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Economic Transformation and Fostering Sustainable Growth through Cashew Research Investment in the Konkan Region of Maharashtra State

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ABSTRACT

The present study was conducted in the Konkan region of Maharashtra. Both primary and secondary data were used to achieve the objectives. CAGR for per hectare investment in cashew research, employment generated, input index, output index, and total factor productivity (TFP) index were estimated. The Divisia-Tornqvist Theil index was used to compute the total output, total input, and TFP indices. TFP sources were analyzed using a linear production function. Returns on investment were assessed using the Estimated Value of Marginal Product (EVMP) and Internal Rate of Return (IRR). The results indicated a mixed trend in year-wise investment in cashew research, with an overall decline of 1.74 per cent per annum in real terms. The area under cashew in the Konkan region grew 8.53 per cent per annum, with production and productivity growth rates at 10.13 per cent and 1.47 per cent, respectively. Employment generated through cashew production increased significantly, with direct and indirect employment growing at 8.06 per cent and 10.14 per cent per annum, respectively. The regression coefficient suggested that each rupee increase in per hectare cashew research expenditure results in a Rs. 0.54 increase in per hectare returns after five years. The average TFP during the study period was 241.60, indicating a 141.60 per cent increase in output due to research, with TFP growing at 1.18 per cent per annum. The EVMP was Rs. 2712.08, showing that an additional rupee in cashew research generates Rs. 2712.08 in income. The IRR for cashew research investment was 229.58 per cent, indicating a high payoff and transformative potential for sustainable growth in the Konkan region of Maharashtra's horticulture sector.

Keywords: Cashew, Konkan region, total factor productivity, sustainable growth.

JEL codes: O13, O44, Q01, Q12, Q18

I

INTRODUCTION

India has seen significant growth in horticultural production, reaching over 341.63 million tonnes during 2021-22 (Ministry of Agriculture and Farmers Welfare). India ranks second globally in fruit and vegetable production. The horticultural sector accounts for about 37 per cent of total agricultural commodity exports, with a sustained rising trend in exports (Jha et al., 2019). The state governments, particularly Maharashtra, have focused on the growth of horticulture, making substantial investments in research and development. Maharashtra has emerged as a key horticultural state, with high-demand crops like Alphonso mango, grapes, and bananas contributing significantly to domestic and international markets. The state's unique agro-climatic conditions, especially in the Konkan region, are ideal for crops like cashew, which has seen significant research and development efforts. The All India

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Coordinated Research Project (AIRCP) on Cashew and other initiatives has led to the development high-yielding varieties and advanced technologies, boosting production and productivity. This strategic focus on horticulture not only enhances the economic viability of agriculture but also promotes sustainable growth by encouraging the cultivation of high-value crops, conserving natural resources, and meeting the growing demand for quality products. This study aims to quantify the returns on investment in cashew research in the Konkan region of Maharashtra, contributing to the broader objective of transforming horticulture for sustainable growth in the Konkan region of Maharashtra.

II

RESEARCH METHODOLOGY

The Konkan region of Maharashtra was deliberately selected for this study due to its agro-climatic suitability for cashew plantations, encompassing the state's top cashew-producing districts, Sindhudurg and Ratnagiri. From these districts, three tahsils were randomly selected and two villages were chosen from each tehsil. In each village, ten cashew growers were randomly chosen. Additionally, 15 cashew processors and 15 nurseries were selected from both districts. The final sample included two districts, six tahsils, 12 villages, 120 cashew farmers, 15 processors, and 15 nurseries. Both primary and secondary data were used to achieve the study's objectives. The compound annual growth rates (CAGR) of area, production, and cashew productivity for each district and the Konkan region were calculated over 40 years (1981-82 to 2020-21). Additionally, the CAGR for per hectare investment in cashew research, employment generated, input index, output index, and total factor productivity (TFP) index for cashew were estimated.

2.1. *Returns to Investment*

Two methodologies were employed to estimate the returns on investment in cashew research and development: the production function approach and the total factor productivity (TFP) approach.

2.1.1 *Production Function Approach*

The multiple linear regression model was employed to estimate the impact of research (R) and development (D) on the gross returns from cashew production (Y). In this context, let 'j' represent the time lag between the investment and the resultant returns. Thorat (2005) estimated that the time lag period for horticultural crops like mango, cashew, etc., is five years, and 't' denotes the specific time period. The functional relationship between these variables and the output (Y) can be expressed as follows

$$Y_t = a + b_1R_{t-j} + b_2D + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + e_t$$

Where,
Y_t = gross value of cashew output per hectare
a = constant term
R_{t-j} = per hectare cashew research investment
D = per hectare development expenditure
X_3 = rainfall
X_4 = maximum temperature
X_5 = minimum temperature
X_6 = Relative humidity (RH_1)
X_7 = Relative humidity (RH_2)
e = error term
b_1, b_2, b_3, b_4, b_5, b_6, b_7 are the regression coefficients of respective variables

2.1.2 *Total Factor Productivity Approach*

The Divisia-Tornqvist Theil index, or trans-log index, was employed to compute the total output, total input, and TFP indices. The Total Output Index (TOI) and Total Input Index (TII) were calculated as follows:

$$TOI = \frac{TOI_t}{TOI_{t-1}} = \prod (Q_{jt}/Q_{jt-1})^{(Rjt+R_{jt-1})^{1/2}}$$

$$TII = \frac{TII_t}{TII_{t-1}} = \prod (X_{jt}/X_{jt-1})^{(Sjt+S_{jt-1})^{1/2}}$$

The Total Factor Productivity index of t^{th} year is 100 times the ratio of TOI_t to the TII_t and is given by

$$TFPI = \left[\frac{TOI_t}{TII_t}\right] \times 100$$

Where,
R_{jt} = Share of j^{th} output in total revenue
Q_{jt}= Output 'j'
S_{it} = Share of i^{th} input in total input cost.
X_{it} = input 'i'

By setting TOI_{t-1} and TII_{t-1} equal to 100 in the initial year, the above equations provided the total output, total input, and TFP for the specified period 't'. TFP reflects the impact on output due to research and development beyond the input use.

2.2 *Rates of Returns to Horticultural Research and Development*

To evaluate the determinants of total factor productivity (TFP) in horticulture, the TFP index was regressed on per-hectare research and development expenditure, serving as a trend variable. Time series data from various years were pooled for this analysis. By using the elasticity of TFP for research and development investment, it is possible to estimate the value of the marginal product of research and development investment (Thorat, 2005). The formula used to calculate the Estimated Value of Marginal Product (EVMP) is

$$EVMP = b \times (V/I)$$

Where,
EVMP = Estimated Value of Marginal Product
I = Investment
V = Value of production associated with TFP
b= TFP elasticity of investment

Using the TFP determinant equation mentioned above, a benefit stream is generated. This benefit stream can be discounted at a rate 'r', where the present value of the benefit stream equals zero. Thus, 'r' is the marginal rate of return on research and development investment. Returns on investment were also assessed using the Internal Rate of Return (IRR).

III

RESULTS AND DISCUSSION

3.1 *Research Investment for Cashew in Maharashtra State*

The state government of Maharashtra has prioritized cashew research in the Konkan region since 1972 to boost the area's development by enhancing cashew productivity. The compound growth rates of total and per-hectare investment in cashew research are shown in Table 1.

TABLE 1 COMPOUND GROWTH RATES OF INVESTMENT AND PER HECTARE INVESTMENT IN CASHEW RESEARCH IN THE KONKAN REGION

Period		CAGR	
		Total investment	Per hectare investment
(1)	(2)	(3)	(4)
1981-82 to 2020-21	Nominal price	5.67**	-2.63**
		(-0.01)	(0.01)
	Real price	-1.74**	-9.47**
		(0.004)	(0.01)

Note: Figures in parentheses are Standard Errors (SE).
** indicates significance at the 5 per cent level.

The annual growth rate of research investment in cashew was 5.67 per cent per annum in nominal terms. However, in real terms, the annual growth rate of investment was significantly negative (-1.74 per cent). Additionally, per-hectare investment in cashew research decreased significantly by 2.63 per cent per annum at nominal prices and by 9.47 per cent at real prices. The negative annual compound growth rates can be attributed to the disproportionate increase in the area under cashew cultivation compared to the increase in research investment. It highlights a need for a strategic approach to research funding to ensure sustainable growth and productivity enhancement in Maharashtra's plantation sector, particularly cultivating cashews. Strengthening research investment will be crucial for transforming cashew plantations in Maharashtra for sustainable growth of the Konkan region.

3.2 Growth of Cashew in Konkan Region of Maharashtra

The compound annual growth rates (CAGR) of area, production, and productivity of cashew nuts in the specified regions are summarized in Table 2.

TABLE 2 COMPOUND GROWTH RATES OF AREA, PRODUCTION, AND PRODUCTIVITY OF CASHEW NUT IN SINDHUDURG, RATNAGIRI, RAIGAD, THANE DISTRICT AND KONKAN REGION

Sr. No.	District	1981-82 to 2020-21 (CAGR)		
		A	P	Y
(1)	(2)	(3)	(4)	(5)
1	Sindhudurg	5.85**	6.52**	0.63^{NS}
		(0.003)	(0.003)	(0.004)
2	Ratnagiri	13.32**	16.90**	3.16**
		(0.01)	(0.01)	(0.01)
3	Raigad	13.41**	17.91**	3.97**
		(0.01)	(0.01)	(0.01)
4	Thane	5.72**	3.97^{NS}	-1.65^{NS}
		(0.02)	(0.02)	(0.02)
5	Konkan	8.53**	10.13**	1.47**
		(0.01)	(0.01)	(0.004)

Note: Figures in parentheses are the standard errors (SE).

** indicates significance at the 5% level. NS indicates non-significant growth rates.

For the entire Konkan region, there was a significant increase in the area (8.53 per cent CAGR), production (10.13 per cent CAGR), and productivity (1.47 per cent CAGR) of cashew nuts. The area under cashew plantations grew from 16,500 hectares to 174,326.4 hectares during the study period. This expansion, reflected in a growth rate of 5.85 per cent for the area and 6.52 per cent for production, is attributed to the establishment of new cashew orchards through the Employment Guarantee Scheme (EGS) and the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA). Due to the government's continuous investment in cashew research and the new technologies developed in cashew, the area, production, and productivity are significantly increasing, improving livelihood security for cashew growers and cashew processors in the Konkan region.

3.3 *Impact on Employment Generation through Cashew Production in Maharashtra*

The cashew research and development initiatives in Maharashtra's Konkan region have substantially contributed to direct and indirect employment generation. Direct employment is created through the expansion of the area under cashew, while indirect employment arises from nursery operations and the processing of cashews. Investing in cashew research enhances productivity and ensures local communities' well-being through job creation. Strengthening these efforts will be vital to transforming horticulture for sustainable growth in the Konkan region of Maharashtra. Table 3 illustrates the annual employment generation across various activities related to cashew production in districts like Sindhudurg, Ratnagiri, Raigad, Thane, and Palghar. The region witnessed a significant annual employment impact of 452.18 lakh man-days. Cashew production activities dominated the employment landscape, followed by processing, establishment of new orchards, and nursery operations. Such employment has bolstered rural livelihoods and contributed to the region's socio-economic development. The region can further enhance its cashew industry's contribution to long-term economic growth and community well-being by leveraging favorable climatic conditions and adopting sustainable horticultural practices.

TABLE 3 ACTIVITY-WISE ANNUAL EMPLOYMENT GENERATION THROUGH CASHEW PRODUCTION IN KONKAN REGION

(*man days in lakh*)

Sr. No		Direct employment		Indirect employment		Total
	District	Production	Establishment of orchard	Nursery	Processing	
(1).	(2)	(3)	(4)	(5)	(6)	(7)
1	Sindhudurg	125.89	15.25	0.354	35.68	177.18
2	Ratnagiri	171.84	13.41	0.298	75.45	260.99
3	Raigad	6.46	1.22	0.030	2.46	10.18
4	Thane and Palghar	3.02	0.99	0.026	0.59	4.64
5	Konkan	307.53	30.00	0.455	114.19	452.18

3.4 *Compound Growth Rates of Direct and Indirect Employment Generated by Cashew Production*

Table 4 provides insights into the compound growth rates of direct and indirect employment generated by cashew production across districts in the Konkan region of Maharashtra. The growth rates reflect the dynamic impact of cashew cultivation on employment over the study period. The Sindhudurg district experienced a significant annual growth rate of 5.49 per cent in direct employment, indicating a steady expansion in employment opportunities related to cashew production. In Ratnagiri district, the state led with the highest growth rate of 12.70 per cent per annum in direct employment, driven by extensive cashew cultivation. Raigad also showed substantial growth at

12.55 per cent per annum, attributed to the rapid expansion of cashew cultivation and the adoption of high-yielding varieties. Similarly, Thane + Palghar recorded a growth rate of 4.32 per cent per annum, reflecting moderate but positive trends in direct employment generation. Sindhudurg, Ratnagiri, and Raigad districts demonstrated significant growth rates of 6.54 per cent, 16.86 per cent, and 17.93 per cent per annum in indirect employment, respectively. However, Thane + Palghar showed a growth rate of 4.29 per cent per annum. The growth rate in the direct employment of the Konkan region was found to be 8.06 per cent per annum, where it was 10.14 per cent per annum from indirect employment due to different cashew activities, which was significant. The analysis underscores the transformative impact of cashew development on employment generation in the Konkan region of Maharashtra. By fostering sustainable horticultural practices and enhancing infrastructure, the region can further amplify its role in promoting socio-economic development and improving livelihoods through diversified activities of cashew production.

TABLE 4 COMPOUND GROWTH RATES OF DIRECT AND INDIRECT EMPLOYMENT GENERATION DUE TO CASHEW PRODUCTION

Sr. No.	Districts	CAGR	
		Direct employment	Indirect employment
(1)	(2)	(3)	(4)
1.	Sindhudurg	5.49**	6.54**
		(0.004)	(0.003)
2.	Ratnagiri	12.70**	16.86**
		(0.009)	(0.008)
3.	Raigad	12.55**	17.93**
		(0.01)	(0.01)
4.	Thane + Palghar	4.32**	4.29**
		(0.02)	(0.02)
5.	Konkan	8.06**	10.14**
		(0.005)	(0.004)

Note: Figures in parenthesis are SE.
** indicates a 5 per cent level of significance.

3.5 *Contribution of Investment in Cashew Research and Development to Gross Returns*

The impact of investment in cashew research and development on gross returns was estimated using functional analysis methods such as Cobb-Douglas production functions. The analysis aims to quantify the returns from investments in enhancing cashew productivity and resilience in the Konkan region of Maharashtra. According to Table 5, the coefficient indicates that a one-rupee increase in per-hectare cashew research expenditure leads to a Rs. 0.54 increase in cashew returns per hectare, with a significant effect observed five years later. This underscores the long-term benefits of investment in research for cashew productivity enhancement. Although positive, the coefficient associated with development expenditure (0.19) was not statistically significant, suggesting that while investments in development contribute positively to cashew output, the relationship is not strong enough to be considered significant.

TABLE 5 FINDINGS FROM THE FUNCTIONAL ANALYSIS

Sr. No. (1)	Parameter (2)	Coefficient (3)	't' Value (4)	'f' Value (5)
1.	Dependent variable i. e. output (kg/ha)			
2.	a=constant term	0.28^{NS}	0.21	
3.	b_1=coefficient associated with R_{t-j}	0.54**	2.95	
		(0.18)		
4.	b_2=coefficient associated with D	0.19^{NS}	0.44	
		(0.42)		
5.	b_3=coefficient associated with rainfall	-0.06^{NS}	-0.35	
		(0.16)		
6.	b_4=coefficient associated with maximum temperature	-1.58^{NS}	-1.55	
		(1.01)		
7.	b_5=coefficient associated with minimum temperature	-2.06**	-2.60	
		(0.77)		
8.	b_6=coefficient associated with RH_1	0.39**	2.23	
		(0.17)		
9	b_7=coefficient associated with RH_2	-0.03^{NS}	-0.16	
		(0.19)		
	R^2 = coefficient of multiple determination	0.54		3.90

Note: Figures in parenthesis are SE. ** indicates a 5 per cent level of significance.

3.6 *Total Factor Productivity of Cashew in the Konkan Region*

In the Konkan region of Maharashtra, the Total Factor Productivity (TFP) of cashew has been assessed over 35 years from 1986-87 to 2020-21, with the base year set at 1986-87. This analysis focuses on understanding how efficiently inputs have been utilized to produce cashew output, reflecting technological advancements and agricultural practices over time.

Table 6 indicated that, in 1986-87, the Total Input Index and Total Output Index were set at 1.00, establishing a baseline for comparison. The corresponding TFP index was 100.00, indicating the initial productivity level relative to inputs. Over the years, both the Total Input Index and Total Output Index have shown a general upward trend. However, the increase in the Total Output Index has consistently outpaced the Total Input Index, illustrating improved efficiency in cashew production practices and technology adoption. The highest recorded values for the Total Output Index were observed in 2020-21 (27.56), marking significant productivity gains. Conversely, the lowest point for the Total Output Index was noted in 1987-88 (1.55), reflecting a period of lower productivity potentially due to unfavorable conditions or inadequate technology. TFP indices indicate the efficiency of input utilization in generating output. The TFP index surged to its highest at 562.43 in 2020-21, highlighting substantial advancements in productivity over the years. However, it dipped notably from 2006-07 to 2008-09, possibly due to external factors impacting production efficiency. Across the study period, the average values were 2.18 for Total Input Index, 5.97 for Total Output Index, and 241.60 for TFP. These averages underscore the overall improvement in productivity and efficiency in cashew production in the Konkan

region. It is concluded that the upward trajectory of Total Factor Productivity indices reflects ongoing advancements in cashew cultivation practices and technological innovations in the Konkan region. These findings emphasize the critical role of research, development, and adoption of new agricultural technologies in driving sustainable growth in cashew production. Continuing investments in enhancing productivity and sustainability will be pivotal in ensuring resilience and prosperity in India's cashew industry.

TABLE 6 YEAR-WISE TOTAL INPUT, TOTAL OUTPUT, AND TOTAL FACTOR PRODUCTIVITY OF CASHEW NUT IN KONKAN REGION

Year	Total Input Index	Total Output Index	TFP	Year	Total Input Index	Total Output Index	TFP
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1986-87	1.000	1.000	100.000	2004-05	1.680	1.823	108.523
1987-88	1.034	1.550	149.892	2005-06	1.769	2.237	126.479
1988-89	1.074	1.874	174.499	2006-07	1.889	1.515	80.232
1989-90	1.101	1.836	166.752	2007-08	1.901	1.509	79.350
1990-91	1.121	1.561	139.324	2008-09	2.090	1.822	87.220
1991-92	1.135	3.191	281.024	2009-10	2.123	3.043	143.337
1992-93	1.161	3.549	305.591	2010-11	2.736	3.862	141.147
1993-94	1.208	4.103	339.546	2011-12	2.843	7.866	276.649
1994-95	1.267	4.162	328.495	2012-13	3.371	5.284	156.735
1995-96	1.319	3.272	248.046	2013-14	3.426	7.535	219.935
1996-97	1.350	4.275	316.598	2014-15	3.574	6.357	177.866
1997-98	1.416	2.145	151.546	2015-16	3.586	8.458	235.869
1998-99	1.495	6.007	401.769	2016-17	3.902	14.764	378.357
1999-2000	1.531	6.630	433.126	2017-18	4.117	14.941	362.950
2000-01	1.561	5.072	324.907	2018-19	4.272	21.045	492.576
2001-02	1.618	4.318	266.790	2019-20	4.647	20.925	450.291
2002-03	1.632	2.118	129.721	2020-21	4.900	27.558	562.427
2003-04	1.663	1.972	118.595	Average	2.186	5.976	241.605

3.7 Growth in Total Input, Output, and Total Factor Productivity of Cashew in the Konkan Region

The compound growth rates for total input, total output, and total factor productivity (TFP) indices were estimated for the period spanning from 1981-82 to 2020-21 (Table 7).

TABLE 7 COMPOUND GROWTH RATES OF INPUT, OUTPUT, AND TFP INDICES OF CASHEW NUT IN KONKAN REGION

1981-82 to 2020-21 (CAGR)		
Input index	Output index	TFP
(1)	(2)	(3)
4.48**	6.08**	1.18^{NS}
(0.002)	(0.01)	(0.01)

(Figures in parenthesis are SE.)
** indicates a 5 per cent level of significance.

The total input index exhibited a compound annual growth rate (CAGR) of 4.48 per cent, while the total output index grew at a higher rate of 6.08 per cent per annum. This disparity indicates that the efficiency and productivity of cashew production in the Konkan region improved significantly over time, likely influenced by advancements in agricultural practices and technology adoption. Despite the robust growth rates observed in both input and output indices, the TFP index showed a modest annual growth rate of 1.18 per cent. This growth, although positive, is statistically non-significant. The lower TFP growth rate relative to input and output indices suggests that while productivity has increased, it hasn't fully capitalized on the gains in input efficiency. The discrepancy between input and output growth rates underscores the impact of technological advancements in adopting high-yielding varieties. This phenomenon reflects a positive trend towards sustainable growth in cashew cultivation in the region. The findings highlight a positive trajectory in the productivity and efficiency of cashew production in the Konkan region over the study period. However, the modest growth rate in TFP suggests opportunities for further enhancing productivity through targeted research, development, and sustainable agricultural practices. Continued efforts in leveraging technological innovations and improving resource management will be crucial in sustaining and furthering the growth of cashew cultivation, contributing to agricultural sustainability and economic development in the region.

3.8 *Drivers of Total Factor Productivity Growth in Cashew Cultivation in the Konkan Region*

The decomposition of TFP growth into its contributing factors reveals significant insights, as summarized in Table 8.

TABLE 8 DRIVERS OF TOTAL FACTOR PRODUCTIVITY GROWTH IN CASHEW IN KONKAN REGION

Variables	Regression coefficient	Standard Error	't' calculated	'F' value
(1)	(2)	(3)	(4).	(5)
Intercept	24.75^{NS}	60.70	0.40	
Per hectare research expenditure	2.03**	0.67	2.99	
Per hectare development expenditure	0.003**	0.0008	3.69	
R^2	0.31			7.26

Note: ** indicates a 5 per cent level of significance.

The regression analysis indicates that a one-unit increase in per-hectare research investment results in a substantial 2.03-unit increase in TFP. However, per-hectare development expenditure shows a minor but positive impact on TFP, with a coefficient of 0.003. This suggests that development investments contribute marginally to productivity growth. Both coefficients for research and development expenditures are statistically significant at the 5 per cent level, emphasizing their measurable impact on TFP growth in the region. It is concluded from the table that investment in research is the major contributor to the sustainable development of cashew.

3.9 *Estimated Value of Marginal Product of Cashew Research Investments*

Table 9 shows the Estimated Value of Marginal Product (EVMP) derived using the elasticity of total factor productivity (TFP) for research investment.

TABLE 9 ESTIMATED VALUE OF MARGINAL PRODUCT OF CASHEW

Sr. No.	Year	Research cost (Rs./ha)	Output (Rs./ha)
(1)	(2)	(3)	(4)
1	1986-87	29.70	9870.87
2	1987-88	30.15	15296.88
3	1988-89	31.53	18498.44
4	1989-90	41.69	18126.56
5	1990-91	60.81	15410.29
6	1991-92	64.57	31493.38
7	1992-93	79.50	35033.46
8	1993-94	111.54	40502.94
9	1994-95	71.68	41080.24
10	1995-96	54.90	32301.47
11	1996-97	173.80	42198.64
12	1997-98	76.95	21175.00
13	1998-99	76.91	59290.00
14	1999-2000	65.06	65440.86
15	2000-01	91.49	50065.09
16	2001-02	62.75	42619.37
17	2002-03	66.69	20902.40
18	2003-04	42.75	19462.13
19	2004-05	16.20	17991.62
20	2005-06	19.91	22081.46
21	2006-07	12.78	14956.75
22	2007-08	16.66	14892.05
23	2008-09	11.26	17989.59
24	2009-10	12.56	30041.09
25	2010-11	13.80	38125.45
26	2011-12	12.81	77644.41
27	2012-13	13.45	52153.46
28	2013-14	15.48	74380.86
29	2014-15	17.21	62746.86
30	2015-16	26.35	83484.81
31	2016-17	20.80	145728.71
32	2017-18	24.28	147483.34
33	2018-19	21.95	207729.48
34	2019-20	23.79	206542.96
35	2020-21	33.73	272020.09
	Total	1545.48	2064761
	Mean	44.16	58993.17

In this study, the regression coefficient for research investment in cashew was positive and statistically significant, validating its contribution to productivity growth. Over the study period, the average research cost per hectare was Rs. 44.16, while the average output per hectare amounted to Rs. 58,993.17. These figures provide the basis for calculating the EVMP, which reflects the additional income generated for each rupee invested in research. By applying the regression coefficient (2.03) to the ratio of average output to average research cost, the EVMP is computed as Rs. 2712.08. This indicates that an additional one rupee investment in cashew research resulted in an average additional income of Rs. 2710.08 per hectare. This indicated the significant role of research investment in driving productivity and sustainable income growth in cashew cultivation.

3.10 *Internal Rate of Return (IRR) in Cashew Research*

The Internal Rate of Return (IRR) analysis was conducted to evaluate the efficiency and profitability of investing in cashew research to enhance the productivity and sustainability of cashew cultivation in the Konkan region of Maharashtra. The findings from Table 10 highlight the compelling economic returns generated from investments in agricultural research.

TABLE 10 INTERNAL RATE OF RETURN IN CASHEW RESEARCH

Sr. No. (1)	Kind of Investment (2)	Internal rate of return (%) (3)
1.	Cashew research	229.58

Table 10 shows that the IRR for investments in cashew research was calculated at an impressive rate of 229.58 per cent per annum. This metric signifies the annualized rate of return that exceeds traditional bank interest rates, which typically range from 12 to 14 per cent per annum during the study period. The substantial IRR underscores the profitability and economic viability of allocating resources toward cashew research initiatives. Such investments yield significant financial returns and contribute to advancing agricultural technology, improving crop resilience, and enhancing farmer livelihoods.

IV

CONCLUSIONS

Over the years, the investment in cashew research has shown a mixed trend, with fluctuations in both upward and downward directions. Despite these changes, the compound growth rate for research expenditure on cashew, when adjusted for real prices, indicates a decline of 1.74 per cent per annum during the study period. In contrast, the area under cashew cultivation in the Konkan region expanded at a robust rate of 8.53 per cent per annum. Production and productivity also saw significant

growth rates of 10.13 per cent and 1.47 per cent per annum, respectively. The cashew industry in the Konkan region has significantly contributed to employment, with direct and indirect employment increasing at annual rates of 8.06 per cent and 10.14 per cent, respectively. The analysis of research expenditure revealed that an increase of one rupee per hectare cashew research expenditure leads to a Rs. 0.54 increase in per hectare cashew returns, albeit with a five-year time lag. The average Total Factor Productivity (TFP) during the study period was calculated to be 241.60, indicating that research efforts contributed to a 141.60 per cent increase in output. TFP itself grew at a rate of 1.18 per cent per annum. Moreover, the Marginal Product value was estimated at 2712.08, suggesting that each additional rupee invested in cashew research generates an additional income of Rs. 2712.08. The internal rate of return for investment in cashew research was an impressive 229.58 per cent, underscoring that investment in cashew research is highly rewarding. These findings emphasize the importance of targeted research investment for transforming horticulture and achieving sustainable growth in the Konkan region. The cashew sector's growth in the Konkan region demonstrates how strategic investment in agricultural research can drive significant economic and social benefits, promoting sustainable development in the horticultural industry.

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