

Agriculture Technology and Nutritional Improvement in Nepal: A Critical Scrutiny

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Abstract

The widespread prevalence of nutrient deficiencies and poor nutritional outcomes is a significant concern in developing countries, particularly in Nepal. This article aims to critically examine the relationship between agricultural technology and nutritional improvement in Nepal, with a focus on the challenges, opportunities, interventions, and policies designed to combat malnutrition. Through a review of secondary data, the article identifies gaps and challenges while also highlighting opportunities to leverage agricultural innovations to address malnutrition and enhance rural livelihoods.

Key words: agricultural technology, nutritional improvement, livelihood, rural, Nepal

Introduction

Agriculture is a key determinant in food security and nutrition improvement in most developing nations such as Nepal. There are some positive changes that have the potential to improve the nutrition of the country in the collection of agricultural practices with time due to technology. This article examines how agricultural technology can improve nutrition and livelihoods, focusing on its applicability and impact on rural populations. Its emphasis on the gaps that need to be filled. Past studies looked only at food production as at end result and not the variety and quality of food that a production system should be able to generate for improved food and nutrition security (Acharya et al., 2018). Notable policies, plans, strategies, and programs in Nepal, such as the Agricultural Development Strategy (ADS), 2015-2035, Agrobiodiversity Policy of 2007, National Agricultural Policy 2004, Multisectoral Nutrition Plan (MSNP) I & II, and National Seed Policy, 2000, have all focused on improving nutrition. Pearl S. Buck stated, "A hungry man can't see right or wrong. He sees food" (Acharya et al., 2018). This statement highlights the importance of food security in shaping ethical and social behaviors.

Nepal's agricultural sector engages approximately two-thirds of its population, with rural communities relying heavily on farming for both income and subsistence. However, malnutrition remains a significant challenge, with high rates of stunting, wasting, and micronutrient deficiencies, particularly among children and women in rural areas. Policy frameworks such as MSNP I & II and ADS 2015–2035 underscore the importance of integrating agricultural advancements with nutritional strategies. While these policies provide a strong foundation, the actual implementation in rural areas has faced numerous challenges, including limited access to technology and inadequate infrastructure (Coile et al., 2021).

Livestock is also another important sub-sector within the Nepalese agricultural sector and accounts for ~25% of the national agricultural Gross Domestic Product (GDP) which also enhances in nutritional values of dietary materials (Khanal et al., 2022). Additionally, agriculture plays a critical role in the economy, employment, and quality of life of the people of Nepal. It contributes to 33

percent of the GDP, 66 percent of the total employment, and 50 percent of the exports. In the past two decades, the Government of Nepal has focused on and implemented policies to promote agriculture but the growth rate has not been impressive which remained below 3 percent. This slow progress can be attributed mostly due to a lack of access to appropriate market-oriented technology, extension services, credit facilities, markets, incentives, and inputs (Babu & Sah, n.d.). Nepal's agricultural growth has been incredibly slow, primarily due to poor coordination and connectivity between public and private partners, research and extension, technology generation and transfer, farmer services, and agro-based industries (Babu & Sah, n.d.). Livestock, poultry, and agroforest are all important components of combined farming systems in agroecological zones, particularly in the mid and high hills, where they are key sources of household income and protein (Krupnik et al., 2021).

In comparison to rural households, particularly those in the country's far west, dietary quality is often higher in urban and Terai districts. These discrepancies resulted from paved highways, agricultural centers, policies that discouraged land fragmentation, parental illiteracy, family poverty, and easy access to markets (Kumar et al., 2020). Accessing health care was a challenge for two-thirds of women. Distance to a Health Facility (HF) was cited as a concern by more than one-third (37%) of the women, and more than half (55%) said they were reluctant to go alone. More than one third (35%) of women said they had trouble paying for treatment, and 16 percent said they had trouble gaining authorization to get treatment (Poudel et al., n.d.).

Recent international experiences with the sustainable intensification of smallholder cropping systems demonstrate that the implementation of conservation agriculture (CA) technology could improve food security and income while lowering production inputs and increasing system sustainability. Three farming tenets are adhered to by CA-based sustainable intensification: minimal soil disturbance, crop retention, and varied and sustainable crop rotations (Amgain et al., 2022a).

As a signatory to the Zero Hunger Challenge (ZHC), which was announced at the Rio+20 Conference in 2012, Nepal has pledged to eradicate hunger in the country by 2025. The ZHC aims to turn the goal of ending hunger into a reality by accelerating development activities in order to eradicate malnutrition during our lifetimes. In order to boost job possibilities and social protection, it expects more money to be invested in rural development and agriculture. In order to make their livelihoods and food systems resilient and able to survive the consequences of climate change as they arise, it is predicated on the idea that everyone should be able to enjoy their fundamental right to food (Acharya et al., 2018).

Despite policy interventions since 1960s, Nepal agricultural sector has struggled to achieve expected growth rates. This slow progress can be attributed to gaps in implementation, limited market access, and inadequate investment in infrastructure. Some gaps and constraints affect the industry including poor and at times contradictory legal provisions, weak institutional framework, and lack of comprehensive approach to formulating agricultural strategies, plans, and programs, also have weak synergy among critical actors in the formulation and implementation of agricultural measures.

In FY2015/16, the Agriculture Development Strategy (ADS) 2015-2035 was introduced to direct the agricultural industry for the ensuing two decades. The ADS aim to transform Nepal's agricultural sector into a self-sustaining, inclusive, and competitive industry. Its objectives include enhancing economic growth, improving food security, and promoting sustainable farming practices. The ADS action plan and roadmap are designed to help achieve this goal. The ADS aim to accelerate agricultural growth by leveraging governance, productivity, commercialization, and competitiveness while ensuring social and geographic inclusivity, sustainability of resources,

private and corporate sector development, and connectivity to market infrastructure {roads, centers, and information and communication technology (ICT)}. It also emphasizes enhancing power infrastructure, including rural electrification and renewable energy. Accelerating inclusive, sustainable, multi-sector, and connectivity-based growth is expected to result in higher and more equal rural household incomes, food and nutrition security, poverty reduction, agricultural trade competitiveness, and increased farmers' rights (Acharya et al., 2018).

Besides, there has been little concentration with wide-ranging feedback about project activities. At the same time, the monitoring system has been substandard which in turn has led to poor outcomes in the agriculture sector. The purpose of the Agriculture Development Strategy (ADS) 2015-2035 is to facilitate the shift of the agricultural sector from bare-bones operations to a more commercialized sector. However, applying the ADS continues to constitute a major challenge. There is a need to implement measures to restructure governance frameworks at federal, provincial, and local levels of government with a higher degree of commitment. To enhance effective interaction among agencies at different levels of government, the ADS needs to be integrated within country and sector strategies (Khanal et al., 2020).

Nepal, along with other UN members states, committed to the Sustainable Development Goals (SDGs) in 2015. Among these, SDG 2 focuses on eradicating hunger and ensuring food security by promoting sustainable agricultural practices. Key objectives include eliminating hunger and malnutrition, ensuring access to safe and sufficient food for everyone year-round, and doubling the agricultural productivity and incomes of small-scale food producers. SDG 2 also emphasizes the need for sustainable food production and resilient agricultural practices, along with preserving the genetic diversity of seeds and cultivated plants. By establishing managed seed banks at national, regional, and international levels, we can work together to secure a healthier future for all (NPC, 2017) (Amgain et al., 2022a).

Various stakeholders collaborate to enhance agriculture, nutrition, and food security in Nepal. The Department of Agriculture and Livestock Services improves production of crops, vegetables, fruits, meat, milk, and eggs, while the Food Technology Department ensures quality control. Home gardens and cereal-based production are promoted by relevant directorates. The National Planning Commission and Ministry of Federal Affairs implement MSNP programs, with the Child Health Division focusing on nutrition security. International organizations like the World Bank, WFP, FAO, LI-BIRD, SUSAHARA II, and HELVETAS contribute through funding, policy support, and initiatives like NeKSAP, community seed banks, and food security projects (Acharya et al., 2018). Recent international experience in empowering smallholders has shown that using conservation agriculture (CA) techniques can reduce production to a lower level, make systems more stable, and thus improve food security and income. CA-based sustainability efforts follow three principles of agriculture: limited land intervention, crop conservation, and multiple crop rotation. The aim of CA is to increase productivity, reduce production costs, and increase farmers' incomes by reducing the use of effort, energy, and other agricultural inputs in agriculture and by increasing the sustainability of crops. Conservation technologies (RCTs) include at least one of the three principles of CA and aim to reduce the use of external resources. This chapter examines the use of CA and RCT to improve the sustainability of rice crops, primarily in Nepal, but also in the Eastern Indus-Gangetic Plain (Amgain et al., 2022b). The aim of this research is to evaluate the function of agricultural technology in addressing malnutrition among rural communities in Nepal. Specifically, it aims to examine the relationship between the adoption of agricultural technology and nutritional outcomes, identify challenges faced by the agricultural sector in combating malnutrition, and assess the impact of precision farming techniques on enhancing crop productivity and quality.

Theoretical Review

The technology transfer process involves the connections that facilitate the adoption of new scientific knowledge and the interactions among various specialists engaged in this process. It consists of six phases: technology innovation, technology confirmation, identification of targeted technology consumers, technology marketing, technology application, and technology evaluation (Pasa, 2017).

Nutrition-sensitive agriculture aims to improve nutrition through agricultural practices by enhancing dietary diversity, fortifying staple crops, and reducing food losses. Additionally, the sustainable livelihoods framework emphasizes the importance of natural, human, social, and financial resources in advancing rural livelihoods through agriculture.

Both the Multi-Sectoral Nutrition Plans (MSNP I and II) effectively outline strategies to combat malnutrition, while the ADS 2015–2035 initiative focuses on modernizing agriculture to ensure food security and promote economic growth. These policies work in tandem at the critical intersection of agriculture and nutrition, particularly in rural areas where poverty and food insecurity are significant concerns. By prioritizing these interconnected strategies, we can develop sustainable solutions that enhance the well-being of vulnerable communities (Ouedraogo et al., 2020).

Methods and Materials

This study provides a comprehensive analysis of the agriculture sector and its impact on nutritional improvement programs, utilizing secondary data along with descriptive and analytical research methods. By examining critical issues like stunting, wasting, and obesity in children under five, we can highlight the urgent need for effective interventions. Additionally, the study addresses the importance of adopting new technologies by farmers. The analysis highlights important trends, challenges, and policy suggestions to improve the impact of agricultural technologies on nutrition and rural livelihoods., demonstrating how innovation can drive progress in both agriculture and child nutrition.

Findings and Discussions

National policy is strategically focused on crucial issues that will transform our agricultural landscape. By promoting a diverse and nutritious variety of plants and animals for food, we can enhance public health and food security. Implementing advanced processing technologies will reduce post-harvest losses, ensuring that more food reaches consumers and reducing waste. Furthermore, improving market access will significantly boost income from off-farm livelihoods and maximize profits from surplus food production. Finally, by adopting superior inputs and innovative techniques, we can dramatically increase agricultural and livestock productivity, paving the way for sustainable growth and development (Acharya et al., 2018).

Research shows that, there is a lack of adequate institutional capacity to meet the diverse needs of farmers, agro-entrepreneurs, and industries. This is compounded by insufficient resources, funding, and staffing at the district, Agricultural Support Center (ASC), and Local Service Center (LSC) levels, which hampers the ability to address the demands of various clients. Additionally, there are problems with staffing management, performance monitoring, and evaluations at the district and ASC levels. Additionally, there is also a shortage of expertise in key areas such as agro-business, environmental change mitigation, smart technologies, postharvest processing, and marketing. Furthermore, there are inadequate efforts to promote public-private partnerships (PPP) in extension services due to the absence of strong policies and mechanisms (Babu & Sah, n.d.).

The main obstacles to implementing priority programs and activities, as well as maintaining resources for high-quality agricultural and nutritional research in Nepal, stem from the inadequate funding provided by the Government of Nepal (GoN). Furthermore, there is no effective mechanism for integrating public and private stakeholders in priority setting, program planning, implementation, monitoring, and scaling up to achieve sustainable impacts (Babu & Sah, n.d.). Farmers who cultivate crops and raise livestock in the Himalayan hills and the Terai the low-lying flatlands adjacent to the hills are particularly vulnerable to the localized effects of global environmental change. This vulnerability is exacerbated by increasing climate variability and the rising frequency of extreme weather events such as flooding (Krupnik et al., 2021).

Precision crop reduction, farm mechanization, and land leveling are all promoted by conservation agriculture (CA) methods. These practices, along with resource conservation technology, have the potential to reduce soil erosion in hilly areas with narrow terraces and sloping mountainous regions. However, despite their numerous advantages, these technologies have not yet been fully adopted by Nepal's national agricultural research and extension system. Land fragmentation, a lack of farm equipment, poor rural infrastructure, difficulties using crop residues to increase soil fertility and feed animals, a lack of awareness among extension agents, farmers, and the public, and a lack of policy support are the primary obstacles to the adoption of conservation-agriculture-based technologies (Amgain et al., 2022a).

The escalating reliance on agrochemicals is jeopardizing the sustainability of agriculture, the backbone of Nepal's economy. This alarming trend has resulted in low Soil Organic Matter (SOM), diminished crop yields, increased food safety risks, and harmful effects on both the environment and public health. To address these pressing issues, we can look to successful international practices for guidance. This review strongly advocates for five crucial pathways to effectively institutionalize Good Agricultural Practices (GAP) in Nepal being include fostering market development, enhancing extension programs, implementing soil fertility management strategies, improving technical capacity, and promoting awareness among farmers and consumers alike. Embracing these strategies is essential for a healthier and more sustainable agricultural future (Kharel et al., 2022).

Addressing financial barriers in Nepal's agriculture sector requires tackling issues such as limited credit access, high loan interest rates, and financial illiteracy. Government initiatives like the Agriculture Credit Guarantee Scheme (ACGS) and Prime Minister's Modernization Project (PMAMP) hold promise, but their impact depends on proper implementation. However, to truly harness these opportunities, we must explore innovative financing models and improve rural infrastructure. These changes should be in harmony with Nepal's Agricultural Perspective Plan and monetary policies. Ultimately, addressing these issues is essential for ensuring Nepal's economic growth, enhancing food security, promoting agricultural financing, and alleviating poverty (Mishra, 2024).

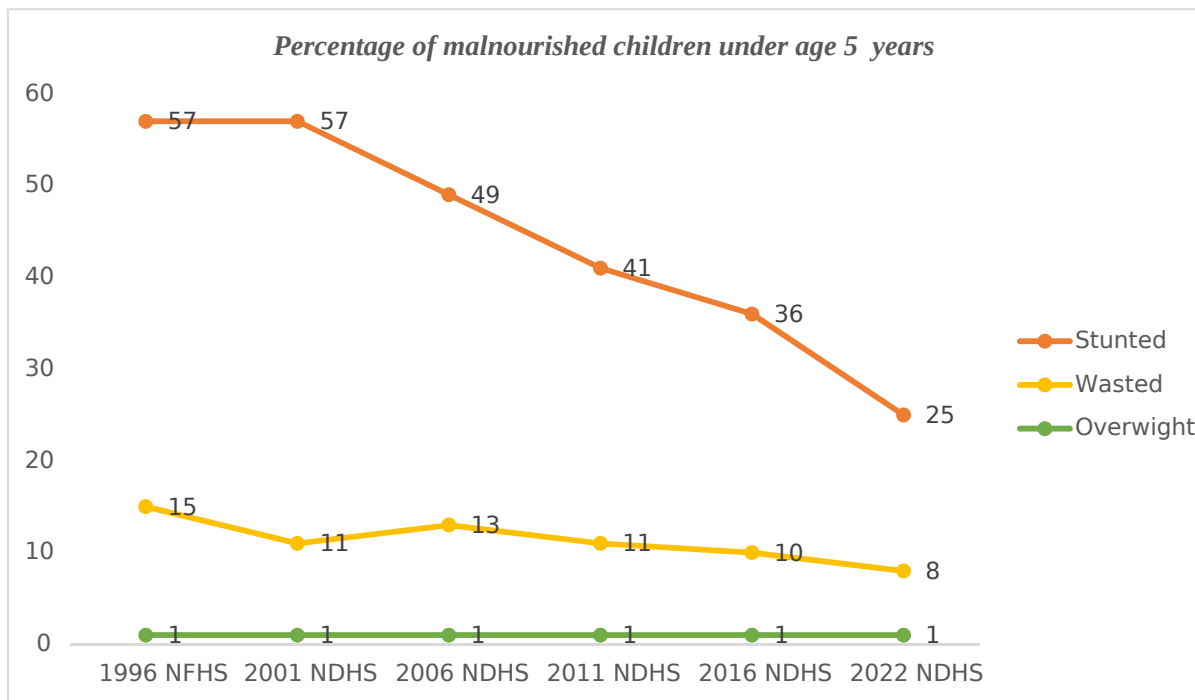
Most policies and legislative measures developed and implemented in Nepal have utilized a top-down, supply-driven approach rather than a bottom-up strategy that actively involves local communities and other key stakeholders. This top-down approach primarily emphasizes the relationship between technological inputs and outputs. In contrast, a supply-driven, bottom-up strategy focuses on effective land management by recognizing and utilizing the complementary characteristics and comparative advantages of various ecological zones (Khanal et al., 2020).

In Nepal, both local and foreign sources are promoting and adopting modern crop varieties at the farm level. These varieties are either officially introduced to the country or acquired unofficially from India through cross-border channels. A recent analysis revealed a significant reliance on foreign-supplied germplasm, with approximately 73 percent of the crop varieties officially released

until 2015 being of foreign origin. In contrast, only 27 percent of the 605 crop varieties registered in the country were of domestic origin (Gauchan, 2019).

The challenges to food and nutrition security are significant and demand urgent action. We face low production and productivity levels, along with fragmented land and scattered farming practices that hinder efficiency. The prevalence of subsistence farming, coupled with increasing population pressure, exacerbates these issues. Changing food habits also play a role, while our agricultural systems struggle with low climate resilience, making us vulnerable to climate shocks and adverse events. Moreover, limited access to irrigated land, rising production costs, and escalating food prices further complicate the situation. Transportation and distribution problems create additional barriers, and inadequate food buffer stocks leave us ill-prepared for crises. There is also a critical need to recognize that diversified agriculture is vital for sustainable food and nutritional security. To effectively tackle these challenges, we must foster collaboration and cooperation among all stakeholders in planning, implementation, monitoring, evaluation, and reporting. By working together, we can create a more secure food future for all (Acharya et al., 2018).

Figure 1:
Trends in Nutritional status of children



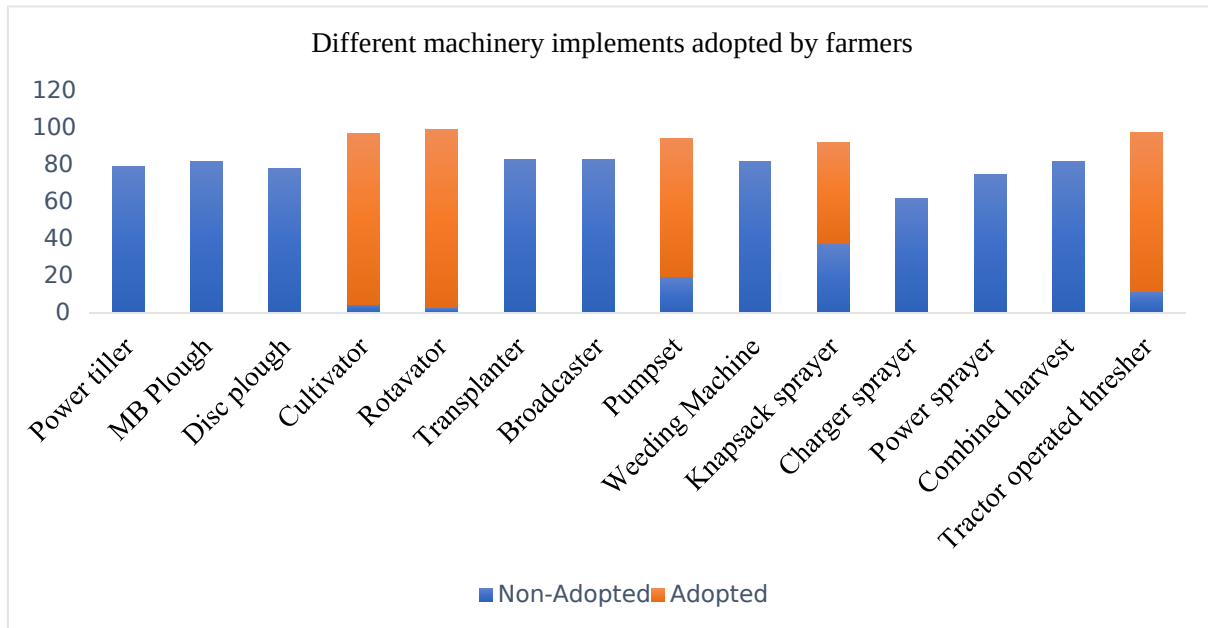
Source: Nepal Demographic and Health Survey 2022, Ministry of Health and Population (MoHP), (Poudel et al., n.d.).

Figure 1 demonstrates a significant decline in the prevalence of stunting and wasting among children in Nepal from 1996 to 2022, attributed to improved nutrition and food security. Agricultural technology has played a crucial role in achieving these outcomes by enhancing food production, reducing post-harvest losses, and increasing access to diverse and nutrient-rich crops. Technologies such as biofortification, improved crop varieties, and precision agriculture have directly addressed micronutrient deficiencies. By adopting sustainable agricultural practices, Nepal can further strengthen its progress toward reducing malnutrition and meeting global nutrition targets.

The government of Nepal's target for the Sustainable Development Goal (SDG) is to reduce the probability of stunting (measured by height-for-age) among children under 5 years to below 29 per cent by 2022 and to 15 per cent or lower by 2030. Similarly, the target for the prevalence of wasting (measured by weight-for-height) among children under 5 years is set at 7 per cent by 2022 and 4 per cent by 2030 National Planning Commission (NPC) (Poudel et al., n.d.).

Figure 2:

Different machinery implements adopted by farmers



Sources: (Household Survey, 2023), (Khadka et al., 2024)

Figure 2 reveals that agricultural adoption technologies, specifically the cultivator (91.83%), rotavator (95.91%), tractor-operated thresher (85.71%), pump sets (74.49%), and knapsack sprayer (54.08%), were the five most commonly adopted machinery implements among farmers in the study area. This indicates a significant shift toward mechanized farming practices, highlighting the growing reliance on modern technology to enhance agricultural productivity and efficiency."

The Global Agriculture and Food Security Program (GAFSP) supports the Food and Nutrition Security Enhancement Project (FANSEP) which aims to transform nutrition in approximately 16 rural municipalities over the next 3 years. FANSEP especially work for empowering communities to improve food security and promote healthy lifestyles, ultimately enhancing the well-being of families in these areas (Fortin et al., 2020).

Agricultural technologies hold significant promise for addressing malnutrition and enhancing rural livelihoods. However, their effectiveness depends on overcoming systemic challenges like inadequate infrastructure, limited access to credit, and insufficient training. For instance, biofortification can effectively address micronutrient deficiencies, while precision farming encourages sustainable resource use.

The MSNP I and II highlight the importance of cross-sector collaboration; however, rural communities often feel excluded from these initiatives. Additionally, while the ADS focus on modernization, it does not sufficiently address the needs of smallholder farmers. It is crucial to adapt policies to tackle the specific challenges faced in rural areas. This can be achieved through

targeted subsidies, capacity-building programs, and mobile-based advisory services (Coile et al., 2021).

Conclusion

Agricultural technologies hold great potential to transform nutrition and livelihoods in rural Nepal. While policy frameworks such as the Multi-Sectoral Nutrition Plan (MSNP) I & II and ADS 2015–2035 provide a strong foundation, their impact is limited by implementation challenges. To address these gaps, it is crucial to invest in infrastructure, capacity-building, and targeted interventions that ensure equitable access for rural communities.

By aligning agricultural innovations with nutritional goals, Nepal can achieve sustainable development and enhance the well-being of its rural population. Efforts should focus on promoting coordination and linkages through effective agricultural technical working group meetings at both district and regional levels. Additionally, there should be a mechanism for integrated program planning, implementation, monitoring, review, and scaling up of smart technologies. Sharing institutional resources between public and private domains to support Research and Development (R&D) programs is also essential. The Government of Nepal (GoN) needs to establish comprehensive legal, policy, programmatic, and institutional frameworks for the delivery of basic health services (BHS). There remains a significant opportunity to fully implement these frameworks on both the supply and demand sides.

Furthermore, in order to guarantee agricultural systems' sustainability and provide food, nutrition, and livelihood security for the expanding population, Climate Agriculture (CA) and Resilient Crop Technologies (RCTs) must be institutionalized immediately. Cooperation and coordination among key stakeholders are necessary for formulating and implementing effective plans and policies that include adequate legislative and institutional provisions.

While other collaborative efforts have been made to promote healthy nutrition for agriculture in Nepal, given its diversity and multifaceted nature, more guidance is needed to strengthen collaboration. Participate in planning, implementation, monitoring, feedback, and sharing of results and lessons learned.

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