Forest and Society
Vol. 9(1): 20-47, June 2025
10.24259/fs.v9i1.31352

REGULAR RESEARCH ARTICLE

Medicinal Plant Production System Management in Rural Java, Indonesia: Views of Local Actors from a Participatory Rural Appraisal Approach

Sri Astutik [1, 2, *], Vianny Ahimbisibwe [3], Kendisha Soekardjo Hintz [2], Purwanto Purwanto [4], and Muhammad Alie Humaedi [5]

AFFILIATIONS

1. Cibodas Botanic Garden, Research Center for Plant Conservation, Botanical Garden and Forestry, National Research and Innovation Agency, Bogor, Indonesia.
2. Institute of International Forestry and Forest Products, Faculty of Environmental Sciences, Technische Universität Dresden, Tharandt, Germany.
3. Thünen Institute of Forestry, Hamburg, Germany.
4. Research Center Behavioral and Circular Economics, National Research and Innovation Agency, Jakarta, Indonesia.
5. Research Center for Social Welfare, Villages and Connectivity, National Research and Innovation Agency, Jakarta, Indonesia.

* Corresponding author:
sri.astutik@tu-dresden.de

RECEIVED 2023-10-24
ACCEPTED 2024-05-04

ABSTRACT

Medicinal plants' production systems in Indonesia's rural Java play a crucial role in sustaining local livelihoods and healthcare needs. Medicinal plants are managed by locals independently based on household preferences and endowments through wild gathering and cultivation-based production systems. However, these situations create a continual problem of weak bargaining positions. Thus, this study aimed to assess local needs and potential in supporting medicinal plants production systems management in Java, Indonesia, with the view to advance local actors' perspectives in a multistakeholder platform. The Participatory Rural Appraisal (PRA) approach proved useful in incorporating local knowledge in the planning and development of strategies. We implemented PRA techniques, such as problem identification based on a cause-and-effect diagram, group discussion and brainstorming, preference ranking of priority species, and a Venn diagram based on stakeholders' classification. These were carried out with 150 local actors from four villages. Results reveal that Candlenut tree are the preferred species in the wild gathering system, while Javanese turmeric and Broadleaf plantain are preferred in the cultivation-based production systems. Urgent interests include more lucrative gathering and cultivation, a remunerative market, and a reliable local economic institution. The PRA results demonstrate that local actors' involvement is highly required in administering production systems to enhance medicinal plants' sustainable production and management.

KEYWORDS
Medicinal plants; Multi-stakeholder platform; Participatory rural appraisal; Production system; Rural livelihood.

1. INTRODUCTION

In Indonesia, medicinal plants, as the source of *Jamu*[1], have been traditionally practiced since 800 AD and deeply rooted in the local culture (Beers, 2001; Tilaar, 2015). Due to the affordable and accessible characteristics of medicinal plants, about 60 to 90% of the rural population in developing countries depend on traditional medicine to fulfill their healthcare needs (Jeelani et al., 2018; Karunamoorthi et al., 2013). In the context of Indonesia, wild gathering and cultivation are the two major production systems that contribute to preserving medicinal cultural heritage and maintaining the population's well-being. Wild gathering refers to forest gathering, while cultivation-based systems include both forest farming and farm-based outgrower production. The wild gathering system is more common than the

[1] Traditional herbal medicine of Indonesia which can comprise a single or mixture of various medicinal plants and can be divided into five classifications of health-care, medicine, cosmetics, beverages and tonic, and body's endurance (Elfahmi et al., 2014; Riswan and Roemantyo, 2002).

cultivation system. Nonetheless, the cultivation system shows a rising trend in Asia, despite its challenges on ecological and socio-economic factors, such as lack of quality of planting material, technical hindrances, small land holdings, lack of post-harvest technologies, biotechnological application, and high cost investment (Astutik et al., 2019; Canter et al., 2005; Negi et al., 2018; Schippmann et al., 2002). Meanwhile, both medicinal plant production systems are a critical part of rural livelihoods and cultural heritage. Against this background, studies that contrast the management practices of the two production systems[2] are scant in literature.

Medicinal plant production systems have contributed to rural development, especially in the forest and agricultural sectors, due to their unique characteristics, such as tradition-based knowledge, daily life use, and livelihood attachment (Rasul et al., 2012a; Riswan, 2002; Smith-Hall et al., 2012). Many studies, especially in Asia, point out that medicinal plants have the potential to alleviate rural poverty through increased income, job provision, and enhancement of skill and well-being (Belcher & Schreckenberg, 2007; Rasul et al., & Kollmair, 2012b; Ruiz-Pérez et al., 2004). Several studies on household income from forests revealed the importance of forest products as a livelihood strategy and thus, to an extent, the rural population is dependent on forest products including medicinal plants. It also helps to achieve poverty reduction and increased income generation to improve rural livelihoods (Adhikari et al., 2004; Angelsen et al., 2014; Heubach et al., 2011; Hickey et al., 2016; Kamanga et al., 2009; Kar & Jacobson, 2012; Oli et al., 2016; Olsen, 2005; Córdova et al., 2013; Rayamajhi et al., 2012; Rijal et al., 2011; Vedeld et al., 2007; Walelign et al., 2016). Studies on cultivation-based systems, such as forest farming and farm-based outgrower production, highlighted similar results in terms of income generation for the producers, besides supply assurance to herbal industries (Liu et al., 2018; Lubbe & Verpoorte, 2011; Pandit & Kumar, 2010). Cultivation of medicinal plants can be integrated into other farm crops or agroforestry models, propagation of endangered species at the village level, and community-based approaches.

Medicinal plants are used at the domestic to the industrial level, and the commercialization encompasses the local, national, and global trade. For these reasons, a sustainable supply of medicinal plants is urgently needed due to the growth of many herbal industries and other traditional medicine requirements. Many more examples showed that most of them rely on wild stock (70-90%), but growing numbers are sourced from cultivation-based systems (Cameron et al., 2005; He et al., 2018; Schippmann et al., 2006). Indonesia is one of the leading producers of Asian medicinal plants, with Java an essential part of production. A total of 1,033 registered traditional medicine industries (129 large-scale and 904 small-scale industries) are found in Indonesia (BPOM Republik Indonesia, 2020). The growing demand for raw materials influences the performance of production systems, through the irregular supply from wild or cultivation sources. Most supplies still depend on wild harvest, especially from natural forests. On the other hand, cultivation sources need to increase their contribution to fulfill commercial market needs, which are mainly processed by small-medium and large-scale herbal industries. Although abundant species exist, only some species are commercialized locally and globally, such as cardamom, curcuma, ginger, and white pepper (BPS-Statistics Indonesia, 2019; Chapman & Chomchalow, 2005). Due to high domestic demand, Indonesia imports raw medicinal plants. For instance, in 2017, Nigeria, India, and Singapore supplied

[2] In this research, two primary production systems categories are wild gathering and cultivation-based systems. Wild gathering studied here refers to forest gathering, while cultivation-based systems comprise of forest farming and farm- based outgrower production approaches.

Indonesia with Ginger (22 tons), Turmeric (429 tons), and Cardamom (1.32 tons), respectively (BPS-Statistics Indonesia, 2017).

Indonesia recognizes medicinal plants as high-value resources for conservation and development priorities and needs. The relevant national policies in this sector comprise Biodiversity, Environmental Management, Health, Forestry, and Agriculture. Some of them are the Convention on Biological Diversity (CBD) (Law No. 5/1994), Environment Management (Law No. 23/1997), Roadmap of Medicine Raw Material Independency (Ministry of Health stipulation No. 87/2013), Conservation Partnership within the Nature Sanctuary and Nature Conservation Area (Ministry of Forestry stipulation No. P.6/KSDAE/SET/Kum.1/6/2018), and Good Horticultural Practices (Ministry of Agriculture stipulation No. 22/2021). Irrespective of the existence of the regulations, farmers face challenges such as (1) wild gatherers possess poorer bargaining positions than industrial and traditional health care clusters, (2) farmers face a lack of cultivation motivation due to production cost fluctuations, low prices, the duration of the planting period, limited technology and weak market access, (3) competition usage in health care sectors between herbal versus chemical-based medicines, and (4) only small amount of cultivated species in production areas (Adi et al., 2022; Nugroho et al., 2016; Pribadi, 2015; Siahaan & Aryastami, 2018). Therefore, improving production systems management requires local people's involvement through participatory approaches alongside its multiplier effects, such as livelihood improvement, feasible utilization, local and formal knowledge integration, the status of resource use, and biodiversity conservation (Diniyati & Achmad, 2015; Dovie, 2003; Phondani et al., 2016; Shukla & Gardner, 2006).

This study assessed local needs and potential for supporting medicinal plants production systems management in Java, Indonesia, with the view to advance local actors' perspectives in a multistakeholder platform. A participatory-based approach is frequently fundamental for non-timber forest products (NTFP) management[3], including medicinal plants (Marshall et al., 2003; Ticktin, 2015). Local people and researchers can take advantage of the learning process. These include priority setting, power and community resources mobilization, stakeholders linkage, inclusiveness, and local-based development and are relevant to most of all social activities and directions (Asmin et al., 2019; Chambers, 1994; FAO, 2022). A participatory approach, such as the Participatory Rural Appraisal (PRA), can be employed as a diagnostic analysis in the earlier phase of the development model (Castelli & Bresci, 2017; Chambers, 2013; Sanogo et al., 2017). The results help diagnose community needs for stakeholder consultation by applying standard techniques, such as discussion, resource-use ranking, problem analysis, and proposed solutions. In this case study, the PRA process provided an approach to engage with local actors (gatherers and farmers) framed around the following research questions: (1) how can local situations be acknowledged through participatory perspectives and (2) under what multistakeholder conditions can a plan be developed for sustainable management of medicinal plants production systems? These questions contribute to a better understanding of how medicinal plant production systems management can support better performance toward improved local livelihoods.

[3] The active strategy to improve NTFP's performance and their benefit to the local and significant actors by controlling pertinent aspects from upstream to downstream levels. These consist of production and utilization, commercialization, and institutional and socio-cultural framework.

2. MATERIALS AND METHODS

2.1 Study area and three medicinal plants production systems

We carried out the PRA in four villages representing three medicinal plants' production systems management on the island of Java (Figure 1). This area is one of Indonesia's central production areas for medicinal plants from wild gathering and cultivation-based systems. Some top commercial and rare species can be found here, such as Betel palm (*Areca catechu*), Football fruit (*Pangium edule*), Javanese long pepper (*Piper retrofractum*), Kedawung (*Parkia timoriana*), Kemukus (*Piper cubeba*), and Pulai (*Alstonia scholaris*) (Hidayat, 2012; The National Development Planning Agency/BAPPENAS RI, 2003). This study changes the source's name and location due to confidentiality concerns. We renamed our study sites "Village A" and "Village B," where forest gathering and forest farming exist. "Village C" and "Village D", by contrast, practice farm-based out-grower production. The PRA occurred at the end of a four-month fieldwork in 2018 and included six sessions with 50 gatherers and 100 farmers, herein called participants.

Figure 1. Three medicinal plants' production systems in study area; (a) A forest gatherer and *Piper cubeba*'s collection; (b) *Piper retrofractum* in forest farming area; (c) Outgrower production in Village C; (d) Outgrower production in Village D.

2.2 Reliability, validity and applicability

As a trait, PRA is a type of qualitative research and inductive approach (Campbell, 2001; Robert Chambers, 1994a). Some principles are applied to meet the requirement approximation of reliability, validity, and applicability. Following Robert Chambers (1994c), PRA principles consist of local-based learning, rapid and forward-thinking, compensating unfairness, triangulation, optimizing synergies, and exploring diversity.

The principles assist in determining the foundation for consensus-building regarding consultation on future stakeholders' priorities (Brown, 2002). The PRA research is typically aimed at in-depth understanding and focused on people who usually communicate and behave within particular contexts during their daily life experiences in a natural environment (Frey et al., 2000; Orb et al., 2001). The participatory approach leads to a manageable and advanced relationship between researchers and participants (gatherers and farmers). So researchers can understand the attitude, circumstances, and pertinent issues and attain participation (Caister et al., 2012; Preece, 2006; Rocheleau, 1994). Hence, local people and researchers can benefit from the learning process.

In this case, the PRA study is part of the research platform on medicinal plants production systems in rural Java. First, the first author immersed herself in all study areas (see 2.1) for four months (September-December 2018). She lived with the family of the local leader at their home during the research. She also took part in developing networks on social activities in the study area. As Armstrong (2010) pointed out, immersion and accuracy are essential to meet the required standard of qualitative research. It can be time-consuming but brings acquaintance to the field site and the local community. Triangulation applied in this study aimed to validate the collected data by using multiple sources of information, such as household surveys, Rapid Rural Appraisal, theoretical engagement, and interviews with relevant stakeholders. It aligned with Narayanasamy's (2009) work who underlined that "information under PRA flows from people, places, and events and processes". This technique can improve data quality and truthfulness due to the use of multiple perspectives (Bryman, 2016; Neuman, 2014). During the PRA process, the researcher gave all participants an equal opportunity to deliver and share their aspirations and desires by indulging and seeking guidance from other participants using a round table approach. This mechanism supports participants' rights and pinpoints and clarifies each participant's perception (Horsburgh, 2003; Orb et al., 2001). The abovementioned circumstances are pivotal to developing the trustworthiness of findings linked to a qualitative research (Denzin & Lincoln, 2018; Noble & Smith, 2015).

Concerning the applicability of the study results, the critical consideration lies in its generalization in other contexts or settings. The findings contribute to theoretical construction and future studies of pertinent subjects (Burns, 1989; Moen & Middelthon, 2015). Generalization faces two main challenges: inadequacy of inductive arguments and particularity context of findings (Mayring, 2007). Instead of being based on a specific case, a case study is essential by modifying or rejecting the referenced theories or new conceptions (Yin, 2018). For instance, many studies and community-based development schemes employ PRA to diagnose sustainable management of natural-based resources linked to rural development, including medicinal plants as a part of non-timber forest products (NTFP) (Chambers, 1994; Cundill et al., 2011; Friday et al., 2006; Malley et al., 2010; Misbahuzzaman & Smith-Hall, 2015; Nemarundwe & Richards, 2002). In this study, the PRA findings support discussions on policy formulation, improvement of market channels, and management of various production systems. It requires connecting their relevance to current knowledge, policy, practice, and research agendas as part of its evaluation assessment (Kitto, et al., 2019). As a qualitative work, PRA has enabled data collection, analysis, and interpretation in unique ways (Agius, 2013; Armstrong, 2010; Chambers, 1994c); and for the purposes of this study, it leads to better understanding the local settings of medicinal plants management. Thus, this research assists in social transformations in the context of local actors and multi-level stakeholders involved in managing medicinal plant production systems in Java.

2.3 The PRA approach

PRA is a self-conscious learning method that encourages local people's participation to actively investigate their knowledge, experiences, and values for possible transitions (Ashby & Pretty, 2006; Bar-on & Prinsen, 1999; Chambers, 1994a). Local people and researchers/facilitators can benefit from the learning process by developing mutual understandings of the local context in resource use decisions. The circumstances mentioned above are crucially needed as a response mechanism to support an improved governance system and further interlinked between institutions, knowledge, power, and science (Fisher et al., 2019; Sheppard et al., 2020; Stringer et al., 2006). With regard to participant recruitment, the criteria are as follows. The approach identified household heads that represented those that participate in forest gathering, forest farming, and outgrower production. These comprised of three categories: (1) forest gatherers who spend at least three months per year to collect wild medicinal plants, (2) forest farmers who practice an agroforestry model combining at least two layers of medicinal plants in the field, and (3) farmers who have developed two years of cooperation with herbal industries. The four techniques applied in this study are problem identification, stakeholder classification, group discussion and brainstorming, and preference ranking of priority species. The length of the discussion was between 50-70 minutes. PRA was technically focused only for one group category classified in each study area, which included forest gatherers (50 males), forest farmers (50; 9 females and 41 males), outgrowers in Village C (25; 9 females and 16 males) and outgrowers in Village D (25 males). Thus, the PRA results serve as an initial phase of a multistakeholder platform.

With respect to technical applications, PRA was caried out twice in Village A and Village B and once in Village C and Village D with 25 participants each. In the case of Village A, PRA took place in a village center to accommodate participants in terms of accessibility and workshop activities. For Village B, Village C, and Village D, all participants were invited to attend the PRA workshop by their local leaders to whom they could trust and feel comfortable sharing their opinions. Most of the workshop's materials were prepared by the facilitator (researcher) with the support of local leaders. All participants received an invitation letter of a planned PRA workshop beforehand. In general, participants showed willingness to participate in the whole workshop and all of them knew each other quite well because they live in the same village and have similar activities as gatherers or farmers or outgrowers. In the opening session, the researcher explained the details of the workshop, such as the goals, discussion stages and all proposed activities. Participants were encouraged by the facilitator to speak up freely and to share their opinions among participants openly. In the closing of each PRA workshop, participants and researchers celebrated a feast of traditional food for gratefulness and togetherness. Thus, a PRA approach could bring social interactions, knowledge sharing, and local needs assessment on one table.

2.3.1 PRA section 1-problem identification based on a cause and effect diagram

In this technique, we asked the participants about their relevant interests in medicinal plant production systems management. We asked them to identify the primary challenge in medicinal plants production systems management. Once the participants agreed on the main problem, each of them wrote several opinions on a piece of paper. All the results were classified based on cause and effect categories. Following Anyaegbunam et al. (2004), we provided a tree-like diagram to assist the participant in determining the main problem (trunk), effects (canopy), and causes (roots). Causes are circumstances inducing the major problem, while effects are its consequences.

The group defined each leading cause's description in the context of the local situation.

2.3.2 PRA section 2-group discussion and brainstorming

Participants were household heads selected for household interviews as well in each study area. The discussion was held over two days with 25 participants each for forest gatherers and forest farmers. Meanwhile, outgrowers in Village C and Village D participated in one-day discussion each. So, in total, there were six group discussions in which each of them comprised four smaller subgroups involving six to seven participants each. The goal was to discuss the three main topics affecting future management. Those are safe and harmful practices, desire and hope for the future, and cooperative establishment. We randomly changed the subgroups' composition to shape the discussion dynamics. This is in line with Morgan (2019) and Hennink (2014) who pointed out that interchange among group members within group discussions can help in managing the dynamics of the group, listening effectively, and advancing discussions. In the discussion process, each member demonstrated their own enthusiasm to make a significant contribution to the overall topic. At the end, each group represented by one or two members delivered their findings with further explanation to obtain a mutual understanding within the whole group.

2.3.3 PRA section 3-preference ranking of priority species

We used the ranking preference technique to sort out the top ten species utilized in the three production systems. The goal is to identify priority species based on market demand and price. The participants were requested to mark the species name (products) collectively. Finally, the list was ranked and agreed upon in descending order.

2.3.4 PRA section 4-venn diagram based on stakeholders' classification

Due to the various stakeholders involved in production systems management, the Venn diagram was chosen to map their importance and influence. First, the group was required to identify all stakeholders involved in production system management. Second, we used some sizes of circles reflecting power and the distance as the importance. During the discussion, the group arranged the circle size and position from the center (gatherers/farmers). The Venn diagram was then transformed into a stakeholder analysis matrix (see Result).

3. RESULTS

In this section, results follow the four techniques we employed in the PRA method. It specifically clarifies how participants expressed their aspirations and preferences on medicinal plant production systems management.

3.1 Problem identification based on a cause-and-effect diagram

The main topic similarly faced by the three production systems is marketing, whilst only out-grower production in Village D deals with the price (see Appendix 2). We present ten specific sub-problems and their descriptions and causes in Table 1.

All participants involved in the production systems underlined that local economic group initiatives need to be actively revitalized or developed. Based on local actors' self-assessment, their previous experiences showed that the critical points are mismanagement and inadequate communication. For instance, they saw that lack of coordination and transparency between leaders and members during decision making processes have lead to mismanagement and declining performance. These affect the spirit of the members' unity and results from issues like lack of support initiatives,

lack of funds, and unclear goals. Hence, farmers identified that the market serves as the most challenging condition due to market distance and limited market channels. As Ros-Tonen et al. (2005) and (Shackleton et al., 2007) mentioned, an unfulfilled return is one of the classical problems in many NTFPs in the context of community-based development. In addition, natural factors are considered an inevitable constraint to yield quantity, such as unpredictable weather, tough rainy season, arable soil, and flooding. Pretzsch et al. (2014) and Noordwijk et al. (2002) pointed out that tropical rural areas usually need more technology and infrastructure to manage natural resources.

Since production inputs are a high necessity, forest farming and outgrower production require significant expenses on labor, fertilizer, pesticides, and customs fees. The case parallels technical hindrances such as the lack of knowledge on ecosystem management, lack of experience in pest management, and inefficient drying infrastructure. So far, product quality still needs to be improved in forest gathering and forest farming. Both mainly sell green materials to village traders or local markets. Meanwhile, in outgrower production, this case is moderately applied due to the standard requirement of herbal industries.

Forest gathering and forest farming see that financial issues are urgent due to debt constraints that result from deficit income and high production and collection costs, while product prices often fluctuate. Concerning limited market information and market distance, forest gathering and out-grower production living in Village C have a similar problem with an overabundance of stock. Gatherers sometimes could not sell the products due to the overload capacity of village traders' storehouses. Due to the limited capacity of the processing infrastructure (e.g. reliance on sunlight for drying process, storage capacity), out-growers' products are occasionally unacceptable. The sub-problem found only in forest gathering is the lack of financial capital, a common problem in rural gatherers/farmers. As a consequence, gatherers depend on *Juragan*[4] due to their financial power. Some well-off people in the community substantially influence lending financial capital. The gatherers typically return it after the harvesting period, either from the forest or forest farming field. The condition affects the revenue from the wild collection due to low prices.

3.2 Group discussion and brainstorming

3.2.1 Safe and harmful practices

Due to wild collection and long-term activities, forest gathering relies on manual equipment and tends to follow sustainable measures in collecting the targeted species. The safe practices comprise mainly (1) collection of fallen fruit, (2) cutting the branch selectively, (3) climbing to harvest the targeted and ripe fruits, and (4) no cutting of trees. Meanwhile, local gatherers perceive some operations below as harmful practices; they include the (1) unsustainable collection of all forest products, (2) illegal logging, (3) too much cutting of the branch, (4) slash and burn activities, (5) cutting the tree entirely for collecting the targeted plant part.

The safe and harmful practices for forest farming and out-grower are similar in the frame of cultivation-based systems. Both production systems combine local knowledge practices and technology adoption to increase yield. The safe practices consist of some principles as follows: (1) minimum soil tillage, especially for slope/terrain areas; (2) in forest farming, trees are mainly aimed for reforestation purposes, avoiding burn activities, and obeying the national/local regulations (3)

[4] An individual who usually lends some money to locals for farming or gathering activities, which is repaid during harvesting.

high-yield seed, (4) organic fertilizer and biopesticide, (5) medium dose of both chemical fertilizer and pesticide, (6) regular maintenance, (7) appropriate period of harvesting, and (8) proper postharvest handling (cleaning, drying, sortation, grading, and storage). The harmful practices for both systems encompass some high-risk activities such as (1) inappropriate handling of slope areas toward landslides, (2) In forest farming, some plants, such as tobacco, coconut tree, and coffee plant, are forbidden by the conservation institution (CI) as the area manager, and only use chemical fertilizer, (3) high dose of chemical pesticide, (4) single manure application, (5) no intercropping practices, (6) unmanageable pests (e.g., worms and caterpillars), (7) inadequate drainage, and (8) improper handling of sloped areas.

3.2.2 Desire and hope for the future

For forest gathering, the most prioritized needs are; that the (1) CI grants access to collect medicinal plants and non-timber forest products, (2) *Enterprise*[5] allows the gathering of non-timber forest products, (3) *Reforestation group*[6] (RG) focus on the reforestation program, (4) the government village supports RG groups, (5) village traders need to offer the best price (6) universities assist in finding market information and market channel and nursery development for native species propagation.

Table 1. Problem identified in three production systems

Problem	Description	Cause/Aspect	Production system
Local economic group initiatives	Ineffective performance due to mismanagement, coordination and participation, no cooperative institution, no self-help group	Mismanagement of self-help group, uncleared goal, lack of unity among members, miscommunication, lack of empowerment, lack of experiences, no cooperative institution, no self-help group	G, F, O
Market	Lack of information or limited market channels to sell the products	Market distance, traders sometimes unavailable, hardship in sale, limited market place and information, unstable demand	G, F, O
Natural factors	Natural conditions affecting yield and production systems management	Hard rainy season, arable soil, unpredictable weather, flooding	G, F, O
Unsatisfied return	Inadequate earnings frequently generated a tiny portion of the margin or just for returning the production costs	Deficit in income, low price, price fluctuation	G, F, O
High expense	High production costs, sometimes sourced from borrowed money, relatives, or neighbors	Labor, fertilizer, pesticides, custom fees	F, O
Product	Lack of required	Low quality of seedling,	F, O

[5] A stated owned enterprise

[6] The farmers' groups who have the right to manage reforestation in an area located at the buffer zone of the conservation site.

Problem	Description	Cause/Aspect	Production system
quality	products standard for the market	cleanliness degree of the rhizome, unsure product quality, less processing, perishable products, products rejection, harvesting failure, ignorance due to much lower price	
Technical hindrances	Lack of experience and knowledge in production systems and postharvest handling	Lack of experiences of pest management, lack of knowledge on ecosystem management, hardship in drying	F, O
Financial issues	Deficiency of financial sources used for production purposes	Lack of funds, debts	G, F
Abundance of stock	Abundance of stock at the R&D Center for Medicinal Plants and Traditional Medicine, the high yield of targeted species, collecting more quantity to meet cash income needs quickly	Limited traders, market distance	G, O
Juragan's role dominance	Money lenders provide capital of farming activities for the community. Consequently, local gatherers who also cultivate some crops and trees on state land rely on them	*Conditio sine qua non** of financial capital required in running farm activities	G

Note*: The meaning of a Latin term is about a condition without which not; a necessary condition (Press, 2023); G: Forest gathering, F: Forest farming, O: farm-based outgrower production.
[Source: Fieldwork 2018]

In the case of forest farming, participants highlighted some following crucial points, namely (1) clarification of the border between the buffer zone of CI and adjacent villages, (2) regular control of reforestation area by CI, (3) avoiding harmful activities that can cause forest fires and flooding, (4) reducing unpredictable yield loss in the field, such as stealing and dryness, (5) better management of plant pests and diseases, (6) exchange information between farmers' groups and their members actively, (7) regular meeting at once in three months, (8) equitable distribution of seedlings for the reforestation program, and (9) strengthened solidarity in either intra and inter farmers groups.

During observation in the fieldwork, participants in Village C and Village D prefer to improve stakeholders' roles to increase yield and remunerative marketing. These are some urgent requirements:

1. The Regional Department of Agriculture supports high-yield and quality seeds.
2. Farmer associations perform better in a bargaining position with herbal industries.
3. Herbal industries upgrade the partnership model by serving investment to farmers and offering a competitive price.

4. Regional Extension Service to provide more extension and training continuously.
5. Universities and research centers conduct more applied studies promoting yield quality and productivity.
6. Village government (VG) stays pro-community-based development and facilitates mutual partnerships with herbal industries.

3.2.3 Establishment of cooperatives

All production systems agree to establish or revitalize a farmer/gatherer cooperative. They underline some points required to achieve good criteria for the cooperative based on previous experiences and group opinion. First, a self-help group can be considered as the preliminary step. Second, capacity building is vital to strengthen either organizational systems or members. Third, credible administrators are trustworthy people who can conduct all assignments properly, especially financial management. The fourth is the strong character of the group leaders who can integrate all members' aspirations, interests, and needs. In particular, good administration and group solidarity are the top priorities in developing a cooperative. Fifth, permanent buyers can be beneficial for gatherers/farmers. Sixth, post-harvest handling needs more extension support and infrastructure. Seventh, market information alongside continuous supply of products is key.

Specifically, outgrower production in Village D, which already has a farmer association, must enhance its contractual agreements with herbal industries to supply semi-processed Javanese turmeric (*Curcuma xanthorrhiza*).

3.2.4 Preference ranking of priority species

The result reveals the top ten nominated species in each of the three production systems (Table 2) from the perspectives of gatherers/farmers and traders. For instance, Candlenut tree for forest gathering, *Empon-empon* (ginger family) for forest farming, and Javanese turmeric and Broadleaf plantain are important for outgrower production. Although it is based on popularity in local market demand for those products, gatherers and farmers are concerned about the price. They have recognized that it has mostly remained constant over the years. Due to cash income needs, all collected/harvested materials are sold to suitable markets of the three production systems: village traders, local markets, the research center 1, and cooperating herbal industry.

Among the top of nominated species, five are listed as rare species for *Jamu*. In forest gathering, those are Javanese long pepper (*Piper retrofractum*), Kembang angin (*Usnea barbata*), Kedawung (*Parkia timoriana*), Kemukus (*Piper cubeba*), and Pulai (*Alstonia scholaris*) (Hidayat, 2012). For forest farming, they consist of Betel palm (*Areca catechu*), Football fruit (*Pangium edule),* Javanese long pepper (*P. retrofractum*), Jaha lawe (*Terminalia bellirica*), Kedawung (*P. timoriana*), Mango ginger (*Curcuma mangga*), and Tamarind (*Tamarindus indica*) (The National Development Planning Agency/BAPPENAS RI, 2003).

Table 2. Top ten nominated species in each production system

No.	Forest gathering	Forest farming	Farm-based outgrower production
1.	Candlenut tree (*Aleurites mollucanus*)/F	Zingiberaceae (Family of Ginger) (*Empon-empon: Javanese)*/R	Village D Javanese turmeric (*Curcuma xanthorrhiza*)/R
2.	Football fruit (*Pangium edule*)/F	Javanese long pepper (*Piper retrofractum*)/F	Village C
3.	Jaha lawe	White pepper	Broadleaf plaintain

No.	Forest gathering	Forest farming	Farm-based outgrower production
	(*Vitex quinata*)/F	(*Piper nigrum*)/F	(*Plantago major*)/L
4.	Pulai (*Alstonia scholaris*)/B	Candlenut tree (*Aleurites mollucanus*)/F	Asiatic pennywort (*Centella asiatica*)/L
5.	Javanese long pepper (*Piper retrofractum*)/F	Cardamom (*Amomum compactum*)/F	Sembung (*Blumea balsamifera*)/L
6.	Kedawung (*Parkia roxburghii*)/F	Mengkudu (*Morinda citrifolia*)/F	Ginger (*Zingiber officinale*)/R
7.	Kemukus (*Piper cubeba*)/F	Football fruit (*Pangium edule*)/F	Java tea (*Orthosiphon aristatus*)/L
8.	Betel (*Piper betle*)/L	Kemukus (*Piper cubeba*)/F	Jombang (*Taraxacum campylodes*)/L
9.	Cardamom (*Amomum compactum*)/F	Betel palm (*Areca catheccu*)/F	Sambung nyawa (*Gynura procumbens*)/L
10.	Arjasa (*Elaeocarpus grandiflora*)/F	Kedawung (*Parkia roxburghii*)/F	Perennial sowthistle (*Sonchus arvensis*)/L

Note: 1: Top rank; 10: lowest rank; plant part traded: B: bark; F: fruit; L: leaves; R: rhizome
[Source: Fieldwork (2018)]

3.3 Venn diagram based on stakeholder classifications

Following Clayton et al. (2003), the Venn diagram (see Appendix 3) was transformed into a matrix classification of stakeholders, which can be seen in Figure 1. The type of stakeholders' action is based on interests, importance, and influence on local actors' management of production systems. In this case, gatherers and farmers expect that stakeholders can participate in supporting them based on the capacity of power, knowledge, networks, and economic potential. Participants classified three kinds of stakeholders, namely primary, secondary, and external parties[7].

Forest gatherers consider CI the primary stakeholders due to their significant role in supporting the community's needs. These consist of access permission to the natural forest, right of use at the buffer area, participation in a rehabilitation program, and extension support. Although forest gathering activities have been handed down from generation to generation, local people realize that recent access has become a challenging one. However, they recognize the need to negotiate with CI to collect wild medicinal plants in natural forests. In the gatherers' view, the village government promotes all CI programs. They facilitate gatherers and CI to communicate better about managing the forest. For instance, the village government fully supports the local community, and CI established a Reforestation group (RG). It aims to expedite the reforestation program and to provide job creation. Among external stakeholders, *Juragan* and village traders are relatively close to the local community due to their influence on economic aspects.

In the case of forest farmers, CI and the village government have high importance and strong influence to support all activities in the buffer area, mostly related to the reforestation program. Both communicate reciprocally to accelerate the main program through some extension and training. At the level of secondary stakeholders,

[7] In this case, the definition of stakeholders' level is based on the community's discussion and agreement. Primary means the first party who is close and influences the people's needs fulfillment significantly. The secondary is the mediatory actors, whose presence is required to catalyze social life. External points out to the institution/actors who support slightly in the process and development.

the NGO focuses on social empowerment by raising awareness and local capacity to be more critical of forest and resource management. For example, they established a self-help group for Family Medicinal Gardens and a farmer group for reforestation. Meanwhile, local and national universities collaborate with CI to conduct applied research on medicinal plants, such as conservation biology, ethnobotany, climate change, and resource conflict management. Village traders, journalists, and tourists contribute lightly to the program's improvement. However, village traders are appreciated for purchasing raw materials, which sometimes can be bulky due to their absence.

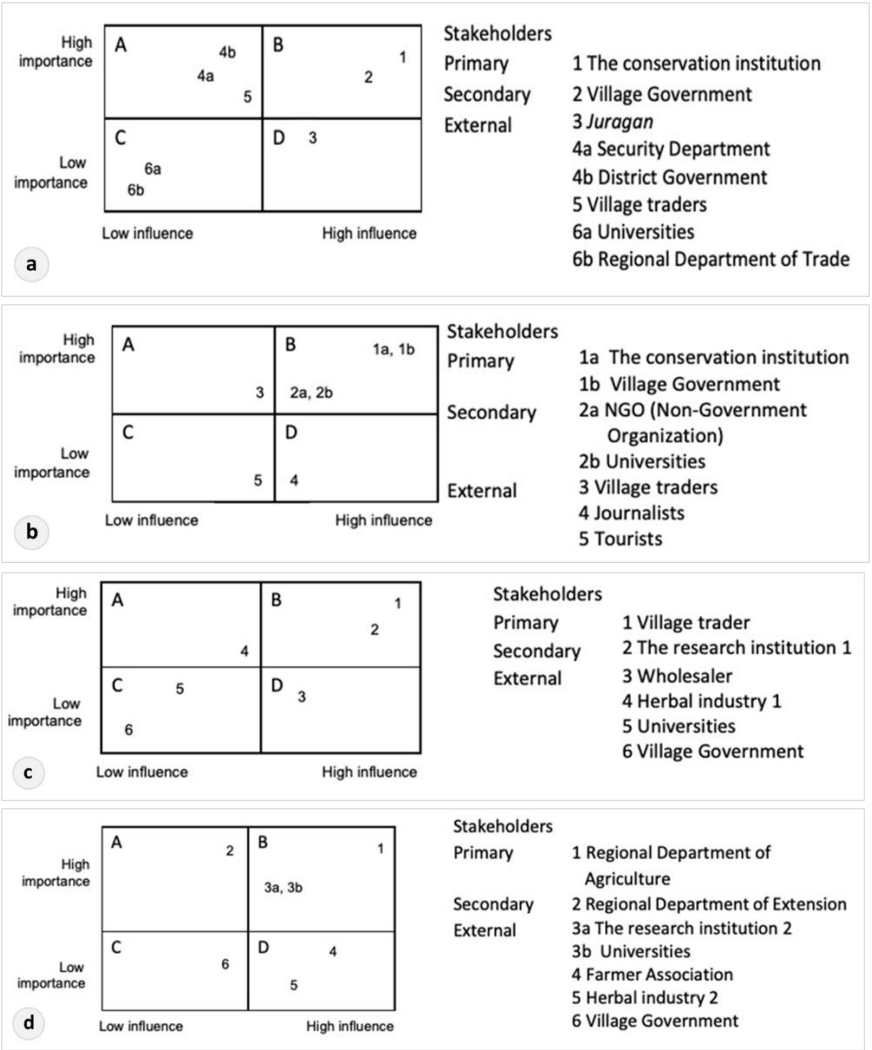

Figure 2. Matrix classification of stakeholders in three production systems; (a) Forest gathering-Village A; (b) Forest farming-Village B; (c) Farm-based outgrower production-Village C; (d) Farm-based outgrower production-Village D.

For outgrower production, village traders and the Regional Department of Agriculture occupy the first layer of the process in Village C and Village D, respectively. Both connect to herbal industries, although Village D has a stronger

relationship than Village C due to a better-established organization. In Village C, village traders sell dried products to wholesalers directly related to herbal industries. Research institution 1 facilitates extension and accommodates some herbal medicine materials. However, their capacity limits supply, which can often be an abundance of production. The local community recognizes that universities contribute slightly to research and education, while the village government indirectly supports the business conditions. In Village D, some institutions pay little attention to the community, namely the research institution 2, Universities, Farmer Association, herbal Industry 2, and the village government. Nevertheless, during the contract period, local farmers are dissatisfied with the unstable prices the herbal industry pays. So, they often decide to terminate the contract temporarily.

4. DISCUSSION

The discussion synthesizes several key aspects, namely management of medicinal plants production system performance enhancement, and local economic resource empowerment. These aspects are necessary to assist a better plan for future management of medicinal plant production systems and livelihood improvement.

4.1 Major priorities to enhance management of medicinal plant production

Applying the PRA method for diagnosing production management of medicinal plants helped to investigate the needs and interests of gatherers and farmers. Following Assche (2015) and Hoggart & Buller (2016), the diagnostic analysis focused on local people as the key actors who share their knowledge and experiences within an open sphere. PRA can provide a foundation of relevant inputs for a multistakeholder platform to support further action plans. The previous studies pointed out that a specific local-context approach should be considered to upgrade medicinal plants' production system management (Maikhuri et al., 2017; Marshall et al., 2003; Ros-Tonen et al., 2005). They include essential factors, such as financial instruments, value addition, market access, community organization, state intervention, available infrastructure, local knowledge systems, conservation, domestication, and livelihood improvement. In general, most of the research in Indonesia conducted on medicinal plant production systems either focus on wild gathering or cultivation and related aspects. This study contrasts both production systems by capturing current and future management strategies and their performance. The study thus permits the identification of root cause and reasonable solutions.

The results of the diagnostic investigation in this study demonstrated that all three production systems rely more on current solutions (see Appendix 1), causing unsatisfied returns due to high expense for carrying out the entirety of management practices. The three production systems required more enhancement to earn sustainable rewards for gatherers and farmers. The PRA results showed that local economic group initiatives, market assurance, access rules, and institutional support are the primary priorities to enhance production systems' performance.

PRA investigation indicated that local economic group initiatives are required to strengthen local resources-based management, empower gatherer/farmer groups' capacity, and increase viable income opportunities. For outgrowers, a reasonable price and an abundance of stock are the central focus. Herbal industries depend on outgrower product supply. However, the lack of mutualism in Village D and the weak bargaining position in Village C led to low margins in which the revenues could not cover the high costs of production inputs. In Village D, outgrowers indicated that during their cooperation with herbal industries, the price remained low, and the result of the negotiation process was often unsatisfying. The findings are corroborated by

recent studies that comprise the value chain approach, cooperative marketing promotion, rare species management, willingness to cultivate, product quality assurance, innovation, community-based approach, balancing conservation goals and industrial needs, political will, and property rights (Chowdhury et al., 2018; Negi et al., 2018; Sheppard et al., 2020). Therefore, strengthening a temporary self-help group for gatherers and forest farmers, and the Farmer Association for outgrowers is vital.

Regarding market assurance, the PRA results demonstrated that market access is the first rank in the consideration of all production systems, followed by safe and harmful management practices, priority species, and the importance of stakeholder roles. Knowing that some species are rare in forest gathering and forest farming, domestication is urgently required to foster the supply side and generate remunerative revenue alongside species conservation goals. Specifically, the national government and herbal industries should focus more on improving cultivation. This is alongside a recent gradual shift from wild gathering to cultivation in Asia (Astutik et al., 2019; Cunningham et al., 2018; Shengji et al., 2010). Market assurance is related to value chain approach, cooperative marketing promotion, rare species management, willingness to cultivate, product quality assurance, innovation, community-based approach, balancing conservation goals and industrial needs, political will, and property rights (Chowdhury et al., 2018; Negi et al., 2018; Sheppard et al., 2020). Thus, integrating market channels and continuous supply of needed products can be a valuable strategy to enhance production systems performance.

Gatherers who harvest the products in the natural forest recognize that access rule is the most pivotal issue in ensuring the continuity of collection activities. Ribot & Peluso (2009) emphasized that access analysis can affect the dynamics of resources management, sustainability, equity, and efficiency regarding conflict, cooperation, well-being, and justice. Since the natural forest of CI supports local actors, such as their livelihoods handed down from generation to generation, a two-way dialogue is urgently needed to understand the interests of both parties. On the other hand, CI—as a conservation institution—commits to protecting the area through their constitutional mandate. Concerning forest farmers who have user rights in the buffer zone area of CI, their major concerns encompass market channels, appropriate technologies adoption for planting and post-harvesting, and low prices. Even though the top ten commercial products are mostly available, the low price causes low-income generation. The buffer zone strategy enables local people to meet their livelihood needs continuously in line with protecting biodiversity (Dash et al., 2016; Salafsky & Wollenberg, 2000; Silori & Badola, 2000). Accordingly, periodic evaluation and improvement of all program impacts on inhabitant household economies applied at buffer zone areas are needed.

On institutional support, the Venn diagram highlighted that the primary stakeholders play a significant role in all production systems. In the meantime, identification of proper stakeholder participation uses the degree (high/low) of importance and influence. Gatherers perceive that CI occupies a central position in terms of access rules. CI and VG both have high importance and influence, while *Juragan* has a strong influence but low importance. The situation indicates that the three of them as key actor groups could be considered to support the forest gathering scheme. In the case of the forest farming system, farmers identify four stakeholders that represent both high importance and influence, they are CI, VG, NGO, and Universities. Journalists have high leverage with low importance. For out-growers in Village C, village trader and research center 1 are acknowledged to have high importance and influence. The wholesalers have high influence with low importance. In the case of outgrowers in Village D, the three stakeholders are critical and

influential: the Regional Department of Agriculture, research center 2, and universities. Farmer Associations and herbal industry 2 are recognized to have high influences with low importance. For outgrowers in Village D, the two last stakeholders are highly engaged in helping with value-adding strategies and entering the more prospective market at local to global levels.

Thus, the first supposition based on the finding mentioned above can be derived as follows: Primary priorities required in improving the performance of medicinal plants production systems cover local economic group initiatives, market assurance, access rules, and institutional support alongside local context considerations.

4.2 Synergistic diversity toward local economic resource empowerment

The multistakeholder platform proposition, as shown in Appendix 1 and Figure 3, illustrates two further steps required after the participatory diagnostic investigation. It describes opportunities on how experiences on the changing views of local situations and could provide additional input for stakeholders to translate plans into action. Proposed actions and all the following aspects should consider community needs due to the broader goals of feasibility and resource availability. It also specifically extends from Table 1, which described identified problems associated with the specific production system. However, most proposed actions address all production systems. These propositions are rooted in the PRA process and are emergent from the casual dialogues with key local leaders and main stakeholders. Hence, it ensures all people's participation in preconceived planning and pragmatic decision-making, with an eye towards more efficient implementation.

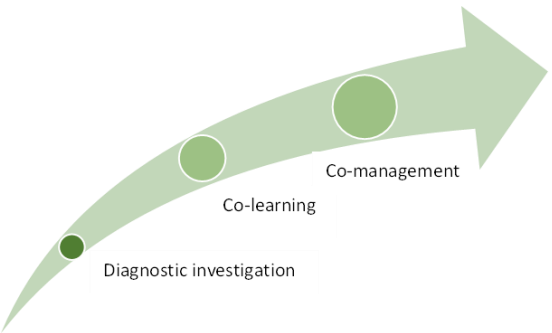

Figure 3. Continuum of participatory engagement toward future management of medicinal plants' production systems.
[Source: Adopted from Lynam et al. (2007) and Miller et al. (2017)].

Figure 3 shows that diagnostic investigation is the first level of the participatory approach, playing a role as the bottom-up initiative in the development process. All information on local needs and interests is summarized by gatherers and farmers to support further decision-making steps. The most crucial elements needed in this stage are the participants' openness, a realization of socio-cultural and economic differences of the local communities, full encouragement to equal opportunity of aspirations, facilitator's immersion skill within local knowledge and their daily life, the ability to constraints identification, and a focus on solutions (Damayanti & Syarifuddin, 2020; Omodei Zorini et al., 2004; Rossio & Seo, 2020; Shamsuddin et al., 2007; Wiersberg et al., 2016). The second phase is co-learning, which grants shared understanding of local circumstances among all responsible parties to propose action plans with the help of outsiders (facilitators) and it can also be seen as a social learning process (Hakkarainen et al., 2022; Parkes & Panelli, 2001; Thorburn et al.,

2011). The primary point to underline in this stage is the mutual transmission of knowledge, capacity, and views toward common goal achievement. Borrini-feyerabend et al. (2007) and Sarkki et al. (2015) pointed out that co-management as the last stage is a complex process in which local people and relevant stakeholders collaborate and share power, knowledge, resources and responsibility to sustainably manage set of natural resources. Several steps are required: preparation, negotiation and learning-by-doing. These indicate that transparent communication of comprehensive local aspirations to seek fair sharing needs greater attention. In this study, medicinal plants as natural resources are mostly commercialized to meet market demand. Sydneysmith et al. (2010) emphasized that this situation faced sensitivity to changes in environmental aspects and institutional arrangements. Therefore, the decision-making process should focus more on allowing wider space for locals' rights, powers, and benefit sharing between government, the private sectors, academia, NGOs, and others. Otherwise, co-management can potentially raise conflicts and marginalize local voices (Daulay et al., 2023; Dharmiasih, 2020; Fisher et al., 2017). This implies that diagnostic analysis is the baseline and a must in implementing the entire stages of the decision-making process which can be accomplished at a co-management level.

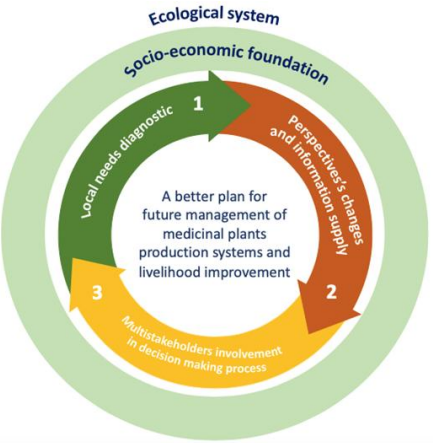

Figure 4. A multistakeholder platform and the feasible actions proposition
[Source: Adopted from Buytaert et al. (2018) and Raworth, (2017)]

The proposed actions aim to develop a support system for a better future of management practices and performance of the three production systems (see Figure 4 and Appendix 1). These are based on current solutions carried out by gatherers and farmers under interconnected socioeconomic backgrounds and ecological systems. These serve as a set of considerations in the decision-making process of current priorities toward future actions extracted through the local needs' diagnostic. It promotes dynamic perspectives of stakeholders for further collaboration in designing desired management outcomes. For instance, the access rule's consultation for forest gathering is proposed alongside CI's consideration of several relevant regulations to achieve a better solution. The community seed bank is vital in ensuring seedling supply for a good harvest. A well-established cooperative or *BUMDES* (village-owned enterprises) can be a local economic institution to cover marketing, for example, and can strengthen the bargaining position at any level of medicinal plant markets. Due to the availability of critical resources, almost all are already in place to provide and distribute use value and generate returns.

Figure 4 illustrates that promoting multistakeholder participation is a must to realize the co-existence of all parties involved. Stakeholder agents and beneficiaries can optimize their specific roles and develop collaborations with promising partners. Support for stakeholders comprises soft and hard skills emphasizing mutual gains and a fruitful partnership. In this regard, we suggest the development process to integrate production systems areas into landscape-level management. This is especially due to the location of Village A and Village B within the area of a global conservation and development institution. For example, the conservation and development institution agenda can incorporate forest gathering and forest farming, thus improving production system performance.

The second supposition that can also contribute is to establish a further management initiative of medicinal plant production systems in Java. This was formulated as follows: First, a plan for future sustainable management must accommodate three co-dependency pillars, namely a local needs diagnostic, information supply, and multistakeholder involvement elaborated under the perspective of socio-economic foundations and ecological systems.

For a multistakeholder platform to be successful, some categories must reflect the appropriate level of basic needs of each action. Participatory, top-down, and technical approaches can support empowerment, address power imbalances, and assist in more sustainable natural resource-based use when done correctly. Meanwhile, the potential outcomes can result in new regulations, agreements, and management models. Legally binding rules can strengthen overall responsibility and maintain the social reputation of all actors.

This study is inspired by the concept of financial performance of production systems aimed to further explore the sustainability of the medicinal plant management system (Rasul et al., 2012b; Rasul & Thapa, 2006). Understanding the complex nuances of production and marketing challenges faced by local farmers is important for formulating effective strategies from the upstream to the downstream diagnostic analysis. In the production process, the emphasis on local economic group initiatives stands out as crucial in improving local resource-based management, catering specifically to the unique needs of farmers in a particular locality. This not only provides farmers with access to the right resources but also tailors technologies to their specific requirements. Furthermore, the empowerment of gatherer and farmer groups through capacity-building remains at the forefront of suggested strategies. This approach to empowerment, envisioned through targeted training programs, can improve knowledge on efficient production techniques, rare species management, and innovation, directly impacting the quality and quantity of outputs.

The challenge of economic sustainability faced by outgrowers underscores the significance of striking a balance between product price and stock availability. However, in villages with lower margins, the gap between revenues and the high cost of production input remains a primary problem. Such challenges may find resolutions in bulk purchasing or the introduction of subsidies to cut down costs. While gatherers often miss out on these essential practices, outgrowers have embraced them, leading to a marked difference in product quality. This postharvest gap can be bridged through the universal adoption of technical practices, enhancing product quality and making them more competitive. For gatherers, there is great potential in adopting new strategies, especially post-harvest processing as outgrowers. The problem is the level of readiness to adopt new interventions given the local impacts it might create. This requires careful approaches to extension, training, infrastructure, and identifying a willingness to adopt before moving forward. In the end, gatherers are usually more concerned about the cash income they receive by selling raw materials to village

traders to fulfil their daily needs. Additionally, the potential commercial viability of certain species presents an opportunity worth exploring, given the potential markets for such products.

On the marketing side, findings underline the necessity for gatherers, forest farmers, and outgrowers to unite, either as collectives or in the form of cooperatives, to enhance their bargaining position in the market. An effective marketing strategy stepping in the value chain approach can be the key to solving efficiency challenges. However, to sell a food product in the market, it is crucial to obtain the appropriate certifications and licenses. It is not enough to ensure compliance with safety standards and regulations, but enhancements must be made to the product's credibility among consumers. A product certification attests to its quality, while a food safety license assures consumers of its safety for consumption. Additionally, for those catering to specific demographics or markets, such as Indonesia, a halal food certification[8] can significantly broaden the product's appeal. Holding these certifications allows sellers to determine a better price. These credentials can also expand their customer base, underscoring the significance of thorough documentation in the food industry. Moreover, by understanding the value-adding activities, the farmer groups who have the right to manage reforestation areas located in the buffer zone of the CI to their products, will ensure their efficiency at every stage. This approach, complemented by the elimination of middlemen through direct interactions between farmers and buyers or offtakers could transform the pricing structure. Support from stakeholders by combining market research and improved product efficiency can further help farmers nail down a competitive price point.

Lastly, the essence of a multistakeholder platform embedded within local actor participation emerges as a key point for the future collaboration among them. Such platforms can act as a vital channel between farmers, buyers, and policymakers. They can harmonize the needs and demands of all involved, culminating in better prices and more effective market strategies. These diagnostic analyses underscore the importance of strengthening production processes while adopting innovative marketing strategies. Furthermore, the importance of institutional support, a hybrid of community-based and government-based models, supported by clear property rights and political will only amplify the potential success of these strategies (Sambodo et.al, 2023). The diagnostic analysis accentuates the confluence of strengthened production methodologies and innovative marketing strategies, with all stakeholders operating in tandem, leading to the foundation of a sustainable and profitable system.

5. CONCLUSION

The Participatory Rapid Appraisal (PRA) approach as a participatory diagnostic investigation proves useful for exploring local needs and interests. The study indicates that marketing issues (Appendix 2) are the main problems in three production systems management leading unsatisfactory returns and deficit income. Gatherers and forest farmers carry out limited post-harvesting treatment leading to low quality products, corresponding low prices. In the case of outgrowers, they practice medium to advanced post-harvest handling, potentially granting increased prices and expanded market access for their products. Therefore, gatherers, forest farmers and outgrowers need to optimize their production systems management and improve their bargaining position in the market scheme. The species listed in this research could be further

[8] Halal food certification is a process by which food products are verified to ensure they comply with the Islamic religion dietary laws. The term "halal" means "permissible" in Arabic.

developed for commercial purposes to increase the profit margins. Based on the research results, the following aspects are required to enhance production system performance. These include: local economic group initiatives, domestication, access rules, and institutional support. Local gatherers, forest farmers, and outgrowers perceive that the level of importance and influence plays a pivotal role in classifying stakeholders in order to improve medicinal plants production systems performance. Thus, an action plan of a multistakeholder platform is urgently needed to ensure that post-participatory programmes take account of the local context. Local actor participation in targeted and supportive ways can fundamentally enhance the effectiveness of a multistakeholder platform in the future to develop medicinal plants production systems management.

Author contributions: Conceptualization, writing—original draft preparation, methodology, data analysis, funding acquisition: SA; writing, methodology, data analysis: VA, KSH, MAH, PP; review and editing: SA, VA, KSH, MAH, PP.

Competing Interests: The authors declare no potential conflict of interest.

Acknowledgments: We would like to extend our gratitude to local communities at the Province of East Java, Central Java, and West Java for welcoming us, sharing knowledge, experiences, and perspectives, field assistants during data collection, the conservation institution and local governments for allowing to work at the study areas, RISET PRO (Research and Innovation in Science and Technology Project)-Ministry of Research, Technology, and Higher Education of the Republic of Indonesia for funding the fieldwork, also BRIN-National Research and Innovation Agency, Indonesia for providing the institutional support. We also gratefully acknowledge the remarkable comments and feedback of Dr. Jude Ndzifon Kimengsi and all reviewers.

REFERENCES

Adhikari, B., Di Falco, S., & Lovett, J. C. (2004). Household characteristics and forest dependency: Evidence from common property forest management in Nepal. *Ecological Economics*, *48*(2), 245–257. https://doi.org/10.1016/j.ecolecon.2003.08.008

Adi, M.B.S., Safrina, D., Wahyono, S. (2022). Determinants of the lack of interest in cultivating medicinal plants in Wonogiri, Central Java. *Jurnal Tumbuhan Obat Indonesia*, *15*, 118–125. http://dx.doi.org/10.22435/jtoi.v15i2.6210

Agius, S. J. (2013). Qualitative research: Its value and applicability. *Psychiatrist*, *37*(6), 204–206. https://doi.org/10.1192/pb.bp.113.042770

Angelsen, A., Jagger, P., Babigumira, R., Belcher, B., Hogarth, N. J., Bauch, S., … Wunder, S. (2014). Environmental income and rural livelihoods: A global-comparative analysis. *World Development*, *64*(S1), S12–S28. https://doi.org/10.1016/j.worlddev.2014.03.006

Anyaegbunam, C., Mefalopulos, P., Moetsabi, T. (2004). *Participatory Rural Communication Appraisal. Starting with the people: A handbook*. FAO of The United Nations.

Armstrong, J. (2010). Naturalistic Inquiry. In N. J. Salk (Ed.), *Encyclopedia of research design* (pp. 880–885). SAGE Publications Inc.

Ashby, J., & Pretty, J. (2006). Commentary: Participatory research for sustainable agricultural research and development. *International Journal of Agricultural Sustainability*, *4*(2), 97–98. https://doi.org/10.1080/14735903.2006.9684792

Asmin, F., Darusman, D., Ichwandi, I., & Suharjito, D. (2019). Mainstreaming community-based forest management in West Sumatra: Social forestry

arguments, support, and implementation. *Forest and Society*, *3*(1), 77–96. https://doi.org/10.24259/fs.v3i1.4047

Assche, K.V., Hornidge, A. K. (2015). *Rural development: Knowledge & expertise in governance*. Wageningen Academic Publishers.

Astutik, S., Pretzsch, J., Kimengsi, J. N. (2019). Asian medicinal plants' production and utilization potentials: A review. *Sustainability*, *11*(5483), 1–33. https://doi.org/10.3390/su11195483

Bar-on, A. A., & Prinsen, G. (1999). Planning, communities and empowerment: An introduction to participatory rural appraisal. *International Social Work*, *42*(3), 277–294. https://doi.org/10.1177/002087289904200303

Beers, S. J. (2001). *Jamu the ancient Indonesian art of herbal healing*. Tutle Publishing.

Belcher, B., & Schreckenberg, K. (2007). Commercialisation of non-timber forest products: A reality check. *Development Policy Review*, *25*(3), 355–377. https://doi.org/10.1111/j.1467-7679.2007.00374.x

Borrini-feyerabend, G., Farvar, M. T., Nguinguiri, J. C., & Ndangang, V. A. N. (2007). *Co-management of natural resources*. Kasparek Verlag.

BPOM Republik Indonesia. (2020). *Sebaran Sarana Produksi Obat Tradisional Terdata di Badan POM*. Indonesia.

BPS-Statistics Indonesia. (2017). *Statistik tanaman biofarmaka Indonesia*. BPS-Statistics.

BPS-Statistics Indonesia. (2019). *Statistics of medicinal plants Indonesia 2018*. BPS-Statistics Indonesia.

Brown, K. (2002). Innovations for conservation and development. *Geographical Journal, 168*(1), 6-17. https://doi.org/10.1111/1475-4959.00034

Bryman, A. (2016). *Social research methods* (5th Edition). Oxford University Press.

Burns, N. (1989). Standards for qualitative research. *Nursing science quarterly, 2*(1), 44-52. https://doi.org/10.1177/089431848900200112

Buytaert, W., Ochoa-Tocachi, B.F., Hannah, D.M., Clark, J., Dewulf, A. (2018). Co-generating knowledge on ecosystem services and the role of new technologies. In M. Schreckenberg, K., Mace, G., Poudyal (Ed.), *Ecosystem Services and Poverty Alleviation: Trade-Offs and Governance* (p. 174-188). Routledge.

Caister, K., Green, M., & Worth, S. (2012). Learning how to be participatory: An emergent research agenda. *Action Research*, *10*(1), 22–39. https://doi.org/10.1177/1476750311414737

Cameron, S. I., Smith, R. F., & Kierstead, K. E. (2005). Linking Medicinal/Nutraceutical Products Research with Commercialization. *Pharmaceutical Biology*, *43*(5), 425–433. https://doi.org/10.1080/13880200590963736

Campbell, J. R. (2001). Participatory rural appraisal as qualitative research: Distinguishing methodological issues from participatory claims. *Human Organization*, *60*(4), 380–389. https://doi.org/10.17730/humo.60.4.4bgnlmy60fkvq4r2

Canter, P. H., Thomas, H., & Ernst, E. (2005). Bringing medicinal plants into cultivation: Opportunities and challenges for biotechnology. *Trends in Biotechnology*, *23*(4), 180–185. https://doi.org/10.1016/j.tibtech.2005.02.002

Castelli, G., & Bresci, E. (2017). Participatory rural appraisal for Diagnostic Analysis of spate irrigation systems in Raya Valley, Ethiopia. *Journal of Agriculture and Rural Development in the Tropics and Subtropics*, *118*(1), 129–139.

Chambers, R. (1994). *Paradigm Shifts and the Practice of Participatory Research and Development. Power and Participatory Development*. Institute of Development Studies (IDS).

Chambers, R. (1994a). Participatory Rural Appraisal (PRA): Analysis of Experience. *World Development*, *22*(9), 1253–1268. https://doi.org/10.1016/0305-750X(94)90003-5

Chambers, R. (1994b). Participatory rural appraisal (PRA): Challenges, potentials and paradigm. *World Development*, *22*(10), 1437–1454. https://doi.org/10.1016/0305-750X(94)90030-2

Chambers, R. (1994c). The Origins and Practice of Participatory Rural Appraisal. *World Development*, *22*(7), 953–969. https://doi.org/10.1016/0305-750X(94)90141-4

Chambers, R. (2013). *Ideas for development*. Earthscan.

Chapman, K., & Chomchalow, N. (2005). Production of medicinal plants in Asia. *Acta Horticulturae*, *679*, 45–59. https://doi.org/10.17660/ActaHortic.2005.679.6

Chowdhury, M. A., Zahra, F. T., Rahman, M. F., & Islam, K. (2018). Village Common Forest Management in Komolchori, Chittagong Hill Tracts, Bangladesh: An Example of Community Based Natural Resources Management. *Small-Scale Forestry*, *17*(4), 535–553. https://doi.org/10.1007/s11842-018-9402-9

Clayton, B.D., Dent, D., Dubois, O. (2003). *Rural planning in developing countries*. Earthscan.

Cundill, G., Shackhelton, S., Larsen, H. O. (2011). Collecting contextual information. In S. Angelsen, A., Larsen, H.O., Lund, J. F., Hall, C.S., Wunder (Eds.), *Measuring livelihoods and environmental dependence. Methods for research and fieldwork* (pp. 71–88). Earthscan.

Cunningham, A. B., Brinckmann, J. A., Schippmann, U., & Pyakurel, D. (2018). Production from both wild harvest and cultivation: The cross-border Swertia chirayita (Gentianaceae) trade. *Journal of Ethnopharmacology*, *225*, 42–52. https://doi.org/10.1016/j.jep.2018.06.033

Damayanti, R. A., & Syarifuddin, S. (2020). The inclusiveness of community participation in village development planning in Indonesia. *Development in Practice*, *30*(5), 624–634. https://doi.org/10.1080/09614524.2020.1752151

Dash, M., Behera, B., & Rahut, D. B. (2016). Determinants of household collection of non-timber forest products (NTFPs) and alternative livelihood activities in Similipal Tiger Reserve, India. *Forest Policy and Economics*, *73*, 215–228. https://doi.org/10.1016/j.forpol.2016.09.012

Daulay, M. H., Susanti, F. D., & Laraswati, D. (2023). New land governance models and management scenarios : Fitting Forest Management Units (FMUs) for forested landscapes outside forest zones in Indonesia. *Forest and Society*, *7*(1), 43–60. https://doi.org/10.24259/fs.v7i1.23962

Denzin, N.K., Lincoln, Y. S. (2018). *The SAGE handbook of qualitative research* (5th Edition). SAGE Publications Inc.

Dharmiasih, W. (2020). Cultural Landscapes in the Asia-Pacific : Re-focusing UNESCO Designation on Community Participation. *Forest and Society*, *4*(2), 271–279. https://doi.org/10.24259/fs.v4i2.10028

Diniyati, D., Achmad, B. (2015). Kontribusi pendapatan hasil hutan bukan kayu pada usaha hutan rakyat pola agroforestry di Kabupaten Tasikmalaya. *Journal Ilmu Kehutanan*, *9*(1), 23–31. https://doi.org/10.22146/jik.10181

Dovie, D. B. K. (2003). Whose involvement? Can hierarchical valuation scheme intercede for participatory methods for evaluating secondary forest resource use? *Forest Policy and Economics*, *5*(3), 265–283. https://doi.org/10.1016/S1389-9341(02)00066-7

Elfahmi, Woerdenbag, H. J., & Kayser, O. (2014). Jamu: Indonesian traditional herbal medicine towards rational phytopharmacological use. *Journal of Herbal Medicine*, *4*(2), 51–73. http://dx.doi.org/10.1016/j.hermed.2014.01.002

FAO. (2022). *Participatory Rural Appraisal*. FAO. Retrieved January 20, 2022 from https://www.fao.org/3/W2352E/W2352E06.html

Fisher, L. A., Kim, Y. S., Latifah, S., & Mukarom, M. (2017). Managing forest conflicts: perspectives of Indonesia's forest management unit directors. *Forest and Society, 1*(1), 8-26. https://doi.org/10.24259/fs.v1i1.772

Fisher, M. R., Dhiaulhaq, A., & Sahide, M. A. K. (2019). The politics , economies , and ecologies of Indonesia ' s third generation of social forestry : An introduction to the special section. *Forest and Society*, *3*(1), 152–170. https://doi.org/10.24259/fs.v3i1.6348

Frey, L.R., Botan, C.H., Kreps, G. L. (2000). Naturalistic inquiry. In Frey, L.R., Botan, C.H., Kreps, G. L. (Eds.), *Investigating communication. An introduction to research methods* (2nd Edition) (pp. 257-285). Allyn and Bacon.

Friday, J. B., McArthur, H. J., & Watson, L. A. (2006). Using participatory rural appraisal and participatory research and extension in a post-independence environment: A case from east timor. *International Journal of Agricultural Sustainability*, *4*(2), 108–118. https://doi.org/10.1080/14735903.2006.9684794

Hakkarainen, V., Mäkinen-Rostedt, K., Horcea-Milcu, A., D'amato, D., Jämsä, J., & Soini, K. (2022). Transdisciplinary research in natural resources management: Towards an integrative and transformative use of co-concepts. *Sustainable Development, 30*(2), 309-325. https://doi.org/10.1002/sd.2276

He, J., Yang, B., Dong, M., & Wang, Y. (2018). Crossing the roof of the world: Trade in medicinal plants from Nepal to China. *Journal of ethnopharmacology, 224*, 100-110. https://doi.org/10.1016/j.jep.2018.04.034

Hennink, M. M. (2014). *Focus Group Discussions*. Oxford University Press.

Heubach, K., Wittig, R., Nuppenau, E. A., & Hahn, K. (2011). The economic importance of non-timber forest products (NTFPs) for livelihood maintenance of rural west African communities: A case study from northern Benin. *Ecological Economics*, *70*(11), 1991–2001. https://doi.org/10.1016/j.ecolecon.2011.05.015

Hickey, G. M., Pouliot, M., Smith-Hall, C., Wunder, S., & Nielsen, M. R. (2016). Quantifying the economic contribution of wild food harvests to rural livelihoods: A global-comparative analysis. *Food Policy*, *62*, 122–132. https://doi.org/10.1016/j.foodpol.2016.06.001

Hidayat, S. (2012). Keberadaan Dan Pemanfaatan Tumbuhan Obat Langka Di Wilayah Bogor Dan Sekitarnya. *Media Konservasi*, *17*(1), 33–38.

Hoggart, K., & Buller, H. (2016). *Rural development: A geographical perspective*. *Rural Development: A Geographical Perspective*. Routledge.

Horsburgh, D. (2003). Evaluation of qualitative research studies. *Journal of Clinical Nursing*, *12*, 307–312. https://doi.org/10.1136/ebn.6.2.36

Jeelani, S. M., Rather, G. A., Sharma, A., & Lattoo, S. K. (2018). In perspective: Potential medicinal plant resources of Kashmir Himalayas, their domestication and cultivation for commercial exploitation. *Journal of Applied Research on Medicinal and Aromatic Plants*, *8*, 10–25. https://doi.org/10.1016/j.jarmap.2017.11.001

Kamanga, P., Vedeld, P., & Sjaastad, E. (2009). Forest incomes and rural livelihoods in Chiradzulu District, Malawi. *Ecological Economics*, *68*(3), 613–624. https://doi.org/10.1016/j.ecolecon.2008.08.018

Kar, S. P., & Jacobson, M. G. (2012). NTFP income contribution to household economy and related socio-economic factors: Lessons from Bangladesh. *Forest Policy and Economics*, *14*(1), 136–142. https://doi.org/10.1016/j.forpol.2011.08.003

Karunamoorthi, K., Jegajeevanram, K., Vijayalakshmi, J., & Mengistie, E. (2013). Traditional medicinal plants: A source of phytotherapeutic modality in resource-

constrained health care settings. *Journal of Evidence-Based Complementary and Alternative Medicine*, *18*(1), 67–74. https://doi.org/10.1177/2156587212460241

Kitto, S.C., Chesters, J., Grbich, C. (2019). Quality in qualitative research. *Medical Journal of Australia*, *188*(4), 211–233. https://doi.org/10.5694/j.1326-5377.2008.tb01595.x

Liu, H. Gale, S.W., Cheuk, M-L. and Fischer, G. A. (2018). Conservation impacts of commercial cultivation of endangered and overharvested plants. *Conservation Biology*, *33*(2), 288–299. https://doi.org/10.1111/cobi.13216

Lubbe, A., & Verpoorte, R. (2011). Cultivation of medicinal and aromatic plants for specialty industrial materials. *Industrial Crops and Products*, *34*(1), 785–801. https://doi.org/10.1016/j.indcrop.2011.01.019

Lynam, T., de Jong, W., Sheil, D., Kusumanto, T., & Evans, K. (2007). A review of tools for incorporating community knowledge, preferences, and values into decision making in natural resources management. *Ecology and Society*, *12*(1), 5. http://dx.doi.org/10.5751/ES-01987-120105

Maikhuri, R. K., Negi, V. S., Rawat, L. S., & Pharswan, D. S. (2017). Bioprospecting of medicinal plants in Nanda Devi Biosphere Reserve : Linking conservation with livelihood. *Current Science*, *113*(4), 571–577. https://doi.org/10.18520/cs/v113/i04/571-577

Malley, Z. J. U., Semoka, J. M. R., Kamasho, J. A., Kabungo, C. V, Malley, Z. J. U., Semoka, J. M. R., & Kamasho, J. A. (2010). Participatory assessment of soil degradation in the uplands of southwestern Tanzania: Implications for sustainable agriculture and rural livelihoods. *International Journal of Sustainable Development & World Ecology*, *13*(3), 183–197. https://doi.org/10.1080/13504500609469671

Marshall, E., Newton, A. C., & Schreckenberg, K. (2003). Commercialisation of non-timber forest products: first steps in analysing the factors influencing success. *International Forestry Review*, *5*(2), 128–137. https://doi.org/10.1505/ifor.5.2.128.17410

Mayring, P. (2007). Generalization in Qualitatively Oriented Research 2 . The Logic of Generalization. *Forum: Qualitative Social Research*, *8*(3). https://doi.org/10.17169/fqs-8.3.291

Miller, D. C., Rana, P., & Wahlén, C. B. (2017). A crystal ball for forests?: Analyzing the social-ecological impacts of forest conservation and management over the long term. *Environment and Society, 8*(1), 40-62. https://doi.org/10.3167/ares.2017.080103

Misbahuzzaman, K., & Smith-Hall, C. (2015). Role of Forest Income in Rural Household Livelihoods: The Case of Village Common Forest Communities in the Chittagong Hill Tracts, Bangladesh. *Small-Scale Forestry*, *14*(3), 315–330. https://doi.org/10.1007/s11842-015-9290-1

Moen, K., & Middelthon, A. L. (2015). Qualitative Research Methods. In Laake, P., Benestad, H. B., & Olsen, B. R. (Eds.), *Research in Medical and Biological Sciences: From Planning and Preparation to Grant Application and Publication* (pp. 321–378). Elsevier Ltd. http://dx.doi.org/10.1016/B978-0-12-799943-2.00010-0

Morgan, D. L. (2019). *Basic and advanced focus groups*. SAGE Publications Inc.

Narayanasamy, N. (2009). *Participatory Rural Appraisal. Principles, methods and application*. SAGE Publications Inc.

Negi, V. S., Kewlani, P., Pathak, R., Bhatt, D., Bhatt, I. D., Rawal, R. S., … Nandi, S. K. (2018). Criteria and indicators for promoting cultivation and conservation of

medicinal and aromatic plants in Western Himalaya, India. *Ecological Indicators*, *93*, 434–446. https://doi.org/10.1016/j.ecolind.2018.03.032

Nemarundwe, N., Richards, M. (2002). Participatory methods for exploring livelihood values derived from forests: potential and limitations. In Campbell, M. K., & Luckert, B. M. (Eds.), *Uncovering the hidden harvest: Valuation methods for woodlands and forest resources* (pp. 168–197). Earthscan.

Neuman, W. L. (2014). *Social research methods: Qualitative and quantitative approaches* (7th Edition). Pearson Education Limited.

Noble, H., & Smith, J. (2015). Issues of validity and reliability in qualitative research. *Evidence-Based Nursing*, *18*(2), 34–35. https://doi.org/10.1136/eb-2015-102054

Noordwijk, M. Van, Tomich, T. P., Verbist, B., Ecology, S. C., & Jan, N. (2002). Negotiation support models for integrated natural resource management in tropical forest margins. *Conservation Ecology*, *5*(2), 21. http://dx.doi.org/10.5751/ES-00344-050221

Nugroho, I. A., Nurrochmat, D. R., & Hardjanto, H. (2016). Commercialization of Medicinal Plants in Java Island, Indonesia. *Jurnal Manajemen Hutan Tropika (Journal of Tropical Forest Management)*, *22*(2), 114–125. http://dx.doi.org/10.7226/jtfm.22.2.114

Oli, B. N., Treue, T., & Smith-Hall, C. (2016). The relative importance of community forests, government forests, and private forests for household-level incomes in the Middle Hills of Nepal. *Forest Policy and Economics*, *70*, 155–163. http://dx.doi.org/10.1016/j.forpol.2016.06.026

Olsen, C. S. (2005). Valuation of commercial central Himalayan medicinal plants. *Ambio*, *34*(8), 607–610. https://doi.org/10.1579/0044-7447-34.8.607

Omodei Zorini, L., Contini, C., Jiddawi, N., Ochiewo, J., Shunula, J., & Cannicci, S. (2004). Participatory appraisal for potential community-based mangrove management in East Africa. *Wetlands Ecology and Management*, *12*(2), 87–102. https://doi.org/10.1023/B:WETL.0000021672.15252.54

Orb, A., Eisenhauer, L., & Wynaden, D. (2001). Ethics in qualitative research. *Journal of Nursing Scholarship*, *33*(1), 93–96. https://doi.org/10.1111/j.1547-5069.2001.00093.x

Pandit, B. H., & Kumar, C. (2010). Factors influencing the integration of non-timber forest products into field crop cultivation: A case study from eastern nepal. *Journal of Sustainable Forestry*, *29*(6), 671–695. https://doi.org/10.1080/10549811003741599

Parkes, M., & Panelli, R. (2001). Integrating catchment ecosystems and community health: the value of participatory action research. *Ecosystem Health, 7*(2), 85-106. https://doi.org/10.1046/j.1526-0992.2001.007002085.x

Phondani, P. C., Bhatt, I. D., Negi, V. S., Kothyari, B. P., Bhatt, A., & Maikhuri, R. K. (2016). Promoting medicinal plants cultivation as a tool for biodiversity conservation and livelihood enhancement in Indian Himalaya. *Journal of Asia-Pacific Biodiversity*, *9*(1), 39–46. https://doi.org/10.1016/j.japb.2015.12.001

Prado Córdova, J. P., Wunder, S., Smith-Hall, C., & Börner, J. (2013). Rural income and forest reliance in highland Guatemala. *Environmental Management*, *51*(5), 1034–1043. https://doi.org/10.1007/s00267-013-0028-6

Preece, J. (2006). Participatory Rural Appraisal: Lessons for Countries in the North? *International Journal of Action Research*, *2*(2), 198–221. https://nbn-resolving.org/urn:nbn:de:0168-ssoar-379558

Press, O. U. (2023). *Oxford Reference*. Retrieved March 2, 2023, from https://www.oxfordreference.com

Pretzsch, J., Darr, D., Uibrig, H., & Auch, E. (2014). *Forests and rural development* (Vol. 9). Springer-Verlag, Germany.

Pribadi, E. R. (2015). Pasokan dan permintaan tanaman obat Indonesia serta arah penelitian dan pengembangannya. *Perspektif: Review Penelitian Tanaman Industri*, *8*(1), 52–64. https://doi.org/10.21082/p.v8n1.2009.%p

Rasul, G., Choudhary, D., Pandit, B. H., & Kollmair, M. (2012a). Poverty and livelihood impacts of a medicinal and aromatic plants project in India and Nepal: An assessment. *Mountain Research and Development*, *32*(2), 137–148. https://doi.org/10.1659/MRD-JOURNAL-D-11-00112.1

Rasul, G., Choudhary, D., Pandit, B. H., & Kollmair, M. (2012b). Poverty and livelihood impacts of a medicinal and aromatic plants project in India and Nepal: An assessment. *Mountain Research and Development*, *32*(2), 137–148. https://doi.org/10.1659/MRD-JOURNAL-D-11-00112.1

Rasul, G., & Thapa, G. B. (2006). Financial and economic suitability of agroforestry as an alternative to shifting cultivation: The case of the Chittagong Hill Tracts, Bangladesh. *Agricultural Systems*, *91*(1–2), 29–50. https://doi.org/10.1016/j.agsy.2006.01.006

Raworth, K. (2017). *Doughnut economics. Seven ways to think like a 21st-century economist*. Penguin Random House.

Rayamajhi, S., Smith-Hall, C., & Helles, F. (2012). Empirical evidence of the economic importance of Central Himalayan forests to rural households. *Forest Policy and Economics*, *20*, 25–35. http://dx.doi.org/10.1016/j.forpol.2012.02.007

Ribot, J. C., & Peluso, N. L. (2009). A Theory of Access*. *Rural Sociology*, *68*(2), 153–181. https://doi.org/10.1111/j.1549-0831.2003.tb00133.x

Rijal, A., Smith-Hall, C., & Helles, F. (2011). Non-timber forest product dependency in the Central Himalayan foot hills. *Environment, Development and Sustainability*, *13*(1), 121–140. https://doi.org/10.1007/s10668-010-9252-x

Riswan, S., Roemantyo, S. (2002). Jamu as traditional medicine in Java, Indonesia. *South Pacific Study*, *23*, 2–10.

Rocheleau, D. E. (1994). Participatory research and the race to save the planet: Questions, critique, and lessons from the field. *Agriculture and Human Values*, *11*(2–3), 4–25. https://doi.org/10.1007/BF01530443

Ros-Tonen, Mirjam, Wiersum, A.F., Freerk, K. (2005). The Scope for Improving Rural Livelihoods Through Non-Timber Forest Products: an Evolving Research Agenda. *Forests, Trees and Livelihoods*, *15*(2), 129–148. https://doi.org/10.1080/14728028.2005.9752516

Rossio, C. P. Y., & Seo, Y. (2020). Participatory Approaches in the Planning of Drinking Water Supply and Basic Sanitation Projects in the Rural Areas of Colombia. *KSCE Journal of Civil Engineering*, *24*(4), 1374–1382. https://doi.org/10.1007/s12205-020-1091-1

Ruiz-Pérez, M., Belcher, B., Achdiawan, R., Alexiades, M., Aubertin, C., Caballero, J., … Youn, Y. C. (2004). Markets drive the specialization strategies of forest peoples. *Ecology and Society*, *9*(2). http://dx.doi.org/10.5751/ES-00655-090204

Salafsky, N., & Wollenberg, E. (2000). Linking livelihood and conservation: a conceptual framework and scale for assessing the integration of human needs and biodiversity. *World Development*, *28*(8), 1421-1438-. https://doi.org/10.1016/S0305-750X(00)00031-0

Sanogo, D., Ndour, B. Y., Sall, M., Toure, K., Diop, M., Camara, B. A., … Thiam, D. (2017). Participatory diagnosis and development of climate change adaptive capacity in the groundnut basin of Senegal: Building a climate-smart village model. *Agriculture and Food Security*, *6*(1), 1–12. https://doi.org/10.1186/s400

66-017-0091-y

Sarkki, S., Rantala, L., & Karjalainen, T. P. (2015). Fit between Conservation Instruments and Local Social Systems : Cases of Co-management and Payments for Ecosystem Services. *Change and Adaptation in Socio-Ecological Systems, 2,* 59–78. https://doi.org/10.1515/cass-2015-0007

Schippmann, U., Leaman, D., & Cunningham, A. B. (2006). A comparison of cultivation and wild collection of medicinal and aromatic plants under sustainability aspects. In D. Bogers, J., Craker, L.E., Lange (Eds.), *Medicinal and Aromatic Plants: Agricultural, Commercial, Ecological, Legal, Pharmacological and Social Aspects* (pp. 75–95). Springer Netherlands.

Schippmann, U., Leaman, D. J., Cunningham, A. B., Leaman, J.;, D., & Cunningham, A. B. (2002). Impact of cultivation and gathering of medicinal plants on biodiversity: global trends and issues. *Biodiversity and the Ecosystem Approach in Agriculture, Forestry and Fisheries*, *2*, 31–44. FAO.

Shackleton, S., Shanley, P., & Ndoye, O. (2007). Invisible but viable: Recognising local markets for nontimber forest products. *International Forestry Review*, *9*(3), 697–712. https://doi.org/10.1505/ifor.9.3.697

Shamsuddin, M., Alam, M. M., Hossein, M. S., Goodger, W. J., Bari, F. Y., Ahmed, T. U., … Khan, A. H. M. S. I. (2007). Participatory rural appraisal to identify needs and prospects of market-oriented dairy industries in Bangladesh. *Tropical Animal Health and Production*, *39*(8), 567–581. https://doi.org/10.1007/s11250-007-9062-9

Shengji, P., Hamilton, A. C., Lixin, Y., Huyin, H., Zhiwei, Y., Fu, G., & Quangxin, Z. (2010). Conservation and development through medicinal plants: A case study from Ludian (Northwest Yunnan, China) and presentation of a general model. *Biodiversity and Conservation*, *19*, 2619–2636. https://doi.org/10.1007/s10531-010-9862-5

Sheppard, J. P., Chamberlain, J., Agúndez, D., Bhattacharya, P., Chirwa, P. W., Gontcharov, A., … Mutke, S. (2020). Sustainable Forest Management Beyond the Timber-Oriented Status Quo: Transitioning to Co-production of Timber and Non-wood Forest Products—a Global Perspective. *Current Forestry Reports*, *6*(1), 26–40. https://doi.org/10.1007/s40725-019-00107-1

Shukla, S., & Gardner, J. (2006). Local knowledge in community-based approaches to medicinal plant conservation: lessons from India. *Journal of Ethnobiology and Ethnomedicine*, *2*, 20. https://doi.org/10.1186/1746-4269-2-20

Siahaan, S., & Aryastami, N. K. (2018). Studi Kebijakan Pengembangan Tanaman Obat di Indonesia. *Media Penelitian Dan Pengembangan Kesehatan*, *28*(3), 157–166. https://doi.org/10.22435/mpk.v28i3.119

Silori, C. S., & Badola, R. (2000). Medicinal plant cultivation and sustainable development. *Mountain Research and Development*, *20*(3), 272–279. https://doi.org/10.1659/0276-4741(2000)020[0272:MPCASD]2.0.CO;2

Smith-Hall, C., Larsen, H. O., & Pouliot, M. (2012). People, plants and health: A conceptual framework for assessing changes in medicinal plant consumption. *Journal of Ethnobiology and Ethnomedicine*, *8*, 43. https://doi.org/10.1186/1746-4269-8-43

Stringer, L. C., Dougill, A. J., Fraser, E., Hubacek, K., Prell, C., & Reed, M. S. (2006). Unpacking "participation" in the adaptive management of social-ecological systems: A critical review. *Ecology and Society*, *11*(2). http://dx.doi.org/10.5751/ES-01896-110239

Sydneysmith, R., Andrachuck, M., Smit, B., Hovelsrud, G. K. (2010). Vulnerability and adaptive capacity in Arctic communities. In Armitage, R. & Plumme, D. (Eds.),

Adaptive capacity and environmental governance (p. 307). Springer Germany.

The National Development Planning Agency/BAPPENAS RI. (2003). *Indonesian Biodiversity Strategy and Action Plan National Document*. BAPPENAS Republic of Indonesia.

Thorburn, P.J., Jakku, E., Webster, A. J., Everingham, Y. L. (2011). Agricultural decision support systems facilitating co-learning: a case study on environmental impacts of sugarcane production. *International Journal of Agricultural Sustainability*, *9*(2), 322–333. https://doi.org/10.1080/14735903.2011.582359

Ticktin, T. (2015). The ecological sustainability of non-timber forest product harvest. Principles and methods. In Shackleton, T., Pandey, C. M., & Ticktin, A.K. (Eds.), *Ecological Sustainability for Non-timber Forest Products. Dynamics and Case Studies of Harvesting* (pp. 31–52). Routledge.

Tilaar, M., Widjaja, B. T. (2015). *The tale of Jamu. The green gold of Indonesia*. Gramedia Pustaka Utama.

Vedeld, P., Angelsen, A., Bojö, J., Sjaastad, E., & Kobugabe Berg, G. (2007). Forest environmental incomes and the rural poor. *Forest Policy and Economics*, *9*(7), 869–879. https://doi.org/10.1016/j.forpol.2006.05.008

Walelign, S. Z., Charlery, L., Smith-Hall, C., Chhetri, B. B. K., & Larsen, H. O. (2016). Environmental income improves household-level poverty assessments and dynamics. *Forest Policy and Economics*, *71*, 23–35. https://doi.org/10.1016/j.forpol.2016.07.001

Wiersberg, T., Callo-Concha, D., & Ewert, F. (2016). Pitfall or priority drift? Participatory tree domestication programs: The case of agroforestry in the Peruvian Amazon. *Journal of Sustainable Forestry*, *35*(7), 486–499. http://dx.doi.org/10.1080/10549811.2016.1213641

Yin, R. K. (2018). *Case study research and aplications. Design and methods* (6th Edition). SAGE Publications Inc.