



## Nutrition-sensitive agroecological interventions to improve the resilience of dryland farming communities in the Sahel



## **POLICY NOTE**

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agroecological  
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to improve the  
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### **Cover photo**

*Women tending to their collective field of inter-cropped vegetables in the village of Ndiao (Senegal).*

*Credit: Agrecol Afrique.*

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## Key messages

- An estimated 12 million small-scale farmers living in the ecologically fragile, risk prone drylands of the Sahel are in a crisis. They have become chronically vulnerable to food and nutrition insecurity, because of land degradation, declining soil fertility and climate change.
- A growing percentage of dryland farm households have become ultra-poor, living on less than 0.50 US dollars a day. They suffer from hunger, not only in bad but also in good rainfall years. They are forced to adopt negative coping mechanisms, including taking exploitative loans, selling their animals, eating their seeds stocks, and reducing the number of daily meals.
- Many dry land farm families are caught in a vicious downward spiral of declining productivity, and loss of assets. They end up in a hunger-debt trap characterized by a severe “resilience deficit”. They are so vulnerable that even the mildest shock generates a widespread crisis across the Sahel, aggravating the state of malnutrition in the region, and requiring humanitarian aid. Malnutrition thus becomes an issue relegated as a health issue, for which remedial action is curative, rather than prevention.
- Too often, awareness-raising on the issue of malnutrition tends to narrowly focus on acute malnutrition, whilst chronic malnutrition in the first 1,000 days (from gestation to two years of age) linked with vitamin and micro-nutrient deficiencies, which are equally critical to the sound health of human beings, are sidelined. Hence the name of “hidden hunger” is given to this phenomenon. Anemia for instance, attributable to an iron deficiency, affects between 49% (Burkina Faso) and 58% (Senegal) women in Sahelian countries<sup>1</sup>, which is above the 40% threshold set by the World Health Organization (WHO) to signal a severe public health problem.<sup>2</sup>
- Malnutrition specifically affects children and pregnant and lactating women. The latter require 300 to 500 kilocalories over and above their daily food intakes (i.e. four rather than three meals a day), but too often their nutritional needs are not met. Malnutrition irreversibly impairs the long-term cognitive and physical aptitudes of children less than two years of age.
- The Agroecology+6 (AE+6) program was developed as a “proof of concept” action research initiative in three sites in the Sahel (Burkina Faso, Mali and Senegal) to show that “agroecology” can be the essential foundation on which effective resilience activities must be based. However, to be effective, equity, women’s empowerment, and nutrition must be fully integrated into the agroecology approach for resilience, and major social mobilization is required to scale it out rapidly.
- The AE+6 initiative **found that the benefits of agro-ecological-based practices on dry land farming systems will only have a limited resilience impact if nutrition is not strongly embedded into such interventions to make agriculture, through agroecology, the primary solution to the malnutrition crisis.**
- Despite growing awareness and commitment towards nutrition-sensitive agriculture, national ministries are failing to implement crosscutting strategies to embed improved nutrition into the agricultural sector’s priorities. This is also true of many programs focusing on agroecology as a remedy to depleted soils, and the degradation of the natural resources on which rural livelihoods in the Sahel depend.

- Among the key challenges to integrate improved nutrition into agriculture are:
  - i. the lack of cross-sectoral cooperation between the sectors of health, agriculture and rural development
  - ii. the limited nutritional knowledge of agricultural extension staff
  - iii. the strong tendency to regard nutrition mostly as a health issue, and
  - iv. the general absence of nutrition indicators and targets within nationally implemented agricultural development projects
- Promoting nutrition-sensitive agriculture<sup>3</sup> also entails promoting nutritional education, diversification of farm crops to grow more nutrition rich foods for local markets, and restoring knowledge about indigenous foods that are nutritionally dense and the related culinary knowledge.
- The selection of what crops to grow and what dietary habits need to change for improved nutrition also need to be addressed. This is because **farm families tend to not consume the commercial crops they grow** (despite their nutritional value). If nutrient rich crops are not grown, then many farm families need to generate more income in order to access food with high nutrition value at local markets.
- Linking nutrition with agroecology therefore rests on the **simultaneous implementation of initiatives touching on agricultural production, income generation and the empowerment of women in agriculture.**
- The **FAO's 10 recommendations** related to the integration of agricultural into nutrition<sup>4</sup> can easily be adapted by organizations working in the field of agroecology and wishing to incorporate nutrition into its existing activities. These recommendations promote relevant and measurable interventions to improve nutrition, particularly by the groups who are most vulnerable to malnutrition (children under than five years of age, lactating and pregnant women, particularly those from poorer households).
- Actors engaged in agricultural development can quite easily incorporate relatively low-cost and easy to apply nutrition-related data collection tools into their toolbox of assessment methods, to monitor to what extent their interventions are improving nutritional outcomes without these requiring too much additional time and work, or specialized staff.
- It is critical that such interventions be implemented jointly with state structures, especially at the decentralized level, in order to ensure a multisectoral approach and ensure their long-term sustainability.



## To the attention of decision makers

Detailed recommendations tailored for different categories of decision makers (national government, local municipal councils and technical services, farmer organizations, non-governmental organizations, technical and financial partners) are outlined in detail below. What follows are “overarching” policy recommendations:

### Actors operating at the National and local Government Level

1. Increase incentives to improve the availability, access and consumption of diversified, nutritious and healthy food produced by family farmers in a sustainable, environmentally friendly way, for sale on local, regional and national markets.
2. Monitor food consumption and access to varied and nutritious food especially for vulnerable groups (pregnant and breastfeeding women, children under 2 years of age (i.e., the first 1,000 days).
3. Take measures to promote the empowerment of women and poor households in agriculture, particularly relating to access to productive resources, credit and training in agroecological methods.
4. Strengthen human and institutional capacities to improve the population’s nutrition via appropriate support for the agro-processing sector.
5. Support incentive mechanisms leading to concrete cross-sectoral strategies for nutrition, particularly within agriculture.

### Actors working at the decentralized local level

6. Create awareness and capacity on the issue of nutrition-sensitive agriculture through the training of technical staff/extension officers and field workers.
7. Formulate a cross-sectorial strategy to ensure the integration of nutrition in agricultural programs and agriculture-related messages by health and nutrition staff.
8. Include in the five-year municipal development plans and budgets specific targets to decrease chronic malnutrition and favor nutrition sensitive farming practices.
9. Create a network including all local stakeholders to facilitate regular information flow on nutrition-sensitive agricultural development options across all communes in a selected agroecological area.

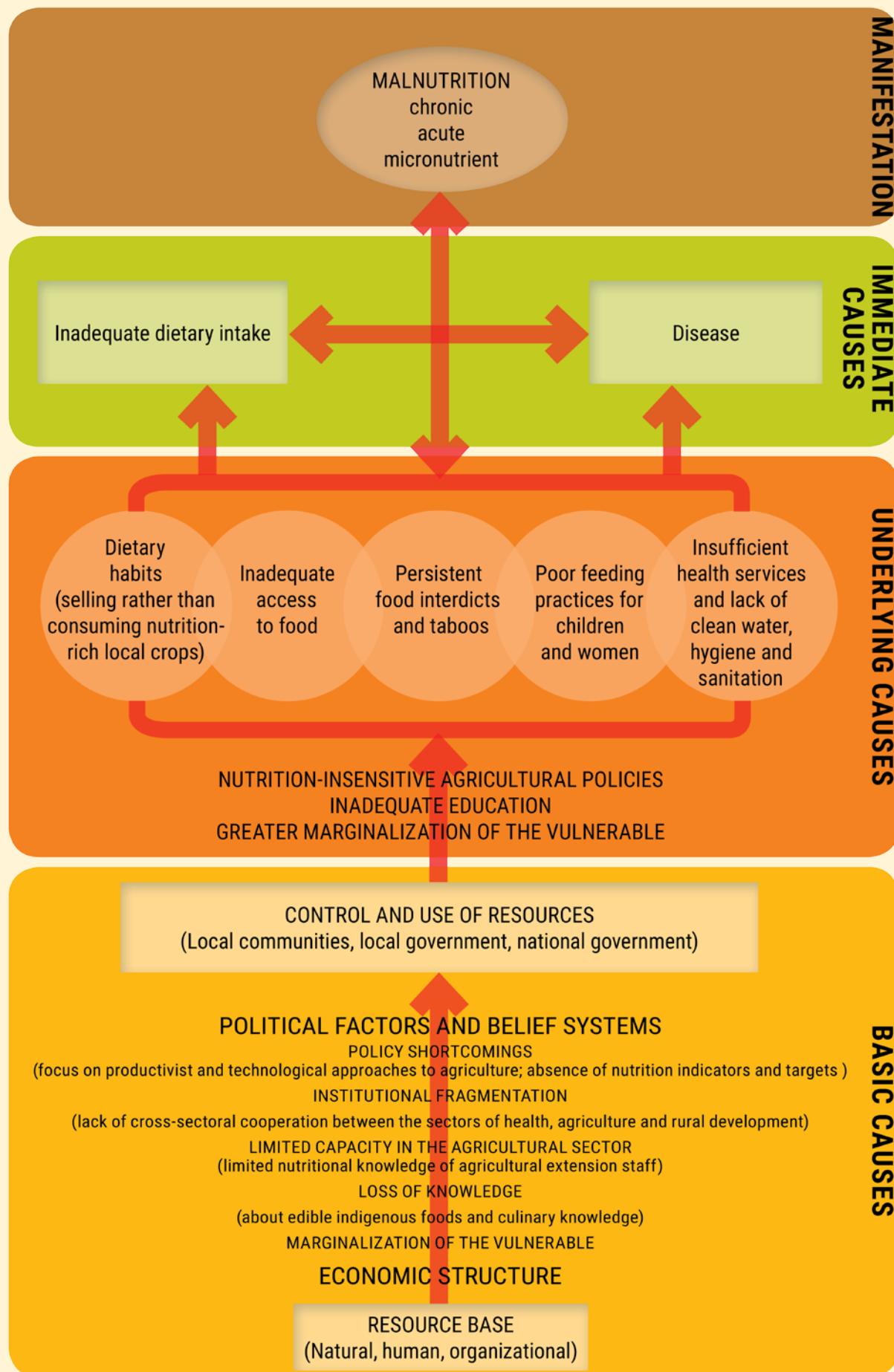
## Why integrate nutrition into the design and implementation of agro-ecological programs?

### How critical is the malnutrition problem in the Sahel?

Over 30.1 million people in the Sahel are food insecure. In 2017, at least 12 million of them were locked in a debt and hunger trap and required emergency food assistance.<sup>5</sup> Malnutrition irreversibly impairs the long-term cognitive and physical aptitudes of children less than two years of age. Stunting often results in poor school performance and reduced intellectual capacity. Wasting can lead to increased severity and duration of and susceptibility to infectious diseases and an increased risk of death.<sup>6</sup> Iron-deficiency also impairs the cognitive and physical development of children and reduces the work capacity of individuals and entire populations. It has been estimated that 1% drop in the adult’s hemoglobin (a symptom of iron deficiency) leads to 1% decrease in this individual’s productivity. But in the child, this same 1% entails that his future production will be diminished by 2.5%.<sup>7</sup>

Generic indicators in the Sahel region indicate that the prevalence of chronic (and other forms of malnutrition have slowly declined over the past decade. However, the overall rate of chronic malnutrition for children under 5

Figure 1. The basic and underlying causes of malnutrition

Source: Redrawn from the UNICEF malnutrition framework (1990)<sup>11</sup>

remains alarmingly high. The World Health Organization “warning threshold” for stunting is 20%. The averages in the AE+6 countries mostly exceed this: 38.5% in Mali, 32.9% in Burkina Faso and 19.4% in Senegal.<sup>8</sup> However, in some rural areas in these countries, the rate is over 40%. The pace of improvement has also been slowing down in many countries with high rates for children from the poorest households remaining stagnant.

Burkina Faso has the highest rate of anemia in the world for children less than 5 years, a shocking 90%.<sup>9</sup> Burkina also has the highest rate of anemia for pregnant women in the world, at 72.5%.<sup>10</sup>

## **What are the causes of malnutrition (in the specific context of food security and agriculture)?**

The fundamental causes of malnutrition that is rooted in food security and agriculture have to do with the lack of food diversity and inadequate nutrition for children and for pregnant and lactating women.

Women do much of the farm work, and as well have domestic duties and child care. Although women have major responsibility for food preparation and the nutrition for their households, they have limited discretionary income. Nor do they have sufficient ownership and control over productive resources to ensure high quality nutrition. Households are often reluctant to consume a part of their more nutritious cash crops (such as peanuts, sesame or cowpeas) as they generally lack alternative sources of income to offset the monetary loss such consumption would entail.

## **Why should nutrition be integrated into agricultural (and agroecological) programs?**

Agroecology can be a major vehicle through which the emergency level crisis of malnutrition in the Sahel could be addressed. This is because 60 to 70% of the population relies primarily on agriculture for its subsistence. It is in the public interest that farm families who live on the land, and whose livelihoods depend on the land, should be able to directly derive sound nutrition from the soils under their stewardship. What crops they farm and how they farm, harvest and preserve their crops is therefore critical.

Agricultural systems should not be considered solely through a production and environmental lens, but also from a nutrition and equity lens. Transforming the farming system, as well as the socio-economic fabric of agrarian systems in the drylands can also go a long way to end the every day malnutrition crisis affecting the most vulnerable groups, and to reduce the growing need for emergency humanitarian assistance.

If productive assets (land, water, seeds, tools, animals, credit) are provided to women farmers and if they can control these and derive income from them, and if these women can be educated on good nutrition practices, then the malnutrition picture in the Sahel could dramatically improve.

### **What is agroecology?**

Agroecology is an approach to farming that mimics the functioning of local ecosystems,<sup>12</sup> allowing for “food production that makes the best use of nature’s goods and services while not damaging these resources.”<sup>13</sup> It is a science that applies ecology to the design of farming systems; uses a whole-systems approach to farming and food systems and replaces “external inputs by natural processes such as natural soil fertility and biological control”.<sup>14</sup> Agroecological farming systems are “developed on the basis of farmers’ knowledge and experimentation”<sup>15</sup> and link ecology, culture, economics and society to create healthy environments, food production and communities. It is a multi-functional approach to farming that is productive, economically viable, socially just, resilient to climate change, sustainable and nutrition sensitive.



## Why is nutrition so poorly integrated into agriculture (and agro-ecology)?

Of late, there has been greater awareness on the need to integrate nutrition into agricultural planning and to foster multi-sectoral nutrition strategies, including in the Sahel.

This is because:

- Agricultural programs still fail to reach the most vulnerable and do not take into account the nutritional status of these vulnerable groups. National agricultural production targets are essentially focused on food security – i.e. the availability of food – and are silent on nutritional aspects, as testified by the general absence of nutritional targets in the agricultural programs carried by ministries but also by civil society organizations (CSOs).
- Attempts to improve nutrition generally translate into a productivist strategy (i.e., produce more to have more foodstuffs available) or technological (e.g. bio-fortification) approaches, rather than strategies that address accessibility and nutrition.
- Agricultural extension staff have limited nutritional knowledge and tend to consider nutrition as a responsibility that is exclusive to the health sector.
- There is a lack of cross sectoral information sharing and communication to convey and scale out message and knowledge on nutrition and how agriculture can contribute to improved nutritional outcomes.
- There is a persistent lack of capacity for designing nutrition-sensitive food and agriculture policies and programs, despite the existence of cost effective and easy to manage operational tools, principles and strategies that can be used by practitioners and policy makers to effectively integrate nutrition into agriculture.

## How can practitioners and policy makers ensure nutrition-sensitive agro-ecological interventions?

Determining the impact of programs aimed at integrating nutrition within agriculture can be challenging. Agricultural projects focused on increased yield and income may result in greater food intake and, depending on the crops grown, an increase in vitamin A. However, such programs do not necessarily lead to an improvement of biological and anthropometric indicators.<sup>16</sup>

The challenge arises because malnutrition is a complex set of issues. It is at the centre of a nexus that regroups the following:

- **socio-economic dimensions** (poverty/hunger trap, education levels, access to markets)
- **norms and belief systems affecting dietary habits**
- **farming considerations** (water access, soil quality, biotic and abiotic stresses)

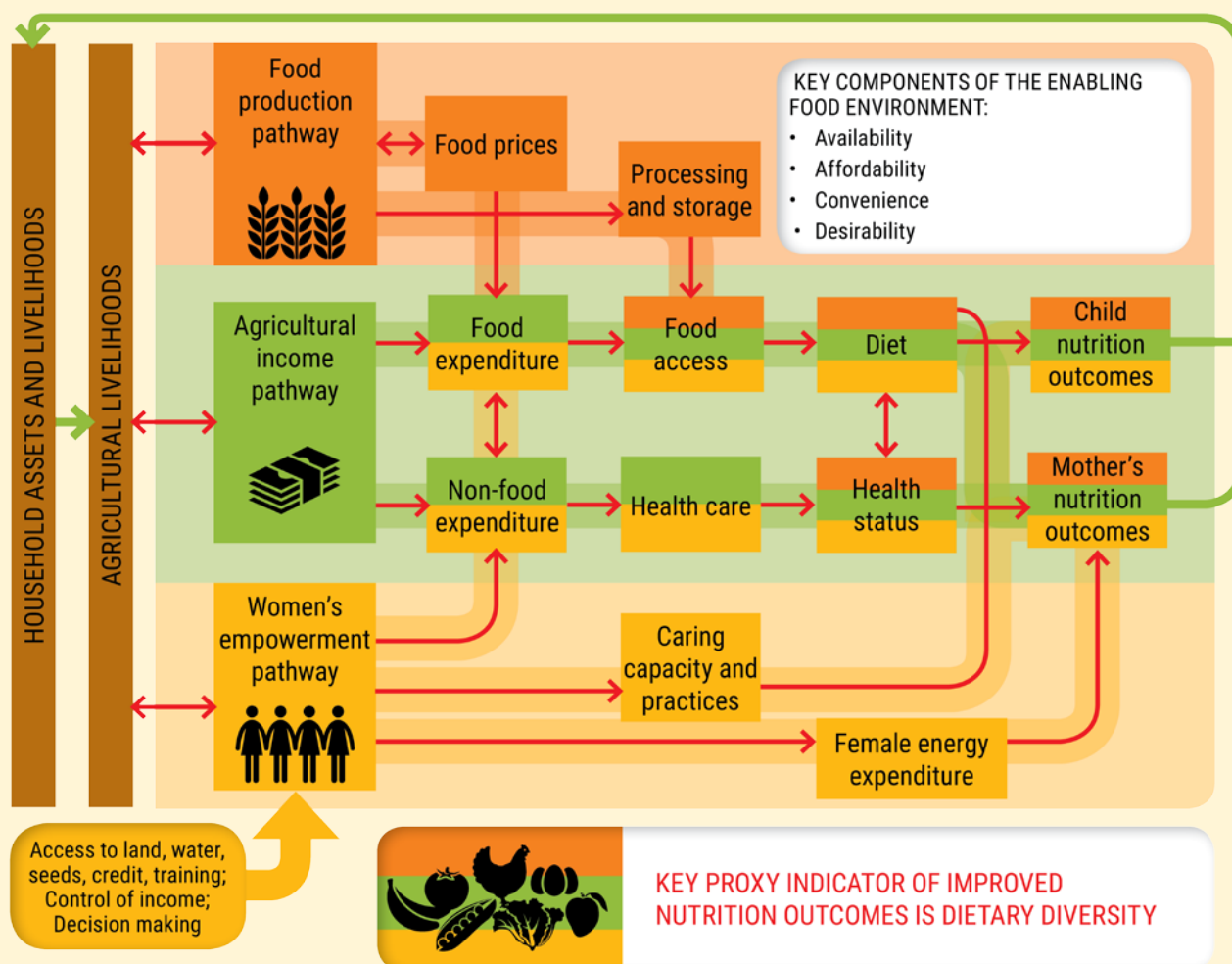
However, dietary diversity is often cited as a useful proxy to assess improved nutritional outcomes (from agriculture).<sup>17</sup>

## Three symbiotic pathways to nutrition-sensitive agro-ecology

The literature however points to strong linkages between nutrition and agriculture. Three pathways have emerged and that, if implemented in a way to foster inherent synergies, can create fertile ground for nutrition-sensitive agriculture. These include:

- **The agricultural income pathway**<sup>18</sup> which entails a focus on growing cash crops for income generation, so as to diversify food intake and therefore improve the nutrition status of the household, but which can also lead to too much dependence on cash crops and increase the burden of women to the detriment of child care.
- **The food production pathway**<sup>19</sup> which entails a focus on changes in on-farm food production on diversifying and improving the quality of diets among smallholder households.<sup>20</sup>
- **The women's empowerment pathway**<sup>21</sup> which touches on women's use of income for food and general expenditures, the ability of women to care for themselves and their families, and how women's spend their time and energy.

**Figure 2: The three pathways for a greater integration of nutrition into agriculture and the enabling food environment<sup>22</sup>**



Source: Adapted from the USAID/Strengthening Partnerships, Results, and Innovations in Nutrition Globally (SPRING) Project (2014) and based on Herforth & Ahmed (2015).<sup>23</sup>



## Key levers of success for ensuring nutrition-sensitive agroecological interventions

Based on its experience gained from running the Agroecology Plus Six (AE+6) program in the drylands of three Sahelian countries (Burkina Faso, Mali and Senegal), the Groundswell West Africa network has defined key levers of success to integrate nutrition into agroecological activities aimed at strengthening the resilience of households farming in fragile and drought-prone ecosystems.

### Success factors to integrate nutrition into the agricultural activities of NGOs involved in the promotion of agroecology

#### Key success factor # 1: Train NGO staff on malnutrition

Run training sessions to give project teams a solid grasp of nutritional issues, how to capture baseline information on nutritional status of a given population and how to design interventions to improve a given population's nutritional status. This should include a review of national policies to identify policy gaps in practice, and the adaptation of the Food and Agriculture Organization's 10 principles for integrating nutrition into agriculture.<sup>24</sup>

#### Key success factor # 2: Train NGO agricultural staff on the use of nutrition-focused tools

Project teams can easily be trained on the use of tools such as:

- the Household Hunger Scale (HHS) indicator, which helps measure household hunger in food-insecure areas<sup>25</sup>
- the Household Dietary Diversity Score (HDDS) for Measurement of Household Food Access tool, which provides an approach to collecting and measuring household dietary diversity as a proxy measure of household food access
  - The use of such tools is cost and time effective and project team needn't be expert to be able to apply such resources for diagnosis and to track change in nutritional outcomes.
  - Such tools helps to capture the baseline in terms of food and nutrition security in a specific location to ensue that initiatives are tailored to local needs, but also to measure the longer term impacts of projects activities. They therefore constitute valuable monitoring and evaluation tools for organizations engaged in nutrition sensitive agriculture.
  - With this data in hand, organizations are also equipped with evidence based arguments and knowledge for advocacy work.

### Success factors to improve the nutritional status of vulnerable communities

#### Key success factor # 3: Target the most vulnerable households

Target the most nutrition-vulnerable through community based participatory rural appraisal (PRA) to improve the nutritional situation of the most vulnerable, and especially women and children in the poorest, most food insecure households.

#### Key success factor # 4: Raise awareness on the malnutrition issue

Make the community as a whole an ally in combatting malnutrition by creating awareness on the causes and consequences of malnutrition from the outset, and how changing dietary habits and diversifying production can address these issues.

**Key success factor # 5: Promote the home consumption of self-produced crops**

Households will only be able to consume a portion of their nutrition rich commercial crops if the associated monetary loss can be offset through the generation of alternative income. Enticing populations to diversify their diets should go hand-in-hand with various income generating activities.

**Key success factor # 6: Support and disseminate new culinary knowledge**

Cooking demonstrations offer an effective means to successfully introduce new crops into a village and ensure that these will be grown; if women are to be enticed to grow more diverse food, they need to know how to cook them. Organize these demonstrations with selected women from villages who are then tasked with replicating this training in their own villages.

**Key success factor # 7: Promote the harvest of non-timber forest products (NTFPs) and identification of value chains**

NTFPs are often a neglected resource to feed households and generate income. Train women groups on the nutritional properties of such products, and on how to process these for income generation purposes (e.g. making of shea butter) and "*soumbala*" from néré tree pod beans.

**Success factors to integrate nutrition into farming systems****Key success factor # 8: Train and support women with diversifying their production using agro-ecological principles**

Collective dry season gardens tended by women enable women to work together and learn from each other. These collective communal gardens serve as "fertile ground" to encourage inter-household experiences regardless of women's social backgrounds. Through a domino effect, these practical experiences of agricultural production by women inspire women in other villages, who are encouraged to follow the example.

**Success factors to empower women in the agricultural sector**

The reader is referred to the policy note on women empowerment in agriculture, which discusses in detail success factors to empower women farmers in their communities.

**Success factors to raise awareness, scale out and disseminate knowledge on nutrition****Key success factor # 9: Adopt a phased approach between pilot villages and scaling out villages**

An efficient way of spreading knowledge and innovative practices aiming to change behaviour for effective integration of nutrition and agriculture consists of combining pilot villages (where best practices and the whole range of interventions are implemented in a concentrated "action research" manner) with the scaling out villages. In the scaling out villages, simpler and proven agroecological practices are spread. This creates enthusiasm. This in turn helps create the basis to persuade the community to phase in changes in the diversity and selection of crops for improved nutrition.

**Key success factor # 10: Disseminate lessons learnt and new knowledge widely**

- A variety of media can be used to disseminate knowledge and lessons learnt, including community radio broadcasts, making and showing short documentary films highlighting the testimonies of women and local farmers, staging of theatre plays, field visits, and itinerant caravans to share and disseminate experiences and lessons learnt.

- Learning exchange visits to collective plots where diversified crops are grown for nutritional purposes helps spread knowledge and fosters a deeper sense of ownership of innovations.
- Women credit and saving groups also offer a valuable platform to convey important knowledge about nutrition.
- Entrust locally trained women with the responsibility to spread improved farming techniques, culinary knowledge and nutrition messages to others. Invite religious and local leaders to take part in awareness raising and training sessions, as they will have a strong influence on changing people's behaviors.
- Provide opportunities to key leaders to learn about and directly witness the successes and challenges to undertaking nutrition strategies.
- Conduct "cross training" of health post nutrition and health staff to incorporate messages about growing and consuming nutrition rich crops.

### Success factors to ensure the long-term sustainability of this integration nutrition/agriculture

#### Key success factor # 11: Integrate nutrition sensitive agriculture into national and regional networks

Integrate a nutrition agenda into national or regional agroecology Civil Society networks.

Integrate nutrition sensitive agriculture into national or regional nutrition networks (ie., Scaling Up Nutrition-SUN) and resilience networks (Global Alliance for Resilience Initiatives-AGIR), so that they can learn from best practices and experiences in the field.

#### Key success factor # 12: Partner with and build the capacity of local institutions

Actively engage decentralized governance structures, both at the municipal elected level and at the village level, into all training and awareness-raising on nutrition. Encourage them to become champions and advocates for nutrition sensitive agriculture.





## Key recommendations

It is essential that decision makers and other key stakeholders involved in agricultural programs and rural development in general consider the following recommendations:



### National Government

**R1. Increase incentives to improve the availability, access and consumption of diversified, nutritious and healthy food produced by farming and distribution systems that are sustainable and environmentally friendly.**

Place emphasis on nutrition rich fresh food and fruit production, leguminous varieties, aviculture, the production of small ruminants, fishing/aquaculture, i.e. foods that are relatively scarce and costly but that very nutritious and remain under-utilized as a sources of food and income.

**R2. Monitor food consumption and access to varied and nutritious food especially for vulnerable groups.**

Track changes in the diets of pregnant and breastfeeding women, and children under two years of age (i.e., the 1,000 first days) Track also the availability and price of these foods.

**R3. Make provision for measures aiming at protecting and promoting the empowerment of women and poor households.**

Such measures can include:

- social protection measures allowing the most vulnerable groups to access nutritious food when shocks arise or during the lean season (when income levels are low)
- securing land tenure rights, particularly for women
- ensure equitable access to productive resources (land, water, tools, credit, training, animals, with a particular focus on women)
- assist vulnerable farmers to access markets (this includes accessing information and providing adequate marketing infrastructure)

**R4. Strengthen human and institutional capacity to improve the population's nutrition via the agro-processing sector.**

Make adequate investments in the staffing and institutional capacities required for promotion of nutrition sensitive agriculture. This implies including basic information about nutrition in the training of agricultural extension officers, without making them nutrition experts, but rather nutrition educators by being aware of the nutritional benefits of agriculture based livelihoods for healthy diets.

**R5. Support incentive mechanisms leading to concrete cross-sectoral strategies for nutrition.**

This implies the following:

- support the establishment and management of multi-sectorial coordination platforms that are steered by national, regional and local government inter-agency structures
- facilitate and encourage on-going, practical dialogue based on concrete outcomes, and lessons learned about initiative that integrate health, nutrition, agriculture and rural development



## Local Government

**R6. Assess the context at the local level, to design appropriate activities to address the types and causes of malnutrition, including chronic or acute under-nutrition, vitamin and mineral deficiencies.**

Context assessment can include potential food resources, agro-ecology, seasonality of production and income, access to productive resources such as land, market opportunities and infrastructure, gender dynamics and roles, opportunities for collaboration with other sectors or program and local priorities.

**R7. Create awareness on the results of the context assessment results. Strengthen institutional capacity on the issue of nutrition-sensitive agriculture through the training of technical staff/extension officers and field staff, and of health post staff.**

**R8. Formulate a cross-sectorial coordination strategy to ensure the integration of nutrition in agricultural programs.**

**R9. Include in the five-year municipal development plans and budgets specific targets to:**

- decrease chronic malnutrition
- increase the number of crops farmers grow (diversification)
- increase the number of plots granted to women groups in perpetuity
- such targets should be backed by performance indicators to measure achievements

**R10. Create a network including all local stakeholders to facilitate regular information flow on nutrition-sensitive agricultural development results, and lessons learned across all communes in a selected agroecological or administrative area.**



## Non governmental sector

**R11. Review and apply (in close coordination with the municipal council and other stakeholders) the FAO 10 Key Recommendations for Improving Nutrition through Agriculture and Food Systems:**

- i. Incorporate explicit nutrition objectives and indicators into their design, and track and mitigate potential harms.
- ii. Assess the context at the local level, to design appropriate activities to address the types and causes of malnutrition.
- iii. Target the vulnerable and improve equity through participation, and access to productive resources.
- iv. Collaborate with other sectors and programs.
- v. Maintain or improve the natural resource base.
- vi. Empower women.
- vii. Facilitate production diversification, and increase production of nutrient-dense crops and small-scale livestock.
- viii. Improve processing, storage and preservation to retain nutritional value and food safety, to reduce seasonality and post-harvest losses, and to make healthy foods convenient to prepare.
- ix. Expand market access for vulnerable groups, particularly for marketing nutritious foods.
- x. Incorporate nutrition promotion and education.

**R12. Train NGO staff on the key concepts of nutrition and malnutrition, the issue of nutrition-sensitive agroecological practices and the key tools that can be used.**

Make agricultural extension workers knowledgeable of nutrition without making them nutrition expert, but rather nutrition educators by being aware of the nutritional benefits of agriculture based livelihoods for healthy diets at the household and community level.

**R13. Develop, implement, monitor & evaluate strategies to integrate nutrition in the existing and new agro-ecological activities.****R14. At the operational level, ensure that project activities:**

- embed nutrition considerations in decision-making tools and procedures
- empower targeted communities – through PRAs - to conduct village surveys based on disaggregated data so that the most nutrition insecure can be identified as prime beneficiaries of any project
- are informed by baseline information captured through tools such as HHS, SHARP, HHDS and nutritional surveys, against which progress will be measured in the medium and long term
- such tools are piloted and adapted to suit local contexts, if needed
- decentralize training programs to ensure the widest reach to selected excluded groups
- link these nutrition-sensitive initiatives with other existing and relevant support projects
- make provision for a scaling-out and sustainability strategy via the establishment of community and institutional relays

**Farmer organizations****R15. Organize learning/immersion visits to nutrition-sensitive projects and initiatives.****Strategic partners****R16. Increase financial support to nutrition-sensitive agricultural projects that are not only focused on the production and sustainability, but also nutrition, equity, women's empowerment and resilience.**

## Endnotes

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