20	52.00	10.93	14.46	0.07	22.55

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Crop diversification indices

In Table 4, indicates crop diversity indices of different crop groups of all taluks of Chikkaballapur district for 10 years 2010-11 to 2019-20. The estimated average values of Herfindahl index(HI) for different crop groups are 0.39, 0.41, 0.33, 0.53, 0.49 and 0.44 respectively for Bagepalli, Chikkaballapur, Chintamani, Gauribidanur, Gudibanda and Sidlaghatta taluks, In Chikkaballapur District average HI is 0.39, which is less than 0.5 of diversity index. Nagpure.*et.al* [7] in their study on crop diversification in Ankola, Amravati, Buldhana and Yavatmal districts of western Vidarbha region of Maharashtra observed that the value of HI is very low i.e below 0.5 and opined that subsistence crop to more commercial crops is high in these districts. In Chintamani is 0.33 is high as compared to 0.53 in Gauribidanur which is low crop diversity compared to other taluks of Chikkaballapur district.

Simpson's Index for the area under different crop groups

The Simpson's index increases with increase in crop diversification and vice versa. The computed average values of Simpson's index for different crop groups of all taluks of Chikkaballapur district are indicated that hierarchically Chintamani, Bagepalli, Chikkaballapur, Sidlaghatta, Gudibanda and Gauribidanur taluks were increase crop diversification. In Chikkaballapur district records 0.61 Simpson's index.

Entropy Index for the area under different crop groups

Entropy index(EI) for different crop groups of Chikkaballapur district for the period 2010-11 to 2019-20 estimated as in the table 4. Entropy index increases with crop diversification. The values of entropy index show clearly that Chintamani Taluk records very high of 0.53 of crop diversity. Gudibanda and Sidlaghatta taluks have the same diversity index of 0.42. Bagepalli, Chikkaballapur, and Gauribidanur taluks have shown that 0.48, 0.45 and 0.39 EI of crop diversification. In Chikkaballapur district records an average of 0.49 as EI. Basavaraj *et.al*. [2] reported that crop diversity is more in Gadag and Shirahatti taluks of Gadag district using EI of crop diversity.

Gini Index or Gini Coefficient for the area under different crop groups of Chikkaballapur District

The crop diversification using Gini Index (GI) is estimated as shown in the table 4. GI is direct proportional to crop diversity. The average values of GI of all taluks of Chikkaballapur district are 0.85, 0.83, 0.81, 0.80 and 0.76 of Gauribidanur, Gudibanda, Sidlaghatta, Bagepalli and Chikkaballapur taluks respectively. In Chikkaballapur district observed that 0.82 as GI of Crop diversity.

Table 3: Average of Crop diverfsification indices of all taluks of Chikkaballapur district

Index	Taluks						
	Bagepalli	Chikkaballapur	Chintamani	Gauribidanur	Gudibande	Sidlaghatta	Chikkaballapur Dist
HI	0.39	0.41	0.33	0.53	0.49	0.44	0.39
SI	0.61	0.59	0.67	0.47	0.51	0.56	0.61
EI	0.48	0.45	0.53	0.39	0.42	0.42	0.49
GI	0.81	0.80	0.76	0.85	0.85	0.83	0.82

Table 4: Crop diversification indices of all taluks of Chikkaballapur district

Year	Bagepalli Taluk				Chikkaballpur Taluk				Chintamani Taluk			
	H.I	S.I	E.I	G.I	H.I	S.I	E.I	G.I	H.I	S.I	E.I	G.I
2010-11	0.39	0.61	0.48	0.81	0.39	0.61	0.47	0.80	0.29	0.71	0.56	0.72
2011-12	0.37	0.63	0.49	0.79	0.38	0.62	0.48	0.80	0.29	0.71	0.56	0.71
2012-13	0.36	0.64	0.50	0.79	0.41	0.59	0.44	0.81	0.32	0.68	0.53	0.77
2013-14	0.38	0.62	0.49	0.81	0.43	0.57	0.42	0.81	0.36	0.64	0.50	0.80
2014-15	0.42	0.58	0.45	0.82	0.42	0.58	0.43	0.80	0.37	0.63	0.50	0.80
2015-16	0.40	0.60	0.48	0.82	0.43	0.57	0.42	0.81	0.32	0.68	0.54	0.78
2016-17	0.32	0.68	0.54	0.76	0.44	0.56	0.41	0.81	0.32	0.68	0.54	0.78
2017-18	0.50	0.50	0.41	0.85	0.41	0.59	0.44	0.80	0.36	0.64	0.51	0.81
2018-19	0.43	0.57	0.46	0.83	0.39	0.61	0.47	0.80	0.31	0.69	0.54	0.67
2019-20	0.33	0.67	0.53	0.79	0.36	0.64	0.50	0.79	0.32	0.68	0.54	0.77

Year	Gauribidanur Taluk				Gudibanda Taluk				Sidlaghatta Taluk				Chikkaballapur Dist			
	H.I	S.I	E.I	G.I	H.I	S.I	E.I	G.I	H.I	S.I	E.I	G.I	HI	SI	EI	GI
2010-11	0.57	0.43	0.35	0.86	0.51	0.49	0.42	0.85	0.44	0.56	0.42	0.82	0.37	0.63	0.50	0.81

2011-12	0.58	0.42	0.34	0.86	0.49	0.51	0.42	0.85	0.46	0.54	0.42	0.84	0.37	0.63	0.50	0.81
2012-13	0.62	0.38	0.31	0.87	0.55	0.45	0.39	0.86	0.47	0.53	0.40	0.84	0.41	0.59	0.48	0.83
2013-14	0.60	0.40	0.33	0.87	0.51	0.49	0.42	0.85	0.48	0.52	0.40	0.84	0.42	0.58	0.46	0.83
2014-15	0.60	0.40	0.33	0.87	0.55	0.45	0.38	0.86	0.50	0.50	0.36	0.84	0.43	0.57	0.45	0.83
2015-16	0.50	0.50	0.41	0.85	0.60	0.40	0.35	0.87	0.39	0.61	0.44	0.82	0.40	0.60	0.49	0.82
2016-17	0.43	0.57	0.47	0.84	0.45	0.55	0.45	0.84	0.40	0.60	0.46	0.81	0.35	0.65	0.53	0.81
2017-18	0.51	0.49	0.42	0.85	0.44	0.56	0.46	0.84	0.42	0.58	0.44	0.82	0.42	0.58	0.47	0.83
2018-19	0.43	0.57	0.48	0.84	0.43	0.57	0.47	0.84	0.44	0.56	0.43	0.82	0.36	0.64	0.51	0.81
2019-20	0.43	0.57	0.48	0.84	0.40	0.60	0.49	0.83	0.43	0.57	0.45	0.83	0.35	0.65	0.52	0.81

IV. CONCLUSION AND POLICY IMPLICATIONS

The nature and extent of crop diversification have analysed using the Herfindahl index, Simpson's index, Gini index and Entropy index. The results have shown that except commercial crops all other crop groups have higher diversification. Pulses have ranked first and the cereals and oilseeds remain second in overall crop diversification of the study period.

The results have indicated that the major factors influential for the change in crop diversification are urban population, per capita income, proportion of area under high yield variety of pulses and cereals, proportion of total irrigated area to the total cropped area, average size of landholding, market exposure and fertilizer consumption.

The basic Infrastructures like more supply of drip irrigation facilities, creation of more market places of international level, motivate of subsidized increase of the sustained greenhouse cultivation, easy access to the fertilizers, proper roads and easy transit of cultivated agriculture produce and encouraging mixed cultivation of crop groups, which will guarantee the income of farmers and boost the crop diversification.

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