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Research Article

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Analysis of Profitability in Good Agricultural Practices Based Vegetable Farming System in Mid-hill Region of Nepal

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Abstract

Implementing Good Agriculture Practices (GAP) impacts both the economic viability and sustainability of vegetable production. Since income significantly influences farmers' decisions to adopt GAP, understanding the profitability of following GAP is crucial for facilitating the transition from non-GAP to GAP. This study aimed to assess the profitability of GAP farms compared to non-GAP farms in three districts of the Kathmandu Valley: Kathmandu, Lalitpur and Bhaktapur. Altogether six farms, one GAP and one non-GAP farms from each district, were selected purposively. The GAP farms selected for this study were following GAP for more than five years. Primary data on farm characteristics were collected through pre-designed interview questionnaire. Profitability analysis of the selected farms was conducted using the Benefit-Cost Ratio (BCR). The farm characteristics showed that GAP farms prioritized reducing chemical fertilizers and pesticides, while non-GAP farms relied heavily on chemical inputs. The BCR revealed that despite higher fixed and variable costs in GAP farms higher gross and net returns were observed in these farms. The GAP farms were more profitable and sustainable compared to non-GAP farms in all three districts. The highest BCR of 1.52 was observed in the GAP farm in Kathmandu, followed by 1.41 in the GAP farm in Lalitpur, and 1.23 in the GAP farm in Bhaktapur. In contrast, lower BCRs were found in non-GAP farms: 1.04 in Bhaktapur, 0.95 in Kathmandu, and 0.72 in Lalitpur, indicating a loss in the latter two farms.

Keywords : Good Agriculture Practices; gross margin; input cost; profitability; vegetable

Introduction:

Implementing Good Agricultural Practices (GAP) in vegetable production is essential for ensuring food safety, enhancing agricultural sustainability, and reducing negative environmental effects (Kharel et al., 2023). The Food and Agriculture Organization (FAO) of the United Nation defines Good Agricultural Practices (GAP) as *"a set of principles for on-farm production and post-production processes, ensuring safe and healthy food and non-food agricultural products with a focus on economic, social, and environmental sustainability"* (Sareen, 2016). In this study, "Good Agricultural Practices" (GAP) are defined as farming methods designed to minimize the use of agrochemicals. In contrast, "non-Good Agricultural

Practices" (non-GAP) refer to "business as usual" or conventional farming practices that do not incorporate GAP in vegetable production.

The vegetable sector is crucial in Nepal and plays a significant role in the national economy. It provides employment for 3.2 million people and contributes 9% to the agriculture GDP (CASA, 2020). Smallholder farmers are increasingly shifting from cereals to vegetables production (CASA, 2020). Vegetables are being grown commercially, as they provide higher profits compared to cereals crops (Rai et al., 2019). The country's favorable climatic conditions support the cultivation of diverse vegetable crops like tomatoes, cauliflowers, cabbages, pumpkins, peas, and okra, making the vegetable sector important in terms of both area and production (Thapa, 2017).

In Nepal, the commercialization of vegetable production heavily depends on the haphazard application of agrochemicals, often involving inappropriate types, doses, compositions, and application methods, especially regarding chemical fertilizers and pesticides (Kharel et al., 2023). This practice adversely affects the livelihoods of smallholder farmers and presents a major obstacle to achieving agriculture sustainability (Tiwari et al., 2008; Bhandari, 2019). The vegetable sector in Nepal accounts for 80% of the country's pesticide use (Adhikari, 2018), raising serious concerns regarding chemical residues and food safety in the vegetables sold in markets. Each year, pesticide application in vegetable production rises by 10–20% nationwide, with increases of 25%, 9%, and 7% observed in the Terai, mid-hill, and mountain regions, respectively (Nepali et al., 2018). Additionally, the imbalanced application of chemical fertilizers is a widespread issue in agriculture (Dahal et al., 2007). The heavy reliance on chemical fertilizers, coupled with insufficient application of farmyard manure, has led to a significant decline in soil pH (Raut and Situala, 2012) and Soil Organic Matter (SOM) levels (Pahalvi et al., 2021) in agricultural lands of Nepal.

In 2018, the concept of GAP was introduced in Nepal. This initiative aims to enhance the overall quality and safety of agricultural products in the country (DFTQC, 2024). Farmers are increasingly adopting GAP voluntarily, as highlighted in a recent study conducted in the mid-hills of Nepal (Kharel et al., 2023). Worldwide, the adoption of GAP has emerged as an effective strategy for establishing safe and sustainable farming systems (Kharel et al., 2022).

Research has highlighted the significant benefits of GAP in minimizing the use of chemical fertilizers and pesticides (Bairagi et al., 2018; Leong et al., 2020). Furthermore, studies show that the adoption of GAP can result in higher crop yields, increased income, and greater profitability for farmers (Ghimire et al., 2011; Mohammad et al., 2012). In addition, previous studies have found that GAP positively impacts Soil Organic Matter (SOM) content (Aydin and Akturk, 2018; Laosutsan et al., 2019) and enhances water use efficiency (Mohammad et al., 2012). Although various factors influence the decision of farmers to implement GAP, income has been identified as the most crucial factor for vegetable farmers (Laosutsan et al., 2019).

As GAP is relatively new to Nepal, research in this area has been quite limited, especially regarding the comparison of profitability between GAP and non-GAP farms. Without clear evidence of profitability, farmers may find it challenging to transition from non-GAP to GAP methods. Therefore, this study aims to evaluate the profitability of GAP farms compared to non-GAP farms, focusing on costs, returns, and benefits. The findings of the study will support farmers in making informed decisions about transitioning to GAP. Moreover, the results will provide valuable insights for agricultural practitioners and policymakers to develop strategies, policies, and incentives that promote GAP in Nepal. This research study addresses following research questions:

1. What are the key characteristics that differentiate GAP farms from non-GAP farms?
2. How does the distribution of input costs differ between GAP and non-GAP farms?
3. What are the differences in the Benefit-Cost Ratio (BCR) between GAP and non-GAP farms?

Materials and Methods:

The study was conducted in the Kathmandu Valley, which includes three districts: Kathmandu, Bhaktapur, and Lalitpur. Six farms (three GAP and three non-GAP) were selected purposively for this study in such a way that there were one GAP and one non-GAP farm in each district. In selected GAP farms, farmers were implementing GAP for more than five years. Primary data on farm characteristics were collected through a pre-designed interview questionnaire. Tabular and descriptive statistics were used to analyze the data.

A profitability analysis of the farms was conducted using the BCR. The definitions of costs used in this study are as follows:

Total Fixed Cost (TFC): This includes the cost of land rent as fixed cost.

Total Variable Cost (TVC): This includes costs associated with variable items such as land preparation, irrigation, fertilizer/compost, interest on loans, pesticides, weeding, labor, seeds/saplings, and transport.

Total Cost (TC): This is the sum of TFC and TVC.

Gross Return (GR): GR represents the total market value of the farm's production. Gross returns were calculated by multiplying the total volume of production from the farm by the price of the agricultural products.

Gross Margin (GM): GM is calculated by deducting TVC from GR.

Net Return (NR): NR is calculated by deducting TC from GR.

Benefit-Cost Ratio (BCR) Benefit-Cost Analysis (BCA) is a commonly used method in agriculture to evaluate farm profitability. This approach serves as a fundamental tool for examining the financial sustainability of investments, helping to determine if the benefits outweigh the costs. The BCR reflects the ratio of a farm's benefits to its costs. A BCR greater than 1.0 suggests that the farm is likely to generate a positive net present value, delivering favorable returns to the farmers (Hayes & Kindness, 2020).

Mathematically,

BCR = Total revenue/ Total cost

The cost categories used in the study are defined below:

Land preparation: This involves activities such as ploughing, adding lime, applying farmyard manure, and applying a basal dose of chemical fertilizers necessary to prepare the soil for planting. In the study area, farmers ploughed their land using tractors and mini tillers. The cost of liming was particularly significant for GAP farms.

Irrigation: The surveyed farms had year-round irrigation facilities for vegetable production. Water requirements were met through streams, shallow tube wells, solar pumps, and rainwater. Irrigation methods included pipe, drip, irrigation canals, foggers, and sprinklers. The primary cost incurred for irrigation was electricity for pumping water.

Fertilizer/compost: This category includes the cost of chemical fertilizers and compost. GAP farms predominantly used compost, whereas non-GAP farms relied heavily on chemical fertilizers.

Interest for loans: This category includes interest on loans obtained for farm activities. Most farmers borrowed loans from financial institutions and were required to repay them with interest.

Rent: This category covers the cost of land rent. In the study areas, many farmers were migrants who leased land and were required to pay the rent. The duration of land lease agreements was for five years and required renewal in every five years.

Pesticide and weeding costs: These costs comprise the purchase of pesticides and herbicides from markets. Both GAP and non-GAP farms used pesticides. GAP farm mostly used homemade botanical pesticides. In the case of purchased pesticides, they used only blue and green-labeled options as a last resort and applied them systematically under the guidance of technicians.

Labor costs: Labor costs were the most significant costs incurred in vegetable production, including expenses related to record-keeping, farm management, compost making, preparation of botanical pesticides, and other cultivation practices. Both GAP and non-GAP farms mostly used hired laborers.

Seed/sapling: This includes the cost of purchasing seeds/ saplings from markets. The quality of seeds/saplings is crucial for vegetable production.

Transport: This category includes transportation costs of compost, marketing agricultural produce, and other necessary farm inputs.

Results:

Key characteristics of GAP and Non-GAP farms

Both GAP farms and non-GAP farms reflected distinct characteristics in their farming practices. Tomatoes were the common crop for all GAP and non-GAP farms (Table 1). Farmers highlighted tomatoes as their most favored crop due to year-round market demand, serving as a reliable source of income. One GAP farmer specifically mentioned, "Tomatoes are our primary crop. We get premium prices for them. We are also aware that the market price for tomatoes can fluctuate. Additionally, tomatoes are susceptible to pests and diseases. Therefore, we practice crop rotation and mixed cropping, growing tomatoes alongside other crops like cauliflowers and cabbages. This strategy not only reduces production risks but also diversifies our income."

Table 1: Major crops grown in GAP and non-GAP farms

Districts	Experience of GAP farms (years)	Three major crops grown in GAP farms and area coverage in ropani[1]	Three major crops grown in non- GAP farms for past 3 years and area coverage in ropani
Kathmandu (KTM)	7	Tomato, broccoli, coriander (13 ropani)	Tomato, cauliflower, beans (5 ropani)
Bhaktapur (BKT)	8	Asparagus, Broccoli, tomato (38 ropani)	Cauliflower, tomato, leafy greens (7 ropani)
Lalitpur (LPR)	10	Tomato, cucumber, cauliflower (26 ropani)	Tomato, cucurbits and leafy greens (14 ropani)

[1] 20 ropani=1ha

On an average, GAP farmers had around 8 years of experience of implementing GAP. GAP farmers cultivated veg[2]etables on an average of 25 *ropani* of land, while non-GAP farmers cultivated vegetables on an average of 9 *ropani*. GAP farmers received training on GAP and other sustainable agricultural practices from agricultural technicians, whereas non-GAP farms did not receive any specific training and relied on their own knowledge for vegetable farming. GAP farms applied lime annually during land preparation to maintain soil health, a practice not found in non-GAP farms. GAP farms aimed to reduce the use of chemical fertilizers and pesticides gradually, opting for more sustainable practices, while non-GAP farms relied heavily on these chemical inputs. Various crop management practices like crop rotation, mixed cropping, green manuring, and legume integration were employed in GAP farms which contrasted with market-oriented cropping practices of non-GAP farms that lack specific planning for these sustainable techniques. Additionally, GAP farms also practiced sustainable soil management practices (use of improved compost, vermicompost, liquid fertilizer, etc.) and integrated pest management techniques (use of botanical pesticides, lures, traps, etc.).

Another key difference was record-keeping; GAP farms maintained better records of farm activities compared to the poor record-keeping in non-GAP farms. The primary aim of GAP farms was to improve soil health, focusing on long-term sustainability, whereas non-GAP farms aimed to maximize production in the short term. Regular soil testing, including pH measurement was a routine practice in GAP farms, but this was typically not done in non-GAP farms. These differences highlight a more sustainable and environmentally conscious approach to GAP farming compared to non-GAP farming.

Distribution of Input cost in GAP and non-GAP farms

The results on input costs between GAP farms and non-GAP farms showed differences across various categories, such as fertilizer/compost, pesticides, labor, land rent, and seed costs (Figure 1). GAP farms allocated a higher percentage of costs to fertilizer/compost (19.6%) compared to non-GAP farms (11.9%). During in-depth interviews, GAP farmers highlighted that they prioritized using compost and organic soil amendments to maintain soil health, while non-GAP farmers expressed a reluctance to use compost due to the high labor required for its production.

Regarding pesticide costs, non-GAP farms spent more on pesticides (10.2%) compared to GAP farms (2.8%), reflecting the heavier reliance of non-GAP farms on chemical inputs. In terms of loan interest, GAP farms spent more on interest payments (13%) compared to non-GAP farms (7.3%), possibly due to higher initial investments in sustainable practices and technologies.

Labor costs were also higher for GAP farms, with greater expenses for activities such as harvesting, fertilizer application, and other farm operations (28.6%) compared to non-GAP farms (18.6%), highlighting the labor-intensive nature of GAP. Similarly, weeding costs were higher for GAP farms (5.3%) as compared to non-GAP farms (3.2%) suggesting that manual weed control is more prevalent in GAP farms. Conversely, rental costs were higher for non-GAP farms (21.3%) compared to GAP farms (16.1%) which may indicate differences in land use intensity or lease agreements.

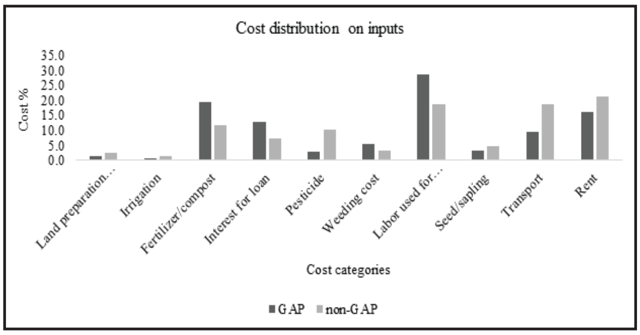

Figure 1. Distribution of the input cost to the total cost

Detailed benefit-cost analysis of GAP and non-GAP farms

The comparison of the costs, returns, and benefits associated with GAP farm versus non-GAP farms is presented in Table 2. The detailed breakdown covers various cost categories such as land preparation, irrigation, fertilizers, interest on loans, pesticides, weeding, labor, seed/sapling, transport, and land rent. The total production costs were higher in GAP farms (NPR 355,303) than those for non-GAP farms (NPR 201,239). This higher expenditure was attributed to both fixed and variable costs. The fixed costs for GAP were NPR 57,146, whereas for non-GAP they were NPR 42,886. Similarly, the variable costs were substantially higher for GAP, totaling NPR 298,157 compared to NPR 158,354 for non-GAP.

Despite the higher costs, the gross returns from GAP farms were more than double in comparison to non-GAP farms, amounting to NPR 496,412 compared to NPR 182,250. The higher returns in GAP farms were attributed to lower pesticide costs, as well as higher yields and higher selling prices. As showed in Figure 1, the cost of pesticides was lower in GAP farms compared to non-GAP farms.

GAP farmers reported that implementing GAP resulted in 10-20% higher yields. They believed that the higher yields were possible due to improved knowledge and practices related to soil health management techniques in their farms. Since tomatoes were only common crop in both GAP and non-GAP farms, the yield comparison shows that tomato production was 4,667 kg per *ropani* in GAP farms compared to 3,667 kg per *ropani* in non-GAP farms, indicating a 21% higher yield in GAP farms. Farmers sold their GAP products to major market centers (57%) at Lagankhel, Kalimati, Balkhu, and Koteshwore and safe food traders (25%),

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hotels and restaurants (11%), and nearby cooperatives (7%), whereas non-GAP products were mostly sold to market centers at Lagankhel, Kalimati, Balkhu, and Koteshwore. It was found that GAP farmers received premium prices of 10–30% for some vegetables, such as tomatoes, asparagus, off-season broccoli, and coriander. For tomatoes, the income from GAP farms was NPR 160,667 per *ropani*, whereas it was NPR 102,333 per *ropani* from non-GAP farms, indicating a 36% higher income for GAP tomatoes. The reason for receiving premium prices was the visibly high quality of their products, even without specific labeling for GAP. The difference in returns highlights the economic advantage of implementing GAP.

The gross margin, which represents the difference between gross returns and variable costs, was also markedly higher for GAP, with a total of NPR 198,254 compared to just NPR 23,896 for non-GAP farms. Similarly for net returns, the result showed higher net returns of NPR 141,109 from GAP farms compared to NPR 18,989 for non-GAP farms. In Kathmandu and Lalitpur districts, non-GAP farms even resulted in negative net returns, underscoring the economic risks associated with these practices.

GAP farmers also reported that they experienced several benefits from implementing GAP beyond economic advantages. They noted that GAP improves soil health, enhances the farm's positive image, minimizes the use of chemical fertilizers and pesticides, and ensures safety from agrochemicals. Additionally, these benefits contribute to increased environmental sustainability, as well as enhanced product safety and quality, which keeps them motivated to continue using GAP.

Table 2: Cost analysis for GAP and non-GAP farms

Cost categories	GAP (cost per ropani of land / % of the total cost)					Non-GAP (cost per ropani of land / % of the total cost)				
	KTM	BKT	LPR	Total	%	KTM	BKT	LPR	Total	%
Land preparation	3230.8 (2.06)	657.9 (0.54)	1230.8 (1.60)	5119.5	1.4	1600 (2.01)	2142.9 (3.68)	928.6 (1.47)	4671.5	2.3
Irrigation	923.1 (0.59)	315.8 (0.26)	800 (1.04)	2038.9	0.6	600 (0.75)	1714.3 (2.94)	585.7 (0.92)	2900	1.4
Fertilizer/ Compost	30769.2 (19.66)	22368.4 (18.34)	16483.1 (21.45)	69620.7	19.6	6000 (9.71)	8571.4 (14.71)	9285.7 (14.66)	23857.1	11.9
Interest for loan	38461.5 (24.58)	4210.5 (3.45)	3461.5 (4.50)	46133.5	13.0	0	3000 (5.15)	11785.7 (18.60)	14785.7	7.35
Pesticide	3076.9 (1.97)	1315.8 (1.08)	5692.3 (7.41)	10085	2.8	10000 (12.56)	8571.4 (14.71)	1942.9 (3.07)	20514.3	10.2
Weeding	7700 (4.92)	7894.7 (6.47)	3269.2 (4.25)	18863.9	5.3	2550 (3.20)	2857.1 (4.90)	1071.4 (1.69)	6478.5	3.2
Labor	34769.2 (22.22)	47368.4 (38.83)	19615.4 (25.52)	101753	28.6	30000 (37.69)	4285.7 (7.35)	3214.3 (5.07)	37500	18.6
Seed/sapling	2307.7 (1.47)	4368.4 (3.58)	4230.8 (5.50)	10906.9	3.07	1000 (1.26)	4285.7 (7.35)	4428.6 (6.99)	9714.3	4.8
Transport	11538.5 (7.37)	15789.5 (12.95)	6307.7 (8.21)	33635.7	9.5	15251.8 (19.16)	1428.6 (2.45)	21251.8 (33.55)	37932.2	18.8
Rent	23692.3 (15.14)	17684.2 (14.50)	15769.2 (20.52)	57145.7	16.1	12600 (15.83)	21428.6 (36.76)	8857.1 (13.98)	42885.7	21.3
Total cost (TC)	156469.2	121973.6	76860	355302.8	100.00	79601.8	58285.7	63351.8	201239	100.0
Total fixed cost (TFC)	23692.3	17684.2	15769.2	57146		12600	21428.6	8857.1	42886	
Total variable cost (TVC)	132776.9	104289.4	61090.8	298157		67001.8	36857.1	54494.7	158354	
Gross return (GR)	238334.61	150000	108076.92	496412		76000	60714.29	45536	182250	
Gross margin (GM)	105557.71	45710.60	46896.12	198254		8998.2	23857.19	-8,959	23896	
Net return (NR)	81865.41	28026.4	31216.92	141109		-3601.8	2428.59	-17,816	18989	
Benefit cost Ratio (BCR)	1.52	1.23	1.41			0.95	1.04	0.72		

The result showed the highest BCR of 1.52 from GAP farm in Kathmandu district indicating good profitability (Fig 2, Table 2). Conversely, the BCR of 0.95 for non-GAP farms in this district demonstrates that these practices were less economically advantageous compared to GAP. Similarly, the BCR of 1.23 for GAP farm in Bhaktapur district indicates moderate profitability. Although the net return was positive, the overall profitability was lower than in GAP farm in Kathmandu, highlighting potential areas for improvement in GAP implementation. For non-GAP farm in the same district, the BCR of 1.04 indicates marginal profitability, suggesting that these practices just covered costs, with very little financial gain. The BCR of 1.41 for GAP farms in Lalitpur district indicates profitability. In contrast, the BCR of 0.72 for non-GAP farm in this district indicates a loss, as the returns did not cover the costs, underscoring the importance of adopting GAP to ensure economic sustainability.

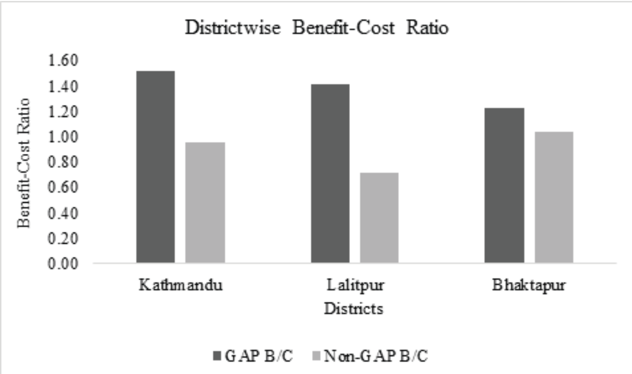

Figure 2. Benefit-Cost Ratio of GAP and non-GAP farms

Discussion:

Farmers choose to grow vegetables for income (CASA, 2020). However, unsustainable farming practices, including the haphazard use of agrochemicals, lead to unsafe food production and create negative impacts on the environment, challenging the sustainability of vegetable production in Nepal (Kharel et al., 2023). While the transition to sustainable practices such as GAP may involve initial risks and high upfront costs, the long-term benefits for profitability and environmental health are substantial, making it a viable strategy for farmers. Our results indicate that GAP farmers received training on GAP from agricultural technicians and adopted a range of strategies to improve soil health, crop management practices and farm record management which contributed to increased crop yields and greater farm profitability. Our finding aligns with a previous study that indicates increased crop yields and income from implementing GAP (Danquah et al., 2015; Dorji et al., 2016; Bairagi et al., 2018). Similarly, GAP farmers had regular access to markets and received premium prices for vegetables, including tomatoes, which contributed to increased farm profitability. This aligns with a past study indicating farmers' willingness to offer premium prices for safe and quality agricultural products (Bhattarai, 2019).

The cost analysis indicated that GAP farms invested more on soil health and fertility, with a notably higher allocation to compost, aligning with similar findings from a previous study (Puzyreva et al., 2022) which suggests that GAP farmers consider soil health to be one of the key incentives for following GAP. Labor costs, including weeding, were higher in GAP farms due to the increased labor requirements for uprooting weeds, making compost, and maintaining farm records, including others as revealed during in-depth interviews. This aligns with other studies which highlighted the labor-intensive nature of GAP farms (Crowder and Reganold, 2015). Another distinct difference between GAP and non-GAP farms was the cost of pesticides. During in-depth interviews, GAP farmers mentioned their aim to reduce pesticide use and, when necessary, to apply pesticides systematically following technician's advice. Reducing the use of agrochemicals, such as pesticides, can lower input costs and provide several benefits, including safe food production (Leong et al., 2020).

The BCR revealed notable differences between GAP and non-GAP farms across Kathmandu, Bhaktapur, and Lalitpur districts. The BCR greater than 1 in all three districts indicates good profitability from GAP. Similarly, a previous study suggested that tailored and locally adapted sustainable practices can significantly enhance farm profitability (Uddin et al., 2024). In contrast, the BCRs of 1.04, 0.95 and 0.72 for non-GAP farms in Bhaktapur, Kathmandu and Lalitpur districts respectively, indicate a loss. Although a BCR greater than 1 was found in non-GAP farms in Bhaktapur, it barely covers costs and indicates minimal financial gain.

Despite the lower total costs associated with non-GAP, there was a loss in profitability, as reflected by a lower BCR. This suggests that, while non-GAP farms may incur fewer expenses, they generate insufficient returns to be economically advantageous compared to GAP farms. The profitability of non-GAP farms can be improved by addressing inefficiencies in transportation. Implementing more efficient logistics can help reduce costs. Non-GAP farms may also benefit from following technicians' advice, particularly on soil management techniques, and reducing pesticide use and applying it systematically only when necessary. In conclusion, the data reveals that GAP generally ensures profitability across the districts, with Kathmandu showing the most significant benefits. Non-GAP practices, while sometimes still profitable, do not match the economic returns of GAP and in non-GAP in Kathmandu and Lalitpur, the result can lead to financial losses. Therefore, promoting GAP adoption and tailoring site-specific strategies are critical for improving the overall economic outcomes of GAP-based vegetable production.

Conclusion:

The comparison of costs, returns, and benefits between

GAP and non-GAP farms revealed a clear economic advantage in following GAP. Despite higher fixed and variable costs, GAP farms showed significantly higher gross returns, gross margins, and net returns. The gross returns from GAP farms were more than double those of non-GAP farms. Furthermore, the BCR indicated that GAP farms were notably more profitable than non-GAP farms. Overall, the findings underscore the economic risks associated with non-GAP and highlight the importance of following GAP for improved economic sustainability in vegetable production. This study supports the transition from non-GAP to GAP-based vegetable farming to achieve higher profitability and long-term viability for farmers.

Declaration of conflict of interest and ethical approval:

The authors declare that there are no competing interests regarding this manuscript.

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