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An Economic Analysis of Market-induced Production of Winter Cucumber: A study in the Cooch Behar District of West Bengal

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ABSTRACT

The study was conducted during September, 2022 to August, 2023 in Cooch Behar, a terai district of West Bengal, India to investigate the economics of market-induced winter cucumber production in Cooch Behar, West Bengal, across four staggered sowing windows, with emphasis on intra-seasonal profitability variability and marketing cost burden. Depending on the consistency of demand, the sowing time was staggered into four successive spells between mid-September to mid-November, each having two weeks gap to constitute fourteen weeks supply window between mid-November to end of February. Data was gathered through a field survey and structured interviews. The study comprises 1338.73 t of green cucumber worth ₹ 21974738.09 supplied by 56 practicing farmers. While the second crop (sowing early to mid-October) produced the highest gross returns at ₹ 10,44,599.70 ha^{-1} and the best return-cost ratio of 3.66, the fourth crop (sowing early to mid-November) unfortunately led to a net loss of ₹ 97,622.40 ha^{-1}. Labour made up 38–42% of variable costs, and marketing expenses by farmers were quite low (1.00–2.65% of gross returns). This revealed significant variability in intra-season value returns, as indicated by a Gini coefficient of 0.6985. This recommended that farmers should restrict cultivation up to the third spell of sowing or to search for a new market destination.

KEYWORDS: Market demand, off-season, recession, variability, intra-season, cultivation

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1. INTRODUCTION

India ranks as the second-largest producer of fruits and vegetables in the world, with vegetables contributing approximately 28.3% to the total output value of the crop sub-sector in 2022–23, thereby surpassing cereals as the most economically valuable crop group (Anonymous, 2022; Anonymous, 2023). Among the diverse range of vegetable crops cultivated across the country, cucumber (*Cucumis sativus* L.), a member of the Cucurbitaceae family, has emerged as one of the fastest-growing vegetable commodities in terms of both area and production (Chakravarty, 1982; Mukherjee et al., 2013). Cucumbers are widely used in a variety of salads. Due to the continued realization of the importance of fruits in our diets and the overwhelming importance of cucumber health benefits, along with skin care. It is grown as both a subsistence and a commercial crop. It is considered to be a high-potential crop for processing in the future (Shrestha, 2008; Subedi et al., 2019). Between 2012–13 and 2021–22, the area dedicated to cucumber cultivation expanded by 191.20% nationally, while production rose by 164.31% during the same period (Anonymous, 2022; Kumar et al., 2008). In 2021–22, West Bengal led the nation in cucumber cultivation, contributing 21.24% of the national area under the crop and 20.34% of total output (Anonymous, 2022; Valpiani et al., 2015). Within this productive state, the Cooch Behar district, situated in the Terai region, offers a distinctive agro-climatic scope conducive to off-season *Rabi* cucumber cultivation during the recession of monsoon rains (Kumar and Chauhan, 2017; Meena et al., 2026). Despite consistent consumer demand, cucumber supply remains highly climate-dependent and distinctly seasonal, rendering off-season production an additional scope (Mukherjee et al., 2013; Mohamed and Nagger, 2018). The demand-driven market force encourages area expansion under such a crop, and accordingly adequate supply force is also gained over time. The rule of the game will primarily be controlled by the demand market who will decide the farm price through a derived demand mechanism. The sustenance of the system will depend on remunerative returns to farm producers along with the expansion of demand through the invasion of newer markets (Okonkwo-Emegha, 2025; Kumari and Kalpana, 2025). Farmers who successfully introduce early-season produce into markets with limited supply often secure premium prices, while those who plant late frequently face compression of price (Kumar et al., 2018; Azeez and Madukwe, 2010). Sequential and staggered sowing techniques enable farmers to spread crop entry points across multiple market windows (Reddy et al., 2023; Ayyogari et al., 2014); however, the economic prosperity of each sowing period also needs to be ascertained. Market-induced price variability in seasonal vegetables such as cucumber creates differential income opportunities depending on sowing decisions, arguably the single most consequential choice a farmer can make (Kumar et al., 2018; Engindeniz and Engindeniz, 2006). The price premium for early-season arrivals often compensates for elevated production risk, while late-season production typically confronts saturated markets and declining prices (Dhaka and Poornia, 2010; Dastagiri et al., 2013). This cash crop can generate large remuneration and can help alleviate poverty and strengthen the food security situation of the country as well. The Commission for Agricultural Costs and Prices (CACP) cost framework was used for computing cultivation costs for this study (Anonymous, 2025; Franco et al., 2020). Economic analyses employing return-cost ratios and Gini coefficients have been used to capture intra-seasonal variability on supply vs price, which has provided insights into profitability differentials (Rathore, 2024; Parveen et al., 2025; Sanjeev and Desai, 2015). Against this backdrop, the present study investigated the economics of market-induced winter cucumber production in Cooch Behar, West Bengal, across four staggered sowing windows, with emphasis on intra-seasonal profitability variability and marketing cost burden.

2. MATERIALS AND METHODS

2.1. Study area and sampling design

The study was conducted as a part of the post-graduation dissertation of the first author during September, 2022 to August, 2023, in the Cooch Behar district of West Bengal, India. However, the present field survey was carried out from August, 2022 to March, 2023 only. The location of the study refers to around 26.35° N latitude and 89.45° E longitude. The area usually receives 2500 to 3000 mm of monsoon rain between June to September and a prolonged cold winter from December to March. Even the sowing of a normal *Rabi* crop from the end of November becomes challenging due to the retention of high residual moisture in the soil. The present practice of cucumber cultivation by adjusting the dual challenge of management of soil moisture and cold winter may be regarded as farmers' innovation in response to distant market demand. The respondents were selected through Simple Random Sampling without Replacement (SRSWOR), resulting in a total of 56 farmers from three villages comprising a production cluster.

2.2. Intra-seasonal categorisation of crop according to sowing and harvesting window

The winter Cucumber vine was a four-month crop, having an initial eight weeks for vegetative maturity and subsequent eight weeks for harvesting green fruits. It was observed that farmers practice staggered sowing of crop through four distinct sub-periodic slots, each having two weeks spread. Thus, the first Crop could be categorised as Early Season practice sown in the first fortnight of September,

usually grown on well-drained upland. Second crop can be categorised as First Middle Season crops sown during the first fortnight of October, grown in medium land topography. The third crop comprises Second Middle Season practices sown during the second fortnight of October, typically devoted to lower-lying fields. Fourth crop represents Late Season practice sown during the first fortnight of November, grown in marginal low-lying areas. Accordingly, marketing was done from mid-November to the end of February, allowing each crop category a two-month window for harvesting.

2.3. Cost concepts and analytical framework

The estimation of cultivation costs has been performed based on the standard cost concepts set out by the Commission for Agricultural Costs and Prices (CACP). The cost hierarchy was defined as follows in Table 1:

2.4. Profitability indicators

To evaluate profitability, we calculated several income measures:

Farm business income (FBI)=Gross returns–Cost A_2. This capture returns to the farmer's own investment and profit after meeting all direct expenses.

Family labour income (FLI)=Gross returns–Cost B_2. This estimates the remuneration available for the farm household's labour and profit.

Net farm income (NFI)=Gross returns–Cost C_2 or Cost C_3. This represents pure profit after imputing all costs, including owned resources.

Return-Cost ratio=Gross returns/Total cost. A ratio exceeding unity indicates economic viability; a value below unity signals financial loss.

2.5. About the marketing

2.5.1. Supply chain

Harvesting of the present crop fully depended on demand from the destination market, which needed 599 km to 1618 km of road transportation to reach. Farmers disposed of their produce only to a commission agent who opens their seasonal purchasing counter near the production field. The local commission agent operates in favour of their counterpart, who remains in the destination market from where the said produce was sold through auction. Usually, farmers were price takers as the market rate was decided by the commission agent of the distant market, which was announced by the local trader every day at evening. The said traders were competitive in an oligopolistic mode and survived upon a symbiotic partnership with their producer client. The present study encompassed only the initial part of the respective supply chain where producer farmers act as fundamental players. Altogether, 90% of the produce follows the said pathway, while the remaining portion was sold in the local market.

Table 1: Different CACP cost concepts

Cost concept	Compounds Included
Cost A_1	Hired Labour, tractor/tillage, mulching, manure, fertilizer, seeds, PPC+PGR, staking, irrigation, interest on working capital
Cost A_2	Cost A_1+Rent paid for leased-in land
Cost B_1	Cost A_1+Interest on fixed capital
Cost B_2	Cost B_1+Imputed rental value of owned land.
Cost C_1	Cost B_1+Imputed value of family labour
Cost C_2	Cost B_2+Imputed value of family labour
Cost C_3	Cost C_2+Managerial charges (10% of Cost C_2)

Source: Anonymous, 2025, Methodology for the computation of costs of production. Commission for Agricultural Costs and Prices (CACP)

2.5.2. Marketing slots

The whole marketing period has been broken into seven slots to understand the intra-seasonal variability of supply load, market access and falling price (Table 2)

2.5.3. Marketing cost

The marketing costs included expenses like transportation, loading and unloading charges, and packaging costs for getting the produce from the farm to the outlet of the local commission agent. No market fee was charged for this purpose.

2.5.4. Measure of intra-seasonal inequality

To enumerate differences in volumes of aggregate business observed between intra-seasonal cucumber crops, the researchers used the Gini coefficient.

3. RESULTS AND DISCUSSION

3.1. Cost and return across intra-seasonal crops

The Table 3 layed out a thorough cost-benefit analysis of cucumber farming over four growing seasons: Early (First crop), First Middle (Second crop), Second Middle (Third crop), and Late Season (Fourth crop). The costs were divided into variable costs, fixed costs, and a managerial charge, which was 10% of the combined variable and fixed costs. Variable costs made up the bulk of the total expenses, consistently representing about 85–86% across all seasons. The highest single cost was labour, both hired and family, which accounted for 38–42%, reflecting the labour-intensive nature of cucumber cultivation. Similar findings were discovered by Sanjeev and Desai. (2015) and Mishra et al., 2023. Other key variable inputs included PPC+PGR,

Table 2: Market disposal of winter cucumber according to falling price slots received by the farmer

Harvesting slots for market disposal	Duration	Actual period of operation	Price range of green cucumber (₹ kg^{-1})	Participating crops	Destination market
Slot 1	2 weeks	Mid november to end november	26–29	First crop only	Delhi, Kolkata
Slot 2	2 weeks	Early december to mid-December	23–26	First and second crop	Delhi, Kolkata, Bareilly
Slot 3	2 weeks	Mid december r to end December	19–23	First, Second and third crop	Delhi, Varanasi, Kolkata, Bareilly, Noida
Slot 4	2 weeks	Early january to mid-january	16–19	All four crops	Delhi, Varanasi, Kolkata, Bareilly, , Noida
Slot 5	2 weeks	Mid-january to end january	12–16	Second, third and fourth crop	Delhi, Varanasi, Kolkata
Slot 6	2 weeks	Early february to mid-february	9–12	Third and fourth crop	Varanasi, Kolkata,
Slot 7	2 weeks	Mid-February to end February	7–10	Fourth crop only	Nepal

Source: Primary data collected through the field survey, September, 2022–March, 2023; Distance of market destination from point of production: Delhi: 1618 km, Varanasi: 816 km, Kolkata: 683 km, Bareilly: 1326 km, Noida: 1575 km, Nepal: 599 km

manure, and fertilisers. Fixed costs were relatively low, hovering around 5%. When it came to gross returns, the First Middle Season recorded the highest gross return at ₹ 10,44,599.70, while the Late Season brought in the least at ₹ 3,69,145.95. In fact, the Late Season was the only time that showed negative net returns for both variable costs (–₹ 32,956.95) and total costs (–₹ 97,622.40), signalling a financial loss. On the other hand, the Early and Middle seasons were more lucrative, with the First Middle Season delivering the highest net return (Rathore, 2024; Sharma, 2022).

3.2. Profitability analysis over various cost concepts

The Table 4 provided a detailed look at the profitability of cucumber farming throughout the four seasons, showing how returns stack up against different cost levels ha^{-1}. The cost estimated range from basic input costs (A_1/A_2) to the more comprehensive Cost C_3, which included management fees. The gross returns peak during the First Middle Season at ₹ 10,44,599.70, while they reached the lowest value in the Late Season at ₹ 3,69,145.95. This finding corroborated earlier research demonstrating that optimal sowing time significantly influenced economic returns in vegetable production (Reddy et al., 2021). Net returns stayed positive during the Early (First crop), First Middle (Second crop), and Second Middle seasons (Third crop) across all cost levels, indicating that cultivation was profitable. However, the Late Season (Fourth crop) becomes unprofitable starting from Cost C_1, with a maximum loss of ₹ 97,622.40 at cost C_3. The return cost ratios backed up this trend, showing that the First Middle Season (Second crop) was the most efficient, generating ₹ 3.66 for every rupee invested, even at Cost A_1. This finding was similar to that of Mishra et al. (2023). In contrast, the Late Season (Crop 4) ratios drop below 1.0 starting from Cost C_1, highlighting its lack of viability. Farm business income and family labour income remained positive across three seasons, while net farm income only turned negative in the late season, primarily due to adverse weather conditions and market saturation, which aligned with findings from Kumar and Chauhan (2017).

3.3. Assessment of marketing cost born by producer farmer

The Table 5 provided a clear look at the marketing costs and efficiency for various crops across four sowing seasons, measured in Rs per hectare (₹ ha^{-1}), and how these factors influence profitability. Table 5 showed that marketing expenses fluctuated with the seasons, ranging from ₹ 9,776.85 during the Late Season to ₹ 13,974.38 in the First Middle Season. Net returns over Cost C_3, the First Middle Season showed the best profitability at ₹ 5,64,313.35, whereas the Late Season unfortunately resulted in a loss of ₹ 97,622.40. Efficiency metrics indicate that the "Marketing cost as percentage of gross return" is at its lowest in the early season, 1.00%, but it rises to 2.65% in the late season. This efficiency was higher than that reported in studies from other regions where marketing costs constituted 5–8% of gross returns (Dastagiri et al., 2013). Overall, the early and middle seasons offer better marketing efficiency and net

Table 3: Cost of cultivation over variable and fixed costs of cucumber grown in intra-seasonal breaks with gross and net returns (₹ ha^{-1})

Cost items	First crop		Second crop		Third crop		Fourth crop	
	Actual cost	%	Actual cost	%	Actual cost	%	Actual cost	%
Variable cost								
Hired labour	59225.25	11.54	63564.30	13.63	67883.55	14.36	54215.40	11.86
Family labour (imputed)	153167.78	29.85	119126.03	25.55	113652.53	24.03	136391.18	29.85
Total labour	212393.03	41.39	182690.33	39.18	181536.08	38.39	190606.58	41.71
Tillage	20465.78	3.99	19891.65	4.27	17508.00	3.70	13032.60	2.85
Mulching	6386.25	1.24	7396.80	1.59	3257.93	0.69	0.00	0.00
Manure	59108.10	11.52	53157.83	11.40	54941.55	11.62	56673.45	12.40
Fertilizers	37222.88	7.25	36994.43	7.93	39117.38	8.27	33898.28	7.42
Seed	16659.53	3.25	23208.38	4.98	24475.28	5.18	19300.05	4.22
PPC+PGR	61116.83	11.91	49231.05	10.56	56466.98	11.94	54380.63	11.90
Staking	13039.80	2.54	9774.45	2.10	9708.68	2.05	8461.80	1.85
Irrigation	4588.73	0.89	4530.83	0.97	5262.23	1.11	4951.58	1.08
Interest on working capital	12501.60	2.44	12048.75	2.58	12537.98	2.65	11021.10	2.41
Total variable cost	443482.58	86.43	398924.48	85.55	404812.05	85.61	392326.05	85.85
Depreciation	5753.48	1.12	5851.73	1.25	5930.78	1.25	5589.23	1.22
Interest on fixed capital	2250.00	0.44	1518.75	0.33	1518.75	0.32	1406.25	0.31
Imputed value of own land	15000.00	2.92	17625.00	3.78	17625.00	3.73	16125.00	3.53
Total Fixed cost	23003.48	4.48	24995.48	5.36	25074.53	5.30	23120.48	5.06
Managerial charge (10% of VC and FC)	46648.60	9.09	42392.00	9.09	42988.65	9.09	41544.65	9.09
Total cost	513134.66	100	466311.98	100	472875.30	100	456991.50	100
Cost of marketing	10058.10		13974.38		13028.85		9776.85	
Gross return	1003361.63		1044599.70		903304.58		369145.95	
Net return over variable cost	549821.03		631700.85		485463.68		-32956.95	
Net return over total cost	480168.98		564313.35		417400.43		-97622.40	

Source: Primary data collected through the field survey, August 2022–March 23

profits, suggesting that farmers should prioritise early and first-middle sowing windows to maximise profitability and enhance their livelihoods.

3.4. Aggregate business: variability analysis

Variability of aggregate business made by different cucumber crops over quantity vs value return has been shown in Table 6. It was observed that, out of the total quantity of marketed supply (1338.73 t), proportional sharing by the early season (First crop) were 23.01%, by the first middle season (Second crop) 32.56%, by the second middle season (Third crop) 28.59%, and by the late season (Fourth crop) 15.84%. However, this pattern of intra-crop percentage shared changes in case value return. Out of the total businesses of ₹ 2,19,74,738.09 value return, receipt share by early season were 32.27%, by first middle season were 34.07%, by second middle season were 23.98%, and by late season it was 9.69% only. The given difference was a unique observation of this study. Mere successful production of a crop with a higher yield would not ensure profit; it was the prevailing price that would decide how much return could be gained. The early crop ensured more income compared to the succeeding crop. The said difference had again been established through the value of the Gini coefficient, calculated to quantify this variability. In the present case, the calculated value of Gini was 0.6985, showing a high degree of variability between crops based on the value returned over the whole season. The concentration of high-value returns in the early and first-

Table 4: Profitability analysis of the cucumber crop grown in different intra seasonal breaks (₹ ha^{-1})

Items	First crop	Second crop	Third crop	Fourth crop
Cost A_1	296068.20	285650.18	297090.38	261524.18
Cost B_1	298318.20	287168.93	298609.13	262930.43
Cost B_2	313318.20	304793.93	316234.13	279055.43
Cost C_1	451485.98	406294.95	412261.65	399321.60
Cost C_2	466485.98	423919.95	429886.65	415446.60
Cost C_3	513134.55	466311.98	472875.30	456991.50
Gross return	1003361.63	1044599.70	903304.58	369145.95
Cost of marketing	10058.10	13974.38	13028.85	9776.85
Net return over cost A_1 (FBI)	697235.33	744975.15	593185.35	97844.93
Net return over cost B_1	694985.33	743456.40	591666.60	96438.68
Net return over cost B_2 (FLI)	679985.33	725831.40	574041.60	80313.68
Net return over cost C_1	541817.55	624330.38	478014.08	-39952.50
Net return over cost C_2 (NFI)	526817.55	606705.38	460389.08	-56077.50
Net return over cost C_3	480168.98	564313.35	417400.43	-97622.40
Return cost ratio				
Return cost ratio over cost A_1	3.39	3.66	3.04	1.41
Return cost ratio over cost B_1	3.36	3.64	3.03	1.40
Return cost ratio over cost B_2	3.20	3.43	2.86	1.32
Return cost ratio over cost C_1	2.22	2.57	2.19	0.92
Return cost ratio over cost C_2	2.15	2.46	2.10	0.89
Return cost ratio over cost C_3	1.96	2.24	1.91	0.81

Source: Primary data collected through the field survey, August, 2022–March 23

Table 5: Marketing cost and efficiency indicators across sowing seasons (₹ ha^{-1})

Season	Marketing cost	Gross return	Net return over cost C_3	Marketing cost as % of Gross Return	Marketing cost as % of total cost
First crop	10,058.10	10,03,361.63	4,80,168.98	1.00	1.96
Second crop	13,974.38	10,44,599.70	5,64,313.35	1.34	2.99
Third crop	13,028.85	9,03,304.58	4,17,400.43	1.44	2.75
Fourth crop	9,776.85	3,69,145.95	-97,622.40	2.65	2.14

Source: Primary data collected through the field survey, August 2022–March 23; 1 US$=INR 82.25 (Average monthly for March, 2023)

Table 6: Variability of aggregate business made by different cucumber crops over the season due to falling price

Crop	Aggregate business quantity (in tonne)		Aggregate business value		Variability index (Gini ratio)
	Actual	Percentage share	Actual (Rs)	Percentage share	
First crop	308.00	23.01	7090422.34	32.27	0.6985
Second crop	435.86	32.56	7486297.73	34.07	
Third crop	382.80	28.59	5269276.53	23.98	
Fourth crop	212.65	15.84	2128741.50	9.69	
Total season	1338.73	100.00	21974738.09	100.00	

Source: Primary data collected through the field survey, August, 2022–March, 23

middle periods reinforced recommendations for targeted extension services to promote timely sowing practices (Zhao et al., 2019; Biswas and Sarkar, 2026).

4. CONCLUSION

The market driven cultivation of off-season *rabi* cucumber has shown strong intraseasonal variation in value return from staggered sown crop. While the second crop gave the highest return, the fourth earned a net loss. This was mainly due to oversupply at the producer level and falling prices in the destination market. Labour costs accounted for 38–42% of variable expenses.

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