Indian Farming 75 (03): 81-84; March 2025

Monetization of ecosystem services for agrifood production systems

Himanshu Joshi[1], M. A. Ansari[1]*, N. Ravisankar[1], M. H. Ansari[2] and Sunil Kumar[1]

[1]*ICAR-Indian Institute of Farming Systems Research, Modipuram, Meerut, Uttar Pradesh 250 110*
[2]*VKS College of Agriculture, BAU, Dumraon, Buxar, Bihar 802 136*

Indian agrifood systems rely heavily on ecosystem services (ES) that underpin agricultural productivity and ecological sustainability. In India, monetizing ES, such as through payment for ecosystem services (PES), has emerged as a strategy to promote sustainable agricultural practices aligning with climate-smart goals, and support policy-making. Further, monetizing ES contributes to added capitalizable environmental benefits such as carbon sequestration, improved water & soil resource management, biodiversity conservation, coastal protection, etc. The presented work highlights the applicability of key approaches typically employed for the valuation of ES such as market-based valuation, cost-based approaches, and willingness-to-pay models. Further, it also underscores successful pilot PES implementations across the country. However, challenges persist, including data scarcity, lack of standardized methodologies, and risks of inequity, often marginalizing smallholder farmers. To scale PES programs, a unified National PES Policy coupled with technological interventions like GIS and blockchain, and public-private partnerships are critical. Further, community involvement, cultural alignment, and robust institutional frameworks are also requisite for ensuring equitable benefit-sharing and fostering widespread adoption of sustainable agri-practices.

Keywords: Agrifood systems, Ecosystem services, Policy, Valuation

AGRIFOOD systems are intricately dependent on the ecosystem services (ES) emanating from the natural systems. Often defined as the benefits that humans derive from ecosystems, ES encompass, (i) *Provisioning services* (e.g., food, water, and raw materials), (ii) *Regulating services* (e.g., climate regulation, pest control, and water purification), (iii) *Supporting services* (e.g., soil fertility, nutrient cycling, and pollination), and (iv) *Cultural services* (e.g., spiritual and recreational benefits). These services form the backbone of sustainable agriculture, enabling the production of food, fiber, and fuel while maintaining ecological balance. In the Indian agrifood system, ES plays a pivotal role due to the country's diverse agro-climatic zones and reliance on natural systems for farming. Provisioning services form the dietary backbone of the nation while regulating services are essential for maintaining agricultural productivity in regions prone to climate variability. Likewise, the supporting services are critical for the productivity of high-value crops, including fruits and vegetables, and cultural services, such as sacred groves and agricultural festivals, reflect the deep interconnection between agriculture and cultural traditions in India.

Why monetize ecosystem services?

Monetization of ES, which attaches economic value to the often-overlooked benefits of natural systems, is a vital strategy to enhance sustainable agriculture. By recognizing the economic value of ES, farmers are more likely to adopt sustainable practices such as crop diversification, organic composting, agroforestry, etc., leading to better resource management thus aligning with the principles of climate-smart agriculture. Further, valuing ES also brings significant fiscal benefits, encouraging investment in sustainable practices, which if disrupted, would require costly artificial alternatives. Additionally, this valuation assists in the harmonization of farming practices with environmental goals by providing policymakers with the necessary data to justify investments in sustainable agriculture, agroecology, and ecosystem restoration. In the Indian context, the

Payment for Ecosystem Services (PES) has the potential to not only improve farmer incomes but also contribute towards other added environmental benefits such as carbon sequestration, water & biodiversity conservation, etc. It is directly aligned with several UN SDGs (SDG 2-Zero Hunger (2.3, 2.4 & 2.5); SDG 12- Responsible Consumption and Production (12.2 & 12.8); SDG 15-Life on Land (15.1, 15.3, 15.5 & 15.9)), and India's NDCs under the Paris Agreement 2016 (NDC 1 (Mission LiFE), and NDC 5 (Additional carbon sink of 2.5 to 3 billion tonnes of $CO_{2\,eq}$ by 2030)), as it fosters balance between agricultural productivity and ecological sustainability. Below figure depicts the logic for the PES in agrifood production systems.

Methods of monetization

Several methods are used globally and in India to assign monetary values to ES. Key methods include, (i) *Market-based valuation* (utilizes observable market prices to estimate the value of goods and services directly derived from ecosystems), (ii) *Cost-based valuation* (estimates the financial implications of replacing or restoring lost ES), (iii) *Benefit transfer method* (employed when primary valuation is infeasible due to time or resource constraints), (iv) *Willingness-to-pay* (WTP) approach (uses surveys to assess how much stakeholders are prepared to pay for preserving or enhancing ES), (v) *Production function approach*, and (vi) *Replacement cost method* (estimates the financial outlay required to substitute lost services with artificial solutions). These methods use context-specific approaches to quantify services from natural systems. Market-based approaches are particularly useful for the valuation of natural pollination services and provisioning services such as water, timber, etc. The cost-based approach is particularly effective for regulating services such as flood control, pest management, water purification, etc., which are difficult to monetize directly but critical for sustaining agriculture. Similarly, the benefit-transfer method is typically used for the assessment of carbon sequestration potential, nutrient cycling, etc., while the WTP is conventionally used to capture the societal value of services that lack direct market pricing such as clean water, biodiversity, etc. Likewise, the production function approach evaluates the contribution of ecosystem services to agricultural output, e.g. the impact of natural wetlands in irrigation services, while the replacement cost method finds application in the valuation of degraded ecosystems such as wetlands, watersheds, etc.

Logic of PES in agrifood production systems

Case studies from Indian agriculture

Monetizing ES within Indian agriculture has been explored through various initiatives, notably PES schemes and agroforestry practices. In 2010, the Village Forest Development Society and the Palampur Municipal Council established India's first PES agreement. This rural-urban partnership focuses on the sustainable supply of water and the protection of the catchment area, with downstream beneficiaries compensating upstream communities for conservation efforts. PES was also inducted to incentivize farmers towards the adoption of non-burning methods of residue management in Punjab and Haryana. Under the program, conditional cash transfers of up to ₹ 2,000 per acre were made which led to a verifiable 15% reduction in crop residue burning. This not only reduced pollution levels but also provided farmers with supplemental income. Likewise, in the Kuhan village of Himachal Pradesh, a community-driven PES model enhanced water availability by promoting soil and water conservation practices. Farmers received payments of ₹5,000 annually for implementing measures like terracing, check dams, etc. This initiative led to a 30% increase in irrigation water availability and improved crop yields by 20%, benefitting over 150 households. Similarly, in Uttar Pradesh, Poplar (*Populus deltoides*) has been successfully integrated with traditional crops like wheat and sugarcane. Farmers reported earning an additional ₹ 1.2 lakh/ha annually from the sale of timber, alongside income from crops. Additionally, the agroforestry system sequestered ~5 tonnes of carbon/ha/annum, supporting climate change mitigation. The carbon sequestered over private lands may act as a suitable source of carbon crediting. Analogously, the 'Wadi' agroforestry model, developed by the BAIF Development Research Foundation, has been implemented in tribal-dominated regions of Gujarat and Maharashtra. This model combines fruit orchards with forestry species on smallholder plots. Participating farmers earned an additional ₹25,000 per ha per annum from fruit sales, with the potential for timber income after 10 years. The model demonstrated a 15% increase in soil organic matter over five years and significantly improved the region's biodiversity. Other key monetization ventures for ES include (i) the *Mid-Himalayan Watershed Development Project of Himachal Pradesh*, where degraded watersheds were restored through afforestation and sustainable land, following community engagement, (ii) *Community managed mangrove conservation and management initiatives* in Orissa and Tamil Nadu for coastal protection and support for fisheries, (iii) *East Kolkata Wetland project* in West Bengal where sewage is naturally treated while supporting local livelihoods through fisheries and agriculture, etc.

Policy implications

Following integration of the valuation of ES into decision-making frameworks, PES offered a pathway to balance productivity, environmental stewardship and economic equity and has the potential to revolutionize agricultural sustainability in India. Monetizing ES ensures that the intrinsic value of natural systems such as water regulation, carbon sequestration, soil fertility, etc., is formally recognized in the policy frameworks. This approach shifts the focus of agricultural policies from maximizing short-term yields to ensuring long-term ecological and economic sustainability. One such example is India's National Agroforestry Policy (2014) which explicitly links agroforestry practices with ecosystem benefits, incentivizing farmers to adopt tree-based systems that enhance carbon sequestration and assist in biodiversity conservation. Another example is the recently launched Green Credit Program (GCP) of the *MoEFCC*, GOI under the National Mission for a Green India. Two of the green credits (GC), namely, (i) Tree plantation-based, and (ii) *Sustainable agriculture-based*, under this scheme are in direct alignment with sustainable agriculture. The first GC aims to promote activities for increasing the green cover across the country through tree plantation and related activities, while the latter intends to support natural and regenerative agricultural practices and land restoration to improve productivity, soil health, and nutritional value of food produced. Additionally, it has also attracted private sector investment into sustainable agriculture, e.g., corporate social responsibility (CSR) funds can be directed toward PES initiatives, linking environmental conservation with economic gains.

Potential for scaling up

Scaling up PES programmes requires the assurance that the producer groups see tangible benefits. Making farmers understand the quantifiable gains such as an increase in crop productivity following a specific water management practice, etc., is required to ensure widespread adoption. Likewise, the transaction cost, which covers the expenses of monitoring, verifying, and enforcing PES contracts, must be reduced. This otherwise can prove to be a significant barrier to scaling up of PES. Leveraging technology, such as satellite imagery for monitoring and blockchain for transparent payments, can reduce these costs. One such example is the *Bhungroo* Water Harvesting System in Gujarat where blockchain is utilized to track water usage and incentivize its equitable distribution among smallholders. Also, Current PES programs often focus on narrowly defined ecosystem services, such as carbon credits. Broadening the scope to include services like pollination and pest control can encourage participation from farmers cultivating high-value crops. Finally, scaling up PES programs requires robust institutional frameworks that can manage payments, monitor compliance, and mediate conflicts. India's decentralized governance system offers a potential model for local PES implementation. Capacity-building efforts, such as training programs for local governance bodies, can facilitate smoother implementation.

Challenges

Significant challenges also persist in monetizing ES, primarily in the agri-sector. These are due to data

scarcity and the absence of standardized quantification methods. The lack of comprehensive and reliable data hampers accurate valuation of ES, complicating the establishment of baseline values essential for effective PES programs. This deficiency often leads to inconsistent assessments, undermining the credibility of valuation efforts. Moreover, the absence of universally accepted procedures for measuring ES further exacerbates these issues, resulting in varied and sometimes conflicting valuation outcomes. This inconsistency poses difficulties in policy formulation and the implementation of PES schemes, as stakeholders may question the legitimacy of the valuations. Additionally, monetization mechanisms can inadvertently perpetuate or exacerbate social inequities. Without careful design, PES programs may favor wealthier landowners who have more resources to participate, thereby marginalizing smallholder farmers and indigenous communities who are often the primary stewards of ecosystems. This disparity can lead to unequal distribution of benefits, with marginalized groups receiving minimal compensation despite their significant contributions to ecosystem conservation. Furthermore, the commodification of ecosystem services may overlook the cultural and spiritual values that local communities attach to natural resources, leading to conflicts and social tensions. Further, many PES programmes rely on international or CSR funding, which can be inconsistent. Establishing dedicated national funds could ensure long-term sustainability.

Way forward and recommendations

Integrating the monetization of ES into India's agrifood systems necessitates a multifaceted approach that combines policy innovation, technological advancement, and active stakeholder engagement. A critical first step involves the comprehensive valuation of ES within agricultural landscapes, recognizing both marketable and non-marketable services. Developing a unified framework with standardized methodologies, say a National PES Policy, that integrates PES into national agricultural and environmental policies would provide consistency and scalability. This valuation should inform the development of incentive structure, to encourage sustainable agricultural practices. One such example is The Economics of Ecosystems and Biodiversity (TEEB) AgriFood initiative in Uttar Pradesh which has demonstrated the importance of incorporating the value of ecosystem services into agricultural policies to promote sustainability. Secondly, public-private partnerships (PPPs) play a decisive role in this integration. By mobilizing resources and fostering innovation the PPP initiatives can ensure scalability. Collaborations between government entities and private stakeholders can lead to the development of sustainable agricultural practices that are both economically viable and environmentally sound. Thirdly, leveraging technological interventions is also essential for the effective implementation and monitoring of ES monetization. Utilizing remote sensing, geographic information systems and data analytics can enhance the precision of ES assessments and facilitate real-time monitoring of agricultural practices. These technologies enable the accurate valuation of ecosystem services, ensure compliance with sustainable practices, reduce transaction costs, and strengthen monitoring & verification, thus, improving overall transparency and building trust among stakeholders. Lastly, engaging local communities to ensure the integration of traditional knowledge into sustainable practices, and that the benefits of ES monetization are equitably distributed are prerequisite. Conducting awareness campaigns highlighting the financial and ecological benefits of PES, targeting both farmers and policymakers are also obligatory. Engaging local communities in the valuation process and recognizing their traditional knowledge can enhance the accuracy of ES assessments and promote social equity and trust. Additionally, integrating cultural and spiritual values into PES programmes can ensure that monetization efforts align with the socio-cultural contexts of the communities involved. This shall foster greater acceptance and effectiveness of such initiatives.

SUMMARY

Ecosystem Services are the backbone of sustainable agrifood systems, particularly in the Indian context. ES, including provisioning, regulating, supporting, and cultural services, underpin agricultural productivity and ecological balance. Monetizing these services through PES mechanisms attaches economic value to benefits derived from ecosystems, encouraging sustainable agricultural practices. PES, which aligns with multiple national and international goals such as India's NDCs and UN SDGs, promotes environmental stewardship in agricultural practices and policies. The valuation methods such as market-based approaches, cost-based valuations, WTP models, etc., enable the quantification of ES. Pilot studies across India demonstrate the success of PES, such as improved water availability and crop yields via integration of apt water conservation methods in Himachal Pradesh, additional farm income from timber and sequestered carbon via agroforestry in Uttar Pradesh, etc. These programs highlight the dual benefits of economic resilience and ecological sustainability. Despite its potential, challenges persist, including data scarcity, lack of standardized measurement methods, and risks of inequity in PES mechanisms, often marginalizing small farmers. Addressing these requires robust data systems, inclusive policies, and community involvement. The way forward involves the development of a comprehensive National PES Policy, leveraging public-private partnerships, and employing technologies like GIS and blockchain for assessment, monitoring, and verification. Moreover, engaging local communities and recognizing their traditional knowledge shall ensure equitable benefit distribution and cultural alignment, fostering sustainable agricultural practices across the country.

*Corresponding author email: merajiari@gmail.com