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# The dynamics of Indonesia agricultural development and livelihoods in drylands: concepts, actors, and challenges

## *Dinamika pembangunan pertanian dan penghidupan di lahan kering Indonesia: konsep, pelaku, dan tantangan*

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**Abstrak**

Keragaman pendekatan dari aktor negara, LSM, dan sektor swasta dalam mengembangkan pertanian lahan kering mencerminkan kompleksitas tantangan nasional. Perbedaan pendekatan tersebut menyoroti perlunya pemahaman yang lebih mendalam mengenai sinergi dan integrasi untuk mencapai tujuan pembangunan berkelanjutan. Meningkatnya peran pola tumpang sari menunjukkan relevansinya dalam mengatasi tantangan pengembangan pertanian lahan kering; namun, mengatasi tantangan lingkungan dan sosial yang kompleks sangatlah penting untuk meningkatkan kesejahteraan masyarakat. Penelitian ini bertujuan untuk mengkaji dinamika pembangunan pertanian dan penghidupan pada komunitas petani lahan kering. Penelitian ini menggunakan metode tinjauan literatur. Temuan penelitian menggarisbawahi bahwa, dalam konteks pertanian lahan kering di Indonesia, berbagai pendekatan dari aktor negara, LSM, dan sektor swasta memerlukan sinergi melalui desentralisasi, partisipasi, dan kemitraan. Pola tumpang sari muncul sebagai model yang bermanfaat untuk meningkatkan agroekosistem dan ketahanan pangan di daerah perdesaan. Pengelolaan yang berkelanjutan membutuhkan pengakuan terhadap praktik-praktik tradisional, memahami faktor-faktor yang memengaruhi transisi tanaman, dan terlibat dalam kolaborasi lintas lembaga untuk mengatasi tantangan lingkungan dan meningkatkan kesejahteraan masyarakat.

*Kata kunci: mata pencaharian, pembangunan pertanian, pertanian lahan kering, petani lahan kering*

**Abstract**

The diversity of approaches from state actors, non-government organizations (NGOs), and the private sector in developing dryland agriculture reflects the complexity of national challenges. Differences in approaches highlight the need for a deeper understanding of synergy and integration to achieve sustainable development goals. The increasing role of intercropping patterns demonstrates its relevance in addressing the challenges of dryland agricultural development; however, addressing complex environmental and social challenges is essential to improve community well-being. This study aims to examine the dynamics of agricultural development and livelihoods in dryland farming communities. This study utilizes literature review methods. The research findings underscore that, within the context of dryland agriculture in Indonesia, various approaches from state actors, NGOs, and the private sector necessitate synergy through decentralization, participation, and partnerships. Intercropping patterns emerge prominently as beneficial models for improving agroecosystems and food security in rural areas. Sustainable management requires acknowledging traditional practices, understanding factors influencing crop transitions, and engaging in cross-institutional collaborations to address environmental challenges and enhance community well-being.

*Keywords: agricultural development, dryland farmers, dryland farming, livelihoods*

## 1. Introduction

This research investigates the dynamics of agricultural development and livelihoods in a dryland farming community. The intricate relationship between agricultural development and livelihoods warrants a contextual approach, as posited by Gibbens and Schoeman (2020). Considering Sustainable Development Goal (SDG) 1, "End Poverty," agricultural development needs a sustainability dimension. Feliciano (2019) emphasizes the necessity for new research and impact evaluation methods adopting a sustainable approach

to poverty, particularly in assessing how crop diversification contributes to SDG 1. Thus, understanding the intersection of agricultural development and sustainability dimensions in current Indonesian contexts becomes imperative.

Agriculture remains integral in the 21st-century development agenda, playing a dual role across the five key pillars of growth, poverty alleviation, gender equality, food security, and environmental sustainability (Byerlee et al. 2009; Mursalat 2022). It is a linchpin for sustainable development (Stanciu et al. 2019; Volkov et al. 2021), exerting significant pressure on the environment while being a preserver of biodiversity (Marinov 2019; Wiśniewski et al. 2021) and contributing to landscape diversification and enhancement (Wiśniewski et al. 2021). By 2050, Indonesia is expected to become the world's fifth-largest food provider after China, India, Nigeria, and the United States (Kementerian Pertanian 2020).

Agriculture generates employment opportunities and enhances the productivity of millions of small-scale farmers (Byerlee et al. 2009). According to the Pusat Kajian Anggaran Badan Keahlian DPR RI (2021), the agricultural sector significantly contributes to Indonesia's gross domestic product (GDP). From 2011 to 2019, its average contribution stood at 13.25% (second to the manufacturing industry). Moreover, it remains the largest job provider, contributing an average of 32.21% compared to other sectors, which contribute less than 19%.

According to Zakaria (2000), rural changes are driven by both the state and rural elites, who play pivotal roles. However, non-state actors such as civil society organizations and the private sector (companies) also significantly influence rural development. Non-state actors are often viewed as more agile, with less rigid organizational structures, allowing for more efficient actions than state bureaucracies (Weiss et al. 2013). In the agricultural sector, the private sector plays a crucial role in driving transformations in the food and agriculture system due to consolidation, globalized supply chains, and technological innovation. FAO (2013) states that the private sector plays a critical role in nearly every dimension of the FAO's mission and mandate at national, regional, and global levels.

The collaboration between the Food and Agriculture Organization (FAO) and the private sector in addressing food insecurity requires working with community organizations at the grassroots level. This approach should be based on strong local relationships. Additionally, it is important to note that the private sector and non-governmental organizations (NGOs) play a crucial role in the development and production of agriculture, acting as catalysts for food security. Hence, the private sector and NGOs contribute to lifting many individuals in developing countries out of poverty and hunger through responsible and productive investments, innovation, efficiency improvements, and job creation (FAO 2013).

Nevertheless, both state and non-state actors are equally crucial in rural development. Despite studies indicating that non-state actors contribute more significantly than the state in agricultural development (Luqman et al. 2021), for instance, in agricultural extension, skill development, and providing micro-scale credit, state actors can create an environment conducive for the private sector to optimize its role in rural development. Hence, synergy between state and non-state actors is necessary in implementing rural development, including the agricultural sector (FAO 2013).

The sustainability of agricultural sector development cannot be defined separately from livelihood issues. Sustainable agriculture, food systems, and natural resource use are crucial to securing the livelihoods of the rural poor (FAO 2019). Pender (2004) identifies future livelihoods based on agricultural potential, market access, infrastructure provision, and population density. The implications of agriculture on sustainable livelihoods can be seen in terms of food security, a part of livelihood security that addresses food vulnerability (Haug 1999). Achieving food security today is not merely a matter of increasing total production levels but rather ensuring that individuals have the right to food (Ewoti 2024). Therefore, the rural agricultural sector—one element in a web of interconnected livelihood strategies—plays a role in development by improving the livelihood security of impoverished rural communities.

Previous studies emphasize the significance of examining the implications of specific agricultural development approaches and focus on the sustainability of farmers' livelihoods. This research investigates agricultural development and farmers' livelihoods within the specific context of a dryland farming community. This particular case is chosen due to the heterogeneous agricultural system and unique livelihood assets and farming practices in dryland areas (Haileslassie et al. 2016). Drylands are dynamic locations for commercial production activities (Li 2002). Therefore, exploring agricultural development and farmers' livelihoods in the context of dryland farming proves to be an intriguing area for study.

The researcher notes the importance of tailoring agricultural development programs to consider the distinct physical and socio-economic characteristics within specific local contexts, particularly related to

farming practices and agricultural commodities. Indonesian farmers actively respond to market dynamics and agricultural commodities, with farmers actively shifting from one livelihood strategy to another in response to changing crop prices and climate anomalies (Kühling et al. 2022). In addition, the emerging role of agricultural insurance and farmer cooperatives in sustainable rice production highlights the proactive approach of Indonesian farmers in managing risks and optimizing resources (Lopulisa et al. 2018). Several studies suggest that crop rotation or shifts in farming commodities are influenced by factors such as harvest times, prices (profitability), farming experience, and farmers' income (e.g., Sitorus 2007; Halimah 2013; Kaizan et al. 2014; Samosir 2015; Harahap 2018; Rajagukguk et al. 2018; Zulkarnain and Sukmayanto 2019; Setiani et al. 2019; Suchato et al. 2021; Arsi et al. 2021). Indonesian farmers consistently take steps to manage risks and maximize resources by employing various livelihood strategies, such as switching between different commodity crops. These strategies are influenced by both economic factors and the ecological environment (Ariyanto 2023a).

The novelty of this research lies in its deep understanding of the synergy among various development approaches adopted by actors within the context of dryland agriculture in Indonesia. Moreover, the emphasis on sustainable management recognizing traditional practices, understanding crop transition factors, and fostering inter-agency collaboration to address environmental challenges contributes significantly to the research literature on sustainable agricultural development in drylands. This paper also aims to explore (1) the concepts, perspectives, and actor approaches in agricultural development and (2) agriculture and the livelihoods of dryland farmers.

## 2. Methodology

This research employs a literature review method. This technique involves working with secondary data by sourcing materials from libraries through activities such as reading, note-taking, and processing research materials, including official documents from relevant institutions, scholarly journals, research reports, theses, dissertations, conference proceedings, and other scientific papers. The stages involved in this literature review are 1) defining the scope and context of the review topic, 2) identifying relevant and high-quality reference materials through Google Scholar, 3) selecting several references from Google Scholar and categorizing them based on the research topic, 4) organizing the previous research scheme from the acquired articles, 5) composing a review, and 6) drawing conclusions and applying the review results (Ariyanto 2023b).

The topic of this research revolves around the implications of agricultural development programs on sustainable livelihoods. Consequently, the researcher utilized keyword searches in both Indonesian and English languages, including terms such as "agricultural development," "rural development," "rural livelihoods," "sustainable agriculture," "dryland agriculture," "commodity change dynamics," "state and non-state development programs," "approaches in agricultural and rural development interventions," "agricultural development and livelihoods," "local governance and agricultural development," "rationalization of dryland farmers," and "sustainability of agricultural commodities." The researcher then sought reference articles aided by the Publish or Perish version 8 software, scouring around 1,000 documents using Google Scholar. Lastly, relevant articles were chosen from this pool of 1,000 articles, and their findings were compiled, elaborated upon, and summarized, serving to elaborate on the data from previous research findings.

## 3. Results and discussion

### *3.1. Agricultural development: concept, perspectives, and stakeholder approaches*

Development is defined as "improvement" (Pieterse 2010; Li 2012; Veltmeyer and Bowles 2021), organized intervention in collective affairs based on improvement standards (Pieterse 2010). Appropriate improvement and intervention criteria vary based on class, culture, historical context, and power relationships (Pieterse 2010). Development is a process in which members of a society enhance their personal and institutional capacities to mobilize and manage resources to generate sustainable and equitable improvements in their quality of life participatively, enhancing their well-being (Li 2012). The development also reflects an image of the desired improvement or change and acts as a theoretical tool involving policy and future projections (Pieterse 2010). It can also be defined as a process that amalgamates all the social, economic, political, and cultural forces shaping a society and links contemporary events with historical heritage (Hooks 2016).

In development studies, the terms "agricultural development" and "rural development" are often used interchangeably or equated. It is important to note that while rural communities are characterized by the significance of agricultural activities, rural development is broader than agricultural development (Szirmai 2005). Both are interconnected as agricultural development significantly contributes to rural development by improving the income and livelihoods of rural communities. However, the fundamental idea within both concepts is "improvement." Therefore, agricultural development can be defined as an effort to "improve" the agricultural (and rural) sector. As per de Laiglesia (2006) and Dumasari (2020), agricultural development is an endeavor to achieve economic growth, enhance living standards, and ensure sustainable well-being for farmers and communities, conducted by the government with community participation.

The majority of rural communities rely on the agricultural sector for their livelihoods, making agriculture the cornerstone of rural development. Various pieces of literature have examined the approaches used in agricultural and rural development. As cited by Thesocialripples (2020), rural development approaches consist of the bottom-up approach, participatory rural appraisal, rapid rural appraisal, community-based development approach, growth center approach, and others. Hence, the current emphasis is on the importance of participatory approaches to address the unique challenges and opportunities in rural areas (Ellis and Biggs 2001), particularly with a focus on agricultural development.

In addition to the above typologies, there are other concepts in agricultural development approaches. The integrated rural development approach serves as a multidimensional strategy to improve the quality of rural life (David 2012). Then, the agroecology approach aims to help countries achieve more sustainable food security and agricultural practices (Pretty 2006). The systems approach states that responsible social and environmental advancements will be based on thinking, knowing, and learning new ways (Chadfield et al. 2024). Additionally, the agribusiness and agro-industrial approach aim to enhance the competitiveness of farmers by strengthening agricultural cooperatives (Lestari 2020) to boost family income sources in rural areas.

The economic theories and theories related to agricultural development have significantly influenced rural development policies over the last half-century. Both donor practices and government policies have been shaped by broader thoughts on social, non-agricultural, and national development (Ellis and Biggs 2001). This is reflected in successive phases of rural development practices in low-income countries, occurring as a series of overlapping transitions: from community development (1950s) to an emphasis on smallholder agricultural growth (1960s); continued smallholder agricultural growth into integrated rural development (1970s); state-led rural development (1970s) transitioning to market liberalization (1980s); process-oriented approaches, participation, empowerment, and stakeholder engagement (1980s and 1990s); the emergence of sustainable livelihoods as an integrative framework (1990s); and integrating rural development into poverty reduction strategy documents (2000s).

The diverse perspectives and roles of these actors reflect the complexity and challenges in developing the agricultural sector sustainably. Agricultural development involves various actors with distinct roles and approaches. The state, private sector (business groups), and civil society organizations or non-governmental organizations (NGOs) are actors commonly involved in contemporary agricultural development in Indonesia. Understanding the roles and relationships between the state, private sector, and NGOs with village governments in the context of village autonomy (decentralization) is crucial to comprehend how agricultural development is carried out.

Decentralization has become a significant issue in the development theory and policy debate over the last two decades (Hadiz 2004), including in the agricultural development agenda. The political reforms in Indonesia since 1998 have opened new opportunities to alter the relationship between the state and the society. Village governments now have extensive autonomy, not requiring approval from higher authorities to make decisions and implement policies (Antlöv 2003). Decentralization has recognized the long-standing rights and duties of villages, improved service performance at the lowest administrative level, and reduced social disparities and poverty (Lewis 2015; Nasution 2016). However, decentralization has not fully leveraged widespread participation (Turner and Podger 2003).

While decentralization has progressed, development policies sometimes overlook the role of local leaders. For instance, in local infrastructure development programs and targeted social initiatives, local leaders and communities possess better knowledge about the poor than the central government (Galasso and Ravallion 2005; Alatas et al. 2012; Mansuri and Rao 2013). This implies an imbalance in

decentralization and its implementation, where policies disregarding the roles of local leaders and local knowledge can affect the effectiveness of development programs.

Rasahan (1996) states that the agricultural development paradigm has shifted from centralized planning to decentralization. New approaches in agricultural and rural development are based on decentralization, participation, and public-private partnerships (Suryana and Erwidodo 1996). Decentralization has the potential to address localized and heterogeneous agricultural aspects, particularly in extension services, by bringing the government closer to rural communities (Byerlee et al. 2009). The effectiveness of decentralization in agricultural development heavily relies on integrated innovations to enhance productivity, infrastructure development, especially in irrigation, and rural institutional development to improve agricultural productivity and production (Winoto and Siregar 2008; Rusastra et al. 2016).

The government's role in rural (agricultural) development involves steps towards decentralization, providing autonomy to village governments, and enhancing community participation. The involvement and responsibility of local governments and coordination between departments (horizontal coordination) play a crucial role in developing and maintaining agricultural infrastructure. Additionally, vertical coordination is necessary to integrate infrastructure development across various levels of governance (Winoto and Siregar 2008). The increasing scale of large land ownership has speculative dimensions, with the landowners engaged in non-agricultural activities and holding positions in village governance structures (Ambarwati et al. 2016).

Other than state and rural elite actors, rural development is also driven by non-state actors, such as NGOs and the private sector. Non-state actors tend to be more agile, and their loosely structured organizations allow for more efficient actions in addressing issues and improving living standards than state bureaucracy (Weiss et al. 2013). In the agricultural sector, the private sector plays a significant role in driving the transformation of food and agricultural systems due to the consolidation, globalization of supply chains, and new technological innovations. According to FAO (2013), private sector entities play a crucial role in almost every dimension of the FAO's mission and mandate at national, regional, and global levels.

The synergy between FAO and the private sector in combating food insecurity requires grassroots collaboration with NGOs, using a bottom-up approach and established local relationships. The development and production of agriculture are core activities of the private sector, and NGOs act as catalysts in the field of food security. Therefore, the private sector and NGOs contribute to lifting many people in developing countries out of poverty and hunger through responsible and productive investments, innovation, efficiency improvements, and job creation (FAO 2013).

Despite this, both state and non-state actors play equally important roles in rural development, utilizing both top-down and bottom-up approaches. Although some studies indicate that non-state actors have a greater contribution compared to the state in rural development, for example, in agricultural and forestry extension, education, healthcare, skill development, and providing microcredit (Luqman et al. 2021), state actors can create an environment conducive to the private sector to optimize its role in rural development. In the field of agriculture, FAO is well-positioned to facilitate dialogue and collaboration between the public and private sectors (FAO 2013). Therefore, the role of public-private partnerships in agricultural development, specifically how state actors and the private sector collaborate to promote agricultural development for achieving food security and poverty reduction, is crucial.

In Indonesia, interventions in agricultural and rural development often adopt a top-down approach. Rural communities frequently exhibit passivity, relying on external aid to implement development programs. The success of the Green Revolution in achieving rice self-sufficiency in 1984 is an example of the top-down approach in Indonesia (Assadi et al. 2009). The government used a top-down approach through extension programs and the deployment of field extension workers. Regarding agricultural development planning, Fadlina et al. (2013) revealed that the planning for organic agriculture development in Kota Batu was conducted by the Agency of Agriculture and Forestry using a technocratic approach concerning the technical and substantive aspects of planning. Additionally, there were top-down approaches adopted by the Ministry of Agriculture in the PUAP program in 2008 within the framework of the PNPM Mandiri (Jamal 2008). Moreover, there have been several programs with top-down approaches that yielded positive outcomes, such as the Insus program, which successfully achieved food self-sufficiency, and the SLPHT and PIR methods (Wahyuni 2009).

In Indonesia, state actors such as government bodies and ministries play a crucial role in intervening in agricultural and rural development. These state actors commonly employ a top-down approach in addressing agricultural concerns (Purwandari et al. 2012). This approach involves the central government or other higher-level institutions in decision-making and policy implementation, which is subsequently delegated to lower administrative levels, including regional and local governments.

Kementerian Pertanian (2022) has outlined several key approaches to support agricultural and rural development: 1) policy framework: developing policies and regulations to support agricultural and rural development; 2) infrastructure development: investing in rural infrastructure, such as roads, irrigation systems, and market facilities, to improve market access and increase productivity; 3) extension services: providing agricultural extension services to farmers, including training, technical assistance, and knowledge transfer, to enhance farming practices and increase productivity; 4) research and development: investing in agricultural research and development to promote innovation, develop new technologies, and enhance crop varieties. These approaches resemble those employed in countries like Zimbabwe and across Africa. Research conducted by the Ministry of Lands, Agriculture, Water, Climate and Rural Resettlement Zimbabwe (2018) indicates that investing in agricultural research and development, extension services, and rural infrastructure is crucial to achieving sustainable agricultural growth and reducing poverty.

The top-down approach employed by state actors in the intervention of agricultural and rural development in Indonesia is primarily characterized by policy formulation, resource allocation, planning and implementation, capacity building, monitoring and evaluation, as well as coordination and collaboration. Although the top-down approach has been dominant, there's increasing recognition of the importance of participatory and bottom-up approaches. The shift towards more inclusive approaches aims to enhance local ownership, ensure sustainability, and promote the overall well-being of rural communities. NGOs are often involved in enhancing community capacities and supporting autonomy and empowerment through assistance to community groups and participatory processes (Chowdhury and Islam 2024).

In Indonesia, the modernization approach as the paradigm for development programs and the concept of agricultural regions in its practical application has generated various social issues. Hence, there is a need for social groups that can mobilize communities to be empowered, such as grassroots social movements, NGOs (Shepherd 1998), with a participatory bottom-up approach. The main assumption of this approach prioritizes the community as the primary actor in all development activities (Munthe 2010). However, in the realm of development approaches, NGOs are not always successful in becoming a social movement to implement a bottom-up approach effectively. While initially established as independent organizations representing civil interests, they often face challenges of donor dependence and experience shifts in ideological orientations (Assadi et al. 2009).

Non-governmental organizations (NGOs) in Indonesia frequently collaborate with local communities and farmers to support agricultural and rural development. These organizations often utilize various participatory approaches in their interventions within the agricultural and rural development context in Indonesia (Budhi 2008). These participatory approaches encourage community involvement, empowerment, and ownership, enabling sustainable agricultural and rural development interventions that are context-specific and responsive to the needs of local communities in Indonesia. Some studies assert that regional and local development policies should not disregard the socio-economic conditions of rural communities through the participation of local actors (Konvitz 2001; Thomson et al. 2014; Chesterman et al. 2019; Bartolucci et al. 2022; Adego 2022).

Summarized from the studies by Barzin (2012), Islam (2017), and Abiddin et al. (2022), the examples of approaches utilized by NGOs in agricultural and rural development interventions include 1) capacity building through training programs for farmers and rural communities on sustainable agricultural practices, natural resource management, and entrepreneurship; 2) community empowerment by facilitating the formation of farmer groups or cooperatives to enhance collective bargaining power, access to credit, and marketing opportunities; 3) advocacy and policy influence by advocating policy changes and influencing decision-making processes concerning land rights, sustainable agriculture, and rural development; and 4) sustainable livelihoods by promoting diverse and sustainable livelihood strategies such as agroforestry, livestock husbandry, and activities for increasing non-agricultural income.

The private sector, including agribusiness companies and investors, also plays a crucial role in agricultural and rural development interventions in Indonesia. The bottom-up approach is adopted by

the private sector in these interventions to empower local communities, enhance their livelihoods, and promote sustainable and inclusive rural development (Thorpe and Maestre 2015). Examples of bottom-up approaches utilized by the private sector in agricultural and rural development interventions encompass 1) value chain development, involving investments in supply chain infrastructure to enhance market access and value addition; 2) engaging smallholder farmers through contract farming arrangements providing inputs, technical assistance, and guaranteed markets; 3) investment and technology transfer, incorporating agricultural investments, adopting advanced farming technology, and promoting best practices to improve productivity and efficiency; and 4) market linkages, facilitating connections between smallholder farmers and buyers to enhance market access and income opportunities.

The private sector plays a strategic role in accelerating agricultural development through corporate social responsibility (Iqbal and Sudaryanto 2008). According to McEwan et al. (2017) and Kamnoonwatana et al. (2018), the private sector utilizes a community development approach in local and national development. While the private sector can address some shortcomings of the public extension system, challenges are faced, including misuse of public funds, inadequate farmer accountability, unfair service provision, inadequate quality, and limited coverage of various farmer needs (Feder et al. 2011).

### *3.2. Dryland agricultural development: concept, actors, and challenges*

#### *3.2.1. Farming and livelihoods of dryland farmers*

About 60% of dryland areas are situated in developing countries (Parr et al. 1990). In Indonesia, the dryland area reaches approximately 144.47 million hectares (about 88.7% of the total agricultural land area) (Kementerian Pertanian 2022). Drylands are regions with low rainfall (less than 2,000 mm per year) and limited soil moisture, making agriculture in these areas highly dependent on weather uncertainties, particularly rainfall (FAO n.d; Stewart 2016). In this concept, dryland farming comprises two aspects: dryland agriculture (plantations) and home gardens, both with distinct characteristics. In Javanese terminology, home gardens are referred to as gardens within a home (Li 2002). In the context of dryland in Lampung, Kusworo (2013) uses the term "*tegalan*" for dryland and "irrigated fields" for paddy fields. Li (2002) describes "irrigated fields" or rain-fed fields, typically planted with rice. Meanwhile, "*tegalan*" or "*tegal*" refers to dry fields that are more or less permanently cultivated. Levang's 1989 survey highlighted that irrigated fields, gardens, perennial shoots, and dry fields with annual food crops were the primary farming systems in Lampung in the 1980s. These systems were often practiced as mixed farming (Kusworo 2013) .

The concept of dryland agricultural development is multifaceted, encompassing sustainable practices, water use efficiency, and crop diversification. Shangyou et al. (1997) and Shehrawat and Singh (2003) both emphasize the importance of sustainable agriculture, with Shehrawat highlighting the economic and social aspects and Shang-you focusing on water use efficiency and diverse crop products. Yu-fen (2014) further explores the potential for dryland agricultural development in northwestern China, emphasizing the need for comprehensive development, diversified business operations, and policy and engineering support. Stewart and Thapa (2016) underscores the challenges of dryland farming, including the need for water conservation, sustainable crop yields, and the adoption of conservation agriculture. These studies collectively underscore the importance of sustainable practices, water use efficiency, and crop diversification in dryland agricultural development.

In studies of dryland agriculture, the focus is on exploring cultural aspects and their dynamics. For instance, studies such as Bustan et al. (2020) explore the Manggarai culture, indicating that the cultural function of Manggarai identity has changed with the community's dynamics. This includes changes within the dryland agricultural system, such as variations in the name and form of agricultural land, the number and types of cultivated land, land preparation techniques, crop varieties, and seasonal classification taxonomy (Bustan et al. 2020). In the North Central Timor District, cultural changes within dryland agriculture are also evident. Sasi (2022) describes how the *atoni pah meto*, which consists of eighteen rituals of farming, five work patterns, gender-based work division, and work ethic, have shifted due to interactions with other nationalities, ethnicities, and global climate change, influencing the agricultural rituals, work patterns, work division, and work ethic. Climate change has significantly impacted the existence and culture of farmers, particularly in terms of farming rituals, work patterns,

division of labor, and work ethics, influencing the sustainability of agriculture and the livelihoods of rural communities.

In West Timor, Tjoe (2016) studied the role of tribal communities and customary law in the sustainable livelihoods in dryland subsistence corn cultivation. Findings indicate that the clan system and customary law play a role in reducing livelihood vulnerability by managing community forest resources and preserving members' rights to access agricultural land and natural resources. This aligns with the findings of Neely et al. (2009) that the recognition of traditional resource use affects their access to resources and economic and social development and reduces the impacts of drought and climate change. As Scoones suggests, during the dry season, long-term pressures on asset ownership and investment strategies influence production and consumption patterns, resulting in shifts in vulnerability levels (Scoones 1996).

van Ginkel et al. (2013) state that dryland agriculture involves a complex mix of productive components: staple crops, vegetables, livestock, trees, and fish that are interconnected and interact, especially in cultivated areas and water flows. Managing risk and enhancing productivity through sustainable diversification and intensification are crucial to secure and improve rural livelihoods. Intercropping systems play a role in improving agroecosystems, increasing productivity, and farming income (Prasmatiwi et al. 2023), contributing to the improvement of farmers' livelihoods (Ulukan et al. 2022).

Rana et al. (2001) and Matusso and Mucheru-Muna (2014) assert that intercropping is fundamentally a system for small-scale and dryland farmers. There's plenty of evidence that small-scale farmers are problem solvers who are adaptive, experimental, and experts in devising innovative survival strategies (Beckford et al. 2007). For instance, in Africa, intercropping of coffee-banana (van Asten et al. 2011), cereal-legumes (Matusso and Mucheru-Muna 2014), labor-efficient maize-based systems in China (Hong et al. 2019), and maize-legumes in Tanzania (Nassary et al. 2020) are far more beneficial for small-scale farmers than monoculture. The primary reasons small-scale farmers practice intercropping are flexibility, profit maximization, risk minimization, soil conservation and fertility enhancement, weed management, and pest and disease control (Matusso and Mucheru-Muna 2014; Mthembu et al. 2019).

### *3.2.2. Actors and challenges in dryland agricultural development*

Dryland agriculture, particularly in India and China, faces significant challenges in terms of low productivity, inadequate support, and the threat of climate change (Guo-qin 2008; Nagaraj 2013). Small and marginal farmers are the primary contributors to this sector, and their livelihoods are at risk due to these challenges (Nagaraj 2015). To address these issues, there is a need for the development and adoption of new production technologies, along with institutional, infrastructural, and policy interventions (Nagaraj 2013). Additionally, the reorientation of public policies, better targeting of development interventions, and the promotion of water as a catalyst for development are crucial for the sustainable growth of dryland agriculture (Bantilan et al. 2006).

Moving forward, Indonesia is expected to become increasingly reliant on dryland agriculture (Rejekiningrum et al. 2022). Efficient water usage is a primary focus in dryland agriculture. One strategy to enhance the productivity of dryland is through implementing a dryland climate water management approach (Haryati 2014; Heryani and Rejekiningrum 2020). This approach aims to support food self-sufficiency and involves various aspects such as water management, balanced fertilization, organic material management, soil amelioration and conservation, integration of crops and livestock, and strengthening farmer institutions (Haryati 2014; Heryani and Rejekiningrum 2020). The application of water-efficient irrigation is crucial under conditions of water scarcity. Tillage up to depths of about 20 to 30 cm has been widely employed in dryland agriculture as an effective method for rainfall (Stewart et al. 2006).

The dynamics of dryland agricultural development in various countries, including Indonesia, often involve the role of livestock in improving land fertility and providing an additional source of income for farmers, especially those with small plots of land. Livestock, particularly in smallholder farming systems, play a crucial role in enhancing land fertility and providing additional income sources (Arriaga-Jordán and Pearson 2004). However, the sector's growth must be managed to minimize environmental impact (Herrero et al. 2013). Forage-based studies in developing countries have shown the potential of forages in improving agricultural productivity and livestock nutrition (Ates et al. 2018). In Indonesia, small-scale cattle raising has been identified as a viable source of livelihood, especially in areas with rising urban demand for beef (Priyanti et al. 2015).

Dryland agriculture confronts various obstacles, including water scarcity, land degradation, and inadequate technology dissemination (Bantilan et al. 2006). Bantilan et al. (2006) and Farooq and Siddique (2016) stress the importance of water management, crop diversification, and institutional innovations to overcome these challenges. In India, pivotal for dryland agriculture, interventions encompass technological, institutional, infrastructural, and policy measures to enhance productivity (Nagaraj 2013). These efforts should prioritize new production technologies, efficient input delivery, and market connections. Despite these hurdles, dryland agriculture holds substantial promise in providing sustenance and livelihoods (Farooq and Siddique 2016).

Dryland agriculture faces numerous challenges, including unsustainable crop yields, frequent droughts, and soil erosion (Farooq and Siddique 2016). These challenges are exacerbated by poverty, malnutrition, and lack of infrastructure (Bantilan et al. 2006). To address these issues, there is a need for innovative water management, crop diversification, and better targeting of development interventions (Bantilan et al. 2006). The development and adoption of new production technologies, along with institutional, infrastructural, and policy support, are also crucial (Nagaraj 2015). However, the threat of climate change and the rise in non-farm wages further complicate the sustainability of dryland agriculture (Nagaraj 2015).

### *3.3. Crop diversification and the dynamics of dryland crop commodity switching: a challenge*

Sustainability in dryland agriculture is challenging due to various constraints such as poor soil fertility, inadequate irrigation facilities, moisture stress, small land ownership, and limited agricultural investment (Sagar 2020). Intercropping is a fitting choice to maximize productivity in drylands. It's considered an environmentally sustainable and economically beneficial cropping system (Fung et al. 2019; Glaze-Corcoran et al. 2020; Khanal et al. 2021; Ariyanto 2023a). Intercropping has proven to have advantages over monoculture systems in drylands. Kaizan et al. (2014) found that intercropping coffee in the Way Kanan District had better feasibility and land surplus than coffee monoculture. Intercropping contributes to sustainable food systems for rural farmers (Mthembu et al. 2019; Fung et al. 2019; Daryanto et al. 2020).

Crop rotation and diversification are fundamental strategies in agricultural diversification. In addition to diversification, another strategy employed by farmers to enhance their well-being is transitioning between cultivated crops. This entails the shift from one crop to another, which has been observed in various instances: coffee being replaced by rubber and citrus, rubber transitioning to oil palm and corn. Similarly, damar and candlenut crops are being substituted with cocoa, which in turn switches to pepper. Another example includes the shift from rice cultivation to sugarcane. These transitions signify changes in agricultural commodity crops in dryland areas involving both monoculture and intercropping practices.

The study on transitioning from coffee to rubber farming conducted by Kaizan et al. (2014) in the Way Kanan District, specifically analyzing smallholder coffee plantations, revealed that rubber farmers exhibited better viability than coffee farmers. Additionally, the surplus land used in rubber farming was larger than in coffee farming. The harvest period and prices were the most significant external factors influencing the shift from coffee to rubber farming. Internally, significant influential factors were farmer income, land size, livestock experience, and farmer age.

In another case, the shift from rubber to oil palm and maize was explored. For instance, findings from Harahap (2018) in North Sumatra revealed that the profitability of oil palm cultivation was higher than that of rubber. Rubber had low attractiveness and moderate competitiveness, while oil palm was highly attractive and competitive. Factors such as high rainfall, labor usage, investment costs, harvest duration, production costs, and selling prices influenced the decision to switch from rubber to oil palm. Additionally, Suliandari and Hidayat (2019) studied the replacement of rubber with maize in Subang and Purwakarta. Their findings suggested that this change was financially feasible under the assumption of normal productivity levels and prices.

The transition from coffee to citrus was examined in a study by Samosir (2015) in North Sumatra, revealing that production factors, prices (income), land size, knowledge (education), and farming experience were contributing factors causing coffee farmers to shift to citrus cultivation. Regarding the shift to cocoa cultivation in Lampung Selatan, Rajagukguk et al. (2018) studied the changes in plant composition and planting patterns in damar agroforestry to cocoa agroforestry. According to the real livelihood choice theory by Gladwin, their findings suggested that the change was influenced by income, production sustainability, gestation periods, maintenance and harvesting convenience, local knowledge, and the parent plant's tolerance when cultivated with other plants. The predominant planting pattern

involved cocoa as the primary crop alongside cloves, bitter beans, local fruit, and durian. Another pattern was a combination of damar as the main crop with cloves, durian, coconut, and bitter beans. In Gayo Lues District, Aceh, Halimah (2013) reported that factors influencing the transition from candlenut to chocolate cultivation were predominantly prices and income, while capital did not impact it.

In another scenario, Zulkarnain and Sukmayanto (2019) reported that the factors influencing farmers' decisions to switch from cocoa cultivation to pepper plants in East Lampung District included the farmer's age, family dependence, farming experience, and income. Additionally, in the case of shifting from longan to avocado, the decision was rationally influenced by easier maintenance, high economic value, stable and profitable sales for farmers (Arsi et al. 2021). Transitioning to a global case, in Thailand, Suchato et al. (2021) examined the shift from rice farming to sugarcane cultivation, finding that the size of land, experience in crop conversion, sugarcane prices, household assets, and assured sugarcane prices significantly affected farmers' land-use decisions. However, farmers' concerns about cash flow and their ability to access the sugarcane market critically reduced their likelihood of shifting to sugarcane production. They also tended to plant sugarcane when climatic conditions and soil fertility supported it.

In Indonesia, dryland agriculture plays a significant role in ensuring food security and generating income for rural communities. However, it faces numerous challenges, including climate change, soil degradation, and limited access to resources and technology. Understanding the current state of dryland agriculture and the livelihoods of dryland farmers is crucial for developing effective strategies to enhance their resilience and sustainability. As per study Haileslassie et al. (2016), dryland areas host diverse agricultural systems, each with unique livelihood assets and farming practices. Therefore, this final literature review emphasizes the livelihoods of dryland farmers.

In general, most literature examines farmers' livelihoods in dryland areas by analyzing food insecurity due to climate change and food resilience to alleviate rural poverty. Agricultural sustainability is a prerequisite for poverty reduction and food insecurity. Food availability is closely tied to food resilience and the sustainability of dryland agriculture. In East Nusa Tenggara, Riptanti et al. (2021) reported that sustainable management of dryland agriculture plays a crucial role in food-insecure areas. To enhance the sustainability of managing dryland agriculture in the future, several strategies have been applied. These include the involvement of financial institutions, group-based agricultural management patterns, agricultural insurance programs, the utilization of agricultural livestock waste (Riptanti et al. 2021), utilizing government and environmental inputs, reducing family resource inputs, using appropriate agricultural system models, leveraging government policies, enhancing output, and strengthening household food resilience among farmers (Riptanti et al. 2022).

Similarly, in Gunungkidul, research by Antriyandarti et al. (2023) shows that household food resilience remains low due to malnutrition and food insecurity. Hence, households in dryland farming areas need support from local government or private entities to receive information on managing expenses and ensuring good nutrition to improve food resilience. Collaboration among farmer communities, the government, and academia is considered an alternative approach to poverty alleviation. Agricultural intensification on land while curbing population growth (Ayu et al. 2022) is suggested. Strategies for adapting to climate change are vital for sustainable food resilience (Murniati and Mutolib 2020). Additionally, studies by Robinson et al. (2015) and Tui et al. (2021) demonstrate that sustainable agricultural intensification in dryland areas impacts food resilience and livelihoods.

Sustainable agricultural practices involve various approaches, and one key approach for sustainable agricultural development is crop diversification. Crop rotation is one of the practices of crop diversification in dryland farming. Crop diversification can enhance resilience by mitigating disease outbreaks and supporting crop production against the greater variability in climate and extreme events (Lin 2011; Tesfaye and Seifu 2016), while also enhancing ecosystem services in agriculture (Alcon et al. 2020).

Crop diversification has implications for enhancing crop productivity, income, food security, and household nutrition (Schroth and Ruf 2014; Makate et al. 2016; Barman et al. 2022). It provides a better condition for food security, enabling farmers to grow surplus products for sale in the market and improve household income. Diversification can also manage price risks by assuming that not all products will experience low market prices simultaneously, thereby enhancing the profitability of farming communities (Khanam et al. 2018).

## 4. Conclusions and policy implications

In Indonesia, the state actors have primarily implemented a top-down approach in agricultural and rural development interventions. NGOs play a significant role in Indonesia's agricultural and rural development interventions, employing various participatory approaches to engage local communities. The private sector also plays a crucial role in these interventions, often utilizing bottom-up approaches involving local communities. This has implications for rural agricultural development, emphasizing the importance of decentralized, participatory, and public-private partnership approaches. Additionally, both horizontal and vertical coordination between institutions and the government is necessary for agricultural development.

It is crucial to acknowledge indigenous practices in natural resource management. Recognizing these can impact communities' socio-economic development and their ability to address environmental challenges such as drought and climate change. Prior findings underscore the need for participatory and inclusive approaches involving local communities in decision-making processes related to natural resource management in dryland areas.

Crop diversification characterizes farming practices in drylands and is prevalent in small-scale agriculture. Many studies have found that crop diversification is superior compared to monoculture. Crop diversification has proven beneficial for improving agroecosystems in dryland agriculture, enhancing productivity, increasing income, minimizing risks, improving soil fertility, and furthering sustainable food security for rural farmers.

Dryland agriculture is highly open to transitions in the types of crops farmers cultivate. Farmers switch crop types due to factors like profitability, pricing, income, and farming experience. These rational factors guide farmers' choices in cultivating crops in dryland contexts, shaped by environmental and economic factors.

Dryland agriculture is heterogeneous and unique in its farming practices. It is closely related to livelihood issues as it's highly vulnerable to climate change. This vulnerability leads to food insecurity, contributing to poverty in rural areas. Hence, sustainable management of dryland farming systems is crucial, necessitating synergy between the central government, local authorities, agricultural institutions, farming communities, and financial institutions to achieve sustainable food security in drylands.

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