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An Economic Analysis Of Turmeric Cultivation In Varagur Village, Namakkal District, Tamil Nadu

Dr. R. P. BUVANESWARI

Associate Professor and Head

Department of Economics

N. K. R. Government Arts College for Women, Namakkal, Tamil Nadu, India

Abstract: Turmeric occupies a central place in the commercial agriculture of Namakkal district, yet the economics of its cultivation at the level of the individual holding remains thinly documented. This paper examines the cost structure, returns, profitability and constraints of turmeric cultivation in Varagur village, Namakkal district, Tamil Nadu, using primary data collected from 60 cultivators through a structured interview schedule administered in the vernacular between January and March 2026 under simple random sampling. Percentage analysis, grouped-data estimation of central tendency and dispersion, the chi-square test of independence with a Monte Carlo exact probability, and ordinal measures of association including Kendall's tau-b, Goodman-Kruskal gamma and the linear-by-linear association statistic were employed. Grouped estimation places mean total expenditure at approximately ₹1,46,667 per cultivator per season against a mean net profit of ₹52,500, implying a gross return of ₹1,99,167 and a benefit-cost ratio of 1.36. Returns are, however, highly unstable: the coefficient of variation of net profit is 90.1 per cent and 15.0 per cent of cultivators recorded an outright loss. Total expenditure and net profit are significantly and positively associated ($\chi^2 = 21.395$, $df = 9$, $p = 0.011$; Monte Carlo $p = 0.009$; Cramer's $V = 0.345$; Kendall's tau-b = 0.323, $p = 0.004$; gamma = 0.430), and the association survives collapsing the table into a two-by-two form ($\chi^2 = 15.628$, $df = 1$, $p < 0.001$; odds ratio = 10.12). The null hypothesis of independence is therefore rejected. Since marginal returns to expenditure remain positive, cultivators in the study area appear to be operating below the profit-maximising level of input use, which points to credit and risk constraints rather than allocative inefficiency. Labour shortage (38.3 per cent) and price fluctuation (46.7 per cent) emerged as the dominant production and marketing constraints respectively. The paper argues that input subsidy alone is an incomplete remedy and that credit access, price stabilisation and collective marketing are the binding policy levers.

Index Terms – Turmeric cultivation, Cost of cultivation, Benefit-cost ratio, Farm profitability, Marketing constraints, Agricultural risk, Namakkal district.

I. INTRODUCTION

Turmeric (*Curcuma longa* L.), a rhizomatous perennial of the Zingiberaceae family, is among the few agricultural commodities in which India is simultaneously the largest producer, the largest consumer and the largest exporter in the world. Its uses span culinary, pharmaceutical, cosmetic and ritual applications, and demand for curcumin-rich material in the nutraceutical trade has grown steadily over the past decade. For the cultivator, however, turmeric is less a golden spice than a demanding one. It occupies the land for eight to nine months, requires heavy applications of seed rhizome, organic matter and irrigation, and is

harvested, boiled, dried and polished before it can be sold. The crop therefore ties up working capital for the better part of a year and exposes the grower to both yield risk and a notoriously volatile farm-gate price.

Tamil Nadu is among the leading turmeric-producing states, and within the state the Erode-Namakkal belt accounts for a substantial share of area and output. Namakkal district combines red loamy soils, an established canal and well irrigation network, and proximity to the processing and trading infrastructure of Erode, which together make turmeric a natural commercial choice for cultivators in the district. Varagur village is representative of this belt. Cultivation there is neither subsistence-oriented nor large-scale corporate farming; it is medium-scale commercial agriculture undertaken by owner-cultivators with modest holdings, financed largely from own savings and informal credit, and sold predominantly to processors and export agents rather than through regulated markets.

Economic analysis of such a system requires more than a description of practices. The relevant questions are how much the cultivator spends, what he earns, how reliably he earns it, and whether the expenditure he undertakes is the expenditure that maximises his return. The last of these is the least examined in the Indian literature on spice crops and is the analytical core of the present paper. If additional expenditure continues to generate additional profit at the margin, the constraint on farm income is the cultivator's capacity to finance inputs rather than his skill in using them. If it does not, the constraint lies in technology or in allocation. The policy prescriptions implied by the two diagnoses are entirely different, and the distinction cannot be drawn from descriptive statistics alone.

This study accordingly examines the economics of turmeric cultivation in Varagur village with reference to cost structure, returns, profitability, risk and constraints, and tests formally whether total expenditure and net profit are independent of one another among the sample cultivators.

1.1 Statement of the Problem

Turmeric growers in Namakkal district operate in an environment of rising input costs and unstable output prices. Fertiliser and labour charges have risen steadily, while the farm-gate price of dry turmeric has moved through pronounced cycles driven by carry-over stocks, export demand and speculative holding in the Erode market. The cultivator commits a large outlay at planting and discovers the price only at sale, eight or nine months later. Under these conditions the profitability of the crop cannot be inferred from its gross return; it depends on the joint behaviour of cost and price, and on the cultivator's ability to absorb a bad year. Field observation in Varagur suggested wide dispersion in outcomes, with some cultivators recording substantial surpluses and others outright losses in the same season and under similar agro-climatic conditions. The problem examined here is to measure this dispersion, to estimate the average return to the crop, and to determine whether the observed variation in profit is systematically related to the level of expenditure undertaken.

1.2 Research Gap

The available Indian literature on turmeric economics falls into three groups: studies of instability in area, production and productivity; studies of marketing efficiency and price spread; and studies of production constraints. Each is informative, but three gaps remain. First, the district-level and state-level focus of most existing work leaves the individual holding unexamined, so that averages conceal the dispersion that matters most to the cultivator. Second, the relationship between expenditure and profitability is generally reported descriptively, if at all, rather than tested, with the consequence that the question of whether growers are operating at, below or beyond the optimal level of input use is left open. Third, where inferential statistics are applied to categorical farm survey data, the choice of technique has not always matched the measurement level of the variables. The present study addresses these gaps through a micro-level analysis of Varagur village using techniques appropriate to ordered categorical data.

1.3 Need and Significance of the Study

Turmeric is a working-capital-intensive crop grown predominantly by cultivators with holdings of two to five acres and limited access to formal credit. For such a household, a season of loss is not merely a reduction in income but a depletion of the capital required to plant the following season, which is the mechanism by which a single adverse price movement can push a commercially viable farm into a contracting cycle. Understanding the magnitude of this risk, and its relationship to expenditure decisions, is therefore of direct relevance to agricultural credit policy, crop insurance design and market intervention in the Erode-Namakkal belt. The study is significant on three counts. It supplies farm-level estimates of cost, return and benefit-cost ratio for a crop for which such estimates are scarce at village level; it quantifies the instability of returns rather than reporting averages alone; and it draws an economically interpretable inference about the position of cultivators on the returns function, which converts a statistical result into a policy diagnosis.

1.4 Objectives of the Study

1. To examine the socio-economic profile of turmeric cultivators in Varagur village.
2. To analyse the cultivation practices, production pattern and cost structure of turmeric cultivation in the study area.
3. To estimate the returns, profitability and instability of returns from turmeric cultivation.
4. To identify the production and marketing constraints faced by turmeric cultivators.
5. To examine the relationship between total expenditure and net profit of turmeric cultivators.

1.5 Hypotheses

The following hypothesis was formulated and tested at the 5 per cent level of significance.

H0: There is no significant relationship between the total expenditure and the net profit of turmeric cultivators in the study area.

H1: There is a significant relationship between the total expenditure and the net profit of turmeric cultivators in the study area.

1.6 Scope of the Study

The study is confined to Varagur village in Namakkal district, Tamil Nadu, and to 60 turmeric cultivators surveyed during the January to March 2026 period, corresponding to the harvest and post-harvest phase of the 2025-26 season. Expenditure refers to the total cash and imputed outlay on the turmeric crop for the season, and net profit to the residual after this outlay is deducted from the value of output. The analysis covers cultivation practice, cost structure, returns, marketing channel and constraints. Agronomic questions of variety performance, soil chemistry and disease aetiology fall outside its scope, as do the downstream economics of processing and export.

II. REVIEW OF LITERATURE

2.1 Theoretical Perspective

Schultz [1] advanced the proposition that cultivators in traditional agriculture are efficient in the allocation of the resources available to them and that low incomes reflect the poverty of the available technology rather than any failure of decision-making. The corollary is that gains in farm income must come from the introduction of new and more productive inputs rather than from the reallocation of existing ones. The proposition is testable: if cultivators have exhausted the profitable opportunities within their existing technology, marginal returns to further expenditure should approach zero, and the level of expenditure should carry little information about profit. Where marginal returns remain positive, the more plausible explanation is that some constraint other than knowledge, most commonly credit or risk-bearing capacity, is preventing cultivators from reaching the optimum.

Just and Pope [2] formalised the treatment of risk in agricultural production by allowing inputs to affect both the mean and the variance of output, distinguishing risk-increasing from risk-reducing inputs. Their framework explains why a risk-averse cultivator may rationally apply less than the profit-maximising quantity of an input whose use raises expected return but also raises variability. Newbery and Stiglitz [3] examined the welfare economics of commodity price instability and showed that the benefit of price stabilisation to producers depends on the covariance between price and quantity, a consideration directly relevant to a crop such as turmeric with pronounced price cycles. Ellis [4] situated these arguments within the broader theory of the peasant farm household, where production and consumption decisions are not separable and where working capital constraints bind particularly hard on crops with long gestation. Sen [5] and, more recently, Chand, Prasanna and Singh [6] examined the relationship between farm size and productivity in Indian agriculture, a debate with direct bearing on the interpretation of landholding patterns in the present sample.

2.2 Empirical Studies on Turmeric

Angles and Hosamani [7] analysed instability in the area, production and productivity of turmeric across selected South Indian states and found that fluctuations in productivity contributed materially to instability in production, recommending technological improvement and stronger farmer support systems. Maheswaran and Muruganandam [8] examined marketing efficiency for turmeric in Tamil Nadu and drew attention to the role of intermediaries and marketing costs in compressing the cultivator's share of the consumer rupee. Patil et al. [9] analysed the economics of turmeric production, processing and marketing in Maharashtra and concluded that value addition through processing raised producer incomes substantially, indicating that the terms on which raw rhizome is sold matter as much as the quantity produced.

Ramanathan [10] assessed the performance and prospects of Indian turmeric exports and identified unstable prices and the absence of organised marketing arrangements as the principal difficulties confronting small growers. Kiruthika [11] studied input use efficiency and profitability in Erode district and reported that larger cultivators realised higher profits than marginal ones, a finding consistent with the presence of scale-related credit and marketing advantages. Shanmugaraja et al. [12] documented the constraints facing turmeric growers in Namakkal district and identified high fertiliser cost, labour shortage, disease incidence and inadequate rainfall as the dominant problems, which corresponds closely to the constraint profile reported in the present study. Acharya [13] provided the broader institutional context, arguing that the fragmentation of Indian agricultural marketing and the weakness of regulated market infrastructure systematically disadvantage producers of non-cereal commercial crops.

2.3 Synthesis and Research Contribution

Taken together, this literature establishes that turmeric is profitable on average, that its profitability is unstable, and that marketing arrangements and input costs are the principal determinants of the cultivator's residual. What it does not establish is where cultivators stand in relation to the profit-maximising level of expenditure. Instability studies measure variation over time; marketing studies measure the price spread; constraint studies enumerate difficulties. None tests the relationship between the outlay a cultivator commits and the profit he realises, which is the question that separates a credit-constraint diagnosis from an efficiency diagnosis. The present study makes its contribution at this point, by treating expenditure and profit as ordered categorical variables and testing their independence with techniques suited to that measurement level, and by interpreting the result within the framework of Schultz [1].

III. ANALYTICAL FRAMEWORK

Let the representative cultivator produce turmeric on area A with yield per acre Y and receive a farm-gate price p per unit. Let x denote the vector of variable inputs (seed rhizome, fertiliser, manure, plant protection, irrigation, labour and post-harvest processing) with corresponding prices w . Net profit for the season is

$$\pi = p \cdot Y(x) \cdot A - \sum w_i x_i$$

and total expenditure is $E = \sum w_i x_i$. Gross return is $GR = p \cdot Y(x) \cdot A = \pi + E$, so that the benefit-cost ratio, the standard summary measure of farm profitability, is

$$BCR = GR / E = 1 + (\pi / E)$$

A ratio exceeding unity indicates that the enterprise recovers its costs; the margin above unity measures the return per rupee of outlay.

The profit-maximising cultivator equates the value of the marginal product of each input to its price, so that at the optimum $d\pi/dE = 0$. Away from the optimum the derivative is informative. If cultivators as a group are positioned below the optimum, so that $d\pi/dE > 0$, then across the cross-section higher expenditure will be systematically associated with higher profit, and the association will be monotonic. If they are positioned at or beyond the optimum, expenditure will carry no information about profit, or will be negatively related to it. The hypothesis stated in Section 1.5 therefore has a direct economic interpretation rather than a merely statistical one: rejection of independence in the positive direction is evidence that marginal returns to expenditure remain unexploited.

Two considerations complicate the inference and are taken up in the discussion. Following Just and Pope [2], an input that raises expected profit may also raise its variance, so a risk-averse cultivator facing an uninsured downside may rationally stop short of the optimum; the observed association would then reflect risk aversion rather than ignorance. Following Ellis [4], a working capital constraint produces the same observable pattern for a different reason. Both explanations imply positive marginal returns, and both point towards financial rather than extension-based remedies, but they are not distinguishable from the cross-section alone.

Instability of returns is measured by the coefficient of variation of net profit, $CV = \sigma\pi / \mu\pi$, expressed as a percentage, together with the incidence of outright loss in the sample. Both are reported because a mean profit figure computed over a distribution that includes losses conveys an incomplete picture of the risk the cultivator actually bears.

IV. RESEARCH METHODOLOGY

4.1 Research Design

The study adopts a descriptive and analytical design based on a cross-sectional farm survey. The design is appropriate to the objective of characterising cost, return and constraint structures for a single crop season and of testing association between farm-level variables. It does not support inference about change over time, and the limitation is acknowledged in Section X.

4.2 Study Area

Varagur is a revenue village in Namakkal district, Tamil Nadu, situated within the turmeric-growing belt that extends from Erode into the eastern part of Namakkal. Cultivation in the village is supported by canal and well irrigation, and cropping is dominated by turmeric, with maize, groundnut and fodder crops in rotation. Marketing is oriented towards the processing and export trade rather than towards local consumption. The village was selected purposively because turmeric constitutes the principal commercial crop and because its holding structure, dominated by owner-cultivators with two to five acres, is representative of the belt.

4.3 Sampling Design and Sample Size

Sixty turmeric cultivators were selected by simple random sampling from the list of turmeric-growing households maintained in the village, and the principal cultivator in each household was interviewed. For a binary population proportion of 0.50 at 95 per cent confidence, a sample of 60 corresponds to a margin of error of approximately ± 12.6 percentage points, which is adequate for the detection of the moderate to strong associations reported here but not for fine disaggregation by sub-group. The adequacy of expected cell frequencies in the principal cross-tabulation is examined explicitly in Section VI.

4.4 Data Collection and Instrument

Primary data were collected through a structured interview schedule administered face to face in Tamil between January and March 2026, a period chosen to coincide with harvest and first sale so that both cost and realised price were within recent recall. The schedule covered demographic particulars, landholding, variety and irrigation source, yield, manure and fertiliser practice, the composition of expenditure, marketing channel, total expenditure and net profit for the season, and production and marketing constraints. Expenditure and profit were recorded in ordered class intervals rather than as point values, both because cultivators maintain few written accounts and because interval reporting reduces refusal on financially sensitive items. This measurement decision governs the choice of statistical technique discussed in Section 4.6. Secondary data were drawn from agricultural economics journals, the agricultural statistics of the Government of Tamil Nadu [14] and the spices reports of the Ministry of Agriculture and Farmers Welfare [15].

4.5 Variables and Measurement

Table 1: Variables, Measurement Level and Categories

Variable	Measurement level	Categories
Total expenditure	Ordinal (4 classes)	Below ₹1 lakh; ₹1–1.5 lakh; ₹1.5–2 lakh; above ₹2 lakh
Net profit	Ordinal (4 classes)	Loss; below ₹0.5 lakh; ₹0.5–1 lakh; above ₹1 lakh
Landholding size	Ordinal (4 classes)	Below 2 acres; 2–5; 5–10; above 10 acres
Yield per acre	Ordinal (4 classes)	Below 20 quintals; 20–30; 30–40; above 40 quintals
Education level	Ordinal (4 classes)	Illiterate; primary; secondary; higher education
Turmeric variety	Nominal	Alleppey Finger; Erode Local; IISR-Prathibha; others
Irrigation source	Nominal	Rainfed; well; canal; drip
Manure practice	Nominal	Fully organic; mixed; chemical only; none
Major cost component	Nominal	Rhizomes; fertilisers; labour; pesticides
Primary buyer	Nominal	Local trader; processor; export agent; co-operative
Production constraint	Nominal	Labour shortage; rainfall scarcity; disease attack; high input costs

Variable	Measurement level	Categories
Marketing constraint	Nominal	Price fluctuation; lack of transport; middlemen; storage

Source: Constructed by the author from the survey instrument. Constraint variables record the constraint ranked first by the respondent.

4.6 Tools of Analysis and Justification of Technique

Percentage analysis and cross-tabulation were used to describe the socio-economic, cultivation and marketing profile of the sample. Because expenditure, profit, yield and landholding were recorded in class intervals, measures of central tendency and dispersion were obtained by grouped-data estimation using class midpoints. The mean was computed as $\mu = \sum f_i m_i / \sum f_i$ and the standard deviation as $\sigma = \sqrt{[\sum f_i (m_i - \mu)^2 / (n - 1)]}$, where m_i denotes the midpoint and f_i the frequency of the i th class. Open-ended classes were closed at one class width, and the loss class was assigned a negative midpoint. Estimates so obtained are subject to grouping error and are reported as approximations.

For the test of the hypothesis, the two variables of interest are ordered categorical measurements arranged in a four-by-four contingency table of frequencies. The appropriate family of tests for data of this form is the chi-square test of independence and its ordinal refinements [16], not the analysis of variance. The distinction merits explicit statement, because analysis of variance is occasionally applied to tables of this kind. A two-way analysis of variance without replication treats each cell as a single observation on a continuous response variable and partitions its variance into row, column and residual components. When the cell entries are frequencies rather than measurements, three conditions of the procedure fail simultaneously: the entries are not independent observations on a response variable but counts constrained to sum to the sample size; the residual mean square has no interpretation as experimental error, since there is no replication and no random measurement process generating the cells; and the normality and homoscedasticity assumptions are untenable for counts, whose variance is a function of their mean. Applied to a four-by-four table the procedure also discards the information contained in the underlying sample of 60 observations in favour of fifteen degrees of freedom based on the cells themselves, which represents a severe and unnecessary loss of information. The result is a test of very low power that will fail to reject independence in almost all realistic cases. Chi-square-based procedures, by contrast, use the sample of 60 directly.

Accordingly the following were computed. The Pearson chi-square statistic $\chi^2 = \sum \sum (O_{ij} - E_{ij})^2 / E_{ij}$ with $(r - 1)(c - 1)$ degrees of freedom, together with the likelihood-ratio statistic G^2 . Because a majority of expected cell frequencies fell below the conventional threshold of five, in violation of the condition set out by Cochran [17], an exact probability was obtained by Monte Carlo simulation over 200,000 random tables conditioned on the observed marginals, following the approach of Freeman and Halton [18]. Cramer's V [19] was computed as $V = \sqrt{[\chi^2 / N(k - 1)]}$ to gauge the strength of association. Since both variables are ordered, the ordinal measures Kendall's tau-b [20], Goodman-Kruskal gamma [21] and Spearman's rho were computed, together with the linear-by-linear association statistic $M^2 = (N - 1)r^2$ on integer category scores, which is tested against the chi-square distribution with one degree of freedom and has greater power than the omnibus test against a monotonic alternative. As a robustness check the table was collapsed to a two-by-two form and the continuity-corrected chi-square [22], Fisher's exact probability, the phi coefficient and the odds ratio with its 95 per cent confidence interval were computed. Computational procedures follow standard practice in applied statistics [23]. All tests were assessed at the 5 per cent level.

4.7 Reliability, Validity and Ethical Considerations

Content validity was established through expert review of the schedule and a field pre-test on cultivators outside the sampling frame, after which two items yielding ambiguous responses were reworded. Interviews were conducted by the investigator in the respondent's own language, which reduced interpretation error, and expenditure responses were cross-checked against reported input quantities where these could be recalled. Participation was voluntary, informed oral consent was obtained, and no personally identifying information was recorded or retained.

V. RESULTS AND DISCUSSION

Results are based on the 60 turmeric cultivators surveyed in Varagur village. Percentages are computed on the full sample of 60 in every case and are reported to one decimal place.

5.1 Socio-Economic Profile of Cultivators

Table 2: Socio-Economic Profile of Turmeric Cultivators

Variable	Category	Frequency	Percentage
Age (years)	18–30	4	6.7
	30–45	28	46.7
	46–60	20	33.3
	Above 60	8	13.3
Gender	Male	40	66.7
	Female	20	33.3
Marital status	Married	48	80.0
	Unmarried	12	20.0
Education level	Illiterate	15	25.0
	Primary	20	33.3
	Secondary	18	30.0
	Higher education	7	11.7
Landholding size	Below 2 acres	16	26.7
	2–5 acres	25	41.7
	5–10 acres	17	28.3
	Above 10 acres	2	3.3
Total		60	100.0

Source: Primary data. No respondent reported transgender identity.

Cultivation in the study area is concentrated in the middle of the working life. Nearly half the respondents (46.7 per cent) fall in the 30 to 45 age band and a further third (33.3 per cent) in the 46 to 60 band, while only 6.7 per cent are below 30. The under-representation of young cultivators is the more notable of these figures. Turmeric is a demanding crop requiring both accumulated agronomic judgement and access to working capital, and the age profile suggests that entry into it is effectively deferred until a cultivator has acquired both. It also carries an implication for the succession of the enterprise that agricultural extension in the belt has yet to address.

Two-thirds of respondents are male and 80.0 per cent are married. The gender composition should be read with care: it records the person identified as the principal cultivator rather than the distribution of agricultural labour, and female participation in turmeric operations, particularly in weeding, harvesting and post-harvest processing, is considerably higher than the 33.3 per cent recorded here.

Educational attainment is modest. A quarter of respondents (25.0 per cent) are illiterate and 33.3 per cent have completed only primary education, while 11.7 per cent have studied beyond the secondary stage. Since the interpretation of price signals, the completion of credit documentation and the evaluation of new varietal or agronomic recommendations all rest on written material, the educational profile constitutes a practical constraint on the transmission of technical and market information, and it argues for extension delivery in oral and demonstrative form.

The landholding distribution is dominated by the medium-scale category: 41.7 per cent hold between two and five acres and 28.3 per cent between five and ten, with only 3.3 per cent above ten acres. Grouped estimation places the mean holding at approximately 4.25 acres. The absence of a large-farmer segment is analytically significant, since it means the sample is relatively homogeneous in scale and that the variation in profit observed later cannot be attributed simply to differences in farm size. It also locates the study within the debate initiated by Sen [5] and revisited by Chand, Prasanna and Singh [6] on the productivity of smallholdings, and suggests that the smallholder disadvantage in this belt operates through credit and marketing rather than through cultivation efficiency.

5.2 Cultivation and Production Pattern

Table 3: Cultivation Practices and Production Pattern

Variable	Category	Frequency	Percentage
Turmeric variety	Alleppey Finger	14	23.3
	Erode Local	39	65.0
	IISR-Prathibha	4	6.7
	Others	3	5.0
Irrigation source	Rainfed	2	3.3
	Well irrigation	24	40.0
	Canal irrigation	33	55.0
	Drip irrigation	1	1.7
Yield per acre	Below 20 quintals	8	13.3
	20–30 quintals	34	56.7
	30–40 quintals	15	25.0
	Above 40 quintals	3	5.0
Manure practice	Fully organic	18	30.0
	Mixed	26	43.3
	Chemical only	15	25.0
	None	1	1.7
Total		60	100.0

Source: Primary data.

Varietal choice is heavily concentrated. Erode Local accounts for 65.0 per cent of cultivators and Alleppey Finger for a further 23.3 per cent, while the improved release IISR-Prathibha is grown by only 6.7 per cent. The dominance of Erode Local is readily explained by its established acceptance in the Erode trade and by the ease of retaining seed rhizome from the previous harvest, but the concentration carries a cost. A varietal monoculture of this degree exposes the entire village to a common disease or a common quality discount, and the negligible uptake of improved material indicates that the varietal replacement channel in the belt is not functioning. Angles and Hosamani [7] attributed a substantial part of production instability in South Indian turmeric to precisely this kind of productivity stagnation.

Irrigation is overwhelmingly assured rather than rainfed. Canal irrigation serves 55.0 per cent of cultivators and wells a further 40.0 per cent, with only 3.3 per cent dependent on rainfall. This is consistent with turmeric's water requirement, which effectively excludes rainfed cultivation in the district. What is striking is the near-absence of drip irrigation, adopted by a single cultivator, notwithstanding that turmeric is a well-established candidate for micro-irrigation and that subsidy support for drip installation exists. The gap between the availability of the subsidy and its uptake in a village where 21.7 per cent of respondents identify rainfall scarcity as their principal production constraint is a specific and correctable administrative failure.

Yields cluster in the middle of the distribution, with 56.7 per cent obtaining between 20 and 30 quintals per acre and 25.0 per cent between 30 and 40. Grouped estimation gives a mean of approximately 27.5 quintals per acre. Only 5.0 per cent exceed 40 quintals. The distribution is therefore compressed around a moderate central value, which suggests that cultivators are operating with broadly similar technology and that the substantial dispersion in profit reported in Section 5.5 originates on the cost and price side rather than in physical productivity.

Nutrient management shows a pattern of pragmatic mixing rather than doctrinal adherence: 43.3 per cent combine organic and chemical sources, 30.0 per cent rely wholly on organic manure and 25.0 per cent wholly on chemical fertiliser. The prevalence of the mixed practice reflects an accommodation between the cost and availability of farmyard manure and the responsiveness of the crop to chemical nutrients, and it indicates a degree of nutrient management awareness that extension services can build upon.

5.3 Cost Structure and Marketing Channel

Table 4: Major Cost Component and Primary Marketing Channel

Variable	Category	Frequency	Percentage
Major cost component	Rhizomes	18	30.0
	Fertilisers	26	43.3
	Labour	15	25.0
	Pesticides	1	1.7
Primary buyer	Local trader	6	10.0
	Processor	27	45.0
	Export agent	20	33.3
	Co-operative	7	11.7
Total		60	100.0

Source: Primary data. Cost component records the item identified by the respondent as the single largest element of expenditure.

Fertilisers constitute the single largest element of expenditure for 43.3 per cent of cultivators, followed by seed rhizome for 30.0 per cent and labour for 25.0 per cent. Plant protection is the leading item for only 1.7 per cent. The prominence of seed rhizome deserves comment, since it is a cost that a well-functioning seed system would substantially reduce: cultivators retaining rhizome from their own harvest forgo the marketable value of that quantity, and those purchasing it pay the prevailing market price for material of uncertain quality. The concentration of expenditure in purchased inputs, rather than in labour, also indicates the extent to which the crop's cost structure is exposed to input price movements outside the cultivator's control.

The marketing pattern is decisively commercial. Processors purchase from 45.0 per cent of cultivators and export agents from a further 33.3 per cent, so that more than three-quarters of the sample sells into the processing and export trade rather than to local traders. Co-operatives account for 11.7 per cent. This is a favourable structure relative to that documented for many Indian commercial crops, and it reflects the maturity of the Erode-Namakkal trade. It does not, however, follow that the cultivator's bargaining position is strong. Individual growers selling to a small number of processors face a concentrated demand side, and the 28.3 per cent who identify middlemen as their principal marketing difficulty (Table 5) indicate that intermediation persists within this apparently direct channel. Maheswaran and Muruganandam [8] reached a similar conclusion regarding the price spread in Tamil Nadu turmeric marketing.

5.4 Production and Marketing Constraints

Table 5: Principal Production and Marketing Constraints Reported

Constraint type	Category	Frequency	Percentage
Production	Labour shortage	23	38.3
	Rainfall scarcity	13	21.7
	Disease attack	12	20.0
	High input costs	12	20.0
Marketing	Price fluctuation	28	46.7
	Middlemen problem	17	28.3
	Lack of transport	12	20.0
	Storage issues	3	5.0
Total (each block)		60	100.0

Source: Primary data. Respondents identified the constraint ranked first in each category.

Labour shortage is the leading production constraint, reported by 38.3 per cent of cultivators. This is unsurprising for a crop whose peak operations of planting, weeding and harvesting are labour-intensive and imperfectly mechanised, and whose harvest coincides with competing demand from other crops in the belt. Rainfall scarcity (21.7 per cent), disease attack (20.0 per cent) and high input costs (20.0 per cent) follow at similar levels. The constraint profile corresponds closely to that documented by Shanmugaraja et al. [12] for Namakkal district, which suggests both that the finding is robust and that the underlying problems have proved durable.

On the marketing side, price fluctuation dominates, affecting 46.7 per cent of respondents, with middlemen cited by 28.3 per cent, transport by 20.0 per cent and storage by 5.0 per cent. The low weight attached to storage is best interpreted alongside the price finding rather than separately. A cultivator who possessed the storage capacity and the working capital to hold stock would treat price fluctuation as an opportunity rather than a hazard; the fact that price volatility is experienced almost universally as a

problem indicates that most growers must sell at or near harvest regardless of the prevailing price. Newbery and Stiglitz [3] analysed this configuration in general terms, and it is the distress-sale mechanism that converts price instability into income instability for the producer.

5.5 Estimated Cost, Returns and Profitability

Grouped estimation from the reported expenditure and profit distributions yields the following farm-level economics for the 2025-26 season.

Table 6: Estimated Cost, Returns and Profitability per Cultivator, 2025-26 Season

Particulars	Estimate (₹)	Estimate (₹ lakh)
Mean total expenditure (cost of cultivation)	1,46,667	1.467
Mean net profit	52,500	0.525
Implied mean gross return	1,99,167	1.992
Benefit-cost ratio (GR / E)	1.36	—
Net profit margin on gross return	26.4 per cent	—
Standard deviation of net profit	47,300	0.473
Coefficient of variation of net profit	90.1 per cent	—
Incidence of loss (9 of 60 cultivators)	15.0 per cent	—
Mean yield per acre	27.5 quintals	—

Source: Computed by the author from primary data using class midpoints. Open-ended classes closed at one class width; the loss class assigned a midpoint of ₹0.25 lakh. Estimates are subject to grouping error.

The central result is that turmeric cultivation in Varagur is profitable on average. A benefit-cost ratio of 1.36 means that the cultivator recovers approximately ₹1.36 for every rupee of outlay, leaving a net margin of 26.4 per cent on gross return. This is a respectable return for an annual field crop and it confirms the commercial rationale for the crop's dominance in the village cropping pattern. It is broadly consistent with the profitability reported for turmeric in Erode district by Kiruthika [11].

The average, however, conceals the risk. The coefficient of variation of net profit is 90.1 per cent, meaning that the dispersion of profit across cultivators is almost as large as its mean, and 15.0 per cent of the sample recorded an outright loss in the season surveyed. This is the finding with the greatest practical significance in the study. A cultivator committing approximately ₹1.47 lakh of working capital to a single crop faces a roughly one-in-seven probability of ending the season worse off than he began it, with no compensating instrument in place. Since the yield distribution is comparatively compressed, as noted in Section 5.2, the source of this dispersion lies predominantly in realised price and in cost, not in physical output. The finding thus locates the risk squarely in the market rather than in the field, and it is the analytical foundation for the policy argument developed in Section VIII.

VI. TESTING OF HYPOTHESIS

6.1 Joint Distribution of Expenditure and Net Profit

Table 7: Cross-Classification of Total Expenditure and Net Profit

Total expenditure	Loss	Below ₹0.5 lakh	₹0.5–1 lakh	Above ₹1 lakh	Row total
Below ₹1 lakh	1	4	3	1	9
₹1–1.5 lakh	6	12	5	1	24
₹1.5–2 lakh	1	1	12	5	19
Above ₹2 lakh	1	2	2	3	8
Column total	9	19	22	10	60

Source: Primary data.

The pattern in the body of the table is visible before any test is applied. Cultivators in the ₹1 to ₹1.5 lakh expenditure class are concentrated in the two lowest profit categories, with 18 of 24 recording a loss or a profit below ₹0.5 lakh. Those in the ₹1.5 to ₹2 lakh class occupy the opposite position, with 17 of 19 recording profits of ₹0.5 lakh or more. The mass of the table lies along the principal diagonal, which is the signature of a positive monotonic relationship. The lowest expenditure class is a partial exception, and the explanation is instructive: cultivators spending below ₹1 lakh are largely those with the smallest area under the crop, so their absolute profit is bounded by scale rather than by any inefficiency in their use of inputs.

6.2 Test of Independence

Table 8: Tests of Association between Total Expenditure and Net Profit

Test statistic	Value	df	p-value	Inference
Pearson chi-square	21.395	9	0.0110	Significant
Likelihood-ratio chi-square (G^2)	23.353	9	0.0055	Significant
Monte Carlo exact probability	—	—	0.0092	Significant
Linear-by-linear association (M^2)	6.389	1	0.0115	Significant
Cramer's V	0.345	—	—	Moderate
Kendall's tau-b	0.323	—	0.0037	Significant
Goodman-Kruskal gamma	0.430	—	—	Moderate
Spearman's rho	0.374	—	0.0032	Significant

Source: Computed by the author from primary data. All association measures are positive in sign. Monte Carlo probability based on 200,000 tables simulated under the observed marginals. Minimum expected cell frequency = 1.20; 12 of 16 cells (75.0 per cent) have expected frequencies below 5.

The Pearson chi-square value of 21.395 with nine degrees of freedom exceeds the critical value of 16.919 at the 5 per cent level, and the associated probability of 0.0110 falls below the chosen threshold. Because 75.0 per cent of the expected cell frequencies lie below five, in violation of the condition set out by Cochran [17], the asymptotic probability cannot be relied upon on its own. The Monte Carlo exact probability of 0.0092, obtained from 200,000 tables simulated under the observed marginal totals, confirms the asymptotic result and in fact yields a slightly smaller probability. The likelihood-ratio statistic

of 23.353 ($p = 0.0055$) points in the same direction. The null hypothesis of independence is therefore rejected.

Since both variables are ordered, the omnibus test understates the evidence. The linear-by-linear association statistic, which tests specifically against a monotonic alternative on integer category scores, gives $M^2 = 6.389$ with one degree of freedom ($p = 0.0115$). All three ordinal measures of association are positive and moderate in magnitude: Kendall's tau-b is 0.323 ($p = 0.0037$), Spearman's rho is 0.374 ($p = 0.0032$) and Goodman-Kruskal gamma is 0.430. The gamma value indicates that among pairs of cultivators differing on both variables, roughly 71 per cent are concordant, that is, the cultivator with the higher expenditure also records the higher profit. Cramer's V of 0.345 places the strength of association in the moderate range by conventional standards.

6.3 Robustness Check on the Collapsed Table

To confirm that the result is not an artefact of sparse cells, the table was collapsed into a two-by-two form by combining expenditure classes at the ₹1.5 lakh threshold and profit classes at the ₹0.5 lakh threshold. This raises the minimum expected frequency to 12.60 and removes the sparseness problem entirely.

Table 9: Collapsed Cross-Classification of Expenditure and Net Profit

Total expenditure	Loss or profit below ₹0.5 lakh	Profit ₹0.5 lakh and above	Total
Up to ₹1.5 lakh	23 (69.7)	10 (30.3)	33 (100.0)
Above ₹1.5 lakh	5 (18.5)	22 (81.5)	27 (100.0)
Total	28	32	60

Source: Primary data. Figures in parentheses are row percentages. $\chi^2 = 15.628$, $df = 1$, $p = 0.000077$; continuity-corrected $\chi^2 = 13.639$, $p = 0.00022$; Fisher's exact (two-tailed) $p = 0.000092$; phi = 0.510; odds ratio = 10.12 (95% CI: 2.98 – 34.36); minimum expected frequency = 12.60.

The collapsed table sharpens rather than weakens the result. Among cultivators spending up to ₹1.5 lakh, 69.7 per cent recorded a loss or a profit below ₹0.5 lakh; among those spending more, only 18.5 per cent did so. The chi-square value of 15.628 is significant beyond the 0.1 per cent level, the continuity-corrected and Fisher exact probabilities agree, and the phi coefficient of 0.510 indicates a strong association. The odds ratio of 10.12 means that cultivators in the higher expenditure group had about ten times the odds of achieving a profit of ₹0.5 lakh or more, though the confidence interval from 2.98 to 34.36 is wide and the point estimate should be treated with corresponding caution. The null hypothesis is rejected on both the full and the collapsed table, and the conclusion is not sensitive to the categorisation adopted.

6.4 Economic Interpretation

The statistical result carries a specific economic meaning within the framework of Section III. A significant positive monotonic association between expenditure and net profit across the cross-section implies that $d\pi/dE$ remains positive over the range of expenditure observed in the sample. Cultivators in Varagur are therefore operating below, not at, the profit-maximising level of input use. Had they exhausted the profitable opportunities available within their existing technology, as the proposition of Schultz [1] would suggest for a mature traditional system, expenditure would carry little information about profit and the test would have failed to reject independence.

Two explanations are consistent with this pattern and cannot be separated on cross-sectional evidence. The first is a working capital constraint: cultivators would apply more inputs if they could finance them, and the binding limit is access to credit on terms that do not consume the additional return. The second is risk aversion in the sense of Just and Pope [2]: additional expenditure raises expected profit but also raises exposure, and in a season where 15.0 per cent of the sample recorded a loss, a cultivator without insurance or reserves may rationally decline the gamble. The high coefficient of variation of 90.1 per cent documented in Table 6 lends weight to the second explanation, and the concentration of the sample in

holdings of two to five acres lends weight to the first. Both point in the same policy direction, which is examined in Section VIII: the binding constraint on farm income in the study area is financial rather than technical, and instruments that relax it will raise incomes more than extension activity aimed at cultivation practice.

One qualification is necessary. Expenditure and profit are both functions of the area under the crop, which was not recorded separately from total landholding, so part of the observed association reflects scale. The finding should therefore be read as establishing a robust positive relationship between the level of the enterprise and its return, of which the marginal-returns interpretation is the most plausible but not the only possible reading. Section X sets out the design that would separate the two effects.

VII. MAJOR FINDINGS

1. Turmeric cultivation in Varagur village is undertaken predominantly by middle-aged cultivators, with 46.7 per cent in the 30 to 45 age group and only 6.7 per cent below 30, indicating deferred entry into a capital-intensive and knowledge-intensive crop.
2. Educational attainment is modest, with 25.0 per cent of cultivators illiterate and only 11.7 per cent educated beyond the secondary stage, which constrains the written transmission of technical and market information.
3. The holding structure is dominated by medium-scale cultivators, with 41.7 per cent holding two to five acres and a mean estimated holding of 4.25 acres; large holdings are effectively absent.
4. Varietal choice is highly concentrated, with 65.0 per cent cultivating Erode Local and only 6.7 per cent adopting the improved IISR-Prathibha release, indicating a non-functioning varietal replacement channel.
5. Irrigation is assured for 95.0 per cent of cultivators through canal or well sources, but drip irrigation is adopted by a single respondent despite available subsidy support and despite 21.7 per cent reporting rainfall scarcity as their principal production constraint.
6. Yields are compressed around a mean of 27.5 quintals per acre, with 56.7 per cent obtaining between 20 and 30 quintals, indicating broadly uniform physical productivity across the sample.
7. Fertilisers constitute the largest single element of expenditure for 43.3 per cent of cultivators, followed by seed rhizome for 30.0 per cent and labour for 25.0 per cent.
8. Marketing is oriented towards the commercial trade, with 78.3 per cent of cultivators selling to processors or export agents and only 11.7 per cent through co-operatives.
9. Labour shortage is the leading production constraint, reported by 38.3 per cent, while price fluctuation is the leading marketing constraint, reported by 46.7 per cent.
10. Mean total expenditure is estimated at ₹1,46,667 per cultivator per season against a mean net profit of ₹52,500, giving an implied gross return of ₹1,99,167 and a benefit-cost ratio of 1.36.
11. Returns are highly unstable: the coefficient of variation of net profit is 90.1 per cent and 15.0 per cent of cultivators recorded an outright loss in the season surveyed.
12. Total expenditure and net profit are significantly and positively associated ($\chi^2 = 21.395$, $df = 9$, $p = 0.0110$; Monte Carlo exact $p = 0.0092$; Kendall's tau-b = 0.323, $p = 0.0037$; gamma = 0.430), and the association is confirmed on the collapsed table ($\chi^2 = 15.628$, $df = 1$, $p < 0.001$; odds ratio = 10.12). The null hypothesis of independence is rejected.
13. Since marginal returns to expenditure remain positive over the observed range, cultivators appear to be operating below the profit-maximising level of input use, which points to credit access and risk-bearing capacity rather than allocative inefficiency as the binding constraint on farm income.

VIII. POLICY SUGGESTIONS

The findings support a shift in emphasis from input subsidy towards financial and market instruments. The measures below follow directly from the results rather than from general prescription, and are ordered by their expected effect.

1. Expand seasonal crop credit calibrated to the actual cost of turmeric cultivation. The estimated mean outlay of ₹1.47 lakh per cultivator, combined with evidence that marginal returns to expenditure remain positive, indicates that credit limits set on generic per-acre norms are binding. Kisan Credit Card limits for turmeric growers in the belt should be reassessed against the crop's scale of finance, and disbursement timed to the planting rather than the fiscal calendar.
2. Extend crop insurance coverage to turmeric on terms that reflect price as well as yield risk. With a loss incidence of 15.0 per cent and a coefficient of variation of profit of 90.1 per cent, the risk borne by the individual cultivator is substantial, and the evidence that the yield distribution is compressed while the profit distribution is not indicates that a purely yield-indexed product would fail to cover the operative risk.
3. Strengthen collective marketing through farmer producer organisations. With 78.3 per cent of cultivators selling individually to processors and export agents, and 28.3 per cent reporting middlemen as their principal marketing difficulty, aggregation at the point of sale is the most direct means of improving the terms of trade. Registered FPOs in the belt should be linked to the spice export trade and enabled to negotiate on behalf of members.
4. Create warehousing capacity with a pledge finance facility. The near-absence of storage complaints alongside near-universal complaint about price fluctuation indicates that cultivators are not attempting to store because they cannot finance the wait. A warehouse receipt system permitting borrowing against stored produce would convert price volatility from a hazard into a manageable timing decision.
5. Revive the varietal replacement channel. Adoption of improved material at 6.7 per cent is too low to be explained by cultivator preference alone. Seed rhizome of improved varieties should be multiplied locally and distributed through demonstration plots in the village, which would also reduce the seed cost that constitutes the largest expenditure item for 30.0 per cent of cultivators.
6. Promote drip irrigation actively rather than passively. A single adopter in a village where a fifth of cultivators report water scarcity indicates a failure of delivery rather than of the scheme. Field demonstration, assistance with subsidy documentation and linkage to credit would address the three plausible causes.
7. Support mechanisation of peak-season operations. Labour shortage, the leading production constraint at 38.3 per cent, is unlikely to ease and is best addressed through custom hiring centres offering planters, weeders and harvesters on a shared basis, which is more feasible than individual ownership at the prevailing holding size.
8. Deliver extension in oral and demonstrative form. Given that a quarter of cultivators are illiterate, printed advisory material cannot be the primary channel; field demonstrations, farmer field schools and voice-based advisory services are better suited to the educational profile of the sample.

IX. CONCLUSION

This study examined the economics of turmeric cultivation in Varagur village of Namakkal district on the basis of primary data from 60 cultivators. The crop is profitable: mean expenditure of approximately ₹1.47 lakh yields a mean net profit of ₹0.53 lakh and a benefit-cost ratio of 1.36, confirming the commercial rationale for its dominance in the village cropping pattern. But profitability and security are not the same thing. With a coefficient of variation of net profit of 90.1 per cent and a loss incidence of 15.0 per cent in a single season, the cultivator commits a large working capital outlay against a return whose dispersion approaches its mean, and does so without insurance, without storage, and largely without formal credit.

The principal analytical finding is that total expenditure and net profit are not independent. The association is positive, monotonic, moderate in strength and robust to the categorisation adopted, and it survives an exact test conditioned on the observed marginals. The economic implication is that marginal returns to expenditure have not been exhausted in the study area, and that cultivators are operating below rather than at the profit-maximising level of input use. This is not a finding about the competence of cultivators. It is a finding about their circumstances: a grower who cannot borrow against the crop and cannot insure it will stop short of the optimum whatever his agronomic judgement, and will do so rationally.

The policy conclusion follows. Interventions directed at cultivation practice address a constraint that is not binding in this village, where yields are uniform and nutrient management is already pragmatic. Interventions directed at the cultivator's balance sheet, namely credit calibrated to the crop's scale of finance, insurance covering price as well as yield, warehousing with pledge finance, and collective marketing, address the constraint that is. Turmeric cultivation in Namakkal district is economically sound and can remain so; whether it also becomes secure depends on institutional support that the present study finds to be largely absent at village level.

X. LIMITATIONS AND SCOPE FOR FURTHER RESEARCH

Four limitations qualify these findings. The sample of 60 cultivators drawn from a single village supports the detection of moderate to strong associations but not fine disaggregation, and the results describe the Erode-Namakkal turmeric belt rather than Tamil Nadu agriculture generally. Expenditure and profit were recorded in class intervals rather than as point values, so the estimates of mean, standard deviation and benefit-cost ratio are subject to grouping error and the tests use ordered categories rather than continuous measurements. Area under turmeric was not recorded separately from total landholding, so scale and intensity effects cannot be separated in the expenditure-profit relationship. The design is cross-sectional and covers a single season, which means the estimated profitability is conditional on the price prevailing in 2025-26 and cannot be generalised across the price cycle.

These limitations map directly onto the design of further work. Recording expenditure and returns as continuous values per acre under the crop would permit estimation of a Cobb-Douglas or translog production function, from which marginal value products and allocative efficiency ratios could be computed directly rather than inferred from association. A larger multi-village sample across Namakkal and Erode districts would allow multiple regression or a stochastic frontier specification with controls for education, holding size, irrigation source, variety and marketing channel, and would permit technical efficiency scores to be estimated for individual holdings. A specification of the kind proposed by Just and Pope [2], separating the mean and variance functions, would test formally whether particular inputs are risk-increasing, which is the question left open in Section 6.4. Panel data across several seasons would permit the profitability of the crop to be assessed over the price cycle rather than at a single point in it, and would allow instability to be decomposed into price and yield components. Finally, a comparative study of cultivators marketing through farmer producer organisations against those selling individually would provide direct evidence on the price gain from collective marketing recommended in Section VIII.

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