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Food Systems Transformation in Nepal: Commitments and Challenges in Boosting Nature-Positive Food Production

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ABSTRACT

Nepal stands at a pivotal moment in its development trajectory as it prepares to graduate from least developed country status by 2026. Despite this milestone, food insecurity, malnutrition, and unsustainable agricultural practices persist, exacerbated by climate change, demographic shifts, and global geopolitical trade dynamics. The current food systems fail to deliver sufficient, nutritious, and safe food for a growing population without damaging natural resources and the environment. In response, Nepal developed the 2021 Food Systems Transformation Strategy, aligning with global pathways to build sustainable, resilient, and equitable food systems. Translating these commitments into tangible action requires alignment with policy, planning, and fiscal investment. However, achieving Action Track 3, which focuses on boosting nature-positive food production at scale, remains a significant challenge due to entrenched policy practices, low public investment, knowledge and capacity gaps, and limited implementation of sustainable agriculture initiatives. The concept of food systems is not new to Nepal; however, there is limited literature examining the evolving shifts and dynamics of food systems and their transformation pathways toward achieving triple outcomes, beyond food security and economic growth. The main objectives of this paper are to identify barriers to implementing nature-positive food systems at the scale in Nepal and to offer insights and lessons that should be prioritized to effectively advance the goals outlined in Nepal's Food Systems Transformation Strategy 2021. This paper analyzes Nepal's policy landscape, agricultural performance, and gaps in sustainable agriculture implementation to examine their alignment with nature-positive food systems goals. Drawing on national and international experiences, it identifies systemic barriers, including policy incoherence, insufficient local capacity, limited research and innovation,

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and lack of empirical evidence, that hinder the adoption and scaling of sustainable practices. A "one-size-fits-all" approach to transform the systems is inadequate for Nepal's diverse agroecological zones, marked by significant provincial variation and increased demographic and socio-economic changes. The paper advocates for a transformative mindset, governance, investment, and multi-stakeholder coordination shifts to foster nature-positive food systems tailored to Nepal's diverse context. Key actions include enhancing local capacities, reorienting subsidies, improving governance and monitoring systems, and strengthening private sector engagement. Ultimately, a systems-oriented and context-specific approach is essential to accelerate the transition toward environmentally sustainable and inclusive food systems in Nepal.

Key words: Subsidy, food systems transformation, nature-positive, sustainable agriculture, policy

INTRODUCTION

Nepal, one of the least developed countries, is set to graduate to developing country status in 2026, a milestone that indicates both emerging opportunities and impending challenges (NPC, 2024). Food insecurity remains a persistent challenge in Nepal, with significant regional disparities, affecting an average of 13% of households, ranging from 8% in Gandaki Province to 32% in Karnali Province (NDHS, 2022). This persists despite the country's longstanding efforts to drive economic growth through agricultural development and its recent legal commitment to the right to food. Several studies evidence that current food systems fail to deliver sufficient, nutritious, and safe food for a growing population without damaging natural resources and the environment. Nepal's food systems are highly vulnerable and unsustainable due to the impacts of climate change, demographic shifts, and evolving geopolitical trade dynamics. Declining agricultural productivity and increasing pressure on soil, water, and forests (Shrestha et al., 2021) have contributed to Nepal's slow agricultural growth rate of 0.06%, the lowest among India, Bangladesh, and Pakistan (Sharma & Pudasaini, 2020). Nepal's food imports have been rising rapidly, with a 65% increase in key agricultural product imports between 2015 and 2020, signaling alarming trade dependency (Adhikari et al., 2021). Despite some improvements in maternal and child dietary diversity, only less than half of children aged 6-23 months and women of reproductive age consume foods that meet minimum nutritional standards. Marginalized groups face persistent disparities in accessing adequate and quality food, compounded by the high costs of a healthy diet. More

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than half of the population in the mountainous regions cannot afford a nutritious diet (FNG, 2021). Meanwhile, the consumption of unhealthy foods characterized by high sugar, high salt, and unhealthy fats is increasing at an alarming rate across both rural and urban areas in all provinces of Nepal, with rates ranging from 57% in Karnali Province to 78% in Koshi Province (NDHS, 2022).

To address these issues within the current food system, the National Planning Commission, working in collaboration with the Ministry of Agriculture and Livestock Development, other relevant ministries, and development partners, developed Nepal's Food Systems Transformation Strategy in 2021. This strategy, framed around six action tracks aligned with UN Food Systems Transformation Pathways, aims to transform the food systems towards sustainability, resilience, and equity. It calls on all development stakeholders, civil society, and the private sector to contribute to accelerating the momentum in this process. However, achieving the goals of the strategy, particularly Action Track 3, which focuses on "boosting nature-positive food production systems at scale", by 2030 remains a significant challenge, considering the limited historical progress on sustainable agriculture development initiatives in Nepal. Despite clear priorities and the urgent need for action around food systems transformation, the national budget for the recent fiscal years has with no significant changes in allocations. Public sector investment in agriculture remains very low. According to last year's annual budget 2024, agriculture accounted for only 3.17% of the total federal budget, 8% of provincial budgets, and just 1.4% of local government budgets. Furthermore, a substantial portion continues to support chemical fertilizer subsidies, reflecting entrenched policy practices.

The concept of food systems is not new to Nepal; however, there is limited literature examining the evolving shifts and dynamics of food systems and challenges of their transformation pathways toward achieving triple outcomes, beyond food security and economic growth. This paper provides an overview of sustainable food system pathways, with a particular focus on Action Track 3, boosting nature-positive food systems at scale. The food systems approach is complex and multisectoral, extending beyond the agriculture sector, however, agriculture remains a central component that shapes food systems. This paper, hence, highlights key agricultural indicators and some country contexts to discuss their potential linkages to sustainable food systems within the broader development landscape. Although policy frameworks increasingly advocate for sustainable agricultural systems, there remains a significant gap between policy

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design and effective implementation (Atreya et al., 2020). Drawing on Nepal's initiatives to promote sustainable agricultural intensification, alongside international experiences with nature-positive food systems, the paper discusses key implementation challenges and proposes potential ways forward for the policy coherence and strategic investment pathways to support the transition toward environmentally sustainable and productive food systems in Nepal.

The main objectives of this paper are to identify barriers to implementing nature-positive food systems at the scale in Nepal and to offer insights that should be prioritized to effectively advance the goals of food systems transformation. The paper is structured into four sections. The first section outlines the national context, presenting key agricultural performance indicators data to provide a foundation for understanding, which is crucial while designing and implementing any programs. The second section offers an overview of Action Track 3, boosting nature-positive food systems, as articulated in Nepal's Food Systems Transformation Strategy, reflecting the Government of Nepal's commitment to sustainable food system pathways. The third section reviews the status and challenges of ongoing sustainable agriculture initiatives in Nepal, drawing on national and international experiences and lessons learned. The last section synthesizes key barriers to the effective implementation of nature-positive food production systems, along with proposing some potential ways forward to accelerate the food systems transition towards sustainability and greater resilience.

1. Some agricultural performance indicators and country context for food systems transformation

Nepal's agriculture sector is at a crossroads, facing the dual challenge of advancing agricultural modernization and intensification, while also urgently transforming toward more sustainable and resilient systems to adapt to changing global dynamics. Historically, Nepal has been an agrarian country, with agriculture serving as the primary source of livelihood for over 80 percent of households, was self-sufficient in food and a net exporter of agricultural products until the early 1980 (Baral, et al., 2020) and has been a cornerstone of the country's economy. However, over the past two and a half decades, the sector has undergone significant changes, as illustrated in Table 1, based on findings from the most recent National Living Standards Survey (NLSS III-2022/23). The agriculture sector's contribution to Nepal's gross domestic product (GDP) has

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declined significantly from 39% in 2001 to 24.1% in 2023, while the service sector's share has increased, reflecting a broader structural transformation of the Nepali economy over the past two decades (NPC, 2024).

Table 1. Selected agricultural indicators, 1995/96-2022/23
(Source, NLSS-III, 2024)

Description	Nepal Living Standards Survey			
	1995/96	2003/04	2010/11	2022/23
Agricultural households (percentage of total households)	83.1	77.5	73.9	60.3
Average size of agricultural land (in hectares)	1.1	0.8	0.7	0.4
Average number of parcels	3.8	3.1	2.9	2.8
Holdings operating less than 0.5 hectares (percentage of total holdings)	40.1	44.8	52.7	88.5
Percentage of holdings operating on rent-in-land only	4.8	7.3	5.4	18.4
Percentage of holding growing main paddy	76	76.1	72.3	64.3
Percentage of holdings growing summer vegetables	35.6	60.8	68.8	39.3
Percentage of holdings with cattle	73.5	66.6	64.2	37.8
Percentage of holdings with poultry birds	49.9	52.7	53.6	43.9

With the continued decline in agricultural households, the national average now stands at 60.3%, varying significantly across provinces from 82% in Karnali to 42% in Bagmati, indicating that a shift away from agriculture as the primary source of livelihood is high. Households classified as poor are more likely to be engaged in agriculture (73.9%) compared to non-poor households (57.6%). Agricultural land covers 28% of the total land, and only 21% of it is cultivable. Additionally, the average size of agricultural landholdings is decreasing, and the proportion of holdings operating on less than 0.5 hectares is rising along with provincial variation, an indication of increasing land fragmentation at different rates. This fragmentation poses significant challenges for efficient agricultural practices and limits the ability to achieve economies of scale (NPC, 2024). According to the 2021/22 Agriculture Census, the area under paddy, wheat, and maize cultivation has declined, along with a reduction in the number of households owning large livestock compared to the previous census. The adoption of modern farming techniques in Nepal remains low compared to other South Asian countries, despite being a key priority in the agriculture sector since the Agriculture Perspective Plan of 1995. This trend is driven by urbanization, land fragmentation, land use changes, labor shortages, and shifting market dynamics.

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In reviewing the various facts and trends related to agriculture, it becomes evident that current food systems changes are not in a positive direction of sustainable and resilient development. A "one-size-fits-all" approach to transform the systems is inadequate for Nepal's diverse agroecological zones, marked by significant provincial variation and an increased trend of rural-to-urban and Hill/Mountain to Terai migration. However, most agricultural programs continue to emphasize commercially oriented farming systems, often under the premise of improving the subsistence conditions of smallholders. These initiatives frequently overlook the root causes and structural barriers to transformation, ultimately benefiting only a small number of large-scale commercial farmers. Transforming food systems is a critical challenge that requires a deep, holistic understanding of the complex and multifaceted barriers to achieving sustainability, with political economy barriers at the core, often serving as foundational system-level obstacles to meaningful change (Even B., 2024). In this context, it is important to examine Nepal's food systems transformation pathways, particularly how the nature-positive food systems are being envisioned and to what extent they are achievable. Without such a nuanced approach, efforts toward sustainable and inclusive transformation risk falling short despite Nepal's progress in developing policies, plans, and programs aligned with international guidelines and national commitments.

2. Unfolding Action Track 3 "Boosting Nature Positive Food Production Systems"

Approaches to addressing food-related challenges and priorities have evolved over time from a narrow focus on increasing calorie production to a broader systems approach that incorporates health, inequality, and environmental sustainability (Farmery et al., 2025). Like many other developing countries, Nepal has historically prioritized increasing agricultural productivity and food access through agricultural modernization and market development to drive food security and economic growth. However, with a growing sense of urgency to address current food systems issues in Table 2, Nepal has prioritized the six food systems transformation Action Tracks, building on the existing policies, plans, and programs. The action tracks are: 1. ensuring access to safe and nutritious food for all, 2. shifting to sustainable consumption patterns, 3. boosting nature-positive production at scale, 4. advancing equitable livelihoods and value distribution, 5. building resilience to vulnerabilities, shocks, and stresses, and 6. Right to food and food sovereignty. These interrelated action tracks involve trade-offs and synergies, and policy coherence and strong governance across sectors, health,

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nutrition, education, agriculture, forestry, environment, and land management are crucial for successful implementation.

Table 2. Issues of current food production systems in Nepal

Food Production Trends	Drivers
Highly climate-sensitive food production systems, with only 27% of agricultural land irrigated, and smallholders disproportionately affected by droughts and other climate-induced disasters, 90% crop losses and damages due to climate-induced disasters	Environmental impacts, limited technologies, and investment in infrastructure for diverse ecosystems
Heavy reliance on agricultural commodities (eg, chemical fertilizers, pesticides, feed, farming tools) and food imports—80% of grains, a 62% rise in import spending, and declining exports, reflecting a growing trade deficit and a vulnerable food system	Trade globalization, socio-economic (increased income, migration), demographic changes (changing food habit and life style, urbanization, out-migration), Geopolitics
38% of forest land, 37% of pasture/rangeland, and 10% of agricultural land have been affected by the land degradation process, feminization in agriculture, with 70% women workforce, declining soil fertility, and crop productivity	Socio-economic-Poverty and demographic shifts-urbanization, male migration, Physical-infrastructure, market constraints, Policies for agriculture intensification, and politics of modernization in agriculture (chemical fertilizer subsidy schemes)
Land use changes such as about 65,000 ha of premium land suitable for cereal cultivation, has been converted into urban areas, shrinking agricultural cultivable land	Socio-economic (increased income), demographic (such as urbanization, migration),
On average 37% of arable land is abandoned in Nepal with almost 21% of *bari* land (upland) and 5% of *khet* (paddy) land in hills and underperformance of agriculture	Socio-economic (increased income), demographic (such as urbanization, migration), and Technological (poor agriculture growth and underperformance)
Loss of biodiversity is rapid, with 50% traditional crops varieties in the past six decades of agricultural development	Socioeconomic-changes in food habit based on few calories, animal protein and processed food and life style, technological-limited research and development on traditional crops, Policies for agriculture intensification and politics of modernization
Environmental pollution (water, soil, air); Greenhouse gas emissions- values for Nepal equals about 23% of total national gross GHGs emission per annum in terms of CO2	Agriculture intensification, misuse of agrochemicals- Technological-poor management practices, and limited innovation and research on climate smart animal husbandry

Source: NPC & WFP, 2021

The Ministry of Agriculture and Livestock Development plays a leading role in driving the transformation of Nepal's food systems, particularly the Action Track-3 "Boosting Nature Positive Food Production" to meet the fundamental human right to healthy and nutritious food while operating within plenary boundaries. Nature-positive food production systems are characterized by a regenerative, non-

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depleting, and non-destructive use of natural resources in food production systems. It focuses on environment-friendly food and feed production systems that ensure biodiversity, conserve soils and water, reduce pollution, and enhance climate resilience and social responsibility. The framework for nature-positive food systems is presented diagrammatically in Figure 1.Nature-positive food systems are built on three pillars: protecting, sustainably managing, and restoring (agro) ecosystems (E. Hodson de Jaramillo et al., 2023). Nepal's 2021 food systems transformation strategy outlines action areas for each pillar within the national context, with implementation, and assessing the success of actions underway.

Action area 1: Protect natural systems from new deforestation and conversion for food and feed production: Some proposed actions under this pillar are: enforcement of Land Use Act (2019) and Land Use Policy (2015), Land use planning enforcement through land pooling, unused fallow land, land bank etc., Subsidies and safety nets to resource poor to prevent forest encroachments.

Action area 2: Manage sustainably existing food production systems: Some proposed actions under this pillar are: Agroecosystem and landscape based planning focusing on comparative and competitive advantage; regenerative agriculture production system with focus on ecological, organic and conservation agriculture, sustainable use of agrobiodiversity including value chain development of local crops, promotion of climate-resilient food systems and animal husbandry technologies; intensification of Good Agricultural Practices

Action area 3: Restore degraded ecosystems and rehabilitate soil functions for sustainable food production: Some proposed actions under this pillar are: convert degraded riverbeds to gardens, watershed conversion, improvement of soil fertility through legume rotation, integrated farming, agroforestry promotion and green manuring; revitalization of local indigenous food systems, removal of subsidies for unhealthy/agrochemical intensive food production system. Political will and sustained commitment are essential to reduce land conversion and degradation, prevent biodiversity loss, safeguard indigenous knowledge, restore ecosystem services, and ensure the sustainable management of natural resources, all critical to achieving nature-positive food systems outcomes. Several existing policies, acts, and regulations in Nepal provide an enabling policy environment to support and scale up nature-positive food production initiatives. Key among them are presented in table 3.

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Table 3. Policy Environment for Nature-Positive Food Production Systems

S.N.	Policies/Strategies/Plans	Key highlights
1	Environment Protection Act and Regulation (2019	Provides the legal foundation for environmental conservation and regulation
2	National Adaptation Plan (2021–2050)	Outlines long-term climate adaptation strategies
3	Nature Conservation National Strategic Framework for Sustainable Development (2015–2030	Guides integrated approaches to conservation and development
4	National Climate Change Policy (2019)	Promotes climate-resilient development across sectors
5	National Agroforestry Policy (2019)	Supports sustainable land use through integrated agriculture and forestry practices

Additionally, several other agriculture sector development policies, strategies, and plans, particularly related to sustainable agriculture, underscore the implementation of nature-positive food production actions. The promotion of sustainable agriculture with several approaches has long been part of Nepal's policy discourse, often positioned as a pathway toward long-term environmental sustainability and to minimize the negative impacts of agricultural intensification in the context of climate change. However, the systematic evolution of policies and programs explicitly supporting sustainable agriculture is relatively recent. While sustainability principles have been embedded within the broader frameworks of conventional or modern farming systems, they have not always been central or consistently prioritized. Since the 10th Five-Year Plan (2002-2007), there has been a growing emphasis on mainstreaming sustainable agriculture approaches, particularly organic agriculture, into national development strategies and plans. Yet, despite this recognition, the organic agriculture movement has remained slow and not encouraging (Atreya, et al. 2015, Gauchan et al, 2020, and Acharya, et al, 2020).

3. Landscape of sustainable agriculture development programs

Different sustainable agriculture approaches versus organic agriculture

Traditional and industrial agriculture both fall short of meeting the demands of a growing population sustainably. While traditional practices cannot support large-scale production, modern industrial agriculture, heavily dependent on chemical

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inputs, has led to serious environmental and health concerns. In response, sustainable agriculture has emerged as a vital alternative, aiming to balance environmental health, economic viability, and social equity in the production of crops, livestock, and fisheries. To address global sustainability challenges, various alternative farming systems have evolved, including integrated farming, conservation agriculture, agroforestry, regenerative agriculture, organic farming, and more (Atreya et al., 2020). Recently, nutrition-sensitive agriculture and nature-positive food production have also gained attention. Among these, organic agriculture has received significant recognition, especially in Nepal. However, organic farming alone is not sufficient to achieve the broader goals of agricultural sustainability (Tal, 2018).

In Nepal, efforts toward promoting sustainable agriculture remain limited, and most initiatives disproportionately focus on organic farming. A more tailored approach, considering socio-economic conditions, demographic shifts, and ecological potential, is needed. Rather than treating sustainable practices as competing models, they should be viewed as complementary tools grounded in agroecological principles. Clear definitions, distinct goals, and innovation pathways for each approach are essential to avoid confusion and ensure wider adoption beyond small pilot initiatives.

Policy setbacks for sustainable agriculture

Most agriculture sector development policies, plans, and strategies in Nepal are in favor of conventional agriculture, particularly emphasizing enhanced productivity using synthetic fertilizers, chemical pesticides, and irrigation, despite the organic agriculture movement starting in 1987. There are limited separate sectoral policies that support different sustainable agriculture systems, and they are often found mainstreamed within the broader frameworks of conventional or modern farming systems.

- Agriculture Perspective Plan 1995, National Fertilizer Policy 2002, the 9th Five Year Plan: Emphasizing integrated pest management
- National Coffee Policy 2003, National Agricultural Policy 2004, Agribusiness Policy 2006:Promotes organic agriculture with focus on export (organic coffee)
- Agricultural Biodiversity Policy 2006- Regulates GMO and promotes organic agriculture
- National Standards of Organic Agriculture Production and Processing 2007-Sets standards for organic production and processing

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- Trade Policy 2009, Nepal Trade Integration Strategy 2010-Supports organic certification, and promote organic tea, coffee, honey, and vegetables for export
- Agricultural Development Strategy 2015-Emphasizes organic branding for export, promotes bio-fertilizers, good agricultural practices
- The 10th, 11th, 12th , 13th 14th, 15th and 16th Five Years Plans-Promotes organic agriculture as the part of sustainable, competitive and prosperous agricultural economy with food and nutrition security, food sovereignty
- District level organic fertilizer subsidy guideline 2015:Promotes the use of and increased access to organic manures, fertilizers for organic agriculture
- Karnali Province's Policy and Development Program 2018:Outlines gradual transformation into a fully organic province, Endorsed the Organic Agriculture Bill, Prioritizes for organic fertilizer plants, agro mechanization and organic pesticides plants, One local level one model organic farm, One cooperative one model agriculture, livestock and fisheries farm

While reviewing existing sustainable agriculture-related policies in Nepal, it becomes evident that most emphasize organic agriculture, with only a few other sustainable intensification approaches such as integrated pest management, integrated soil nutrient management, climate-smart agriculture, and agroforestry. Notably, there is a lack of explicit policy support for conservation agriculture, ecological agriculture, regenerative agriculture, and climate-smart animal husbandry. Since the 10th Five-Year Plan, organic agriculture has received increasing policy attention at the federal, provincial, and local levels, an important acknowledgment of the progress made in Nepal's organic movement. However, most of these policies remain fragmented and piecemeal, with a predominant focus on market development, export promotion, and income generation. This focus often diverges from the foundational agroecological principles of organic agriculture. Consequently, current approaches tend to exclude smallholder and subsistence farmers, favoring large-scale producers instead of ensuring inclusivity and broader food system transformation.

Emerging issues and insights in advancing sustainable agriculture

While the literature widely highlights the benefits of sustainable agriculture, such as reduced input costs, biodiversity conservation, lower environmental degradation, and improved food quality, there is limited data-driven evidence in

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the context of evolving agricultural systems. From a global perspective, including Nepal's experience, the drawbacks of sustainable agriculture include inefficient land use, labor intensiveness, lower crop yields and income, and time-consuming practices (Shrestha et al, 2021). The limited application of science-based practices in promoting sustainable agriculture is largely due to a lack of action research, which hinders farmers from adopting and scaling these approaches. For instance, while composting is widely practiced, many farmers perceive it simply as collecting organic waste and dumping it into a pit. This improper practice leads to significant nitrogen loss through leaching and runoff, especially during the rainy season. As a result, it fails to enhance soil fertility, leading to low agricultural productivity and poor economic returns (Amagain et al., 2017). Moreover, inefficient composting not only undermines soil and crop productivity but also contributes to groundwater pollution and increases the carbon footprint (Tal, 2018).

Organic amendments alone are unlikely to be sufficient to maintain high levels of productivity, and imbalanced fertilizer use poses major fiscal and environmental challenges in South Asia, and high labor demands and costs of organic inputs limit their use, despite their benefits, making farmers favor synthetic alternatives. (Kishore, et al., 2020). The comprehensive reviews found that organic agriculture has a 34% lower yield than conventional; the transition to a fully organic system would require 30% more land usage than conventional (Tal, 2018). Due to the ban on agrochemicals in Jumla to declare an organically certified district in Nepal, several cultivation, technical, and operational challenges have emerged, resulting in only apples being certified. This reflects a gap between the ambitious goals and the necessary investments in infrastructure, technological research, and innovation to provide viable alternatives to agrochemicals (Baral, et al., 2020). Farmers practicing large-scale organic agriculture face challenges due to limited technical and extension support for meeting organic standards, poor access to affordable inputs, and a lack of effective technological innovations. (Acharya, et al, 2020).

Although organic agriculture is fundamentally intended to promote agrobiodiversity, current policies and programs, centered on export promotion and income generation, primarily support a limited range of cash crops such as coffee, tea, ginger, honey, walnut, apple, and certain vegetables. These efforts often overlook underutilized crops, with a lack of organic certification standards that would otherwise support the conservation and use of local crop diversity.

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Moreover, the organic certification process remains complex, costly, and not easily accessible. As a result, most smallholder farmers, producers, and traders are either unaware of the process or unable to navigate it effectively (Gauchan, et al. 2020). The organic fertilizer promotion subsidy programs were not found to be effective, as the subsidy distribution data did not show the increased consumption of organic fertilizers. Organic fertilizers are bulky in nature, with transportation challenging and a lack of quality assurance discouraging farmers from purchasing fertilizers even at a subsidized rate. (Amagain, et al, 2017). There are many issues and challenges while accelerating organic agriculture at scale due to the ambiguity of the roles of the three tiers of government, along with a lack of effective coordination. Limited capacity of local government, both in terms of technical, human resources, and financial resulting in lower service and support delivery to farming communities who are interested in organic agriculture (Baral, et al., 2020).

Scaling up climate-smart agriculture practices such as solar irrigation, rainwater harvesting, resilient crop varieties, ICT-based advisory services, insurance, and gender-friendly tools remains limited to pilot projects due to poor access to technology, high costs, inadequate extension services, and weak institutional support (Gurung, et al., 2016). Conservation Agriculture-based Sustainable Intensification (CASI) has gained academic and policy attention in South Asia; however, despite growing awareness and farmer interest, the adoption of zero tillage remains stagnant. Beyond issues of low yields and weed infestation, key barriers for farmers include unsuitable land, limited access to CASI machinery, a shortage of skilled operators, and inadequate financial support (Karki, et al., 2024). Regenerative agriculture is considered the key to improving soil health, biodiversity, and the climate crisis, however, no-till farming with the use of heavy herbicides to manage weeds in U.S harm the soil life (Food tank, 2025)
Beyond policy gaps, sustainable agriculture faces implementation challenges rooted in farmers' motivation. Although farmers recognize their role in environmental sustainability, they are primarily driven by economic gains and improved livelihoods. Accelerating food systems transformation requires responsible investments that address these barriers by building physical, human, and intangible capital to enhance productivity, food security, nutrition, and sustainable development (Shrestha and Shrestha, 2023).

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4. Challenges of and Call for Actions to Nature-positive food systems

The transition to nature-positive food systems is hindered by various agronomic, economic, and social challenges, further intensified by gaps in knowledge and capacity (Hodson de Jaramillo et al., 2023).

1. Agronomic and technological performance challenges

Yield reductions- Nepal's food systems vary across its three agroecological zones: Terai, Hill, and Mountain. In the Terai, food production is heavily reliant on high external inputs. Transitioning to nature-positive systems through normative sustainable approaches such as conservation agriculture, organic farming, ecological, and regenerative agriculture often leads to reduced yields and income. As discussed in Section 3, the limited application of science-based practices in promoting sustainable agriculture has made it difficult for these approaches to compete with conventional or commercial farming methods. Additionally, demographic shifts, particularly rising urbanization and increased male migration, have led to a decline in households rearing large livestock in Nepal. This trend poses a challenge for sustainable soil nutrient management, as livestock are a primary source of organic manure. Sustainable agriculture that prioritizes quality production and environmental benefits, but overlooks yield and economic returns, poses challenges, especially in the context of ensuring food security for a growing population. The strategy of sustainable intensification, hence, has recently gained considerable attention to increase yield potential and productivity from the same amount of land while reducing negative environmental impacts (Tal, 2018).

2. Economic Challenges

High labor and land demand-Nature-positive food systems tend to be labor-intensive, as highlighted by several studies discussed in Section 3. This presents a significant challenge in Nepal's evolving context, where high rates of male and youth migration have left approximately 70% of the agricultural workforce composed of women. While mechanization could reduce the labor burden, it is often not feasible in Nepal's diverse and rugged terrain. Moreover, the high cost of mechanization remains prohibitive for many smallholder farmers, further limiting its adoption. Land use inefficiency poses a significant challenge to promoting nature-positive food systems, especially in the current context of Nepal, where land fragmentation is increasing and average landholding size is declining, as shown in Table 1. However, the trend of fallow land shows opportunity to better utilize through nature positive production systems.

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Higher transaction cost- Nature-positive food systems, due to their diversity, often produce a wider range of crops or livestock in smaller volumes, limiting market and processing opportunities. They also demand greater knowledge, experimentation, and risk-taking. Farmers may bear the financial and technical burden of sourcing and applying alternative inputs. Additionally, many practices require collective action across landscapes, involving multiple stakeholders, which increases coordination demands and transaction cost (Hodson de Jaramillo et al., 2023).

Limited value chain support for sustainable practices- The consumption of unhealthy, ultra-processed foods high in sugar, salt, and fat is rising among women and children in both rural and urban areas across all provinces of Nepal (NDHS, 2022). These foods are often cheap, easily available, convenient, and appealing, making them strong competitors to healthier alternatives. In contrast, nutritious foods produced through nature-positive value chains tend to be more expensive and often remain unaffordable for marginalized communities. A key challenge lies in the dominance of mono-cropping of calorie-dense staples through industrial agriculture, which benefits from economies of scale and lower unit costs, unlike the diverse crop systems required to support healthy and sustainable diets.

3. Political Challenges

Policy incoherence- One of the key game-changing solutions proposed in Nepal's Food Systems Transformation Strategy to restore degraded ecosystems and rehabilitate soil functions for sustainable food production is the removal or redirection of subsidies that support unhealthy or agrochemical-intensive production systems. Notably, following CoP28, Germany revised its Nationally Determined Contributions (NDC) to include concrete steps toward phasing out harmful subsidies; an important precedent that could help accelerate food systems transformation (e.g., R. and J. Xu, 2025). Despite clear priorities and the urgent need for action around food systems transformation in Nepal, the national budget for the recent fiscal years has with no significant changes in allocations. According to last year's annual budget 2024, a substantial portion continues to support chemical fertilizer subsidy programs, reflecting entrenched policy practices that pose a significant challenge to reorienting programs toward more ecological and sustainable goals aligned with nature-positive food systems. The relationship between fertilizer subsidies and the promotion of nature-positive

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agriculture is complex and multifaceted. Evidence from previous research indicates that such subsidies may undermine nature-positive food systems in three key ways

- High Opportunity Costs- Subsidy budgets have a high opportunity cost, and empirical evidence on their effectiveness remains limited (Gautam, 2015). A significant portion of public agricultural budgets is allocated to subsidizing chemical fertilizers, particularly urea. This diverts scarce financial resources away from more strategic and transformative investments, such as research and development of nature-positive technology advancement, agroecological practices, and sustainable land management innovations. Redirecting subsidy funds from urea, which no longer requires promotional support could encourage farmers to adopt a more balanced use of NPK fertilizers (Shrestha, 2010).
- Overdependence and Soil Degradation-Continued fertilizer subsidies have increased farmers' reliance on synthetic inputs, often without proper soil testing or awareness of nutrient requirements. This practice, especially the excessive use of urea, contributes to nutrient imbalances and long-term soil degradation, undermining the ecological foundation of sustainable food production.
- Environmental and Climate Impacts-The use of nitrogen-based fertilizers is a major source of greenhouse gas emissions, particularly nitrous oxide, which contributes significantly to agriculture's carbon footprint. This trend directly contradicts the goals of climate-smart agriculture and undermines efforts to promote nature-positive food systems that emphasize environmental sustainability and climate resilience.

4. Agricultural knowledge systems gaps

Poor knowledge and limited advisory systems capacity- Public and private investment in research on nature-positive food systems remains significantly lower compared to other innovative agricultural approaches, leading to persistent and substantial knowledge gaps. There is a clear lack of systems-oriented, trans-disciplinary, and long-term field research, resulting in a disconnect between knowledge generation, advisory services, and the capacity needed to support nature-positive food systems (Hodson de Jaramillo et al., 2023). Accelerating the promotion of nature-positive food systems in Nepal may face several challenges,

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primarily due to unclear roles and responsibilities across the three tiers of government and a lack of effective coordination. Local governments, which serve as the primary implementing bodies, often have limited technical, human, and financial capacity. This results in inadequate service delivery and support for farming communities interested in pursuing nature-positive food systems in Nepal. Additionally, the lack of data and empirical evidence on the effectiveness of nature-positive food system implementation hinders the delivery of need-based, context-specific technical and advisory services, limiting efforts to accelerate adoption and scale-up.

Call for actions

Numerous structural lock-ins continue to reinforce the unsustainability of current food production systems. Achieving a transition to nature-positive food systems requires a fundamental shift in mindset and silo approach, and actions across the entire food value chain, from policymakers and researchers to practitioners, local extension services, private sector entities and communities. This also calls for a realignment and strengthening of collaboration among all stakeholders, minimizing power imbalances, vested interests, and conflicts (Even et al, 2024). Based on national and international experience and insights, some actions are proposed to advance a nature-positive food system.

- Increase policy coherence and strengthen governance across all three tiers of government by establishing effective coordination mechanisms across multi-sectors including forestry, land management, nutrition, health, and education, with clearly defined roles, responsibilities, and accountability. To minimize policy and practice gaps, committed actions should be integrated into periodic agricultural plans, backed by adequate funding and strong institutional frameworks.
- Enhance local government capacity in terms of technical, human, and financial resources to advance nature-positive food systems. Challenges ranging from limited awareness and financing to land access and sociocultural barriers must be addressed through local government's leadership in collaboration with province, federal government and other stakeholders such as private sector actors, and development partners, with a focus on policy support, technical assistance, and farmer capacity building.
- Prioritize responsible investment in boosting knowledge and technological innovation for nature-positive food systems, with a focus on addressing challenges such as land use inefficiency, low yields, labor intensity, and high time and cost requirements

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- Develop a clear vision and understanding for a comprehensive sustainable intensification agriculture as a pathway for transitioning to nature-positive food systems, rather than applying a one-size-fits-all approach focused on organic agriculture.
- Establish a robust monitoring and learning mechanism to generate data and evidence on the effectiveness of various nature-positive food system approaches such as conservation agriculture based sustainable intensification, regenerative agriculture, climate resilient agriculture, climate smart animal husbandry practices, nutrition sensitive agriculture, agroforestry, polyculture and ecosystem based commercial agriculture. This should include evaluating local community people's perception on what works, what does not, and why, along with identifying opportunities for improvement and strategies to accelerate adoption and scale-up in achieving policy objectives.
- Engage private sector entities for capacity strengthening and infrastructure development including market linkages for nature-positive food systems since public sector investment alone may not be adequate.

CONCLUSION

Transforming food systems toward sustainability is an urgent and complex global challenge, vital for improving human health, securing livelihoods, and safeguarding the environment. Current food systems characterized by unsustainable practices are major contributors to malnutrition, biodiversity loss, land and water degradation, and greenhouse gas emissions, ultimately undermining the productivity, resilience, and long-term sustainability of food production. Existing program interventions continue to serve as the primary vehicles for implementing food systems transformation efforts, but these programs lack innovation and targeted budget allocations to operationalize key action tracks. Furthermore, advancing transformation through nature-positive food production pathways requires a comprehensive understanding of the complex and multifaceted barriers that impede progress. This transition demands not only innovation in technologies and practices but also fundamental shifts in food system governance. Such shifts must include bold reforms in policies, investments, and incentives, particularly in response to evolving socio-economic, political, demographic, and global dynamics, which currently do not adequately support sustainable and equitable practices.

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