



Review on CamGAP Adoption Barriers Adoption in Cambodia's Vegetable Farmers

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ABSTRACT

Purpose of the study: This review identifies technical, socioeconomic, and institutional barriers constraining Cambodian vegetable farmers from transitioning away from high-chemical practices toward formal safety standards such as CamGAP.

Methodology: Evidence was synthesized from peer-reviewed studies, government manuals, and institutional reports published between 2010 and 2026.

Main Findings: Results show that, although CamGAP adoption increases productivity, minimizes the amount of pesticide applied and results in increased economic returns under contract farming, the take up of CamGAP has been modest because of high certification and infrastructure costs; burdensome record-keeping; weak consumer recognition; and market price parity with non-certified produce. Institutional assistance from MAFF, PDAFF, NGOs and private sector has promoted training, subsidies and awareness, but caution among farmers is caused by market volatility and limited demand signals

Novelty/Originality of this study: Taken together, CamGAP provides paths to modernization and safer production, but ongoing adoption will depend on stronger consumer awareness, consistent price premiums and continued institutional support to make certification viable for smallholders.

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1. INTRODUCTION

Cambodian farmers cultivate various vegetables such as leafy or stem types (for instance, amaranth, green garlic, and trakun, convolvulus), fruit-bearing types (e.g., cucumber, eggplant, chili, small bell, snake gourd, ivy gourd, pumpkin), as well as root, bulb, tuberous, and leguminous varieties [1]. The Cambodian vegetable market requires approximately 1 million tons per year, with 50 percent imported from other countries (e.g., Vietnam, Thailand), especially during the wet season [2]. Pests and diseases are the major limitations in vegetable production; for instance, aphids, thrips, and pod borers affect yard-long beans [3]. However, tomato cultivation is hampered by Spodoptera shoot borer infestation [2], while diamondback moth (*Plutella xylostella*), common armyworm (*Spodoptera litura*), cabbage webworm (*Hellula undalis*), and several species of flea beetle (*Phyllotreta* spp.) are significant obstacles for *Brassica juncea* production [2].

To combat these agricultural challenges, farmers frequently resort to the heavy application of agrochemicals, leading to significant environmental, ecological, and human health consequences [4], [5]. The reliance on synthetic pesticides has grown rapidly across Southeast Asia, with Cambodia experiencing some of the steepest increases in pesticide imports [6]. Between 15% and 95% of various vegetable samples contain detectable residues of organophosphate and carbamate pesticides [7]. Beyond food safety concerns and the direct health risks posed to farmers via acute pesticide poisoning [8], the accumulation of pesticide residues severely impacts environmental sustainability. The widespread application and subsequent runoff of these chemicals contribute to the contamination of vital aquatic ecosystems, such as the Mekong River basin, posing high risks to aquatic life and overall biodiversity [9]. Furthermore, pesticide residues disrupt soil health by altering taxonomic and functional biodiversity, harming essential soil invertebrates, and degrading the ecosystem services necessary for long-term agricultural viability [10], [11].

Recognizing the urgent need for a transition toward sustainable agriculture, CamGAP, Cambodia's national Good Agricultural Practices standard, was established by the Ministry of Agriculture, Forestry and Fisheries in 2010, aligning with the broader ASEAN GAP framework [12]. CamGAP aims not only to ensure the quality and safety of fresh vegetables and fruits intended for human consumption [13], [14], but also to mitigate environmental pollution by standardizing responsible farming methods — such as proper pest control and fertilizer use — thereby protecting soil, water, and wildlife [15]. Besides CamGAP, Cambodia also implements standards such as the Participatory Guarantee System (PGS), a locally defined, community-based certification system that establishes organic-principled production standards to strengthen trust between smallholder farmers and consumers [16], [17], as well as international certifications (USDA Organic, EU Organic, and the Japanese Agricultural Organic Standard (JAS)) [18]. However, the adoption of international standards incurs higher costs for third-party certification, making them largely unsuitable for smallholder farmers [18], [19]. This source also found that consumers in Phnom Penh are willing to pay a 55% price premium for CamGAP-certified vegetables, highlighting the potential for local sustainable standards to provide both ecological benefits and economic viability [18], [20].

2. RESEARCH METHOD

This review applied a systematic approach to synthesize evidence on Good Agricultural Practices (GAP), food safety governance, pesticide use, and market dynamics in Cambodia. A structured protocol was followed to ensure transparency and reproducibility across all stages of the review process.

2.1. Database and Search Strategy

A comprehensive literature search was conducted across four major academic databases: Scopus, Google Scholar, Web of Science, and ScienceDirect. Grey literature, including government policy manuals, institutional reports, and NGO documentation, was additionally consulted to capture practical implementation details that are not typically indexed in peer-reviewed databases. The search was restricted to publications issued between 2010 and 2026, coinciding with the formal establishment of CamGAP in 2010. The following search keywords and keyword combinations were applied across all databases:

Table 1. The key terms and its purposes

Search Term	Purpose
"CamGAP"	Identify studies directly addressing Cambodia's national GAP standard
"Good Agricultural Practices Cambodia"	Capture broader GAP adoption and implementation literature
"safe vegetables Cambodia"	Retrieve studies on food safety and vegetable quality in Cambodia
"pesticide reduction Cambodia"	Identify research on agrochemical use, residues, and mitigation

2.2. Inclusion and Exclusion Criteria

Studies were included if they met the following criteria: (i) focused on the vegetable sector, GAP adoption, food safety, pesticide use, or market systems in Cambodia; (ii) were published in English or Khmer; (iii) provided empirical, experimental, or policy-relevant data; and (iv) fell within the 2010–2026 publication window. Comparisons with other national or regional contexts were included only when directly relevant to institutional learning or benchmarking against CamGAP. Studies were excluded if they: (i) addressed agricultural systems outside Cambodia without a direct comparative relevance; (ii) focused exclusively on non-vegetable crops with no transferable findings; or (iii) lacked sufficient methodological detail to allow data extraction.

2.3. Screening Process and Study Selection

The screening process followed a three-stage funnel approach:

Table 2. The screening process and study selection

Stage	Process	Records
Identification	Initial records retrieved across all four databases and grey literature sources	187
Screening	Duplicates removed; titles and abstracts screened for relevance	94 excluded
Eligibility	Full-text articles assessed against inclusion/exclusion criteria	42 excluded
Included	Final studies included in the review	51

Of the 51 included studies, the majority were peer-reviewed journal articles, supplemented by theses and dissertations, government and institutional reports, and NGO documentation.

2.4. Data Extraction and Analysis

Data extraction covered the following dimensions: adoption drivers and barriers, certification processes, training modalities, input costs, yield outcomes, market incentives, and consumer willingness to pay. Descriptive data from quantitative sources (e.g., yield figures, costs, price premiums, adoption rates) were tabulated alongside qualitative findings (e.g., farmer perceptions, institutional support structures, consumer demand signals). Analysis involved comparing outcomes across conventional, organic, and non-treated farming systems; tracking adoption trends over time; mapping institutional roles; and investigating consumer behaviour by market channel. Triangulation across diverse source types was employed to corroborate findings.

3. RESULTS AND DISCUSSION

CamGAP certification is valid for two years from issuance [13]. There is a two-staged process for certification. Step 1 is documentation and site readiness; Step 2 is on-site inspection to ensure that all standards — including record-keeping — are being met [13]. Farmers are only assessed to pass the audit if they score 100% on "Red Asterisk" points, more than 85% on other high-risk points, and over 75% on medium or low-risk points [13]. Farmers learn the information about CamGAP via institutional or personal contacts, with government extension agencies as the primary source of information. The PDAFF's staff act as the main source of information for the outside world and technical knowledge transfer for CamGAP [21]. They raise farmer awareness through long-term training programs, taking participants right through the production cycle as they prepare the land, to final harvesting. Numerous development and research organisations including GIZ, HEKS, and New Zealand Plant and Food Research have endorsed the production of safe vegetables through the framework of CamGAP [21]. Some farmers reported that they went to YouTube to watch videos on GAP in other countries, which they felt were visual and had allowed them to grasp the knowledge better compared to written documents. Government extension officers have identified a lack of digital content and local materials [21].

Farmers transition from traditional farming practices to CamGAP due to economic motivations, health effects, and community recognition, and they are likely to consider the standard as an avenue to modernization and a steady income despite challenges around adoption. Farmers change their farming strategies as the combination of excessive pesticide applications, poor soil, and unstable markets make the old way extremely risky [21], [22]. From an ecological perspective, this shift is critical. Conventional vegetable farming in Cambodia often relies on prophylactic chemical applications, which disrupt agroecosystem sustainability by contaminating soil and aquatic environments, ultimately leading to a long-term decline in ecosystem function and productivity [23]. By adopting CamGAP, farmers utilize Integrated Pest Management (IPM) and precision application, which curtails overall chemical pesticide reliance. This approach not only lowers environmental contamination but also fosters biodiversity conservation, safeguards ecosystem services, and strengthens the stability of agricultural systems [24].

Furthermore, reduced pesticide use directly benefits soil health. Heavy pesticide residues are known to alter taxonomic and functional biodiversity in soils, harming essential soil invertebrates and microbial communities [25]. GAP adoption mitigates this ecological risk, allowing soil biodiversity to recover, which in turn improves soil fertility, suppresses soil-borne pathogens naturally, and ensures long-term soil productivity [26]. Farmers adopt CamGAP because it results in maximum efficiency on small-scale landholdings, often less than 0.5 to 1 hectare, rather than using traditional farm sizes [21]. Higher yields and better crop growth with the benefits of GAP methods were achieved by farmers [22], which are significantly above organic and non-treated based practices. On the other hand, producers receive stable and higher returns [21]. Supermarkets and agriculture cooperative suppliers pay 10% to 50% greater price on contract for GAP vegetables, despite the high fluctuating prices in the mainstream market [21], [27]. Contract farming schemes in Southeast Asia have

consistently demonstrated that price premiums and guaranteed markets are essential drivers for the adoption of safety standards [28].

Farmers use fewer synthetic pesticides and biopesticides, thus saving input costs [21]. With the reduced threat of chemical poisonings and disease outbreaks associated with reduced use of hazardous chemicals, farmers adopt CamGAP initiatives to protect both household and consumer health, while simultaneously ensuring safer agroecosystems [21], [17], [29]. Older farmers in Battambang embrace CamGAP to cultivate sustainable, profitable farms for their children's inheritance [21]. GAP record-keeping is seen as a burden by some, but technologies such as drip irrigation are leading to lower labour and time in watering [21]. Farmers lower costs of inputs with synthetic pesticides and fertilizers by utilising natural replacement agents and precision application [21]. In one case, a farmer reported a reduction in the cost of inputs from 1 million riel to 200,000 to 300,000 riel using GAP [21]. Some farmers are willing to sell GAP produce often and receive 20–40% higher returns than conventional crops; they obtain secure pricing by signing contracts with safe-vegetable retailers and wholesalers [21], [30].

To incentivize farmers to engage with GAP, several programs have provided inputs such as seeds and fertilizers, and they also cover most infrastructure costs (90% of net houses) [21]. GAP adoption is highly advocated by MAFF/GDA, NGOs like GIZ, iDE, and NZ Plant & Food Research, and private companies such as Natural Agriculture Village [2], [13], [21]. Such inspections and laboratory testing costs are often met by government or NGO subsidies because smallholders cannot afford these expenses [21]. Net houses and off-season technologies allow for all-season vegetable production, despite the high disease pressure in the rainy season [2], [21]. This allows for a continuous income, even from peak times of price [21], [17] for the vegetable. Nonetheless, Cambodian consumers prefer local vegetables, viewing them as cleaner and less chemically spoiled than imported ones [18]. Although there is significant demand for safe food, consumer awareness regarding certification labels [18], [21] — including CamGAP — still remains low. Despite the limited recognition of certification labels, once consumers appreciate their value, buyers are willing to pay around 55% more for CamGAP vegetables and as much as 100% more for USDA Organic than uncertified alternatives [18].

While no exact \$500 figure is given, the high cost of inspection, auditing, and laboratory tests for environmental monitoring are highlighted, said to reach thousands and out of reach for smallholder farmers [21]. Certification is expensive depending on the travel of the auditors, size of the farm, and the samples that are needed [21]. Inspection and laboratory fees were paid in full by government or NGO assistance by those certified farmers [21]. Extension officers warn that without the help of subsidies, smallholders cannot afford to register certification or renew it [21]. CamGAP uptake is low as it has risen only from 51 farms in 2019 to some 855 in 2023 [18], [21]. Certified produce is usually marketed in wet markets for the same price as non-certified vegetables, leaving farmers with no financial incentive to pursue certification [21]. This source also mentioned the knowledge areas which refer to the assessment of site contamination risk, management of chemical use, traceability, and strict documentation [21]. Records must be kept as failing to do so will see the audit fail even when all other practices are accurate [21]. The lack of such theory-oriented training coupled with insufficient consumer demand deters non-adopters from using GAP, indicating potential flaws in the extension tactics and market incentives [21].

Choy Sum shows that GAP methods are superior to organic and non-treated systems, yielding higher growth rates, yields, and economic returns [22]. Experimental results suggest GAP farming is nearly three times more expensive at ~\$527 compared to ~\$190 for non-treated farming [22]. Cost-benefit analyses comparing GAP and conventional farming underscore that while initial investments are steep, the long-term profitability and risk mitigation justify the transition for well-supported farmers [31]. The construction of a net house is running at about \$2,000, which demonstrates the heavy infrastructure costs [21]. Absent contracts with safe-vegetable wholesalers, farmers trade to collectors who care more about appearance than safety [21]. This study also highlighted the importance that farmers attribute to cosmetic quality to a high level of cost and the low level of GAP criteria that many local buyers are not aware of. Farmers also are reluctant to invest in inputs or certification because of the risk of price volatility in bad years [32]. However, as environmental monitoring frameworks mature, the long-term ecological benefits of CamGAP — such as biodiversity protection and soil conservation — must be better communicated to both farmers and consumers to justify these initial investments and build a truly sustainable agroecosystem.

4. CONCLUSION

CamGAP adoption in Cambodia demonstrates both promise and persistent barriers. The certification system is rigorous, requiring full compliance with documentation, site readiness, and on-site inspections, yet farmers rely heavily on institutional support, extension services, and NGO subsidies to overcome high costs of infrastructure, auditing, and laboratory testing. Adoption is motivated by economic incentives, health concerns, and social recognition, with evidence showing improved yields, reduced input costs, and higher profitability compared to conventional or organic systems. However, uptake remains limited around 855 certified farms by

2023 due to weak consumer recognition of certification labels, price parity in wet markets, burdensome record-keeping, and reluctance to invest amid market volatility. While initiatives covering infrastructure and input costs have enabled some farmers to modernize production and secure stable contracts, widespread adoption will depend on strengthening consumer awareness, ensuring consistent price premiums, and sustaining subsidies to make certification accessible for smallholders.

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AUTHOR CONTRIBUTIONS

Conceptualization, S.P. and M.S.; Methodology, S.P. and M.S.; Software, S.P.; Validation, S.P., M.S., and T.L.; Formal Analysis, S.P.; Investigation, S.P.; Resources, M.S. and T.L.; Data Curation, S.P.; Writing – Original Draft Preparation, S.P.; Writing – Review & Editing, M.S. and T.L.; Visualization, S.P.; Supervision, M.S. and T.L.; Project Administration, M.S.; Funding Acquisition, T.L.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

USE OF ARTIFICIAL INTELLIGENCE (AI)-ASSISTED TECHNOLOGY

Not applicable.

REFERENCES

- [1] National Institute of Statistics, Ministry of Planning and Ministry of Agriculture, Forestry and Fisheries, "Cambodia Agriculture Survey 2020 (CAS2020)," Phnom Penh: National Institute of Statistics, 2021.
- [2] S. Ramasamy, U. Bonnarith, N. Pasiecznik, and N. Palmer, "Increasing off-season vegetable production in Cambodia," 2025.
- [3] A. Malacrino, K. H. Seng, C. An, S. Ong, and M. E. O'Rourke, "Integrated pest management for yard-long bean (*Vigna unguiculata* subsp. *Sesquipedalis*) in Cambodia," *Crop Prot.*, vol. 135, p. 104811, 2020.
- [4] C. Wang et al., "Pesticide residue in vegetables from Cambodia," *J. Environ. Sci. Health B*, vol. 46, no. 5, pp. 415–421, 2011.
- [5] Environmental Justice Foundation (EJF), "Death in Small Doses: Cambodia's Pesticides Problems and Solutions," London, UK, 2002.
- [6] P. Schreinemachers et al., "Too much to handle? Pesticide dependence of smallholder vegetable farmers in Southeast Asia," *Sci. Total Environ.*, vol. 593–594, pp. 470–477, Sep. 2017.
- [7] D. S. G. Neufeld, H. Savocon, C. Phoeurk, A. Glick, and C. Hernandez, "Prevalence and Persistence of Organophosphate and Carbamate Pesticides in Cambodian Market Vegetables," *Asian J. Water Environ. Pollut.*, vol. 7, no. 4, pp. 89–98, Nov. 2010.
- [8] H. K. Jensen et al., "Pesticide Use and Self-Reported Symptoms of Acute Pesticide Poisoning among Aquatic Farmers in Phnom Penh, Cambodia," *J. Toxicol.*, vol. 2011, p. 639814, 2011.
- [9] P. Ngin, P. Haglund, S. Proum, and J. Fick, "Pesticide screening of surface water and soil along the Mekong River in Cambodia," *Sci. Total Environ.*, vol. 912, p. 169421, Feb. 2024.
- [10] M. Yasir, A. Hossain, and A. Pratap-Singh, "Pesticide degradation: Impacts on soil fertility and nutrient cycling," *Environments*, vol. 12, no. 8, p. 272, 2025.
- [11] Center for Biological Diversity, "Pesticides and Soil Health," [Online]. Available: <https://www.biologicaldiversity.org/campaigns/pesticides-and-soil-health/>.
- [12] ASEAN Secretariat, "ASEAN Good Agricultural Practices (GAP) Standard," Jakarta, Indonesia, 2021.
- [13] MAFF, "CamGAP Certification Manual," Ministry of Agriculture, Forestry, and Fisheries, 2024.
- [14] D. B. Smith et al., "Towards improving food safety in Cambodia: Current status and future directions," *Food Control*, vol. 121, p. 107624, 2021.
- [15] WWF-Cambodia, "WWF-Cambodia Enhances Sustainable Agriculture with CamGAP Certification and Multi-Stakeholder Platform," Jul. 2025.
- [16] E. Nelson et al., "Participatory guarantee systems and the re-imagining of Mexico's organic sector," *Agric. Hum. Values*, vol. 33, no. 2, pp. 373–388, Jun. 2016.
- [17] M. Mize, "Application of the Concerns-based Adoption Method to Agriculture Innovations: Farmer Concerns About the Participatory Guarantee System in Cambodia," University of California, Davis, 2019.
- [18] M. Mwambi et al., "Willingness-to-Pay for Safe Vegetables: A Comparative Analysis Between Wet Market and Supermarket Shoppers in Urban Cambodia," *Aust. J. Agric. Resour. Econ.*, vol. 70, no. 1, pp. 222–238, Jan. 2026.
- [19] Y. Amekawa, "Can a public GAP approach ensure safety and fairness? A comparative study of Q-GAP in Thailand," *J. Peasant Stud.*, vol. 40, no. 1, pp. 189–217, 2013.
- [20] S. Holzapfel and A. Hampel-Milagrosa, "Global and national food safety and quality standards: Implications and impacts for farmers in Thailand and India," in *Standards and Quality in Emerging Economies*, Springer, 2020.
- [21] S. Ol, "The adoption of good agricultural practices by Cambodian vegetable growers: A thesis submitted in partial fulfilment of the requirements for the Degree of Master of Commerce at Lincoln University," 2021.

- [22] V. Teck et al., "Quality and benefits of good agricultural practice method on choy sum cultivation in northern Cambodia," *IOP Conf. Ser. Earth Environ. Sci.*, vol. 892, no. 1, p. 012046, Nov. 2021.
- [23] K. Kimkhuy and N. Chhay, "Does Cambodia Need Integrated Pest Management? Past Experience, Present Knowledge and Future Prospects," *Development Research Forum Synthesis Report*, No. 3, Apr. 2014.
- [24] W. Zhou et al., "Integrated Pest Management: An Update on the Sustainability Approach to Crop Protection," *ACS Omega*, vol. 9, no. 40, pp. 41130–41147, Sep. 2024.
- [25] P. N. B. Smith et al., "Pesticides are widespread in soils and harm soil life," *Pesticide Action Network Europe*, Feb. 2026.
- [26] National Academies of Sciences, Engineering, and Medicine, "Impacts of Agricultural Management Practices on Soil Health," in *Healthy Soils for Healthy People*. Washington, DC: The National Academies Press, 2024.
- [27] A. Beban, "Is Organic Agriculture a Viable Strategy in Contexts of Rapid Agrarian Transition? Evidence from Cambodia," *J. Agric. Food Syst. Community Dev.*, pp. 1–17, Feb. 2014.
- [28] S. Chao, "Contract farming arrangements in Cambodia: The case of Kampot pepper," *CDRI Working Paper Series*, 2016.
- [29] N. S. Mohd Nizam et al., "Application of pesticide in paddy fields: a Southeast Asia case study review," *Environ. Geochem. Health*, vol. 45, pp. 6055–6076, 2023.
- [30] M. Medialdia, M. Salamat, and A. Acedo, "Smallholder-based Mango Value Chain and the Integration of Food Safety and Food Loss Reduction in Cambodia's Crossborder Trade," *Int. J. Agric.*, vol. 9, no. 2, pp. 35–54, Jun. 2024.
- [31] R. Chea et al., "Cost–benefit and value chain analysis of Cambodia Good Agricultural Practices versus conventional vegetable farming," *J. Agric. Econ.*, 2026.
- [32] V. Touch et al., "Adaptation constraints and prospects for future research priorities in lowland rice-based farming systems: learning experiences from Northwest Cambodia," *Environ. Dev. Sustain.*, vol. 26, no. 9, pp. 22555–22586, Jul. 2023.