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Linking food, nutrition and the environment in Indonesia

A perspective on sustainable food systems

Mulia Nurhasan^{1,2}, Yusuf Bahtimi Samsudin¹, John F McCarthy³, Lucentezza Napitupulu⁴, Rosita Dewi⁵, Dian N Hadihardjono⁶, Aser Rouw⁷, Kuntum Melati⁸, William Bellotti⁹, Rodri Tanoto¹⁰, Stuart J Campbell¹¹, Desy Leo Ariesta¹, M Hariyadi Setiawan¹², Ali Khomsan¹³ and Amy Ickowitz¹

Highlights

- This brief reviews the interlinkages between food, nutrition and the environment in Indonesia, and the role of national food policies in addressing the challenges in these sectors.
- While Indonesia is a mega-biodiverse country, nationally supported agricultural production programs tend to focus on a few high-value commodities, contributing to low dietary diversity.
- Lessons from past food estate programs suggest that food system interventions that focus heavily on increasing monocropping, especially rice production, overlook the capacity of local people to develop their own food systems, while failing to provide healthy diets, and damaging the environment.
- To move towards sustainable food systems, we argue that policies need to: focus on delivering healthy and diverse diets; support local food production practices that are environmentally sustainable; embrace local cultures and values; re-evaluate centralized and top-down policies; and avoid overly focusing on production of rice.
- Policies that decentralize and localize food production can enhance resilience and the sustainability of food systems.

1 Center for International Forestry Research (CIFOR); 2 University of Copenhagen; 3 Australian National University (ANU); 4 World Resources Institute (WRI) Indonesia; 5 Indonesian Institute of Sciences (LIPI); 6 University of Indonesia; 7 Agency for Agricultural Research and Technology (BPTP) of West Papua Province; 8 Stockholm Environment Institute (SEI) Asia; 9 The University of Queensland; 10 Independent consultant; 11 Rare Indonesia; 12 EntreVA; 13 IPB University

Background

In recent years, Indonesia has become the tenth largest economy in terms of purchasing power parity and has made enormous progress in reducing poverty by more than half (World Bank 2020). However, Indonesia has only made halting progress towards achieving global nutrition targets¹ (Global Nutrition Report 2020). In 2018, over 30% of children under the age of five were stunted (having low height for their age), an indication of chronic undernutrition (Risksdas 2018). Meanwhile, the rate of overweight and obese Indonesian adults increased from 19.1% in 2007 to 35.4% in 2018. Diet-related non-communicable diseases, like strokes, diabetes and hypertension also increased (Risksdas 2018). As a result, Indonesia is now one of the largest countries in the world facing the severe double burden of malnutrition, i.e. the simultaneous manifestation of both under- and over-nutrition (Popkin et al. 2020a). Together such facts reveal that while Indonesia has been successful in achieving economic development, it has been less successful in improving the food security and nutrition of its citizens.

This poor performance in nutritional outcomes has coincided over recent decades with the degradation of Indonesia's rich natural resources, as food production has become less sustainable and as deforestation has facilitated the development of plantation agriculture. There are also significant problems with overfishing, food loss during distribution, water management, and the impacts of trade on the environment (Vermeulen et al. 2019; Austin et al. 2019; CEA and Green 2018). This sees Indonesia ranking close to the bottom of the Food Sustainability Index² (BCFN 2020).

This brief reviews and provides perspectives on some of the key nutritional and environmental problems caused by Indonesia's food system and discusses the interlinkages between these two sets of challenges. Special attention is given to the impact of the country's rice-centred policy on its food security and nutrition, as well as the environment. The brief points to potential pathways for developing more sustainable food systems. Drawing on the lessons of unsuccessful top-down and 'magic bullet' approaches, we advocate for a more sustainable use of landscapes and biodiversity within food systems. We argue that, while a diversity of solutions is a prerequisite, special attention should be given to the 're-localization' of food systems in Indonesia, a strategy that has been overlooked in national food security and nutrition policies.

1 Out of seven indicators, Indonesia achieved progress on just two.

2 The Food Sustainability Index measures the sustainability of food systems around three key issues: (i) food loss and waste, (ii) sustainable agriculture, and (iii) nutritional challenges.

Key issues

Mega-diverse country with low dietary diversity

Being the largest archipelagic country in the world with more than 16,000 islands (Indonesia.go.id 2018), Indonesia has been categorized as a mega-diverse country (UNEP-WCMC 2020). Indonesia is blessed with a great variety of edible food sources, provided through its mega-biodiversity. For centuries, this biodiversity has provided diverse food rich in micronutrients for local diets (Gardjito et al. 2018). Indonesia's 3.5 million square kilometres of ocean provide more than 80% of its marine fish consumption (Vermeulen et al. 2019). Tropical warm water marine fish, like those found in Indonesia's marine waters, contain high concentrations of calcium, iron and zinc (Hicks et al. 2019). A study by the Ministry of Environment and Forestry showed that at least 100 types of carbohydrate, 100 legumes, 450 fruits and 250 vegetables and mushrooms were consumed in the country (MoEF 2006 in Walujo 2011). Indonesia has approximately 300 local cultivars of banana (*Musaceae*) (Poerba et al. 2018), and 208 native cultivars of mangoes (*Fitmawati et al. 2010*), with a wide range of colours, indicating different nutrient composition (Fitmawati et al. 2013).

Yet despite the high diversity found in Indonesia's agro-ecological systems, today's agricultural production tends to focus on a few high-value commodities and only a few high-yielding crop varieties. This limits the varieties of food available in the market, leaving hundreds of edible and nutritious species underutilized (IPBES 2019). Indonesia's increased consumption of fritters, noodles and sweets has made the country one of the world's largest importers of wheat and crystal sugar (FAO 2021). By contrast, consumption of healthy foods which can be provided by Indonesian biodiversity, such as green leafy vegetables, sago, fresh legumes and wild meat, decreased (Nurhasan et al. forthcoming³).

The marketing and consumption of industrially produced food like instant noodles and sugar-sweetened beverages contributes to the transition of Indonesian diets away from healthy traditional and wild foods (Pawera et al. 2020; Nurhasan et al. forthcoming³). Such a transition is associated with a rise in overweight and obesity, along with non-communicable diseases (Kelly 2016; Oddo et al. 2019; Popkin et al. 2020a), changing gut microbiota population (Wan et al. 2020), and even higher risk levels for Covid-19 infection (Popkin et al. 2020b). Nutritional transitions have also been linked to negative environmental impacts, like soil health, climate change, land stress and water scarcity (Gill et al. 2015; Bamberger et al. 2021).

3 The paper 'Changing food consumption patterns in Indonesia's most and least deforested areas' has been reviewed and is in the process of publication.

Research has shown that dietary diversity, in other words the number of food groups consumed, is associated with better micronutrient adequacy (Steyn et al. 2006; Kennedy 2009; Arimond et al. 2010), and lower likelihood of child stunting (Mahmudiono et al. 2017). More recently, research has highlighted that the number of species consumed per day is also associated with better micronutrient adequacy. A study conducted by Lachat et al. (2018), using 24-hour recall data from rural areas in seven low-and-middle-income countries, found that for every additional species consumed, dietary nutrient adequacy increased. Evidence from aquatic food systems also suggests species and ecological functional diversity enhances nutritional benefits (Bernhardt and O'Connor 2021). This points to the need to explore nutrition-sensitive agricultural and ecosystem conservation interventions, to improve nutritional outcomes in Indonesia.

Indonesia's Ministry of Agriculture uses Desirable Dietary Pattern (DDP) to understand the food groups consumed across the archipelago, and refers to this score to indicate national dietary diversity (Food Security Agency 2020a). From 2013 to 2019, Indonesia's DDP score has increased from 81.4 to 90.8 (out of a maximum score of 100). According to this, diets of Indonesians are close to the maximum score in its composition of food variety, measured based on the proportion of the energy contribution of the various food groups (Food Security Agency 2020a). However, studies using other methods to measure dietary diversity suggest a different trend. Household dietary diversity analysis using Indonesian Family Life Survey data shows that dietary diversity declined between 2000 and 2015 (Mehraban and

Ickowitz 2021). The Overview of Food Security and Nutrition in the Asia and the Pacific region reported that approximately 46% of Indonesian children aged 6–23 months failed to attain minimum dietary diversity (FAO et al. 2021). The FAO has also suggested that Indonesian diets are poor in dietary diversity; low on protein and vitamins, but high in carbohydrates (FAO 2014). Comparing the DDP recommendations with those of EAT-Lancet shows that Indonesia's DDP recommends far too high calorie intake from cereals (56% as opposed to 34% of total calorie intake per day), which may partly explain why Indonesia, despite having an increasingly high DDP, scores low on dietary diversity (Arif et al. 2020).

Until recently, interventions to address malnutrition in Indonesia have focused on supplementation and fortification, with iodized-salt and iron-wheat fortification programs and iron-folic-acid and vitamin-A supplementation programs being conducted at a national scale (Soekirman and Jus'at 2017; WHO 2021). Although this approach may be cost-effective (Baltussen et al. 2004), it also faces multiple challenges in terms of compliance, distribution and sustainability (Yip and Ramakrishnan 2002; Untoro et al. 2010; Gayer and Smith 2015). Despite a mass program providing iron tablet supplements, between 2013 and 2018 maternal anaemia increased from 37.1% to 48.9% (Risksedas 2018). Indonesia's nutrition community has recognized some of these limitations, and policy is moving towards more holistic and multi-sectoral approaches. In the 2018 Stunting Summit, the Indonesian government formally called for a more integrated and multi-sectoral approach to tackle malnutrition (BAPPENAS 2018).



Figure 1. Local wisdom of agricultural land allotment with the *lodok* system in Flores, Manggarai Regency, East Nusa Tenggara
Photo by KEHATI

Climate change and food production

Agriculture, forestry, fisheries, and food and beverage manufacturing, are important sectors for the Indonesian economy, contributing 19% of Indonesia's gross domestic product (BPS 2019). But these sectors are also the most significant contributors of greenhouse gas (GHG) emissions in Indonesia, caused directly by agricultural activities, and indirectly by food loss and waste, land-use change, peat and forest fires (MoEF 2015). Land-use change for food and plantations, particularly from peat and forest, is among the major drivers of fires in some areas of Indonesia (Dennis et al. 2005; Chamorro et al. 2017; Warren et al. 2017).

Climate change also affects agricultural production in Indonesia (Moediarta and Stalker 2007; Caruso et al. 2016), through the changing temperatures and rainfall that influence how crops are planted, grow and yield (Ruminta et al. 2018). In Indonesia, climate change is projected to decrease yields by 44% and leave 19 million people at risk of hunger by 2045 (ADB 2019). Climate variability is also linked with chronic and acute child malnutrition in Indonesia, where, during the prenatal period, monsoon season delays are associated with a reduced height of children aged 2–4 years (Thiede and Gray 2020). In Indonesian fisheries, meanwhile, climate change will affect the rise of sea levels and coastal water temperature, which eventually are expected to impact fish yields – the nation's most dominant source of animal protein (Rizal and Anna 2019). Efforts to boost fish and seafood production through aquaculture have contributed to the loss of 40% of Indonesian mangroves, which provide ecosystem services, including for food security (as fish spawning grounds) and climate change (as carbon storage) (see Murdiyarto et al. 2015).

Indonesia's rice-centred food policy

Indonesia's food policy framework is based on the FAO's four dimensions of food security –availability, accessibility, utilization and stability (UU 18/2012⁴). However, scholars have noted that policy applications tend to emphasize food availability and pay little attention to other dimensions (Neilson and Wright 2017). Following food shortages during the post-independence period, Indonesia's food policy under President Soekarno prioritized an increase in rice production to alleviate food insecurity and achieve national prosperity. Self-sufficiency in rice production was seen as critical for national security and an issue of national pride (Neilson and Wright 2017). President Soeharto pursued a green revolution strategy, focusing on new and better yielding varieties, infrastructure

for irrigation and rural credit schemes. These policies successfully sought to avert food shortages and protect against price shocks in international markets by increasing rice yields. Indonesia briefly attained rice self-sufficiency in the 1980s (Djurfeldt et al. 2005). During the 1998 East Asian Crisis, the 2008 food price spike (Davidson 2018), and the current Covid-19 crisis (Media Indonesia 2020), the Indonesian government has continued to strengthen its commitment to stabilize food supply through boosting national rice production.

The heavy focus on rice production has important consequences for nutritional and environmental outcomes, however. The intensification of rice production is associated with increasing chemical use, which went unregulated until integrated pest management was introduced (Mariyono et al. 2010; Thorburn 2015). The conversion of wetlands to grow rice (and oil palm) monocultures can reduce access to wild foods and change biodiversity, as well as change the foods that are consumed by local communities (Purwestri et al. 2019; Partasmita et al. 2020). Rice fields also emit significant amounts of methane (CH₄) contributing to GHG emissions (Crippa et al. 2021), and rice production is particularly vulnerable to climate fluctuations and El Niño events (Naylor et al. 2007). In contrast, traditional food resources are less vulnerable to climate fluctuations (Bantacut 2014).

The policy to increase national rice production also focuses on just a small number of high-yielding varieties. By 1989–90, agricultural production was focused on just four internationally-bred rice varieties of IRRI (IR64, IR36, IR42 and IR46), and two Indonesian-bred varieties (Cisadane and Krueng Aceh), meaning that just six varieties accounted for all of the rice grown in almost all paddy fields in Indonesia (Fox 1993); this contrasts starkly with the more than 8,000 local paddy varieties that were once grown across the archipelago (Iskandar and Iskandar 2018). Research suggests that rice varieties may vary in terms of nutrient composition (Kennedy and Burlingame 2003), so reducing production to just a few varieties could also be reducing nutritional diversity, contributing to micronutrient deficiency (Demment et al. 2003). On top of this, after its decade of green revolution, Indonesia became vulnerable to pest resistance and disease outbreaks due to the loss of genetic diversity, putting national food security at risk (see Thorburn 2015).

When it comes to achieving food security, there are alternatives to developing large-scale monocultures of rice. Historically, rice was not an indigenous crop to Indonesia (Deng et al. 2020), and many of Indonesia's 1,300 ethnic groups cultivated other staple crops. For instance, indigenous people in Eastern Indonesia grew sago (*Metroxylon sagu*) and other staple foods more suitable for the ecosystem (Arif 2019). In Kalimantan and Sumatra, local communities also consumed sago (Charras

4 Law No. 18 Year 2012 on food: <https://www.hukumonline.com/pusatdata/detail/lt50b48fe0bfe90/undang-undang-nomor-18-tahun-2012>

2016; Jong 2018). Many Indonesians living in the outer islands became rice consumers in the 1980s after the central government introduced the cetak sawah (paddy fields printing) program. This program converted land to rice cultivation in many parts of the country (Presidential Decree No. 54 Year 1980)⁵, and was associated with land grabbing in Papua (Dewi 2017). In the 1990s, more areas in eastern Indonesia became increasingly dependent on rice, after the national rice-based social assistance program (*beras miskin* or *raskin*) was established. Many locals now view rice as the preferred and more prestigious staple food (Delfi 2017).

Transitions away from traditional staples towards rice, may have health impacts. Sago has a lower glycaemic index than rice, and therefore, a better impact on blood glucose levels (Diyah et al. 2016; Syartiwidya et al. 2019). This is very important, considering that diabetes is an issue of increasing concern in Indonesia. Studies have found a strong association between high levels of white rice consumption and increased risk of diabetes (Hu et al. 2012). After the 2008 crisis, the government recommended a reduction in per capita rice consumption, and adopted policies to diversify staple foods beyond rice and wheat (Presidential Regulation No. 22 Year 2009⁶ and Minister of Agriculture Decree No. 64.1/KPTS/RC.110/J/12/2017⁷). Despite these new policies illustrating changes in understanding around the over-reliance on rice in the Indonesian diet, national policies and perspectives on the production side do not seem to have changed – the expansion of rice fields has remained a government priority through the national food estate programs (Kamim and Altamaha 2019; Sutrisno 2020).

Transformation towards sustainable food systems

In recent years, policy communities have become increasingly interested in applying a food systems approach to food security and nutrition challenges. This approach facilitates an integrated assessment of highly complex interrelated issues, focusing on impacts and leverage points in different domains of the food system (Ingram and Zurek 2019). A food system approach combines all the elements (environment, people, inputs, processes, infrastructures, institutions, etc.) and activities that relate to the production, processing, distribution,

preparation and consumption of food, and the outputs of these activities, including nutrition and health status, socio-economic and environmental outcomes (HLPE 2014).

For a food system to be sustainable and equitable, it has to deliver food security and nutrition for all, in such a way that the economic, social and environmental bases to generate food security and nutrition for future generations are not compromised (Nguyen 2018). These ideas have been incorporated in the HLPE's (2020) update of the four food security dimensions discussed above, by the addition of two more dimensions – sustainability and agency. While the importance of sustainability has been well recognized in Indonesian policies partly through the adoption of UN Sustainable Development Goals, agency may be considered a new concept in Indonesian policy. Agency refers to the capacity of individuals or groups to make their own decisions about what foods they produce and eat, how the foods are produced, processed and distributed within food systems, and their ability to engage in processes that shape food system policies and governance (HLPE 2020). This is to assure the right to food for all people at all times, including marginalized communities and future generations. HLPE (2020) further recommends transformational shifts from exclusive, sectoral and 'one size fits all' policies, towards integrated, interconnected and contextual policies.

For Indonesia to move towards food systems that increase sustainability and strengthen agency, policies need to shift from overly focusing on the production of rice, to policies that focus on delivering healthy and diverse diets through sustainable food systems that embrace local cultures and values. Centralized and top-down policies could be re-evaluated, and gradually shifted towards more context-specific approaches that strengthen the agency of people to develop their own sustainable food systems (HLPE 2020). Food security needs to be defined in ways that move beyond the availability of the key staple food (rice), taking a more pluralistic approach that focuses on the diversity of foods necessary for healthy diets, as well as the other dimensions of food security – accessibility, utilization, sustainability, agency and stability.

Opportunities and challenges for transformation

Indonesian policymakers, such as the Directorate of Food and Agriculture at the Ministry of National Development Planning/the National Development Planning Agency (BAPPENAS), are working with other sectors, including nutrition, agriculture, fisheries and the environment, to support a shift from the traditional silo approach to a more integrated and connected food systems approach. The Directorate of Food Availability and Vulnerability in the Food Security Agency (BKP), Ministry of Agriculture, is developing an integrated information and assessment system to provide data

5 Presidential Decree concerning the cetak sawah policy: [https://peraturan.bpk.go.id/Home/Download/57664/Keppres No 54 TH 1980.pdf](https://peraturan.bpk.go.id/Home/Download/57664/Keppres%20No%2054%20TH%201980.pdf)

6 Presidential Regulation concerning the policy to accelerate diversification of food consumption based on local resources: <https://peraturan.bpk.go.id/Home/Details/42303/perpres-no-22-tahun-2009>

7 Minister of Agriculture Decree, concerning technical instructions for the development of local food: http://bkp.pertanian.go.id/storage/app/media/informasi%20publik/Pedoman/JUKNIS_P3L_TAHUN_2018.pdf

and information on food access and vulnerabilities, by involving various parties, such as Statistics Indonesia (BPS), the Ministry of Marine Affairs and Fisheries (KKP), and the Meteorological, Climatological and Geophysical Agency (BMKG) (Food Security Agency 2020b). At local level, the government of Bandung City is working on *Buruan Sae*, an integrated urban farming programme to strengthen household food security (DKPP Kota Bandung 2020). Meanwhile in East Flores, the government has launched a programme called *Gerobak Cinta* or *Love Wagon*, where they distribute healthy and traditional supplementary food for children (Prabandari 2019). In addition to these governmental efforts, non-governmental institutions like the *Koalisi Rakyat untuk Kedaulatan Pangan (KRKP)*, *Konsorsium Pangan Bijak Nusantara*, *Yayasan Kehati*, *Hivos Indonesia*, *WWF Indonesia*, *Mantasa* and other local organizations, are also working to support inclusivity, farmer prosperity and the localization of food systems, including sustainable consumption and production and sustainable diets for all.

At the beginning of the Covid-19 pandemic, proponents of sustainable food systems advocated for a transition towards more locally-based food systems by shortening food value chains as a logical option for an archipelagic country during lockdown.

Their arguments were supported by the multiple local initiatives that flourished during the pandemic, such as *Panen Mart*, *Kampung Brenjonk*, *Papua Muda Inspiratif*, and many more. These local initiatives work to support local farmers and food producers to market their products directly to end consumers (Nurhasan et al. 2020). At the same time there is evidence that, in response to the Covid-19 pandemic, local communities have shifted back to agriculture, and that policy in some areas of Indonesia have supported this shift, seeking to enhance the resilience of rural food systems (McCarthy et al. 2020). Interestingly, research in the fisheries sector in Indonesia has found that domestic supply chains were less impacted by the pandemic compared with export supply chains. This suggests that enhancement of domestic supplies through added value, market diversification and improved management may provide a buffer against external shocks (Bassett et al. 2021; Campbell et al. 2021).

In June 2020, in response to concerns over a food crisis resulting from Covid-19, the Indonesian government announced that it was going to develop a food estate project in Central Kalimantan Province, starting with 30,000 hectares in *Pulang Pisau*, with a target of 165,000 hectares by 2022 (Shofihara 2020). By September 2020, the President had announced



Figure 2. Failed past food estate in Central Kalimantan has left a mark of frequent peatland fire and haze, disrupting local people daily activities, hazarding people's health in the long term

Photo by Aulia Erlangga/CIFOR

further expansion of this plan to include the provinces of Papua, East Nusa Tenggara (NTT) and South Sumatra (Ihsanuddin 2020). Meanwhile, the Ministry of Agriculture issued the 4 Cara Bertindak (Four Actions Strategy) policy, with the agenda of maintaining national food stocks (MoA 2020), including development of a food estate on Central Kalimantan land that was previously used for the Peatland Development Project (PLG) (Koran Tempo 2020). The Ministry of Environment and Forestry (KLHK) showed its support for this agenda, issuing regulation that permits state forests to be designated as Forest Areas for Food Security (Kawasan Hutan untuk Ketahanan Pangan, KHKP) in degraded 'protected forest' (*hutan lindung*) and 'production forest' (*hutan produksi*) areas. While, through the Forest Estate Release Mechanism (Mekanisme Pelepasan Kawasan Hutan), the state can now also allow forest areas to be re-classified as non-forest areas, and then converted to plantations or food estates (Ministerial Decree No. 24 Year 2020⁸).

A variety of critics have raised serious questions about the relevance of these political responses, with commentators highlighting that the proposed food estates promote rice cultivation in unsuitable areas, including highly sensitive peat areas that are subject to environmental degradation (Najiyati n.d; Arumingtyas et al. 2020; Sulaeman et al. 2021). The government has responded with assurances that it will use agroforestry approaches to grow more than rice (Ministerial Decree No. 24 Year 2020⁸). However, technical documents have yet to be made publicly available, raising concerns among human rights and environmental activists (Grain 2021). A news investigation report on the state audit board found that expansion of food estates was not supported by adequate planning, nor were farmers and their prospective land ready (Paskalis 2021).

Here the history of past Kalimantan food estates projects may offer valuable lessons for the future. Previous food estates in Kalimantan in the mid-1990s were not as successful as expected, because the agro-ecological conditions of the area do not favour large-scale rice production (Surahman et al. 2018). The use of heavy machinery disturbed the toxic pyrite layer in the peatland and dried it out, making it vulnerable to fire (Sumawinata 1992; Furukawa 2004). Subsequently forest and peat fires created haze problems (Collier 1979; Sabiham 2004). Peatland drainage led to land subsidence, frequent flooding and loss of agricultural land in coastal areas where the mineral soil is below sea level (Hooijer et al. 2012; Sutikno et al. 2017; Bassi et al. 2020). This mirrors exactly the recent flooding experienced in the

newly-established food estate in Central Kalimantan (Sya'rawie 2021).

Food self-sufficiency strategies may benefit countries with large populations, high food insecurity, rich agricultural resources, and where the dominant staple food is traded globally by few suppliers (Clapp 2017). Indonesia falls into these categories; hence food self-sufficiency policies with respect to rice could potentially help to avert national food shortages (in terms of calories), should there be a shock in the international rice markets. However, on its own, a food production agenda provides a limited solution for assuring food and nutritional security. Policy needs to distinguish the challenge of achieving national production targets for key staples, from the necessity of ensuring that households in specific locations have access to nutritious food. Otherwise, the food estates program could achieve rice self-sufficiency at the national level, without addressing important nutritional security issues at the local level.

Food policy can take into account such questions of scale by addressing national agendas while also enhancing the capacity of the rural poor to access and utilize nutritious foods at the local level (McCarthy and Obidzinski 2017). This involves enabling smallholders to utilize their own assets to address food poverty and enhance their access to foods like green leafy vegetables and fresh legumes, which are critical for healthy diets but are being consumed less in recent years (Nurhasan at al. forthcoming). The national rice-based social assistance programs have assisted poorer Indonesians to gain access to calories. However, other policies are also required to support diverse smallholder production, which is positively correlated with dietary diversity and negatively correlated with young child linear stature (Jones 2017).

Research has shown that stunting can be high in intensive rice growing areas like lowland Aceh (McCarthy 2020) and Central Java (Purwestri et al 2018). In contrast, communities which still rely on more traditional staple foods have been found to be food secure (Saediman et al. 2019) and better nourished (Purwestri et al. 2019). Likewise, a focus on increasing rice yield without improving value chain management can be counterproductive, as seen with rice overstocks in Papua Province (Rhapsudyah 2020), and rice being wasted in cases of abundance (Eloksari 2019). Food system interventions that focus heavily on increasing rice production may fail to address the complex challenges of Indonesia's food systems, and overlook the lessons of past failures, subsequently exacerbating current food security, nutrition and environmental problems. Evidence that smaller farms are able to produce higher yields and harbour greater crop and non-crop biodiversity (Ricciardi et al. 2021), suggests that the government's intention to be a food sovereign nation can be achieved without implementing mega-projects with a top-down approach.

8 Minister of Environment and Forestry Regulation concerning the preparation of forest areas for food estate development: http://jdih.menlhk.co.id/uploads/files/P_24_2020_PENYEDIAAN_KH_PEMBANGUNAN_FOOD_ESTATE_menlhk_11092020081519.pdf

The way forward?

A diversity of solutions is a prerequisite to ensure the sustainability of food systems. However, we argue that policies supporting the re-localization of food systems in Indonesia merit particular attention, as such policies would encourage local people to regain power over their food systems at regional, provincial, regency and even community level. Practically speaking, policies can advance this agenda by supporting local agroecosystem practices, promoting traditional food cultures, prioritizing short and efficient food value chains, issuing provincial or regional dietary guidelines that match local contexts, re-orientating consumer preferences towards the great diversity of healthy local foods, and discouraging the expansion of unhealthy ultra-processed foods industries.

Many of Indonesia's native and endemic plant species that are adapted to local ecosystems could be further developed through research and investments. Sago (*Metroxylon sagu*), Borneo illipenut – locally known as tengkawang (*Shorea* spp.), mangosteen (*Garcinia mangostana*), Nipah (*Nypa fruticans* Wurmb), pineapple (*Ananas comosus*), and banana (*Musa paradisiaca*) varieties are food-producing plants adapted to wet conditions or low-drainage peat swamp areas (Tata and Susmianto 2016; Uda et al. 2020). As these foods are more likely to be culturally familiar, the use of such plants in agroforestry systems is also more likely to be accepted by local farmers, provided that they increase farmers' livelihoods, food security and nutrition (Samsudin et al. 2020). Complex agroforestry systems can have physiognomy and structures similar to natural forests (de Foresta et al. 2000; Murniati 2020), thus avoiding debate over whether land should be used for forestry or food production. Such nature-positive solutions could improve community livelihoods as well as support food security and nutrition without sacrificing ecosystem health, and without the risks entailed in introducing alien species and agricultural systems that may not fit the physical characteristics of local ecosystems and social systems (Bantacut 2014; Trisia et al. 2016).

Re-localization of food systems can aim to increase fish consumption among children in coastal areas, including addressing the issue of why mothers delay feeding fish to their children. This responds to evidence that fish consumption is associated with better dietary diversity and lower stunting rates (Marinda et al. 2018; Dasgupta et al. 2021), and addresses issues seen in coastal areas like those around Komodo Island, where children under the age of five have high stunting rates and low fish consumption (Gibson et al. 2020). Other studies demonstrate the positive impacts of forests on dietary diversity (Rasmussen et al. 2019), reduced rates of stunting (Rasolofoson et al. 2018) and physical activity (Dounias et al. 2007). A study found that Indigenous Peoples practicing traditional livelihood strategies like



Figure 3. Floating market in Martapura river, Banjarmasin, South Kalimantan (<https://flic.kr/p/2hb78y4>)

Photo by Victor (CC BY-NC-ND 2.0)

swidden agriculture and the harvesting of wild foods ate more fruit, dark green leafy vegetables and fish than those who worked in oil palm plantations. Lower rates of anaemia were also seen among mothers in traditional households, compared with mothers working in oil palm (Purwestri et al. 2019). Regions with rich natural forest, like the islands of Papua and Kalimantan, should therefore be encouraged to include forests and wild foods in their food security and nutrition strategies, so as to improve the low consumption of vegetables, fruits and animal-source foods.

A policy shift towards sustainable food systems can provide for a more *integrated approach*. To this end, it is important to train and instil systemic systems thinking to policymakers in all institutions in Indonesia. Failure to do this may result in repeated mistakes: while trying to achieve one food security goal, policy may undermine other objectives. For example, NTT has sought to develop and expand kelor (*Moringa oleifera*)⁹ and poultry products as local commodities with nutritious potential to reduce under-nutrition (Rahayu and Nurindahsari 2019; Bere 2020; Jahang 2020). However this well-intentioned policy also caused the eviction of Pubabu-Besipae indigenous communities, including children and pregnant women (Kaha 2020;

⁹ Kelor or *Moringa Oleifera*, whose leaves and seeds have nutritive value, is resilient to severe environmental conditions (Gopalakrishnan et al. 2016). This plant is grown in NTT and has been promoted by the local government as a nutritious food to reduce stunting rate (Bere 2020).

Keda 2020)¹⁰. In a sustainable food system framework, these vulnerable individuals should be the actors whom the government empowers through food security and nutrition programs, not the victims.

BAPPENAS has developed plans for regional food systems and provided training regarding food system thinking to policymakers. The idea is to decentralize food and agriculture development in the archipelago into six 'food system regions' (Sumatra, Java, Kalimantan, Sulawesi, Papua and Bali-Sumba-Maluku-NTT), with each geographical area sharing food system similarities across that 'food system region'. Each region is mapped against its agricultural potential, and will have a food system to manage food planning, production, consumption, industry and secure stocks (Noegroho 2020). This is a great step towards the re-localization of food systems. The private sector can play an active role in supporting local communities to sustain native or adaptive food producing systems (Bellotti et al. 2018). Examples like Katingan Mentaya Project in Katingan Regency, Central Kalimantan – which combines restoration and carbon emission credits with the creation of livelihoods in coconut sugar production in the project buffer area (Katingan Mentaya Project 2021) – need to be mapped against these geographical 'food regions' and the food systems they champion. Albeit complicated, participation, engagement, and coordination between government, non-government, and private sector organizations will also be necessary. Uncovering existing practices and their champions is essential to complete information gaps and firm up what these regional food systems could look like in reality.

Conclusions

The issues of food, nutrition and the environment are closely interconnected in Indonesia and need to be explicitly linked in efforts to transition towards sustainable food systems. Macro-level policies that address food insecurity, such as those that promote rice self-sufficiency, also need to consider how these policies are likely to affect individual food choices, and the implications of these choices for nutrition and health. These policies should also be adopted with consideration of their likely impact on landscapes and biodiversity. This will almost certainly entail an approach that moves

beyond a focus on a single commodity, and involves anticipating the impacts on the environment, local food cultures, and health and nutrition challenges.

Policies to rehabilitate local food cultures can be pursued alongside initiatives to prevent the poor food habits that are associated with expansion of the processed food industry. Lessons learned from previous projects suggest that incorporating the rich heritage of Indonesia's biodiversity, agricultural practices and food cultures into food policies will help to avoid the problems that arose from previous top-down and 'magic bullet' approaches. The lead planning and development agency and key civil society actors have a vision for moving towards a systemic approach to address the nation's food and nutrition challenges. With more than 16,000 islands and 1,300 ethnic groups, Indonesia's food system has multiple food cultures and practices to build upon. To transition towards sustainable food systems, Indonesia can embrace this diversity of local diets and agricultural practices, supporting local agents in using local resources, so as to develop context-appropriate solutions to the food security and nutrition challenges they face.

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¹⁰ In 1982, to facilitate Australian investors in poultry, the government rented an area from the Pubabu adat community until 2012. The government requested to extend this rental period, but the adat community refused. However, in 2013, a certificate for the right to use the land was issued on behalf of the government. In 2017, there were reports that some adat community members were assaulted and forced to sign an agreement letter and evict the land. In 2020, the local government evicted the indigenous communities to begin development of moringa and poultry farms, on the understanding that the land was theirs (Bere 2017; de Rosary 2020; Rachmawati 2020; Nahar 2021).

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Captions and Photo Credits

Front Cover (from left to right):

1. Fresh fern (locally known as *pakis*) leaves from Kalimantan Forest, handpicked by local people for daily meal (Photo by: Icaro Cooke Vieira/CIFOR)
2. Dryland rice from North Kalimantan (Photo by: Sopian Hadiwijaya)
3. Fresh vegetables on sale at local food stall in conservation district of Pegunungan Arfak, West Papua Province (Photo by: Research and Development Agency of West Papua Province)
4. Purple corn harvested in Hokeng, East Flores, is one of the local corn in the region (red, white, and yellow corns are also local varieties) (Photo by: KEHATI)
5. Colourful sorghums, locally known as *Watablolo*, grown in Adonara, East Flores, East Nusa Tenggara (Photo by: KEHATI)
6. A basket of colourful forest fruits in North Kalimantan (Photo by: Tezza Napitupulu)
7. Tropical fruits from Sangihe Island Regency, North Sulawesi (Photo by: KEHATI)
8. Freshwater fish caught from the river of Kalimantan (Photo by: Aulia Erlangga/CIFOR)
9. Red fruit (locally known as *buah merah* or *Pandanus coinodeus*), known to be rich in vitamin A and anti-oxidant substances (Photo by: Manuel Boissière/CIRAD and CIFOR)
10. On sale for home meal: Parrot fish captured by small scale fishers using traps in Panggang Island, Jakarta (Photo by: Mohamad Susanto)

Back Cover:

Forest in misty mountain of Halimun-Salak National Park (Photo by: Mokhamad Edliadi/CIFOR)



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