WORLD FOOD FORUM | GLOBAL YOUTH ACTION

YOUNG SCIENTISTS GROUP

Youth-led innovation for sustainable agrifood systems

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About the World Food Forum

The World Food Forum (WFF) was launched in 2021 as an independent network of partners hosted by the Food and Agriculture Organization of the United Nations. It serves as the premier global platform to actively shape agrifood systems for a better food future, accelerating the achievement of the Sustainable Development Goals. Through youth action, science and innovation, and investment, the WFF forges new paths of action and multi-sector partnerships for agrifood impact at the local, regional and global levels to achieve a more sustainable, resilient, inclusive and hunger-free food future for all.

Within this framework, the WFF Global Youth Action Initiative was established to harness the passion and power of youth, and to incite positive action for agrifood systems through youth empowerment. It acts as a catalytic movement and driver of youth engagement in food governance and serves as a knowledge center and innovation lab, fostering and inspiring youth-led solutions. It thus actively contributes to the implementation of the UN Youth 2030 Strategy and enhances youth engagement in the follow-up to the 2021 UN Food Systems Summit.

The WFF Global Youth Action Initiative is implemented through a set of thematic programmes that leverage intergenerational and cross-sectoral collaboration around policy, innovation, education, culture and local action.

About the Young Scientists Group

The mission of the World Food Forum (WFF) Young Scientists Group (YSG) is to provide scientific evidence and technical knowledge to the various initiatives of the WFF, and to develop research on topics of concern to youth related to agrifood systems transformation. Established in 2022, the YSG has completed two cohorts. Its third cohort began activities in May 2025 as part of a two-year tenure (2025–2027).

The composition of the YSG reflects FAO's four betters: better production, better nutrition, a better environment and a better life, leaving no one behind. The diversity of YSG members' expertise mirrors the diversity of challenges and solutions associated with achieving agrifood systems transformations and the Sustainable Development Goals.

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Abbreviations

CSO	Civil Society Organization
AFI	Alliance for Financial Inclusion
AICCRA	Accelerating Impacts of CIGAR Climate Research for Africa
AIM4Forests	Accelerating Innovative Monitoring for Forests
AI	artificial intelligence
BSF	Black Soldier Fly
CIGAR	Consultative Group on International Agricultural
CIGAR CCAFS	Consultative Group on International Agricultural Research Program on Climate Change, Agriculture and Food Security
CIRAD	French Agricultural Research Centre for International Development
CORAF	West and Central African Council for Agricultural Research and Development
CSV	Climate-Smart Village
HLPE-FSN	High Level Panel of Experts on Food Security and Nutrition
ICT	information and communications technologies
IFAD	International Fund for Agricultural Development
ILO	International Labour Organization
IMPRESS	Improving Measurement for Payments to Reduce Emissions and Strengthen Sinks
ISAT	Intelligent Agricultural Systems Advisory Tool
MYFRP	Malawi's Youth Forest Restoration Programme
NPK	nitrogen phosphate potash fertilizer
ODI	Overseas Development Institute
OECD	Organisation for Economic Co-operation and Development
SSF	small-scale fisheries
STEM	science, technology, engineering and math
UNCCD	United Nations Convention to Combat Desertification
WFF	World Food Forum
YSG	World Food Forum Young Scientists Group

Abstract

Transforming agrifood systems in sustainable and equitable ways requires innovation, defined as doing something new or different to address systemic challenges. This report introduces the current landscape of innovation in sustainable agrifood production, focusing on initiatives that are youth-led or co-developed with grassroots communities. The analysis spans four thematic areas: (1) agricultural methods, (2) fisheries and aquaculture, (3) forestry and (4) climate-smart approaches for smallholder resilience.

Grounded in a scoping literature review and insights from the World Food Forum Youth Assembly consultations, the study investigates two guiding questions: What types of innovation are contributing meaningfully to agrifood systems transformation? And which areas (such as digital technologies, including artificial intelligence, gender equality, generational renewal and climate adaptation) remain underrepresented across research, investment and governance frameworks? To deepen the analysis, the article presents four representative thematic areas where youth played a catalytic role in designing, implementing or scaling agrifood innovation. These thematic areas present examples of innovations, which were selected for their geographical diversity, relevance to youth engagement and capacity to inform broader policy and investment priorities. Each thematic area includes a table that highlights key success factors and structural gaps, offering lessons on what enables innovation to move beyond the pilot stage and deliver scalable, inclusive impact.

Findings reveal persistent gaps in data, funding pathways and national policy alignment, especially in the Global South. The article concludes by proposing a data- and policy-driven framework to strengthen youth participation, support inclusive innovation ecosystems and guide strategic investment in next-generation solutions for climate resilient food systems.

Keywords: *youth, innovations, agrifood systems, climate resilient, community-led.*

1. Introduction

1.1. Background and context

Agrifood systems comprise an interconnected network of producers, processors, distributors, and consumers of food and related services. Currently, the global agrifood system is at a critical juncture, faced with mounting pressure to feed the 8 billion people amid emerging and worsening pressures, including climate change, biodiversity loss, land degradation, water scarcity, pollution, loss of indigenous knowledge, rural to urban migrations, shifting demographics and evolving dietary preferences (Food and Agriculture Organization of the United Nations/FAO, 2023). Excessive practices across these systems can generate significant environmental and social impacts. For example, irrigation expansion as a strategy to de-risk agriculture often occurs in areas already under acute water stress (Mehta *et al.*, 2024; Hebinck *et al.*, 2021), while overfishing reduces catches, reproductive capacity and fish populations, ultimately threatening both ecosystems and fishers' livelihoods (Hountcheme and Simon, 2024).

The need for agrifood transformation into sufficient, sustainable, inclusive, resilient and equitable systems remains a key priority. This transformation requires more than just an increase in food production; it requires systemic change that integrates numerous variables, including ecological stewardship, social justice and economic viability.

Such a shift can be best achieved with the active participation and leadership of young people, who represent both the present and the future of global food systems, and the incorporation of transformative innovations. The FAO report The Status of Youth in Agrifood Systems emphasizes the demographic and strategic significance of youth in agrifood systems transformation. To illustrate, the youth population represents 1.9 billion people worldwide, accounting for 23 percent of the global population. In regions such as sub-Saharan Africa, they constitute over 35 percent of the agricultural labour force, demonstrating their power and potential to drive and inspire change (FAO, 2025).

1.2. The imperative role of youth in the agrifood transformation

Despite the many challenges they face, youth are at the centre of key changes shaping the world; by their sheer numbers, consumption patterns, advocacy and labour, they critically participate in poverty reduction, job creation and food security outcomes (Hasegawa *et al.*, 2021). Even in regions with smaller youth populations, their proactive engagement and innovative thinking are crucial for sustaining local economies and the social fabric of rural communities.

Though the demand for diverse and healthy foods are increasing, the working conditions and income of people working in agriculture remains poor, particularly in lower income countries and, as a consequence, youth participation in agriculture is declining (Organisation for Economic Co-operation and Development/OECD, 2021). In the absence of youth, labour shortages, a slowdown in agricultural and entrepreneurial activities and weakened intergenerational knowledge transfer could hinder the transformation of agrifood systems.

Youth are uniquely placed to play a key role in advancing agrifood systems transformation for several reasons. First, unlike the older generations, they are more likely to adopt new technologies, experiment with innovative production methods and embrace climate-smart agricultural practices coupled with digital tools (FAO, 2025). Second, their participation is essential for generational renewal, succession and entry of younger farmers to sustain farm businesses and rural vitality through transfers of land, assets and decision-making across generations. In sub-Saharan Africa, for example, the average age of farming household heads is over 49 years (International Fund for Agricultural Development/IFAD,

2019a), raising concerns about the intergenerational transfer of agricultural knowledge, the stability and the long-term viability of agriculture. Third, youth bring innovative approaches, unique creativity and an entrepreneurial mindset to the sector. Youth-led innovations are already shaping more sustainable production and market systems, from precision aquaculture to agroforestry initiatives and e-commerce. Yet the limited adoption and scaling of these innovations is less a matter of their underrepresentation in formal policy and investment frameworks, and more a reflection of the exclusion and marginalization of communities – particularly youth, women and smallholders – whose participation is essential to driving and sustaining systemic change (FAO, 2025).

1.3. Barriers to youth participation in agrifood systems transformation

Youth hold immense potential to transform agrifood systems, yet unlocking this promise requires addressing the persistent and intersecting barriers that currently limit their full and meaningful participation. Many young people lack secure land tenure, affordable financing and accessibility (e.g. to machinery, technology and equipment). These factors are further compounded by cultural norms, unfavourable inheritance laws and stringent credit policies (FAO, 2025). Gaps in skills and knowledge also present a considerable hurdle, given that education and training systems frequently fail to equip youth with the technical, entrepreneurial and digital competencies required to effectively tap into the opportunities presented by modern agrifood value chains (IFAD, 2019a; FAO 2025).

At the policy level, youth inclusion is often not adequately captured in national strategies, and where they are, the majority of the frameworks do not incorporate youth-responsive metrics, nor do they provide for structured engagement in decision-making processes (FAO, 2024). Difficult market access, inadequate infrastructure, weak value chain linkages and high transaction costs constraints compound these issues, making it difficult for young people to access a more profitable and sustainable market.

Gender inequality further exacerbates these structural challenges. Young women in agrifood systems are disproportionately disadvantaged compared to their male counterparts, further affected by limited land ownership, constrained access to credit and training, under engagement and underrepresentation in leadership roles. Limited land ownership, constrained access to credit, and restricted participation in training opportunities significantly hinder their productivity and leadership potential (IFAD, 2019b; High Level Panel of Experts on Food Security and Nutrition/HLPE-FSN, 2021). In sub-Saharan Africa and South Asia, cultural norms and discriminatory inheritance laws further reinforce these barriers, resulting in underrepresentation of women in leadership and decision-making roles (FAO, 2025a). Intersectional disadvantages linked to factors such as ethnicity, disability or migration can deepen exclusion, creating several layers of obstacles that restrict the ability of many young people to fully participate and thrive in agrifood systems (FAO, 2025).

1.4. Emerging opportunities for young people

If adequately nourished, educated and engaged in productive activities, young people have the potential to drive economic transformation and global prosperity. However, without being offered meaningful opportunities, their potential could remain untapped, deepening vulnerabilities and social inequalities (FAO, 2025). The agrifood system offers a wide range of opportunities for young people, including blockchain-based supply chain traceability, AI-driven disease detection in crops and digital agriculture, where they could offer mobile-based climate advisory services. But such innovations should be based on participatory design and citizen science practices to prevent perpetuating models in which business takes precedence. Evidence shows that citizen science can democratize agricultural research

and knowledge production, ensuring inclusivity and accountability (Haklay *et al.*, 2020; Valencia-García *et al.*, (2019). Such approaches nurture rural revitalization, sustainable change, resilience and shared prosperity, and they ensure local knowledge, youth agency and community agendas inform the technologies (Klerkx *et al.*, 2022). Case studies, such as the Agroecomakers initiative in Latin America and a pilot citizen science project involving Kenyan smallholder farmers, describe how information and communications technologies (ICTs) and youth action intersect to empower agroecological traceability, rural rebirth and climate-resilient innovation (Consultative Group on International Agricultural Research Research Program on Climate Change, Agriculture and Food Security/CGIAR CCAFS, 2021; Davies *et al.*, 2022). These practices demonstrate that citizen-driven innovation strengthens the sustainable transformation of agrifood systems while fostering equity, resilience and global prosperity (Franzoni and Sauermann, 2020).

Agroecology, including biodiversity conservation, restoration, and enhancing farming systems that combine Indigenous knowledge with regenerative agriculture, is another area in which young people could engage. Furthermore, value addition and processing can create locally relevant products that exploit market opportunities while strengthening rural livelihoods. Social innovation is another prime area, with cooperative models, youth-led networks and participatory governance mechanisms fostering collective action and amplifying community impact. Collectively, these developments illustrate that youth engagement is not merely a demographic imperative but a practical and strategic pathway toward building sustainable, resilient and inclusive agrifood systems.

1.5. The problem the current research seeks to address

While youth-led initiatives in different conveyor belts of agrifood systems are emerging globally, consolidated evidence on the trends, financing streams and related policy landscapes remains scarce (FAO, 2025). A gap exists in the global typology of youth-led innovations, specifically, disaggregated by geographic location, thematic area, gender and socio-economic status examining both success factors and barriers. Additionally, investment streams are not well-documented, making it difficult to understand the financial adjustments needed to fully support young innovators, given that the stringent collateral requirements and high interest rates pose significant barriers to accessing financing from mainstream institutions (Khandker and Yamano eds., 2025; Alliance for Financial Inclusion/AFI, 2021). Finally, a governance gap is evident and weak institutional policies could hinder meaningful participation of youth in agrifood systems (FAO, 2025). Without targeted interventions to bridge these gaps, many promising youth-led initiatives risk remaining untapped or would never survive the valley of death.

1.6. Purpose and objectives of the study

This study explores youth- and community-led innovations within four thematic areas: (1) agricultural methods, (2) fisheries and aquaculture, (3) forestry and (4) climate-smart smallholder resilience. The four thematic areas considered were selected based on their centrality to sustainability, interconnectedness across value chains and potential to yield high-impact youth engagement. With a global geographic scope, the research aims to:

1. Map the typologies of youth- and community-driven innovations across these thematic areas.
2. Examine the factors that shape the conceptualization, development, adoption and scaling of such initiatives, including the institutional, economic and social conditions that enable or constrain their long-term viability.

3. Assess the extent to which cross-cutting priorities, digital technology, gender equality, generational renewal and climate adaptation are embedded in the design and implementation of youth-led agrifood innovations.
4. Propose policy and investment priorities to strengthen youth participation, inclusiveness, equity and sustainability in agrifood systems.

2. Methodology and framework

To capture the diversity and nuances of youth-led innovation in agrifood systems, this research adopted an explorative and thematic desk review approach. The research process began with a review of core literature produced by FAO – available in its knowledge repository (https://openknowledge.fao.org/) – and its key partners, including the HLPE-FSN, IFAD, CGIAR and other actors engaged in youth-focused agricultural and climate-smart initiatives. These foundational materials provided both a baseline understanding and an institutional lens to situate the analysis. The analysis was guided by key dimensions of youth engagement, such as innovation pathways, inclusion and equity, generational renewal in agriculture and governance, while allowing flexibility for sector-specific insights to surface. This collective review process informed the structure of the sections and sub-sections, where individual authors examined their assigned thematic areas – agricultural methods, fisheries and aquaculture, forestry and climate-smart innovation – for smallholder resilience, using the shared literature base and applying a consistent analytical lens. The thematic areas were selected to cover the main domains of youth-led innovation within agrifood systems, while also reinforcing the interdisciplinarity areas of the authors. Each author contributed their own domain knowledge to highlight the most relevant trends, gaps and opportunities in their respective area.

For each thematic area, additional resources were identified through targeted keyword searches with area-specific keywords relevant to each topic and the cross-referencing of academic and grey literature. From this body of materials, illustrative case studies were also selected to provide concrete evidence of youth-led initiatives and actions within each domain. Building on these case studies, we identified success factors that enable the implementation and sustainability of such initiatives, as well as barriers and challenges that constrain them. This process further contributed to a more specific analysis of the bottlenecks affecting youth-led initiatives, highlighting areas that can be addressed in the context of agrifood systems transformation.

Rather than following a predetermined analytical model, the research remained intentionally open to emerging insights. The goal was to synthesize not only existing knowledge, but also areas where evidence is still fragmented, underexplored or missing altogether. Ultimately, this methodology allowed for a grounded yet adaptable synthesis of what exists, what's emerging and what remains to be addressed in the field of youth-led innovation for sustainable agrifood systems.

3. Thematic areas of innovation

3.1. Agricultural methods

3.1.1. Background

Amid declining youth engagement in traditional farming, young people are emerging as key innovators in agricultural methods, developing and adapting practices that enhance sustainability, productivity and resilience in agrifood systems. According to IFAD, of the 1.2 billion young people between the ages of 15 and 24 worldwide, nearly 800 million live in rural and peri-urban areas (IFAD, 2019a). However, the proportion of young people in rural areas is declining, reflecting a "generational break" in the way rural youth aspirations intersect with agriculture. The HLPE-FSN report Promoting youth engagement and employment in agriculture and food systems notes that agriculture is often not the first livelihood choice for young people, even in contexts where it dominates rural economies. This trend is influenced not only by personal preferences but also by structural constraints, including limited access to land, natural resources, infrastructure, finance, technology and knowledge, as well as low remuneration and persistent gender inequalities (HLPE-FSN, 2021).

3.1.2 Status of youth in agriculture

Globally, about 85 percent of youth live in lower-income countries and youth unemployment is approximately 3.5 times higher than adult unemployment. Approximately 44 percent of young people were engaged in agriculture in 2025, representing a decline of 10 percentage points compared to 2005 (FAO, 2025). This downward trend is expected to continue due to the ongoing transition toward industrialized agriculture, which further reduces opportunities for youth participation in traditional farming systems.

Yet, youth remain a driving force in the transition toward sustainable agriculture, taking on pivotal roles as future producers, processors, service providers and informed consumers (FAO, 2025). This transformation has been driven by a combination of technological, ecological and social innovations, where biodiversity plays a central role. Regenerative practices, community-led and citizen science initiatives are empowering local actors to generate relevant knowledge, while models like agroecology and urban agriculture have increasingly been adopted by youth-led and grassroots organizations, especially in underserved regions (HLPE-FSN, 2021). Such initiatives directly improve biodiversity by restoring soils, supporting pollinators and diversifying crops and landscapes. At the same time, emerging technologies such as AI, and improved access to them, are expanding market access, improving climate-resilient agricultural practices, and strengthening links between producers and consumers to support short supply chains and sustainable farming (HLPE-FSN, 2021; Aijaz et al, 2025).

3.1.3 Role of youth led innovation in managing natural resources, specifically water

In terms of natural resources used in agriculture, access to irrigation is widely recognized as the most critical adaptation strategy for increasing yields and coping with climate variability (Koo-Oshima, 2023). Agriculture accounts for about 72 percent of all freshwater withdrawals globally, making it the largest water-consuming sector. Reliable water supply, especially through irrigation, significantly boosts yields and stabilizes food production against climatic variability, with irrigated cropping areas rising from about 139 million hectares in 1961 to over 328 million hectares in 2018 (FAO 2021). Groundwater, specifically, is crucial as 38 percent of irrigated areas use groundwater as source, and 70 percent of the overall use of groundwater is in irrigation. Yet, irrigation itself faces acute challenges due to climate change and groundwater scarcity coupled with overexploitation of available resources. Youth-led innovations can help to address these issues.

Water resources are not only finite but also highly heterogeneous in terms of regional availability, quality, reliability and access. Regions such as South Asia, the Near East and North Africa, and parts of Central Asia suffer from acute water stress, with irrigation water use frequently exceeding renewable supplies. In parts of South Asia, for example, the expansion of irrigation has shifted reliance toward groundwater, a resource long assumed to be renewable. Nearly 70 percent of groundwater withdrawals are for agriculture, but unsustainable extraction, particularly in groundwater-dependent regions like India, has led to falling water tables, declining quality and rising extraction costs. Groundwater, once regarded as a renewable resource, is now being extracted faster than it can be replenished, rendering many aquifers effectively non-renewable and threatening food security and livelihoods (FAO, 2021). Prolonged over-pumping has led to declining water tables, and in some regions, aquifers may take decades, or longer, to recover, if at all.

These effects differ across regions due to variations in aquifer types, local hydrology and energy costs. For example, in India, where 60 percent of irrigation depends on groundwater, the energy for pumping is either free or subsidized. Because of this free energy, there is no marginal cost, which gives farmers no reason to conserve water. Although energy subsidies help ensure food security, they harm groundwater resources, creating what is often called the water-energy-food nexus (Fishman *et al.*, 2011). The issue is worsened by fragmented governance and limited community involvement, despite clear evidence that both fair access and environmental sustainability are at risk (Mukherjee, 2018). Scientific use and management of water resources is also crucial from the point of view of generational renewal; without access to water, agriculture remains a risky proposition and youth tend to move to urban areas in search of more secure livelihood.

Policies and technologies for farm water use have mostly focused on using less water to grow the same or more crops. This approach is called demand-side management. An example is drip irrigation. However, due to the "rebound effect" or Jevon's paradox, there may be no net water savings at the overall level. Even if farmers use less water for a specific crop, there might be a shift toward water-intensive crops or expansion of irrigation areas, ultimately negating the total water savings (Fishman, Devineni and Raman, 2015).

To address these challenges, it is crucial to integrate both supply- and demand-side management strategies, such as rainwater harvesting, conjunctive use of surface and groundwater, and reuse of treated urban wastewater. Equally important are innovations that involve communities and leverage new technologies to more accurately measure and manage water resources at the local level. Simultaneously, we must efficiently implement these policies to provide broad access to irrigation. The significant poverty-reducing impact of irrigation has been clearly demonstrated. Additionally, innovations in the energy sector are essential for expanding access to irrigation. Given the complexity and location-specific nature of the issue, innovations must also develop locally, with youth leading this effort by treating it as a business opportunity.

3.1.4 Youth- and community-led innovations in agricultural methods and resource conservation

Given the diversity and complexity of water-agriculture linkages, uniform national policies are unlikely to succeed. The best approach is to create an enabling environment for local entrepreneurs to develop context-specific innovations that address regional hydrology, resource availability, societal factors and governance challenges, empowering communities and youth to shape sustainable water and agricultural futures. Local adaptation and integrated approaches – incorporating new business models, digital solutions, participatory governance and the integration of surface and groundwater – are key. As these cases show, empowering local entrepreneurs, youth and communities to drive innovation is essential for building resilience, enhancing productivity and stewarding water resources for generations

to come. The following cases illustrate how youth can play an active role in addressing the issues of access to irrigation and groundwater overexploitation by leveraging technologies, digital tools and community participation.

In Gujarat, India, the innovative Solar Power as Remunerative Crop model helps farmers replace grid electricity with solar irrigation pumps grouped in cooperative micro-grids that sell surplus solar energy back to utilities, incentivizing groundwater conservation by monetizing solar power as a "crop". This model has led to significant groundwater use reduction and inspired a national government project promoting grid-connected solar pumps (Shah *et al.*, 2016). Recently, youth-driven entrepreneurial activities are emerging (for example, Oorja) in the area of promoting solar pumps with different business models, boosting India's green energy transition efforts, simultaneously improving farmers' access to irrigation. Africa also has immense potential to use solar powered irrigation because of abundant sunshine and lack of electric grids for irrigation. In Ghana, solar photovoltaic irrigation pumps provide smallholders with an affordable and sustainable energy solution, especially in areas of limited energy access, supported by several youth-driven business models, including cooperative-led business models and policy frameworks that promote scaling while protecting vulnerable aquifers (Gebrezgabher *et al.*, 2021). Youth can also play a key role in integrating digital tools to efficiently schedule and manage irrigation. Across rural India, Nano Ganesh has transformed community life by letting farmers remotely switch their irrigation pumps on and off using mobile phones, saving both water and energy while expanding access for women and elderly users, and improving efficiency and quality of life for over 50 000 installations (World Bank, 2016). Meanwhile, in Malaysia's Sawah Sempadan rice belt, farmers use a satellite-based web geographic information system platform integrating soil moisture and weather sensor data to optimize irrigation and crop management, driving precision farming that boosts yields and reduces resource waste (World Bank, 2024). These cases underscore how youth and communities are harnessing innovative technology and collective action to advance sustainable rural livelihoods across diverse contexts.

Table 1. Success factors, barriers and gaps in innovations in agricultural methods

Innovations	Success factors	Barriers and gaps
Solar photovoltaic technology for smallholders (Ghana)	Affordable, sustainable energy; viable financials (Gebrezgabher *et al.*, 2021)	Policy support to address upfront costs, infrastructure requirements and the creation of an enabling environment that fosters the emergence of new businesses in the area
Nano Ganesh (India)	Mobile remote control, broad adoption, and efficiency in irrigation (World Bank, 2016)	Network coverage, initial costs and maintenance, funding to develop a broader distribution and support networks
Precision farming with satellite-based water sensors (Malaysia)	Data-driven decisions, scalable and resource-efficient (World Bank, 2024)	Access to technologies, training, adoption resistance and lack of incentive
Solar power as a "remunerative crop" (India)	Financial incentives, groundwater reduction and government support (Government of India, 2019)	Cooperative governance, infrastructure needs, difficulty in scaling due to a lack of policy coherence And conflicting policy goals across sectors

3.2. Fisheries and aquaculture

The global fisheries and aquaculture sectors are likewise undergoing a profound transformation, increasingly shaped by the contributions of young professionals. Youth bring fresh perspectives to enduring challenges in sustainability, efficiency and equity. As the sector faces escalating environmental pressures, including climate change, biodiversity loss, and overfishing, their active engagement in innovation is both timely and essential. However, despite their potential, youth participation in fisheries and aquaculture is declining, threatening traditional intergenerational practices and workforce continuity (Suh and Nyiawung, 2023; Coleman *et al.*, 2019). This trend is partly driven by concerns over future fish availability and uncertainty around natural resources (Suh and Nyiawung, 2023; Power *et al.*, 2014; Worm *et al.*, 2007). However, re-engaging youth through innovation, skills development, and knowledge-sharing can help preserve cultural heritage while advancing sustainability (Espinoza-Tenorio *et al.*, 2022). Examples of innovations in aquaculture and fisheries are presented below, highlighting those that are either led by youth or designed to be accessible to youth and other minorities, supporting their active engagement.

3.2.1. Digital, technological and financial innovations

ASustainability challenges in fisheries and aquaculture can be effectively addressed through climate-smart innovations, and information and communication technologies (Bhusan *et al.*, 2025; Calderwood, 2022; Katsidoniotaki *et al.*, 2024). Evidence shows how these tools not only support more efficient and resilient practices but also encourage youth engagement in fisheries, aquaculture and value-chain management (Arulingam *et al.*, 2019; FAO and WorldFish, 2020). To illustrate, smartphone applications provide real-time data on weather conditions, market prices and post-harvest management, enabling more climate-resilient and informed decision-making in fishing communities (Calderwood, 2022; FAO and WorldFish, 2020). ICTs also help modernize the small-scale fisheries (SSF) sector, making it more attractive and accessible to younger generations (Arulingam *et al.*, 2019).

In aquaculture, advanced technologies, such as AI, smart sensors and camera systems are increasingly used to automate feeding, detect diseases and monitor water quality (Chang *et al.*, 2022; Wang *et al.*, 2021; Zhang and Gui, 2023). Katsidoniotaki *et al.* (2024) developed a smart modeling system integrated into a digital twin platform, allowing real-time monitoring and prediction of aquaculture net cage behaviour under harsh marine conditions. This supports structural integrity assessments, reduces fish escape risks and enables remote, climate-resilient operations.

Academic institutions are also contributing to innovation. At Cagayan State University in the Philippines, researchers developed MangngalApp, a mobile-friendly, science-based tool offering integrated support to small-scale coastal producers. The app enhances productivity, environmental awareness, and inclusive livelihoods by providing services related to fishing, seaweed farming, and post-harvest activities (Javier *et al.*, 2023).

Beyond single tools, the integration of big data and cloud computing enables better traceability, forecasting and decision-making by combining environmental, production and market data (Zhang and Gui, 2023). Blockchain technology, while still emerging, is showing potential for sustainability certification and ownership tracking, increasing transparency across the value chain (Karthikeyan, 2025).

Another frontier lies at the intersection of aquaculture and climate finance. Pilot initiatives are testing carbon credits as incentives for best management practices among small-scale farmers. While promising for both environmental and financial gains, these schemes also raise concerns about equity, particularly when vulnerable groups are expected to reduce productivity to offset emissions generated by wealthier

actors (FAO and French Agricultural Research Centre for International Development/CIRAD, 2023). Overall, these technologies can advance sustainable fisheries and aquaculture while creating new entry points for youth participation. However, the extent of youth involvement still depends heavily on access to training, technology and financial resources.

3.2.2. Social and organizational innovation: building communities of practice

Aquaculture holds significant potential for income generation, youth employment, food security and sustainable livelihoods. Youth-led science, technology, engineering and math (STEM) e-learning platforms are equipping the next generation with aquaculture expertise and 21st-century skills (Setiawati *et al.*, 2024). In Kenya, integrated initiatives link aquaculture with public health and nutrition, applying systems thinking to human-environment interactions (Blackmore *et al.*, 2022). Training on climate adaptation and sustainable resource use has been shown to enhance youth participation in small-scale fisheries (Espinoza-Tenorio *et al.*, 2022), while summer programs in Canada have promoted youth retention through intergenerational knowledge exchange (Power *et al.*, 2014). In West Java, Indonesia, researchers at the Institut Pertanian Bogor trained local youth in aquaculture practices, including acclimatization, feeding and pond management, building capacity among participants new to the sector (Umar *et al.*, 2024). Youth entrepreneurs are increasingly generating value through innovations such as fish-based snacks from integrated production systems, which help stimulate local economies (Blackmore *et al.*, 2022). Many young people are discouraged from entering fisheries and aquaculture due to declining catches, the physically demanding nature of the work compared with off-farm opportunities, limited training pathways and low income prospects. Young women face even greater barriers, particularly restricted access to production inputs and resources (IFAD, 2019b). In Equatorial Africa – for instance, in Cameroon – climate stressors, declining fish stocks, and limited adaptive tools further deter youth participation (Suh and Nyiawung, 2023). Addressing these challenges requires climate-smart training and stronger investment in capacity building to make fisheries and aquaculture more attractive and viable career options for the next generation.

3.2.3 Gender equality, generational renewal and climate adaptation

Although technological advances offer significant potential, they need to be assessed in the context of the sector's long-standing structural challenges. Gender inequality continues to limit women's participation in leadership and innovation. Despite representing 21 percent of the 58.5 million people employed in fisheries and aquaculture, women face systemic barriers to training, finance and decision-making (Suh and Nyiawung, 2023). Climate change exacerbates these issues, with declining fish stocks and rising poverty forcing many out of seafood production systems (Macusi *et al.*, 2022).

A gender lens reveals clear divisions of roles in fisheries and aquaculture, shaped by social, cultural and economic contexts. Men typically dominate fish catching, particularly offshore and deep-sea fishing, while women are more engaged in coastal and onshore activities. Women often manage small boats, but their main responsibilities lie in labour-intensive tasks such as net making, fish processing, marketing and supporting fishing operations. In regions like West Africa and Asia, women are estimated to market up to 60 percent of seafood, and globally they play a crucial role in shellfish gathering and clam gleaning (FAO, 2016).

Gender-inclusive innovation has shown potential to improve access rights, resource management and economic resilience. In the Gambia, for instance, women oyster harvesters engaged in mangrove reforestation were more willing to continue their activities under climate stress, illustrating the link between adaptation and livelihood resilience (Suh and Nyiawung, 2025). Similarly, IFAD has promoted integrated homestead food production systems in Bangladesh, combining small fish ponds with vegetable gardens and backyard livestock. This nutrition-sensitive and women-led approach has

enhanced dietary diversity, increased nutrient-rich small fish production and strengthened women's control over household food security (IFAD, 2019b). Such initiatives demonstrate how gender-sensitive approaches can simultaneously boost resilience, nutrition and empowerment.

Generational renewal is equally urgent. Youth participation in fisheries and aquaculture is often limited not by choice but by structural barriers, including lack of access to land, licenses, finance and decision-making spaces, conditions rooted in gerontocratic systems and inequitable policy frameworks (Arulingam *et al.*, 2019). Moreover, youth are not a homogenous group; their engagement is shaped by factors such as age, gender, education, legal status and livelihood aspirations. The limited availability of data, especially on young women, highlights the need for youth-specific and intersectional approaches in both research and policy.

The innovations and trends presented here are summarized in the table below (Table 3). These examples demonstrate that youth engagement in fisheries and aquaculture is strengthened when innovation, community-building and equity are pursued together. Digital tools, from smartphone applications to AI-driven monitoring systems, can modernize small-scale fisheries and aquaculture, making them more climate-resilient and attractive to younger generations. Social and organizational innovations, including STEM-based e-learning, intergenerational training and youth-led entrepreneurship, support knowledge transfer, stimulate local economies and retain skills within the sector. At the same time, addressing persistent gender inequality, ensuring generational renewal, and integrating climate adaptation into training and policy frameworks are essential to making these innovations accessible to all.

Table 2. Success factors, barriers and gaps in aquaculture and fisheries innovations

Innovations	Success factors	Barriers and gaps
Smart modeling system and digital twin (Katsidoniotaki *et al.*, 2024)	Real-time monitoring of aquaculture net cage behavior, structural integrity enhancement, reduction in fish escape risk, the enabling of remote operations under harsh conditions	Requires high technical expertise, investment in hardware/software and access to training
Development of MangngalApp, Cagayan State University, Philippines	Mobile-friendly, science-based tool for small-scale coastal producers; integrates fishing, seaweed farming and post-harvest services; boosts productivity, environmental awareness and inclusive livelihoods	Access to technology and digital literacy required, potential limitations in internet connectivity and funding for scaling
Carbon credits for small-scale aquaculture (FAO and CIRAD, 2023)	Incentivizes best management practices, potential for environmental and financial gains	Risk of inequity if vulnerable groups bear disproportionate productivity losses, complexity in implementation and verification
Integrated aquaculture with public health and nutrition, Kenya (Blackmore *et al.*, 2022)	Systems thinking approach, links aquaculture with health and nutrition outcomes, promotes holistic sustainability and community wellbeing	Possible lack of resources for replication, dependency on multi-sector coordination

Summer programs for youth in small-scale fisheries, Canada (Power *et al.*, 2014)	Intergenerational knowledge exchange, promotes youth retention in the sector, strengthens cultural heritage	Limited scalability, seasonal and potentially short-term engagement
Youth aquaculture training at Institut Pertanian Bogor, West Java, Indonesia (Umar *et al.*, 2024)	Practical skills development in acclimatization, feeding, and pond management; builds capacity for newcomers	Need for continued mentorship and follow-up, limited financial incentives for start-up aquaculture ventures
Youth entrepreneurship in value-added fish products (Blackmore et al., 2022)	Creation of fish-based snacks from integrated production systems, stimulates local economies and adds value to raw materials	Market access, branding and distribution challenges; potential capital constraints for scaling production
Women oyster harvesters and mangrove reforestation, the Gambia (Suh and Nyiawung, 2025)	Gender-inclusive innovation, climate adaptation through ecosystem restoration, improved willingness to continue activities under stress	Persistent gender inequality in access to finance, training and decision-making spaces
Integrated homestead food production systems in Bangladesh (IFAD, 2019b)	Nutrition-sensitive, women-led approach; combines small fish ponds, vegetable gardens and backyard livestock; enhances dietary diversity; boosts nutrient-rich small fish production; strengthens women's control over household food security	Scalability may be limited by resource constraints, requires sustained support for women's empowerment and capacity building, potential challenges in integrating multiple components across diverse households

3.3. Forestry

In recent years, a range of youth-led initiatives in the forestry sector have emerged as key contributors to combating deforestation and climate change. These initiatives, often driven by innovation, leverage local knowledge, technology and community mobilization to restore degraded lands, enhance biodiversity and support sustainable livelihoods. However, while certain innovations have demonstrated notable successes, significant gaps persist in the research, investment and governance frameworks supporting youth-led forestry innovation. Furthermore, existing research has found that youth play a vital role in conservation decisions but face structural barriers to meaningful participation, and research on the International Union for Conservation of Nature's Youth Strategy and the World Conservation Congress reveals that while youth have agency, their engagement in global environmental governance remains stratified, unequal and often tokenistic (Sithole *et al.*, 2024). Robson, *et al.* (2019) provide guidance to overcome barriers and encourage the better inclusion of youth in shaping the future of forestry. They recommend a standardized methodology that can capture both shared and context-specific youth perspectives across cultures. However, they note that meaningful engagement also requires local facilitation, adequate time, interactive activities and opportunities for youth to co-lead, deepen civic commitment and influence community and environmental decision-making. This approach highlights that youth are eager to be informed, involved and supported as active change-makers through participatory strategies that respect cultural contexts and foster intergenerational collaboration (Robson *et al.*, 2019).

There are several examples of how youth organizations across the globe have piloted creative approaches to sustainable forestry management. In Bhutan, projects led by the Bhutan Youth Development Fund aim to plant high carbon-capturing trees, reduce paper waste through recycling and preserve eco-friendly weaving traditions, all with the overarching goal of mitigating climate change (Bhutan Youth Development Fund, n.d.). Similarly, in Kenya, the Young Forest Champions initiative has engaged over 10 550 community members and planted more than 150 000 trees in eight counties since its launch. Backed by the Improving Measurement for Payments to Reduce Emissions and Strengthen Sinks (IMPRESS) project (2021–2023) and expanded under the Accelerating Innovative Monitoring for Forests (AIM4Forests) programme (2023–2028), these youth champions contribute to Kenya's ambition to restore 10.6 million hectares of degraded landscapes by 2032. The programme not only supports national forest monitoring systems but also expands capacity to include mangrove restoration, and provides young volunteers with practical experience in forestry, wetlands and natural resource management (FAO, 2024).

Global networks such as Youth in Landscapes, emerging from the 2013 Global Landscapes Forum, serve as collaborative platforms for young professionals engaged in sustainable land use. These initiatives foster peer learning, advocacy and innovation sharing among youth leaders worldwide (United Nations Convention to Combat Desertification/UNCCD, 2022). Networks like this are aligned with principles of youth-led participatory action research, which has been shown to empower young people to actively shape and lead community-focused environmental agendas (Ozer and Piatt, 2024).

Despite these successes, multiple challenges hinder the scaling and sustainability of forestry innovations. *The State of the World's Forests 2024* report identifies four systemic barriers to scaling innovation in the forestry sector: lack of an innovation-oriented culture, high risk perception, limitations in access to various forms of capital, and unsupportive policies and regulations (FAO, 2024).

These barriers often overlap with youth-specific constraints identified in the Youth Engagement in Land and Ecosystem Restoration working paper, which include inadequate education and contextual capacity building, insufficient income, insecure land tenure, gender inequalities, inadequate financing and weak policy-to-practice linkages (UNCCD, 2022).

Ghana's Youth in Afforestation/Reforestation Project once engaged around 50 000 young people in restoration work (2018 peak), but participation fell to 33 394 by 2021 due to low wages and limited funding, weakening momentum and long-term forest management

By contrast, the Malawi Youth Forest Restoration Programme (MYFRP) has maintained strong engagement through government backing, Indigenous knowledge and diversified livelihoods. Key successes include the restoration of 50 000 hectares, planting of 145 000 trees, promotion of natural regeneration and community sensitization against deforestation.

This case is considered a success, especially for women and youth as it encourages them to establish woodlots, bee colonies and Moringa powder enterprises, promoting tree planting over deforestation while creating climate-adaptive livelihoods that address poverty and build environmental stewardship skills (UNCCD, 2022).

What distinguishes MYFRP and similar cases is their alignment with robust policy frameworks, adequate resourcing and the integration of social equity goals into environmental restoration. These conditions amplify the transformative potential of youth-led innovation and contribute to sustained outcomes.

Table 3. Success factors, barriers and gaps in forestry innovations

Innovations	Success factors	Barriers and gaps
Bhutan Youth Development Fund (Bhutan)	Community-based action, integration of cultural heritage into conservation, focus on high carbon-capturing species (Bhutan Youth Development Fund, n.d.)	Limited scaling capacity, absence of advanced digital technology integration
Young Forest Champions (Kenya)	Large-scale community mobilization, technical training via FAO's IMPRESS and AIM4Forests, inclusion of mangrove restoration, links to national restoration targets (African Forest Forum, 2024)	Dependent on external project funding, limited explicit gender equity framework
Youth in Afforestation/ Reforestation Project (Ghana)	Large-scale youth participation in plantation establishment, government backing (Forestry Commission of Ghana, 2022)	Declining participation due to low wages, lack of competitive funding, insufficient long-term incentives
Malawi Youth Forest Restoration Programme (Malawi)	Government-funded, integration of indigenous knowledge, strong gender inclusion (80 percent women in leadership), livelihood diversification, domestic budget financing (UNCCD, 2022)	Daily wages remain low, potential vulnerability if domestic funding is reallocated

For youth-led innovation in forestry to thrive and contribute more fully to sustainable agrifood systems, several strategic priorities should be pursued, as outlined by the UNCCD (2022). Raising awareness of innovation is essential, which can be achieved through targeted outreach, the showcasing of success stories and the integration of forestry innovation into education systems. Equally important is ensuring more accessible financial resources by developing competitive funding streams, grants and blended finance models tailored for youth enterprises. As demonstrated in the examples above, when financial incentives are in place, that ensures and secures greater participation, and therefore, the opportunity for innovation to emerge.

Strengthening policy processes is also critical to enable structured youth representation, ensure inclusive governance, and bridge the gap between policy design and practical implementation. In parallel, promoting responsible and inclusive innovation is necessary to safeguard equity, gender sensitivity and the integration of local knowledge.

3.4. Climate-smart innovations for smallholder resilience

Smallholder farmers are on the frontlines of climate change, especially in regions with fragile ecosystems, limited infrastructure and scarce institutional support. As the impacts of climate variability intensify, from shifting rainfall patterns to increasing soil degradation, smallholders face shrinking margins of resilience. "Almost all (95%) of the surveyed smallholder farmers have observed climate change", notes Harvey *et al.* (2018) upon observing the situation in Central America. Within this landscape, innovation becomes not a luxury but a survival mechanism. A new generation of youth and community-led actors is stepping

into this space, driven by necessity, curiosity and an urgent need to rethink agrifood systems. While policy discourses often highlight high-tech solutions, this section focuses on a broader spectrum of climate-smart innovations: from endogenous and survival-driven responses to digitally enabled and partnership-fueled approaches that target adaptation, equity and scale.

3.4.1 Endogenous and survival-driven innovation models

In many contexts, climate-smart innovation emerges not from external interventions but as a response to lived ecological and economic stress among adults and youth alike. A recent study by FAO found that "globally, 44 percent of working youth rely on agrifood systems for employment compared to 38 percent for working adults" (FAO, 2025). In Ghana, Konfo *et al.* (2024) describe how youth and farmer cooperatives developed low-cost innovations such as clay-based grain storage structures, ash-based pest control, and organic composting methods using locally available biomass. These approaches are not only adaptive to changing climate realities but also reflect embedded knowledge systems and resource efficiency.

Similar innovation logics are found in West Africa, where smallholder farmers are adopting biopesticides made from neem, low-tech irrigation techniques and organic fertilizers derived from Black Soldier Fly (BSF) larvae (West and Central African Council for Agricultural Research and Development/CORAF, CIGAR and Accelerating Impacts of CIGAR Climate Research for Africa/AICCRA, 2023). For example, Anyega *et al.* documented that combining BSF frass plus nitrogen phosphate potash (NPK) fertilizer resulted in yield increases between 22 and 135 percent relative to sole NPK for various crops like tomatoes, kale and beans in smallholder settings.

These solutions stem from both necessity and circularity, maximizing limited inputs while building long-term soil and ecosystem health. The Climate-Smart Village (CSV) model, promoted by CGIAR across West and Central Africa, also demonstrates how localized innovation hubs can stimulate collective action. CSVs experiment with climate-resilient seed varieties, conservation agriculture and natural resource management practices that are scaled regionally through spillover mechanisms (AICCRA, 2023). While not always youth-led, these models often empower young farmers to test and refine adaptation techniques through structured participation.

3.4.2 Tech-enabled and youth-relevant climate adaptation

Digital tools are increasingly supporting smallholders to adapt to change in real time. A study on internet use in maize farming observed that farmers who used the internet had 13.92 percent higher yields per hectare than those who did not, controlling for other factors (Zheng *et al.*, 2022). In Senegal, the Intelligent Agricultural Systems Advisory Tool (ISAT) provides weekly advisory messages tailored to rainfall forecasts, helping farmers adjust planting and input strategies (CORAF, CIGAR and AICCRA, 2023). In Mali, the RiceAdvice app enables young rice farmers to receive localized guidance on seed selection, fertilization and spacing to optimize yields under volatile weather conditions.

Other innovations leverage participatory design to ensure contextual relevance. Smart-Valleys, a water management system co-developed with farmers in Mali, enables smallholders to co-design inland valley irrigation schemes, enhancing water retention while reducing labour and environmental impact (Djagba *et al.*, 2024). While these tools are not exclusively developed by youth, they increasingly target younger farming populations due to higher mobile penetration and digital literacy. However, significant gaps persist in access to climate-smart technologies and enabling infrastructure, especially in remote and underfunded regions (AIM for Climate, 2023).

3.4.3 Enabling ecosystems: partnerships, scale and equity

Scaling climate-smart innovations requires more than technical fixes; it demands ecosystems that support experimentation, knowledge exchange and financial access. Multi-stakeholder initiatives like AICCRA's Climate-Smart Agriculture Innovation Pitch sessions foster collaboration between youth innovators, researchers, policymakers and private sector actors (AICCRA, 2023). Public-private investments also play a critical role. The AIM for Climate initiative identifies bundled investment packages, combining tech deployment with training, data access and market linkages to bridge the gap between pilot and scale (AIM for Climate, 2023). Similarly, the West African Initiative for Climate-Smart Agriculture proposes regional finance mechanisms to support both institutional and grassroots innovations across countries (Climate Finance Lab, 2024).

Nevertheless, equity must remain central. As Konfo *et al.* (2024) argue, many climate-smart initiatives risk bypassing or co-opting local knowledge if not co-designed with the very communities they aim to serve. A shift toward inclusive governance, intersectional data collection and localized monitoring is essential to ensure that smallholder resilience is not only strengthened, but also shaped by the people most affected.

Table 4. Success factors, barriers and gaps in climate-smart innovations for smallholder resilience

Innovations	Success factors	Barriers and gaps
Clay storage, ash pest control and organic Compost (Ghana) (Konfo *et al.*, 2024)	Youth-developed, low-cost, climate-resilient techniques using local materials; builds endogenous innovation capacity	Limited institutional recognition and support, informal scaling mechanisms, low access to funding and validation
Smart-Valleys water management system (Mali) (Djagba *et al.*, 2024)	Farmer co-designed, reduces labour, increases water retention, supports adaptive agriculture	Scaling requires technical training and community mobilization, limited integration into national water policy
RiceAdvice App (Mali) (AICCRA, 2023)	Mobile-based, tailored agronomic guidance for rice farmers; youth-friendly and data-driven	Requires smartphone access and digital literacy; gendered digital divide limits equitable access
ISAT Advisory SMS (Senegal) (CORAF, CIGAR and AICCRA, 2023)	Delivers timely, localized weather and planting advice; supports decision-making under climate uncertainty	Language limitations, coverage gaps and weak linkage to extension services; reliance on donor funding
CSV model (West and Central Africa) (CGIAR, 2023)	Participatory platform to test adaptive practices; promotes shared learning and peer-to-peer spillover	Not always youth-led; needs sustained investment and localized monitoring to maintain impact

4. Conclusion

Across agricultural methods, fisheries and aquaculture, forestry and climate-smart innovation for smallholder resilience, youth are emerging as central actors in reimagining agrifood systems toward sustainability, equity and climate resilience. Their engagement spans diverse forms of innovation: from regenerative agricultural practices and AI-powered aquaculture monitoring, to community-led forestry restoration and locally adapted climate-smart farming models. These innovations share common strengths: They integrate traditional and scientific knowledge, address both ecological and socio-economic dimensions and increasingly leverage digital technologies to connect producers with markets, improve decision-making and foster collaborative learning.

A recurring strength across sectors is the ability of youth-led or youth-relevant initiatives to combine technological solutions with social and organizational innovation. This dual approach enhances adoption, supports generational renewal and embeds innovations in community contexts. Equally notable is the alignment of successful initiatives with an enabling environment (robust policy support, adequate financing and inclusive governance frameworks), which together enable scalability and long-term impact. Many case studies highlight the transformative potential of gender-responsive and intersectional approaches, demonstrating that diversity and equity are not secondary considerations but essential drivers of innovation.

However, significant limitations constrain the realization of this potential. Structural barriers, including insecure land tenure, limited access to finance, inadequate infrastructure, policy incoherences and exclusion from decision-making at the governmental level, persist across all thematic areas. Digital innovations, while promising, risk widening inequalities when access to training, technology and connectivity is uneven, particularly for women, marginalized youth and rural communities. In addition, many initiatives remain dependent on short-term projects or external funding, limiting continuity and scale. The lack of youth-specific data and evidence in certain sectors, such as forestry, also hampers targeted policy and investment.

Overall, the analysis of examples suggests that technological breakthroughs are most effective when supported by enabling ecosystems that emphasize equity, sustained investment and participatory governance, highlighting the potential for youth to play a more central role. By embedding innovation in inclusive policies, securing long-term financing and recognizing the value of diverse knowledge systems, agrifood systems can harness the creativity, energy and commitment of youth to address climate, biodiversity and food security challenges. In doing so, these systems can transition toward models that are not only more productive and resilient, but also more just and regenerative for current and future generations.

To address the critical gaps identified in advancing youth- and community-led innovations for sustainable agrifood systems, it is essential to strengthen collaboration between governments, youth and other stakeholders to co-design solutions and remove barriers linked to existing projects and funding pathways. This should include open and transparent feedback mechanisms to evaluate both successes and challenges, ensuring that promising initiatives are supported, refined and scaled rather than abandoned. Equally important is raising awareness of engagement opportunities for youth, women and Indigenous groups, whose active participation is critical for driving inclusive, climate-resilient innovation. Without such engagement, these communities risk further exclusion from emerging opportunities and decision-making processes. Practical strategies to foster inclusion include establishing multi-stakeholder coalitions, integrating innovation-focused learning into school curricula, launching targeted digital outreach campaigns and convening specialized workshops. While notable advancements are emerging in areas such as climate-smart agriculture, fisheries and forestry, significant gaps remain in the

visibility, dissemination and adoption of these solutions at scale. Embedding these recommendations into future research, investment and governance frameworks will help ensure that underrepresented voices, knowledge systems and innovations are recognized, replicated and integrated into the transformation of agrifood systems worldwide.

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