Alliance

Bioversity International

CIAT

IFAD
Investing in rural people

How to do

Crop selection for diet quality and resilience

Nutrition-sensitive agriculture - Note no. 1

How To Do Notes provide tools for good practice design based on best practices collected at the field level. They guide teams on how to implement specific recommendations of IFAD's operational policies, standard project requirements or financing tools. The How To Do Notes are "living" documents and will be updated periodically based on new experiences and on feedback. If you have any comments and suggestions, please contact the originators.

Originators

IFAD Nutrition Team and Bioversity International

Acknowledgements

The writing of this toolkit has been a collaborative effort led by Bioversity International and IFAD Nutrition Team. It was authored by Dunja Mijatovic, Gaia Lochetti, Gennifer Meldrum, Jessica E. Raneri, and Stefano Padulosi with contributions from Charlie Mbosso, Nadezda Amaya, Hugo Lamers, Nina Lauridsen, and Rose Robitaille. We warmly acknowledge the efforts of our research partners at Insitut d'Economie Rurale in Mali, Action for Social Advancement (India), PROINPA (Bolivia), LI-BIRD (Nepal), Universidad del Valle de Guatemala and Mancomunidad Copanch'orti' (Guatemala) in collecting data presented throughout this report. .

This document was developed in the framework of the IFAD Grant on "Strategic support on mainstreaming nutrition in IFAD's investments" funded by the Government of Canada and implemented by Bioversity International during the 2017-2018 period.

Contact

Antonella Cordone
Senior Technical Specialist Nutrition and Social Inclusion
Environment, Climate, Gender and Social Inclusion Division
E-mail: a.cordone@ifad.org

March 2021

Cover photo: Participatory workshop on diversification options for climate change adaptation in Magar Tagar, Madhya Pradesh, India. Credit: Gennifer Meldrum/Bioversity International

Contents

List of Acronyms

ASA	Action for Social Advancement, India
BFN	Biodiversity for Food and Nutrition
COSOP	Country Strategic Opportunity Programme
CPM	Country Programme Manager
FAO	Food and Agriculture Organization of the United Nations
FCA	Four Cell Analysis
FGD	Focus Group Discussion
HTDN	How To Do Note
ICO	IFAD Country Offices
IFAD	International Fund for Agricultural Development
INFOODS	International Network of Food Data Systems
IP	Indigenous People
KII	Key Informant Interview
NUS	Neglected and Underutilized species
PDS	Public Distribution System
PGRFA	Plant Genetic Resources for Food and Agriculture
PROINPA	Local Initiatives for Biodiversity, Research and Development, Nepal
RAE	Retinol Activity Equivalents
SUN	Scaling Up Nutrition Movement

Introduction

Agricultural biodiversity (agrobiodiversity) is a strategic asset to fight food and nutrition insecurity, climate change vulnerability, and poverty. The wealth of food crops is estimated at 5,000 species (Kew Royal Botanic Gardens 2016) but global food systems are increasingly dominated by just three crops—rice, maize, and wheat—which altogether make up more than 50% of human plant-based caloric intake and cover 40% of arable land globally (FAOSTAT 2013). The diversity of livestock in agricultural systems is also in dramatic decline (Yaro et al. 2016). Modern agricultural practices, uniformity in agricultural markets, and changing lifestyles are causing the disappearance of crop and livestock diversity from production and food systems.

Box 1. Definition of nutrition-sensitive agriculture

Nutrition-sensitive agriculture is an approach to agricultural development that prioritizes nutritionally rich foods, dietary diversity, and food fortification as the means to overcome malnutrition and micronutrient deficiencies. This approach stresses the multiple benefits derived from enjoying a variety of foods, recognizing the nutritional value of food for good nutrition, and the importance and social significance of the food and agricultural sector for supporting rural livelihoods (FAO 2014).

The use of wild foods is also threatened due to degradation of natural habitats. Such a situation is having multiple impacts on peoples' livelihoods as cultivations are becoming more susceptible to climate change, farmer assets are being eroded, and consumers have fewer choices for nutritious and healthy diets.

Neglected and underutilized species, or NUS for short, are species that have been left at the margins of research and development. The word 'neglected' underlines the low level of research investments made on these species when compared with mainstream commodities and 'underutilized' alludes to their untapped livelihood potentials. NUS include wild, semi- or fully domesticated plants from various food groups (cereals, vegetables, legumes, roots and tubers, fruits, spices) with diverse growth forms (field crops, trees, shrubs, vines, and others). NUS also include minor livestock species and fungi (Padulosi et al. 2019a). NUS are an integral part of local cultures and food traditions. They are increasingly in the spotlight of efforts for revitalizing local cuisine, celebrating the identity of the 'terroir', and fostering more nutrition-sensitive agriculture.

Hot spots of NUS diversity coincide with regions where Indigenous Peoples live—largely remote areas where standardization of agricultural practices has not been very intense and agro-ecological practices have prevailed. Many of these areas are characterized by challenging conditions for agriculture where NUS are central in traditional farming and risk-management practices owing to their capacity to tolerate climate stresses and thrive in marginal conditions (e.g. water-limited, poor quality soil). Indigenous women are often the custodians and knowledge holders of NUS because of the relevance these species have for household nutrition and other livelihood needs. In spite of being fundamental in the lives of communities around the world, NUS have been sidelined by the Green Revolution and have received very little investment for their research and development. Scarce attention has been directed to enhance their yields and overcome challenges in their production, processing, and marketing. Such a trend needs to be reverted, as investing in these species represents a strategic opportunity to unlock nutrition, resilience and other livelihood benefits, especially for Indigenous Peoples, and women and youth in their communities.

Under IFAD's Strategic Framework 2016-2025 (IFAD 2016), Strategic Objective 1 states that "IFAD's country programmes and projects will systematically promote the availability, accessibility, affordability and consumption of diverse, nutritious foods". It further states that "IFAD's programmes will also work to raise nutrition knowledge and education and seek to improve practices and behaviours that lead to year-round healthy diets for all household members, including those dealing with food choices, and food quality, storage, preservation and preparation". Strategic Objective 3 states that "special attention needs to be paid to environmental sustainability and climate resilience in agriculture while also promoting a reduction of greenhouse gas emissions from agriculture and agrifood value chains, and harnessing underutilized

synergies that exist between adaptation and mitigation". Strategic Objective 3 also emphasizes that IFAD project interventions should focus on addressing the loss of habitat and biodiversity. The rich diversity of NUS is a resource that can be leveraged to contribute to these objectives both directly in strengthening nutrition, adaptation and mitigation, and indirectly by offering opportunities to build untapped synergies across disciplines and sectors owing to their multiple roles in peoples' livelihoods.

A holistic value chain approach for use-enhancement of NUS

A holistic value chain approach for the use-enhancement of NUS has been developed and tested through IFAD-supported research grants. This approach involves interdisciplinary and participatory interventions at different stages of NUS value chains to overcome bottlenecks in their use and enable nutrition, resilience, and income generation outcomes to be reaped (figure 1). The holistic value chain approach is outlined in the Operational Framework "*Supporting Nutrition Sensitive Agriculture Through Neglected and Underutilized Species*" (Padulosi et al. 2019b). This NUS Operational Framework was developed to support IFAD Country Directors, Country Programme Managers (CPMs) and IFAD Country Offices (ICOs) and supported projects to integrate NUS and Indigenous Peoples' issues into nutrition-sensitive agricultural investment programmes, consistent with IFAD's 2019-2025 Action Plan on Mainstreaming Nutrition Sensitive Agriculture (IFAD 2019). The NUS Operational Framework is complementary to the published volumes of IFAD's "*Nutrition-sensitive value chains: A guide for project design*" (De la Peña and Garrett. 2018), and to the How-to-do Note on Mainstreaming nutrition into COSOPs and investments projects (IFAD 2019), while providing specific guidance for integrating NUS in projects because these foods are easily overlooked and demand some special approaches for value chain development compared to established commodities.

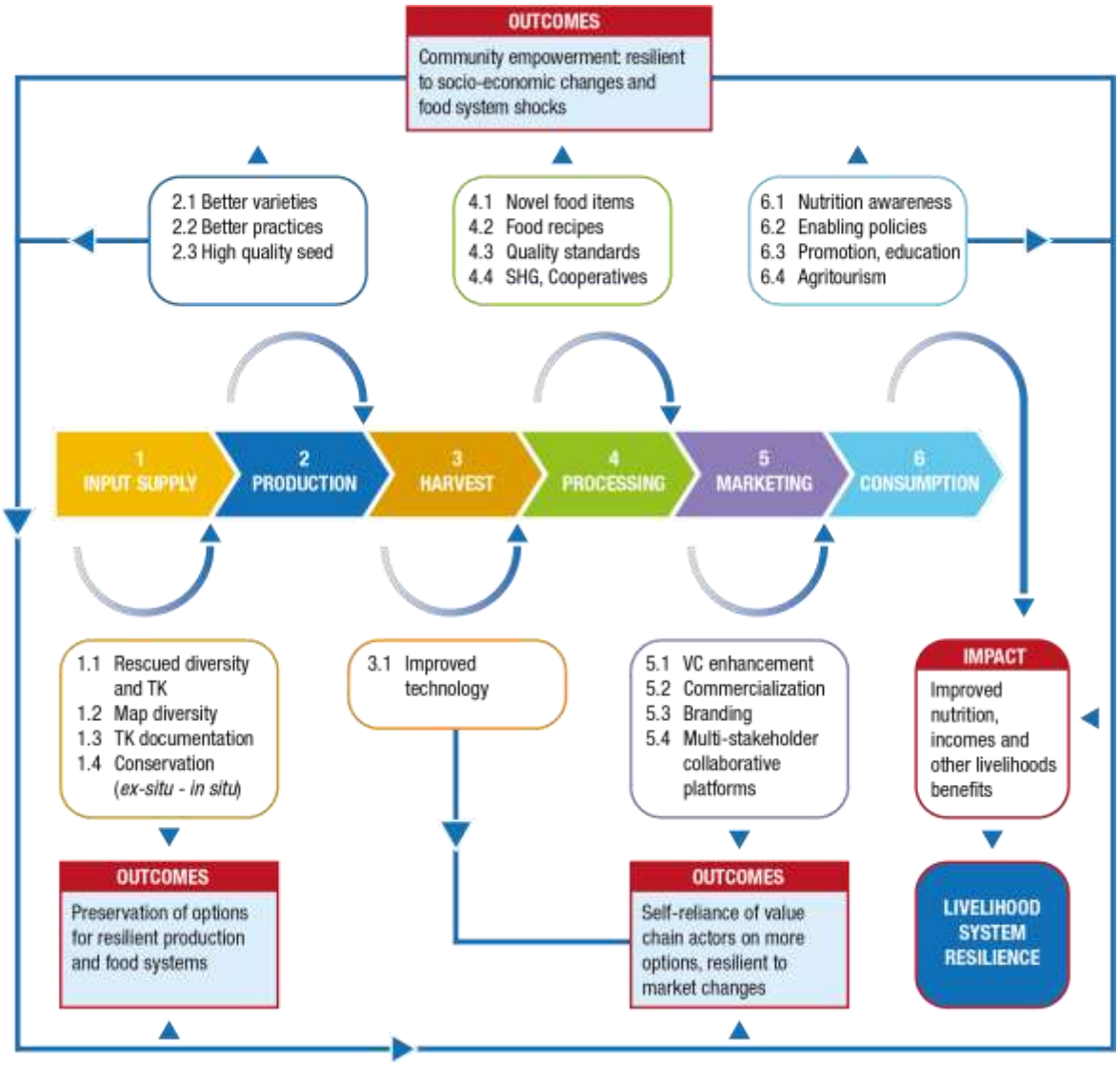
The NUS Operational Framework is specially concerned with improving diet quality as a means of improving nutrition, which is realized by: 1) increasing diet diversity through increased consumption of foods from multiple food groups, and: 2) increasing micronutrient intakes through increased consumption of more nutritious species and varieties. The enhanced cultivation, use and marketing of NUS achieved through the holistic value chain approach can foster nutrition outcomes through several pathways, including the income pathway, own-production pathway and market pathways described by De la Peña and Garrett (2018). Value chain development aims to encourage the greater production of nutritious and climate-resilient species by providing economic incentive, while increasing availability of nutritious foods in markets and encouraging their greater consumption among rural and urban populations. IFAD has long been supporting research projects promoting NUS. The NUS Operational Framework draws on past experiences and provides a systematic set of guidelines for promoting these species for stimulation of smallholder economy and increased nutrition and climate resilience.

About this HTDN

This *How to Do Note on Crop selection for diet quality and resilience* is part of a series of five Notes that offer recommendations on practical methods, approaches, and tools for use-enhancement and mainstreaming of NUS in both design and implementation of IFAD-funded projects to support more nutrition-sensitive agriculture. The Notes build on lessons learned and draw on evidence-and experience-based insights from a number of research for development projects, including those financed by IFAD. The Notes focus primarily on plant species, including crops and wild edibles, while the concepts and methods can also apply to animal and fungi species. The Notes present approaches and project designs especially targeting Indigenous Peoples, who are the primary custodians of NUS and who can benefit strongly from their promotion for leveraging their multiple benefits for nutrition, climate resilience and income generation. Specific consideration is made for approaches that can support empowerment of women, and youth through the use-enhancement of NUS. The five HTDN in the series are as follows:

1. Crop selection for diet quality and resilience
2. Assessing market needs and emerging opportunities in value chains
3. Interventions in support of NUS domestic markets
4. Interventions in support of NUS export market
5. Policy and mainstreaming of NUS

Figure 1. Holistic value chain approach



Source: Padulosi et al. (2014). Sustainability 2014, 6, 1283-1312. https://bit.ly/2FftCpt

This HTDN on "*Crop selection for diet quality and resilience"* provides advice on how to identify NUS that can be promoted for more nutrition-sensitive and climate-resilient agriculture. Following the NUS Operational Framework (Padulosi et al. 2019b), the crops prioritized for project interventions should have a strong potential to improve diets, climate change resilience and livelihoods, revitalize local food cultures and empower Indigenous Peoples, including women and youth specifically. The prioritization of species is based on participatory multi-stakeholder processes that involve local communities and take into consideration their needs, knowledge and preferences. Species are examined against criteria on diet quality, resilience, conservation and sustainability, market potential as well as cultural dimensions and potential for positive social transformation. The prioritization approach presented in this HTDN is complementary to the commodity selection process outlined in the "Nutrition-sensitive value chains: A guide for project design" (step 2; De la Peña & Garret, 2018). NUS could stand out in commodity selection for nutrition-sensitive agriculture projects because of their great potential for improving nutrition and climate change resilience, however, they are easily overlooked as a result of being poorly known by mainstream agriculture or unpopular because they are considered 'food for the poor'.

This HTDN outlines approaches and methods to enable nutritious NUS to be considered in the species selection process of agriculture development initiatives. The selection process can guide identification of species for value chain development, as well as promotion through home consumption pathways (e.g. home gardens) or other uses (e.g. school gardens).

©IFAD/Francesco Cabras

1. Background and context

A growing body of literature highlights the link between nutrition, climate change and poverty (Thomson & Fanzo, 2015). The historic focus of agricultural research on a few calorie-rich staple crops resulted in improved yields with extensive use of agrochemicals, but food insecurity and malnutrition remain global problems, exacerbated by climate change (FAO 2018; box 2). Diets are increasingly dominated by starch-rich crops such as rice or wheat, which provide only a low amount of protein, amino acids, and essential micronutrients that are found in abundance in pulses, fruits, nuts, tubers, vegetables, fish, meat and edible insects. Moreover, production of a limited diversity of crops leaves farming systems more vulnerable to environmental shocks and pest and disease pressure that are increasing under climate change.

Diversification—a transformation of current agriculture and food systems towards more diversity at all levels—is an effective means of producing food needed for a healthy diet in the context of accelerating climate change (Gaudin et al., 2015; Makate et al., 2016; Waha et al., 2018). Agricultural diversification, from dietary and production perspectives, is recognized as a sustainable means of improving diet quality and increasing climate change resilience (Bommarco et al., 2018). Nonetheless, current investment levels are lower for crops better adapted to future climates and tend to decrease as crop nutrient richness increases (Manners & Etten, 2018). Among starch-rich crops, maize, barley and rice are over-researched, while more nutritious crops like sweet potato, lentil, broad bean, chickpea are under-researched in regions where these crops will tend to benefit from future climates (Manners & Etten, 2018). There is an urgent need to shift research and development priorities towards species that can improve diet quality and climate change resilience, and at the same time create new income generating opportunities for women, Indigenous Peoples and youth.

Box 2. The failure of historical approaches for agricultural development to tackle malnutrition

The focus on improving food availability in the 1970s by increasing yields of a few crops failed to provide adequate nutrition. The main reasons include insufficient policy emphasis on healthcare, childcare, women's empowerment, gender equality and diverse and quality foods. The focus on food access in the beginning of the 1980s resulted in more emphasis on increasing farmers' income and assets, but only those programmes that included additional components, such as nutrition education, produced improved nutrition outcomes. During the 1990s, interventions have drawn more attention to alleviation of micronutrient deficiencies and food utilization encompassing diet quality and childcare practices. Food fortification has been successful for some nutrients in specific contexts but this approach also has a number of limitations. Still today over two billion people worldwide are affected by "hidden hunger" or a lack of essential vitamins and minerals in their diets.

Source: Burchi et al., (2014).

NUS that are nutritious, climate-resilient, economically viable, and culturally important have great potential to support agricultural diversification and create synergies between strategies aiming to improve diet quality and climate change resilience (Baldermann et al., 2016). Many NUS have similar or better nutritional profiles as compared to major commodity crops and benefit from greater productivity under more challenging growing conditions. The tolerance of many NUS to abiotic stresses (e.g. drought, frost, and heat) and biotic stress (e.g. pest and disease), and their lower water and nutrient requirements make them strategic for increasing availability of nutrient-dense foods without exacerbating climate change vulnerability. The diversity of species used in Indigenous Peoples' food systems is vast, while they vary in their potential to enhance diet quality and/or climate resilience. The prioritization process described in this HTDN enables recognition of species with strong potential to provide multiple benefits through greater use. Ignored by policy makers and excluded from research and development agendas, NUS were left behind in their conservation, cultivation, harvest, postharvest, as well as marketability and studies related to their contribution to food and nutrition security, gender, youth and policies and legal frameworks to regulate their use.

2. Key Issues

Building on traditional knowledge

Crop prioritization processes for nutrition-sensitive agriculture can easily overlook NUS as they are generally poorly documented and excluded from agricultural databases (Meldrum et al., 2019; Galluzzi & Lopez Noriega, 2014). Information on nutritional and agronomic characteristics, value chains, and other relevant data on the use and potentials of NUS are often lacking. Documenting local knowledge on properties and values of NUS is thereby crucial for supporting priority setting and species selection. Participatory approaches can enable rapid documentation of the full range of available local species diversity, types and levels of use, the characteristics of crop species and varieties and the social and cultural identity of foods to inform the prioritization process. This can help prevent the loss of traditional knowledge about NUS and facilitate transmission of knowledge from elders to younger generations. The combination of traditional and scientific knowledge can guide a focus on species that will have an impact on people's livelihoods in ways that are consistent with nutrition and resilience goals, as well as other social or ecological aspects related to local cultures and visions of wellbeing.

A transdisciplinary and multi-stakeholder approach

Promoting the use-enhancement of NUS requires the engagement of a wide range of stakeholders, each bearing different interests and perceptions on best choices. Involving stakeholders and technical experts across all relevant areas (climate change, nutrition, health and market) in species prioritization can be important for identifying and successfully promoting NUS with multiple benefits. Such a multi-stakeholder prioritization process should be guided by the principles of transdisciplinary research that seeks to establish a collaboration with local communities, allowing them to influence and engage in the research and decision-making processes (Bracken et al., 2015). Involvement of Indigenous Peoples in the species prioritization process can help create resilient food system that will provide diets rich in all essential nutrients, while maintaing local knowledge of unique value for society at large. Engaging women and youth in the prioritization process can ensure that their experiences, knowledge and views are considered, thereby contributing to their empowerment. A number of methods for participatory data collection and consultations with local communities are available and described in this HTDN to facilitate the involvement of local communities in a transdisciplinary multi-stakeholder approach for NUS identification and prioritization. An examples of multi-stakeholder prioritization is given in case study 1.

Prioritizing a combination of NUS for diet quality and climate change resilience

Initiatives for nutrition-sensitive agriculture should be compatible with efforts for adapting and mitigating climate change. Increasing production and use of nutrient-dense foods should not increase vulnerability to climate change or increase emissions of greenhouse gases. Promoting a combination of species, rather than just one species, is most strategic to support the diversification of diets and agricultural systems needed for improved diet quality and resilience. Central in the holistic approach to prioritize and promote NUS is the goal of diversification of production systems. Crop diversification along with improved management of soil and water resources are widely recognized as the key strategies to strengthen climate change resilience. The goal of the prioritization approach presented in this HTDN is accordingly to assess the local situation to identify a combination of species that can:

1) increase the availability of food groups and/or specific nutrients that are under-consumed in local diets and under produced in farm portfolios or local food systems across different food groups (vegetables, fruits, pulses, cereals); and

2) increase the diversity of species and crop varieties that have traits of importance to climate change resilience (e.g. drought tolerance, early maturation, pest tolerance, disease resistance, adaptation to poor soil).

Meeting multiple criteria

In addition to contributing improved diet quality and climate change resilience, the species prioritized should be culturally significant or have a potential to revive local food systems and cultural traditions linked to local crop diversity. The combination of prioritized species should meet a number of criteria related to cultural significance, women and youth empowerment, market potential and conservation and sustainability (table 1). In projects focused on marketing and value chains, ideally, the portfolio of selected species should target different types of markets and purposes (local village market, distant market, food or industrial ingredient, processed retail product, home consumption, etc.) to reduce economic risks for producers.

Local priorities versus national priorities

This HTDN proposes a participatory multi-stakeholder process for prioritization, especially focused on local priorities in targeted areas. NUS prioritization can be undertaken to address nutritional challenges or climate change adaptation goals at the national level. Country-level prioritization is conducted by examining species inventory, nutrition data, and climate change threats. Country-level prioritization can encourage policy makers and governments to recognize the importance of NUS and to promote them at the national level. However, national priorities may fail to address specific nutrition gaps or climate vulnerabilities, which vary across different agroecological or geographical zones within country. An important consideration is cultural food preferences. National priorities may not be consistent with traditions and preferences of Indigenous Peoples', who rely on a specific set of local plants that often have important cultural role. An example of regional and national priority setting exercise conducted for the Future Smart Food Initiative (Li & Siddique, 2018*)* is discussed in case study 2.

Addressing the needs of women and youth

While collecting data for NUS prioritization, it is important to apply gender and youth lens in every step of the process. Most data collection methods described in this HTDN can be conducted in a way to understand the gender and age differences with respect to the use and perceptions of different NUS. This is achieved by involving women and men of different ages to identify, record and discuss their distinct needs, experiences and values, which are then evaluated and considered when prioritizing NUS species. For example, when prioriting species in a community, Four Cell Analysis, food availability calendar and participatory landscape mapping, and other activities, can be conducted in age and gender differentiated groups (i.e. young women, young men, older women, older men), and the results can be shared in plenary discussion. Data collection sessions should also be an opportuity for the local community members to discuss among themselves and advance the prioritization through consensus.

Reviving local food systems

Many NUS have long been a part of local cultures and traditions, and are associated with diverse food habits, health practices, religious rituals and social exchanges. NUS often have nutritional, ecological, medicinal, cultural and other values for local communities. This is why promoting NUS has potential to contribute to the social empowerment of Indigenous Peoples' communities by helping them to maintain and harness local knowledge and unique agricultural heritage and food culture. This is particularly true for Indigenous Peoples' communities. Many NUS projects worked with Indigenous Peoples and women. Among them are the Quechua and Aymara communities who partnered in projects seeking to promote Andean grains (quinoa, cañahua and amaranth), which have been cultivated by their ancestors for hundreds of years. Other NUS like chaya, fonio and small millets are deeply embedded in local cultures and are part of Indigenous food systems. The promotion of culturally important NUS can contribute to the re-newel of Indigenous Peoples' cultural identity, while creating new opportunities for young people to improve their livelihoods and continue their role as guardians of agrobiodiversity.

3. An approach for selection of high-priority NUS

This section presents an approach for identifying crops that can be promoted in agriculture development projects for improved diet quality, climate change resilience and livelihoods. The prioritization approach presented in this HTDN builds on previous experiences (Polar and Flores 2008) but seeks to put more emphasis on the needs of Indigenous Peoples, women and youth, rather than market demand. Approaches to explore the market potential of species are presented in the second HTDN in this series. The approach proposed here involves working closely with local communities using participatory methods to complete assessments that consider the entire local food system, including its ecological, social and cultural dimensions. This holistic approach can foster desired outcomes for improved diet quality, resilience, livelihoods, and strengthened social equity and empowerment of Indigenous Peoples and women. Key criteria for prioritization of species are given in table 1. Local species are identified, assessed against criteria and prioritized for promotion in a process that consists of four steps (figure 2):

Step 1 is an agrobiodiversity assessment, which aims to create a complete inventory of local diversity and generate a 'long list' of species to be evaluated in later steps.

Step 2 evaluates nutrition situation and which species identified in step 1 can be leveraged for improving diet quality.

Step 3 assesses local experiences with climate change and opportunities for diversification to identify crop species and varieties that can be promoted to enhance resilience.

Step 4 engages stakeholders in an evaluation of the short-listed species generated in steps 2 and 3 to select a combination of species to promote through project activities.

The information needed for the prioritization can be collected by a variety of modes (box 3). Most of the necessary information can be collected by literature review and focus group discussions, which can provide a relatively rapid and resource efficient assessment. Structured and semi-structured surveys, direct observations, and participatory methods may also be applied depending on the time and funding available, as well as the specific priorities of the project. A number of participatory methods can be used to engage local communities to include their views, experiences and knowledge in the prioritization process. The four steps of the prioritization process are described in detail in the following sections.

Figure 2. The four steps of the selection of high-priority NUS

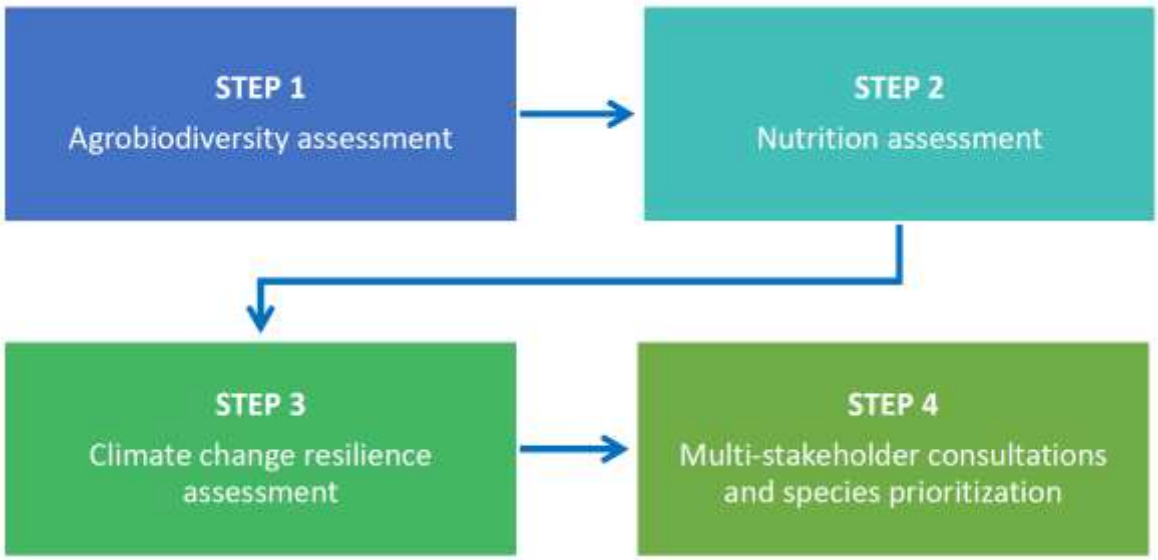


Table 1. Criteria and steps for the prioritization of NUS (see also figure 2)

Criteria for species prioritization		Steps
Nutrition	Contributing to diet quality year round or at key points of year by: providing food in under-consumed food groups providing under-consumed micronutrients.	Step 1, 2
Climate change resilience	Adapted to harsh and variable climatic conditions, with traits such as drought tolerance, early maturation, resistance to pest and disease, and the capacity to grow in poor soils.	Step 1, 3
Cultural significance	Important in local food systems, cultural practices, or histories of a community.	Step 1, 4
Women and youth empowerment	Potential to contribute to women and youth empowerment (e.g. through drudgery-removal, or new or improved income opportunities).	Step 1, 4
Market potential	Economically viable, attractive to consumers, and suitable for processing and storage.	Step 1, 4
Conservation and sustainability	Cultivated in diversified agro-ecosystems without chemical inputs or sustainably harvested in the wild (for wild species). Crop species with multiple local varieties. Rare crop species and varieties to revive through community-based on-farm conservation activities (e.g. community seed banks, custodian farmers).	Step 1, 4

Box 3. Methods of data collection that can be used in the selection of high-priority NUS

Desk review involves gathering data and information on a topic that is already documented from past research efforts in project reports and scientific literature. Literature searches are performed by searching key words in reliable indexes (e.g. Google Scholar, Web of Knowledge, PubMed, Agricola).

Focus group discussions are meetings on a specific theme organized with members of local communities or other stakeholders. The demographics of the participants can be defined to reflect perspectives of groups of interest (e.g. men, women, elderly, specific age groups or ethnicities). Specific themes can be investigated through participatory dialogue in structured activities and open discussion, promoting exchange of ideas, experiences, suggestions and knowledge. Focus groups typically include around 6-10 participants. They should not last longer than three hours, and should serve as an open space in which community members can freely contribute to discussion. Gender specific groups are recommended when women and men may not speak freely in a mixed-gender setting.

Structured surveys are carried out with a representative sample of a target population. Questions are typically closed in order to gather comparable answers from a large number of respondents, for example individuals in the household (e.g. the woman and/or the household head) or consumers or vendors in the market. These surveys allow the collection of quantitative information that reflects the frequency, magnitude, and variability of factors in the target population, which can be related statistically to other characteristics of the respondents.

Key informants interviews are semi-structured, in-depth conversations with stakeholders that involve open questions on specific themes. These types of interviews provide qualitative information and are well suited to explore processes (‘how’) and motivations (‘why’).

Direct observations of species diversity, traditional food preparation methods, and agronomic performance can support the prioritization process.

Measurements of species’ nutritional composition, the nutritional status of populations, and weather variables can support the prioritization process.

STEP 1: Agrobiodiversity assessment

In the first step of the prioritization process, a complete inventory of species that are cultivated, wild-sourced, consumed, shared among families and available at the market is developed with the aim to generate the 'long list' of local species. The assessment considers: a) the diversity of crop species and varieties cultivated in local farming systems; b) the diversity of wild species sourced from the local landscape, and c) the diversity of species available in the market. Important information to collect in diversity assessments include:

- names of local species
- uses and key characteristics of local species
- cultural significance
- the levels of availability of different species over the seasons
- type of cropping systems and land uses where species are cultivated and sourced.

The information can be obtained through several modes (box 3). A rapid assessment is completed through focus group discussions and literature review, which can be sufficient to capture the relevant information in a short period of time. Structured surveys, direct observations, and several participatory data collection methods may be applied as complementary or alternative methods depending on the time and funding available and the specific objectives and activities of the project.

Varietal diversity: The agrobiodiversity assessment should collect information on species diversity as well as variety diversity of local crops. Many crops have high intra-specific diversity and not all varieties are equal in terms of their capacity to improve diet quality and resilience, or their capacity for use-enhancement and income generation. Specific varieties within NUS may be more relevant in meeting project objectives.

Rapid assessment

Desk review: National production statistics, ethnobotanical literature, and past production system surveys in the target area provide an important base for the agrobiodiversity assessment. Existing information on local agrobiodiversity, levels of production, and seasonal availability should be accessed. National production statistics rarely consider NUS but could provide insight on some minor crops as well as major crops and commodities in the region. Detailed production system surveys and ethnobotanical studies will be more likely to cover NUS; however, their scope and methodology should be examined carefully as they may only reflect a partial set of local agrobiodiversity. Information on agroecological zones, soil characteristics, and local production systems can be investigated to understand the context in which foods are produced and sourced. Information may also be found in the literature on the diversity of foods available in markets in the target area.

Focus group discussions: Several methods can be applied in focus groups to complete the agrobiodiversity assessment with the participation of local communities:

- **Free-listing** is a fast way to develop a list of species and varieties produced in the target area, as well as foods sourced from the wild and the market. The free-listing approach can be performed by food group, or for specific cropping systems and land uses. Special attention should be given to inquire about rare species, varieties and foods that were used more often in the past.
- **Species evaluation** combines free-listing with scoring and ranking. Species (and varieties) are listed, and then scored against a number of criteria (e.g. taste, yield, cultural significance[1]). Based on the score, the species can be ranked. For example, the participants (e.g. farmers, Indigenous

[1] A useful method to assess cultural significance of foods is that of Pieroni (2001): CFSI =QI x AI x FUI x PUI x MFFI x TSAI x FMRI x 10-2 [the formula takes in account seven indexes which express the frequency of quotation (QI), the availability (ALI), the frequency of utilisation (FUI), the plant parís used (PUI), the multifunctional food use (MFFI), taste score appreciation (TSAI), and the food-medicinal Tole (FMRI)].

Peoples, women) are asked to list all local species and give them a score for parameters of interest (e.g. extent of consumption, degree of consumption, perceived nutritional value, cultural importance). Evaluation can be carried out for crop varieties (see example in table 2). An example of prioritization based on species evaluation is given in case study 3 (page 29).

- **Four Cell Analysis** is a versatile tool to assess the diversity of crops and livestock in a focus group. The assessment can be conducted at species level or it can be conducted for varieties of species with high intra-specific diversity. The participants provide information on the relative number of households producing each species or variety (few or many) and the quantity produced (small or large). In this way, the crops are distinguished into four cells based on these criteria (figure 3). A similar approach can be used to assess the levels of availability and sourcing of foods from the wild and the market (e.g. small or large amount available and small or large amount sourced by households). An example of crop diversity information collected in four cell analysis is given in table 3.
- The **seasonal availability of foods** can be assessed in a focus group by discussing and documenting the months in which foods are available and their relative availability when they are in season (e.g. low, medium, high). The assessment can distinguish between foods available in the production system, wild areas, and the market. The seasonal availability assessment is particularly relevant for perishable foods such as fruits and vegetables that may not be stored for long periods. Techniques used for preserving foods to extend their availability should be discussed. An example of information collected using this method is given in table 4 and figure 4.
- **Participatory landscape mapping** can be used to identify important cropping systems and land uses in the landscape of the target communities. Areas where foods are produced and sourced from the wild can be indicated on the map.
- **Exploring foodways** in focus groups is a way to collect information about food preparation and other aspects of traditional knowledge related to food. Traditional knowledge of local plants, their properties, uses, cultivation and harvesting, storage and methods for post-harvest processing and food preparation are particularly important. For example, local knowledge can be helpful in understanding how to process NUS for suitable consumption, as some may have toxic or anti-nutrient properties and must be consumed in small amounts or processed in special ways to reduce toxin content.

Figure 3. FCA for production system diversity

Large areas Many households (=common)	Large areas Few households
Small area Many household	Small area Few households (=rare)

Table 2. Bambara groundnut varieties (29) under cultivation in six communities of Sikasso and Segou regions of Mali

Big grain size (big), good taste, good yield and early maturation were the most important reasons given by producers for growing varieties of this pulse.

Bambara groundnut varieties	Reasons for cultivation									
	Early maturation	Good market	Good taste	Big grain	Good yield	Easy harvest	Easy processing	East to cook	Adapted to poor soil	Good storage
Lomapoa	■			■						
Soutrai teint rouge				■			■			
Soutrai teint noir				■						
Loma Tobo	■			■						
Lomabia				■						
Tioma foua	■		■		■					
Tioma tombo				■						
Dawanou			■		■					
Tioma tjine				■						
Alirinaro	■	■	■	■						
Paratourou	■	■			■					
Tiamba						■	■			
Bakia				■						
Tianfin	■				■					
Blanche			■					■		
Rouge			■	■						
Noire					■		■			
Noudie			■						■	
Noufin									■	
Yoroba			■	■						
Boufigue	■	■	■						■	
Bouyiga					■					
Kiamba				■	■					
Fitere				■						
Bignega				■						
Bignieniere				■						
Bounigo										■
Boubogo		■		■						
Boussadon				■	■					
Total	**7**	**4**	**8**	**17**	**8**	**1**	**3**	**1**	**3**	**1**

Source: Padulosi et al. (2012)

Complementary and alternative methods

Key informants' interviews: Interviews can be held with community members and other local actorsto provide detailed, qualitative information on species diversity, uses and availability in the targeted areas.

Structured surveys: Household-level questionnaires can be used to collect information about the species and varieties cultivated in fields, home gardens and other plots. Household surveys can include questions on various aspects of agrobiodiversity management as seen needed for the prioritization process. Questions on the collection of wild species can also be included to understand which species are collected during which seasons. A gender-segregated approach can reveal the species cultivated and collected specifically by women and men in the household. Interviews of market vendors can be a strategic approach for developing an inventory of foods available in the market and their seasonal availability.

Direct observations: Field observations combined with key infomant interviews can be used to document diversity in home gardens, crop fields and other cultivated plots. Transect walks can be combined with field observations. Researchers and project officers walk with one or more community members along a defined path (transect) in the community's landscape. The path can cross fields, home gardens, forests and other areas. During this activity, participants show and describe the different land uses and which foods (wild and cultivated) are produced and sourced in different parts of the landscape. Market surveys can involve directly observing and noting the diversity of foods available in markets, which can also include documentation of levels of processing, and prices. Market surveys would best be completed seasonally to capture variation in food availability and prices.

Participatory methods: Diversity fairs, festivals and religious events are convivial events during which community members display plants, seeds and traditional food items to raise awareness for the importance of agrobiodiversity and provide opportunity to exchange seeds and planting materials. These events can allow a rapid documentation of agrobiodiversity by recording all the species and varieties displayed by the participants. Participatory selection can be carried out at the beginning or during the project to evaluate species and crop varieties and to identify those with high potential for successful promotion. In some projects, prioritization may take a longer period of time to characterize a large sample of crops and crop varieties. This involves identification of morphological, agronomic, nutritional and other traits of species and varieties and their evaluation with the participation of local farmers. An example of *participatory variety section* is presented in case study 4 (page 31).

Generating the 'long list' of species

The information collected through agrobiodiversity assessment will generate a 'long list' of species (and crop varieties) that will inform the next steps of the selection process for high-potential NUS. All the species identified in this step should be identified to scientific name with the help of local ethnobotanists to enable cross comparison of information with the literature. A single species or variety can have several names in local languages. The precise identity is thus best verified by morphological and/or genetic evaluations. Taking samples and photographs of the species and varieties is a good practice that can support the identification to scientific name. Example agrobiodiversity assessments from Bolivia and India are shown in tables 3 and 4 respectively. A study conducted in Benin described in case study 3 (page 29) provides a long list of NUS identified based on farmers' evaluation in different regions and ethnic groups (table 9).

Table 3. Crop species cultivated in Cachilaya, Bolivia and their level of cultivation assessed using five cell analysis[2]; Andean lupin has been identified as a lost crop, along with several local potato varieties

Species name	Common names	Level of assessment	Number of Households	Area
Chenopodium quinoa	Quinua (quinoa)	**Crop-level**	Many	Large
Vicia faba	Haba (fava bean)		Many	Large
Hordeum vulgare	Cebada (barley)		Many	Large
Avena sativa	Avena (oat)		Many	Large
Solanum spp.	Papa (potato)	**Variety level**		
		Chiyara sani	Many	Large
		Huaycha	Many	Large
		Janqu Imilla	Many	Large
		Janqu pala	Many	Large
		Sani imilla	Many	Large
		Wila sani	Many	Large
		Allka sani	Many	Small
		Chiyara pala	Many	Small
		Chiyara piñu	Many	Small
		Janqu Llocalla	Many	Small
		Llocallito	Many	Small
		Papa rojo	Many	Small
		Surimana	Many	Small
		Wila pala	Many	Small
		Kullo	Few	Small
		Papa rosado	Few	Small
		Pitikalla	Few	Small
		Waca lajra	Few	Small
		Wila nairan polo	Few	Small
		Wila piñu	Few	Small
		Janqu polo	None (lost variety)	None (lost variety)
		Luki	None (lost variety)	None (lost variety)
		Piñu	None (lost variety)	None (lost variety)
		Warisaya	None (lost variety)	None (lost variety)
		Wayllachia llocallito	None (lost variety)	None (lost variety)
Oxalis tuberosa	Oca	**Crop-level**	Many	Small
Ullucus tuberosus	Papalisa		Many	Small
Tropaeolum tuberosum	Isano		Many	Small
Chenopodium pallidicaule	Canahua		Many	Small
Pisum sativum	Arveja (pea)		Many	Small
Zea mays	Maiz (maize)		Many	Small
Lactuca sativa	Lechuga (lettuce)	**Crop-level**	Few	Small
Petroselinum crispum	Perejil (parsley)		Few	Small
Brassica rapa subsp. *rapa*	Nabo (turnip)		Few	Small
Daucus carota	Zanahoria (carrot)		Few	Small
Lupinus mutabilis	Tarwi (Andean lupin)	**Crop-level**	None **(lost crop)**	None **(lost crop)**

Source IFAD-NUS III-IV, PROINPA and Bioversity International.

[2] This is bascially the Four Cell Methods to which another cell is added to list lost varieties being reported by farmers

Table 4. Seasonal availability of dark green leafy vegetables in eastern Madhya Pradesh

The level of availability is indicated by numbers, 1=low, 2=medium, 3=high. The months, corresponding to the Hindu calendar, are indicated by letter, A=Chaitra; B=Vaishakha; C= Jyeshta; D= Āshādha; E= Shrāvana; F = Bhaadra; G = Āshwina; H= Kārtika; I= Agrahayana, J= Pausha, K= Māgha; L= Phālguna.

Scientific name	Local and common names	Month												Storage	
		A	B	C	D	E	F	G	H	I	J	K	L	Form	# months
Cultivated															
Amaranthus dubius	Lal bhaji; red amaranth				1	2	3	3	2	3	3	3	3		
Amaranthus sp.	Rajgir bhaji; amaranth		2					1	3	3					
Bauhinia sp.	Kevlar bhaji	1	2	3	1										
Brassica juncea	Rai bhaji; mustard							3	2					Dry	12
Chenopodium album	Bathua bhaji; lamb's quarters	3	3											Dry	3
Cicer arietinum	Chana bhaji; chickpea								2	3	3	1		Dry	12
Colocasia sp.	Guiyaan bhaji; tarul					3	3	3							
Colocasia sp.	Kochai bhaji; taro				3	3	3	2							
Commelina bengalensis	Kankaua bhaji				1	3	2								
Cucumis melo spp. *agrestis*	Kachar bhaji; muskmelon						3								
Moringa oleifera	Munaga bhaji; moringa	2										2	2		
Portulaca oleracea	Nuniya bhaji; purslane										1	3	2		
Raphanus raphanistrum	Mooli bhaji; radish							2	3						
Spinacia oleracea	Palak bhaji; spinach	2	1			3	3	3	3	3	3	3	3	Dry	4
Trigonella foenum-graecum	Methi bhaji; fenugreek							3	3	3	3	3	3	Dry	2
Unknown	Kajara bhaji				1	2	3	2	2	1				Dry	12
	Lakodi bhaji							3							
	Khutna bhaji				1	3	3	3							
	Kamati bhaji				1	3	3								
	Poa bhaji							1	3						
	Labher bhaji	3	3												
	Paakhar bhaji	3	3												
	Charaiya bhaji					1	3	1							
Semi-domesticated (cultivated and wild forms)															
Cassia tora	Chakora bhaji; sickle senna				3	3	1							Dry	12
Corchorus sp.	Chech bhaji; Jute							3	3	1				Dry	12
Wild															
Antidesma acidum	Khatua bhaji			3	3										
Unknown	Lasari bhaji	1	3												
	Peepar bhaji			3											

Source: IFAD-EC NUS, ASA and Bioversity International

STEP 2: Nutrition assessment

The second step consists of the nutrition situation analysis and an assessment of the nutrition-improvement potential of NUS with the aim to identify a 'short list' of NUS with potential to bridge local dietary gaps. The evaluation of the nutrition-improvement potential of NUS is informed by a nutrition situation analysis as described in STEP 1 of IFAD's publication "*Nutrition-sensitive value chains: A guide for project design*" (De la Peña & Garret, 2018) and the How-to-do Note on mainstreaming nutrition into COSOPs and investement projects (IFAD, 2019). The nutrition situation analysis considers the prevalence and forms of malnutrition in the target population, the causes of malnutrition, and the main dietary problems. This allows for the identification of dietary gaps in terms of foods that may be insufficiently or inadequately consumed, contributing to food-based nutritional problems (De la Peña & Garret, 2018).

The evaluation of the nutrition-improvement potential of NUS considers how the species identified in the agrobiodiversity assessment (Step 1) could be leveraged to fill dietary gaps identified in the nutrition situation analysis. NUS from under-consumed food groups or NUS with high levels of micronutrients that are consumed in inadequate levels may be promoted to fill the identified nutrition gaps. NUS that are available in particularly lean or low consumption periods and/or those from food groups or with micronutrients that are under-consumed would be prioritized. To start the evaluation, the 'long list' of species identified in the agrobiodiversity assessment (Step 1) should be classified into food groups with support from a nutritionist. The nutritional composition of locally-available foods should also be evaluated to identify species or varieties that have the potential to provide important micronutrients. The seasonal availability and nutritional value of locally-available foods should be compared against local dietary gaps to identify underutilized foods with potential to improve diet quality, and hence contribute to improving nutrition.

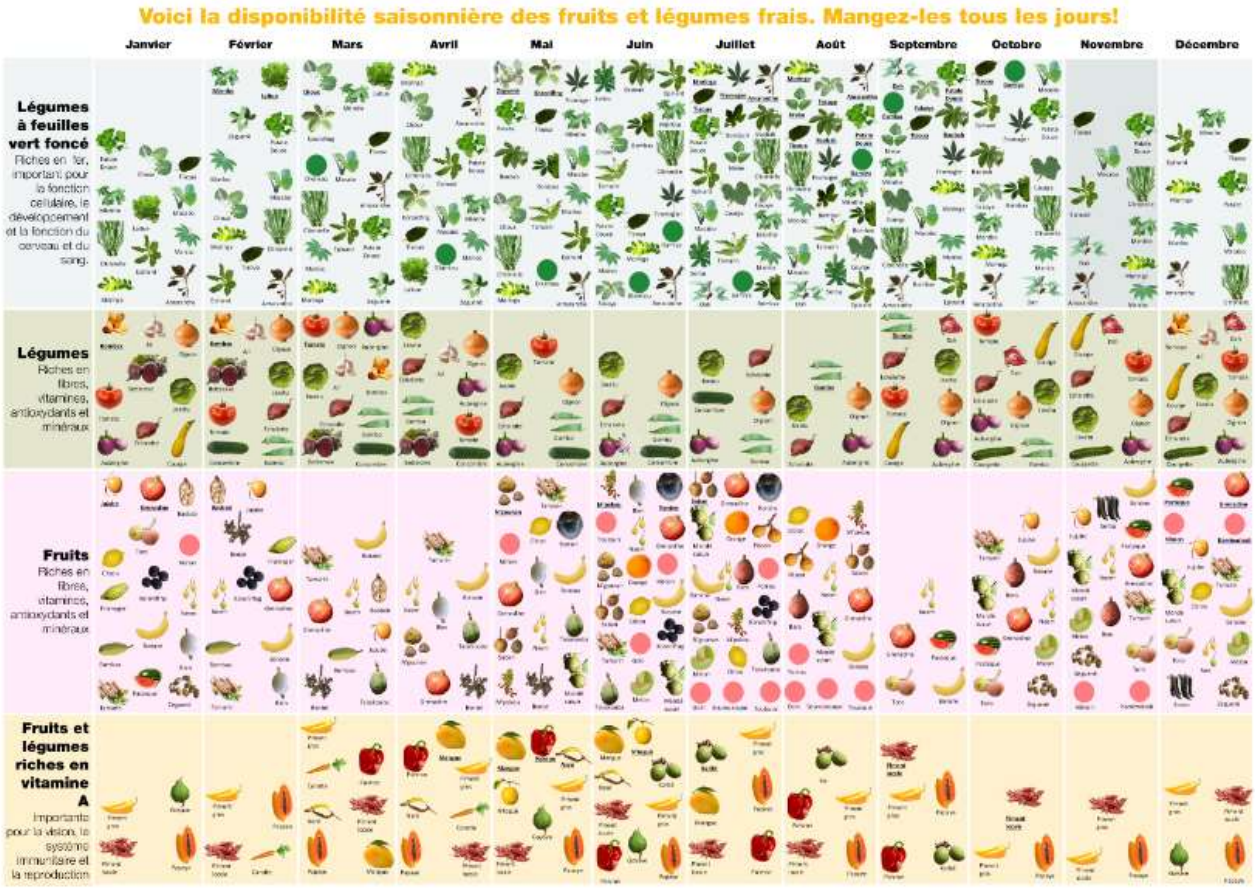
The information required for the evaluation can be collected through various means. Focus group discussions and literature review can be sufficient to capture the relevant information in a short period of time with limited resources. Structured surveys and direct observations and measurements may also be applied depending on the time and funding available and the specific objectives and activities of the project.

Rapid assessment

Desk review: A desk review is a first step for the nutrition situation analysis. Most of the necessary information may be available already in existing reports and databases. National Ministries or Departments of Health and/or Nutrition, together with international data collection collaborations such as the UNICEF MICS and Demographic Health Surveys are a good first entry point. Data specific to the target site may not available, but regional or national data may provide enough indication on the primary drivers of malnutrition and poor diet quality. The nutritional values of locally available foods (identified in the agrobiodiversity assessment; Step 1) should also be reviewed. The first level of nutritional value that can be assigned is based on the associated food group. Guidance on food group allocation can be taken from national institutes of nutrition, or by using the UN FAOs Diet Diversity classification system[3] (FAO and FHI 360, 2016). An example is provided in figure 4. A more detailed and nuanced classification of the nutritional value of NUS is to evaluate the nutrient composition. To gain this knowledge, it is possible to consult national or regional food composition tables or global databases such as INFOODS. Nutritional composition is available for many species but the composition of many NUS is still unknown and collecting this information through nutritional composition assessments can be strategic for projects targeting NUS, as described in greater detail below. Reviewing public health nutrition education campaigns disseminated by national institutes other organisations (e.g. SUN, Alive and Thrive) provides insights into how to guide nutrition related concepts to communities when collecting data, such as how foods should be grouped.

[3] http://www.fao.org/nutrition/assessment/tools/minimum-dietary-diversity-women/en/

Figure 4. Seasonally available fruits and vegetables in Segou region, Mali



Source: Bioversity International and IER 2018a,b

Figure 5. FCA for diet diversity

Frequently consumed Many households	Frequently consumed Few households
Rarely consumed Many households	Rarely consumed Few households

Focus group discussions: FGDs, as described in Step 1, can be used for rapid assessment of food consumption patterns of the foods identified in the agrobiodiversity assessment (step 1) . Four-Cell Analysis can be applied to understand which species are consumed more or less frequently, why and by how many households in the targeted area (figure 5; Raneri et al., 2017). Repeating the assessment at different times, or having open discussions with participants can help understand seasonal dietary patterns, level of consumption and use of local agrobiodiversity and/or food groups by different demographic groups (e.g. elderly, women, men, children, etc).

Complementary and alternative methods

Key informants' interviews: In these interviews, which for this step can be held with local partners, health and nutrition workers, village representatives can provide detailed, qualitative information on the main issues faced with malnutrition and local crops that may stand out for improving diet quality.

Structured surveys: Household-level and individual-level surveys may be conducted to provide a more detailed understanding of drivers related to nutrition and of diet quality of local populations. Diet quality can be assessed through the use of the 24 h dietary intake recall, either quantitative or qualitative. This method is a recall of all the foods and drinks consumed by one or more members in the household (normally, women of reproductive age and children aged 6-24months) in the 24 h prior to the data collection. The quantitative dietary intake assessment allows a calculation of the amount of micro and macro nutrient consumed throughout the day to identify insufficient intakes of nutrients, whereas the qualitative 24 h recall provides information on the food groups consumed to calculate diet diversity but not the quantities consumed. To understand how dietary quality changes throughout the year and is influenced by seasonal variations in local food availability, this method should be ideally repeated during both lean and abundant seasons to understand differences in the diet in the best and worst case scenarios. If resources are avaialble for more frequent data analysis, repeating assessments across time can allow for more nuanced monitoring of changes in diet quality and evaluation of the potential of NUS to enhance diet quality. Indicators for food security can also be evaluated such as the Months of Adequate Household Food Provisioning[4], the Food Insecurity Experience Scale[5], or the Household Food Insecurity Access Scale[6]. Questions on food purchase, knowledge, attitudes and practices related to food and nutrition, and decision making responsibility related to food and nutrition could also be included and ideally should be adminsitered to the same women who participated in the diet recall.

Measurements: The nutrient profiles of many NUS is still unknown and therefore conducting nutrient composition analysis of NUS (that includes a profile of the of macro- and micro-nutrients, toxins and anti-nutrients) may be required to enable a complete assessment on the nutritional value of NUS beyond food group classification. While requiring more time and resources, performing nutrient composition analysis has the advantage of building the evidence base on the value of under-studied crops. These analysis can be costly and time consuming; a good strategy to overcome this problem is to establish partnerships with local research centres, institutions and universities in a coordinated research effort to expand coverage of national agriculture statistics and provide data to national food composition tables. Anthropomorphic measurements including blood samples can be carried out for assessing nutrition status.

Box 4. Prioritizing species in Kenya based on micronutrient values

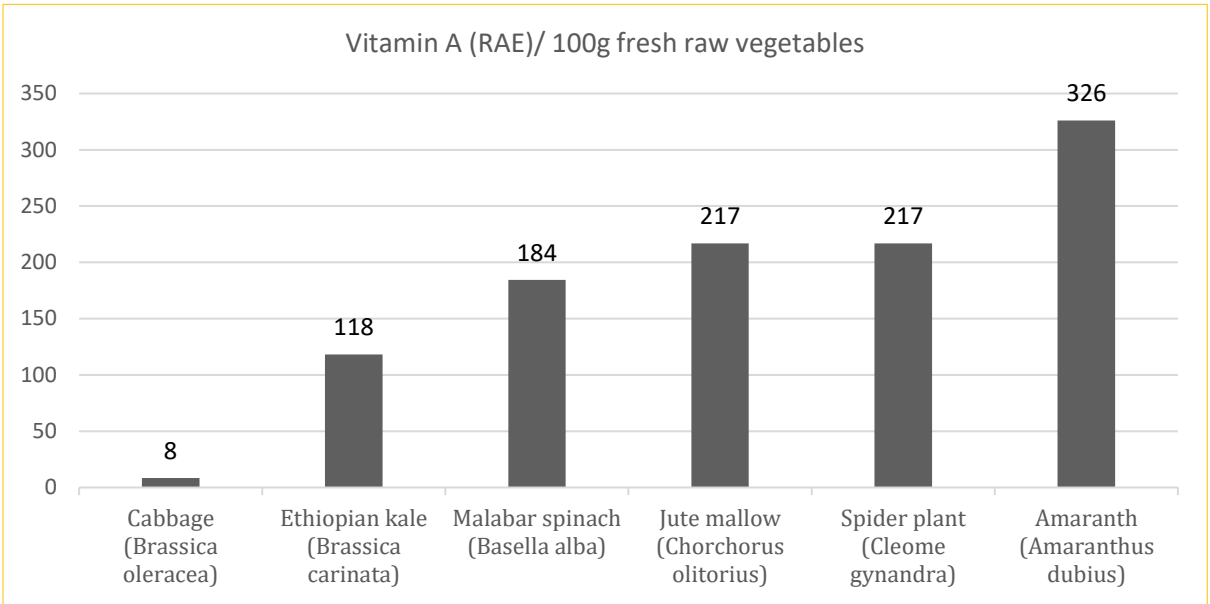
In the Biodiversity for Food and Nutrition project (BFN) in Kenya. Nutrient composition analysis of selected traditional vegetables indicated higher micronutrient contents (e.g. Vitamin A) compared to cabbage, which is commonly grown and consumed but is not a traditional crop (figure 6). Ethiopian kale (*Brassica carinata*), jute mallow (*Chorchorus olitorius*) and spider plant (*Cleome gynandra*) were prioritized among the dark green leafy vegetables for their high content of vitamin A and iron (Hunter et al., 2016). These species were chosen for promotion at the local and national levels.

[4] https://www.fantaproject.org/monitoring-and-evaluation/mahfp

[5] http://www.fao.org/in-action/voices-of-the-hungry/fies/en/

[6] https://www.fantaproject.org/monitoring-and-evaluation/household-food-insecurity-access-scale-hfias

Figure 6. Nutrient composition data for African leafy vegetables (fresh, raw)



Source: BFN Project and Staldmayr et al. (2012)

STEP 3: Climate Resilience Assessment

The third step should identify NUS with potential to support climate resilience through diversification of production systems. This is an activity to carry out with participating communities to understand local experiences of climate change and to identify species and varieties that can be promoted to strengthen resilience. This activity provides information on important resilience traits of species that are to be considered for NUS prioritization, such as drought tolerance, pest and disease tolerance, and early maturation. The result of this step is a list of species with important traits for resilience that can be promoted to diversity local food systems.

Rapid assessment

Desk review: Literature review would seek information on issues of climate change and climate-related stresses, pest and diseases that affect the area, climate forecasts, agronomic performance of crops linked to climate variables, etc.

Focus group discussions: Participatory Assessment of Opportunities for Diversifying Agroecosystems (Mijatović et al 2019) can be conducted with large or small groups of farmers to help understand the effects of climate change, assess diversity and management practices, and explore diversification options that can be supported by the project (see examples in box 5 and table 5). The assessment consists of four steps:

1. **Understanding local experiences of climate change and variability**: identifying the main climate-related challenges, as well as adaptation strategies already being applied in the community.
2. **Diversification of species, varieties, and breeds**: evaluating the characteristics of species and varieties to identify opportunities to increase the diversity of traits (e.g. early maturing, drought tolerance, pest tolerance, and diseases resistance) to spread risk of harvest loss and support adaptation.
3. **Diversification of fields and farms**: evaluating cropping practices and mixed species systems to identify diversity-rich practices that can improve soil conditions, reduce pest and disease pressure, and moderate field-level climate conditions.

4. **Diversification of the landscape**: identifying the role of different land uses to identify areas that can be protected and restored to buffer climate extremes, support regeneration of natural resources, and provide alternative food, medicine, and income sources.

Complementary and alternative methods

Key Informants Interviews: Interviews with local partners, village representatives and farmers to obtain more detailed information on resilience traits of the species available in the targeted areas and other relevant information on their cultivation and management practices.

Measurements: Field trials and evaluations, climate variables and modeling studies, etc.

Participatory methods: Participatory selection of species and varieties (case study 4) with the focus on traits of importance for resilience.

Structured surveys: Questionnaires for household surveys with the focus on climate change experiences, various aspects of diversity management and characteristics of local species and varieties.

This third step should identify a 'short list' of NUS with potential to support climate resilience. Such a list will be the basis of further evaluation and discussion in the prioritization process in Step 4.

Box 5. Resilience assessment in Mali

A Participatory Assessment of Opportunities for Diversifying Agroecosystems (Mijatovic et al., 2019) was undertaken with farmers in Sikasso and Segou Regions of Mali to understand local experiences of climate change and to identify gaps in species and varietal portfolios, and practices that can strengthen resilience. The results showed that farmers had been experiencing increasingly erratic and decreasing rainfall and unpredictable seasonal fluctuations. Several species and varieties of cereals, particularly fonio, have a good tolerance to climate stresses like drought and irregular rainfall (table 5). Fast maturing varieties can escape drought but have lower yields. Fonio, Bambara groundnut and cowpea stood out for their contribution to resilience, especially for their adaptation to poor soils and resistance to pests and diseases. In Sikasso region, fonio and Bambara groundnut have largely been abandoned in favour of extensive production of cotton and hybrid maize. The assessment showed a gap in availability of pest tolerant vegetables and a gap in availability of fruits adapted to poor soils. This particular assessment considered only cultivated species, but the great diversity of wild fruits and vegetables available in the landscape in Mali could also be relevant as a climate resilient food source. Agroforestry was identified by farmers as an important adaptation practice with multiple benefits for nutrition and productivity. Therefore, a greater focus on wild fruit species may be a good choice for improving both nutrition and resilience.

Table 5. Stress tolerance portfolio of cereals, pulses, vegetables, and fruits cultivated in N'Gountjina, Mali

The species (and number of varieties) with specific stress tolerances are listed.

Type	Drought tolerance	Tolerance to intense rainfall events and storms	Pest resistance	Disease resistance	Adaptability to poor soil
Cereals	Maize (4) Sorghum (6) Fonio (3) Pearl millet (1)	Maize (4) Sorghum (2) Rice (2) Fonio (3)	Maize (3) Sorghum (2) Rice (3) Fonio (3)	Maize (5) Sorghum (6) Rice (3) Fonio (3)	Maize (1) Fonio (3)
Pulses	Bambara groundnut (1) Cowpea (2)	Bambara groundnut (1) Cowpea (2)	Bambara groundnut (1)	Bambara groundnut (1)	Bambara groundnut (1)
Vegetables	Aubergine Chili African eggplant Okra	Okra African eggplant		Aubergine Chili	Aubergine Chili
Fruits	Local Mango Lemon	Local Mango Lemon	Local Mango Lemon	Local Mango Lemon	

Source: IFAD-EC NUS; Mijatovic et al. (2019)

STEP 4: Multi-stakeholder consultations and species prioritization

The final step of the crop prioritization process should engage stakeholders in reviewing the short listed species from Step 2 and 3 and evaluating the potential for their promotion. Various considerations need to be made for the final selection. There are often several factors that drive the underutilization of NUS. Some of these factors could be overcome through project actions (e.g. raising consumer awareness to reverse perceptions of food of the poor, developing and introducing processing technology to reduce drudgery and enhance product quality, etc.). Other factors may be more difficult to overcome or may require specific focus and investment in resources that may not be available within a specific project (e.g. breeding efforts to develop varieties with no seed shattering, uniform flowering and maturing stage, etc.).

In this step, species that are included in the short lists are evaluated against additional criteria including cultural importance, conservation and sustainability, women and youth empowerment and market potential (table 1). These criteria are the basis of the species selection process. The selection criteria are aligned with those described *Nutrition-sensitive value chains: A guide for project design* (De la Peña & Garrett, 2018), while some additional considerations that are particular to underutilized species are addressed. Criteria for the evaluation of the 'short lists' of species identified in Steps 2 and 3 are discussed below.

Cultural significance: The prioritization aims to identify species culturally acceptable and important to the target group. Culturally significant species are most closely associated with Indigenous and local peoples who depend upon those species for food, medicine and other needs. The species that play important cultural roles vary widely from one place to another. In general, however, these are the species that are embedded in peoples' cultural traditions, including food but also cultural ceremonies, dances, songs, etc. For example, fonio (*Digitaria exilis* and *Digitaria iburua*) is a NUS crop, which has a central role in some local cultures in West Africa. It is loved for its taste by local communities and appreciated for its drought-tolerance and other important traits; however, labor-intensive processing, low yields and lack of support and incentives have contributed to its displacement.

Women empowerment: Women's roles, responsibilities, and aspirations should be considered in the prioritization processes to facilitate the selection of species that can better address their needs, and harness their valuable knowledge. Women's experiences, knowledge and preferences for crops and varieties differ from those of men (see example in table 6). The prioritization process should focus on crops (and crop varieties) that have a potential to support women's empowerment by improving cultivation, access to seed, processing and marketing. *Inter alia,* interventions may work towards reducing time and

labour burdens for women or increasing productivity of the priority crops and the income that women gain from their products. While some NUS do not involve drudgery, like indigenous vegetables, other nutritious but neglected species need to be processed, especially cereals and pulses. Oftentimes, labour-intensive and time-consuming processing techniques, detoxification and other operations are the main reasons why nutritious local crops have been progressively abandoned.

TABLE 6: Varieties of fonio per gender preference (FGDs) in Sikasso and Segou regions (Mali)

	Fonio varieties									
	Kassambara	**Finidje**	**Peazo**	**Niatia**	**Bacokoutre**	**Pebru/peribou**	**Petrime**	**Peyibe**	**Beuike**	**Total**
Women	0	2	2	2	1	0	0	0	1	8
Men	1	2	0	1	1	1	1	1	1	9
Total	1	4	2	3	2	1	1	1	2	17

Finidje, Peazo and Niatia are varieties of fonio preferred by women because of the processing qualities.

Youth empowerment: Taking into consideration young people's views and involving them into prioritization process is key to the sustainability of NUS interventions. Prioritization and subsequent promotion of NUS species can help and inspire young people to reconnect with their land and the traditional culture of their elders, and can provide them with a sense of belonging and identity, in a world where youth migration is rising.

Market and income-generation potential: For value chain development, crops with growth potential and competitiveness in markets (e.g. unmet market demand, consumer preferences and unused competitive advantages) would be prioritized. NUS with attractive traits for marketing such as cultural roots, high nutrient or nutraceutical values, and unique culinary properties can have good potential for marketing. NUS can have good income-generation potential because of their low production costs, useful by-products, and capacity to raise ecosystem productivity through cultivation in marginal areas (at end of crop rotations, or on marginal soils). Selecting a few species to work on simultaneously that target different type of markets and purposes (local village market, distant market, processed retail product, home consumption) reduces risks. The prioritization should assess existing, realistic and attainable prospective market potential, market trends and consumers preferences. This will allow researchers to avoid choosing a product on the basis of mere speculation. The income generation potential of the crops should be considered. More details on market analyses for NUS are elaborated in the HTDN2 on *Assessing market needs and emerging opportunities in value chains*.

Conservation and sustainability: An important aspect of NUS prioritization process is the assessment of their conservation status. Some wild as well as domesticated NUS are at risk of extinction and many others are threatened and endangered. The major threats for cultivated NUS include abandonment by farmers or replacement with commodity crops. Rare crops or varieties may stand out in Step 1 agrobiodiversity assessment (see table 3), and in the nutrition and resilience assessments (step 2 and 3). Special approaches may be needed to promote their propagation and increased availability, which could represent a burden in project implementation but it also has great potential toward supporting the conservation of biological diversity in synergy with improving diet quality and resilience (see example in box 6). The risks of promoted species displacing other rare crops and varieties in the system should also be considered carefully during the prioritization process. For wild plants, major threats are habitat loss and degradation, and overexploitation (see case study 5, page 31), as well as reduced rights of Indigenous Peoples to land, territories and resources. Projects aiming at the prioritization of wild NUS species, if not properly carried out, could unwillingly lead to the overexploitation and consequent damage of natural resources and habitats of wild species, thus threatening their existence and the livelihoods of people who depend on it. If species with the potential for prioritization have a low conservation status, there are a number of action that

can help revive rare crops and varieties and prevent or reverse a depletion of their genetic diversity. These actions include:

- Support to on-farm/*in-situ* conservation (e.g. recovery of traditional seeds, establishment of community seed banks and biodiversity registers, establishment and recognition of conservation areas, etc.)
- Support to *ex-situ* conservation
- Encouragement of domestication of potential wild NUS such as wild fruits to avoid over-exploitation
- Implementation of biodiversity-friendly marketing practices (e.g. marketing variety mixtures or several varieties, marketing of sustainably harvested plants)
- Development and improvement of local seed systems.

Engaging multiple stakeholders in the prioritization is advised to gather the information and perspectives necessary to inform the decisions and to ensure greatest success of the project interventions. Stakeholders can include, among others, researchers, local partners, farmers, health and agriculture extension workers, traders, consumers, indigenous representatives, etc.

The multi-stakeholder consultations and final prioritization can be carried out through various approaches. A multi-stakeholder workshop is effective means to engage discussion and debate necessary to recognize high potential crops for promotion. The workshop would best be supported by a desk review summarizing results of steps 1-3 and exploring the key prioritization issues elaborated above. Depending on project objectives and the time and resources available, additional inquiry and investigation can be made through focus group discussions, surveys, and field trials.

Box 6. Reviving varietal diversity of NUS

Rare or even lost crop species and varieties have been prioritized for promotion, and NUS projects have a big role to play in their revival and conservation both on-farm conservation ex situ conservation in gene banks (Meldrum et al., 2018). The IFAD NUS project *Enhancing the Contribution of Neglected and Underutilized Species to Food Security and to Incomes of the Rural Poor* (2001-2004) promoted the conservation of the diversity of Andean grains in Bolivia and Peru. The project supported *ex-situ* conservation through the establishment of protocols for storage, documentation and taxonomic identification. Collection missions helped increase the number of accessions of quinoa (*Chenopodium quinoa*), amaranth (*Amaranthus caudatus*) and cañahua (*Chenopodium pallidicaule*). Rare cañahua landraces were made available to farmers through various mechanisms, including community seeds banks. Cañahua is a pseudo-cereal closely related to quinoa. It is remarkably frost-tolerant and has high nutritional value in terms of protein and dietary fibre contents. Its re-introduction to local communities was helpful in strengthening the resilience of local production systems.

Rapid approach

Desk review: Reviewing the conservation status for wild species on the short list is recommended, along with any guidance on sustainable harvesting practices and domestication potential. The agrobiodiversity assessment results can be examined to understand whether short listed species are common or rare/endangered varieties or species. A literature review can help in building an understanding of gender roles in the target population that can inform on potential opportunities and trade-offs for promoting the short-listed crops. Examining studies on consumer preferences and market trends in the region can also support the prioritization.

Participatory workshop: Multi-stakeholders consultations are an effective approach for gathering perspectives from different actors that would be involved in the value chain development of NUS and that could influence its success. Stakeholders to involve in the process are representatives from producer communities, value chain actors (traders, private sector, service providers), local authorities, development organizations, and experts from a range of disciplines (nutrition, food technology, agronomy, etc.). Marketing brings economic risks and thus a value chain development program should help farmers to take calculated risks by making informed decisions. As it is the farmer, cooperative or entrepreneur who takes the risk, it is important they are themselves involved in such crucial decision making.

The workshops should be supported by a synthesis of the results of the agrobiodiversity, nutrition and resilience assessments and additional points of interest raised in the desk review. Criteria for the selection of NUS should be handled in a flexible way, considering the social, environmental and economic situation of the study area, as well as the established research objectives. To reach an agreement, participatory ranking and impact filters methods can be used:

> Scoring and ranking: Participants are asked to score and then rank those species against each criterion in table 1. Agreement within the group should be reached. The species that rank the highest for several criteria are the ones that can be prioritized for promotion. Stakeholders can be free to implement changes or additions, and add criteria as appropriate.

Complementary and alternative methods

Focus groups: on key issues, e.g. variety evaluations of traits (see example in table 2), consumer preferences, etc. Preferences and barriers for consumption of different foods can be explored in these discussions. Gender and youth considerations can also be further explored (see example in table 6),

Stuctured and semi-structured interviews: These interviews, which for this step can be held with local partners, agriculture extension workers, village representatives and farmers, can provide detailed, qualitative information on role of women and men in local agriculture, consumer preferences. Market surveys allow integrating information on species availability in local markets. They can also provide information on prices, quantities, mode of sale, processing, salespersons, foods and food groups available. Short interviews with sellers could provide additional information on problems, constraints in the value chain, income opportunities, food preferences etc. HTDN no. 2 deals in detail with mapping markets and value chains of NUS. Gender-disaggregated questions on the uses of species and varieties, on their contribution to income and livelihoods and on their management by household members.

Measurements: field trials and taste trials can support the prioritization through assessment of crop performance and consumer preferences.

Participatory methods: Participatory variety evaluations can be carried out for factors not included in the resilience assessments (see case study 4, page 31).

Final prioritization

The result of the final prioritization is a combination of crops with strong potential to enhance diet quality, climate change resilience and provide multiple livelihood benefits through greater use. A participatory consensus that takes into account women, Indigenous Peoples and youth perspectives should be reached. Examples of species prioritized for project interventions are Tepary bean, Chaya in Guatemala; fonio, Bambara groundnut and Jute mallow in Mali; and kodo millet and little millet in India. The key characteristics of these nutrition-dense and resilient species based on which the species were prioritized for promotion are given in table 7 in case study 1.

4. Case studies

In this section, five case studies are presented showing examples of the different aspects of the prioritization process from a number of projects. The case studies give examples of prioritized species and of methods used in the prioritization processes. The project briefly presented in case study 1 applied and engaged in multi-stakeholder processes in three countries to identify local NUS species. Case study 2 discusses differences between priority setting at the local and national/regional levels on an example from Nepal. Case study 3 presents a prioritization process based on a farmers' evaluation of local species in Benin. Case study 4 gives an example of participatory variety selection of crop varieties of tropical fruit species in four Asian countries. Case study 5 gives an example of the conservation status assessments of wild plants used in species prioritization in Turkey.

CASE STUDY 1: Mali, India and Guatemala: Prioritization of NUS

A multi-stakeholder process was applied to select NUS to promote the holistic value chain approach in India, Mali and Guatemala through the IFAD and EC supported project *Linking agrobiodiversity value chains, climate adaptation and nutrition: Empowering the poor to manage risk* (2015-2017). The species were selected through national stakeholder consultations involving project partners, farmers associations, women's associations, local experts of nutrition, climate change, conservation of crop genetic resources, social science, and anthropology, as well as community members, policy makers, and private sector actors. During these consultations, a thorough analysis of the local situation for nutrition, climate change, and vulnerable groups was undertaken. Comparative advantages of resilient and highly nutritious local crops were debated along with issues related to the use-enhancement of these resources from agronomic, economic, and social perspectives. The crops selected for the project stood out as best options in view of their high nutritional profiles, their high appreciation in local food cultures, and the fact that they are able to respond to the effects of climate change such as unpredictable rains and soil degradation. The selected crops were tepary bean (*Phaseolus acutifolius*) and Mayan spinach (*Cnidoscolus aconitifolius*) in Guatemala, Bambara groundnut (*Vigna subterranea*), fonio (*Digitaria* sp.), and jute mallow (*Corchorus* spp.) in Mali, and kodo millet (*Paspalum scrobiculatum*) and little millet (*Panicum sumatrense*) in India. The features of these crops and potentials to support improved diet quality and resilience through value chain development are summarized in table 7.

To support the discussions in the stakeholder workshops, participating experts undertook a situation analysis for nutrition and climate resilience through desk review that was presented during the stakeholders' workshops. The selection of crops was made based on the results of the analyses and participants' knowledge of local agricultural biodiversity. This approach was effective for selecting a set of species in each context that could enhance diet quality and resilience. The crops prioritized during the stakeholders' workshops were the focus of initiatives for value chain development, while more detailed assessments of agrobiodiversity, diet quality and climate resilience were made in each site to deepen understanding of the local context and identify additional NUS that could be relevant to promote through future initiatives. Furthermore, in India, it was decided that additional investigations should be carried out in the project area to identify fruits and/or vegetables that could complement the climate-hardy millets in diversified production systems as the local stakeholders did not have sufficient knowledge of the local diversity and traits of fruits and vegetables.

Table 7. NUS prioritized in Guatemala, Mali and India to be promoted for improved nutrition and climate resilience

Crop	Nutrition	Climate resilience	Role of/ Importance for women and IP
Tepary bean *(Phaseolus acutifolius)*	• Similar energy, protein, fat and carbohydrate levels as other commonly grown beans in Guatemala (e.g. black and red varieties of *Phaseolus vulgaris*) • Heat from cooking tepary bean inactivates its antinutrients (trypsin inhibitors)	• Well-adapted to arid conditions; grows in areas with as little as 40-170 cm of annual rainfall • High drought, heat, and cold tolerance • Early maturation • Fairly high yielding; outperforms common bean in hot environments • Drought tolerance is owed to its deep root system, which also enables resistance to soil salinity	<u>Guatemala</u> • Important in traditional food and recipes of local ethnic groups (Maya Quiché, Mam and Tzutuhil) but the cultivation of this bean is disappearing with conversion to cash crops
Chaya *(Cnidoscolus aconitifolius)*	• Dark green leafy vegetable produces a harvest year round, including the dry season when few other vegetables are available • Compared to similar vegetables, contains higher amounts of protein, vitamin A, niacin and vitamin C. • Good source of calcium, iron, thiamine, and riboflavin • Uncooked leaves contain cyanogenic glycosides, but these toxic substances are broken down during cooking and other processing steps	• Tolerance to heat and drought • Perennial woody species • Cultivated in home gardens and field edges • Capacity to be dried for longer storage	<u>Guatemala</u> • Important crop for women, who are the main producers and sellers of the crop • Used for both food and medicine • Important crop in pre-Colombian production systems of Mayan groups, especially in the Yucatan
Fonio (*Digitaria exilis*)	• Compared to other commonly consumed cereals in West Africa: excellent source of protein and is rich in amino acids methionine and cysteine, which are deficient in rice, maize, and sorghum, and supplies greatest amounts of iron, zinc, magnesium and vitamin B6 • Good source of fibre, calcium, copper, and folate. • Considered safe for people with gluten intolerance and has a low glycaemic index, which makes it an ideal source of carbohydrates for diabetics • Antinutrients (phytate) interfere with iron absorption. Processing reduces but does not eliminate content	• Can escape drought because of its fast maturation—considered the world's fastest maturing cereal • Low water requirements • Provides food during a time of critical shortage before other crops, such as sorghum and maize, are ready for harvest • Resistant to flooding • Thrives in poor soils without the use of fertilizers • Typically planted later in crop rotation cycles, after maize or sorghum	<u>Mali</u> • Women mainly responsible for its processing, in many cases as a source of income • Fonio processing is drudgerous for women, such that improving processing techniques can improve women's quality of life • Strong cultural importance. It is served to guests as a sign of honour; the Dogon People consider it the seed from which the universe has sprung. It has traditional role in women's initiation ceremonies
Bambara groundnut (*Vigna subterranea*)	• Good source of protein, fat and carbohydrate, with sufficient levels to be considered a complete food • Excellent source of fibre, iron, potassium, calcium, and several B vitamins • Similar levels of protein, calcium, iron, zinc, copper, potassium and magnesium as other important legumes in	Compared to other major pulses in Mali has superior: • Adaptation to poor fertility soil • Drought tolerance • Resistance to pests and diseases • Low input requirements • Leguminous crop that contributes to soil fertility through nitrogen fixing	<u>Mali</u> • Typically cultivated by women • Women involved in processing and commercialization of final products

Crop	Nutrition	Climate resilience	Role of/ Importance for women and IP
	Mali • Low in amino acids methionine and cysteine but surpasses levels in cowpea, peanut, and pigeon pea • Red-coloured seeds contain twice as much iron as cream-colored seeds • Tannins and trypsin inhibitors limit protein absorption, but dehulling and other preparation methods, such as boiling, reduce their activity.		
Jute mallow (*Corchorus olitorius*)	• Rich in iron and other minerals such as calcium • Good source of protein and dietary fibre • Rich in beta-carotene, thiamine, riboflavin, niacin, folate, vitamin C and E • Long shelf life when dried • Important leafy vegetable in several countries	• Adaptable to a wide range of soils • Good pest and disease resistance • Can be planted any time of the year if conditions are appropriate	Mali • Collected mainly by women for household nutrition
Kodo millet (*Paspalum scrobiculatum*)	• Good source of phosphorus and iron. • Higher content of sulphur-containing amino acids (cysteine and methionine) than rice and wheat • High in B vitamins, especially niacin, pyridoxine, and folic acid, in addition to minerals such as calcium, iron, potassium, magnesium, and zinc. • Processing reduces the levels of antinutrients (tannins and phytates) that interfere with the bioavailability of nutrients.	• Relatively short growth period (120-180 days) • Contingency crop in water stressed areas; can be planted later in the season and still be harvested in the fall • Commonly used as an intercrop • Resistant to pests and diseases • Requires few inputs • Long storage period supports food security during lean periods	India • Women mainly responsible for weeding and processing that are both highly drudgerous tasks • Important crop for the Gond People in Madhya Pradesh that is preferred equally and more than rice
Little millet (*Panicum sumatrense*)	• Low in fat and high in fibre and protein • High in sulphur-containing amino acids (cysteine and methionine) and overall has a more balanced amino acid profile than other cereals • Especially rich in iron, and is also an excellent source of carotene and zinc • Anti-nutrient levels are reduced by processing	• Short growth cycle • Water efficient, grown in rainfed conditions • Heat tolerant, pest and disease resistant • Low yields but grown on less fertile lands, enabling farmers to increase production by utilizing areas of land not suitable for other crops • Intercropped with legumes, gram, or sesame • Requires little to no inputs • Long storage period, supports food security during lean periods	India • Women mainly responsible for weeding and processing, both highly drudgerous tasks • Important crop for the Gond people in Madhya Pradesh that is preferred equally and more than rice

The results of such a prioritization sparked an interest in governing bodies, which have shown interest in promoting NUS crops at both the local and the national level in the three project's countries. In Guatemala, with the support of Mancomunidad Copanch'orti', a local organization focused on territorial development for the Maya Ch'orti region, chaya was proposed and approved by the government to be an ingredient for the School feeding program in the Department of Chiquimula. The government approved it to be a key ingredient in 3 of the 20 menus to be prepared in public schools located in Chiquimula in 2019 and will also

be considered as an alternative in other dishes among other local leafy vegetables. In Mali negotiations are in progress with the Ministry of Health to set up national dietary guidelines inclusive of fonio, bambara groundnut and local vegetables and fruits. This is an important discussion as national dietary guidelines are yet not available in the country. Finally, in India the prioritization process and the following project achieved a great result in terms of promotion of NUS, as minor millets have been included in the Public Distribution System (PDS), meaning that they will be included into relevant schemes and programs aimed at furthering their use. Furthermore, the Food and Agriculture Organization of the United Nations is endorsing India's proposal to declare 2023 as the International Year of Millets. These results clearly show how a multi-proged approach is needed to promote NUS into diffirente domains, from policy to education, and how a prioritization process that is rooted in a deep understanding of the local context can help to achieve these results.

CASE STUDY 2: Nepal: National and regional priority setting

An example of regional and national priority setting exercise comes from *Future Smart Food Initiative* (Li & Siddique, 2018) implemented by the FAO Regional Office for Asia and the Pacific to provide strategic advice on NUS to decision-makers. The regional priority-setting exercise included scoping, prioritizing and mapping of NUS in Asia. The exercise applied a methodology that covered a range of different disciplines, including nutrition, agricultural production, ecology and socio-economics. 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. The purpose was to identify promising NUS crops that are nutritionally dense, climate resilient, economically viable, and locally available or adaptable. The priority setting exercise comprised a situation and gap analysis to identify the major challenges each country is facing with regard to hunger and malnutrition (e.g. micronutrient deficiencies such as iron, vitamin A, zinc or iodine deficiency), and climate change (e.g. drought, flood, heat waves), as well as economic and cultural aspects such as unfavourable value-chain arrangements, farming practices and local diets, including traditional food habits, food taboos and religious restrictions.

Based on the analysis of the nutrition situation, climate change effects and other aspects, six crops were prioritized for each country. These six crops cover the main food groups: cereals, pulses, roots and tubers, horticultural crops, fruits and oilseeds. As an example, table 8 reports the crops prioritized for Nepal, according to main food groups.

Nepal is a multi-ethnic and multi-lingual country with dozens of indigenous communities with distinct food cultures and other species may hold unntapped potential for the local communities.The diverse indigenous communities have a strong association with plants and knowledge of their potential role and purposes (e.g. medicinal, economic, and cultural). In Nepal, 800 species were recorded as medicinal plants, 440 species as wild food plants, 100 species as fodder and for animal bedding, 71 species as fiber bearing plants, and 30 species as spices; and systematic surveys among indigneous communities would reveal many more useful plants (Dangol 2008).

Table 8. NUS selected in Nepal

Food group	Scientific name	English common name
Cereals	*Fagopyrum tataricum*	Tartary buckwheat
Pulses	*Vicia sativa*	Grass pea
Roots and tubers	*Colocasia esculenta*	Taro
Horticultural crops	*Moringa oleifera*	Drumstick
Fruits	*Artocarpus heterophyllus*	Jackfruit
Oilseeds	*Bassia latifolia*	Nepal butter tree

Participatory selection trials have been conducted involving women and men in evaluating the performance, and culinary and aesthetic qualities of the species. The results of such a prioritization serve as a direction for governments to recognize the importance of NUS and promote them at the national level. However, other NUS may be more suitable to meet specific goals, e.g. climate change resilience in diverse enviroments. Nepal, for example, has agro-ecological zones ranging from tropical to arctic, and each zone

would require the selection a different set of crops. A project implemented by Bioversity International and partners, *Integrating Traditional Crop Diversity for Mountain Food Security*[7], has worked in the Himalayan region promoting local crops since 2014. The focal villages of the project have some residents of the Gurung and Jirel ethnicities, which are two local indigenous groups. The project prioritized a set of species adapted to high mountain areas: amaranth, barley, foxtail millet, finger millet, beans, buckwheat, proso millet and rice. All the selected crops "are time tested reliable crops under unreliable environments" and "farmers to continue maintain them because of their capacity adapt to biotic and abiotic stresses, require little external inputs and are adapted to unpredictable environments.[7]" One of the crops prioritized in the initatiave is amaranth, that is consumed as a nutritious grain in high mountain communities and as an iron rich leafy vegetable in the rest of Nepal. Amaranth is a gluten free grain and a great source of lysine, which is an essential amino acid rare in plant-based foods. Even though amaranth is not native to Nepal, it is part of Nepali food culture and associated with purity and used as a food during religious fasting.

CASE STUDY 3: Benin: Species evaluation based on farmers' perceptions

Species evaluation can be carried out as part of surveys, or in focus group discussions and community workshops. To evaluate species, the participants (e.g. farmers) are asked to list all the species and rank them, or give them a score for a number of parameters related to their nutritional, cultural and market values, uses and important traits. A study in Benin (Dansi et al., 2012) is an example of a NUS prioritization based on farmers' evaluation. The aim of the study was to identify species that should receive more attention by scientists and students for their potential to improve nutrition, alleviate poverty and increase the sustainability of food production. The study was conducted through survey interviews across different agro-ecological zones (arid, semiarid and humid) that are home to 29 ethnic groups.

Local species and their characteristics were listed by the interviewees, and each species was evaluated for ten parameters: extent of production, extent of consumption, degree of consumption, perceived nutritional value, cultural importance, medicinal properties, market use, market value, contribution to household income, and contribution to women empowerment. The evaluation was done using three scores: 3 (low/restricted), 5 (average/region-wide), and 7 (High/countrywide). Based on the information gathered from 580 interviewees, 41 crop species were listed as neglected and underutilized. Among these were 3 cereals, 4 roots and tubers, 5 pulses, 13 leafy vegetables, 4 seeds vegetables, and 12 fruits (table 9). Out of the 41 species, 27 were scored high (on average) for at least one of the parameters and were therefore considered as the important neglected and underutilized crops of Benin (Dansi et al., 2012).

The study found that vernacular names, the degree of consumption and other characteristics of the identified neglected and underutilized were found to vary across ethnic groups, and the uses of species were linked to gender roles (Dansi et al., 2012). The gender role would mostly vary according to the crops and the regions and sometimes the ethnic areas. While some species are well documented, others lack information. The study called for further research in the following areas, of which documentation of indigenous knowledge is listed as the first one:

- ethnobotanical investigation and documentation of the indigenous knowledge
- identification and prioritisation of the production constraints
- domestication
- agromorphological characterisation and genetic diversity analysis
- improvement of the agricultural practices
- documentation of the pests and diseases
- agronomic (yield, biotic and abiotic stresses) evaluation
- assessment of the seeds quality and conservation
- analyses of the biochemical composition and assessment of the nutritional values
- improvement of postharvest conservation and processing technologies
- study of the value chains and assessment of the contribution to household income
- germplasm collection and conservation.

[7] http://himalayancrops.org/

Table 9. NUS selected in Benin based on farmers' evaluation

Food Group	Scientific Name	Common name
Cereals	*Pennisetum glaucum*	Pearl millet
	Sorghum bicolor	Sorghum
	Digitaria exilis	Fonio
Root and tuber crops	*Dioscorea dumetorum*	Bitter yam
	Ipomea batatas	Sweet potato
	Cyperus esculentus	Yellow nutsedge
	Colocasia esculenta	Taro
Leafy Vegetables	*Launaea taraxacifolia*	African lettuce
	Sesamum radiatum	Sesame
	Crassocephalum rubens	Yoruban bologi
	Crassocephalum crepidioides	Fireweed
	Corchorus olitorius	Jute mallow
	Justicia tenella	Justicia
	Acmella oleracea	Para cress
	Bidens pilosa	Blackjack
	Vitex doniana	Black plum
	Ceratotheca sesamoides	False sesame
	Cleome gynandra	African spider plant
	Talinum triangulare	Waterleaf
	Telfairia occidentalis	Fluted gourd
Pulses	*Macrotyloma geocarpum*	Hausa groundnut
	Vigna subterranea	Bambara groundnut
	Cajanus cajan	Pigeon pea
	Sphenostylis stenocarpa	African yam bean
	Phaseolus lunatus	Lima bean
Seed vegetables	*Citrullus lanatus*	Watermelon
	Cucumeropsis mannii	Egusi
	Parkia biglobosa	African locus bean
	Sesamum indicum	Sesame
Fruits	*Adansonia digitata*	Baobab
	Irvingia gabonensis	Bush mango
	Tamarindus indica	Tamarind
	Blighia sapida	Akee
	Borassus aethiopum	Elephant palm
	Chrysophyllum albidum	White star apple
	Uvaria chamae	Bush banana
	Ximenia americana	Tallow wood
	Dialium guineense	Velvet tamarind
	Synsepalum dulcificum	Miracle berry
	Sclerocarya birrea	Marula
	Artocarpus altilis	Breadfruit

Source: Dansi et al. (2012)

CASE STUDY 4: India, Indonesia, Malaysia and Thailand: Identification of best varieties of tropical fruit tree species

The Tropical Fruit Tree project (2009-2015)[8] was implemented by Bioversity International and partners in India, Indonesia, Malaysia and Thailand to promote fruit crops for health and nutrition. Fruits are accessible sources of nutrients, particularly when consumed fresh, and are suited for cultivation in mixed and agroforestry systems which are considered more resilient in comparison to systems based on production of

[8] http://tft.agrobiodiversityplatform.org/tiki-index.php?page=New_Homepage

a single commodity crop. One of the aims of the project was to characterize a large number of fruit varieties to identify those with most favorable traits for widespread promotion. The project assessed on-farm diversity and surveyed 36 communities in the four countries to identify, characterize, conserve and promote the use of citrus (*Citrus* spp.), mango (*Mangifera indica*), rambutan (*Nephelium lappaceum*) and mangosteen (*Garcinia mangostana*) and their wild relatives. The project used multiple methods to identify farmers' best varieties or genotypes with distinguished or unique traits (e.g. colour, taste, shape, quality, aroma, local adaptability, disease resistance). A total of 95 varieties of mango, 32 citrus, 5 mangosteen and 2 rambutan were identified and best-performing trees were collected and multiplied in 126 fruit tree nurseries and made available to over 77,000 farming households.

CASE STUDY 5: Turkey: An example of sustainability index for wild plant prioritization

For the BFN project in Turkey, wild species used for food were assessed to select those with highest nutritional and economic values. Along with nutritional and economic values, a number of environmental and conservation parameters were taken into consideration. The selection of priority species began with rural and urban market surveys across three geographically distinct project sites. Over two thousand questionnaires were administered to local collectors, sellers and consumers of wild foods, leading to the identification of 43 commonly-used species. Samples were collected from markets and from the wild, and were analysed for food composition and antioxidant activity. A sustainability index (table 10) was developed to evaluate and rank each species according to the sustainability of environmental, economic, food and nutrition criteria, including their conservation status[9].

Table 10. Criteria of BFN Sustainability Index

ENVIRONMENTAL	ECONOMIC	FOOD and NUTRITION
Conservation - *ex situ* - *in situ*/ on farm	**Collection/production continuity** - collection/production constraints - distance from collection/production site - collection/production continuity	**Iron content**
Cultivation - easy of production - growth rate - high adaptability - vegetation period - annual growth	**Market characteristics** - recognizable - easily packed - suitable for storage	**Calcium content**
Disappearance/threat - habitat destruction and fragmentation - pollution, exploitation - destructive harvesting practices	**Processing industry available**	**Fibre content**
Widespread distribution	**Marketing opportunities**	**Antioxidant content**
Habitat preference	**Distance from market**	**Vitamin A**

[9] http://www.b4fn.org/fileadmin/templates/b4fn.org/upload/documents/Country_profiles/COUNTRY_PROFILE_-_TURKEY_May_2016_TB.pdf

©IFAD/Francesco Cabras

5. Guidance for project design and implementation

Prioritization of NUS species is a process that will typically happen before or at the start of a project. Following the rapid approaches for completing the steps of the crop selection, it is feasible to complete the prioritization process in 3 to 6 months. Initiatives may also dedicate a longer amount of time and resources toward identify high priority NUS through more in depth investigations. The research and project team should be composed of people with different fields of expertise, such as nutrition, gender, agronomy, marketing, ecology etc. Suggested timelines for the prioritization, considering the rapid approach, is outlined in table 11. Key informant interviews and some direct observations (transect walk, market agrobiodiversity assessment) could be completed in the same period (3-6 months) to support the assessment on similar timeframe and level as the desk review. More in-depth methods for assessing agrobiodiversity and its roles in enhancing diet quality and resilience would require more time. Household surveys to elaborate on the agrobiodiversity assessment, consumption 24hr recall, cultivation practices would extend the prioritization process to approximately one year or potentially two years for completing statistical analyses. Completing nutritional composition testing would require one or two years. Field trials for monitoring crop performance would require two to four years. To use participatory methods that empower Indigenous Peoples to define the research plan and prioritization process would be best to complete in a project of three to four years.

Additional details are provided in Annex 1.

Table 11. Summary of activities, suggested timeline, and resources required for rapid prioritization of NUS

Teal=data collection, Orange= analysis and reporting

Activity	Month						Human Resources	Materials
	1	2	3	4	5	6		
Desk review: covering background information, statistics for agrobiodiversity, nutrition, resilience, and key prioritization aspects (gender, conservation, etc.)							Junior researchers and supervision from senior researchers or Project officer specialized in fields of inquiry	Literature review of the target area. Species, people, culture
Agrobiodiversity assessment: participatory mapping, free-listing, four cell analysis, and seasonal availability							Facilitator, translator, note taker, researcher	Large papers, pens, beans (or other prompts locally adequate), data entry papers / notes, photo cameras, refreshments
Nutrition assessment: focus groups on diet quality and consumer preferences and perceptions							Facilitator, translator, note taker, researcher	
Resilience assessment: participatory workshop on diversification opportunities							Facilitator, translator, note taker, researcher	
Mutistakeholder consultations and prioritization							Facilitator, translator, note taker, researcher	

There are other costs and resources to consider, which are not included above. Whenever possible, local enumerators with background in fields such as agronomy and nutrition should be hired. Their training, along with training of the note takers and the facilitators is fundamental for a good result and should be a responsibility of local partners or researchers specialized in the field of inquiry. Researchers and other support staff should be consulted throughout the whole process of prioritization to provide backstopping, training and support with management of information when necessary. Local partners should be consulted before the start of the activities to identify suitable enumerators, facilitators, key informants and other

stakeholders. Enumerators' full understanding of the questions and of how to fill the data entry papers will ensure accuracy in the data during survey implementation. Data entry papers should be provided to note takers during participatory activities, and they should be trained on the type of information to register. Facilitators need to be able to engage the participants, to allow everyone to speak and to enable positive communication among the group. A better understanding of the subject discussed will help them in achieving this. Digital data entry, especially for larger projects with bigger samples, is a time consuming activity that should be taken into account. Laboratory data analysis, if samples of species have been collected during field visits, are also time consuming and costly, but of invaluable importance. Longer activities such as focus group discussions should include refreshments for the participants: breaks for drinks and snacks should be organized as a way to demonstrate appreciation for people's participation. For daylong activities, a lunch should be offered, preferably involving local chefs and resources.

©IFAD/Francesco Cabras

References

Baldermann, S., L. Blagojević, K. Frede, R. Klopsch, S. Neugart, A. Neumann et al. 2016. Are Neglected Plants the Food for the Future? In Critical Reviews in Plant Sciences 35 (2): 106–119.

Bharucha, Z. and Pretty, J. 2010. The roles and values of wild foods in agricultural systems. Philosophical Transactions of the Royal Society B: Biological Sciences, 365(1554), pp.2913-2926.

Bernet, T., A. Devaux, G. Thiele, G. López, C. Velasco, K. Manrique, and M. Ordinola. 2011. The participatory market chain approach: stimulating pro-poor market-chain innovation. Innovation for Development, p.142.

Bioversity International and IER. 2017. Underutilized crops in the livelihoods, diets, and adaptation practices of smallholders in Sikasso and Ségou, Mali: Baseline results from the programme “Linking agrobiodiversity value chains, climate adaptation and nutrition: Empowering the poor to manage risk”. Rome, Italy.

Bioversity International and IER. 2018a. Calendrier saisonnier des fruits et légumes pour une alimentation diversifiée (Sikasso, Mali). Rome, Italy and Bamako, Mali.

Bioversity International and IER. 2018b. Calendrier saisonnier des fruits et légumes pour une alimentation diversifiée (Segou, Mali). Rome, Italy and Bamako, Mali.

Bommarco, R., G. Vico and S. Hallin. 2018. Exploiting ecosystem services in agriculture for increased food security. Global Food Security 17:57-63.

Bracken, L.J., H.A. Bulkeley, and G. Whitman. 2015. Transdisciplinary research: Understanding the stakeholder perspective. Journal of Environmental Planning and Management. 58:1291–1308.

Burchi, F., J. Fanzo, and E. Frison. 2011. The role of food and nutrition system approaches in tackling hidden hunger. International Journal of Environmental Research and Public Health. 2011;8(2):358–73.

Dangol, D.R. 2008.Traditional uses of plants of common land habitats in Western Chitwan, Nepal. Journal of the Institute of Agriculture and Animal Science. 29:71-78

Dansi, A., R. Vodouhè, P. Azokpota, H. Yedomonhan, P. Assogba, A. Adjatin, Y.L. Loko, I. Dossou-Aminon, and K. Akpagana. 2012. Diversity of the neglected and underutilized crop species of importance in Benin. The Scientific World Journal, May 2012.

De la Peña, I. and J. Garrett. 2018. Nutrition-sensitive value chains, A guide for project design (Vol II and II). IFAD https://bit.ly/2PWtTzV and https://bit.ly/2D8qoBf

FAO and FHI 360. 2016. Minimum Dietary Diversity for Women: A Guide for Measurement. Rome, FAO.

FAO, IFAD, UNICEF, WFP and WHO. 2018. The State of Food Security and Nutrition in the World 2018. Building climate resilience for food security and nutrition. Rome, FAO.

FAO (2017) Self-evaluation and holistic assessment of climate resilience of farmers and pastoralists (SHARP). Rome, Italy.

Flyman, M.V. and A.J. Afolayan. 2006. The suitability of wild vegetables for alleviating human dietary deficiencies. South African Journal of Botany, 72(4):.492-497.

Galluzzi, G.; López Noriega, I. Conservation and Use of Genetic Resources of Underutilized Crops in the Americas—A Continental Analysis. *Sustainability* 2014, *6*, 980-1017.

Gaudin, A.C.M., T.N. Tolhurst, A.P. Ker, K. Janovicek, C. Tortora, and R.C. Martin 2015. Increasing crop diversity mitigates weather variations and improves yield stability. PLOS One 10(2): e0113261

International Fund for Agricultural Development (IFAD). 2015. Mainstreaming Nutrition-Sensitive Agriculture at IFAD: Action Plan 2016-2018. Rome.

International Fund for Agricultural Development (IFAD). 2016. Strategic Framework 2016-2025 Enabling inclusive and sustainable rural transformation.

International Fund for Agricultural Development (IFAD). 2017. Mainstreaming of climate, gender, nutrition and youth https://webapps.ifad.org/members/repl/11/03/docs/IFAD11-3-R-4.pdf

Li, X. and K.H.M. Siddique. 2018. Future Smart Food - Rediscovering hidden treasures of neglected and underutilized species for Zero Hunger in Asia, Bangkok, 242 pp.

Makate, C., R. Wang, M. Makate and N. Mango. 2016. Crop diversification and livelihoods of smallholder farmers in Zimbabwe: Adaptive management for environmental change. Springerplus 19;5(1):1135.

Manners, R., and van Etten J. 2018. Are agricultural researchers working on the right crops to enable food and nutrition security under future climates? Global Environmental Change. 53:182-194.

Meldrum, G., S. Padulosi, G. Lochetti, R. Robitaille and S. Diulgheroff. 2018. Issues and prospects for the sustainable use and conservation of cultivated vegetable diversity for more nutrition-sensitive agriculture. Agriculture, 8(7):112.

Mijatović, D., Meldrum, G., and R. Robitaille. 2019. Diversification for Climate Change Resilience: Participatory assessment of opportunities for diversifying agroecosystems. Bioversity International and the Platform for Agrobiodiversity Research, Rome, Italy.

Padulosi, S., N. Bergamini and T. Lawrence, editors. 2012. On farm conservation of neglected and underutilized species: status, trends and novel approaches to cope with climate change: Proceedings of an International Conference, Frankfurt, 14-16 June, 2011. Bioversity International, Rome.

Padulosi S., K. Amaya, M. Jäger, E. Gotor, W. Rojas, and R. Valdivia. 2014. A Holistic Approach to Enhance the Use of Neglected and Underutilized Species: The case of Andean Grains in Bolivia and Peru. Sustainability 6:1283-1312.

Padulosi, S., B. Mal, O.I. King, and E. Gotor. 2015. Minor millets as a central element for sustainably enhanced incomes, empowerment, and nutrition in rural India. Sustainability 7(7):8904–8933.

Padulosi, S., D. Cawthorn, G. Meldrum, R. Flore, A. Halloran and F. Mattei. 2019a. Leveraging Neglected and Underutilized Plant, Fungi, and Animal Species for More Nutrition Sensitive and Sustainable Food Systems, Editor(s): P. Ferranti, E. M. Berry, and J. R. Anderson, Encyclopedia of Food Security and Sustainability, Elsevier, Pages 361-370.

Padulosi, S., P. Roy, and F.J. Rosado-May. 2019b. Supporting Nutrition Sensitive Agriculture Through Neglected and Underutilized Species. Proposed IFAD Operational Guidance.

Pieroni, A. 2001. Evaluation of the cultural significance of wild food botanicals tradionally consumed in NorthWestern Tuscany, Italy.Joumal of Ethnobiology 21(1): 89-104.

Polar, V. and P. Flores. 2008. Priority Setting for Research on Neglected and Underutilized Species. System-wide Genetic Resources Programme.

Raneri, J., Ahern, M., Bellon, M. Turmel, M., Chandrabalan, D., Zheng, S., Meldrum. G., van Zonneveld, M., Staver, C., & Sthapit, B. 2017. Agrobiodiversity Assessment Four-Cell Focus Groups: A Guide to Methodology and Analysis. Bioversity International, Rome. http://www.abd-data.org

Rosado-May, F.J., V.B. Cuevas-Albarrán, F.J. Moo-Xix, J.H. Chan, and J. Cavazos-Arroyo. 2018. Intercultural Business. A Culturally Sensitive Path to Achieve Sustainable Development in Indigenous Maya Communities.

Sidibe, A., Coulibaly, H., Berthe, N.A., Koreissi, Y., Brahima, D., Vodouhe, R., Padulosi, S. and Meldrum, G.. 2015. Promoting fonio (*Digitaria* spp.), Bambara groundnut (*Vigna subterranea*) and nutritious underutilized vegetables in Sikasso and Ségou regions of Mali. In Agricultural biodiversity to manage risks and empower the poor Proceedings of the International Conference 27-29 April 2015. Bioversity International, Rome, Italy

Sthapit, B.R., R.B. Rana, A. Subedi, S. Gyawali, J. Bajracharya, P. Chaudhary, B.K. Joshi, S. Sthapit , K.D Joshi, and M.P. Upadhyay. 2006. Participatory four cell analysis (FCA) for local crop diversity. In: Sthapit, B.R., P.K. Shrestha and M.P. Upadhyay. 2006. Good practices: On-farm management of agricultural biodiversity in Nepal, NARC, LI-BIRD, IPGRI and IDRC.

Thomson, M. and J. Fanzo. 2015. Climate change and nutrition. In Global Nutrition Report 2015: Actions and accountability to advance nutrition and sustainable development. Chapter 6. Pp. 74-84. Washington, DC: International Food Policy Research Institute (IFPRI).

Waha, K., M.T. van Wijk, S. Fritz, L. See, P.K.,Thornton, J. Wichern, and M. Herrero. 2018. Agricultural diversification as an important strategy for achieving food security in Africa. Global Change Biology 24: 3390-3400.

Yaro, M. , Munyard, K. A., Stear, M. J. and Groth, D. M. (2017), Molecular identification of livestock breeds: a tool for modern conservation biology. Biol Rev, 92: 993-1010.

Annex I. Project design and implementation

An overview of the timeline for the prioritization process is provided in table A1, in Guidance for project design and implementation. The table in this annex provides a detailed overview of activities, estimated time and information for each step of the prioritization process. The estimated duration ultimately depends on the scale of data collection, sample size and the geographic areas of focus for the project.

All the activities presented are time and resource dependent, and it might not be possible or needed to implement them all. For each of these activities organization is key to ensure positive outcomes in project activities. This section provides a checklist of things to consider while preparing activities for NUS prioritization and some indications on the time, the materials and the resources, people and budget, required.

While some are time consuming and costly, their implementation and the knowledge generated can better inform future choices as well as monitoring and evaluation of the project. Each of these activities refers back to one or more step of the prioritization process.

Local partners can help in the identification of suitable key informants, relevant stakeholders, enumerators and facilitators that can take part to the prioritization process. Local partners can furthermore inform on local customs and social norms that should be kept into consideration when organizing activities with the targeted communities.

Table A1. Summary of steps, activities and information in the prioritization process for NUS

STEP	MODE OF DATA COLLECTION	ACTIVITY	ESTIMATED TIME	INFORMATION
0. Project design and organization	Literature review, FGDs, KIIs	Design of surveys, organization of KIIs, FGDs, diversity fairs and other activities	1 to 3 months	Background information, statistics etc.
1. Agrobiodiversity assessment	Literature review	Literature review	Two weeks	Background information, statistics etc.
	Survey	Household survey	About a month	Agrobiodiversity cultivated or collected from the wild, diversity and management of species, income etc.
		Market Survey	A day per market	Agrobiodiversity available in the market, prices, processing etc.
	Direct observation	Transect walk	A day per community	Availability of agrobiodiversity, cultivation practices etc.
	Focus Group Discussions and participatory activities	Four Cell Analysis	6 hours per community/group	Agrobiodiversity cultivated or collected, conservation status etc.
		Seasonal Availability Calendar	6 hours per community/group	Available agrobiodiversity
		Diversity fairs	A day per community	Available agrobiodiversity, traditional knowledge, cultivation and conservation practices etc.
	Key Informants interviews	In depth interviews with key informants	Up to 3 hours per interview	Local agrobiodiversity management and practices; taboos and cultural aspects.
2. Nutrition assessment	Literature review	Literature review	Two weeks	Background information, statistics etc.
	Survey	Household survey	About a month	Food security and nutrition and food related knowledge, attitues and practices
		Individual survey / 24 H recall	About a month	Diet quality indicators of diet diversity and/or micro and macronutrient intake.

STEP	MODE OF DATA COLLECTION	ACTIVITY	ESTIMATED TIME	INFORMATION
	Focus Group Discussions and participatory activities	Four Cell Analysis	6 hours per community/group	Relative food consumption and frequency.
	Key Informants interviews	In depth interviews with key informants	Up to 3 hours per interview	Local preferences and traditions for food production, preparation, conservation and consumption; taboos and cultural aspects.
3. Climate change resilience assessment	Literature review	Literature review	Two weeks	Background information, statistics etc.
	Focus Group Discussions and participatory activities	Participatory Assessment of Diversification Opportunities	6 hours per community/group	Effects of climate change, diversity and management practices, diversification options.
	Key Informants interviews	In depth interviews with key informants	Up to 3 hours per interview	Resilience traits, management practices etc.
4. Multi-stakeholders consultations	Key Informants interviews	In depth interviews with key informants	Up to 3 hours per interview	Market potential, discussion on main traits of local species emerged from previous assessments etc.
	Focus Group Discussions and participatory activities	Stakeholders meetings	1 day per community	Discussion on species potential, opportunities, constraints etc. for diet quality and climate change resilience.
		Impact filter	6 hours per community/group (can be done in the context of a stakeholders meeting)	Ranking of species on expected impact that different market opportunities are likely to have on poverty, and on social and environmental objectives.
		Participatory ranking	6 hours per community/group (can be done in the context of a stakeholders meeting)	On traits related to nutrition, production and resilience.

International Fund for Agricultural Development
Via Paolo di Dono, 44 - 00142 Rome, Italy
Tel: +39 06 54591 - Fax: +39 06 5043463
Email: ifad@ifad.org
www.ifad.org

facebook.com/ifad
instagram.com/ifadnews
linkedin.com/company/ifad
twitter.com/ifad
youtube.com/user/ifadTV

Investing in rural people

Alliance

Bioversity International

CIAT
International Center for Tropical Agriculture
Since 1967 Science to cultivate change

CGIAR

Canada