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Building Livelihood Resilience through Participatory Action Research and a Circular Economy Model for Female-Headed Farming Households

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ABSTRACT
Background: Female heads of households in rural areas face economic vulnerability due to limited access to productive resources and high dependence on household food expenditures. In rural households, the potential of kitchen waste and yard land has not been managed in an integrated manner.
Purpose of the Study: This article aims to analyse the implementation of a community service program based on a circular economy through the integration of native chicken (layer) farming, kitchen waste management, and micro-vegetable gardens for female heads of households.
Methods: The community service program used a Participatory Action Research (PAR) approach, involving participants as active subjects in problem identification, action planning, implementation, and reflection. Data were collected through participatory observation, FGDs, interviews, questionnaires, and production records.
Results: The results showed a Hen Day Production rate of 70–80%, additional income of Rp 180,000–Rp 390,000 per month, and savings on vegetable purchases of Rp 40,000–Rp 60,000 per month. The integration of activities formed a circular economy flow that strengthened household economic and food resilience.

Keywords
Circular economy; Free-range laying hens; Female head of household; Micro vegetable garden; Participatory Action Research

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Introduction

Household poverty in rural areas of Indonesia remains a multidimensional issue that is not only associated with limited income, but also with unequal access to productive resources, food security, and household-level environmental management capacity (Suharto, 2005). One of the groups facing the highest level of vulnerability in this context is female-headed households, who often bear economic and social responsibilities simultaneously while having limited access to assets, capital, and social networks.

Karanganyar Regency, as an agrarian region, possesses considerable local resource potential in the form of small-scale household livestock farming, yard land, and relatively abundant household kitchen waste. However, these resources have not yet been managed in an integrated and sustainable manner. Household kitchen waste is generally discarded as garbage, while small-scale native chicken (layer) farming tends to rely heavily on commercial feed, resulting in high production costs. As a result, opportunities for economic efficiency, income enhancement, and the strengthening of household food security have not been optimally utilised.

The circular economy approach offers a relevant conceptual framework to address these challenges through resource cycle optimisation, waste reduction, and value creation based on local potential (Kirchherr et al., 2017). In the context of rural households, a circular economy can be realised through the integration of kitchen waste management, native chicken (layer) farming, and the use of yard land for micro-vegetable gardens. Such integration enables household waste to be recycled into production inputs in the form of feed and organic fertiliser, while simultaneously generating food and additional income in a sustainable manner.

A number of community service initiatives and applied research studies in Indonesia indicate that integrated farming systems based on zero-waste principles, namely the reutilization of production waste, have the potential to increase household income while improving environmental quality (Wiranata, 2024; Wrihatnolo & Dwijowijoto, 2007). Nevertheless, most of these practices remain focused on sectoral and technocratic interventions, such as livestock or gardening programs implemented separately, without a comprehensive, sustainable circular-economy framework. Moreover, the empowerment approaches employed are generally top-down in nature, limiting community participation, particularly that of female heads of households, to the program's implementation stage.

Conversely, the Participatory Action Research (PAR) approach has been widely applied in community empowerment programs to promote participation, critical reflection, and social change. However, the explicit integration of PAR with a circular economy framework at the rural household level remains relatively underexplored, especially in the context of female-headed households in Indonesia. This is notable, given that this group occupies a strategic position in household food management, waste handling, and domestic economic decision-making. This condition indicates a research and service gap at the intersection of PAR, circular economy concepts, and the empowerment of female-headed households as key agents of social and economic transformation in rural areas.

In this context, the circular economy approach is operationalized through the integration of native chicken (layer) farming, micro-vegetable gardens, and kitchen waste management into a unified household ecosystem. This integrated model is considered more effective than stand-alone livestock programs because it creates functional linkages among production subsystems within a single household. Independent livestock programs commonly face constraints, including high feed costs, dependence on external inputs, and economic risks from production and price fluctuations. In contrast, integration with yard-based vegetable gardens and kitchen waste management enables cost efficiency through the use of organic waste as fermented feed and fertiliser, diversification of food and income sources, and the strengthening of household food security. Accordingly, the integrative model of native chicken farming–micro-vegetable gardening–kitchen waste

management not only enhances economic productivity but also reinforces ecological sustainability, household self-reliance, and livelihood resilience among female-headed households in rural areas.

Based on the identified gaps in community service practice and applied research, this article aims to describe and analyse the implementation of a circular economy–based community service model through the integration of native chicken (layer) farming, micro-vegetable gardens, and kitchen waste management for female-headed households in Karanganyar Regency using a Participatory Action Research (PAR) approach. Specifically, this article seeks to (1) demonstrate how the PAR approach strengthens the engagement, capacity, and sense of ownership of female heads of households in managing a household-scale circular economy system, and (2) analyze the effectiveness of the integrative poultry–home garden–waste management model in enhancing economic resilience, food security, and the sustainability of rural household livelihoods.

Through these objectives, this article is expected to contribute both practically and conceptually to the development of community service models that position female-headed households as primary agents of change, while also enriching the discourse on participatory circular economy implementation at the rural community level.

Method

Approach and Community Service Design

The Participatory Action Research (PAR) approach in this community service program was oriented toward participatory learning processes and community capacity building. Accordingly, the program design was not intended to test causal relationships through experimental methods, but rather to document empowerment processes and their impacts. The PAR approach was implemented by integrating research, action, and reflection in a participatory manner. This approach was selected because it positions female-headed households as primary subjects of change rather than passive program beneficiaries, and enables social transformation grounded in everyday experiences and practices.

Subjects and Location of Community Service

The community service activities were conducted in Karanganyar Regency, Central Java, involving five female heads of households as the primary participants. Participants were selected using purposive sampling based on the following criteria: (1) having the status of a female-headed household, (2) economic dependence on the informal sector, (3) access to household yard land, and (4) willingness to participate in all stages of the community service program. The program was implemented over a five-month period, from June to October 2025.

Stages of Participatory Action Research–Based Community Service

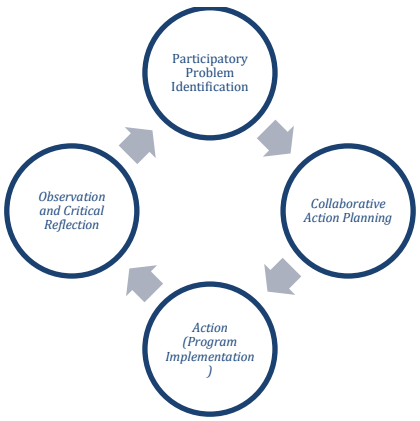

Figure 1. PAR-Based Community Service Cycle

The Participatory Action Research (PAR) approach in this program was applied contextually in conjunction with circular economy principles, whereby participants were involved not only in the social processes of empowerment, but also in the design, management, and evaluation of household-level resource utilisation flows. Each PAR stage was designed to foster participants' awareness of the cyclical relationships among waste, production, and consumption within the household economic system.

Problem Identification Stage

At the problem identification stage, the primary tool employed was household resource flow mapping, covering the types and volume of kitchen waste, food consumption patterns, livestock feed costs, and the use of yard land. This tool was implemented through focus group discussions (FGDs) and reflections on lived experiences. Through these processes, participants collectively identified inefficiencies and underutilised opportunities for resource reuse within their households.

Action Planning Stage

The action planning stage involved participants in co-designing an integrated circular economy model tailored to each household's context and capacity. Together with the community service team, participants developed schemes to utilise kitchen waste as fermented feed and compost, manage native chicken (layer) farming as a source of egg production and manure, and use yard land for micro-vegetable gardens. This planning process emphasised co-design principles, whereby technical and operational decisions were made collaboratively.

Action Implementation Stage

During the action implementation stage, circular economy principles were realised through hands-on practices in managing the integrated household system. Participants actively engaged in kitchen waste processing, native chicken (layer) rearing, and the use of livestock outputs and compost for micro-vegetable gardens. This stage was accompanied by intensive facilitation to ensure that circular resource flows operated as planned, while also allowing for adaptive adjustments based on participants' experiences.

Observation and Reflection Stage

The observation and reflection stage was conducted periodically by combining production record-keeping, reflective discussions, and participatory evaluations of the functioning of the circular economy system. Participants were encouraged to assess changes in production costs, income levels, food expenditure savings, and environmental impacts resulting from the implemented practices. These reflections formed the basis for subsequent improvements, enabling PAR to function as an iterative learning process in the management of household-scale circular economy systems. Overall, the application of PAR within a circular economy framework in this community service program served not only as a participatory approach but also as a collective learning mechanism, enabling female-headed households to develop sustainable production and consumption systems based on resource reuse.

Data Collection and Analysis Techniques

Data were collected through participatory observation, reflective interviews, focus group discussions (FGDs), pre- and post-program questionnaires, and production records of egg output and micro-vegetable garden yields. Data analysis was conducted using a descriptive qualitative approach and simple quantitative analysis. Qualitative data were analysed through thematic categorisation of interview and reflective discussion results, while quantitative data were analysed by comparing pre- and post-program conditions across indicators of egg production, household expenditure savings, and potential additional income.

Ethical Considerations

The implementation of the community service program adhered to participatory ethical principles, including voluntary informed consent, egalitarian relationships between the community service team and participants, and respect for the lived experiences of female heads of households. All PAR processes were conducted dialogically to avoid top-down approaches.

Result

Participant Engagement in the Participatory Action Research Cycle

The implementation of the community service program demonstrated the active engagement of female heads of households across all stages of the Participatory Action Research (PAR) cycle, from problem identification to evaluative reflection. All participants were involved in focus group discussions (FGDs), action planning, activity implementation, and periodic recording of production outcomes. Participant attendance was consistently documented in each session, including during decision-making processes related to livestock management, kitchen waste utilisation, and the development of micro-vegetable gardens.

Figure 2. Participatory action planning with female heads of households

During the assessment stage, which employed the household resource flow mapping tool, findings indicated that the economic burden borne by female heads of households was relatively high. This condition was reflected in an imbalance between resource inflows and outflows, with outflows exceeding inflows, compounded by multiple resource leakages. The results of the household resource flow mapping exercise, based on FGD outcomes, are illustrated as follows:

Figure 3. Household resource flow map (adapted from FGD results)

Participatory observation conducted during the assessment stage also provided insights into the participants' living environments, which were generally modest in condition. This is illustrated in the sketch of the household land layout of one participant, as presented below:

Figure 4. Sketch of household land and yard layout (one participant)

Collaborative Action Planning and Technology Selection

Joint action planning with participants resulted in agreement on the selection of appropriate technologies, as outlined below.

1. Native Chicken (Layer) Farming

Given that most participants did not own their residential land and lived on relatively small plots, a battery cage system was selected over a free-range system. The battery cage model was considered advantageous because it requires limited space, is easier to clean, and allows better control of feed intake.

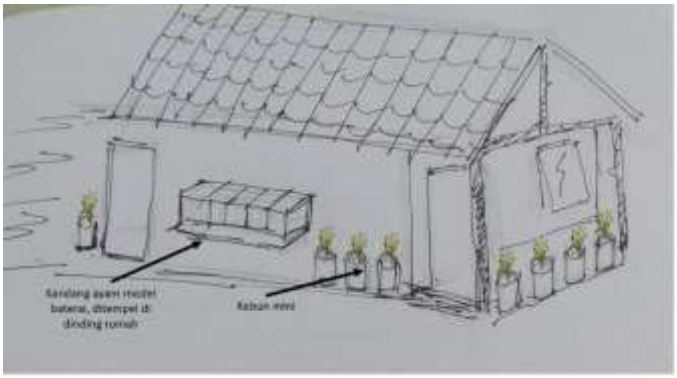

Figure 5. Layout of chicken cages and micro-vegetable garden at one participant's household

2. Micro-Vegetable Gardens

The micro-vegetable gardens were co-designed with participants using reused water gallon containers, complemented by the innovative addition of 1.5-litre plastic bottles to collect household organic waste that could not be directly consumed by chickens or used as maggot feed. These bottles were also used to process chicken manure into organic fertiliser. This innovation functioned similarly to a mini biopore system. A sketch of the micro-vegetable garden design is shown below:

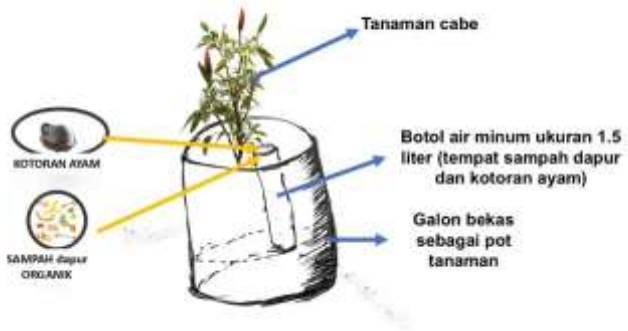

Figure 6. Sketch of the micro-vegetable garden design

Productivity of Native Chicken (Layer) Farming

Each participant managed ten native chickens using a household-scale battery cage system. Based on daily production records, a positive trend in monthly egg production was observed.

Table 1. Egg production of native chickens per participant (June–October 2025)

Month	Ernawati	Tri Rahayu	Tri Wahyuni	Sih Qurniatun	Atik
June	57	45	0	30	0
July	78	86	28	76	7
August	151	103	53	105	30
September	204	128	101	117	95
October	166	160	122	130	107

As shown in Table 1, egg production stabilised after the second month of rearing, coinciding with the chickens' adaptation to the fermented feed and cage environment. Average egg production was 7–8 eggs per household per day. When expressed as the Hen Day Production (HDP) indicator, production performance ranged between 70–80%.

Figure 7. Native chickens in participant-owned battery cages

Household Income from Egg Production

Participant income was derived from the sale of native chicken eggs at an average price of IDR 3,000 per egg.

Table 2. Income from native chicken egg sales per participant (IDR 3,000/egg)

Month	Ernawati	Tri Rahayu	Tri Wahyuni	Sih Qurniatun	Atik
June	171.000	135.000	0	90.000	0
July	234.000	258.000	84.000	228.000	21.000
August	453.000	309.000	159.000	315.000	90.000
September	612.000	384.000	303.000	351.000	285.000
October	498.000	480.000	366.000	390.000	321.000
Average per Month (Post-Production Phase)	393.600	313.200	228.000	274.800	179.250
Total Income for Five Months	**1.968.000**	**1.566.000**	**912.000**	**1. 374.000**	**717.000**

Table 2 indicates an increase in income during the June–October 2025 period, with variations across participants influenced by the initial production phase and the level of livestock adaptation. Average monthly income ranged between IDR 180,000 and IDR 390,000 after the chickens entered the production phase.

Figure 8. Eggs produced by female-headed households

Micro-Vegetable Garden Outputs and Household Expenditure Savings

The utilisation of household yards as micro-vegetable gardens produced horticultural commodities such as chilli, tomatoes, and eggplant.

Table 3. Harvest outputs and economic impacts

Participant Name	Number of Plants	Harvest Status	Tangible Impacts
Atik	22 plants	Frequent harvest	Sold 1 kg of chilli, self-consumption, saved on chilli purchases for one month.
Sih Qurniatun	22 plants	Frequent harvest	Sold 0.5 kg of tomatoes, self-consumption; saved on chilli purchases for one month.
	~33 plants	Harvested	Total tomato harvest of approximately 1 kg; chilli harvest of approximately 100 g per picking.
Tri Rahayu	4 plants	Tomato harvest	Self-consumption (tomatoes used for household cooking).
Parti Ernawati	2 plants	Not yet harvested	Plants are healthy and beginning to flower.

As presented in Table 3, monitoring results indicate savings in vegetable expenditures of IDR 10,000–15,000 per week, equivalent to IDR 40,000–60,000 per month per household. Some participants had reached a routine harvesting stage, as illustrated in Figure 5 showing the micro-garden of Mrs Sih Q, while others remained in the plant growth and flowering stages.

Figure 9. Micro-vegetable garden in a gallon-bottle media ready for harvest

Ecological Footprint within the Circular Economy System

The integration of kitchen waste management, native chicken (layer) farming, and micro-vegetable gardens formed a closed-loop circular economy system at the household level. Kitchen waste was processed into fermented feed and compost, chickens produced eggs and manure, and the manure was reused as organic fertiliser for micro-vegetable gardens. This integration reduced dependence on external inputs while lowering household waste volumes.

Figure 10. Circular economy flow diagram

The findings indicate that these three components formed a mutually reinforcing system. Kitchen waste management served as the entry point of the cycle by providing alternative feed and compost, thereby reducing feed costs and enhancing the sustainability of native chicken farming. Chickens functioned as the primary production node, generating eggs as a source of food and income, as well as manure. The manure was subsequently utilised as organic fertiliser for micro-vegetable gardens, contributing to household savings on food expenditure and strengthening food security.

This integration created a closed production–consumption cycle that reduced waste, lowered production costs, and diversified household income and consumption sources. Accordingly, the system functioned not only as an income-enhancement strategy but also as an adaptive mechanism for strengthening the economic and food resilience of female-headed households.

From an environmental sustainability perspective, the ecological footprint was estimated based on two components: native chicken manure production and household organic waste generation. Estimates of chicken manure production were based on general poultry waste data, which indicate approximately 80–120 grams per chicken per day (FAO, 2013). With ten chickens per household, this amounted to approximately 0.8–1.2 kg of wet manure or 0.3–0.5 kg of dry manure per day, equivalent to 24–36 kg of wet manure or 9–15 kg of dry manure per month. At the group level (five households), this totalled approximately 120–180 kg of wet manure or 45–75 kg of dry manure per month. All manure produced was processed into organic fertiliser for micro-vegetable gardens through simple treatment methods, resulting in no residual livestock waste.

Meanwhile, participatory survey results indicated that each household generated approximately 0.5–1 kg of organic kitchen waste per day, equivalent to 15–30 kg per month. At the group level, this amounted to 75–150 kg of organic waste per month. By processing organic waste into fermented feed and compost, an estimated 75–150 kg of organic waste per month was effectively managed, reflecting improved resource-use efficiency. These findings demonstrate that integrating native chicken farming, micro-vegetable gardens, and kitchen waste management not only enhances household income and food security but also provides measurable ecological benefits by reducing organic waste and reusing nutrients within a closed production cycle.

Progress Achieved through Community Service Implementation

The community service team does not claim that full social transformation occurred during the implementation period. Rather, the program facilitated incremental progress, as described above, which serves as a foundation for the broader social transformation objectives of community service based on Participatory Action Research. A comparative table is presented below to illustrate changes in conditions before and after program implementation.

Table 4. Comparison of conditions before and after the community service program

Aspect	Condition Before the Program	Condition After the Program
Economic – Household Income	No additional income sources based on household assets; reliance on informal sector employment with unstable earnings.	Additional income generated from the sale of native chicken eggs amounts to IDR 180,000–390,000 per household per month.
Economic – Food Expenditure	Relatively high routine expenditure on daily vegetable purchases.	Savings of IDR 40,000–60,000 per month through micro-vegetable gardens.
Local Asset Productivity	Household yard land and kitchen waste were not optimally utilised; kitchen waste was treated as household trash.	Yard land utilised as micro-vegetable gardens; kitchen waste processed into fermented feed and compost
Production System	Livelihood activities were conducted separately and in a non-integrated manner (e.g., poultry farming operated independently without utilising kitchen waste).	An integrated circular economy system established, linking poultry farming, kitchen waste management, and micro-vegetable gardening.
Household Food Security	Food access depended on the market and was vulnerable to price fluctuations.	Household food availability increased through self-produced eggs and vegetables.
Capacity and Skills	Participants lacked skills in poultry care, vitamin production for chickens, and vegetable cultivation.	Improved technical skills in poultry farming, micro-vegetable gardening, production of amino acids and probiotics for chickens, and practice-based waste management.
Participation and Social Roles	Female heads of households tended to act as program or aid recipients.	Participants became active subjects in planning, implementation, and evaluation through the PAR approach.
Social Capital and Self-Confidence	Limited social interaction and economic networks.	Increased self-confidence, solidarity, and social capital through regular discussions and collective marketing activities.

Participant Reflections and Lived Experiences

To complement the quantitative findings, this study also captured participants' reflective experiences throughout the circular economy integration process. Participant narratives revealed shifts in perspectives regarding waste management, livestock farming, and the utilisation of

household yards.

One participant explained the tangible impact of using kitchen waste as fermented feed on the sustainability of livestock farming:

> "Previously, kitchen leftovers such as vegetable scraps and rice were simply thrown away. Now they can be used as chicken feed. Feed costs are lower, and the chickens continue to lay eggs regularly."*(Sih Qurniatun, Lalung, Karanganyar)*

Another participant highlighted the interconnection between livestock and micro-vegetable gardens in meeting household food needs:

> "It feels very satisfying to collect the eggs. The chicken coop does not smell because I use maggots. The leftover maggots are used as fertiliser for my chilli plants, so I no longer need to buy commercial fertiliser. Everything is supplied from home." *(Sri Tri Rahayu, Jongke, Karanganyar)*

Beyond economic impacts, participants also experienced increased self-confidence and pride:

> "Now I feel proud because I have my own business. The eggs can be sold or cooked for my children, and the vegetables can be harvested directly. Sometimes I even give them to neighbours when they ask. I'm also happy because many neighbours have started planting chilli in their yards, and I enjoy teaching them." *(Parti Ernawati, Jati, Karanganyar)*

One participant also demonstrated creative experimentation in chicken farming, despite encountering initial failure:

> "Yesterday I tried to make an incubator from a cardboard box and attempted to hatch five eggs. Unfortunately, the temperature inside the box was too high, and the eggs ended up cooked." *(Tri Wahyuni, Ngringo, Karanganyar)*

These narratives indicate that the integration of a circular economy system implemented through Participatory Action Research not only generated material benefits but also strengthened the subjective capacities of female-headed households to manage household resources independently and sustainably.

Discussion

Effectiveness of the Participatory Action Research Approach in Empowering Female-Headed Households

The effectiveness of the Participatory Action Research (PAR) approach in empowering female-headed households in this program is empirically reflected in participants' active engagement across all stages of the service-learning cycle. During the problem identification phase, participants collaboratively mapped household resource flows, including kitchen waste, livestock feed costs, and the utilisation of home yards, which subsequently formed the basis for action planning. This process resonates with the findings of Kanyagui et al. (2024), whose PAR work with women's self-help groups in rural India also began with collaborative identification of core livelihood challenges. At the planning stage, the PAR approach facilitated the collective formulation of context-specific technical decisions, such as selecting a battery cage system and designing micro-vegetable gardens using recycled water gallons. These decisions reflect a co-design process that considered spatial constraints, housing status, and participants' capacities, positioning female heads of households as primary decision-makers rather than mere program implementers.

The effectiveness of PAR was further evident during the implementation and reflection phases, where participants made experience-based adjustments, including the production of fermented feed, the utilisation of maggots, and the use of livestock manure as fertiliser. The

emergence of independent initiatives and small-scale experimentation indicates the development of reflective capacity and willingness to innovate, both of which are key indicators of empowerment. This aligns with the core PAR principle of iterative learning and action for transformative change, as articulated in the Just Transitions PAR Implementation Framework, which highlights reflection and iteration as a core element for fostering meaningful change (Fochesatto et al., 2026).

Beyond technical and economic outcomes, PAR also generated subjective transformations, including increased self-confidence, pride, and enhanced social roles within the community. Reflective narratives reveal a shift in the positioning of female-headed households from program beneficiaries to resource managers and knowledge-sharing agents. These findings affirm that PAR is effective not only in improving economic outputs but also in transforming social relations and bargaining positions of vulnerable groups, in line with the PAR framework articulated by Kemmis (2014). However, it is critical to engage in reflexive practice regarding the power dynamics inherent in such university-community partnerships. As noted by Fochesatto et al. (2026), without intentional, justice-centred adaptations, participatory research risks reinforcing the very exclusions it aims to challenge. While our co-design process aimed for equity, a deeper, longitudinal analysis of decision-making authority and knowledge ownership is needed to fully assess the transformative depth of participation achieved.

Household-Scale Circular Economy Model in a Rural Context: Achievements and Conceptual Boundaries

The implementation of a circular economy model through the integration of native laying chicken farming, kitchen waste management, and micro-vegetable gardens demonstrates that principles of resource circulation can be applied effectively at the rural household scale. Productivity outcomes of native laying chickens indicate that systems based on local resources can operate successfully despite limited capital and technological inputs. The utilisation of kitchen waste as feed and fertiliser reduced dependence on external inputs while lowering production costs, aligning with the principle of resource efficiency central to the circular economy concept (Kirchherr et al., 2017).

Compared to previously reported zero-waste integrated farming practices (Wiranata, 2024; Wrihatnolo & Dwijowijoto, 2007), the primary contribution of this program lies in explicitly strengthening the participatory and community engagement dimensions as the core of the service-learning process. However, it is crucial to delineate the conceptual scope of our intervention. This five-month pilot with five households established a functional, household-level circular resource loop, a vital micro-foundation for a circular economy. A full-fledged circular economy, however, entails systemic transformation across value chains, waste management infrastructure, and supportive policies (Kirchherr et al., 2017). Our model, while promising, operated within significant constraints. Similar to the barriers identified by Tantoh et al. (2026) in South Africa, structural factors, such as limited land ownership (as most participants did not own their plots) and a lack of integrated gender perspectives in local agricultural programs, pose formidable challenges to scaling and sustaining these micro-practices into a robust circular system.

Navigating Resilience and Vulnerability: A Critical Appraisal of the Integrated Model

From a livelihood resilience perspective, household resilience is not solely measured by income increases but by the capacity of livelihood systems to absorb shocks (absorptive capacity), adapt to change (adaptive capacity), and enable long-term transformation (transformative capacity) (Folke, 2006; Speranza et al., 2014). Findings from this program indicate that integrating a circular resource system contributed to all three dimensions, yet also reveal potential vulnerabilities that

must be acknowledged.

In terms of economic resilience, diversifying food and income sources through egg production and micro-vegetable gardens reduced immediate household reliance on markets for some staples. The utilisation of kitchen waste and livestock manure lowered variable costs, thereby enhancing the capacity to absorb small-scale economic shocks. This mirrors findings from Ethiopia, where participatory seed potato management led to significant cash earnings and livelihood diversification for women farmers (Oumer et al., 2014). However, our model may also create new dependencies and risks. Concentrating on a single type of poultry increases the risk of disease outbreaks. Furthermore, as observed in Malawi, collective action and external support are often key to resilience (Suh et al., 2025); our program's end raises questions about the durability of benefits without ongoing facilitation and access to veterinary or market networks.

At the social resilience level, the PAR approach strengthened adaptive capacity through participatory decision-making and knowledge exchange, fostering ownership and social capital. This trust-based social capital is a key element for sustaining local practices (Putnam, 2000) and aligns with strategies employed by female-headed households in Zimbabwe, who leverage social networks as a critical drought-coping mechanism (Siambale et al., 2025). Yet, social capital alone cannot overcome structural barriers. As a synthesis of female-headed household vulnerability research confirms, limited access to finance, land, and technology remains a pervasive source of vulnerability (Surahman et al., 2026). The self-confidence gained must be matched with changes in the enabling environment.

From an ecological perspective, the application of circular principles enabled nutrient reuse and organic waste reduction within a closed household cycle. However, the claim of reduced ecological footprint, while directionally correct, is based on estimates. A comprehensive life-cycle assessment was beyond the scope of this short-term intervention. The model's ecological sustainability is also contingent on continued proper management to prevent nuisance or pollution from concentrated waste and manure in a small space.

Social Implications, Structural Constraints, and Pathways Forward

In addition to economic impacts, the program generated meaningful social changes, including increased self-confidence, solidarity, and strengthened peer networks. However, these positive subjective changes exist within a context of deep-seated structural inequalities. The experiences of agrarian women in Vietnam and Tanzania highlight how gender norms, limited land access, and gender-blind policies fundamentally constrain resilience-building capacity (Tran et al., 2025; Awoke et al., 2024). Our participants' achievements are therefore a testament to their agency despite these constraints, not an indicator that the constraints have been removed.

The limitations of this study, its small scale, short duration, and dependence on facilitative support, directly underscore these points. They highlight that household-level technical integration, while necessary, is insufficient for transformative change. Future replication and scaling of PAR-based circular models must be coupled with concerted advocacy and action to address the systemic barriers identified in the literature. This requires:

1. Integration with Gender-Responsive Policies: Linking micro-projects to village-level planning and national policies that secure women's access to land, credit, and extension services, as repeatedly called for in the literature (Awoke et al., 2024; Tantoh et al., 2026).
2. Investment in Local Institutions: Strengthening farmer groups or cooperatives to provide ongoing technical support, collective bargaining power, and risk-sharing mechanisms, crucial for resilience as shown in Malawi (Suh et al., 2025).

3. Longitudinal, Critical PAR: Engaging in longer-term PAR cycles that explicitly tackle these structural issues with communities, moving from technical co-design to co-advocacy, guided by frameworks like Just Transitions PAR (Fochesatto et al., 2026).

Conclusion

This community service model, based on a circular economy approach integrating native laying chicken farming, kitchen waste management, and micro-vegetable gardens through Participatory Action Research (PAR), demonstrates effectiveness in strengthening the economic and food resilience of female-headed households in Karanganyar Regency. The approach not only generated economic benefits but also fostered active participant engagement as agents of change throughout all stages of the program.

The experience of this program indicates that household-scale circular economy integration, when combined with participatory and reflective processes, can build food production systems grounded in local assets while simultaneously strengthening social capacity and community ownership. This highlights the importance of participatory approaches that position communities as strategic partners rather than passive beneficiaries. Ensuring the sustainability and scalability of this model requires institutional support at the village level and continued facilitation so that similar community service initiatives can be replicated and adapted to other local contexts.

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