Food and Agriculture Organization of the United Nations

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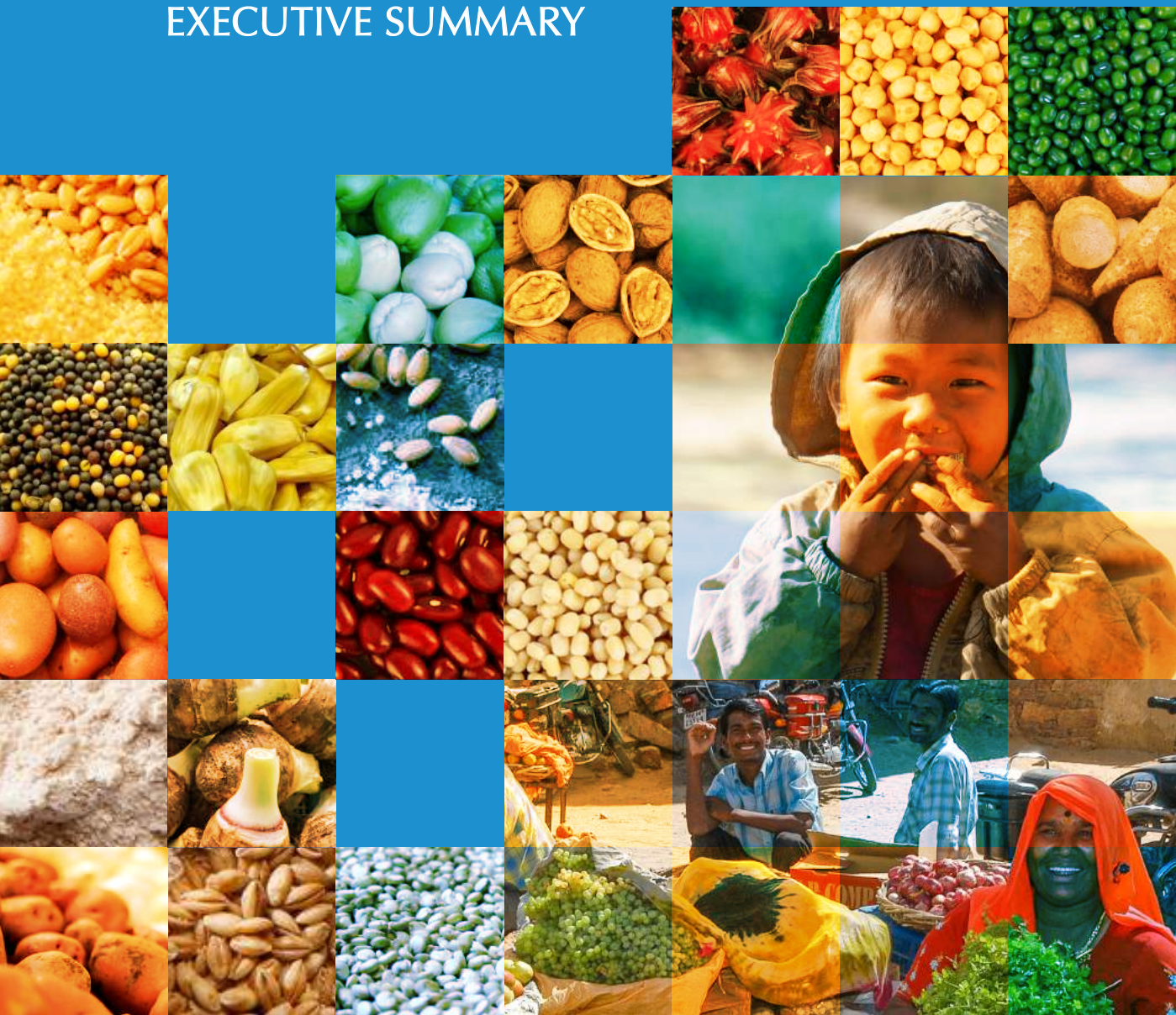
FUTURE SMART FOOD

Rediscovering hidden treasures of neglected and underutilized species for Zero Hunger in Asia

EXECUTIVE SUMMARY



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Editors
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Foreword

Achieving the Sustainable Development Goals (SDGs) is at the heart of the work of the Food and Agriculture Organization (FAO), especially Sustainable Development Goal 2, which calls for the eradication of hunger and all forms of malnutrition. Delivering on this pledge requires that all people are able to access adequate and nutritious food, which will require a sustainable increase in the productivity and incomes of smallholder farmers. Furthermore, it will entail a transformation of food systems and an inclusive pro-poor boost to rural development to be pursued while sustaining our natural resource base and safeguarding biodiversity.

The purpose of this publication is: i) to demonstrate the multidimensional benefits of neglected and underutilized species (NUS) and their potential contribution to achieving Zero Hunger; ii) to identify promising NUS – sometimes called 'orphan crops' – that are nutrition-dense, climate-resilient, economically viable and locally available or adaptable as 'Future Smart Food' (FSF); iii) to highlight the challenges and opportunities for harnessing these less-mainstream food crops; and iv) to provide strategic recommendations to create an enabling environment for the promotion, production, marketing and consumption of FSF assuring healthy diets for the future.

FAO considers that NUS have a central role to play in the fight against hunger and malnutrition, and that they are currently being overlooked. Today, just 103 out of the nearly 30 000 edible plant species worldwide provide up to 90 percent of the calories in the human diet (and 60 percent of the world's caloric intake comes from just a few staples such as maize, rice, wheat, soybean and potato. This percentage can reach up to 80 percent in some parts of the world).

Buoyed by the successes of the International Year of Quinoa (2013) and International Year of Pulses (2016), awareness of NUS as a valuable resource for sustainable agriculture and rural development has increased. Using sound scientific underpinnings to promote NUS can help diversify food production and diets in economically, socially and environmentally sustainable ways while contributing to the resilience of smallholder and rural populations.

The overarching global vision on NUS needs to be translated into concrete actions on the ground. FAO's Regional Office for Asia and the Pacific, as part of its Regional Initiative on the Zero Hunger Challenge, is taking a leading role in harnessing the hidden treasures embodied in NUS, which we like to call Future Smart Food. These foods are smart because they can bolster dietary diversification, improve micronutrient intake, enhance soil health, require fewer inputs such as chemical fertilizers, and often prove resilient to climate change and adverse farming conditions.

Turning the potential of FSF into real benefits is not an easy task. It requires a systems approach, multidisciplinary analysis, multi-stakeholder consultation and cross-sectoral coordination. To achieve Zero Hunger, more attention needs to be given to both production and consumption. Identifying which species are appropriate is just an initial step from a food-system perspective. How to create an enabling environment across value chains – to promote sustainable production, processing, marketing and consumption of FSF – is essential to achieving Zero Hunger.

It is also important to develop capacity and facilitate knowledge-sharing across regions on how to better harness the potential of FSF for Zero Hunger, and to build on the valuable experience gained in Asia on NUS.

It is now time to take advantage of the wealth of knowledge that we have accumulated on neglected and underutilized species so that we can develop more sustainable, nutrition-dense, climate-resilient and diversified food systems. The evidence is at hand. We need to act promptly and collectively.

José Graziano da Silva
FAO Director-General

Preface

For centuries people in Asia and the Pacific have grown and consumed a wide variety of nutritious foods. Unfortunately, more recent generations have slowly but surely changed their diets and have moved away from many of these traditional foods. The Food and Agriculture Organization of the United Nations (FAO) is working with our Member Countries to reinvigorate both production and consumption of these crops – often referred to as neglected and underutilized species (NUS).

This work is consistent with FAO's role in providing support to countries to meet the targets of the Sustainable Development Goals (SDGs), primarily, but not limited to, SDG 2 which aims to achieve Zero Hunger, specifically to "end hunger, achieve food security and improved nutrition, and promote sustainable agriculture" by 2030. The Zero Hunger goal implies that no one should be left behind. The Asia-Pacific region is home to most of the world's undernourished people (490 million). Other forms of malnutrition remain challenging, including stunting and micronutrient deficiencies. While in some countries there are rising rates of overweight and obesity.

The issues are manifest in both the demand side and supply side. On the demand side, there is population growth, urbanization, migration and the changing consumption associated with rising incomes. On the supply side, the combined effects of climate change, declining agricultural biodiversity, water scarcity, land scarcity and the degradation of natural resources are threatening world food security.

The demand and supply dilemma highlights two gaps in agriculture and food systems:

1 Production gap – FAO projections suggest that by 2050, agricultural production must increase by 50 percent globally to meet food demand. Increased production of traditional staple crops is unlikely to meet the increasing demand.

2 Nutrition gap – between what foods are grown and available, and what foods are needed for a healthy diet.

So what to do?

Increasing the availability of and access to nutritious foods necessary for a healthy diet will help to close both the production and nutrition gaps. But conventional staple foods do not supply all the nutrients needed for a balanced diet. Tackling the health problems caused by malnutrition requires a transformation of current agriculture and food systems towards more diversity on all levels.

FAO work has demonstrated that dependence on a few crops has negative consequences for ecosystems, food diversity and health. Food monotony increases the risk of micronutrient deficiency. In other words, we must make food and agriculture more nutrition-sensitive and climate-resilient. Over-reliance on a few staple crops coupled with low dietary diversity is a leading cause of persistent malnutrition.

The dependency on rice, in particular, leads to insufficient intake of nutrient-rich foods, which increases the 'nutrition gap.' To achieve SDG 2, the agriculture and food system must be more sustainable – we have to ensure climate-smart agriculture and prioritize a paradigm shift: *save and grow*. Unsustainable high-input, intensive crop production and monocultures have led to environmental degradation. How to bridge the 'production gap' remains a huge challenge. Policymakers need to recognize that policy support for monocropping or cash crops has driven this unbalanced shift.

Diversification is an effective means of closing the production and nutrition gaps, and achieving Zero Hunger. Governments need to promote agricultural diversification, from a dietary and production perspective. Dietary diversity is a cost-effective, affordable and sustainable means of eradicating hunger and malnutrition. Production diversity helps to address malnutrition and climate change simultaneously. NUS offer considerable potential to bridge both production and nutrition gaps, and are abundant in the region. NUS that are nutritionally dense, climate resilient, economically viable, and locally available or adaptable are considered Future Smart Food (FSF). Increasing the share of FSF in diets is the way forward to achieving Zero Hunger. FSF have received few incentives for production in the Asian region, which is mostly geared towards rice, and there is little consumer awareness of their nutritional and health benefits. Governments need to lessen their focus on staple and cash crops, and tap into the vast potential of FSF. Creating an appropriate enabling environment for FSF is critical. It is time to rediscover these hidden treasures for achieving Zero Hunger.

Kundhavi Kadiresan
Assistant Director-General and Regional Representative
FAO Regional Office for Asia and the Pacific

Note from the editors

The FAO Regional Office for Asia and the Pacific (RAP)'s Future Smart Food Initiative (FSF Initiative), as endorsed by the FAO Director-General, is intended to promote agriculture diversification with sustainable intensification addressing Zero Hunger. This report moves forward with the outcomes of FAO RAP's regional priority-setting exercise on neglected and underutilized species (NUS), including the Regional Expert Consultation on Scoping, Prioritizing and Mapping of NUS in Asia (the Consultation).

The Consultation was co-organized by FAO and Australian Centre for International Agricultural Research (ACIAR) under FAO RAP's Regional Initiative on Zero Hunger Challenge (RI-ZHC), and took place from 3-5 December 2016 in Bangkok, Thailand. The purpose of the Consultation was to identify promising NUS crops that are nutritionally dense, climate resilient, economically viable, and locally available or adaptable, and to provide strategic advice to decision-makers. These promising NUS are referred to as Future Smart Food (FSF).

The Consultation was held in the context of hunger, food insecurity and malnutrition as major challenges in the twenty-first century for the Asia-Pacific region. To achieve the Zero Hunger goal, which is the aim of Sustainable Development Goal (SDG) 2, dietary patterns and food systems need to be improved urgently. Stakeholders in the agriculture and food value chain are affected by the disconnect between production, consumption and nutrition. Countries are facing challenges associated with population growth and climate change. Agricultural diversification offers enormous opportunities for addressing hunger and malnutrition, especially in the context of climate change. In this regard, NUS[1] offer diverse and nutritious food resources, and agricultural resilience. NUS are important in specific agro-ecological niches and are often linked with traditions and cultural heritage in their places of origin. They are an essential source of protein and micronutrients, and can enhance climate resilience, improve agriculture sustainability, and boost household incomes and livelihoods with considerable commercial potential. In this context, FAO, together with ACIAR, and in collaboration with national and international partners, organized the Consultation during the International Year of Pulses (2016). Thirty-five participants, representing eight countries,[2] including four governments represented by national focal points on the Zero Hunger Challenge (ZHC), as well as 21 national and international partners, attended the Consultation. Participants at the Consultation identified ten recommendations for policymakers.

[1] "Neglected and underutilized species are those to which little attention is paid or which are entirely ignored by agricultural researchers, plant breeders and policymakers. They are wild or semi-domesticated varieties and non-timber forest species that are not typically traded as commodities." Padulosi, Thompson and Rudebjer (2013).

[2] Australian Centre for International Agricultural Research (ACIAR); Bangladesh Agriculture Research Institute (BARI); Bioversity International (BI); Cambodian Agricultural Research and Development Institute (CARDI); Chinese Academy of Tropical Agricultural Sciences-Tropical Crops Genetic Resources Institute (CATAS-TCGRI); Crops for the Future (CFF); Department of Agriculture, Ministry of Agriculture and Forests, Bhutan; Department of Agricultural Research (DAR), Myanmar; Food and Agriculture Organization of the United Nations (FAO); FAO Special Ambassador for International Year of Pulses 2016; International Centre for Agricultural Research in the Dry Areas (ICARDA); International Centre for Integrated Mountain Development (ICIMOD); International Crops Research Institute for the Semi-Arid Tropics (ICRISAT); International Tropical Fruits Network (TFNet); Mahidol University, Thailand; M S Swaminathan Research Foundation – Leveraging Agriculture for Nutrition in South Asia (MSSRF-LANSA); National Agriculture and Forestry Research Institute (NAFRI), Lao PDR; Nepal Agriculture Research Council (NARC); National Plant Resources Centre, Vietnam Academy of Agricultural Sciences, Viet Nam; The Akshaya Patra Foundation, India; The University of Western Australia (UWA); Uttar Banga Krishi Viswavidyalaya (UBKV), West Bengal, India.

The RI-ZHC of FAO RAP was formulated to assist its Member Countries following the launch of the global ZHC at the Rio+20 Conference in June 2012, and the Asia-Pacific regional ZHC in April 2013 by the United Nations and associated agencies, with participation by heads of governments, and other high-level and senior officials from across the region. Subsequently, the United Nations Regional Thematic Working Group on Poverty and Hunger, chaired by FAO, along with UNESCAP and UNDP, prepared the 'Regional Guiding Framework for Achieving Zero Hunger in Asia and the Pacific.' This Framework calls for all stakeholders to carry the momentum forward with concrete action at the country level.

Under this Framework, RI-ZHC established three major programmatic work areas in consultation with governments:

1 creating environments for food security and nutrition;

2 data collection, analysis, and monitoring on food security and nutrition; and

3 strengthening sustainable agriculture and food systems.

The FSF initiative is an integral component under RI-ZHC.

The initiative is implemented under the overall Strategic Programme of FAO to *"contribute to the eradication of hunger, food insecurity and malnutrition,"* in collaboration with various other strategic programmes.

Inspired by a request from Member Countries to identify alternative crops to address Zero Hunger in a changing climate, Kundhavi Kadiresan, Assistant Director-General and Regional Representative of FAO RAP, launched the FSF Initiative. The FSF Initiative is built on the strong foundation and the long-standing experience of FAO on NUS at global and regional levels, in particular, the International Year of Quinoa (2013), International Year of Pulses (2016), and the approach that the Director-General highlighted to address hunger and malnutrition from a food-system perspective. A concept note was developed, based on intensive consultation with strategic programme leaders of FAO; the technical departments responsible for agriculture, and economic and social development; the Office of the Director General, RAP; and FAO representatives in the Zero Hunger countries. Subsequently, the Consultation on NUS was organized. The results of the Consultation paved the way for implementation of FAO RAP's Regional Technical Cooperation Project on Creating Enabling Environments for Nutrition-Sensitive Food and Agriculture to Address Malnutrition.

The development of the FSF Initiative started with a three-stage priority-setting exercise, which was the building block for achieving the goal of creating an enabling environment for promising NUS in the region. A special feature of the exercise was its applied methodology that covered a wide range of different disciplines, including nutrition, agricultural production, ecology and socio-economics. The first stage of the process involved preliminary scoping of the availability and use of NUS crops in eight countries in the region: Bangladesh, Bhutan, Cambodia, Lao PDR, Myanmar, Nepal, Viet Nam and West Bengal in India, and the preparation of eight studies to serve as directions for governments to recognize the importance of NUS and to promote them at the national level. The preliminary scoping reports were reviewed and presented at the Consultation. The objectives of the review were to:

1 validate the preliminary scoping reports on crop-related NUS in selected countries,

2 rank and prioritize high-potential NUS based on established priority criteria,

3 identify five to six crop-related NUS per country, and

4 strategize to enhance production and utilization of the selected crops in local diets.

These studies were revised according to the outcomes and suggestions during the Consultation, and went through a peer review by FAO and the international partners that had participated in the Consultation. The background, objectives, process, methodology and preliminary results for each country are presented in Chapter 1. Chapter 2 then presents details on the regional priority-setting exercise on FSF among NUS for Zero Hunger.

Partnerships are essential to the process of the FSF Initiative. The prioritization process is an interdisciplinary consultation with the governments of Lao PDR, Myanmar and Nepal (represented by National Focal Points of the Zero Hunger Challenge), national research institutes in Bangladesh, Bhutan, Cambodia, Lao PDR, Myanmar, Nepal, Viet Nam and West Bengal, as well as leading international experts from agriculture, nutrition and socio-economic disciplines, including the FAO Special Ambassador for the International Year of Pulses, the University of Western Australia, ACIAR, the International Centre for Agricultural Research in the Dry Areas (ICARDA), the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Bioversity International, the MS Swaminathan Research Foundation – Leveraging Agriculture for Nutrition in South Asia (MSSRF-LANSA), Mahidol University in Thailand, the Chinese Academy of Tropical Agricultural Sciences – Tropical Crops Genetic Resources Institute (CATAS-TCGRI), the International Centre for Integrated Mountain Development (ICIMOD), Crops For the Future (CFF), the International Tropical Fruits Network (TFNet), and the Akshaya Patra Foundation (a non-government organization from India). The prioritization exercise was led by FAO, and collectively conducted and owned by governments, and national and international partners. The prioritized lists of FSF are country specific, and have been reviewed by an international expert panel, and finalized by each country.

The main outputs of the prioritization exercise were two-fold. First, lists of prioritized FSF in Bangladesh, Bhutan, Cambodia, Lao PDR, Myanmar, Nepal, Viet Nam and West Bengal in India were prepared by national researchers to provide context-specific crops that are nutritious, climate-smart and have economic potential. The studies, presented in Part II of this report, were peer-reviewed by FAO and leading international experts from agriculture, nutrition and socio-economic disciplines. Second, recommendations were made to policymakers on how to support FSF to address hunger and malnutrition in a changing climate through appropriate national policies. In the recommendations, presented in the Conclusion (Chapter 14), experts from the Consultation jointly proposed the term 'Future Smart Food' for promising NUS to change the negatively perceived attributes of these 'hidden treasures'. Subsequently, the leading international experts contributed thematic chapters, presented in Part I, which illustrate the justification, grounds and needs for an enabling environment to promote FSF production, marketing and consumption for Zero Hunger. The outputs of the exercise, including the Recommendations of the Consultation, were endorsed by the Minister of Agriculture in Lao PDR on behalf of Asia and the Pacific countries at the Zero Hunger Plenary Event during the 40th Session of the FAO Conference in Rome in 2017.

Chapter 1 of the report serves as a guiding chapter, outlining the context and justification of FSF to address Zero Hunger in the changing climate; the priority-setting exercise in terms of the objective, scope, principle, methodology and process; and the key recommendations on FSF for policymakers.

Part I comprises four chapters (Chapter 2 through Chapter 5) contributed by FAO and leading international experts. Chapter 2 highlights the challenges, opportunities and strategies to develop NUS into FSF.

Chapter 3 analyses the potential of FSF for nutrition enhancement and climate resilience to address Zero Hunger. Chapter 4 presents experiences in South Asia of FSF crops in a paddy fallow agri-food system. Chapter 5 discusses how to mainstream FSF into national strategies and programmes on food security and nutrition.

Part II (Chapter 6 through Chapter 13) provides an overview of scoping and prioritizing FSF for eight countries: Bangladesh, Bhutan, Cambodia, Lao PDR, Myanmar, Nepal, Viet Nam and West Bengal in India. For each country, high-potential crops were shortlisted after being prioritized on the basis of a set of multi-dimensional criteria. The studies include mapping of the availability of FSF, an assessment of their multiple benefits and the challenges they face, and feature lists of prioritized crops with potential in each country. Each study provides background on the country's agro-ecological environment, food composition, predominant cropping patterns and crops in the national farming system. A situation analysis identifies gaps and major challenges each country is facing with regard to hunger and malnutrition, climate change, and market and economic considerations, as well as cultural aspects. To link suitable FSF in each country to the identified challenges, potential FSF were assessed and prioritized according to their nutritional features, adaptation potential to local environments and climate change, economic potential, and sociocultural suitability. Each study also includes a set of recommendations and subsequent actions to further promote FSF in the respective country.

The Conclusion (Chapter 14) presents the policy recommendations made by the Panel of Experts.

Xuan Li and Kadambot H.M. Siddique

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We are deeply grateful to those who have contributed in various ways to the publication of this report. It presents the origin and latest results of the FAO RAP's Future Smart Food Initiative (FSF Initiative). The FSF Initiative is led and launched to address the Zero Hunger Challenge by Kundhavi Kadiresan, Assistant Director-General and Regional Representative, FAO RAP, in collaboration with national and international partners, and has been endorsed by the FAO Director-General. This publication is the result of collective contributions from partners and experts dedicated to the regional priority-setting exercise on neglected and underutilized species (NUS).

We acknowledge the valuable contributions from the experts, particularly the Regional Expert Consultation on Scoping, Prioritizing and Mapping of Neglected and Underutilized Crop Species in Asia (hereafter, "the Consultation"), in observance of the International Year of Pulses, held in Bangkok from 3-5 December 2016. The Consultation was co-organized by FAO and the Australian Centre for International Agricultural Research (ACIAR) under the Australian Government, in collaboration with The University of Western Australia (UWA), the International Centre for Agricultural Research in the Dry Areas (ICARDA), the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Bioversity International, the M S Swaminathan Research Foundation – Leveraging Agriculture for Nutrition in South Asia (MSSRF-LANSA), Mahidol University in Thailand, the Chinese Academy of Tropical Agricultural Sciences – Tropical Crops Genetic Resources Institute (CATAS-TCGRI), the International Centre for Integrated Mountain Development (ICIMOD), Crops for the Future (CFF), the International Tropical Fruits Network (TFNet), and the Akshaya Patra Foundation.

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Acronyms and abbreviations

ACIAR	Australian Centre for International Agricultural Research
BARI	Bangladesh Agriculture Research Institute
CATAS-TCGRI	Chinese Academy of Tropical Agricultural Sciences – Tropical Crops Genetic Resources Institute
CDB	Convention on Biological Diversity
CFF	Crops For the Future
FAO	Food and Agriculture Organization of the United Nations
FSF	Future Smart Food
GHI	Global Hunger Index
GPA	Global Plan of Action
ICAR	Indian Council of Agricultural Research
ICARDA	International Center for Agricultural Research in Dry Areas
ICIMOD	International Centre for Integrated Mountain Development
ICRISAT	the International Crops Research Institute for the Semi-Arid Tropics
ICN2	Second International Conference on Nutrition
IFAD	International Fund for Agricultural Development
MSSRF-LANSA	MS Swaminathan Research Foundation – Leveraging Agriculture for Nutrition in South Asia
NUS	neglected and underutilized species
PGRFA	Plant Genetic Resources for Food and Agriculture
RAP	Regional Office for Asia and the Pacific [FAO]
RI-ZHC	Regional Initiative on Zero Hunger Challenge
SDGs	Sustainable Development Goals
TFNet	the International Tropical Fruits Network
UNDP	United Nations Development Programme
UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
UNEP-GEF	United Nations Environment Programme-Global Environment Facility
ZHC	Zero Hunger Challenge

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Executive summary

Chapter 1: Introduction: Setting the scene by Xuan Li, Kadambot H.M. Siddique, Festus Akinnifesi, Karel Callens, Sumiter Broca, Arshiya Noorani, Günter Hemrich, Chikelu Mba and Nomindelger Bayasgalanbat provides the overall context of the Sustainable Development Goals (SDGs), highlights the main features of agriculture and food systems, and justifies neglected and underutilized species (NUS) as entry points for addressing hunger and malnutrition from a food system perspective. It also lays out the global policy frameworks and their integration of NUS, and describes the origin, criteria, process and outcome of the regional priority-setting exercise on NUS: Future Smart Food (FSF).

1 Context

SDG 2: Zero Hunger calls for the eradication of hunger and all forms of malnutrition, with targets for doubling agricultural productivity and incomes of small-scale food producers (SDG 2.3), ensuring sustainable food systems (SDG 2.4) and maintaining genetic diversity (SDG 2.5). Promoting NUS could be a powerful means of achieving the Zero Hunger goal while offering solutions to some worrying trends in agriculture.

From a demand perspective, the multiple challenges for global agriculture and food systems include population growth, increasing urbanization and the emergence of a larger middle-class, which has given rise to new food preferences and changing consumer attitudes that involve concerns about food quality and safety. Taken together, these trends will have a huge impact on Asia's future dietary patterns. From a supply perspective, there is concern about the slowing down of yield growth in staple crops to levels that are insufficient for meeting future food demands without the expansion of agricultural land, which is already scarce in Asia. The combined effects of climate change, declining agricultural biodiversity, water scarcity and degradation of natural resources are challenging world food security. Some studies predict that in South Asia, the climate change scenario would result in a 14 percent decline in rice production relative to the no-climate-change scenario, a 44-49 percent decline in wheat production, and a 9-19 percent fall in maize production (Nelson *et al*. 2009).

There are two significant gaps that exist, or will emerge, in our agriculture and food systems:

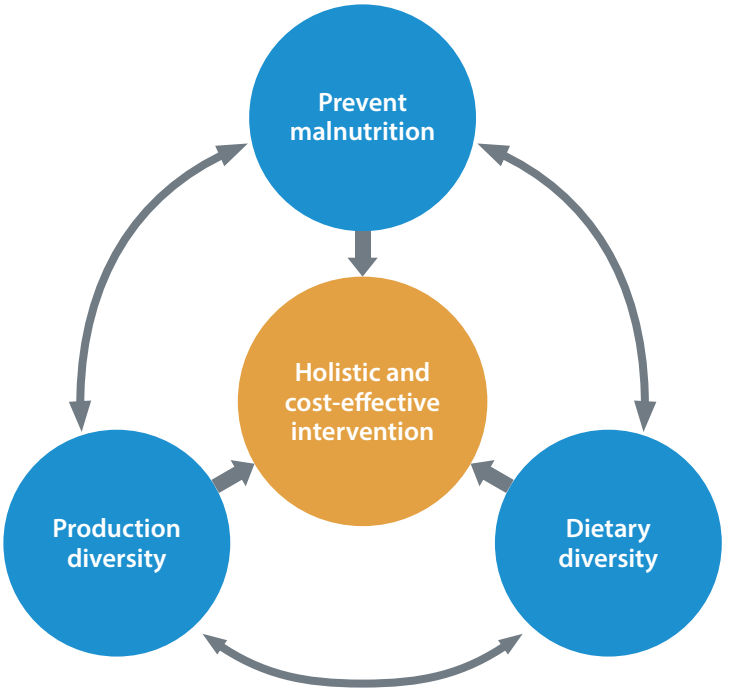
1 **Production gap**. A 30 percent increase in the global population by 2050 will require a 60-70 percent increase in food production, taking into account changing consumption patterns. Production increases of traditional staple crops are unlikely to meet the increasing demand; irrigated wheat, rice and maize systems appear to be near 80 percent of the yield potential. Therefore, relying on these crops alone will not be enough to close the gap between food supply and demand.

2 **Nutrition gap**. Even if traditional staple crops provide enough calories to prevent hunger, they do not provide all the nutrients necessary for a healthy diet. Current high levels of malnutrition are often due to unbalanced diets with insufficient nutrition diversity.

Closing the production and nutrition gaps requires a transformation of current agriculture and food systems towards greater diversity.

A holistic food system perspective can provide answers for tackling malnutrition, and addressing climate change and environmental threats in agricultural production. Nutrition-sensitive and climate-smart agriculture interventions can tap local potential to promote agricultural productivity that meets nutritional requirements. These interventions will go beyond the promotion of current staple crops and include crops previously considered of secondary importance.

FIGURE 1 Features of agriculture and food systems



Characteristically, NUS are nutritious, climate resilient, economically viable (in the right setting) and adapt to local conditions, especially in marginal areas. In the past, NUS have been ignored by agricultural research, not included in agricultural extension curricula, and did not benefit from organized value chains. However, due to their adaptability and nutritional qualities, many NUS could make a major contribution to increased food availability, affordability and nutrition security.

Recognizing this potential, FAO RAP's Regional Initiative on Zero Hunger Challenge (RI-ZHC) has embarked on the promotion of NUS crops as a means to foster food and nutrition security, although the definition of NUS also includes livestock, fisheries and aquaculture species.

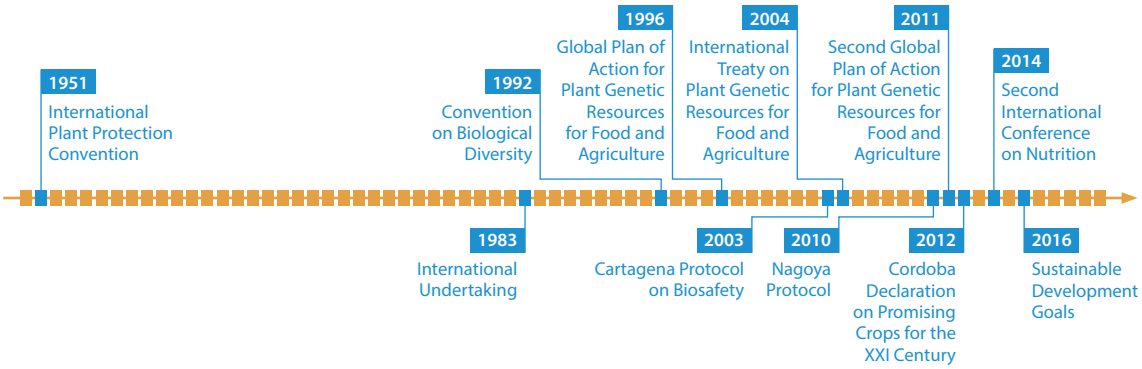
2 Agriculture and food systems

There is a clear connection between the over-reliance on a few staple crops, low dietary diversity and malnutrition in agricultural and food systems at the country level. A leading cause of persistent malnutrition is poor dietary diversity (poor quality and limited variety of food in the diet).

Dietary diversity is low when a high consumption of cereals is accompanied by a low intake of vegetables, fruits and pulses, which could provide the necessary micronutrients and fibre. This dependency leads to a significant nutrition gap. Agricultural production in Asia focuses on a few staple crops, particularly rice. The pattern reflects a structural issue: too many people consume food with too few nutrients and too much food is being produced without offering enough nutrients. This is often the involuntary consequence of government policies that prioritize quantitative food production targets.

Figure 1 highlights that agricultural diversification is a powerful tool for achieving Zero Hunger. It outlines why we need diversity on two counts: dietary diversity, which is a cost-effective, affordable and sustainable way to prevent hunger and malnutrition; and product diversity, which makes it possible to supply nutritious and diversified food that provides better options for dealing with changing environments, especially the effects of climate change.

FIGURE 2 Timeline showing the major relevant international policy frameworks for the conservation and sustainable use of plant diversity



There are two major limiting factors in global agriculture and food systems, both of which are observed in Asia:

1 **Limited production diversity** with an emphasis on starchy crops can lead to unbalanced diets and ultimately malnutrition. An abundant supply of a few staple crops alone does not provide sufficient nutrition.

2 **Reliance on a few staple crops** with high input requirements leaves farming more vulnerable to environmental shocks, especially under a climate change scenario.

According to Graziano da Silva (FAO, 2012a), dependence on a few crops has negative consequences for ecosystems, food diversity and health. Food monotony increases the risk of micronutrient deficiency.

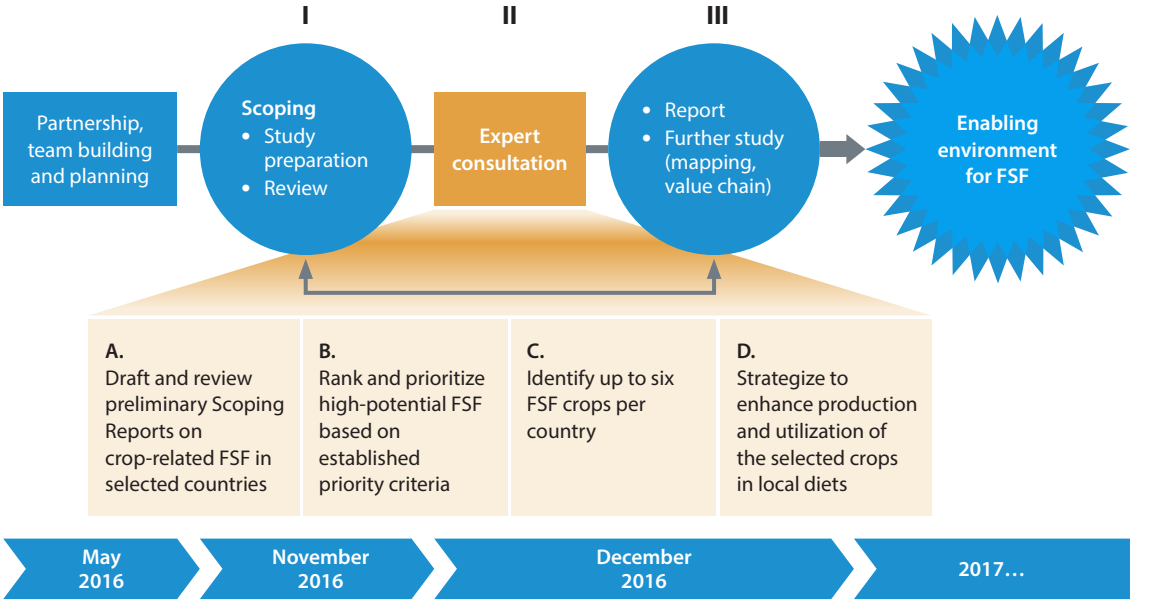
3 Neglected and underutilized species as entry points for addressing malnutrition from a food system perspective

From a food system perspective, dietary and production diversity need to improve to address malnutrition. NUS are underexplored and can be called 'hidden treasures' that offer tremendous opportunities for fighting poverty, hunger and malnutrition. As the FAO Director-General highlighted, NUS play a crucial role in the fight against hunger and are a key resource for agriculture and rural development (FAO, 2012a). Considering the wide coverage of NUS including crops, livestock, fisheries and aquaculture, and forests, this regional priority-setting exercise set crops as an entry point among NUS to address hunger and malnutrition. Historically, underutilized plants have been used for food and other uses on a large scale and, in some countries, are still common, especially among small or marginal farmers in rural areas where many are traded locally, and a lucky few NUS have made their way to export niche markets around the world (Akinnifesi *et al*., 2008). NUS have high nutritional value and can be an essential source of micronutrients, protein, energy and fibre, which contribute to food and nutrition security. Apart from their superior nutritional qualities, many of these crops do not require high inputs, can be grown on marginal lands and easily intercropped or rotated with staple crops, as well as fit easily into integrated practices such as agro-ecology. Because they are frequently adapted to marginal conditions, and many have the unique ability to tolerate or withstand stresses, NUS can make production systems more sustainable and climate resilient.

4 Global policy frameworks and the integration of neglected and underutilized species

The importance of NUS is widely recognized by the global scientific community (Joint FAO/IAEA 2004; Kahane *et al*., 2013; Khoury *et al*., 2014; Nyadanu *et al*., 2016; Rutto *et al*., 2016; Stamp *et al*., 2012). The development and implementation of policies are often a key component in promoting NUS/FSF into agricultural production systems (Noorani *et al*., 2015). This section provides an overview of the policy frameworks. It includes the first Global Plan

FIGURE 3 Regional priority-setting exercise on scoping, prioritizing and mapping of NUS



of Action (GPA) for the Conservation and Sustainable Use of Plant Genetic Resources for Food and Agriculture (PGRFA) (FAO, 1996) adopted by 150 countries in 1996; the International Treaty on Plant Genetic Resources for Food and Agriculture (the Treaty) that entered into force in 2004, which provides a legal framework whereby governments, farmers, research institutes and agro-industries can share and exchange PGRFA and benefits derived from their use (FAO, 2009); the Second Global Plan of Action for Plant Genetic Resources for Food and Agriculture (Second GPA) in 2011 (FAO, 2012b); the Cordoba Declaration (FAO, 2012c), which was elaborated upon at the international seminar on Crops for the XXI Century, and further emphasized the importance of underutilized and promising crops for the international arena; and the Second International Conference on Nutrition (ICN2) held in Rome in 2014, which showcased the profile of NUS and adopted the Rome Declaration on Nutrition. This high-level conference emphasized the importance of NUS through Recommendation 10: *"Promote the diversification of crops including underutilized traditional crops, more production of fruits and vegetables, and appropriate production of animal-source products as needed, applying sustainable food production and natural resource management practices."* All these policies reflect recent trends and calls for a global commitment to enhance the conservation and sustainable use of NUS/FSF, and for these frameworks to be translated into actions (see Figure 2 for a timeline of relevant international policy developments).

5 Regional priority setting exercise on NUS: Future Smart Food

Given the wide range of NUS and their diverse characteristics and potential benefits, the Zero Hunger Initiative started by scoping, identifying and prioritizing promising NUS at the country level to create a list of NUS capable of helping to close production and nutrition gaps. Apart from their advantages for nutrition and production, the selected NUS also needed to be economically viable and socially acceptable.

The criteria for prioritizing NUS were established in four categories:

1 Nutrition (nutritional value and health benefits);

2 Production (local knowledge, availability, seasonality, productivity, intercropping and competition from other crops, and processing);

TABLE 1 Potential Future Smart Food in eight countries in South and Southeast Asia

Cereals	Roots and tubers	Pulses	Fruits and vegetables	Nuts, seeds and spices
Amaranth	Elephant foot yam	Black gram	Chayote	Linseed
Buckwheat	Fancy yam	Cow pea	Drumstick	Nepali butter tree
Finger millet	Purple yam	Faba bean	Fenugreek	Nepali pepper
Foxtail millet	Swamp taro	Grass pea	Indian gooseberry	Perilla
Grain amaranth	Sweet potato	Horse gram	Jackfruit	Walnut
Proso millet	Taro	Lentil	Pumpkin	
Quinoa		Mung bean	Roselle	
Sorghum		Rice bean	Snake gourd	
Specialty rice		Soybean	Wood apple	
Tartary buckwheat				

3 Ecology (agro-ecology, adaptability to potentially changing local climates and soil types), and

4 Socio-economy (cultural acceptance and consumer preferences, access to markets and potential income generation).

Each participating country conducted assessments according to these criteria.

The regional priority-setting exercise focused on the following groups:

- cereals,
- horticultural species,
- nuts and pulses,
- roots and tubers, and
- others.

Scoping of NUS was limited to the available species in the national gene bank. Prioritization followed the principles of country ownership and country specificity.

As such, the NUS scoping and prioritization results are owned by the participating countries. International partners offered technical assistance through multidisciplinary reviews and verifications to support each country. The status of NUS is country specific, which means that a species recognized as NUS in one country may not be considered as NUS in another country. Following these principles and criteria, FAO – in collaboration with FAO's Special Ambassador on International Year of Pulses, the University of Western Australia, ICARDA, ICRISAT, MSSRF-LANSA, CATAS-TCGRI, Mahidol University, ACIAR, ICIMOD, CFF, as well as national governments and research institutes – conducted an interdisciplinary priority-setting exercise (Figure 3).

Based on the national scoping studies and international interdisciplinary review, each country prioritized up to six promising NUS as candidates for FSF. The initial results of the FSF selection process in eight countries in South and Southeast Asia (Bangladesh, Bhutan, Cambodia, Lao PDR, Myanmar, Nepal, Viet Nam and West Bengal in India) are presented in Table 1.

Part I of the publication contains four thematic chapters (Chapter 2 through Chapter 5) on the features, challenges, opportunities and strategies related to enabling environments required to promote the production, marketing and consumption of FSF.

Chapter 2: Challenges, opportunities and strategies for Neglected and Underutilized Species as Future Smart Food for Zero Hunger by Mahmoud Solh argues that the projected 50 percent increase in demand for agricultural production from 2013 to 2050 (FAO, 2017) has to be achieved despite the ongoing degradation of natural resources and the serious implications of climate change on agriculture. Despite impressive progress, more than 800 000 people are still facing

hunger globally (FAO, 2017), and many Asian countries are categorized as 'serious' in the Global Hunger Index (GHI) because 20 percent to 34 percent of their populations are undernourished. NUS have important advantages over widely grown commercial crops. They often link with the cultural heritage of their places of origin; are well adapted to specific agro-ecological niches, harsh environments and marginal lands; and perform well in traditional production systems with little or no external inputs. However, NUS have been given little attention by national research, extension services, policy and decision makers, donors, technology providers and consumers. NUS crops are scarcely represented in *ex-situ* collections and, despite having nutritious and/or medicinal properties or other multiple uses, are often not attractive to the public and private sectors due to social, economic, environmental (e.g. genetic erosion of NUS gene pools), agronomic (e.g. lack of seed supply systems) or political reasons.

There are several examples of NUS that have become important commercial crops. Quinoa and lentil are two NUS crops that attracted global interest despite being important mainly in subsistence agriculture locally or regionally. Quinoa used to be a subsistence crop in the Lake Titicaca basin of Peru and Bolivia, but with rising consumer appreciation, its production in Bolivia, Peru and Ecuador almost tripled from 1992 to 2010. Quinoa cultivation has spread to more than 70 countries, including Denmark, England, France, Holland, India, Italy, Kenya, Sweden and even Australia. The reasons for the fast evolution of quinoa as a commercially important food are its high nutritional value, good taste and quick cooking properties. Quinoa was promoted globally, with 2013 being the International Year of Quinoa; but to reach this stage, quinoa underwent numerous phases:

- Perception change among farmers, processors, policymakers and the public in general
- Improved capacity of researchers, educators, policymakers, farming communities and the private sector
- Better documentation of indigenous knowledge and use, propagation, growth characteristics, nutritional aspects, adaptation to harsh environment, resistant traits and variability
- Improved *ex-situ* and *in-situ* conservation
- Breeding programmes to enhance productivity and quality traits
- Development of seed production systems
- Involvement of stakeholders at all stages in the value chain
- Development of the value chain and exploration of markets at local, national and international levels
- Modernization of agricultural production including mechanization
- Development of post-harvest technology and conservation
- Creation of supportive policy environments including legal frameworks at both national and international levels (incentives such as subsidies to promote targeted species)
- Increased cooperation at national, regional and international levels

Lentil, along with other pulses, is known as 'poor man's meat' in the Middle East, North Africa and South Asia due to its relatively high protein content. In addition to this important nutritional advantage, lentil is well adapted to low input agriculture and its ability to fix atmospheric nitrogen enriches soil fertility and ensures agricultural sustainability.

In Ethiopia, India and Turkey, lentils and other pulses are becoming cash crops, as demand has been rising for local production due to government interventions and investments in research and technology transfer with national and international partners. International agricultural research centres, such as ICARDA, in collaboration with national agricultural research systems, worked, in particular, on better crop management and improved varieties, improved crop genetics, horizontal expansion of lentil production in rice–fallow

replacement, reduction of post-harvest losses, and improved plant architecture and mechanical harvesting.

Particularly in South Asia, lentil development has bridged yield gaps by 65 percent to 75 percent in farmers' fields as a result of improved production packages in rainfed agriculture. Lentil cultivars with high concentrations of iron and zinc have been released in Bangladesh, Ethiopia, India, Nepal, Portugal, Syria and Turkey. In Bangladesh, five bio-fortified varieties covered 90 000 ha or 43 percent of the total lentil cultivated area in 2014.

These examples show that NUS are important for conserving and enhancing biological diversity and protecting fragile ecosystems. However, the potential of NUS goes beyond local niches: they have become globally important both as a means to achieving greater food and nutrition security, and as a response to dealing with the implications of climate change.

Chapter 3: Future Smart Food: Hidden treasures to address Zero Hunger in a changing climate by Kadambot H.M. Siddique and Xuan Li highlights the potential of FSF for nutrition enhancement and climate resilience, and points out the compelling need to rethink agricultural strategies in a climate-change context. Production and nutrition gaps will widen if conventional production patterns continue. Finding solutions to bridge the production and nutrition gaps cannot be achieved without a fundamental transformation of the current agricultural and food system. Agricultural diversification with sustainable intensification is a promising strategy for achieving Zero Hunger in a climate-change context, where NUS have a significant role to play.

Most NUS do not require high inputs and can be grown on marginal and degraded lands while contributing to increased agricultural production, crop diversification and a better environment. In turn, food and nutrition security are improved. Pulses, in particular, are a potential health food, reducing risks of chronic diseases, obesity and other conditions. The current over-reliance on a handful of major staple crops (rice, wheat, maize and potato) has inherent agronomic, ecological, nutritional and economic risks. National and international research bodies, non-government organizations, community-based organizations and commercial entities interacting with farmers have not paid enough attention to NUS. However, not all NUS will effectively foster food and nutrition security. NUS have to be assessed and prioritized following established criteria. NUS will be labelled FSF if they are:

1 Nutritionally dense,

2 Climate resilient,

3 Economically viable, and

4 Locally available or adaptable.

Pulses are an excellent example of an FSF that exhibits all four criteria.

The chapter shows that the promotion of FSF will:

- contribute to closing nutrition gaps and offer food security and nutrition;
- reduce the risk of over-reliance on limited numbers of staple crops and increase the sustainability of agriculture by reducing inputs;
- provide focused effort to help marginalized and indigenous people improve their livelihoods and income; and
- contribute to the preservation and celebration of cultural diversity.

These characteristics amply justify investments in NUS, as they have enormous potential for bridging the dual production and nutrition gaps. In light of the multi-functionality of NUS, it is time to rediscover these 'hidden treasures'.

Chapter 4: Future Smart Crops for paddy fallow agri-food systems in Southeast Asia by Suhas P. Wani and Gajanan L. Sawargaonkar argues that since 1950 the global availability of water and land per capita has declined significantly. In the case of India, per capita water availability declined from 5 177 m^3 in 1951 to 1 820 m^3 in 2001, and is expected to decrease further to 1 341 m^3 in 2025

and 1 140 m^3 by 2050. Water is the primary limiting factor in dryland agriculture. Productivity enhancement studies from Africa and Asia demonstrate an enormous potential for enhancing water-use efficiency as well as increaseing the availability of green water. Tapping into this potential is important, as many of the 1 338 million poor people in the world live in dryland/rainfed areas and poverty is strongly linked to variations in rainfall and to the ability of farmers to bridge intra-seasonal dry spells. The adoption of land and water conservation practices, together with crop diversification, improved seed varieties, and integrated nutrient and pest management practices, offers the opportunity for vertical integration of existing cropping systems in South and Southeast Asian countries to meet the increasing food demand. In particular, increased use of paddy fallows could intensify cropping systems and enhance agricultural productivity per unit area.

Paddy remains the most important crop in Southeast Asia, with much of it grown in rainfed conditions. In rainfed paddy, much of the acreage remains fallow in the post-rainy season due to several limitations, primarily due to the limited soil moisture availability in the topsoil layer for crop establishment. Since paddy is grown on some of the most productive lands, there is substantial scope for increasing cropping intensity by introducing a short-duration legume crop with simple seed priming and micronutrient amendments using appropriate technologies. Fallow cultivation also avoids the ecological disadvantages of continuous cereal cropping, while water-efficient short-season grain legumes, which also improve soil health via nitrogen fixation, constitute an ideal secondary crop. However, there are production constraints, including narrow windows for planting, lack of short-duration and high-yielding varieties, poor plant stands due to poor soil–seed contact, and traditional grazing practices, as well as low volumes of crop production and limited markets, non-availability of critical inputs, and scarcity of labour after paddy harvest due to migration.

Potential climate and FSF crops for paddy fallow cultivation include a variety of both warm-season legumes (such as black gram, groundnut, mung bean, pigeon pea, soybean) and cool-season legumes (such as chickpea, faba bean, khesari, lentil, pea), along with nutrient-rich cereals and millet (such as finger millet, pearl millet and sorghum). The inclusion of climate/FSF crops into paddy-based cropping systems can contribute to improved soil structure and nutrition and, as they require less water, they offer better options for safe additional income. Pulses help to improve soil health by fixing nitrogen and increasing soil microbial diversity; leaf droppings provide green manure and, in severely eroded soils, these crops help to conserve topsoil and rejuvenate degraded land. Similarly, pulses are the main source of dietary protein, and the high dietary fibre content in pulses lowers the risk of diabetes, heart ailments and gastrointestinal diseases. To ensure successful cropping system intensification in paddy fallows, efforts need to focus on systemic management of the entire paddy-based cropping system and the promotion of technological interventions for utilization of paddy fallows.

On-farm trials and other studies demonstrate the importance of balanced nutrient management inclusive of secondary and micronutrients. Similarly, the availability of sufficient seed, particularly short-duration varieties, is an important success factor. Therefore, the establishment of decentralized quality seed banks is a possible solution to increase availability of seed, together with approaches to ensure better crop establishment and the promotion of conservation agriculture. Initiatives, in which these approaches were trialed improved per unit productivity, and increased crop yields in a range from 40 percent to 200 percent and incomes up to 100 percent. Paddy fallows thus offer a promising niche for legume cultivation in Southeast Asia, if promoted in a holistic way, including early sowing, minimal tillage and seed priming. Pulses can bring additional income, improve family nutrition, and enhance the capacity of people to cope with the effects of climate change or other natural disasters.

Chapter 5: Promoting and mainstreaming promising NUS as Future Smart Food for Improving food security and nutrition by S.B. Dandin and Krishna N.K. Kumar specifies that mainstreaming of biodiversity for food and nutrition security, and climate resilience has been on the international agenda since 1992 with the signing of the Convention on Biological Diversity (CDB). Biodiversity promotion, in general, includes promotion of NUS for their environmental benefits as well as their potential to overcome the challenges of undernutrition and malnutrition. Many NUS – minor cereals, vegetables, legumes, fruit species, root and tuber crops, etc. – form major components of underutilized biodiversity and provide immense support to ecosystem services. More recently, several international consultations and initiatives have highlighted the need for mainstreaming NUS, given their potential to improve dietary diversity.

Minor crops are widely distributed in both hemispheres, covering tropical, subtropical and, to some extent, semi-temperate regions of the world. NUS have remained ignored often for reasons of poor commercial performance, restricted distribution, consumption by small population groups, inadequate research, absence of modern processing and post-harvest methods, and lack of organized value chains and policy support for popularization.

Despite these drawbacks, there has been research in the last two decades covering the importance of underutilized tropical fruits of Asia, the role of underutilized plant species in poverty alleviation, and the relevance of nutritious minor millets in addressing food security challenges. Various authors and institutions have documented initiatives promoting NUS, and a growing list of institutions is active in the research and development of NUS.

Bioversity International has initiated programmes in temperate regions of Central Asia on tropical fruit tree conservation in South and Southeast Asia and Latin America, and has been involved in, among other activities, various UNEP-GEF and IFAD collaborative programmes and projects. Various bilateral donors, including China, Germany, India, Korea and Malaysia, have supported initiatives on better conservation of germplasm, and promotion of NUS to address food insecurity, poverty and climate change through on-farm conservation of local agrobiodiversity. Bioversity International has initiated a special programme, "Moving from orphan to high potential crops," aimed at mainstreaming certain NUS and making them more popular to substitute or supplement major food crops in Africa, Asia and Latin America.

FSF have high potential to address malnutrition, climate change and economic constraints in South and Southeast Asia. Understanding the context of the agriculture and food system in each country is of paramount importance when starting any new FSF intervention.

Part II (Chapter 6 through Chapter 13) **includes eight country scoping and prioritization studies on FSF**, prepared by national experts from Bangladesh, Bhutan, Cambodia, Lao PDR, Myanmar, Nepal, Viet Nam and West Bengal in India, which provide a comprehensive overview on the status and availability of FSF in the region. Each report has an introductory section with an overview on the country, agro-ecological zones, and status of the current food basket including staple crops, as well as major cropping patterns and crop diversity within these systems. The second section of each study comprises a situation and gap analysis to identify the major challenges each country is facing with regard to hunger and malnutrition, and climate change, as well as economic and cultural aspects. Nutrition challenges are the component with the highest priority and refer to undernourishment; stunting; wasting; underweight; micronutrient deficiencies such as anaemia; vitamin A, zinc or iodine deficiency; and overweight and obesity. Challenges associated with climate change are climate variability (e.g. drought, flood, heat waves) and seasonality that can negatively affect agricultural production systems. In the economic environment, the main risk factors are price fluctuations and commercial potential, distance, access to transportation, and infrastructure. Other challenges are the existing gap between informal

and formal markets, unfavourable value-chain arrangements, subsistence farming and local diets, including traditional food habits, food taboos and religious restrictions.

Following the section on addressing the identified major challenges, a detailed scoping and prioritization of the availability and use of FSF in each country was undertaken based on nutritional value, adaptation to local environments and climate change, as well as economic, social and cultural potential. The results of this prioritization process led to a list of up to six proposed crops in each country. These crops can meet some of the prominent malnutrition challenges, as they complement existing cropping systems, and are deemed to be economically feasible and culturally acceptable.

Bangladesh (by Md. Amjad Hossain, Md. Tariqul Islam, Rozina Afroz and Taslima Jahan) has made progress towards the elimination of hunger and malnutrition, but still has a high prevalence of stunting and underweight among children, as well as high prevalence of other indicators of malnutrition. Some important crops grown in Bangladesh (potato, pulses and oilseed) require temperatures from 18-25°C. In a climate change scenario, these crops are highly sensitive to fog, cloud and changes in humidity, and are predicted to suffer with rising temperatures.

Cultivation of minor cereals in Bangladesh is limited to stress-prone areas that receive only minimal care. Their share in area and production is negligible; among the minor cereals and pseudo-cereals, foxtail millet (*Setaria italica*) is the only crop cultivated in different areas of the country and can be considered the fourth cereal crop after rice, wheat and maize. Other minor cereals and pseudo-cereals (such as barley, barnyard millet, buckwheat, finger millet and proso millet) are so neglected that they are often considered lost crops. Among the pulses, the same fate has met faba bean, horse gram and winged bean. In the last two decades (1994-2014), pulse production has had a 62 percent decline in area, but an increase in yield has, to some degree, offset this decrease.

Minor and underutilized crops received little attention in the past due to the emphasis on major cereals like rice and wheat. High crop competition during the winter (*rabi*) season makes the scope of horizontal expansion for FSF crops limited to stress-prone areas, and the summer and rainy (*kharif*) season. Improvements in the collection and conservation of germplasm of prioritized FSF crops, coordinated research and development, political commitment, as well as organized seed production and marketing systems are preconditions for successful FSF promotion.

Following the prioritization exercise, Bangladesh selected the following FSF:

1 cereal – foxtail millet;

2 roots and tubers – taro;

3 pulses – mung bean;

4 horticultural crops – pumpkin;

5 horticultural crops – snake gourd; and

6 others – bael (*Aegle marmelos*, a tree species native to Bangladesh and India).

Bhutan (by Kailash Pradhan and Ganesh B. Chettri) has made remarkable progress in achieving national as well as regional and international goals and targets. Bhutan is on track to achieve some of the nutrition indicators including reducing wasting in children under five years old, reducing stunting and increasing exclusive breastfeeding. However, due to poor food diversity and accessibility, the prevalence of hidden hunger or malnutrition is quite high in Bhutan. About 21.2 percent of children under five years old are stunted and 9 percent are underweight; and 44 percent of children under five years old and 35 percent of non-pregnant women (aged 15-49 years) are suffering from anaemia. Overall, 68 percent of the dietary energy requirement comes from cereals, mainly rice, and 17 percent from oil. Livestock products, vegetables, fruits and pulses contribute only 25 percent of the energy balance. It is evident from the energy contribution that nutrient intake is limited and diversity of food composition is very poor.

Increasing temperatures and erratic rainfall induced by climate change have negatively impacted food production in Bhutan. The production of major crops is decreasing owing to a decline in soil fertility, inadequate irrigation water, and increasing incidence of pests and diseases.

A major constraint affecting the agriculture sector is the inability to address all the issues along the value chain, even for mainstream crops. Available data show that FSF such as barley, buckwheat, millet and soybean contribute only a small portion to the national food basket but are more important for the household food and nutrition security of small and marginal farmers in rural areas. With the increasing awareness of health and nutrition, consumption and demand are increasing among the urban population, but production technologies are limited, and investment in research and development is negligible.

Six prioritized FSF have a demonstrated potential to improve nutrition and incomes. Their promotion as FSF can address the food and nutritional security of the poor and rural section of the population:

1 grains – sweet buckwheat;
2 grains – quinoa;
3 pulses – soybean;
4 pulses – lentil;
5 nuts – walnut; and
6 others – drumstick/moringa.

In **Cambodia** (by Chhourn Orn and Kynet Kong), the main crop is rice, which is cultivated on approximately 3 million hectares. Cambodian people are the third highest rice consumers in the world (172 kg per person per year). Cambodia has been an important rice exporter since 2005. Cassava is the second major crop, mainly cultivated for starch and bioenergy production. Other crops, including maize and mung bean, are important food crops in upland areas. In some marginal areas, root crops, such as sweet potato and local cassava, are planted to generate income, food security and nutrition.

Cambodia has made some progress concerning child malnutrition, but diets remain dominated by rice. Cambodia is one of the most vulnerable countries to climate change. Scientists predict that climate change will profoundly affect Cambodia's coastal residents, ecosystems and economy. For example, rainfall in Cambodia is expected to increase from 3 percent to 35 percent, exacerbating the already high damage from flooding.

NUS are mostly grown in small quantities for local use only. Local people often do not have sufficient facility or knowledge to process their agricultural products to meet market standards, and public awareness of the benefits of NUS, such as the nutritive value, is limited. As a result, some traditional underutilized crops are being displaced due to pressure from imported species, and demography and household structure changes. In contrast, where markets are available, underutilized crops play an important role in the lives of the rural poor because they contribute to livelihoods, poverty alleviation and sustainable environments. NUS have been rapidly replaced by introduced varieties. Promotional efforts would require germplasm collection of endangered species, documentation of collected materials, development of diversified cropping systems that include NUS, improved public awareness of the importance of NUS for nutritional value and health benefits, and research on sustainable management practices for underutilized species and improved marketing.

From the shortlist of 16 crops, six were prioritized as FSF in Cambodia:

1 pulses – wild vigna (*Vigna umbellata*);
2 roots and tubers – sweet potato (*Ipomoea batatas*);
3 roots and tubers – taro (*Colocasia esculenta*);
4 nuts – peanut (*Arachis hypogaea*);
5 others – Sleuk Bah/ivy gourd (*Coccinia grandis);* and
6 others – drumstick (*Moringa oleifera*).

In **Lao PDR** (by Sivienkhek Phommalath), rice is the key crop for national food and livelihood security. Lao people consume on average 165.5 kg of milled rice per head per year. Seventy-three percent of the population is employed in the rice sector, which accounts for 25 percent of the GDP. The total agricultural sector accounts for 30.8 percent of the national GDP. The main threats to agricultural diversity stem from deforestation, over-exploitation, clearing for infrastructure development, the extension of farming systems into frontier zones, mechanization of agriculture, and adoption of new, high-yielding varieties. The change from a subsistence to an open-market economy, and the availability of fertilizers and other inputs, are contributing to genetic erosion in several crops such as legumes, local vegetables and rice.

In Lao PDR, chronic malnutrition affects 378 388 or 44 percent of the children under five years old, one of the highest rates in Southeast Asia. Micronutrient deficiency rates are also high with 41 percent of children under five years old and 59 percent of children under two years old suffering from anaemia, the latter figure being especially high. Although the underweight malnutrition rate among children under five years old fell from 32 percent in 2006 to 27 percent in 2012, the sudden malnutrition (wasting) rate stood still at 6 percent. Moreover, the chronic and underweight malnutrition rates of the 6-24 month age group are markedly higher than those of other age groups. Scientists predict that in Lao PDR, climate change will lead to rising temperatures, longer dry seasons and more erratic rainfall. The marketing of agricultural products in Lao PDR tends to be regionally confined, resulting in significant variation in market prices from region to region. Also, limited human resource capacity, poor agricultural support and delivery services, and the lack of medium-term and short-term credit and other financial services hamper agricultural development.

For Lao PDR's prioritized FSF, most information is based on indigenous knowledge passed on from generation to generation. This information is scattered and not systematic and there is also a lack of human resources for FSF research and development. However, the Government will consider and invest more in research and development of FSF because of the national strategy to promote food and nutrition security.

The following FSF crops in Lao PDR have been prioritized:

1 roots and tubers – taro;

2 roots and tubers – purple yam;

3 roots and tubers – fancy yam;

4 pulses – mung bean;

5 pulses – rice bean; and

6 pulses – cowpea.

Myanmar (by Min San Thein and Khin Mar Oo) is a surplus producer of rice. Other important food crops are food legumes, fruits, maize, oilseeds, sugarcane, vegetables and wheat. Myanmar is one of the major pulse exporting countries in the world. However, there is still a gap between production and demand that accounts for hidden hunger in the country. Dietary quality in Myanmar is considered poor, being low in protein and vitamins, and high in carbohydrates. Cereals remain the most important source of food energy (50 percent), but their contribution to overall daily energy supply has decreased since 1990. Products from animal origins, such as eggs, milk and meat, have increased notably. Anaemia in Myanmar is a severe public health issue, and is extremely high among pregnant women (71 percent), children under five years old (75 percent) and non-pregnant women (45 percent). Stunting and underweight are more than twice as common in the poorest quintile as in the wealthiest quintile. Severely high rates of vitamin A deficiency (37 percent of pre-schoolers) co-exist with iron deficiency, especially among children and women.

Agriculture value chains are not very advanced; farmers generally sell their produce at the primary market due to constraints such as the lack of a credit system, high transport costs, no storage facilities, lack of market information, and price instability.

Among Myanmar's selected FSF, sorghum has been identified as an important crop for climate adaptation, both for food and feed in the dry zones of Myanmar, but research on outstanding varieties is needed. Among roots and tubers, elephant foot yam has been selected as a rich source of starch, vitamins and minerals. Over-exploitation may endanger the genetic base; and domestication and identification of elite genotypes for cultivation as FSF will become crucial.

The following FSF crops in Myanmar have been prioritized:

1 cereals – specialty rice/Namathalay (*Oryza sativa* L.);
2 cereals – sorghum;
3 roots and tubers – elephant's foot yam;
4 horticultural crops – roselle;
5 horticultural crops – drumstick; and
6 others – amla (*Emblica officinalis*).

Nepal (by Bal K. Joshi and Renuka Shrestha) has diverse agro-ecological zones, ranging from tropical to arctic. Agriculture, including forestry and fishery, is the principal economic activity in Nepal, employing about 66 percent of the population and providing 32.7 percent of the GDP and 60 percent of export earnings (ABPSD, 2015). The total cultivated area of agricultural land is 3 091 000 ha while the uncultivated area is 1 030 000 ha. Agriculture is basically subsistence, with crops, livestock and forests as the three major components of the complex farming system; cereal crops (maize, rice and wheat) are the main crops, followed by lentil and potato. In the lowlands, rice is the major staple crop followed by wheat, and in the hills, maize is the most important food crop. In high hills, potato is the main food crop, followed by maize, buckwheat and barley. Rice is the major source of energy for most Nepali people.

Nepal ranks 157th of 187 countries on UNDP's Human Development Index. The distribution of malnutrition varies geographically by ecological zone and rural/urban residence. The Nepal Demographic and Health Survey (2011) reported that the prevalence of stunting and severe stunting in children under five years old was 41 percent and 16 percent, respectively. Micronutrient deficiencies are widespread, with almost half of pregnant women and children under five years old and 35 percent of women of reproductive age being anaemic.

Nepal is ranked the fourth most-vulnerable country in the world; and its natural-resource-based livelihoods and economy, political conflicts, and low adaptation potential make it vulnerable to climate change. The impact of climate change in Nepal is evident in the increased melting of glaciers, warmer days and nights, erratic monsoons (drought and flood), increased number of rainy days with more than 100 mm per day, and extreme foggy and cold periods.

Agricultural constraints include low-volume production in scattered areas, lack of processing facilities, lack of knowledge of processing and product diversification, and consumer ignorance of nutritional values. Most of the potential FSF in Nepal are considered socio-culturally inferior (e.g. colocasia, grass pea and millet), despite being nutritionally rich. Most FSF are localized and produced and consumed by poor people and the lower caste (e.g. *dalit, damai, kami*). At the local level, there is much diversity in FSF, but they are not grown widely by many households.

In Nepal the following six FSF crops have been prioritized:

1 cereals – tartary buckwheat (*Fagopyrum tataricum* L.);
2 pulses – grass pea (*Vicia sativa* L.);
3 roots and tubers – taro (*Colocasia esculenta* L.);
4 horticultural crops – drumstick (*Moringa oleifera* Lam.);
5 fruits – jackfruit (*Artocarpus heterophyllus* Lam.); and
6 oilseeds – Nepal butter tree (*Bassia latifolia* Roxb.).

Viet Nam (by Pham Hung Cuong) can be divided into eight eco-agricultural zones. Its traditional farming base is an integrated system of rice and other crops. Viet Nam's agricultural share of economic output declined from about 25 percent in 2000 to 17 precent in 2016. Cereals are the main source of energy in the Vietnamese diet providing 78 percent of total energy. The main food is rice, with an average daily consumption of 400 g per person in all regions of the country. Other staple foods such as corn and cassava are grown in the mountainous and plateau regions, sweet potatoes are grown in the plain regions, and roots and tubers are grown in the midland and mountainous regions.

In addition to rice and other staple foods, vegetables, tubers, fruits, oily nuts, beans, soya beans and soya products (tofu, soy sauce and soymilk) play an important role in the Vietnamese diet. The diversity of vegetables includes water spinach, Indian spinach, luffa, bottle gourd, radish, broccoli, cabbage, kohlrabi, chayote, pumpkins, squash, jute, amaranth, star-gooseberry, celery, lettuce and vegetable beans. The daily diet also includes diverse fruits depending on the region. Popular fruits are banana, jackfruit, papaya, guava, grapefruit, oranges, tangerines and mango. In the daily diet, along with plentiful seafood, the amount of meat and animal products has increased significantly.

Viet Nam has made good progress in reducing stunting, which declined from 23 percent in 2011 to 19 percent in 2015. However, overweight and obesity have become a national concern affecting 5 percent of children and 8 percent of women, while at the same time, twice as many women are underweight. Iodine deficiency has resurfaced as a significant public health concern; anaemia continues to affect children under five years old and non-pregnant women. According to a report of the National Institute of Nutrition, the rate of anaemia among women of childbearing age (not pregnant) is 29 percent and among pregnant women is 36.5 percent, reaching its highest percentage in the northern mountainous domain and Central Highlands with nearly 60 percent.

Crop yields in Viet Nam are above the mean level for Asia due to high applications of agricultural inputs and the conversion of marginal lands previously regarded as unsuitable for agriculture. However, over-intensive land utilization is increasing soil erosion and reducing soil fertility. High-intensity rainfall, suboptimal irrigation techniques, and a lack of incentives for farmers to adopt sustainable natural-resource management has led to high levels of soil loss, as well as pesticide and fertilizer runoff, which reduces productivity and causes groundwater and surface water contamination. In economic terms, rural value-chain stakeholders generally only receive a meager share of the value of the final agro-product, usually due to the small scale of production, non-homogenous product quality, poor market information and knowledge, high transaction cost per unit of marketed product, cash shortage, and perishability of product. NUS are grown primarily by native farmers in their place of origin, where they are still important for the livelihood of local communities, or were once more widely grown but are today falling into disuse for a variety of agronomic, genetic, economic and cultural factors.

The following FSF crops in Viet Nam have been prioritized:

1 cereals – buckwheat/mạch ba góc;

2 roots and tubers – taro/khoai môn sọ;

3 roots and tubers – greater yam/củ mỡ;
4) pulses – cowpea/Đậu các loại;

4 pulses – mungbean/Đậu xanh; and

5 horticultural crops – pumpkin/bí ngô.

West Bengal in India (by Apurba Kumar Chowdhury) has a rice-based agricultural system, but other cereals play an important role, and the production and consumption of vegetables is high. The cropping pattern is dominated by rice, followed by cereals (all combined), oilseeds, jute and potato. Since the late 1990s, horticultural crops such as vegetables and fruits have been gaining ground, probably due to the higher relative return to cultivators. India is facing a huge challenge related to the poor nutritional status of the population,

and West Bengal is marginally better than the country overall. The main causes of malnutrition in the state are deficiencies in childcare and poor feeding practices.

Many underutilized nutritious crops exist in West Bengal but only benefit those who live in areas where these plants grow, as technologies to preserve and store NUS have not been developed. Local foods are rarely a subject of research; however, the Indian Council of Agricultural Research (ICAR) has made efforts to develop superior varieties of indigenous and underutilized crops.

West Bengal has prioritized the following FSF for intervention:

1 cereals – aromatic rice/Kalo Nunia,

2 root crops – swamp taro, sweet potato and elephant's foot yam,

3 pulses – lentil, black gram and green gram; and

4 horticultural crops – jackfruit, drumstick, amaranthus and fenugreek.

Chapter 14: Conclusion: Way forward by Kadambot H.M Siddique, Mahmoud Solh and Xuan Li states that hunger, food insecurity and malnutrition are major challenges in the twenty-first century for Asia and the Pacific. To achieve Zero Hunger, which stands at the core of the SDGs, food systems need to be improved urgently, and dietary patterns have to change. There are disconnects in the value chain between production, consumption and nutrition. Current agricultural production patterns are not sustainable, are unlikely to achieve necessary growth rates, and do not offer the right mix of nutrients needed for a healthy diet. Consumers are often unaware of their potential food choices and stick to dietary patterns that do not agree with an urbanized lifestyle. Poor people's diets are still over-dependent on a few staple crops that lack important nutrients and minerals. At the same time, the newly affluent strata of society have begun to suffer from obesity and related health issues.

Agricultural diversification and resilience offer enormous opportunities for addressing hunger and malnutrition, especially in the context of climate change. In this regard, NUS offer diverse and nutritious food resources. NUS are important in specific agro-ecological niches, often linked with tradition and cultural heritage in their places of origin. They are an essential source of protein and micronutrients, they enhance climate resilience, improve agriculture sustainability, and boost household income and livelihoods with considerable commercial potential.

The report expands on the message formulated by a Regional Expert Consultation on Scoping, Prioritizing and Mapping of NUS, organized by FAO in collaboration with national and international partners, which was held in Bangkok from 3-5 December 2016. The panel of experts, representing eight countries, as well as 22 national and international partners, attended the Consultation and developed ten key recommendations:

1 Urgent call for decision makers to raise awareness of the nutrition-sensitive and climate-resilient benefits of NUS to address hunger, malnutrition and climate change.

2 Recognize, identify and promote complementarities of NUS with existing staple crops for nutrition enhancement, climate-change resilience and diversification of cropping systems, and reliable NUS as Future Smart Food (FSF) to popularize these species.

3 Establish a National Coordinating Committee on FSF involving concerned ministries and appoint a Strategic Coordinator at the inter-ministerial level.

4 Create an enabling environment by strengthening national institutional support for mainstreaming FSF into national policies and programmes, using appropriate incentives, procurement of FSF for food programmes (e.g. mid-day meal/school-meal scheme) to enhance national consumption, local production and facilitate marketing.

5 Establish nationally coordinated research for development programmes targeting FSF with high potential, and expand coverage of national agriculture statistics and national food composition data on FSF for evidence-based decision making.

6 Document and validate best-bet FSF case studies, compile indigenous knowledge related to FSF, undertake clinical and field studies to demonstrate the health benefits and climate resilience of FSF, and assemble quantitative data for public dissemination.

7 Enhance public awareness of the importance of FSF by developing nutrition and climate-change education materials and curricula on the importance of FSF for consumers, traders, producers, health professionals, researchers, teachers (e.g. school curricula), farmers, women and youth.

8 Identify key entry points in the value chain and encourage value-chain development for specific FSF, including innovative and targeted interventions for promotion (e.g. ready-to-use food products) and increase funds for research, development and extension capacities on FSF production and processing technologies.

9 Strengthen multidisciplinary and multi-sectoral collaboration through existing coordination mechanisms and build partnerships at national and regional levels, including academia, civil society and the private sector, to enhance research and consumption and to attract the private sector to boost production, processing, value addition, product development and marketing of FSF.

10 Establish a regionally coordinated network on FSF to facilitate the exchange of information, policy, technologies and genetic resources, as well as FSF promotion, in target countries.

Addressing hunger and malnutrition in a changing climate is considered a top priority by most countries in Asia. Within an agricultural diversification and sustainable intensification strategy, promoting FSF through a food systems approach is a cost-effective intervention to address the dual challenge of malnutrition and climate change. An enabling environment for promoting FSF is essential. This requires a long-term vision and holistic approach that integrate political, economic and environmental aspects, multi-stakeholder cooperation, and forward-looking institutions covering production, marketing and consumption stages.

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"I found that FAO's Future Smart Food Initiative is brilliant, and its focus on neglected and underutilized species particularly relevant. The methodology has high originality with strong interdisciplinary nature. The identification of species that are nutrition-dense, climate-resilient, economically-viable, and locally available or adaptable as Future Smart Food for Zero Hunger will have significant importance from policy, institutional and technical perspectives to enhance food security and nutrition strategies. It will certainly contribute to improve practices promoting agriculture and diet diversification and healthy eating at national, regional and global levels."

Dr. Patrick Caron, Chair of The High Level Panel of Experts on Food Security and Nutrition (HLPE) of the UN Committee on World Food Security (CFS)

Original partners to FAO's Future Smart Food Initiative

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