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Towards More Sustainable Agro-food Systems in Indonesia

by Maria Monica Wihardja, Bustanul Arifin and Mukhammad Faisol Amir

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GLOSSARY

AEHRD:
Agricultural Extension and Human Resource Development

ASEAN:
Association for Southeast Asian Nations

BMKG:
Badan Meteorologi, Klimatologi, dan Geofisika (Meteorology, Climatology, and Geophysics Agency)

CPO:
Crude Palm Oil

FLW:
Food Loss and Food Waste

FOLU:
Forestry and Other Land Use

GDP:
Gross Domestic Product

GHG:
Greenhouse Gas

MOA:
Ministry of Agriculture

NDC:
Nationally Determined Contribution

NGO:
Non-governmental Organization

OECD:
Organization for Economic Co-operation and Development

PES:
Payments for Environmental Services

RSPO:
Roundtable Sustainable Palm Oil

SRI:
System Rice Intensification

Susenas:
Survei Sosial Ekonomi Nasional (National Socioeconomic Survey)

EXECUTIVE SUMMARY

The agriculture sector in Indonesia has played a significant role in poverty reduction and economic transformation. However, challenges remain in improving agricultural productivity and farmers' incomes to eradicate extreme poverty and ensure food security. The agriculture sector accounts for around one-third of employment in Indonesia. To achieve Indonesia's ambitious goals of eradicating extreme poverty, improving agricultural productivity, and achieving net-zero carbon emissions, Indonesia needs to transition to more sustainable agro-food systems.

The current strategies for improving agro-food systems in Indonesia are no longer sustainable or effective. The sector has been both a contributor to and a victim of climate change, with agriculture, land-use change, and forestry as major contributors to greenhouse gas emissions. Deforestation for palm oil plantations has been a significant driver of land-use change. Sustainable agro-food systems are essential for achieving Indonesia's climate commitments and mitigating the impacts of climate change on farmers and fishers.

Several key challenges hinder the development of sustainable agro-food systems in Indonesia. These challenges include heavy reliance on ineffective agricultural supports, extensive land expansion for food production, high levels of food waste and loss, lack of agricultural extension services and climate information, and competing goals of food security and energy security. Addressing these challenges requires policy interventions and reforms.

Policy recommendations include redirecting agricultural subsidies towards supporting farmers directly, promoting intensification instead of land expansion, investing in post-harvest logistics and technologies to reduce food loss, strengthening agricultural extension services and climate information systems, and diversifying biofuel sources to reduce pressure on palm oil production. These measures aim to promote sustainability, improve productivity, and enhance the resilience of agro-food systems in Indonesia.

CURRENT SITUATION OF INDONESIA'S AGRO-FOOD SYSTEM

Agricultural growth has contributed significantly to poverty reduction and economic transformation in Indonesia. Although the sector's contribution to the country's gross domestic product has declined (from 17% in 1995 to 13% in 2019,) it still accounts for around one-third of Indonesian employment, compared with around 44% of employment in 1995 (Gil Sander & Yoong, 2021; Savelli et al., 2021).

The agriculture sector is estimated to have been responsible for about half of the reduction in extreme poverty[1] from 2000 to 2021, but the sector's growth has slowed in recent years. It grew by 3.89% and 3.61% in 2018 and 2019 respectively, but growth slowed to 1.75% and 1.84% in 2020 and 2021, and reached only 1.21–1.65% in the first three quarters of 2022 (Statistics Indonesia, 2022).This falling growth rate will not support an agricultural sector that contributes to poverty alleviation and human development. Indonesia's ambition to eradicate extreme poverty by the end of 2024 — it was 2.2% in 2021 — will be next to impossible without further improvement in agricultural productivity and farmers' incomes.

On the consumption side, Indonesia still faces huge challenges meeting its population's nutritional needs. The affordability of food plays a pivotal role in influencing individual nutritional well-being. Today despite ongoing improvement, 21.6% of Indonesian children under five suffer from chronic malnutrition (stunting). In order to reach Indonesia's ambitious goal of reducing its stunting rate to 14% by the end of 2024, it must improve the accessibility and affordability of nutritious food and promote healthier dietary habits. Drawing on data encompassing food prices across 90 cities in 2021 and the *Survei Sosial Ekonomi Nasional* (Susenas) from March 2021, about 68%, or equivalent to almost 184 million individuals in Indonesia, were unable to afford a nutritionally balanced diet (Alta et. al., 2023).

Business-as-usual strategies to improve agro-food systems in Indonesia are no longer sustainable nor effective. Agro-food systems have been both a contributor to and a victim of climate change. Indonesia's ambitious target of net-zero carbon emissions by 2060[2] will be unachievable without more sustainable agricultural practices and improved efficiency along the food value chain.

[1] Extreme poverty is defined as living on less than USD1.9 per day.
[2] This emission target has now been brought forward by a decade to 2050 after Indonesia received USD 20 billion from the Just Energy Transition Partnership (JETP), an international cooperation of advanced economies led by the United States and Japan to finance energy transitions in emerging and low-income economies. With the fund, Indonesia is also increasing its target of renewable energy as a share of total power generation from 11.5 per cent in 2021 to over a third by 2030.

Agriculture, land-use change (mostly deforestation to create agricultural lands), and forestry are the largest contributors to greenhouse gas (GHG) emissions in Indonesia. Methane gas from livestock and rice cultivation, nitrogen oxides from the use of fertilizers, energy use on the farm and fertilizer production systems, and food processing, refrigeration, and transport along the supply chain also significantly contribute to GHG emissions. However, extreme and unpredictable weather has negatively affected Indonesian farmers and fishers (Savelli et al., 2021), and it's estimated that 25–30% of global food production could be affected by extreme weather and other climate change shocks this century (FAO, 2016).

Indonesia needs new strategies for more sustainable agro-food systems if it is to meet its goals of eradicating extreme poverty, maintaining food and nutrition security, and attaining net-zero carbon emissions.

Ideally, agro-food systems should produce agricultural products without deforestation and natural habitat conversion, while educating farmers and consumers to adapt to and mitigate the effects of climate change. Ignoring the emission of GHGs from our agro-food systems is not an option (Ritchie et al., 2020). Indonesia is the world's fifth-largest GHG emitter, contributing about 4% of global GHG emissions in 2019. Transitioning to more sustainable agro-food systems would significantly contribute to global climate change mitigation efforts.

Unfortunately, Indonesia is stuck in a production-centric mindset and faces big challenges in transforming its agro-food systems and embracing sustainability.

CHALLENGES TOWARDS SUSTAINABLE AGRO-FOOD SYSTEM IN INDONESIA

Globally, agro-food systems account for one-third of GHG emissions (Crippa et al., 2021). In Indonesia, GHG emissions from the agro-food system largely come from land-use change and forestry, which contributed 48.7% of emissions in 2019, and agriculture, which contributed 9% (Table 1). In comparison, globally 18.4% of GHG emissions come from agriculture, land-use change and forestry (Ritchie et al., 2020). Indonesia's share of GHG emissions from land-use change and forestry is the highest among ASEAN nations, higher even than China and India. Around 73% of emissions from land-use change and forestry come from deforestation, largely driven by cultivation of palm oil from 2000 until 2016. In 2016 the government imposed a five-year moratorium on the issuance of new oil palm plantation permits (Savelli et al., 2021).

"Indonesia's share of GHG emissions from land-use change and forestry is the highest among ASEAN nations, higher even than China and India. Around 73% of land-use change and forestry emissions come from deforestation, largely driven by palm oil cultivation."

Table 1.
Sectoral contributions to GHG emissions in Indonesia (in %)

	1990	2000	2010	2019
Land-use change and forestry	61	44	32	49
Agriculture	11	12	14	9
Waste	13	16	11	7
Industry	1	2	2	2
Transport	2	5	8	8
Electricity and heat	4	8	13	13
Buildings	3	4	3	2
Fugitive emissions	3	3	4	3
Other fuel combustion	0	1	1	0
Aviation and shipping	0	0	0	0

Sources: Ritchie et al., 2020

Indonesia's agricultural emissions account for 38% of the ASEAN region's total, and Indonesia is home to 41% of the region's population. In many developing Southeast Asian countries, including Indonesia, rice significantly contributes to GHG emissions chiefly through paddy flooding which releases methane (Searchinger & Waite, 2014). Globally, 10% of methane emissions come from rice cultivation, but in Southeast Asia rice cultivation accounts for as much as 25–33% of methane emissions (Umali-Deininger, 2022). Rice cultivation is the largest source of GHG emissions in Indonesia's agriculture sector, contributing 39% of total emissions from agriculture (Savelli et al., 2021).

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In the 1960s, the Green Revolution introduced intensive agricultural practices that require industrial inputs — such as fertilizers, pesticides and high-yielding seeds — to increase yield. Although Green Revolution technology saved Indonesia from rice shortages and famines during times of drought and political instability in the 1960s, the production-centric paradigm[3] of the Green Revolution has created a crisis for the ecosystem — soil, groundwater, air and other natural resources — and human health.

This paradigm is entrenched in farmers' practices and government policies. Shifting towards an ecosystem-centric paradigm is not an easy task (Paliath, 2022). In most parts of the world, efforts to scale up or mainstream alternative agricultural practices, such as organic farming and System of Rice Intensification (SRI), have had limited results in the last three decades (Pretty, 2007).

The challenges faced in creating sustainable agro-food systems in Indonesia are described in detail below. The discussion is by no means exhaustive and instead emphasizes some of the most urgent issues.

[3] A production-centric paradigm focuses on production increases without necessarily considering environmental impacts.

HEAVY RELIANCE ON AGRICULTURE SUPPORTS

Among emerging and OECD economies, Indonesia provides the highest level of support to the agriculture sector measured as a percentage of GDP (World Bank, 2020a). However, agricultural support has been provided mainly in the form of market price supports (e.g., fixed prices and trade barriers) and direct subsidies (e.g., fertilizers, seeds) towards rice production, rather than public goods such as rural and urban infrastructure and post-harvest technologies to reduce food losses. These forms of agricultural support not only discourage farmers from diversifying production away from rice, but also carry large environmental costs in terms of GHG emissions, land degradation, and environmental pollution, since rice is one of the most water-intensive and GHG-intensive crops.

Although most of fertilizer subsidies (one form of agricultural support) target smallholder rice farmers, a significant amount of it leaks to large palm oil plantations (Fabi & Munthe, 2016). Fertilizer subsidies have risen from IDR 2.5 trillion in 2005 to IDR 25.3 trillion in 2021. They account for 25–30% of the annual agricultural budget — or equivalent to 1% of the total state budget. They are expensive, poorly targeted, regressive, subject to leakage[4], and are not a cost-effective way to increase production (World Bank, 2020a).

> "Fertilizer subsidies are expensive, poorly targeted, regressive, subject to leakage, and are not a cost-effective way to increase production."

Subsidies may have caused unbalanced use of fertilizers, with farmers over-applying and causing water pollution, soil degradation, and excess nitrous oxide emissions (Alta, et. al., 2021). Indonesia has higher levels of nitrous oxide emissions[5] from agriculture than all other ASEAN nations, China, and India (World Bank, 2020a). Overuse of chemical fertilizers can lead to a reduction in organic materials in the soil, resulting in decreased water-absorption capacity (Tilman et al., 2002). Consequently, the crops do not obtain adequate water and nutrients to reach optimum growth and production.

Increasing access to pesticides over the past two decades due to looser regulations since the decentralization in 1999 has led to overuse of pesticides and, paradoxically, a resurgence of pests that had previously been successfully managed, such as the brown planthopper. Pesticides are also highly toxic and have had an adverse effect on the physical health of farmers, consumers and the ecosystems.

[4] Leakage refers to when resources from targeted programs are used for other purposes.
[5] Nitrous oxide emissions are a product of nitrogen fertilizer use.

HIGH RATE OF AGRICULTURAL LAND EXPANSION

One-third of Indonesia's 192 million hectares of land area is used for agriculture. Between 2014 and 2018, the rate of agricultural land expansion was 1.7%, higher than the regional average of 1.2% and the second highest in Southeast Asia after Vietnam. The largest contributor to land-use conversion is oil palm plantations. In 2018, rice and palm oil combined were grown on 80% of Indonesia's planted area. Indonesian food production is very rice- and palm-oil-centric if compared to, for example, China which has much more diversified food crops in its planted area (World bank, 2020a).

Since 2020, the Government of Indonesia has been developing "food estates" in the provinces of Central Kalimantan, East Nusa Tenggara, South Sumatra, Central Sulawesi, and Papua. In Central Kalimantan, the government plans to develop about 60 thousand hectares of food estates, mostly utilizing the "one million hectares of peatland" developed during the previous government administrations since the late 1990s. About 2,000 hectares of food estate development in Central Kalimantan are coming from forest-land conversions in the District of Gunung Mas, which was planned for cassava development.

> "The regulation on the Provision of Forest Area for Food Estates has the potential to drive deforestation in Indonesia, contradicting government commitments such as Enchanced Nationally Determined Contribution (NDC) targets and Indonesia's Forestry and Other Land Use (FOLU) Net Sink 2030."

The issuance of Ministry of Environment and Forestry Regulation No. 24/2020 on the Provision of Forest Area for Food Estates allows the conversion of forest areas and peatlands for the food estate program. This regulation has the potential to drive deforestation in Indonesia, contradicting government commitments such as the Enhanced Nationally Determined Contribution (NDC) targets and Indonesia's Forestry and Other Land Use (FOLU) Net Sink 2030 . Under Indonesia's Enhanced NDC agenda, the country committed to reducing GHG emissions by 31.89% or 43.2% with international assistance by 2030. By 2060, it aims to reach its net-zero emission target. Meanwhile, with FOLU Net Sink 2030, Indonesia aims to reach net zero deforestation by 2030.[6]

[6] Based on the roadmap from Ministry of Environment and Forestry Decree No.168/2022

FOOD WASTAGE AND LOW EFFICIENCY ALONG THE SUPPLY CHAIN

Instead of clearing forest and opening peatland to create new agricultural land, the government should focus on improving efficiency along the food value chain, for example, by reducing food loss and food waste (FLW). In per capita terms, Indonesia is estimated to be the second largest food loss and food waste producing country in the world, at 300 kilograms per capita per year (Bappenas, 2021). Globally, food loss and food waste is linked to approximately 6% of GHG emissions,[7] three times the emissions contributed by the aviation sector.

Around one-third of all food produced in Indonesia is either lost or wasted (Bappenas, 2021). The food loss and food waste numbers reflect an inefficient food supply chain in Indonesia, from the production of food crops in the field through to post-harvest and consumption. For example, rice post-harvest losses in Indonesia are estimated at around 10%[8] similar to Vietnam, which has food waste and food loss of about 10–12% (Umali-Deininger, 2022). Increasing rice milling efficiency by 5% in both Indonesia and Vietnam (which have milling efficiency of 63.5% and 62.5% respectively) would add close to five million tonnes of rice to the market. In this way, a small improvement in efficiency could help ease pressures on the thin international rice market and bring down global rice prices (Umali-Deininger, 2022).

> “The food loss and food waste numbers reflect an inefficient food supply chain in Indonesia, from the production of food crops in the field through to post-harvest and consumption.”

Consumption is the stage of the Indonesian food value chain where the most significant food loss and food waste takes place, with 5 to 19 million tonnes of food wasted annually. In terms of food type, the highest amount of food loss and food waste originates from the food crop sector, particularly cereals, with a combined total of 12 to 21 million tonnes each year (Bappenas, 2021).

Investment in post-harvest logistics, storage, and technology is urgently needed to reduce food loss along the supply chain, especially for the perishable horticulture and animal-based products. Over the next five years, the demand for cold storage is projected to increase by 10–20% annually (National Food Agency, 2023).

[7] This number is likely to be underestimated because it does not include food lost on farms during production and harvesting.
[8] This level of waste is similar to Vietnam, which is at 10–12% food waste and food loss.

LACK OF AGRICULTURAL EXTENSION SERVICES AND CLIMATE INFORMATION AND ADVISORY SERVICES

Indonesia has invested little in educating farmers about mitigation of or adaptation to climate change, despite the fact that climate change affects crop production. Government efforts to help farmers adapt to climate change are complicated by a lack of accessible and reliable climate information and advisory services to help farmers understand and manage the risks posed by climate change.

> "Indonesia has invested little in educating farmers about mitigation of or adaptation to climate change."

Since the decentralization in 1999, Indonesian government services providing agricultural advice (extension services) have been weakened. In 2018, only 18 out of 34 Indonesian provinces had agencies to manage and provide extension services. Factors including difficulty recruiting new extension officers, who are paid poorly, have resulted in the government's failure to meet its target to have at least one extension worker per village. In fact, only about half of Indonesian villages have an extension officer (Savelli et al, 2021).

Under the Ministry of Agriculture (MOA)'s Agency for Agricultural Extension and Human Resource Development (AEHRD), the government has been pushing to digitize extension services to compensate for insufficient human resources through improved technology and connectivity (Savelli et al, 2021). Phone calls and video conferences with farmers, CCTV for crop monitoring, increased use of mobile phones and personal computers, and the development of mobile applications for extension services have been part of government efforts to revitalize extension services using technology. However, not all regions have sufficient digital infrastructure to support these services. A dedicated extension service worker is needed on the ground even to make use of digital services. Many farmers use the relevant technology only for communications and accessing social media and lack the familiarity needed to access digital services.

For example, although the 1997 El Niño was predicted, the prediction and its expected effects were not communicated to farmers (World Bank, 2008). Even though farmers now have access to weather and climate forecasts through local offices of the Meteorology, Climatology, and Geophysics Agency (*Badan Meteorologi, Klimatologi, dan Geofisika* or BMKG), it remains inconvenient for farmers to obtain climate information from this agency, and farmers are skeptical of the reliability of the information (Savelli et al, 2021). As a result, most farmers continue to rely on traditional wisdom and intuition to make decisions about production-related activities. For mitigation and adaptation of climate change to be mainstreamed into agricultural extension services, extension workers and farmers must be able to access reliable, always-available climate information and advisory services.

FOOD-ENERGY CONTENTION ON PALM OIL PRODUCTS

In 2006, Indonesia began developing biofuels sourced from crude palm oil (CPO). The CPO-sourced biofuel program potentially threatens food security and drives up land conversion for oil palm plantations, creating competition between food security and energy security (Amir, et al., 2022).

In Indonesia, CPO-sourced biodiesel accounts for close to 40% of total CPO use, while food accounts for close to 50% (Basri, 2022); this creates competition between food security and energy security. For example, in early to mid-2022, the CPO-sourced biofuel policy may have exacerbated the sharp increases in the prices of domestic CPO and cooking oil. The policy may have placed additional pressure on domestic demand at a time when global energy and food prices were high due to the war in Ukraine, and CPO producers rushed to export[9] (Tenggara Strategics, 2022; Wihardja & Patunru, 2022).

> The CPO-sourced biofuel program potentially threatens food security and drives up land conversion for oil palm plantations, creating competition between food security and energy security.

Indonesia's biodiesel policy, which began in 2006 with Presidential Instruction No. 1/2006, stipulates that fossil fuels must be blended with palm oil, with the aim of securing energy, reducing carbon emissions, and reducing trade deficits. According to Indonesia's biofuel development roadmap, biofuels are projected to make up 5% of the country's overall energy mix by 2025. This would amount to a total of 22.26 billion liters of biodiesel, bioethanol, and bio-oil. Specifically, the use of biodiesel is expected to contribute 10% (equivalent to 2.4 billion liters) of total diesel fuel consumption by 2010, and increase to 20% (reaching 10.22 billion liters) by 2025 (Caroko et al., 2020). The regulation contains steady increases in mandatory levels of CPO-sourced biofuel, beginning with 5% in 2006 to reach 30% by 2021 (this goal was achieved on time.)

A 2021 study found that cuts in export revenues from the CPO-sourced biofuel program, if it is carried through to 2030, could outweigh the savings on imports of fossil fuels. It also found that oil palm plantations would need to expand by 48% to 76% to meet biofuel demand (Halimatussadiah, A. and A. A. Siregar, 2021).

[9] In early 2022, as the global CPO prices surged, Indonesian producers rushed to export CPO and domestic CPO and cooking oil prices rose sharply. The government then imposed a Domestic Market Obligation (DMO), which required exporters to sell 20% of their planned exports domestically to increase domestic supply. In March 2022, export of CPO and all its derivatives from Indonesia were banned temporarily, causing chaos in the domestic and global CPO markets, although this export ban was eventually reversed.

CONCLUSIONS

Indonesia can build more sustainable agro-food systems by focusing on intensification instead of extensification, improving efficiencies in supply chains, building climate change adaptation and mitigation capacity through improved agricultural extension services and technology, and removing policies that support unsustainable practices. These changes call for new knowledge, tools, policies and wisdom, and will require an interdisciplinary approach, as ecological and food security risks raise biophysical, socioeconomic, and health issues.

“Indonesia can build more sustainable agro-food systems by focusing on intensification instead of extensification, improving efficiencies in supply chains, building climate change adaptation and mitigation capacity through improved agricultural extension services and technology, and removing policies that support unsustainable practices.”

Reforms to make agro-food systems sustainable must rely on science, using evidence-based policy and implementation at the national, provincial, and local levels. A shift away from production-centric towards ecosystem-centric agricultural practices should be well calibrated, coordinated, and staggered. The real-world experience from Sri Lanka has demonstrated that abrupt measures such as a ban on synthetic fertilizer imports may bring dire consequences for food security.

RECOMMENDATIONS

Continue Redirecting the Fertilizer Subsidy

The government should continue redirecting resources away from fertilizer price subsidies (subsidizing goods) and towards direct subsidies for farmers (subsidizing people) through the Farmer Card (*Kartu Tani*) system (Alta et al, 2021). Targeted social protection such as direct subsidies for farmers requires better social registry data from Indonesia's unified database (*Data Terpadu Kesejahteraan Sosial*), which still has many weaknesses (World Bank and the Australian Government, 2022). The government should also better monitor and regulate dangerous pesticides and fill a regulatory gap in the national integrated pest management system, which refers to a pest management system that applies sustainability principles including using more pest-resistant seed varieties, provision of habitat for natural enemies of pests (predators, parasites, and pathogens), crop rotation, and restricting application of chemical pesticides unless deemed necessary. This must be accompanied by better enforcement and awareness among all stakeholders, including extension service workers, about the dangers of overusing and misusing pesticides.

Invest More in Agriculture Intensification

Indonesia should focus on intensification instead of extensification. Increasing yields rather than expanding agricultural land will increase the income of farmers and help retain and attract new farmers into the industry. Intensification requires more investment in human capital and technology, as well as policy reforms to facilitate this investment. The latter may include:

- Allowing the private sector to compete alongside state-owned enterprises in markets for inputs such as seeds, fertilizers, machines, and other equipment. Indonesia's current policy in agriculture inputs limits the use of more sustainable inputs, such as hybrid seeds to increase yields and plant resiliency, due to certain barriers to market entry (Alta et al., 2021).
- Creating an output market that compensates farmers for their efforts to maintain ecosystems. This would incentivize farmers to adopt more sustainable agricultural practices. The means may include sustainability certification (already used for coffee and palm oil, but could be expanded to export products like tea and cocoa) and payments for environmental services (PES), which is a form of climate financing for smallholder farmers and communities, such as the PES Rejoso watershed project in Pasuruan District, East Java[10].
- Supporting fee-based, private agricultural extension services through partnerships with NGOs, development agencies, farmer associations, and the private sector. To some extent, such initiatives have been underway, such as that supported by confectionery company Mars and NGO Rikolto for cocoa farmers in Sulawesi.[11]

[10] See https://www.worldagroforestry.org/project/rejosokita.
[11] See https://indonesia.rikolto.org/en/project/cocoa-sulawesi-indonesia

Box 1
Case Studies on Sustainability Certification

Case studies on sustainability certification for coffee and palm oil in Indonesia provide examples of ways to move towards inclusive and sustainable agriculture:

Coffee: Sustainability certification in coffee has grown rapidly. Sustainability certification started in Indonesia in 1992 with Gayo Mountain Organic Coffee from the Takengon region of Central Aceh, followed by organic coffee cooperatives in East Timor, Utz Certified coffee (part of the Rainforest Alliance since 2018) in Aceh, Lampung, East Java and in Sulawesi, and the Starbucks CAFÉ Practices scheme in North Sumatra, Aceh and Toraja South Sulawesi (as one of best practices at the company level).

Certification standards have encouraged more sustainable land management practices in Aceh, Toraja, and Bali, where organic, low-input, and shade-grown farming has been adopted by coffee farmers. After some years of implementation, the coffee eco-certification has affected the price structure of coffee: traders selling organic certified coffee to exporters started to receive higher prices than could be commanded by non-certified coffee (Arifin, 2021).

Palm oil: The Roundtable on Sustainable Palm Oil (RSPO) was formed in 2004 by CPO buyers, non-governmental organizations (NGOs), and environmental organizations. The RSPO initially targeted large companies to produce palm oil sustainably, with measures that include refraining from clearing forests, protecting orangutan habitat, conserving wildlife, and not converting peatland. Several Indonesian palm oil companies have been certified by the RSPO.

The management of sustainable certification involving smallholder farmers is a complex and large task. Of Indonesia's producers of fresh fruit bunches (the fruit from which palm oil is made), 41% are smallholders, with most owning no more than two hectares of land. Farmers need to form groups and partner with big companies.

Indonesia is serious about implementing sustainable certification at the global level (RSPO and International Sustainability and Carbon Certification), which is voluntary, and at the national level (Indonesia Sustainable Palm Oil), which is mandatory. The development of sustainable palm oil, especially RSPO certification, has improved the standards of Indonesia's palm oil industry and hence access of the palm oil industry especially to countries that have imposed high sustainability standards, including those of the European Union.

Unlike coffee, sustainable certification does not yet lead to a premium price for small-scale oil palm farmers (Hidayat et al., 2016). Despite these downsides compared to coffee certification, sustainable palm oil is believed to be more inclusive and may help Indonesian palm oil become more competitive.

Prioritize Investment in Post-Harvest Logistics

In order to reduce food loss and food waste, Indonesia should prioritize investment in post-harvest logistics, storage, and technology, especially cold chain logistics, which should be standardized. Existing cold chain logistics in Indonesia are not standardized, for example, in terms of storage temperature, security, and operating procedures (Allied Market Research, 2022). The market for cold chain logistics is forecast to increase to USD 12.6 billion in 2031 from USD 4.97 billion in 2021, and it is therefore a promising industry for both the private sector and the government (Allied Market Research, 2022). Furthermore, a detailed public spending review could be carried out to evaluate the appropriateness and efficiency of spending on agricultural equipment. For example, more spending could be directed to support farmers to buy dryers and to support millers to purchase more modern milling machines in order to reduce post-harvest food losses, rather than providing farmers with four-wheel combine harvesters.

Improve Agriculture Extension Services Including Through Technology Use

The government may institutionalize Science Field Shops that help farmers gain agrometeorological knowledge and adapt their practices to increasing climate variability. The government should commit itself to long-lasting education and training and technology transfers, instead of relying on short-life programs such as a one-off workshop (Winarto et al., 2018). Moreover, the government may support its digital extension service efforts by improving digital connectivity in remote regions and cyber agricultural extension systems, and by engaging younger farmers who may be more adept at using digital technology. Programs to increase technological adoption, such as those currently developed and implemented by the Research Institute for Agricultural Technology (*Balai Pengkajian Teknologi Pertanian*), accessible in all provinces across Indonesia, may be integrated into farmers' empowerment programs under the Centre for Agricultural Extension of the MOA.

Diversify Biofuel Sources

The government should consider diversifying biofuel sources to nonfood commodities such as the seeds of rubber tree and Ricinus (EBTKE, 2021). The government should focus on increasing productivity in palm oil, which is currently low compared to other palm oil producers, to avoid opening new land. For example, Malaysia produces 3.96 tonnes of palm oil per hectare annually, compared to 2.70 tonnes per hectare in Indonesia (Triatmojo, 2019).

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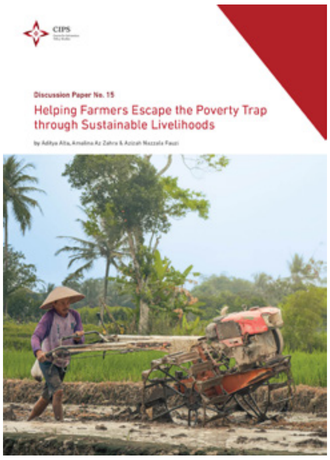

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