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Agrobiodiversity and local wisdom of indigenous communities in food security in Eastern Priangan, West Java, Indonesia

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Tel.: +62-265-330634, ♥email: abdul.mutolib@unsil.ac.id
[2]Program of Agribusiness, Faculty of Agriculture, Universitas Siliwangi. Jl. Tamansari, Tasikmalaya 46191, West Java, Indonesia
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Abstract. *Mutolib A, Widi RH, Nuraini C, Rahmat A. 2026. Agrobiodiversity and local wisdom of indigenous communities in food security in Eastern Priangan, West Java, Indonesia. Biodiversitas 27 (3): d270318. https://doi.org/10.13057/biodiv/d270318*. Food security remains a persistent global challenge, shaped by population growth, climate change, and increasing pressure on natural resources. In Indonesia, despite exceptional biological and cultural diversity, food systems are increasingly threatened by land conversion, environmental degradation, and dietary homogenization. This study investigates how agrobiodiversity, traditional ecological knowledge (TEK), and social capital contribute to strengthening household food security in Kampung Naga, an indigenous Sundanese community in Eastern Priangan, West Java, Indonesia. A mixed-methods approach was employed, integrating biodiversity inventories, thematic analysis of interviews and participant observations, and a social capital survey involving 50 household respondents. Agrobiodiversity was assessed through species identification across major food categories, while social capital was measured using five dimensions—trust, social networks, social norms, participation, and reciprocity—on a four-point Likert scale. Results show that the community maintains a high diversity of food plant species, including tubers and staple foods, fruits, spices and seasonings, leafy and green vegetables, and vegetables and legumes, which enhance dietary diversity, nutritional adequacy, and livelihood resilience. Traditional ecological knowledge informs sustainable agricultural practices such as intercropping, crop rotation, and food preservation, while ritualized expressions of gratitude embed agriculture within cultural and spiritual values. Household and communal food barns further strengthen food stability and collective risk management. Social capital analysis revealed relatively high mean scores for trust (3.40) and social networks (3.45) on a 1-4 scale, indicating strong interpersonal reliability, dense social ties, and effective cooperation in food-related activities. Together, agrobiodiversity and social capital synergistically reinforce the four dimensions of food security-availability, access, utilization, and stability-forming an integrated, resilient, and socially embedded food system. These findings highlight the enduring relevance of indigenous knowledge and institutions in sustaining food security and suggest that strengthening social capital can serve as a strategic policy entry point for designing inclusive, community-based food security interventions in Indonesia and comparable socioecological contexts.

Keywords: Agrobiodiversity, food security, social capital, Sundanese community, traditional knowledge

INTRODUCTION

Food security continues to be a global concern, closely linked to population growth, climate variability, and pressure on natural resources. Recent reports indicate that more than 9 percent of the world's population still struggles with hunger, while the stability of food systems is increasingly threatened by climate-related shocks and socio-economic pressures (FAO 2021). For Indonesia, a nation recognized for its rich biodiversity, this challenge carries particular significance. The archipelago's diverse ecosystems hold substantial potential for developing sustainable food systems, yet this potential is undermined by rapid land conversion, environmental degradation, and the spread of homogenized modern diets that weaken dietary diversity (Rahmi et al. 2020; Choy and Onuma 2025). Addressing these issues requires innovative approaches that balance ecological sustainability with local cultural practices.

Indigenous communities offer important lessons in this regard, as their traditions often embody a balance between human needs and environmental care (Mutolib et al. 2024). Kampung Naga, an Indigenous Sundanese settlement in Eastern Priangan, West Java, exemplifies such resilience. The community has preserved Traditional Ecological Knowledge (TEK) through a spatial system that separates settlements, rice fields, gardens, and forests. This arrangement reflects not only a cultural choice but also an ecological strategy for sustaining food production and conserving resources (Husodo et al. 2019; Truong 2022). In a time when many rural areas face the pressures of modernization, Kampung Naga's ability to maintain traditional practices demonstrates the continuing relevance of Indigenous wisdom in shaping food security.

The community's food system is strongly supported by biodiversity. A wide range of root crops, fruits, vegetables, and spices form the daily diet, providing both nutritional diversity and resilience against crises. Research suggests that communities relying on varied food sources are better prepared to cope with climate fluctuations and market uncertainties (Murniati and Mutolib 2020; Tchonkouang et al. 2024). Beyond commonly cultivated crops, Kampung Naga also utilizes unconventional food plants such as

edible fern (*Diplazium esculentum*) and yellow burrhead (*Limnocharis flava*), which serve as alternative food sources during lean seasons. Additionally, the Kampung Naga community strengthens food security through traditional food granaries, both at the individual and communal levels (Rahman 2024; Prasetyo et al. 2025). This reliance on biodiversity underscores the importance of local ecological knowledge as a buffer against vulnerability and as a foundation for long-term sustainability.

Equally significant are the cultural practices that regulate food production and distribution. Rituals performed during rice cultivation, the principle of *gotong royong* (mutual cooperation), and restrictions on chemical use illustrate how ecological awareness is embedded within cultural norms (Sumitro et al. 2024). These practices help preserve soil fertility, maintain ecological balance, and strengthen community solidarity (Salfarini et al. 2025; Wardana et al. 2026). Social capital is another vital aspect, reflected in trust, networks, and reciprocity among households. Studies in Indonesia show that communities with stronger social capital are more resilient in ensuring food access and managing collective resources (Toibac et al. 2022; Rusmawati et al. 2023; Yusriadi 2025). Taken together, biodiversity, cultural values, and social ties create a system that sustains food security in ways that modern approaches often overlook.

Despite these insights, existing research has generally examined biodiversity and local culture separately. Prior studies often focus on either ethnobotanical aspects or cultural rituals without fully integrating them into broader frameworks of food security. Although such studies provide valuable descriptive insights, they do not quantify how biodiversity, TEK, and social capital jointly contribute to household food security, nor do they operationalize the mechanisms linking these factors within food systems. Consequently, it remains unclear how their interaction builds a resilient community-based food system. Therefore, this study aims to investigates how agrobiodiversity, traditional ecological knowledge (TEK), and social capital contribute to strengthening household food security in Kampung Naga, an indigenous Sundanese community in Eastern Priangan, West Java, Indonesia. This study advances the literature beyond previous works and provides policy-relevant insights for strengthening Sundanese community-based food security strategies.

MATERIALS AND METHODS

Study area

This study was conducted in Kampung Naga, Salawu Sub-district, Tasikmalaya District, West Java, Indonesia. Kampung Naga is situated in a hilly valley at an elevation of approximately 488 m asl, surrounded by rice fields, forests, and the Ciwulan River, which supports agricultural activities. The site was selected because the indigenous community of Kampung Naga continues to preserve traditional knowledge systems and local wisdom practices in managing natural resources. The indigenous community of Kampung Naga adheres to a traditional cultural system, deliberately limiting engagement with modernization and relying on local resources to meet subsistence and food needs. In 2025, the settlement's population was 286 individuals organized into 102 households. The number of residents does not tend to remain constant from year to year, primarily due to constraints on residential land, which totals only 1.5 ha. The research was carried out from May to August 2025, encompassing preparation, data collection, analysis, and report writing. The location of Kampung Naga is shown in Figure 1.

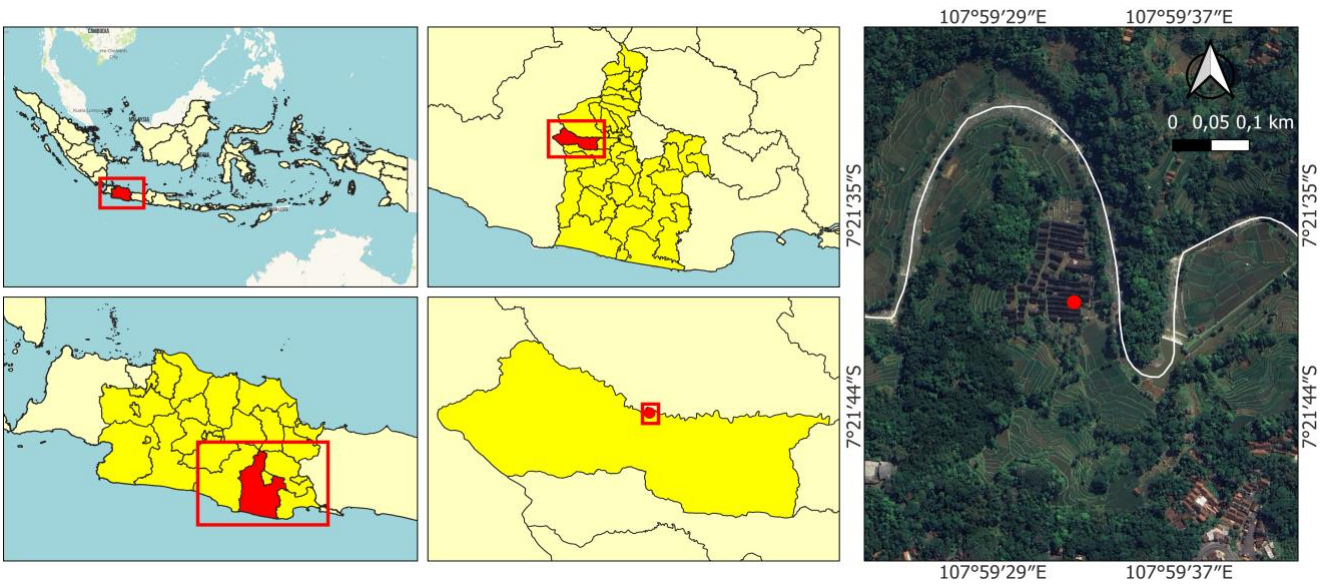

Figure 1. Research area map of Kampung Naga (7°21'39.5"S 107°59'32.5"E), Salawu, Tasikmalaya District, West Java, Indonesia

Research approach and methods

A mixed-methods approach was employed, combining qualitative and quantitative methods. The qualitative component explored the meanings of local wisdom, cultural values, and ecological practices of the community, while the quantitative component measured food biodiversity and household social capital. This integrative approach was chosen to provide a comprehensive understanding of the ecological, social, and cultural factors influencing food security (Creswell and Plano Clark 2018).

Sampling and data collection methods

The total population in the study area (Kampung Naga) consists of 102 households. The selection of respondents in this study employed a purposive sampling method, with the sample size determined using the Yamane formula at a 10% margin of error (Yamane 1967). The sample was determined based on indigenous residents who live permanently in Kampung Naga. Occupational criteria were not considered, as the entire population primarily engages in farming, with equitable participation of both men and women in managing agricultural activities. The research sample size was calculated using the following formula:

$$n = \frac{N}{1 + Ne^2}$$

$$n = \frac{102}{1 + 102(0.1^2)}$$

$$n = 50{,}49 \sim 50$$

Where, n: number of respondents, N: total population/ household (102), e: margin of error (10%).

The respondents' characteristics indicate that 92.5% were female and 7.5% were male. The predominance of female respondents is due to the fact that men usually leave for work from morning until late afternoon, leaving women at home. The average age of the respondents was 52.72 years, suggesting that most respondents are in the productive age range. In terms of formal education, respondents had an average of 6.5 years of schooling, which is equivalent to primary education. Participant observation was employed to document land management practices, local food systems, and traditional rituals, while in-depth interviews with customary leaders, community elders, and household members were conducted to explore cultural values and traditional food practices. A biodiversity inventory was carried out by recording and identifying food plant species across categories, including tubers and staple foods, fruits, spices and seasonings, leafy and green vegetables, and vegetables and legumes. In addition, a social capital questionnaire was administered, structured around five dimensions: trust, social networks, social norms, participation, and reciprocity, using a 4-point Likert scale (Putnam 2000; Forsell et al. 2018).

Data analysis

Agrobiodiversity identification in this study was conducted using the floristic inventory method through field observations and species recording across different habitat types within the Naga Indigenous Village. Interviews with research respondents also complemented the inventory of agrobiodiversity in the Naga community to identify the types of agrobiodiversity cultivated to support household food security, both at the individual and communal levels (Harefa et al. 2023; Sarigu et al. 2025). Questionnaire data were analyzed using descriptive statistics exclusively to identify the maximum, minimum, and mean values for assessing the strength of social capital within the community. The questionnaire comprised Likert-scale statements measuring trust, social networks, norms, reciprocity, and participation (1: strongly disagree - 4: strongly agree); mean scores were categorized into four levels: very low (1.00-1.75), low (1.76-2.50), moderate (2.51-3.25), and high (3.26-4.00). To strengthen the validity of the findings, qualitative and quantitative results were integrated through methodological triangulation, providing a comprehensive understanding of the interrelationship between biodiversity, local wisdom, and household food security (Denzin 2017).

RESULTS AND DISCUSSION

Diversity of local food biodiversity

Biodiversity in Kampung Naga encompasses a wide range of tubers and staple foods, fruits, spices and seasonings, leafy and green vegetables, and vegetables and legumes that not only support community food security but also contribute to the conservation of local ecosystems. Table 1 presents a systematic inventory of plant species as part of documentation and identification for both research purposes and biodiversity conservation.

Table 1 describes the diversity of food plants in the community. Among the 56 documented species (Table 1), 7 are staples and tubers, 16 are fruits, 14 serve as spices and seasonings, 8 are leafy and green vegetables, and 11 are vegetables and legumes. Some species typically considered ornamental or non-staple are also consumed. The diversity of food resources in the study area illustrates the strong linkage between local biological wealth and the traditional ecological practices of the Indigenous community. The inventory shows multiple categories of food plants, including tubers, fruits, leafy vegetables, legumes, and spices. This diversity serves not only as a daily food supply but also as a genetic reserve and a buffer for long-term food security (de la Riva et al. 2023). In addition to the agrobiodiversity presented in Table 1, several complementary plant species were identified, including coconut (*Cocos nucifera*), sugar palm (*Arenga pinnata*), areca palm (*Areca catechu*), and jengkol (*Archidendron pauciflorum*). Although not classified as primary food crops, these species play a supporting role in strengthening local food security. Coconut and sugar palm contribute to food consumption and household income, areca palm reinforces cultural and social cohesion, and jengkol provides plant-based protein that enriches dietary diversity and sustains traditional food systems.

Table 1. Diversity of local food biodiversity

Common name	Local name	Scientific name	Classification
Breadfruit	*Sukun*	*Artocarpus altilis* (Parkinson) Fosberg	Tubers and staple crops
Breadnut	*Kluwih*	*Artocarpus camansi* Blanco	Tubers and staple crops
Cassava	*Singkong*	*Manihot esculenta* Crantz	Tubers and staple crops
Glutinous rice	*Beras ketan*	*Oryza sativa* var. *glutinosa* L.	Tubers and staple crops
Sweet potato	*Ubi jalar*	*Ipomoea batatas* (L.) Lam.	Tubers and staple crops
Taro	*Talas*	*Colocasia esculenta* (L.) Schott	Tubers and staple crops
Yam	*Ubi / gembili*	*Dioscorea* spp.	Tubers and staple crops
Areca palm	*Pinang*	*Areca catechu* L.	Fruits
Banana	*Pisang*	*Musa* × *paradisiaca* L.	Fruits
Coconut	*Kelapa*	*Cocos nucifera* L.	Fruits
Dragon fruit	*Buah naga*	*Selenicereus undatus* (Haw.) D.R.Hunt	Fruits
Durian	*Durian*	*Durio zibethinus* L.	Fruits
Guava	*Jambu biji*	*Psidium guajava* L.	Fruits
Jackfruit	*Nangka*	*Artocarpus heterophyllus* Lam.	Fruits
Kaffir lime	*Jeruk purut*	*Citrus hystrix* DC.	Fruits
Mango	*Mangga*	*Mangifera indica* L.	Fruits
Mangosteen	*Manggis*	*Garcinia mangostana* L.	Fruits
Pineapple	*Nanas*	*Ananas comosus* (L.) Merr.	Fruits
Pomelo	*Jeruk bali*	*Citrus maxima* (Burm.) Merr.	Fruits
Rambutan	*Rambutan*	*Nephelium lappaceum* L.	Fruits
Soursop	*Sirsak*	*Annona muricata* L.	Fruits
Sugar palm	*Aren*	*Arenga pinnata* (Wurmb) Merr.	Fruits
Water apple	*Jambu air*	*Syzygium aqueum* (Burm.f.) Alston	Fruits
Aromatic ginger	*Kencur*	*Kaempferia galanga* L.	Spices and seasonings
Cardamom	*Kapulaga*	*Wurfbainia compacta* (Sol. ex Maton) Škorničk. & A.D.Poulsen	Spices and seasonings
Chili pepper	*Cabai*	*Capsicum annuum* L.	Spices and seasonings
Cubeb	*Kemukus*	*Piper cubeba* L.f.	Spices and seasonings
Galangal	*Lengkuas*	*Alpinia galanga* (L.) Willd.	Spices and seasonings
Ginger	*Jahe*	*Zingiber officinale* Roscoe	Spices and seasonings
Indonesian bay leaf	*Daun salam*	*Syzygium polyanthum* Thwaites	Spices and seasonings
Lemongrass	*Serai*	*Cymbopogon citratus* (DC.) Stapf	Spices and seasonings
Nutmeg	*Pala*	*Myristica fragrans* Houtt.	Spices and seasonings
Pandan leaf	*Pandan*	*Pandanus amaryllifolius* Roxb.	Spices and seasonings
Scallion	*Daun bawang*	*Allium fistulosum* L.	Spices and seasonings
Shallot	*Bawang merah*	*Allium cepa* var. *aggregatum* G.Don	Spices and seasonings
Torch ginger	*Honje / kecombrang*	*Etlingera elatior* (Jack) R.M.Sm.	Spices and seasonings
Turmeric	*Kunyit*	*Curcuma longa* L.	Spices and seasonings
Aloe vera	*Lidah buaya*	*Aloe vera* (L.) Burm.f.	Leafy and green vegetables
Amaranth	*Bayam*	*Amaranthus tricolor* L.	Leafy and green vegetables
Celery	*Seledri*	*Apium graveolens* L.	Leafy and green vegetables
Choy sum	*Caisim*	*Brassica rapa* subsp. *parachinensis*	Leafy and green vegetables
Edible fern	*Pakis*	*Diplazium esculentum* (Retz.) Sw.	Leafy and green vegetables
Mustard greens	*Sawi*	*Brassica juncea* (L.) Czern.	Leafy and green vegetables
Water spinach	*Kangkung*	*Ipomoea aquatica* Forssk.	Leafy and green vegetables
Yellow burrhead	*Genjer*	*Limnocharis flava* (L.) Buchenau	Leafy and green vegetables
Black nightshade	*Leunca*	*Solanum americanum* Mill.	Vegetables and legumes
Chayote	*Labu siam*	*Sechium edule* (Jacq.) Sw.	Vegetables and legumes
Eggplant	*Terong*	*Solanum melongena* L.	Vegetables and legumes
Green bean	*Buncis*	*Phaseolus vulgaris* L.	Vegetables and legumes
Jengkol tree	*Jengkol*	*Archidendron pauciflorum* (Benth.) I.C.Nielsen	Vegetables and legumes
Melinjo tree	*Melinjo*	*Gnetum gnemon* L.	Vegetables and legumes
Peanut	*Kacang tanah*	*Arachis hypogaea* L.	Vegetables and legumes
Pumpkin	*Labu*	*Cucurbita moschata* (Duchesne) Duchesne ex Poir.	Vegetables and legumes
Tomato	*Tomat*	*Solanum lycopersicum* L.	Vegetables and legumes
Winged bean	*Kecipir*	*Psophocarpus tetragonolobus* (L.) DC.	Vegetables and legumes
Yardlong bean	*Kacang panjang*	*Vigna unguiculata* subsp. *sesquipedalis* (L.) Verdc.	Vegetables and legumes

Local wisdom is reflected in the sustained use of alternative staples such as cassava, taro, and sweet potato as complementary foods to rice, indicating an adaptive food system that reduces reliance on a single commodity (Rozaki 2021; Sumarwati 2022; Sagrim 2022). Food diversification based on local potential is a strategic approach

to minimizing vulnerability to food crises. Moreover, the utilization of unconventional food plants (UFPs), such as winged bean (*Psophocarpus tetragonolobus*), edible fern (*Diplazium esculentum*), yellow burrhead (*Limnocharis flava*), and water spinach (*Ipomoea aquatica*) and highlights the importance of ethnobotanical knowledge in expanding access to nutritious food. The sustainability of this practice largely depends on intergenerational knowledge transmission TEK, including intercropping, crop rotation, and the use of home gardens, also strengthens community food security. Non-rice staples based on local tubers remain an integral part of food strategies among Indigenous communities in Eastern Priangan. However, modernization and dietary transitions increasingly threaten the continuity of food biodiversity practices. The shift toward modern diets reduces dependence on local food and leads to declining nutritional quality (Nurhasan et al. 2022). This underlines the importance of revitalizing traditional food systems to remain relevant within the modern food context. From an academic perspective, research on agrobiodiversity and local knowledge has shown significant growth worldwide, particularly in integrating these practices into sustainable food policy (Liu et al. 2022). In Indonesia, Sundanese ethnoecological practices have been proven to support ecological sustainability and household food security (Iskandar et al. 2023).

Thus, food biodiversity and local wisdom in Kampung Naga are not merely cultural heritage but represent concrete strategies for achieving sustainable food security. Strengthening local policies, empowering communities, and promoting community-based research are essential to safeguard traditional food systems amid rapid socio-economic changes (Borelli et al. 2024). This study provides novel and in-depth insights into how the Indigenous community of Kampung Naga establishes food security. Findings from in-depth interviews reveal that the cultural values and social capital underpinning food security have been transmitted across generations and are consciously preserved by the community. Traditional leaders play a crucial role in promoting food security, particularly through the cultivation of local food resources within the village landscape.

Local wisdom in food security

Local wisdom is a system of values and practices transmitted across generations that guides indigenous communities in managing natural resources. In the context of Kampung Naga, Tasikmalaya, local wisdom functions not only as a marker of cultural identity but also as a crucial instrument in supporting food security. Since food security encompasses the dimensions of availability, access, utilization, and stability, local traditions should be regarded as adaptive strategies relevant to contemporary challenges (FAO 2020).

Cultivation of local food crops

The practice of cultivating rice and other local food crops constitutes a fundamental pillar of food security in Kampung Naga. The use of local varieties is motivated not only by consumption needs but also by their resilience to climatic variability and pest attacks. This system supports genetic diversity while reducing reliance on external inputs such as imported seeds and chemical fertilizers (Altieri and Nicholls 2020). The continued use of traditional varieties has been proven to support sustainable intensification without degrading the environment, thereby providing a critical foundation for achieving food self-sufficiency (Pretty and Bharucha 2014).

Living in harmony with nature

The principle of harmony with nature is evident in how the community protects forests, manages water resources, and maintains soil fertility (Muhie 2022; Anikwe and Ife 2023). This principle emphasizes the interdependence between humans and the environment as a prerequisite for sustainability. TEK has been shown to maintain ecological balance and provide the foundation for sustainable farming systems (Berkes 2018). Research on Sundanese Indigenous communities further indicates that local knowledge functions as a conservation mechanism, safeguarding biodiversity and ecological resilience (Iriyani et al. 2024).

Household food barns

At the household level, food barns serve as a strategic instrument for coping with risks such as famine or crop failure. These reserves not only ensure short-term food availability but also reinforce household economic stability. Families that maintain food storage systems are more resilient in the face of price fluctuations and climate variability (Chao 2024; Said 2025). This finding highlights that household barns are not merely physical facilities but also reflect collective awareness of the importance of long-term food security.

Communal food barns

Kampung Naga community maintains a communal food barn measuring approximately 4 × 3 m, centrally located within the settlement. The granary stores rice sourced from voluntary household contributions. There is no mandated quota for donations; any member of the customary community may contribute paddy (unhusked rice) according to their capacity and existing household reserves. This arrangement institutionalizes mutual support while safeguarding a shared stock that can be mobilized during periods of scarcity. Food barns serve as a collective mechanism to strengthen resilience during periods of scarcity. Such systems enhance social solidarity and ensure the fair distribution of food resources, particularly in times of crisis (Fajinmi et al. 2025).

Rituals of gratitude in rice cultivation

The spiritual dimension of local wisdom is reflected in rituals of gratitude performed at each stage of rice cultivation. These rituals connect agricultural activities with religious values, reinforce social cohesion, and instill the understanding that food is a divine gift. Agrarian rituals have been found to regulate agricultural cycles, safeguard ecosystems, and strengthen community solidarity (Kristiansen et al. 2023; Pandey et al. 2024). Thus, rituals of gratitude

function not only as religious expressions but also as socio-cultural instruments that sustain food security.

Collectively, these five forms of local wisdom create a mutually reinforcing system. The cultivation of local food crops ensures availability; harmony with nature sustains ecological integrity; household barns strengthen access; communal barns ensure stability; and rituals of gratitude reinforce value-based utilization. In this way, food security in Kampung Naga is holistic, material, social, cultural, and spiritual. Such an integrated model is highly relevant for sustainable food development, particularly in the face of climate change and global food crises.

Social capital in food security

The measurement of social capital in food security was conducted using five main dimensions: Trust, Social Networks, Social Norms, Participation, and Reciprocity. Each dimension was assessed through several question items reflecting the perceptions and behaviors of community members. Scores were measured using a 1-4 Likert scale, where higher scores indicated greater intensity or strength of social capital. The results of social capital measurement for food security are presented in Table 2.

Table 2 presents the five key dimensions of social capital: trust, social networks, social norms, participation, and reciprocity, which together illustrate the community's collective capacity to sustain local food security. Trust among community members enables effective coordination in food resource management, including cultivation, distribution, and utilization of local food, thereby minimizing the risk of shortages (Munyoro 2025). Social networks facilitate the exchange of information regarding agricultural practices, seed access, and food processing techniques, directly contributing to sustainable food production (Mutolib et al. 2024). Social norms ensure adherence to collective practices, such as maintaining land fertility and prioritizing local food consumption, which guarantees stable food availability (Berkes 2018).

The strength of these dimensions is reflected in tangible community practices. In Kampung Naga, social norms manifest in the tradition of maintaining personal food barns in each household, a practice that is not legally enforced but has evolved into a long-standing cultural obligation passed down for centuries. These individual barns function as a self-reliant mitigation mechanism, allowing households to prevent food scarcity and maintain resilience during lean periods. At the collective level, participation and reciprocity are evident through the communal food barn system, where community members voluntarily contribute rice stocks without formal regulations set by customary leaders. Such voluntary contributions embody solidarity, trust, and shared responsibility, ensuring equitable food distribution and communal preparedness during crises (Holmelin 2021).

Through this interplay, social capital operates as a social mechanism linking local knowledge, collective norms, and cooperative behavior, which strengthens both household and community-level food security. Communities with high levels of trust, cohesive networks, shared norms, active participation, and reciprocity are better equipped to manage food resources sustainably, mitigate shortages, and enhance adaptive capacity in the face of environmental and economic changes.

Discussion

Four interconnected dimensions shape food security

FAO (2006) explains that food security is measured through food availability, food access, food utilization, and food stability. Availability refers to the presence of sufficient quantities of quality food through domestic production or imports. Access concerns individuals' ability to obtain nutritious food through adequate resources and entitlements embedded in social, economic, legal, and cultural systems. Utilization highlights the importance of nutritious diets supported by clean water, sanitation, and healthcare to achieve optimal physiological well-being. Stability requires that availability and access to food are sustained over time without disruptions caused by shocks or seasonal fluctuations. Practically, the food security system of Kampung Naga is strongly rooted in the interaction between local agrobiodiversity, TEK, and social capital. These three elements work together to ensure food availability, access, utilization, and stability within Indigenous ecological and cultural contexts.

Table 2. Measurement of social capital in food security

Dimension	Item	Score	Interpretation
Trust	6	3.41	The level of trust among community members regarding food security is relatively high. The community tends to be reliable and mutually trusting
Social networks	6	3.45	Social relationships among members are strong, with frequent interaction and interconnection
Social norms	6	3.23	Social norms in the community are relatively strong, and members generally adhere to rules and traditions
Participation	6	3.37	The level of participation in community activities is fairly high; members are active in social events and decision-making processes
Reciprocity	6	3.16	Mutual support and sharing are present, though slightly lower compared to other dimensions

Food availability

The community maintains a wide variety of food species like tubers, fruits, vegetables, legumes, spices, and forestry plants that supply essential nutrients and act as genetic reserves for future needs. This diversification enhances resilience to climatic shocks and market instability, consistent with global evidence demonstrating the role of agrobiodiversity in strengthening food availability while preserving ecosystems (Zimmerer and de Haan 2019). Complementary staples such as cassava (*Manihot esculenta*), taro (*Colocasia esculenta*), and yam (*Dioscorea* spp.) reduce dependence on rice and support a consistent food supply (Swiderska et al. 2022). The presence of unconventional food plants (UFPs), including edible fern (*D. esculentum*) and winged bean (*P. tetragonolobus*), further broadens food sources and secures nutrient diversity, particularly during scarcity (Burlingame and Dernini 2019).

Food access

Access to food in Kampung Naga is supported by TEK-based agricultural systems, intercropping, crop rotation, and multifunctional home gardens, which sustain production and secure local entitlements. The community's strong social capital, trust, reciprocity, and collective participation facilitate cooperative cultivation, food sharing, and fair distribution. These social structures operationalize access by ensuring that food is not only produced but also equitably acquired by households. Similar findings globally affirm that social capital increases communities' capacity to maintain food access despite challenges (Aldrich and Meyer 2015).

Food utilization

Food utilization is strengthened by the community's deep ethnobotanical knowledge, which promotes the consumption of nutrient-rich local species and diversified diets reflecting physiological needs. TEK also guides environmentally sound practices that preserve clean water, soil health, and ecosystem services, supporting optimal nutrient absorption and well-being. Rituals linked to rice cultivation reinforce ecological ethics and ensure that agricultural cycles follow natural processes, aligning food utilization with cultural values that prioritize health and harmony with nature (Reyes-García et al. 2019).

Food stability

Stability is achieved through interconnected ecological, cultural, and institutional mechanisms. Household and communal food barns buffer against seasonal shortages and market fluctuations while institutionalizing solidarity and adaptive capacity (Rahman and Ferdousee 2023). TEK acts dynamically to respond to ecological changes, avoiding environmental degradation and protecting long-term food supplies (Gómez-Baggethun et al. 2013). The integration of rituals and collective norms also acts as a cultural safeguard that sustains continuity in production, distribution, and environmental stewardship.

The empirical findings of this study demonstrate that the integration of agrobiodiversity and social capital supports food security in Kampung Naga. Field observations revealed high species richness across agricultural landscapes, directly strengthening food availability by diversifying production and reducing dependence on a single staple. Interviews further indicated that households intentionally cultivate multiple food species to maintain consistent supplies throughout seasonal changes. Descriptive quantitative results showed relatively high social capital values, particularly in trust, reciprocity, and collective participation, which facilitate cooperative farming, food sharing, and equitable access among households. Respondents also highlighted the role of ethnobotanical knowledge in guiding food consumption and preparation, thereby improving utilization through nutritionally diverse diets. Meanwhile, household and communal food barns function as buffering mechanisms against shortages and price fluctuations, reinforcing long-term stability and enhancing overall community resilience. The food security system in Kampung Naga shows important similarities with other Indonesian indigenous communities while retaining unique features. Like the Baduy and Kasepuhan (Tauchid et al. 2022; Lindawati et al 2024; Rahman 2024), it relies on traditional ecological knowledge, diversified agriculture, and strong customary institutions to sustain food availability. This approach promotes stable production and reduces environmental pressure. Additionally, the institutionalized use of communal food barns strengthens long-term reserves and enhances stability. These comparisons indicate that although indigenous food systems share common foundations, localized adaptations play a crucial role in shaping their resilience and sustainability.

Collectively, these findings demonstrate a holistic indigenous model of food security in which agrobiodiversity, TEK, food barns, spirituality, and social capital mutually reinforce availability, access, utilization, and stability. Kampung Naga exemplifies how indigenous food systems contribute to contemporary discussions on sustainability and resilience, especially during climate uncertainty and global food insecurity (Lugo-Morin 2020). Strengthening community-based food security in Indonesia can be guided by empowering indigenous institutions, revitalizing local food systems, and integrating TEK into rural development policies. Further research should empirically quantify the relationships between biodiversity, social capital, and food security outcomes across diverse Indigenous communities in the country.

Limitations and future directions

This study provides a comprehensive exploration of how biodiversity, traditional ecological knowledge, and social capital contribute to food security in Kampung Naga. However, several limitations should be acknowledged. First, the research relied mainly on descriptive qualitative and quantitative approaches without statistically examining causal or correlative relationships among biodiversity, TEK, social capital, and food security outcomes. Second, the study was conducted within a single Indigenous community, which limits the generalizability of the findings to other cultural or ecological contexts. Third, seasonal variations in food availability and consumption were not measured over time, so short-term fluctuations in food

security may not have been fully captured. Fourth, this study recognizes methodological limitations, including purposive sampling that may constrain representativeness and the predominance of female respondents, potentially introducing gender bias. Reliance on self-reported interview data may also affect objectivity. Future research should incorporate structural equation modeling or other inferential methods to quantify interactions among TEK, biodiversity, and social capital. Comparative studies across multiple Indigenous communities and long-term monitoring of seasonal food patterns are also recommended to deepen understanding and support evidence-based policy design for community-based food security systems.

In conclusion, this study revealed that food security in Kampung Naga is sustained through the synergistic interaction of agrobiodiversity, traditional ecological knowledge (TEK), and social capital. The agrobiodiversity inventory documented 56 food plant species, comprising 7 tubers and staple foods, 16 fruits, 1 spice and seasoning, 8 leafy and green vegetables, and 11 fruit vegetables and legumes, indicating a highly diversified local food system. This diversity supports dietary variety, nutritional adequacy, and resilience against climatic and market shocks, particularly by reducing dependence on a single staple crop. Traditional practices, such as intercropping, crop rotation, food preservation, and the maintenance of household and communal food barns, strengthen food availability and stability across seasons.

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