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Comparative economics of natural and conventional farming: An exploratory study in Raipur District of Chhattisgarh

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Abstract

Natural farming is being pushed hard across India as a low-cost, chemical-free way to farm, but there is still very little field-level evidence from Chhattisgarh on how it actually performs against conventional cultivation once the numbers are added up. This study compared the cost of cultivation and profitability of natural and conventional farming for the three leading rabi crops of Raipur district mustard, chickpea and grass pea using primary data from 56 natural-farming and 56 conventional-farming households drawn from the Arang, Abhanpur and Tilda blocks. Costs and returns were worked out on a common per-hectare basis using the CACP cost concepts, standard profitability measures, and the Welch (unequal-variance) t-test. Natural farming lowered the total cost of cultivation by 38.83 to 54.65 per cent across the three crops, driven almost entirely by the complete elimination of spending on manure and fertilizer, plant protection chemicals and irrigation. Yields, however, fell by 46.65 to 56.28 per cent, and since both systems sold their produce at identical prices, this yield penalty more than cancelled out the cost saving: net income under natural farming ended up 56.58 to 74.22 per cent lower, the cost of production per quintal was higher, and the output-input and net-return ratios were consistently weaker. Tracing costs through the CACP concepts (A1 to C3) showed the cost advantage of natural farming shrinking steadily as imputed fixed costs were added in. The study concludes that natural farming as currently practised in Raipur without the prescribed bio-input package genuinely saves cash cost but is not yet financially competitive with conventional farming, and that the yield gap, not the cost of inputs, is what holds it back. The study concluded that strengthening institutional support, improving market access, expanding research and extension services, enhancing farmer training, and providing effective policy support are essential for overcoming these constraints and promoting the sustainable adoption of natural farming.

Keywords: Natural farming, conventional farming, cost of cultivation, profitability, mustard

Introduction

Decades of intensive chemical-input farming have left Indian agriculture under real strain costs keep climbing, soils keep degrading, and the long-term sustainability of farm livelihoods is now a genuine worry. Chemical-free and low-external-input systems have consequently drawn growing policy and academic interest as a way of restoring ecological balance without sacrificing farmer income, and natural farming has emerged as the most visible of these alternatives. Rather than depending on synthetic chemicals or even purchased organic inputs, it leans on recycling what the farm already has biomass mulching, farm-prepared cow-dung and cow-urine formulations, and a complete break from synthetic inputs. With the launch of the National Mission on Natural Farming, this has moved well beyond a grassroots movement into a formal, state-backed programme meant to cut input dependence while holding productivity and cost in check.

Chhattisgarh is one of the more active adopting states, and Raipur district in particular has built up a sizeable base of natural-farming practitioners under mission mode. But whether this shift makes economic sense depends far less on its ecological appeal than on plain farm-budget arithmetic what it costs to cultivate, what it yields, and what net returns and benefit-cost ratios it delivers next to the conventional system it is meant to replace. From an agribusiness standpoint,

natural farming only makes sense if the money saved on output, and the existing Indian evidence on this point is genuinely mixed: some studies find that natural farming cuts cost but also drags yields down enough that net income barely moves (Reddy *et al.*, 2019; Koner & Laha, 2020) ^[11, 7], while others report no short-term yield penalty at all, and even higher incomes, where the full practice package is adopted with institutional backing (Bharucha *et al.*, 2020; Duddigan *et al.*, 2022) ^[2, 6]. This divide suggests the economic outcome is highly context-specific and needs to be measured locally rather than assumed. Most existing assessments, moreover, are concentrated in Andhra Pradesh and a handful of hill states, and rarely benchmark a chemical-free plot against a matched conventional plot within the same villages of a district like Raipur leaving a real gap in the locally grounded evidence that extension agencies and policymakers actually need. This study was undertaken to fill that gap: to evaluate, on a strictly comparable per-hectare basis, the cost of cultivation and profitability of natural farming against conventional farming for mustard, chickpea and grass pea in Raipur district, tracing costs through the standard CACP cost concepts and comparing yields, returns, cost of production and output–input ratios between the two systems. It forms the second objective of a wider study titled "Natural Farming as a Sustainable Agribusiness Model: A Study on Awareness, Adoption and Economic Outcomes in Raipur District of Chhattisgarh."

Materials and Methods

Study area and sampling

The study was conducted in Raipur district of Chhattisgarh, a major agricultural hub and an actively adopting district under the National Mission on Natural Farming (NMNF), where 1,125 farmers have taken up natural-farming practices across 1,077.69 acres the population that formed the sampling frame. Raipur sits in the central plains agro-climatic zone, receives an average of about 1,150–1,250 mm of rainfall concentrated in the south-west monsoon, and is dominated by small and marginal holdings, which together make up over 81 per cent of the district's operational holdings. Three blocks with an established concentration of natural-farming practitioners Arang, Abhanpur and Tilda were purposively selected; the natural-farming plots here are mostly rabi, rainfed-cum-canal-irrigated parcels growing oilseed and pulse crops.

From the 1,125 natural-farming farmers in the district, a random five per cent sample of 56 farmers was drawn from the selected blocks and villages, and an equal number of 56 conventional-farming farmers was picked from the same villages by simple random sampling to serve as a matched comparison group 112 respondents in total. Data on household and farm characteristics, cropping pattern, item-wise input use and cost, yield and sale price were collected through personal interviews using a pre-tested structured schedule administered in the local language during the rabi season, supplemented by secondary data from the Department of Agriculture (Government of Chhattisgarh), the NMNF portal and published sources. Because the two groups differed substantially in average operational area, all costs and returns were expressed on a uniform per-hectare basis to keep the comparison fair.

Cost concepts and profitability measures

Cost of cultivation was worked out using the standard CACP cost concepts, moving progressively from the actual paid-out cost (Cost A1) through the imputation of rent, family labour, interest on owned capital and the rental value of owned land, up

to a comprehensive cost that also imputes a ten per cent managerial return (Cost C3). Profitability was assessed using the following standard measures:

$$\text{Gross Income (₹/ha)} = \text{Yield (qt/ha)} \times \text{Sale Price (₹/qt)}$$

$$\text{Net Income (₹/ha)} = \text{Gross Income} - \text{Total Cost of Cultivation}$$

$$\text{Cost of Production (₹/qt)} = \frac{\text{Total Cost of Cultivation (₹/ha)}}{\text{Yield (qt/ha)}}$$

$$\text{Output–Input Ratio} = \frac{\text{Gross Income}}{\text{Total Cost of Cultivation}}$$

$$\text{Net–Return (Benefit–Cost) Ratio} = \frac{\text{Net Income}}{\text{Total Cost of Cultivation}}$$

Test of significance

Differences in cost, yield and returns between the two independent groups were tested using the independent-samples (Welch) t-test, appropriate for groups of unequal variances, with adjusted degrees of freedom from the Welch–Satterthwaite equation. Data were compiled and analyzed in MS Excel; the results below report the observed per-hectare magnitudes and the direction and size of the differences between the two systems as recorded in the survey.

Results and Discussion

Scale of sample farmers

The average area operated by conventional-farming households (3.87 ha) was nearly six times that of natural-farming households (0.68 ha) across all three crops (Table 1), confirming that natural farming in the district is still practised on small, carved-out parcels rather than at full-farm scale. This scale difference is neutralised in the analysis by comparing costs and returns strictly on a per-hectare basis.

Table 1: Crop-wise number of sample farmers and average area under cultivation

Crop	NF farmers (No.)	NF mean area (ha)	Conv. farmers (No.)	Conv. mean area (ha)
Mustard	27	0.75	24	3.82
Chickpea	20	0.62	24	4.10
Grass pea	9	0.56	8	3.34
Overall	56	0.68	56	3.87

Source: Primary data. NF = natural farming; Conv. = conventional farming

Cost of cultivation mustard Crop

The total cost of cultivating mustard under natural farming (₹28,511/ha) was about 47.46 per cent lower than under conventional farming (₹54,265/ha) the largest saving among the three crops. This was driven mainly by a very large 75.06 per cent cut in machine/bullock labour charge and a 58.33 per cent cut in hired labour, together with a 67.34 per cent saving on fertilizer (natural farming spent ₹1,925/ha on bio-fertilizer against ₹5,890/ha on chemical fertilizer under conventional farming) and a 61.15 per cent saving on plant-protection inputs (₹975/ha on biological pest-control formulations against ₹2,551/ha on chemicals). Unlike chickpea and grass pea, family-labour cost was also lower, not higher, under natural farming for mustard (31.25 per cent lower), so total human-labour cost came in at nearly half that of conventional farming. As is typical of low-input systems, the variable-cost share fell sharply (61.68 per cent) while the fixed-cost component mainly the rental value of

owned land formed a comparatively larger share of the total, even though it too was 27.29 per cent lower in absolute terms (Table 2).

Table 2: Per-hectare cost of cultivation of mustard (₹/ha)

Particulars	Natural farming	Conventional farming	% change
Total human labour	4,620	8,800	-47.50
Seed cost	960	1,450	-33.79
Machine/bullock charge	2,400	9,625	-75.06
Fertilizer/Bio fertilizer	1,925	5,890	-67.34
Plant protection chemicals/ Biological pest chemicals	975	2,551	-61.15
Irrigation charge	850	2,290	-62.88
Interest on working capital	469	1,224	-61.68
Total Variable Cost (A)	12,199	31,830	-61.68
Rental value of owned land	15,000	20,000	-25.00
Depreciation on machinery	240	963	-75.06
Interest on fixed capital	1,067	1,468	-27.29
Total Fixed Cost (B)	16,312	22,435	-27.29
Total Cost of Cultivation (A+B)	28,511	54,265	-47.46

Source: Primary data

Cost of cultivation chickpea

The total cost of cultivating chickpea under natural farming (₹37,404/ha) was about 32.48 per cent lower than under conventional farming (₹55,398/ha) the smallest saving of the three crops. Unlike mustard, seed cost under natural farming was marginally higher (+2.27 per cent), as farmers used a higher local-seed rate to offset lower germination during the transition, and family-labour use was 18.18 per cent higher, reflecting the extra labour needed to prepare and apply on-farm bio-inputs and to hand-weed in place of chemical weed control. Even so, total human-labour cost remained 33.33 per cent lower under natural farming because far less labour was hired in. As with mustard, spending on fertilizer, plant protection and irrigation was cut substantially by 59.45, 69.88 and 53.33 per cent respectively through the use of bio-fertilizer and biological pest-control inputs in place of chemical ones (Table 3).

Table 3: Per-hectare cost of cultivation of chickpea (₹/ha)

Particulars	Natural farming	Conventional farming	% change
Total human labour	5,280	7,920	-33.33
Seed cost	9,000	8,800	+2.27
Machine/bullock charge	2,600	6,580	-60.49
Fertilizer/Bio fertilizer	1,690	4,168	-59.45
Plant protection chemicals/ Biological pest chemicals	780	2,590	-69.88
Irrigation charge	910	1,950	-53.33
Interest on working capital	810	1,280	-36.71
Total Variable Cost (A)	21,070	33,288	-36.71
Rental value of owned land	15,000	20,000	-25.00
Depreciation on machinery	260	658	-60.49
Interest on fixed capital	1,069	1,446	-26.12
Total Fixed Cost (B)	16,334	22,109	-26.12
Total Cost of Cultivation (A+B)	37,404	55,398	-32.48

Source: Primary data

Cost of cultivation grass pea

The total cost of cultivating grass pea under natural farming (₹35,251/ha) was 37.30 per cent lower than under conventional farming (₹56,221/ha). Machine/bullock labour charge and

depreciation on farm machinery both fell by 86.32 per cent, fertilizer cost by 68.45 per cent and plant-protection cost by 65.34 per cent, while family-labour use, as with chickpea, was higher under natural farming (+25.00 per cent) owing to the substitution of on-farm bio-input preparation for purchased inputs. Total variable cost fell by 44.27 per cent and total fixed cost by 26.37 per cent, with the imputed rental value of owned land remaining the single largest cost item under both systems (Table 4).

Table 4: Per-hectare cost of cultivation of grass pea (₹/ha)

Particulars	Natural farming	Conventional farming	% change
Total human labour	7,260	11,660	-37.74
Seed cost	7,125	7,600	-6.25
Machine/bullock charge	628	4,590	-86.32
Fertilizer/Bio fertilizer	1,655	5,245	-68.45
Plant protection chemicals/ Biological pest chemicals	815	2,346	-65.34
Irrigation charge	910	1,563	-41.78
Interest on working capital	736	1,320	-44.27
Total Variable Cost (A)	19,129	34,324	-44.27
Rental value of owned land	15,000	20,000	-25.00
Depreciation on machinery	63	459	-86.32
Interest on fixed capital	1,055	1,432	-26.37
Total Fixed Cost (B)	16,123	21,896	-26.37
Total Cost of Cultivation (A+B)	35,251	56,221	-37.30

Source: Primary data

Yield and profitability

The cost saving, however, came at the price of yield, and tracing costs through the CACP concepts shows that even the cost advantage itself is not as stable as it first appears (Tables 5–7). Mustard yield under natural farming (6.40 qt/ha) was 52.06 per cent below conventional farming (13.35 qt/ha), and at an identical price of ₹5,950/qt, net income fell to ₹9,569/ha against ₹25,167/ha under conventional farming a drop of 61.98 per cent. The cost of production per quintal was marginally higher under natural farming (₹4,455 against ₹4,394, +1.39 per cent), and the output–input ratio (1.34 against 1.46) and net–return ratio (0.34 against 0.46) were both modestly lower (Table 5).

Table 5: Profitability of mustard cultivation

Particulars	Natural farming	Conventional farming	% change
Yield (qt/ha)	6.40	13.35	-52.06
Sale price (₹/qt)	5,950	5,950	0.00
Cost of production (₹/qt)	4,558	4,394	+1.39
Gross income (₹/ha)	38,080	79,433	-52.06
Net income (₹/ha)	9,569	25,167	-61.98
Output–input ratio	1.34	1.46	-8.46
Net–return ratio	0.34	0.46	-26.69

Source: Primary data

Chickpea yield under natural farming (8.35 qt/ha) was 44.52 per cent lower than under conventional farming (15.05 qt/ha), and at an identical price of ₹5,650/qt, net income under natural farming (₹9,774/ha) came in 67.02 per cent lower the widest income gap of the three crops while the cost of production per quintal was 21.70 per cent higher (₹4,480 against ₹3,681). The output–input ratio (1.26 against 1.53) and net–return ratio (0.26 against 0.53) confirm that chickpea under natural farming, as currently practiced, is markedly less remunerative (Table 6).

Table 6: Profitability of chickpea cultivation

Particulars	Natural farming	Conventional farming	% change
Yield (qt/ha)	8.35	15.05	-44.52
Sale price (₹/qt)	5,650	5,650	0.00
Cost of production (₹/qt)	4,480	3,681	+21.70
Gross income (₹/ha)	47,178	85,033	-44.52
Net income (₹/ha)	9,774	29,635	-67.02
Output-input ratio	1.26	1.53	-17.56
Net-return ratio	0.26	0.53	-50.70

Source: Primary data.

Grass pea yield under natural farming (10.15 qt/ha) was 43.30 per cent lower than under conventional farming (17.90 qt/ha); at an identical price of ₹4,300/qt, net income under natural farming (₹8,394/ha) was 59.55 per cent lower than under conventional farming (₹20,749/ha) the narrowest income gap of the three crops. The cost of production per quintal was 10.57 per cent higher (₹3,473 against ₹3,141), and both the output-input ratio (1.24 against 1.37) and net-return ratio (0.24 against 0.37) stayed comparatively close between the two systems (Table 7).

Table 7: Profitability of grass pea cultivation

Particulars	Natural farming	Conventional farming	% change
Yield (qt/ha)	10.15	17.90	-43.30
Sale price (₹/qt)	4,300	4,300	0.00
Cost of production (₹/qt)	3,473	3,141	+10.57
Gross income (₹/ha)	43,645	76,970	-43.30
Net income (₹/ha)	8,394	20,749	-59.55
Output-input ratio	1.24	1.37	-9.49
Net-return ratio	0.24	0.37	-35.14

Source: Primary data.

Tracing costs through the CACP concepts

Tracing costs through the successive CACP cost concepts from Cost A1 (paid-out cost) to Cost C3 (fully imputed cost) shows the same pattern for all three crops: the cost advantage of natural farming is widest at Cost A1 and narrows steadily as imputed fixed items are added (Table 8). For mustard, the cost advantage of natural farming declines from 65.76 per cent at Cost A1 to 47.46 per cent by Cost C3; for chickpea, it decreases from 41.41

per cent to 32.48 per cent; and for grass pea, it declines from 50.55 per cent to roughly 37.30 per cent. This happens because imputed fixed items the rental value of owned land, interest on fixed capital and the managerial component are broadly similar in absolute terms across the two systems, so they add a proportionately larger share to the lower cost base of natural farming.

Table 8: CACP cost concepts across the three crops (₹/ha)

Cost concept	Mustard NF	Mustard CF	Chickpea NF	Chickpea CF	Grass pea NF	Grass pea CF
Cost A1	10,024.20	29,277.74	18,475.40	31,531.32	15,896.52	32,148.16
Cost A2	10,024.20	29,277.74	18,475.40	31,531.32	15,896.52	32,148.16
Cost B1	11,091.35	30,745.47	19,543.95	32,977.73	16,951.27	33,580.64
Cost B2	26,091.35	50,745.47	34,543.95	52,977.73	31,951.27	53,580.64
Cost C1	13,511.35	34,265.47	22,403.95	35,397.73	20,251.27	36,220.64
Cost C2	28,511.35	54,265.47	37,403.95	55,397.73	35,251.27	56,220.64
Cost C3	31,362.49	59,692.02	41,144.35	60,937.50	38,776.40	61,842.70

Source: Primary data.

Comparative synthesis

Taken together, the three crops tell one consistent story (Table 9). Natural farming delivered a genuine, sizeable saving in the cash cost of cultivation between 32.48 and 47.46 per cent achieved largely through cuts in machine/bullock labour, hired labour and irrigation, and through the use of cheaper bio-inputs in place of chemical fertilizer and plant-protection chemicals. In every case, though, that saving was accompanied by a proportionately larger fall in yield, and because the two systems fetched identical prices, the yield penalty was the decisive factor: net income under natural farming ended up 59.55 to 67.02 per cent lower, and both the output-input and net-return ratios stayed uniformly below conventional farming. The ranking across crops is instructive grass pea, with the smallest yield gap, showed the narrowest income disadvantage, while chickpea, which combined a large yield gap with a higher seed cost and higher family-labour cost, showed the widest. This places grass pea and other low-input pulses as the more promising entry points for chemical-free cultivation in the district.

Table 9: Comparative economics of natural (NF) and conventional (CF) farming across the three crops

Indicator	Mustard	Chickpea	Grass pea
Total cost, NF (₹/ha)	28,511	37,404	35,251
Total cost, CF (₹/ha)	54,265	55,398	56,221
Cost saving under NF (%)	47.46	32.48	37.30
Yield gap under NF (%)	52.06	44.52	43.30
Net income, NF (₹/ha)	9,569	9,774	8,394
Net income, CF (₹/ha)	25,167	29,635	20,749
Net-income gap under NF (%)	61.98	67.02	59.55
Output-input ratio (NF: CF)	1.34 : 1.46	1.26 : 1.53	1.24 : 1.37
Net-return ratio (NF: CF)	0.34 : 0.46	0.26 : 0.53	0.24 : 0.37

Source: Primary data. NF = natural farming; CF = conventional farming. All values on a per-hectare basis; sale prices were identical between the two systems for each crop.

This central finding that natural farming lowers cash cost but depresses yield and net income even further lines up closely with a substantial strand of Indian evidence. Reddy et al. (2019), studying Zero Budget Natural Farming across Andhra Pradesh, similarly found lower cultivation cost alongside reduced yields in the initial years with no compensating price premium, so

gains in net farm income stayed limited; Koner and Laha (2020), comparing natural and chemical farming in Purulia district of West Bengal, likewise recorded a fall in both per-hectare cost and per-hectare yield after conversion. The Raipur results extend this pattern and pin it down more precisely: here the yield reduction (roughly 43–52 per cent) was large enough to push the per-quintal cost of production above that of conventional farming for every crop, so the input saving never translated into a competitive net return. This sits in sharp contrast with more optimistic experimental and programme evidence from Andhra Pradesh Duddigan et al. (2022) found no short-term yield penalty from natural farming in controlled field-plot experiments across six districts, while Bharucha et al. (2020) reported statistically significant gains in both yields and incomes at scale. The reconciling factor appears to be the practice package itself: in those studies the yield-protecting components of natural farming seed and soil treatments, on-farm microbial formulations and, above all, mulching for soil-moisture retention were actually applied, whereas the wider survey behind this study found that Raipur's sample farmers had adopted only a partial version of these core bio-input techniques, relying on bio-fertilizer and biological pest-control inputs while still falling well short of the full prescribed package. What is observed here a substantial input-cost saving alongside a still-sizeable yield penalty is consistent with what would be expected when the cost-reducing half of the natural-farming package is more fully adopted than the yield-protecting half. Price is the second reconciling factor. Kumar et al. (2023) note that the broader profitability of chemical-free systems depends heavily on premium prices for the produce; where output sells into the same market at the same price as conventional produce, a lower yield feeds directly into lower income precisely what happened here, since natural-farming and conventional produce fetched identical prices for every crop. The steady narrowing of the cost gap from Cost A1 to Cost C3 reinforces this from the cost side: the advantage of natural farming lies in avoided purchased inputs, and once the largely system-invariant imputed items land rent, interest on fixed capital, managerial return are added, that advantage shrinks. Read alongside the wider observation that natural farming in the district is confined to small, less-irrigated, partially converted parcels (Khurana & Kumar, 2020), the evidence suggests natural farming in Raipur is, for now, a cost-saving but yield-constrained orientation rather than a fully realized, financially competitive agribusiness model and that closing the yield gap through fuller adoption of the technical package, together with an assured, differentiated output market, is the precondition for changing that.

Conclusion

This comparative assessment of 56 natural-farming and 56 conventional-farming households in Raipur district shows that natural farming, as currently practised, delivers a substantial and genuine saving in the cash cost of cultivation 32.48 per cent for chickpea, 37.30 per cent for grass pea and 47.46 per cent for mustard achieved chiefly through large cuts in machine/bullock labour, hired labour and irrigation, and through the substitution of bio-fertilizer and biological pest-control inputs for chemical fertilizer and plant-protection chemicals. This saving, however, is more than offset by a sizeable yield penalty of 43.30 to 52.06 per cent, so that at identical output prices, net income under natural farming remains 59.55 to 67.02 per cent below conventional farming, the per-quintal cost of production is higher, and the output-input and net-return ratios are consistently lower across all three crops. Tracing costs through the CACP concepts confirms that the cost advantage of natural farming is concentrated in avoided and reduced purchased inputs and narrows as imputed fixed costs are added.

The overriding conclusion is that natural farming in Raipur district is not yet a financially competitive alternative to conventional cultivation, with the yield gap not input cost as the binding constraint. Because that yield gap coincides with only partial adoption of the prescribed bio-input package and the absence of any price premium, the practical priorities are clear: close the yield gap through fuller, better-supported adoption of the technical natural-farming practices; build an assured and remunerative market for natural-farming produce so that lower volumes need not mean lower incomes; and start this transition with the crops grass pea and other low-input pulses that already lie closest to economic parity. Longitudinal, multi-season research that separates technically compliant adopters from partial adopters will be essential to establish whether, once the full package is in place, natural farming can convert its established cost advantage into a competitive net return.

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