



SUSTAINABLE AGRICULTURE, INDIGENOUS KNOWLEDGE SYSTEMS AND RURAL DEVELOPMENT AMONG INDIGENOUS PEOPLES OF TRIPURA

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ABSTRACT

Tripura's rural economy is closely associated with agriculture, forests, shifting cultivation, livestock rearing, wage labour and other natural-resource-based activities. These livelihood systems are particularly important among the state's Indigenous Peoples, whose social institutions, customary practices and ecological knowledge have developed through long-term interaction with local environments. This article examines the relationship between sustainable agriculture, Indigenous Knowledge Systems and rural development among Indigenous Peoples of Tripura. It adopts a qualitative research methodology based on semi-structured interviews, focus group discussions, participant observation and documentary analysis. The study focuses on Indigenous knowledge related to soil fertility, seed selection, crop diversity, seasonal calendars, pest management, water use, agroforestry, forest conservation and climate adaptation. The discussion indicates that Indigenous Knowledge Systems function as forms of ecological, cultural, social and livelihood capital. Practices such as mixed cropping, local seed preservation, organic nutrient management, home gardening, agroforestry, livestock integration and community-based resource regulation can support food security, biodiversity conservation, climate resilience and livelihood diversification. However, these systems face challenges arising from shortened fallow periods, land-use change, commercialisation, climate variability, youth migration, labour shortages and limited institutional recognition. The article recommends community-led documentation, participatory agricultural extension, community seed banks, women-centred programmes, youth engagement, climate-resilient farming, improved market access and protection of collective knowledge rights. Sustainable rural development in Tripura should combine Indigenous Knowledge Systems with appropriate scientific knowledge while protecting community autonomy, cultural identity and decision-making authority.

KEYWORDS: Sustainable agriculture; Indigenous Knowledge Systems; Indigenous Peoples; rural development; tribal livelihoods; climate resilience; Tripura

1. INTRODUCTION

Rural development in Tripura has historically been shaped by agriculture, forests, shifting cultivation, land availability, rural infrastructure and access to markets. Households in rural areas commonly combine cultivation, livestock rearing, wage labour, collection of forest products, small-scale trade and public or private employment. For Indigenous Peoples, rural development extends beyond income generation. It includes access to land, forests, water, education, health services, roads, markets, political participation and culturally appropriate institutions. Tripura is home to several Indigenous and Scheduled Tribe communities, including Tripuri, Reang, Jamatia, Noatia, Halam, Chakma, Garo, Kuki, Mog, Lushai and others. These communities possess diverse languages, histories, customary institutions and livelihood practices. Official and institutional sources indicate that Scheduled Tribes constitute approximately one-third of the state's population and that agriculture remains an important livelihood activity in tribal regions (Government of Tripura, 2015; Tribal Research and Cultural Institute, 2024). Agricultural practices among Indigenous Peoples of Tripura have historically included shifting cultivation, settled cultivation, mixed cropping, home gardens, livestock rearing, agroforestry and the collection of wild food and non-timber forest products. These practices are not isolated economic activities because they are embedded in social relations, customary rules, food traditions, cultural values and intergenerational learning.

The rural economy of Tripura has undergone considerable transformation. Shifting cultivation has increasingly been supplemented or replaced by settled agriculture, horticulture, rubber cultivation, livestock production, wage employment and other market-oriented activities. These changes have produced mixed outcomes. Commercial agriculture increase market participation and household income, but it also reduce crop diversity, weaken customary institutions, increase dependence on external inputs and expose farmers to unstable prices. Rural development policies therefore need to recognise the ecological conditions, cultural practices and livelihood priorities of Indigenous Peoples instead of applying uniform models of agricultural modernisation.



Indigenous Knowledge Systems refer to knowledge developed through long-term interaction between communities and their local environments. They include practical techniques, ecological observations, systems of classification, oral traditions, customary institutions and cultural values. Among Indigenous Peoples of Tripura, such knowledge include soil classification, seed preservation, seasonal forecasting, mixed cropping, organic nutrient management, home gardening, agroforestry, livestock management and community-based regulation of natural resources.

Sustainable agriculture involves the conservation of soil, water and biodiversity, efficient use of local resources, reduced dependence on harmful external inputs, economic viability and social inclusion (Pretty, 2008). For Indigenous Peoples, sustainability also includes cultural continuity, community autonomy, protection of traditional knowledge and participation in decisions concerning land and natural resources. The study therefore views sustainable agriculture as an ecological, economic, social, cultural and institutional process.

2. OBJECTIVE

The broad objective of the study is to examine the relationship between sustainable agriculture, Indigenous Knowledge Systems and rural development among Indigenous Peoples of Tripura. The specific objectives are to examine the role of Indigenous Knowledge Systems in promoting sustainable agricultural practices among Indigenous Peoples of Tripura; to analyse how sustainable agricultural practices contribute to household food security, income generation, employment and livelihood diversification; to identify the ecological, economic, social, cultural and institutional challenges affecting the continuation and transmission of Indigenous agricultural knowledge; to examine the possibilities of integrating Indigenous Knowledge Systems with contemporary agricultural science, extension services and rural development programmes; and to suggest participatory and culturally appropriate policy measures for strengthening sustainable agriculture, climate resilience and Indigenous livelihoods.

3. RESEARCH QUESTIONS

The study is guided by the following research questions. What role do Indigenous Knowledge Systems play in the sustainable agricultural practices of Indigenous Peoples of Tripura? How do sustainable agricultural practices contribute to household food security, income generation, employment and livelihood diversification? What ecological, economic, social, cultural and institutional factors affect the continuation and transmission of Indigenous agricultural knowledge? How can Indigenous Knowledge Systems and modern agricultural science complement one another in agricultural extension and rural development? What policy interventions can strengthen sustainable agriculture, Indigenous livelihoods, climate resilience and inclusive rural development in Indigenous areas of Tripura?

4. RESEARCH METHODOLOGY

The study adopts a qualitative, exploratory and interpretive research methodology. A qualitative approach is appropriate because Indigenous Knowledge is often transmitted orally and embedded in everyday agricultural activities, social relationships, customary institutions and community practices. The study seeks to understand how Indigenous Peoples define sustainable agriculture, describe environmental change, evaluate agricultural development programmes and make decisions concerning crops, land, labour and markets. The research design combines documentary analysis with field-based qualitative methods. Documentary sources include government reports, Census materials, agricultural statistics, tribal development documents, policy reports, academic books, peer-reviewed articles and institutional publications. These sources provide contextual information about the demographic, agricultural, ecological and rural-development conditions of Tripura.

Primary data is collected through semi-structured interviews, focus group discussions, participant observation and informal conversations. The interviews examine participants' understanding of sustainable agriculture, traditional crops and seeds, soil and water management, pest control, seasonal indicators, food security, agricultural income, women's roles, land-use change, climate variability, market access, extension services and government programmes. Focus group discussions is organised with farmers, women, men and youth, separately where necessary. Separate discussions create a more comfortable environment for participants and reveal differences in knowledge, labour responsibilities, agricultural priorities and experiences of development interventions. Participatory tools such as seasonal calendars, resource maps, crop calendars, historical timelines and problem-ranking exercises are used. Participant observation is used to understand agricultural practices in their natural context. The researcher observe seed selection, field preparation, sowing, transplanting, weeding, harvesting, livestock management, food processing, household gardening and community labour. Field notes are record not only what participants say but also how agricultural activities are organised, who participates, and how knowledge is shared.

5. RESULTS AND DISCUSSION

5.1 Indigenous Knowledge as an ecological and cultural resource

The analysis indicates that Indigenous Knowledge Systems occupy an important position in the agricultural and livelihood practices of Indigenous Peoples of Tripura. This knowledge is developed through long-term interaction with land, forests, water, crops, animals and seasonal changes. Farmers' understanding of soil colour, texture, moisture, slope and productivity influences their decisions concerning



crop selection, land preparation and cultivation methods. Such knowledge is not usually recorded in formal documents; rather, it is transmitted through observation, participation, oral instruction and practical experience. The results suggest that Indigenous agricultural knowledge is closely connected with cultural identity and community life. Farming activities are associated with food traditions, customary labour exchange, festivals and social cooperation. Agricultural knowledge therefore represents more than a set of technical practices. It also carries values, memories and community relationships. The loss of Indigenous agricultural practices consequently affect cultural continuity and local autonomy in addition to reducing agricultural diversity. The findings further indicate that Indigenous Knowledge is not equally distributed within communities. Older farmers often possess detailed knowledge of soil conditions, seasonal changes, land preparation and cultivation techniques. Women frequently hold specialised knowledge related to seed selection, seed preservation, food processing, kitchen gardens, medicinal plants and wild edible foods. Youth possess less practical knowledge of agriculture because of formal education, migration and changing occupational aspirations. This distribution demonstrates the importance of analysing Indigenous Knowledge through gender and generational perspectives. These findings are consistent with the Indigenous Knowledge Systems perspective, which understands knowledge as socially embedded, environmentally situated and transmitted through everyday practice (Berkes, 2018). The results also demonstrate that Indigenous Knowledge is dynamic. Farmers do not simply reproduce inherited practices; they modify them in response to changing rainfall, labour availability, markets, government schemes and new technologies.

5.2 Crop diversity, mixed cropping and food security

The study indicates that crop diversity contributes substantially to household food security and livelihood resilience. Indigenous farming systems combine rice, vegetables, pulses, oilseeds, tubers, fruits and medicinal plants according to local ecological conditions. Mixed cropping enables households to obtain different types of food during different seasons and reduces dependence on a single crop. The results suggest that crop diversity performs several functions simultaneously. It provides food for household consumption, reduces the risk of total crop failure, supports nutritional diversity and preserves locally adapted plant varieties. Households continue cultivating traditional crops even when those crops have limited market value because they provide reliable food, possess particular taste or nutritional qualities, or carry cultural and ritual significance.

Mixed cropping also reduces the vulnerability associated with commercial monocropping. When a household depends on one market-oriented crop, it becomes more exposed to price fluctuations, pest outbreaks and climatic disturbances. By contrast, diversified production distributes economic and ecological risks among several crops. This finding supports the argument that agro-biodiversity is important for soil health, pest management, nutrition and the conservation of genetic resources (Altieri, 2004; FAO & Alliance of Bioversity International and CIAT, 2021).

However, the results also reveal that crop diversity is under pressure. Commercial demand, the promotion of selected crops, shortages of labour and limited access to markets for traditional products encourage households to reduce the number of crops they cultivate. The decline of crop diversity produce short-term economic benefits in some cases, but it also weaken household food sovereignty and increase dependence on purchased food and external agricultural inputs.

5.3 Indigenous seed systems and agricultural resilience

The findings indicate that Indigenous seed systems remain important for maintaining agricultural diversity and adapting to local ecological conditions. Farmers preserve different varieties according to their maturity period, resistance to drought or pests, taste, storage quality, productivity and ritual importance. Seed selection is often based on accumulated experience rather than formal laboratory testing. Women appear to play a particularly significant role in seed preservation and exchange. Their participation is connected with harvesting, drying, storing, processing and preparing food. Through these activities, women evaluate the quality, taste, storage capacity and suitability of different varieties. Seed knowledge is therefore closely related to household nutrition and food culture. The results show that local seed varieties provide advantages under conditions of irregular rainfall, limited irrigation and low external input use. They be better adapted to local soil and climate conditions than varieties developed for high-input agricultural systems. At the same time, the replacement of local seeds with commercial varieties reduce genetic diversity and increase dependence on external markets. The findings do not suggest that commercial seeds are universally unsuitable. Improved varieties offer advantages in particular conditions, especially when farmers have access to irrigation, fertilisers, technical knowledge and reliable markets. The important issue is therefore not whether Indigenous or scientific seeds should be selected exclusively, but whether farmers are able to maintain choice, access and control over their seed systems. Community seed banks, farmer-to-farmer seed exchange and participatory variety testing could support this objective.

5.4 Shifting cultivation, fallow periods and environmental sustainability

The results demonstrate that shifting cultivation should be analysed in relation to its ecological and social conditions rather than through a universal judgement. When fallow periods are sufficiently long, shifting cultivation allow vegetation regeneration, soil recovery and the cultivation of diverse crops. It also provide access to wild foods, forest products and medicinal plants. However, the findings suggest



that shortening fallow periods creates serious challenges. Land scarcity, population pressure, changes in land use and competing demands for agricultural land reduce the time available for soil and vegetation recovery. Shortened fallow cycles lead to declining soil fertility, erosion, lower yields and increased labour requirements. The sustainability of shifting cultivation therefore depends on fallow length, plot size, crop diversity, slope, rainfall, labour availability and the capacity of the surrounding ecosystem to regenerate. The findings support a shift away from portraying shifting cultivation either as an inherently destructive practice or as an automatically sustainable tradition. Its effects vary according to ecological conditions, land availability and the strength of customary institutions.

The results also suggest that policies promoting the complete replacement of shifting cultivation with settled or commercial agriculture produce unintended consequences. Settled agriculture improve market access and income for some households, but it also reduce crop diversity, increase dependence on purchased inputs and weaken customary resource-management systems. A more appropriate approach would support locally suitable transitions while recognising the knowledge and priorities of farming communities.

5.5 Organic nutrient management, home gardens and agroforestry

The findings indicate that organic nutrient management continues to contribute to soil fertility and resource recycling. Farmers use farmyard manure, compost, crop residues, ash, household waste and other locally available materials. These practices reduce input costs and return nutrients to the soil. They also improve soil structure and reduce dependence on chemical fertilisers. Home gardens represent another important component of Indigenous livelihood systems. They contain vegetables, fruit trees, medicinal plants, spices, poultry and small livestock. The results suggest that home gardens contribute to food security, household nutrition and small-scale income generation. They also provide a space where women's knowledge of seeds, food preparation and medicinal plants is maintained. Agroforestry support soil conservation, slope protection, fuelwood supply, fruit production and biodiversity. The integration of trees with crops and livestock allows households to use land for multiple purposes. It also reduce livelihood risks by producing food, fuel, fodder and marketable products. Nevertheless, agroforestry programmes should be designed in consultation with communities because the suitability of particular tree species depends on local soils, land rights, labour and market conditions.

5.6 Indigenous Knowledge and livelihood diversification

The study indicates that Indigenous Knowledge contributes to livelihood diversification by supporting a range of agricultural and natural-resource-based activities. Households combine crop production with livestock rearing, home gardening, wage labour, forest-product collection, small trade and seasonal migration. This diversification allows families to respond to crop failure, unemployment, climate variability and changing market conditions. Agriculture provides food, income and employment, but its significance cannot be measured only through the sale of crops. A crop retained for household consumption have high livelihood value even if its market price is low. Similarly, livestock provide manure, food, emergency income and social status. Forest products supplement household consumption and provide additional income during periods when agricultural work is limited. The results support the Sustainable Livelihoods Framework by demonstrating that households combine natural, human, social, physical and financial assets. However, access to these assets is unequal. Land-poor households, women-headed households, remote villages and families with limited labour face greater difficulty sustaining diversified farming systems. Rural development programmes should therefore address unequal access to assets rather than assuming that all households have similar livelihood opportunities.

5.7 Women's contribution to Indigenous agricultural knowledge

The findings reveal that women are central to the maintenance of agricultural biodiversity and household food security. Their responsibilities include seed selection, seed preservation, food processing, storage, kitchen gardening, weeding, harvesting, livestock care and the preparation of traditional foods. Women also possess knowledge of medicinal plants, wild edible foods and seasonal availability. Despite this contribution, women's knowledge and labour are often undervalued. Agricultural extension programmes continue to focus primarily on male farmers, even when women perform substantial agricultural work and make important decisions concerning seeds and food. Women also have weaker access to land ownership, credit, training, tools, markets and formal decision-making institutions. The results suggest that women-centred agricultural programmes should move beyond treating women as instruments for improving household welfare. Women should be recognised as knowledge holders, producers, entrepreneurs and decision-makers. Community seed banks, nutrition gardens, processing units, credit facilities, training programmes and collective marketing initiatives strengthen women's economic and institutional position. Women's Self-Help Groups also contribute to knowledge documentation, seed exchange, value addition and collective marketing. However, such groups require sustained institutional and financial support. Without adequate infrastructure, transport, storage and market access, women's agricultural enterprises remain small and economically vulnerable.

5.8 Climate variability and Indigenous adaptation

The results suggest that climate variability is increasingly affecting agricultural decision-making. Farmers observe changes in rainfall timing, dry spells, high-intensity rainfall, temperature, pest behaviour, crop performance and water availability. These observations influence decisions regarding sowing, crop selection, land preparation and water management. Indigenous Knowledge contributes to



climate adaptation through crop diversification, local seed use, adjustments in planting periods, soil-moisture conservation, agroforestry, water harvesting and reliance on multiple livelihood activities. Local environmental indicators also provide early warnings concerning rainfall or seasonal change.

However, the findings indicate that climate change exceed the historical experience on which Indigenous Knowledge is based. Unpredictable rainfall, new pests, prolonged dry periods and extreme weather events reduce the reliability of inherited indicators. Indigenous Knowledge should therefore not be treated as sufficient in isolation.

The results support a complementary approach in which local observations are combined with scientific forecasts, climate information services, soil testing, improved water management, weather-indexed insurance and locally tested crop varieties. Farmers should participate in evaluating adaptation technologies so that interventions remain affordable, culturally appropriate and compatible with local labour and ecological conditions.

5.9 Market transformation and commercialisation

The study indicates that market participation has both positive and negative effects on Indigenous rural livelihoods. Improved market access increase income, create opportunities for value addition and encourage the production of horticultural and other high-value crops. Farmer organisations and women's groups benefit from processing, packaging and collective marketing.

At the same time, commercialisation encourage monocropping and reduce the cultivation of traditional food crops. Farmers become dependent on purchased seeds, fertilisers, pesticides and credit. Price fluctuations can create serious risks, particularly when producers have weak bargaining power and face high transportation costs.

The results suggest that market-oriented rural development should be based on livelihood security rather than production expansion alone. Traditional crops and diversified products require storage, processing, quality certification, institutional procurement and fair pricing. Public procurement through schools, hostels, hospitals and local institutions could create stable demand for traditional and nutritious agricultural products.

5.10 Youth migration and knowledge transmission

The findings indicate that youth migration and changing occupational aspirations are affecting the transmission of Indigenous agricultural knowledge. When young people spend less time in fields and forests, they have fewer opportunities to learn through observation and participation. Formal education and non-agricultural employment also reduce the perceived attractiveness of farming. However, migration should not be understood only as a negative process. Remittances support household consumption, education, housing and agricultural investment. Young people who migrate also bring new information, technologies and market connections to their communities.

The results suggest that rural development programmes should create opportunities for youth to engage with agriculture through entrepreneurship, digital documentation, climate-smart farming, food processing and value addition. School biodiversity gardens, youth farmer clubs and community knowledge archives could connect contemporary education with Indigenous Knowledge. Digital technologies support documentation, but such activities must respect community consent and collective ownership.

5.11 Institutional recognition and knowledge integration

The study finds that Indigenous Knowledge is often treated as informal or unscientific within formal agricultural institutions. This can discourage farmers from sharing knowledge and produce a one-sided extension system in which technologies are transferred without sufficient attention to local conditions.

The results suggest that Indigenous and scientific knowledge systems should be treated as complementary rather than competing systems. Indigenous Knowledge contributes local observation, ecological memory, crop diversity, cultural meaning and practical adaptation. Scientific knowledge can contribute soil testing, disease diagnosis, weather forecasting, irrigation design, improved storage and post-harvest technology.

Successful integration requires participatory experimentation. Farmers, agricultural scientists, extension personnel and community organisations should jointly test technologies and evaluate their effects. For example, locally adapted rice varieties be evaluated alongside improved water-management methods, while traditional composting be examined through scientific analysis of nutrient content and soil response.



Integration must also protect community rights. Researchers and development agencies should not appropriate Indigenous Knowledge for commercial purposes without consent, recognition and benefit sharing. Community knowledge holders should be recognised as experts and resource persons within agricultural extension and research systems.

5.12 Rural development outcomes

The findings indicate that Indigenous Knowledge contributes to rural development through several interconnected pathways. It strengthens household food security by supporting crop diversity and local seed systems. It contributes to income through the production, processing and sale of agricultural and forest products. It supports employment through household labour and collective work. It reduces vulnerability by diversifying livelihood activities and maintaining access to natural resources.

Indigenous Knowledge also supports social development. Collective labour, seed exchange, customary institutions and farmer groups strengthen social relationships and cooperation. Cultural food practices and agricultural festivals contribute to identity and intergenerational continuity. Environmental practices such as agroforestry, organic nutrient management and community resource regulation support ecological sustainability.

However, these contributions are constrained by unequal access to land, markets, infrastructure, credit, extension services and political institutions. Rural development programmes should therefore combine support for Indigenous Knowledge with investments in roads, storage, irrigation, processing, education, health, markets and institutional capacity. The objective should not be to preserve Indigenous practices unchanged, but to enable communities to adapt and innovate while maintaining control over their knowledge and resources.

6. POLICY RECOMMENDATIONS

Government policies should recognise Indigenous Knowledge Systems as a legitimate resource for sustainable rural development. Recognition should involve institutional support rather than symbolic inclusion alone. Local seeds, agricultural practices, seasonal indicators, food traditions and ecological rules should be documented through participatory methods. Such documentation must involve free, prior and informed consent, community ownership, confidentiality and benefit-sharing arrangements. Agricultural extension programmes should combine scientific recommendations with locally tested Indigenous practices. Extension workers should be trained in participatory communication, cultural sensitivity and local languages. Farmer field schools, village demonstrations and peer-to-peer learning can create dialogue between knowledge systems.

Community seed banks should be established and managed by local farmer groups with strong participation by women. Programmes should support seed selection, storage, regeneration, exchange and documentation. Local seed systems should be linked with public agricultural research institutions without displacing community control. Women involved in farming, seed preservation, food processing and biodiversity conservation should receive direct access to training, credit, tools, storage, technology and markets.

Youth programmes should connect agricultural education with Indigenous Knowledge, digital documentation, climate adaptation and entrepreneurship. Community knowledge archives, school biodiversity gardens and youth farmer clubs encourage young people to engage with agriculture while using contemporary technologies. Self-Help Groups and farmer organisations should receive support for collective input purchase, processing, packaging, storage and marketing. Such support should also include training in financial management, quality control and democratic decision-making. Climate adaptation programmes should integrate local climate observations with scientific forecasts and technical advice. Priority areas include drought-tolerant local crops, rainwater harvesting, soil-moisture conservation, agroforestry, crop diversification, weather information, improved storage and suitable insurance. Tribal farmers need better access to roads, storage, processing facilities, producer groups and fair markets. Public procurement and local institutional markets can create demand for traditional crops and diversified food products.

Indigenous communities should be involved in planning, implementing and evaluating agricultural and rural development programmes. Village-level consultations should identify local priorities and assess the social and ecological effects of proposed interventions. Development programmes should respect customary institutions, community land relations and the collective nature of Indigenous Knowledge. Where community knowledge contributes to commercial products or agricultural innovations, mechanisms for attribution, consent and benefit sharing should be established. Universities, government departments, tribal institutions, agricultural research organisations and community groups should collaborate in documenting and testing sustainable practices. Research findings should be returned to participating communities in accessible forms, including local-language materials where possible.

7. CONCLUSION

Sustainable agriculture, Indigenous Knowledge Systems and rural development are closely interconnected among Indigenous Peoples of Tripura. Agriculture is not merely an economic activity; it is connected with food security, cultural identity, social cooperation, environmental management and intergenerational learning. Indigenous Knowledge Systems contribute to sustainable agriculture



through crop diversity, local seed preservation, mixed farming, agroforestry, organic nutrient management, seasonal observation and community-based resource regulation. These practices can support livelihood security, biodiversity conservation and climate resilience when they remain adapted to local conditions.

At the same time, Indigenous Knowledge should neither be romanticised nor marginalised. Land scarcity, shortened fallow periods, market pressures, climate variability, youth migration and inadequate institutional support weaken traditional systems. Their sustainability must be assessed through context-specific evidence rather than assumption. The central policy implication is that Indigenous and scientific knowledge systems should be brought into dialogue through participatory experimentation. Scientific knowledge can contribute soil testing, weather forecasting, disease diagnosis, water management and post-harvest technology. Indigenous Knowledge contributes ecological memory, local observation, crop diversity, cultural meaning and practical adaptation. Sustainable rural development in Tripura should recognise Indigenous Peoples as holders, producers and innovators of knowledge. Policies should strengthen community institutions, support women's leadership, engage youth, protect biodiversity, improve market access and safeguard collective rights over land, seeds and knowledge. A culturally responsive and ecologically grounded approach can contribute to more secure livelihoods, resilient food systems and inclusive rural development among Indigenous Peoples of Tripura.

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