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Commentary

Diversifying Dietary Options: A Strategic Path to Reducing Stunting in East Nusa Tenggara (NTT)

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ABSTRACT

Stunting remains a pressing public health issue in Indonesia, with East Nusa Tenggara (NTT) recording a prevalence of 37% in 2024- nearly twice the national average. The challenge lies less in calorie deficiency and more in poor diet quality driven by limited dietary diversity. While Indonesia has reduced its national stunting rate to 19.8%, progress in high-burden provinces like NTT remains slow, hindered by inadequate resource allocation and continued reliance on water-intensive rice cultivation in a predominantly dry climate. Locally resilient crops such as sorghum (*Sorghum bicolor*) and moringa (*Moringa oleifera*) present viable solutions. Both crops thrive in semi-arid conditions and offer nutrient-dense alternatives to rice, addressing protein, iron, and vitamin A deficiencies that contribute to stunting. Recent studies in NTT show that sorghum- and moringa-based foods improve child growth indicators, demonstrating their potential as scalable interventions. Promoting diversified, locally rooted food systems can not only combat stunting but also reduce wasting and underweight, making food diversification a cornerstone of sustainable nutrition strategies in NTT.

Keywords: Growth disorders; sorghum; moringa; stunting; food diversification

1. INTRODUCTION

Stunting is a growth and development disorder in children under five, characterised by height-for-age more than two standard deviations below the WHO Child Growth Standards median. It is caused by chronic undernutrition, repeated infections, and inadequate psychosocial stimulation during the first 1,000 days of life.[1,2] Early-life stunting has long-lasting negative impacts, including poor cognitive development, low educational performance, and reduced productivity in adulthood. Stunted children who later gain excess weight are also at higher risk of developing nutrition-related chronic diseases, adding to the health burden.

Globally, an estimated 149 million children were stunted in 2022.[3] Undernutrition- including stunting, wasting, and overweight- is linked to nearly half of all child deaths, with low- and middle-income countries bearing the greatest burden. The consequences extend beyond health, affecting social, economic, and developmental outcomes, making stunting a deeply rooted, intergenerational challenge requiring sustained and systemic interventions.

In Indonesia, steady progress has been made, the 2024 Indonesian Nutrition Status Survey (SSGI) reported a reduction in the national stunting rate to 19.8%, down from 30.8% in 2018.[4,5] Despite this improvement, six priority provinces-identified as stunting hotspots- are home to over 50% of Indonesia's stunted children. Evidence shows that 60% of stunting-related funds are directed to centralised programmes, while high-prevalence regions such as East Nusa Tenggara (NTT) and Papua receive only 10-15% of the budget.[5] This limited allocation constrains the ability of these provinces to design and implement context-specific, adaptive interventions. To achieve the revised national goal of 14.2% stunting prevalence by 2029, strategic investments in high-burden provinces are essential. These efforts must be inclusive, equitable, and grounded in local realities- especially in geographically diverse areas like NTT, where many indigenous languages and cultural practices pose additional challenges to health communication and service delivery. Without targeted interventions tailored to local contexts, achieving the national target will be impossible.

East Nusa Tenggara, an archipelagic province of 1,192 islands inhabited across 44 districts, is home to diverse ethnic groups and languages.[6] It remains one of Indonesia's most affected regions, with stunting prevalence at 37% in 2024- nearly double the national average.[4] The wasting and underweight among the children isare also higher in this region. Understanding the province's complex context and economic vulnerabilities is key to designing further effective solutions.

2. CONTEXT AND ECONOMIC VULNERABILITY OF EAST NUSA TENGGARA (NTT) - FRAMING THE NEED FOR ALTERNATIVE FOOD OPTIONS

Nusa Tenggara Timur (NTT), located in eastern Indonesia across the Lesser Sunda archipelago (Flobamorata region), spans around 46,820 km² and hosts over 5.65 million residents across 22 districts.[6,7] Over half the population relies on agriculture, yet the sector contributes under 30% to GRDP- reflecting low productivity, limited agronomic inputs, and frequent crop failures due to minimal rainfall and water scarcity.[6] This insufficient food production and reduced economic output directly impact child nutrition: low dietary variety and income correlate strongly with stunting incidence in NTT.[8] This vulnerability is further exacerbated by NTT's reliance on water-intensive crops such as rice, despite the region's predominantly dry climate and limited irrigation infrastructure.[9]

Such environmental and economic constraints underscore the need for climate-resilient, nutrient-dense, and locally adaptable food sources- such as sorghum, moringa- capable of thriving under dry conditions with minimal inputs. Sorghum, with its superior protein content (13.3%) and higher caloric value. It delivers more energy than rice and offers rich levels of dietary fibre and minerals, as well as beneficial antioxidant compounds.[10] As for moringa, its leaves are exceptionally rich in protein (30%), minerals, calcium and iron, and beta-carotene- making it a powerful tool to enhance household nutrition- especially in rural, semi-arid areas of NTT.[11]

3. DIETARY PATTERNS AND NUTRITIONAL CHALLENGES IN NTT LEADING TO STUNTING

Indonesia's national dietary profile is heavily reliant on rice, often at the expense of dietary diversity and micronutrient intake.[12] A study shows that animal-source foods such as meat, eggs, and milk products, along with vitamin A- rich vegetables, have a significant relationship with stunting in Indonesia, suggesting that deficiencies in high-quality protein and certain micronutrients- particularly vitamin A- are critical contributors. These foods provide essential amino acids, bioavailable iron, zinc, and fat-soluble vitamins that are not sufficiently supplied by a cereal-based diet. In contrast, cereals, which are the dominant staple in many Indonesian diets, did not show a significant association with stunting. This is because cereals generally provide adequate energy but are low in quality protein and certain micronutrients. Meaning, while calorie intake may be sufficient, the diet can still lack the nutrient density needed for optimal growth.[13] As a result, children may not exhibit immediate signs of energy deficiency, but prolonged shortages in protein and vitamin A can impair growth and immunity, cognitive development and risk of repeated infection- perpetuating the high stunting rates observed in regions such as NTT.

According to FAO data, the shared dietary energy from staple food (cereals, roots and tubers) has lowered

in recent years in Indonesia which increased the opportunity to intake of higher nutritional quality, however challenges remain around other food components such as availability of vegetables, lentils etc.[14] With a vastly diverse geographical locations, this is more challenging in the provinces like NTT where agricultural commodities are difficult to grow, often required to export from other regions.[15] The educational gap among the inhabitants regarding dietary diversity and nutritional need further exaggerated the situation. Daily caloric intake in NTT comes largely from grains and tubers, with calories from rice alone contributing over 1,217 kcal, compared to just about 60 kcal from roots and tubers.[16] This reflects widespread micronutrient inadequacy, despite sufficient calorie intake.[12] Picauly et al. (2024) found that the likelihood of stunting increases with the advancing age of toddlers in NTT, a correlation that has also been observed in many other countries.[8] This indicates the emergence of continuous nutrition supplement and education for the in inhabitants is required with advancing age of the children.

Although the average caloric intake in NTT is higher than in Yogyakarta, this does not necessarily translate into better nutritional outcomes. The issue in NTT is not a shortage of calories but rather the poor quality of the diet choice. In NTT, households spend approximately 75% of their income on food- significantly more than households in Yogyakarta. Despite this higher expenditure, the population in NTT is not meeting essential micronutrient requirements, highlighting a gap in dietary quality.[12] In contrast, households in Yogyakarta exhibit more diversified dietary patterns, suggesting that local food systems, awareness, and purchasing capacity supporting both food and nutrition security. Meanwhile, NTT remains focused on fulfilling caloric needs, often overlooking the nutritional value of consumed foods. These patterns underline the importance of promoting local food diversification, targeted nutrition education, and market accessibility to improve dietary quality to reduce stunting.

4. DIVERSIFICATION OF DIETARY OPTIONS IN NTT

Given the overdependence on rice- a staple that provides high calories and energy but is low in protein and other essential micronutrients- there is a pressing need to promote alternative food options from local sources. The goal is to reduce reliance on rice-based diets, which not only limit nutritional diversity but also require substantial water for cultivation, a challenge in the water-scarce environment of NTT. Promoting locally available, nutrient-dense foods can both diversify the diet and improve its quality, addressing protein and micronutrient deficiencies that contribute to stunting, wasting, and underweight in the region. Such diversification strategies would help meet the dietary and nutritional needs of the population while enhancing resilience against environmental and economic vulnerabilities.

4.1 Sorghum

Sorghum (*Sorghum bicolor*) is notably more nutritious than rice, offering superior levels of protein, dietary fibre, essential minerals, and antioxidants- making it a valuable crop for nutrition-sensitive contexts like NTT. A comparative study found that sorghum contained 13.3% protein, significantly higher than rice's 8.0%, along with greater energy value and richer levels of zinc (1.57 mg vs. 0.93 mg) and iron (2.39 mg vs. 0.58 mg) per 100 g.[17] Sorghum also demonstrates significantly higher antioxidant capacity, with elevated phenolic content, especially in varieties like brewing sorghum that are rich in proanthocyanidins and flavonoids.[18] Collectively, these traits make sorghum an excellent alternative to rice for reducing micronutrient deficiencies, improving dietary diversity, and strengthening food security in challenging environments.

Sorghum, once commonly planted alongside corn or rice protecting from pests, has now been recognized for its superior pest and disease resistance as well as its higher nutritional value compared to rice and corn.[19] Since the 1970s- when the Indonesian government prioritized rice production- sorghum cultivation has sharply declined. Fortunately, this crop is already embedded into NTT's traditional farming and scaling production won't require importing new seed and market creation for selling. In East Nusa Tenggara (NTT), where rainfall is limited and the dry season dominates, sorghum presents a strategic advantage. It is a drought-tolerant crop, with local varieties capable of producing 3–4 tons per hectare without fertilizer.[20] Unlike rice, which demands extensive irrigation systems that are challenging to implement in NTT, sorghum thrives in marginal areas with minimal water resources. Moreover, NTT is home to many local sorghum varieties, each adapted to specific microclimates, making it an ideal crop to cultivate across the province's diverse environmental

conditions.[21] Sorghum can be processed into flour for noodles, bread, and porridge, offering value-added opportunities for local small businesses. Sorghum-based porridge which is locally called "bubur sorgum" and steamed sorghum rice are already known in some NTT districts, so it is just revival as a return to heritage foods rather than introducing something new. Indonesian government has already taken initiative to expand sorghum cultivation and launched 'Sorghum Roadmap 2022-2024' to expand the cultivation to 40,000 hectares which is a strategic move to combat stunting in the regions like NTT.

4.2 Moringa

Moringa (*Moringa oleifera*), commonly known as the "drumstick tree" or "horseradish tree," is native to India and thrives in tropical and subtropical regions worldwide. Highly resilient, it can tolerate severe drought as well as mild frost, making it suitable for widespread cultivation across diverse climates.[22] Every part of the tree is considered as the storehouse of important nutrients. NTT is believed as the best producer of Moringa in Indonesia which is locally named as Kelor.[23]

Moringa is a nutrient-dense plant that offers substantial potential in combating child stunting, particularly in low-resource settings. Dried moringa leaves provide protein levels comparable to meat and eggs, making them a strong plant-based alternative where animal-source foods are less accessible. Its leaves are rich in high-quality protein (containing all essential amino acids), calcium, iron, potassium, vitamin A, vitamin C, and antioxidants, making it an effective dietary supplement for growth and immune function.[22,24,25] For children at risk of stunting, these nutrients are critical: protein supports muscle and tissue development, calcium and vitamin D contribute to bone growth, iron prevents anaemia-related growth delays, and vitamin A strengthens immune defences.[26] Regular consumption of moringa leaves can therefore help fill micronutrient gaps that often persist in rural diets dependent on rice or maize.

In East Nusa Tenggara (NTT), Moringa is traditionally consumed almost exclusively for its leaves, while the immature pods- commonly used as a vegetable in India and surrounding South Asian countries- are largely overlooked. This represents a missed opportunity for dietary diversification. Immature pods are not only palatable when cooked but also provide valuable nutrients, including protein (~2–3 g/100 g fresh weight), vitamin C (4–8 mg/100 g), potassium, and moderate amounts of calcium and iron.[26] While their micronutrient profile is lower than that of the leaves, pods contribute beneficial dietary fibre and serve as an additional seasonal vegetable option, reducing dependence on a single plant part. Introducing pods into local diets could diversify flavours and textures, improve nutrient intake variety, and enhance household food security. Promoting simple recipes- such as stews, curries, or stir-fries- can facilitate acceptance, drawing on culinary practices from South Asia where pods are a common staple.[22] The government has shown interest in expanding moringa production and use in provinces like NTT, and it has been introduced in some areas through the free meal programme; however, stronger collective action is still needed to fully integrate its potential at the policy level. Promisingly, a most recent study in NTT found that providing stunted children with cookies made from sorghum and moringa significantly improved their height, weight, and upper arm circumference.[27] This approach offers a multidimensional solution by addressing nutritional deficiencies while also promoting the local production and market expansion of both crops.

5. CONCLUSION AND FUTURE RECOMMENDATIONS

NTT is not only facing one of the highest levels of stunting in Indonesia, but also experiencing a high prevalence of wasting and underweight among children- both nearly twice the national average. Current strategies primarily focus on reducing stunting, while wasting and underweight remain somewhat overlooked- which could be stated as triple burden- as a symptom of the same dietary and economic root causes.

While scaling up efforts to combat stunting is crucial, diversifying locally available foods-such as sorghum and moringa- and promoting their full range of uses can benefit the entire community by improving access to nutrient-rich foods and reducing dependence on monotonous diets. This option is not only relevant for children affected by stunting but can also contribute to the nutritional recovery of underweight and wasted children. Expanding the use of these crops can further lower the region's food import costs, allowing resources to be redirected to other pressing areas of need. Food diversification is not a side project- it is a critical pillar of any sustainable nutrition improvement plan in NTT.

Promoting and diversifying the use of locally available, nutrient-rich foods should be included to stunting reduction efforts, particularly in high-burden regions. Success will rely not only on introducing these options but also on understanding and addressing community food preferences, cultural practices, and household decision-making. Equally important is strengthening market linkages to ensure these crops remain accessible, affordable, and attractive to both producers and consumers.

Looking ahead, investment in research and innovation is essential to identify region-specific solutions that can be scaled sustainably. This includes exploring underutilised crops, reinforcing local supply chains, and designing behaviour change strategies that resonate with community values. By tailoring approaches to the unique food systems of each endemic region, Indonesia can accelerate progress towards its stunting reduction targets and build a more resilient foundation for long-term nutritional security.

Ethical Approval

Not required.

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Competing Interests

All the authors declare that there are no conflicts of interest.

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