

COMPARATIVE ECONOMICS OF CONVENTIONAL VERSUS CONSERVATION METHODS OF POTATO CULTIVATION: FINDINGS FROM ASSAM, INDIA

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ABSTRACT: This study was carried out to estimate the economics of potato cultivation under conventional and conservation agriculture in the Bishwanath Chariali district of Assam utilizing analytical tools like compound growth rates, cost concepts, break-even analysis, and Garrett's ranking technique. It was found that the conservation method generated 32.31 per cent higher net returns than the conventional method of potato cultivation. The results further revealed that the benefit-cost ratio was higher under the conservation method (1.94) than under the conventional method (1.47) of potato cultivation. Break-even production was 171.88 and 101.70 q/ha, against actual production of 330.58 and 289.10 q/ha, while break-even prices were Rs. 777.69/q and Rs. 589.25/q, respectively, indicating that break-even production and break-even price were substantially lower than the corresponding actual levels under both methods. Major problems faced under conservation agriculture were identified and prioritized in the study area. This study recommends that effective government measures need to be implemented through various programs and demonstrations, and encourages the farming community to adopt conservation practices.

KEYWORDS: Break-even analysis, Cost analysis, Conservation practice, Potato production, Trend analysis

INTRODUCTION

The fourth-largest cultivated food crop in the world is the potato, also known as the king of vegetables (*Solanum tuberosum* L.). The potato has a sizable impact on the nation's overall agricultural output. After China, India ranks second in the world for potato production (Rana and Anwer, 2018; Sahu *et al.*, 2024). China and India are the world's leading potato producers, together accounting for nearly one-third of global potato production (FAOSTAT, 2023). Global potato production stood at 376 million tonnes (MT) in 2022–23, with China and India contributing 94 MT and 54 MT, respectively. Globally, potato

production is essential for strengthening agricultural economies while promoting income generation and food security (Devi *et al.*, 2025). Almost 85% of the crop is grown during short photoperiod winters (with roughly 10–11 hours of sunshine), and the crop duration is constrained to 90–100 days. The principal potato-growing states in India are Uttar Pradesh, Himachal Pradesh, West Bengal, Bihar, Gujarat, Madhya Pradesh, Punjab, Assam, Karnataka, Haryana, and Jharkhand. With a production of 191.73 lakh MT from 696.03 thousand ha, Uttar Pradesh is the leading potato-producing state in India, while Gujarat recorded the highest

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productivity at 29.66 MT/ha. During 2023–24, Uttar Pradesh, West Bengal, and Bihar together accounted for 65% of the country's total potato cultivation area and 71% of the national potato production (Agricultural Statistics at a Glance, 2024).

The majority of people in Assam state still rely primarily on agriculture for their income. Despite India's expanding potato production, productivity and sustainability remain constrained by region-specific agroecological conditions, particularly in Assam, where climatic variability, soil characteristics, and production constraints influence potato cultivation. In 2023–24, Assam recorded a potato production of 911.33 thousand tonnes from 106.47 thousand hectares under cultivation, accounting for 5% of the country's total potato cultivation area, with an average yield of 8,560 kg/ha (Agricultural Statistics at a Glance, 2024). In Assam, potato cultivation has long relied on conventional methods, yet many farmers are now transitioning to conservation agriculture. Conservation Agriculture (CA) was developed to improve the sustainability of agroecosystems by enhancing productivity, increasing farmers' income, and ensuring the efficient use of natural resources (Jat *et al.*, 2021). Conservation agriculture is a farming technique that can prevent the loss of arable land and restore degraded areas by involving minimal or no soil disturbance for crop production. This practice reduces the cost of cultivation and saves labour time, energy, and cost. In contrast, conventional agriculture refers to the use of artificial chemical fertilisers, pesticides, herbicides, and other ongoing inputs for production. When the sowing/transplanting of the sali rice is delayed, leading to delayed harvesting, it is difficult to go for rabi crop cultivation, like potato cultivation under the conventional method. In that case, potato cultivation can

be adopted with the help of conservation methods without any tillage. Thus, potato cultivation under a conservation method will reduce labour and total cultivation costs, resulting in lower potato production. Taking into account the above facts, the present study was an attempt to examine the comparative advantage of conservation agriculture over conventional agriculture with reference to cost, returns, and economic feasibility. Therefore, the study was conducted to analyse the comparative economics of the conservation method of potato cultivation vis-à-vis the conventional method and identify the problems of potato cultivation with special reference to the conservation method. The findings can support policymakers and farmers in strengthening the financial viability of potato farming in the region.

MATERIALS AND METHODS

Study area and data

This research was conducted from April 2022 to June 2022 utilizing both primary and secondary data in the Bishwanath Chariali district of Assam, as many farmers opted for the conservation method of potato cultivation over the conventional method. The potato varieties cultivated under each method were Kufri Pukhraj. Secondary information of Sonitpur district was gathered from the District Agriculture Office, Block Agriculture departments, and the official website of the Department of Agriculture, Assam. Primary data for the study were collected from respondents through personal interviews using pretested schedules.

Sampling design

A multistage stratified random sampling design was utilised to draw samples from the Bishwanath Chariali district, which was selected purposively. Under the Bishwanath Chariali district, two ADO circles were

selected, *i.e.*, Baghmara circle and Gingia circle, as the circles have the maximum potato area under conservation agriculture. Two villages from each circle were selected at random for the study. In the next stage, from each village, 10 farmers consisting of marginal (below 1 ha), small (1 to <2 ha), medium (2 to <10 ha), and large (10 ha and above) farmers cultivating potato under conventional agriculture and another 10 farmers practising conservation agriculture were selected randomly in the ratio of 4:3:2:1, respectively. Thus, a total of 80 farmers, 40 each practising conservation agriculture and conventional agriculture, were selected for the ultimate sample.

Analytical framework

Compound Growth rate

To determine the growth trends over time, the compound growth rate was used. The equation of compound growth rate can be written as:

$$Y = ab^t$$

$$\text{Or, } \ln Y = \ln a + t \ln b$$

Compound growth rate was estimated as
CAGR = Antilog $(b - 1) \times 100$

Where, Y represents time series data, b regression coefficient and t is time period.

Cost concepts

The cost of cultivation was analysed by applying different cost concepts given by CACP. In the present study, the following cost concepts were used.

Cost A1: It includes value of hired human labour + value of hired and owned machine labour + value of manures and fertilizers (owned and purchased value of fertilizers) + value of purchased and owned seed + value of plant protection chemicals used + irrigation charges + interest on variable capital + depreciation on farm implements

and machinery + land revenue charges + micronutrients.

Cost A₂: Cost A₁ + rent paid for leased land.

Cost B: Cost A₂ + rental value of owned land + interest on fixed capital.

Cost C: Cost B + value of owned human labour.

Return concepts

To estimate the farm's returns and profits, the following metrics were utilized in this study. The reference period for potato prices used in calculating returns was 2021-22.

Gross return (GR) = Total production × Total price.

Farm business income = Gross return - Cost A₁.

Family labour income = Gross return - Cost B.

Net return (NR) = Gross return (GR) - Total cost, or Cost C

Break-even analysis

Break-even analysis helps determine the economic feasibility of an enterprise. The break-even analysis helps to determine the break-even point at which the cost and revenue are equal, resulting in neither a profit nor a loss. In the present study, break-even production and break-even price were calculated.

$$\text{Break Even Production} = \frac{\text{Fixed cost}}{\text{Price per unit-Variable cost per unit}}$$

$$\text{Break Even Price} = \frac{\text{Total cost}}{\text{Total production}}$$

Garrett's ranking

This technique was utilised to categorize the problems encountered by farmers in potato cultivation under conservation agriculture in the study area.

$$P_{ij} = 100 \left[\frac{R_{ij} - 0.5}{N_j} \right]$$

Where, P_{ij} = Garrett percentage position of the factor for the respondent, denotes the rank assigned to the i^{th} item by the j^{th} respondent,

and represents the total number of items ranked by the j^{th} respondent.

RESULTS AND DISCUSSION

Status of potato cultivation in Assam

The conservation method had an edge over the conventional method for various attributes of potato production, as it reduces the total cost of production and reduces time-consuming tillage operations. The area, production, and productivity of potatoes in Assam demonstrate that all three of these metrics have increased over time (Table 1), whereas, a nonsignificant growth trend was observed for the district during 2010-11 to 2020-21.

Potato cultivation across sample farm size groups

Table 2 presents the area, production, and productivity of potato across sample farm size groups. It was found that the

area under conventional potato was more than the area under conservation potato. Similarly, production and productivity were higher for conventional potatoes than for conservation potatoes. Farmers from the study area are shifting towards conservation potato cultivation due to the lower cost of cultivation and less time-consuming tillage operations. The state government also played an important role in encouraging farmers to adopt conservation methods in potato cultivation. The district agricultural department has also brought many demonstrations and schemes for the farmers so that they can enhance their knowledge of conservation methods and potato cultivation practices.

Comparative economics of conventional v/s conservation method of potato cultivation

Table 3 illustrates the overall comparative economics of potato cultivation under the conservation method versus the conventional

Table 1. Trend estimates of growth pattern of potato in Assam

Year (2010-11 to 2020-21)	Area (in hectares)				Production (in tonnes)				Productivity (in kg/hectares)			
Potato in Assam	CAGR (%)	S.E.	C.I. at 95%		CAGR (%)	S.E.	C.I. at 95%		CAGR (%)	S.E.	C.I. at 95%	
			Lower	Upper			Lower	Upper			Lower	Upper
	1.55***	0.004	0.006	0.025	1.23**	0.004	0.003	0.021	-0.25 ^{NS}	0.004	-0.011	0.006
Potato in Sonitpur district	0.83 ^{NS}	0.007	-0.007	0.023	0.90 ^{NS}	0.010	-0.014	0.032	0.07 ^{NS}	0.005	-0.010	0.011

Note: CAGR- Compound annual growth rate, S.E.- Standard error, C.I.- Confidence interval.

*** and ** Significant at 1 and 5% levels, respectively.

Source: Authors calculations.

Table 2. Estimated potato cultivation across sample farm size groups (area: ha, production: q, productivity: q/ha)

Farm size	Conventional Potato				Conservation Potato			
	No. of farmers	Area	Production	Productivity	No. of farmers	Area	Production	Productivity
Marginal	16	13.32	3922.50	294.48	16	3.15	920.00	262.10
Small	12	22.36	6560.00	293.38	12	2.54	710.00	280.08
Medium	8	42.38	13286.00	313.49	8	1.89	532.50	282.49
Large	4	37.70	14500.00	384.62	4	0.91	292.50	321.43
All farms	40	115.76	38268.50	330.58	40	8.49	2454.50	289.10

Source: Authors calculations

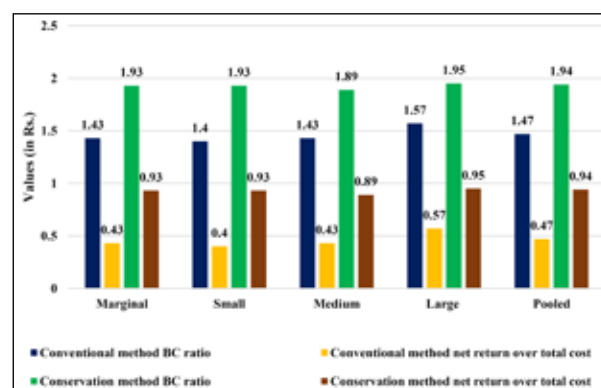
Table 3. Comparative economics of conventional v/s conservation methods of potato cultivation (Rs/ha)

Sl. No.	Particulars	Conventional Potato					Conservation Potato				
		Marginal	Small	Medium	Large	Pooled	Marginal	Small	Medium	Large	Pooled
1	Total variable cost	114790.80	120067.80	123714.90	133239.59	125575.90	76007.09	80822.04	85350.63	91637.78	83154.76
2	Total fixed cost	120177.60	119677.70	127032.80	145664.84	131513.80	79159.36	84549.96	85509.38	96976.91	87198.66
3	Total cost	234968.30	239745.60	250747.70	278904.43	257089.70	155166.50	165372.00	170860.00	188614.70	170353.40
4	Cost A ₁	90220.04	99569.65	109808.90	122306.01	110139.80	67898.27	75972.67	81864.59	87929.33	77406.04
5	Cost A ₂	121377.30	130410.30	141940.80	122306.01	141827.70	67898.27	75972.67	81864.59	87929.33	77406.04
6	Cost B	207416.80	216159.00	233557.50	264556.19	238399.80	144094.20	157395.10	163991.00	181371.80	161449.60
7	Cost C	234968.30	239745.60	250747.70	278904.43	257089.70	155166.50	165372.00	170860.00	188614.70	170353.40
8	Gross return	337053.70	335920.10	358957.50	440389.90	378514.10	300104.50	320691.60	323451.10	368037.40	331019.50
9	Family business income	246833.70	236350.40	249148.60	318083.88	268374.30	232206.20	244718.90	241586.50	280108.10	253613.50
10	Family labour income	129636.90	119761.10	125400.00	175833.71	140114.30	156010.30	163296.50	159460.10	186665.60	169569.90
11	Net return	102085.40	96174.53	108209.80	161485.46	121424.40	144938.00	155319.60	152591.10	179422.70	160666.10
12	Gross return over total cost (Rs.)	1.43	1.40	1.43	1.57	1.47	1.93	1.93	1.89	1.95	1.94
13	Net return over total cost (Rs.)	0.43	0.40	0.43	0.57	0.47	0.93	0.93	0.89	0.95	0.94

Source: Authors calculations

method. It was observed that the total cost of cultivation was significantly lower under the conservation method (Rs. 170,353.40/ha) than under the conventional method (Rs. 257,089.70/ha) ($t = 4.82$, $p < 0.001$). Under the conventional method, the large-farm respondents cultivated potato on their own land, and consequently Cost A₂ remained equal to Cost A₁. The gross return under the conventional and conservation methods was found to be Rs. 378514.10 and Rs. 331019.50, respectively, indicating a significant difference between the two methods ($t = 2.14$, $p = 0.035$). These findings are well supported by the findings of Sujana *et al.* (2017). The net return under the conventional method was found to be Rs. 121424.40, while Rs. 160666.10 under the conservation method. Sinha and Singh (2019) also reported similar findings regarding potato production in Chhattisgarh. It was found that gross return over total cost was higher under the conservation method (1.94) than the conventional method (1.47)

due to lower total cost involved under the conservation method. Figure 1 represents a comparison of net return over total cost and BC ratios between methods for visual impact. Raina *et al.* (2024) studied potato production in Himachal Pradesh and reported a BC ratio of 1.88. According to Singh *et al.* (2019), the return per rupee invested in potato cultivation was Rs. 3.42 for small farmers,

**Fig. 1. Comparison of net returns and BC ratios between methods**

Rs. 2.61 for medium farmers, and Rs. 2.21 for large farmers. Conservation agriculture generated higher net returns over total cost compared with conventional agriculture. The current study's cost concept estimation is consistent with the findings of Singh *et al.* (2020). The above analysis indicates an increasing trend of return per rupee with an increase in farm size for both conservation potato and conventional potato, except for small farms under the conventional method and medium farms under the conservation method. But the return per rupee for the conservation potato was more than that of the conventional potato. The returns from the cultivation of conservation and conventional potato indicate that the benefit gained from the conservation method was more compared to conventional potato, and it is economically more profitable.

Break-even analysis

Break-even production

Table 4 presents the break-even analysis of potato cultivation in monetary and physical terms across different farm categories. In the present study, the break-even production per hectare was calculated, and it was found to be 171.88 q/ha under the conventional method and 101.70 q/ha under the conservation method. The actual production under the conventional

and conservation methods was 330.58 q/ha and 289.10 q/ha, respectively, which was more than the breakeven production. The margin of safety for production under the conventional method was 158.70 q/ha, while the per-ha safety in the conservation method stood at 187.40 q/ha. Break-even analysis provides farmers with a practical framework for optimizing production and managing costs, which indicates a positive margin of safety. These estimates can help farmers assess the minimum production or price required to cover total costs and can support production planning, cost control and price-risk assessment.

Break-even price

Break-even prices under the conventional and conservation methods were found to be Rs. 777.69 and Rs. 589.25 per quintal, respectively, which were lower than the actual price (Table 4). The actual price received under the conventional and conservation methods was found to be Rs. 1145 for both. The margin of safety for price under the conventional method was found to be Rs. 367.31 per quintal, and under the conservation method, it was Rs. 555.75 per quintal. Findings of Raina *et al.* (2024) also supported these findings. The average price received was significantly higher than the break-even price, which indicates that potato cultivation under both conventional

Table 4. Break-even output under conventional and conservation potato production

Particulars	Conventional Potato					Conservation Potato				
	Marginal	Small	Medium	Large	Pooled	Marginal	Small	Medium	Large	Pooled
Break-even production (q/ha)	159.16	162.66	169.29	182.40	171.88	92.58	98.72	101.45	112.77	101.70
Actual production (q/ha)	294.37	293.38	313.50	384.62	330.58	262.10	280.08	282.49	321.43	289.10
Margin of safety (q/ha)	135.21	130.72	144.21	202.22	158.70	169.52	181.36	181.04	208.66	187.40
Break-even price (Rs.)	798.20	817.18	799.83	725.14	777.69	592.01	590.44	604.83	586.79	589.25
Actual price (Rs.)	1145.00	1145.00	1145.00	1145.00	1145.00	1145.00	1145.00	1145.00	1145.00	1145.00
Margin of safety (Rs.)	346.8	327.82	345.17	419.86	367.31	552.99	554.56	540.17	558.21	555.75

Source: Authors calculations

and conservation methods is economically viable. It provides a basis for sound financial planning, appropriate pricing strategies, and realistic production planning.

Percentage change in conservation potato over conventional potato

Table 5 shows the percentage change in cost and returns of conservation potato cultivation over the conventional method of potato cultivation. It was found that the total cost under the conservation method of potato cultivation was 33.73 per cent less than the conventional method of potato cultivation. Similarly, gross return and yield under the conservation method of potato cultivation were found to be 12.54 and 16.08 per cent less than the conventional method of potato cultivation. But the net return was found to be higher under the conservation method by 32.31 per cent as compared to the conventional method of potato cultivation. Findings also revealed that yield was significantly higher under the conventional method (330.58 q/ha) compared with the conservation method (277.40 q/ha) ($t = 3.21$, $p = 0.002$).

Problems faced in potato cultivation using the conservation method

Table 6 presents constraints faced under the conservation method. The major constraint faced under the conservation method was the limited availability of crop residues because the conservation method of cultivation demands a large requirement of crop residues, mainly paddy straw, rice husk, etc., for a small piece of land. Another major problem reported under the conservation method was the incidence of animals in the cultivated field. Bhan and Behera (2014) studied the problems associated with conservation practices, which are aligned with these findings. The shortage of labour at the early stage, as the conservation method involves a

Table 5. Percentage change in cost and returns of conservation potato cultivation over conventional potato cultivation

Particulars	Conventional potato cultivation	Conservation potato cultivation	% change in conservation potato over conventional potato
Total cost (Rs./ ha)	257089.70	170353.40	-33.73
Gross return (Rs./ ha)	378514.10	331019.50	-12.54
Net return (Rs./ ha)	121424.40	160666.10	32.31
Yield per ha	330.58	289.10	-12.54

Source: Authors calculations

Table 6. Problems faced in potato cultivation with special reference to the conservation method

Sl. No.	Problems	Average Score	Rank
1.	Less availability of crop residues	71.12	I
2.	Difficulty in scaling up	62.42	II
3.	Incidence of animals	59.97	III
4.	Higher fencing cost	55.47	IV
5.	Shortage of labour at the early stage	55.20	V
6.	Infestation of pests and diseases	46.55	VI
7.	Environmental problems	36.65	VII
8.	Lack of capital	27.45	VIII
9.	Lack of proper technical knowledge	26.90	IX
10.	Farmers' perception of low crop yield	26.17	X

Source: Authors calculations

large number of operations at the initial stage, which leads to labour shortage for a period of time. Infestation of pests and diseases was ranked sixth, as the incidence of pests such as potato leafhopper, potato bug, and diseases such as late blight of potato was observed under the conservation method of potato cultivation. Another constraint found under the conservation method was environmental hazards, as the conservation method sometimes involves the burning of crop residues in the field for the next crop cultivation, which leads to the emission of harmful gases into the atmosphere, negatively impacting the environment.

The next minor constraint involved was the lack of capital because the conservation method involves a high amount of input cost, which leads to a constraint for marginal and small farmers in adopting the conservation method. The next constraint found was a lack of proper technical knowledge because there was a lack of awareness and knowledge dissemination regarding the conservation method among the marginal group of farmers. Lastly, farmers' perception of low crop yield was ranked last because, due to lack of knowledge and awareness, many farmers believed that the conservation method practice resulted in lower crop yield than the conventional method, so they preferred going with the conventional method of crop cultivation.

CONCLUSION

This study concludes that the area and productivity were found to be moderately high in the conventional method, as compared to the conservation method of potato cultivation. The net return generation was found to be moderately higher in the conservation method than in the conventional method of potato cultivation. Break-even production and break-even price were found to be lower than the actual production and price under the conventional and conservation methods. This study suggests that the government should take effective measures through various programmes and demonstrations to cover all the farmers, encouraging them to adopt the conservation method of crop cultivation, as it facilitates the adoption of double and multiple cropping by reducing the time, energy and cost. Similarly, non-government organisations like Farmer Producer Company should play an important role in helping the needy farmers through proper training and input supply at affordable prices. Therefore, needy farmers

should be given proper skill development guidance and training, and support to make judicious decisions regarding resource utilisation to increase production.

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AUTHORS CONTRIBUTIONS

Kaustabh Kishor Das: Data collection, analysis of data; Riaz Abdul Halim, Nivedita Deka: Study conception and design, review; Saddam Hossen Majumder: Data analysis and review, interpretation of results, review, and manuscript finalization.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

ETHICAL STATEMENT

This article does not contain any studies with human participants or animals performed by any of the authors.

LITERATURE CITED

- Bhan S and Behera UK (2014). Conservation agriculture in India-Problems, prospects and policy issues. *International Soil and Water Conservation Research* 2(4): 1-12.
- Devi RA, Adarsh A, Kumar A, and Singh AP (2025). Basics of economics and marketing practices in potato production. In *Advances in Research on Potato Production* (pp. 407-424). Cham: Springer Nature Switzerland.
- Food and Agriculture Organization (FAO) FAOSTAT (2023). Global potato statistics. Retrieved from <https://www.potatogrower.com/2023/01/global-potato-statistics>.
- Government of India, Agricultural Statistics at a Glance (2024). Ministry of Agriculture & Farmers Welfare Department of Agriculture & Farmers

- Welfare Economics, Statistics & Evaluation Division. Retrieved from Agricultural-Statistics-at-a-Glance-2024_कृषि-सांख्यिकी-एक-झलक-2024.pdf
- Jat HS, Datta A, Choudhary M, Sharma PC, and Jat ML (2021). Conservation Agriculture: factors and drivers of adoption and scalable innovative practices in Indo-Gangetic plains of India—a review. *International Journal of Agricultural Sustainability* 19(1): 40-55.
- Raina A, Sharma P, Gupta G, and Kumari S (2024). An Economics of Potato Production in Kangra District of Himachal Pradesh. *Potato Journal* 51(1): 97-108.
- Rana RK and Anwer MD (2018). Potato production scenario and analysis of its total factor productivity in India. *Indian Journal of Agricultural Sciences* 88(9): 1354-61.
- Sahu PK, Das M, Sarkar B, Adarsh VS, Dey S, Narasimhaiah L, Mishra P, Tiwari RK, and Raghav YS (2024). Potato production in India: a critical appraisal on sustainability, forecasting, price and export behaviour. *Potato Research* 67(4): 1209-1245.
- Singh A, Singh R, Anurag, and Ranjana (2019). Economic Management and Analysis of Potato Cultivation: A case study of Agra district (U.P), India. *International Journal of Current Microbiology and Applied Sciences* 8(2): 525-530.
- Singh B, Raigond P, Dutt S, and Kumar M (2020). Potatoes for food and nutritional security. In *Potato: Nutrition and Food Security*, pp 1-12. Singapore: Springer Singapore.
- Sinha AK, and Singh SK (2019). Economics of potato production in Northern hills of Chhattisgarh. *Economic Affairs* 64(1): 01-07.
- Sujan HK, Islam F, Kazal MH, and Mondal RK (2017). Profitability and resource use efficiency of potato cultivation in Munshiganj district of Bangladesh. *SAARC Journal of Agriculture* 15(2): 193-206.

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