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BEYOND THE PRODUCTION OF FOOD: HOW CAN NUTRITION-SENSITIVE AGRICULTURE ADDRESS NUTRITION CHALLENGES?



INDU KUMARI SHARMA

BEYOND THE PRODUCTION OF FOOD: HOW CAN NUTRITION-SENSITIVE AGRICULTURE ADDRESS NUTRITION CHALLENGES?

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Cover Image: A farm in Southern coastal Bangladesh

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- Universiteit van Amsterdam, Amsterdam, The Netherlands
- Academisch Medisch Centrum bij de Universiteit van Amsterdam, Amsterdam, The Netherlands
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VRIJE UNIVERSITEIT

**BEYOND THE PRODUCTION OF FOOD: HOW CAN NUTRITION-SENSITIVE AGRICULTURE ADDRESS
NUTRITION CHALLENGES?**

ACADEMISCH PROEFSCHRIFT

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ACCOUNT

Chapters 4 through chapter 9 are based on six articles that are either published or under review for publication in international peer-reviewed journals. I have chosen to write these articles in 'we-form'.

Chapter 4.

Sharma IK, Di Prima S, Essink D, Broerse JEW. Nutrition-Sensitive Agriculture: A Systematic Review of Impact Pathways to Nutrition Outcomes. *Advances in Nutrition*. 2021;12[1]:251-75

Chapter 5.

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Chapter 8.

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LIST OF ACRONYMS AND ABBREVIATIONS

Agri-food	Agriculture and food
ANC	Antenatal care
ASF	Animal Source Food
BCC	Behaviour Change Communication
CAS	Complex Adaptive System
CSP	Culture, Structure, Practice
CFIR	Consolidated Framework for Implementation Research
DDS	Dietary Diversity Score
ECD	Early Child Development
EHFP	Enhanced Homestead Food Production
ENUFF	Enhancing Nutrition of Upland Farming Families
FFS	Farmer Field School
FGD	Focus Group Discussion
Hb	Haemoglobin
HFP	Homestead Food Production
HGSF	Home-grown school feeding
IAHBI	Integrated Agriculture and Health-Based Interventions
IYCF	Infant and Young Child Feeding
LMIC	Low- and middle-income Countries
MDD	Minimum Dietary Diversity
M&E	Monitoring and Evaluation
MUAC	Mid-upper arm circumference
NGO	Non-governmental organization
NNSPA	National Nutrition Strategy 2025 and Action Plan 2016-2020
NSA	Nutrition Sensitive Agriculture
OFSP	Orange-fleshed Sweet Potato
OR	Odds Ratio
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
SDG	Sustainable Development Goal
SSI	Semi Structure Interview
SUN	Scaling Up Nutrition
VNT	Village Nutrition Team
WASH	Water, Sanitation, and Hygiene
1000 days	Period that begins with conception of a child to until the child is 2 years of age

CHAPTER 1. INTRODUCTION



Food being dried and stored for consumption in the lean season in Northern Laos

1.1 Malnutrition, an urgent global health problem

Malnutrition is a critical development issue, significantly affecting human health and economic development. Its impact on health is fundamental, as it is one of the main drivers of the global burden of disease [1, 2]. Undernutrition, a form of malnutrition, is associated with almost half (45%) of mortality in children under five years of age [1]. Similarly, three key forms of undernutrition-stunting, severe wasting, and intrauterine growth restriction account for 21% of disability-adjusted life years [2]. The economic implications of malnutrition are detrimental. Undernutrition is associated with an 11 percent annual reduction in GDP in Asia and Africa [3], and it results in a loss of over 10 percent of an individual's lifetime earnings [4]. Therefore, reducing malnutrition is imperative to contribute to global health and development. Addressing malnutrition aligns directly with the second Sustainable Development Goal, striving for zero hunger, food security, and nutrition by 2030 [6]. Furthermore, nutrition's interconnectedness with SDGs like poverty eradication, health improvement, education equity, gender equality, and water sanitation underscore its pivotal role in global well-being and development.

While there has been some progress in reducing undernutrition, it remains a pressing issue. Globally, the proportions of people living with undernutrition decreased, from 12.5 percent in 2005 to 9.9 percent in 2020 [7], amounting to a decrease from 810.7 million to 768.0 million [7]. A quarter of all countries are on course to meet stunting and wasting targets [8]. However, only seven out of 194 countries are progressing to meet four of the six 2025 nutrition targets [8]. Unfortunately, with less than a decade until the SDG deadline, levels of stunting and wasting remain unacceptably high. For instance, 22 percent [149.2 million] of children under five years of age are stunted, and 6.7 percent [45.4 million] are wasted [7]. Disturbingly, anaemia levels have either worsened or shown no improvement in 161 countries [8], and the prevalence of anaemia in women of reproductive age increased from 28.5 percent in 2012 to 29.9 percent in 2019 [7]. Children under five are also significantly affected, with 40 percent experiencing anaemia in 2019 [9]. At the current pace, the world is projected to achieve only one out of six global targets on maternal and child nutrition-breastfeeding, while being off course to meet the others including: stunting, wasting, low birth weight, anaemia, and childhood overweight [8].

Despite substantial strides in reducing poverty over the past five decades in low and middle-income countries (LMICs), undernutrition rates remain disproportionately high in these regions, and the poorest households in these regions bear the heaviest burden of undernutrition [10]. Notably, the rates of undernutrition are up to 10 times higher in the lowest income countries compared to the highest income countries [5]. The COVID-19 pandemic may have offset the improvements made in the last decades, and

even led to further deterioration of the nutrition situation [10]. During the COVID-19 pandemic, world hunger escalated in 2020, with the prevalence of undernourishment increasing by 1.5 percentage points from 8.4 percent in 2019 to 9.9 percent in 2020 in just one year [7]. Consequently, the pandemic has presented a substantial obstacle to achieving the zero-hunger target by 2030 [7].

1.2 The need for nutrition-sensitive agriculture

According to UNICEF’s conceptual framework, malnutrition results from determinants that encompass immediate, underlying, and basic causes [2, 11]. The immediate determinants are inadequate dietary intake and diseases, while the underlying causes concern household food insecurity, inadequate care, unhealthy household environment and lack of health services, and income poverty. The basic causes involve a lack of capital, as well as social, economic, and political contexts that affect malnutrition [2, 11]. Addressing such a multidimensional problem needs a multisectoral approach through nutrition-specific and nutrition-sensitive interventions. Nutrition-specific interventions are the actions that address immediate determinants of malnutrition [12]. Some of such interventions are nutrient supplementation, breastfeeding promotion and management of acute malnutrition and disease prevention and management [1, 13]. Nutrition-sensitive interventions on the other hand, address the underlying determinants of malnutrition, such as food insecurity, and incorporate nutrition-explicit goals and actions [12]. These interventions encompass agriculture and food security, early child development, child protection, education, health [maternal mental health and family planning], social protection, safety nets, water and sanitation, education, and women’s empowerment [1, 12, 13].

Agriculture plays a pivotal role in addressing malnutrition by tackling food insecurity and inadequate access to food. The sector produces ‘food’, the vehicle of nutrition. Agriculture not only increases access to nutrient-rich foods but also enhances livelihood opportunities and income through food production [12]. In this way, agriculture can tackle two fundamental causes of malnutrition-food insecurity and income poverty. Addressing household food insecurity is critical to also address inadequate diet, the food that lacks the balance of essential food – is a significant problem, especially in LMICs. The predominant issue in LMICs revolves around diets dominated by cereals, with a stark deficiency in vegetables, fruits, legumes, nuts/seeds, and essential animal-source foods (dairy, eggs, meat, fish) [8]. Therefore, leveraging agriculture and food systems to address dietary issues is essential in tackling the multifaceted problem of malnutrition [8]. Agriculture, therefore, has the primary role in increasing household food security and improving diets to address malnutrition. Moreover, agriculture stands as the primary source of livelihood

for 80% of impoverished populations residing in rural areas, encompassing a significant number of women [12]. These populations are mostly subsistence farmers. Studies underscore that, particularly in Asia and Africa, subsistence farmers bear the brunt of food insecurity and malnutrition, despite being the primary food producers [14, 15].

Despite the significant potential of agriculture to improve nutrition, the sector has yet to fulfil its role in addressing undernutrition. Traditionally, agriculture has focused on staple grain production rather than the production of micronutrient-rich fruits and vegetables [16]. The lack of diverse nutrient-rich food production in many resource-poor areas in LMICs often leads to inadequate consumption of such foods and consequent malnutrition. Even when the production of nutrient-rich foods is met, it may not contribute to the intake of adequate diets due to a lack of awareness of the importance of consuming a nutrient-rich diet or insufficient resources. Another challenge lies in the targeting of the agriculture sector, which has often given less priority to underprivileged populations residing in remote areas, such as smallholder farmers. These populations have the highest inequity gaps in terms of the prevalence of undernutrition. For example, the stunting ratio between the lowest and the highest wealth quintile has increased over time in five of seven Asian countries, with Bangladesh recording the highest increase. In Bangladesh, the stunting rate among children dropped from 2007 to 2015 by 26 percent for the richest families, but only a nine percent decrease for the poorest families [17]. Despite the fact that a majority of smallholder farmers engage in agriculture, most of the undernourished population in Asia and Africa resides in rural areas [14, 15]. Therefore, it is crucial for the agriculture sector to be more nutrition-sensitive, translating 'agriculture' into 'nutrition-sensitive agriculture'. Nutrition-sensitive agriculture (NSA) interventions are agricultural interventions that incorporate a clear objective to improve nutrition and integrate nutrition actions to achieve the nutrition objective [12, 18].

1.3 Research gaps

Research on the role of agriculture in tackling the problem of malnutrition received increased attention in the last decade after the importance of nutrition-sensitive interventions on nutrition was highlighted in Lancet's research in 2013 [12]. Numerous studies published since then focus on the effect of agriculture on nutrition, the pathways from agriculture to nutrition, and the need for making agriculture nutrition sensitive [16, 18-24].

However, the research on the role of the NSA interventions that incorporate nutrition objectives and actions in agriculture component, is still inadequate. The research gap concerns two key areas: 1) impact pathways from NSA interventions to diet and nutritional status, and 2) the factors influencing the implementation and sustainability of such interventions.

Concerning the first research gap on impact pathways, several studies highlight the impact pathways from agriculture to improving nutrition. The studies suggested the various pathways from agriculture to nutrition [12, 25]: 1) food production, 2) agricultural income, 3) empowerment of women and enhancing their role in nutrition, and 4) changes in food prices. However, the impact pathways from NSA interventions to improving nutrition have rarely been studied in a holistic way. Moreover, the frameworks that build upon empirical studies are rarely available.

The second research gap is on the factors that affect the implementation and scaling-up of NSA interventions. Development programmes are often implemented in a community-based setting and are generally complex as they involve multiple actors and a unique community setting where the implementation occurs. Such complexity can be more complicated in the case of NSA interventions, as they encompass not only agriculture, but also multiple sectors that enable making agriculture nutrition sensitive. Due to this, improving nutrition through NSA interventions is more challenging.

Effectively implementing NSA interventions requires a better understanding of the pathways from NSA interventions to improving nutrition, as well as the factors that affect the implementation and sustainability of such interventions. Impact pathways are crucial to understanding the effectiveness of such interventions in improving nutrition and the pathways through which they can influence diet and nutritional status. Furthermore, effectively implementing such interventions requires knowledge of the factors that influence the implementation and sustainability of such interventions. It is crucial to uncover the facilitators and barriers that influence their implementation and sustainability. A holistic understanding of the pathways from NSA interventions to improving nutritional status and the factors influencing the implementation and scaling-up of such interventions can contribute to addressing malnutrition and inadequate diet in LMICs.

The current research gap on NSA described in the previous section emphasizes the need to achieve the following research aim:

To gain insights into the impact pathways from Nutrition Sensitive Agriculture (NSA) interventions on improving nutritional status and the factors influencing the implementation and sustainability of the interventions in low and middle-income countries.

This research also covers the effects on nutrition outcomes that lie in the pathways between NSA interventions and nutritional status. The effects include food access measured in terms of dietary practices and food consumption, care practices of children and women, and health status measured in terms of diseases. Based on these insights, recommendations were formulated for designing, implementing, and sustaining NSA interventions aimed at addressing undernutrition among children and women in low and middle-income countries. To this end, we conducted two literature reviews on the state-of-the-art and two case studies based on NSA programs implemented in Bangladesh and Lao PDR.

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CHAPTER 2. THEORETICAL BACKGROUND



A sunflower on a farm in Southern Bangladesh

This chapter includes five sections. The first section defines malnutrition, and the second section describes NSA. In the third section, NSA is described as an intervention in a complex adaptive food system. In the fourth and fifth sections, the theories and concepts underpinning impact pathways and the factors influencing the implementation and sustainability of NSA interventions are described.

2.1 Malnutrition

The World Health Organization (WHO) defines malnutrition as deficiencies, excesses, or imbalances in the intake of required nutrients. It includes two broad categories [1]:

- 1) Undernutrition, classified into stunting (low-height-for-age), wasting (low weight-for-height), underweight (low weight-for-age) and micronutrient deficiencies (lack of essential vitamins and minerals-incorporating multiple forms of deficiencies, this research focuses on iron deficiency).
- 2) Overnutrition, classified into overweight, obesity and diet-related non-communicable diseases.

Malnutrition mentioned in the dissertation refers to undernutrition unless stated otherwise.

According to UNICEF's conceptual framework (see Figure 2.1), undernutrition is the outcome of immediate, underlying, and basic causes [2, 3]. The immediate causes are inadequate dietary intake and diseases, and the underlying determinants are mainly household food insecurity, inadequate care, an unhealthy household environment and a lack of health services, and income poverty. The basic causes are a lack of capital, and socio-economic and political context [2, 3]. The focus of this research will be mainly on the underlying and immediate causes.

The target households of the biologically vulnerable populations small holder farmers, the farming households that own and/or cultivate less than two hectares of land [4]. While these populations contribute to the majority of the farming populations, studies highlight that these are the populations most affected by undernutrition in Asia and Africa [5, 6]. The Sustainable Development Goals (SDGs) highlight the need to make smallholder agriculture and food systems more nutrition-sensitive to improve their diet quantity and quality [6]. Diversifying diets from mono-staple-focused food toward protein- and micronutrient-rich diet provides new opportunities for nutrition-sensitive agriculture-led development for smallholder farmers by simultaneously enhancing diet quality and diversity [7]. Therefore, smallholder farmers are the critical entry point for this research.

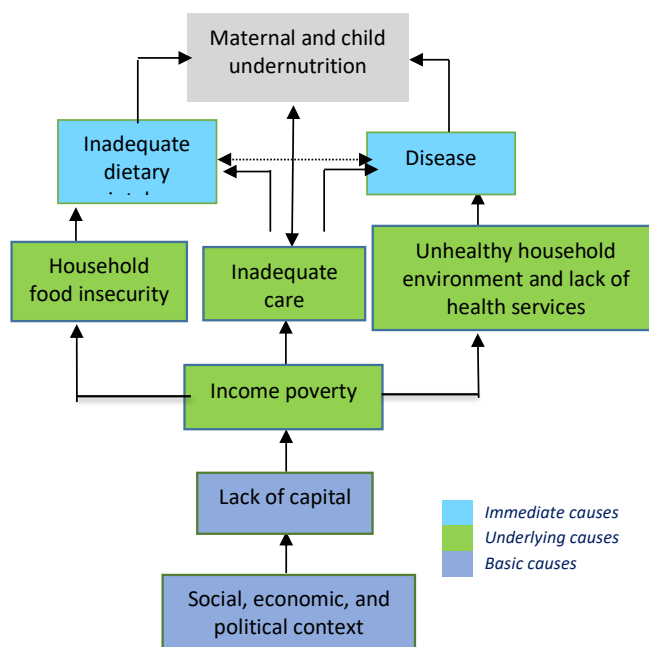


Figure 2.1 UNICEF's conceptual framework of malnutrition [2, 3]

2.2 Nutrition-sensitive agriculture

In this research, agriculture refers to the science and art of cultivating crops, rearing livestock for meat or dairy, or farming fish to produce foods for consumption. The agricultural interventions, thus, comprise activities that aim to produce such foods.

Traditionally, the agriculture system focused on food staples rather than micronutrient-rich fruits and vegetables [8]. While food staple such as cereals and tubers are a great source of energy and play a crucial role in the food system, the focus on staples is the main challenge in meeting dietary diversity and achieving a consequent nutritional status. A lack of access to diverse foods has also been reflected in the food insecurity experience scale, an indicator that measures food insecurity or access to food at the household level. In 2019, the prevalence of moderate or severe food insecurity was 25.9 percent, which is a slightly increasing trend since 2016 (23.2%) [9]. Food insecurity and an inadequate diet are the main causes of undernutrition [10]. Thus, as described in Chapter 1, agriculture needs to be more nutrition-sensitive by transforming conventional 'agriculture' into 'nutrition-sensitive agriculture (NSA)'.

NSA is defined as *“a concept that aims to narrow the gap between available and accessible food and the food needed for a healthy and balanced diet for all people”* [8]. To fulfil this, agricultural interventions incorporate a clear objective to improve nutrition and integrate nutrition actions to achieve the nutrition objective [11, 12]. NSA uses a system approach that links nutrition-related actions and goes beyond conventional agriculture systems to deliver diverse, nutrient-rich, and balanced diets to its consumers throughout the year [8]. For this reason, agriculture should use a “nutrition lens” to sensitize the sector on the importance of nutrition within food security and maximize its effects on nutrition [8]. In doing so, NSA considers a full range of pathways from agricultural investments to translating these investments to improving nutrition. As outlined in previous chapters, these pathways are mainly: 1) producing nutrient-rich foods to increase their access; 2) increasing agricultural income to make nutrition-related expenses; 3) formulating policies that can affect food prices and affect purchasing power; and 4) empowering women and reducing their energy expenditure [11- 13].

2.3 NSA as an intervention in complex adaptive food system

Successful NSA interventions will require food-system change to transform practices across the food system from production to consumption. A food system is defined by FAO (2017) as *“all the people, institutions and processes by which agricultural products are produced, processed and brought to consumers (and consumed)”* [14]. The system includes multiple components comprising agricultural production, processing and storage, distribution and trade, and consumption [15]. NSA interventions are key innovations that aim to change the dominant ways of thinking (culture), organizing (structure) and doing (practice) to make the system nutrition sensitive. Culture, structure, and practice refer respectively to the dominant ways of thinking, organizing, and doing [22, 23]. The transformation in the culture, structure, and practice involves multiple sectors, including agriculture, health, nutrition, education, and welfare to address the complex factors influencing food production, distribution, and consumption [15]. It involves fundamentally transforming food value chains to prioritize nutrition outcomes alongside traditional goals of productivity and profitability. This implies that the fabric of the system, its underlying cultures (e.g., beliefs, values, traditions, norms) and structures (rules, institutions, and physical structures) need to change to enable nutrition-sensitive practices (the behaviours of actors). Recursively, these practices reproduce the cultures and structures in the system and thus provide stability, path dependency and rigidity to the system [16 -18].

I hypothesize that implementing NSA in low resource settings requires a shift in cultures, such as valuing 'production diversity alongside productivity, 'quality of diet in addition to quantity', changing gender roles, and 'breaking traditional food traditions that neglect nutrition sensitive aspects'. Simultaneously, this requires a new way of thinking and organizing to incorporate nutrition-sensitive practices. Imparting behaviour change interventions to change 'culture' and building system reforms such as nutrition-sensitive governance frameworks to change the conventional tradition of providing mono-sectoral approach, altering value chains to facilitate nutrient-rich production, market availability of food and consumption. These components, due to their interdependence, resist unilateral solutions and urge a new multilateral approach to addressing nutrition challenges, a common feature of a complex adaptive system (CAS) [19, 20]. These changes, however, cannot be addressed by relatively linear solutions, but require multi-level and multisectoral approaches. CAS theory provides a framework to further understand the behaviour, and thus change capacity, of social systems [19, 20]. We recognize the food system as a CAS.

CAS theory recognizes that systems are adaptive, but at the same time, they are rigid, and their behaviour is based on internalized rules and path dependency [19, 20]. A CAS has five key attributes which are: 1) many interconnected elements and an open system, 2) feedback loops and time delays; 3) a dynamic nature; 4) a self-organizing and emergent nature; and 5) robustness and resilience [19]. A brief description of these follows hereafter.

1) *Many interconnected elements and an open system*: A CAS comprises many elements that are interconnected within the system as well as within the environment where the system is situated. A CAS features an open system, which means that the system and elements outside the system boundaries and beyond the control of the system can influence the system and vice versa [19]. For example, food price policies, affect the production of agricultural products and at the same time, the production of food can affect demand, influencing the price of agricultural commodities.

2) *Feedback loops and time delays*: Feedback loops and time delays play a significant role in the food system. Feedback loops describe cause-and-effect sequences between elements, and can be reinforcing (+) or balancing (-) [19]. Reinforcing loops lead to system transformation when changes in one variable result in additional changes in the same direction over time. Balancing loops, on the other hand, create stability and resistance to change as they lead to opposite changes over time. These loops can be used to describe vicious circles of problems, such as malnutrition and infection, or malnutrition and poverty [21]. The interconnected elements in NSA interventions are expected to involve several feedback loops, for

example, as illustrated in Figure 2.2, focusing on the adoption of nutrient-rich foods. This research explores various feedback loops in the context of the food system.

3) *Dynamic in nature*: According to this attribute, each element of the system constantly changes its rules to interact with other elements. As a result, the change in one element triggers the change in other elements [19]. Due to this interconnectedness, any force outside the system can stimulate the whole system to change. A CAS, thus, constantly changes or evolves and nothing is static [19, 20]. In the case of this research, an increase in agricultural inputs may trigger a change in production and sales. However, any external forces such as behaviour change activities can stimulate the entire system to transform into one that is primarily focused on the production and consumption of nutrient-rich products rather than only selling them.

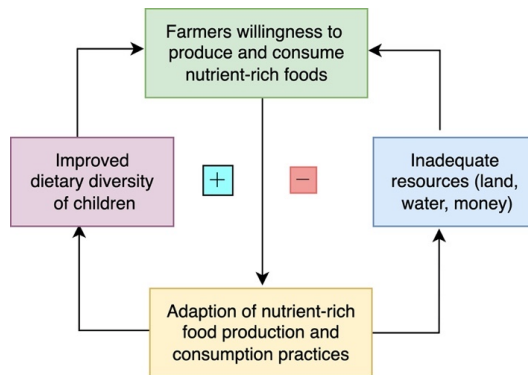


Figure 2.2 An example of reinforcing and balancing loops, adapted from Jagustovic, 2019 [19]

4) *Self-organizing and emergent order*: A CAS operates through self-organization, meaning it lacks a central controller or a single governing rule [20]. Instead, it comprises numerous interacting components, each following its own set of rules. These rules can influence the system's outcomes and the actions of other components [20]. The interaction between the elements defines the influence and interrelationships, such that the higher the interrelationship between the parts, the more complex is the system to understand [19]. In the context of the food system, various elements from inputs and production to processing, trade, distribution, and consumption interrelate. Emergent order results from these interactions, not from the behavior of individual elements or subsystems alone [19]. Understanding such a system necessitates participatory processes involving multiple actors.

5) *Robustness and resilience*: A food system also exhibits robustness and resilience. Robustness is the degree to which the system can withstand unexpected events or changes arising from inside or outside

the system without degrading its performance [19]. Resilience is the capacity of the system to recover its performance after an unexpected internal or external event degrades [19]. Although robustness and resilience can be seen as positive features of a system, they also make changing the system challenging due to the internalized rules and path dependency of the system. This makes it difficult to change the dominant culture, structure, and practice.

This research focuses on smallholder and subsistence farming communities that rely on conventional staple-based food production. However, the change from the unilateral approach of producing staples to the production and consumption of nutrient-rich foods is complex. The multisectoral interventions, the multiple interacting pathways between agriculture and nutrition, the various underlying factors contributing to malnutrition, and the diverse actors with their own mandates, trade-offs, and tensions between different sectoral goals make the system tangled and complicated [24]. NSA interventions are therefore likely to run into the rigidity of the incumbent food system, which poses a serious risk to the sustainability and scaling up of the interventions. However, since CAS are dynamic as well, the challenge will be to identify and address the systemic barriers, and productively use system dynamics.

2.4 Impact pathways from NSA interventions to nutritional status

Impact pathways in this research refer to the construction of a logic model that describes the impact of NSA interventions on several nutrition outcomes as well as the pathways leading to these effects. These outcomes lead towards the impact on nutritional status and the trajectories from the interventions to improving nutritional status. The theories on the impact pathways to the impact are described in the following passages.

2.4.1 Impact on nutrition

The impact of the interventions used in this research is classified using UNICEF's conceptual framework on malnutrition [2, 3] (see Figure 2.1). While this research studies the whole pathway from NSA interventions to nutritional status, the impact of interventions refers to the effects on nutrition across different temporal stages of the pathway. The effects related to the underlying determinants are care practices, household food security, household living environment, and services. The outcomes related to the immediate causes are dietary practices and diseases. The effect on nutrition for this research is measured using the following two levels of outcomes:

1. Nutritional status, measured in terms of undernutrition, categorized into:
 - Micronutrient status [e.g., anaemia] of women and children.
 - Anthropometric measurements: stunting, wasting and underweight in children or underweight or mid-upper arm circumference (MUAC) in women.
2. Effects on the causes of malnutrition based on:
 - Diet, measured in terms of food consumption, dietary diversity, or nutrient intake.
 - Care practices of children and women.
 - Health status measured in terms of diseases.

2.4.2 Pathways from NSA interventions to nutritional status

Because there are no theoretical frameworks published on the pathways from NSA interventions to nutrition, this research refers to the pathways from agriculture to nutrition depicted in a published framework by Kadiyala et al. (2014) [13]. Based on the framework as well as other past studies, five key pathways lead from agriculture to nutrition. The studies have recognized four main pathways [11-13] (see Figure 2.3): 1) food production; 2) agricultural income; 3) food prices; and 4) women's empowerment relating to: women's social status and empowerment; women's time through participation in agriculture; and women's health and nutrition through engagement in agriculture.

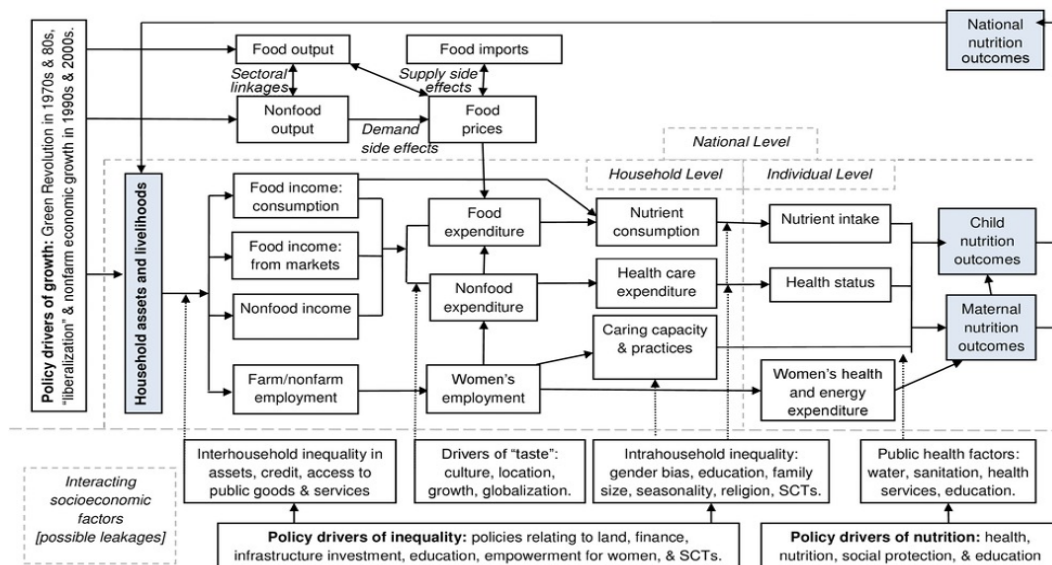


Figure 2.3 Agriculture to nutrition pathways, Kadiyala et al. (2014), *Annals of the New York Academy of Sciences* [13]

The conceptual definitions of the individual pathways are as follows:

1. *Food production*: Agricultural interventions by producing nutrient-rich foods can contribute to increasing food access, which can result in reducing malnutrition.
2. *Agricultural income*: Income raised from the sale of agricultural products can contribute to nutrition-related expenses, namely, food expenditure and expenditure on health care.
3. *Food prices*: A change in the price of food due to changes in supply and demand and /or policies affects purchasing power through either a decrease in the price or an increase in the price.
4. *Women's empowerment*: Women's participation and empowerment in agriculture may lead to either positive or negative outcomes in nutrition. While their engagement in production and earning may improve nutritional status, a trade-off in the time between agriculture and nutrition-related care may result in a lack of care for themselves and their children, compromising nutrition-related practices.

While past studies provide excellent theoretical insights on the pathways from agriculture to nutrition, there is a notable gap in understanding the when nutrition is incorporated into agriculture. As outlined in Chapter 1, there is a necessity to investigate the pathways from NSA interventions to improving nutrition.

2.5 Factors influencing Implementation and Sustainability of NSA Interventions

In this section, we elaborate on the concepts of implementation and sustainability of NSA interventions.

“Implementation” is the process of applying an intervention. Damschroder (2009) indicates that it is a means to assimilate an intervention into an institution [26]. In the context of this research, however, as the interventions occur in a community setting, implementation refers to the process of applying NSA interventions within the setting. It is crucial to understand the effects of food systems on nutrition across different contexts and under different drivers [27].

“Sustainability” is the capacity of interventions to be continued beyond the initial funding cycle [28]. Chapter 7 also describes factors influencing the “scaling-up” of the interventions. Scaling up is considered one of the pathways to enhancing sustainability and can be defined as:

“The process of “institutionalization of an innovation through policy, regulatory, budgetary, or other [] system changes – in other words, the complex process of embedding an innovation in the institutional structure of a [] system” [29].

Scaling up is the embedding of interventions in a new dominant culture, structure, and practice (vertical scaling) [30], while scaling out refers to the broadening of interventions (horizontal scaling).

Factors are the characteristics within a food system that either aid the implementation or sustainability (facilitators) or hinder the implementation or sustainability (barriers) [31]. The reason to choose the neutral term ‘factor’ is that some features act as a barrier or facilitator depending upon the specific context, strategies, and interventions. Nevertheless, a clear indication of whether that factor facilitated or hindered the implementation and scaling up is provided.

Based on Damschroder (2009), the factors encompass five domains: outer setting, inner setting, characteristics of actors, intervention characteristics and implementation process [26] (see figure 2.4).

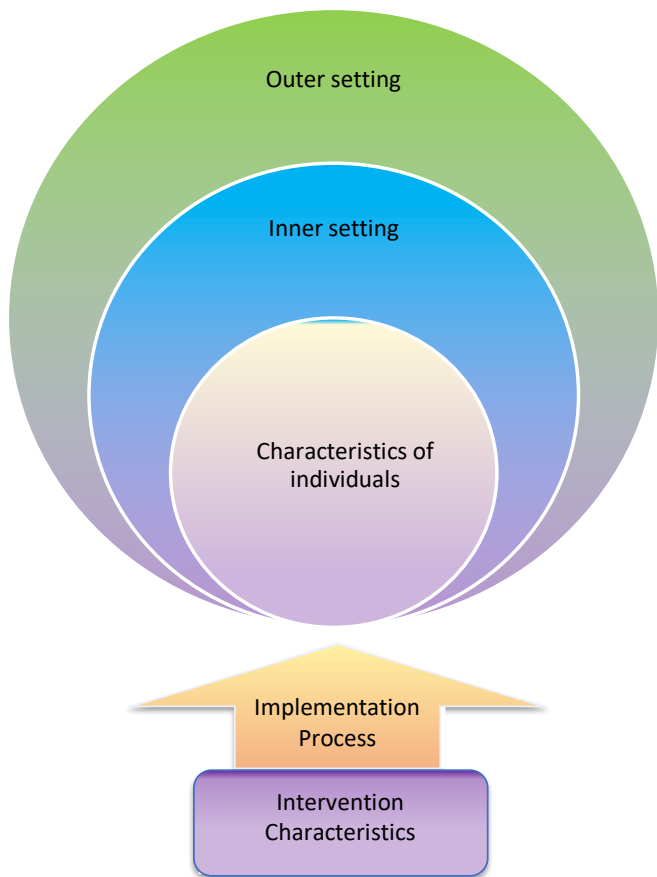


Figure 2.4. The framework for Implementation, adapted from Damschroder (2009) [26] and Khan (2021) [32]

1. *Outer setting*: the factors across global and national levels beyond the implementation area [23]. Examples are the nutrition sensitivity of policies and the national legislative environment.
2. *Inner setting*: the factors within the local food system where implementation occurs [23] including cultural, socioeconomic and biophysical aspect and local capacity.
3. *Characteristics of individuals*: the attributes of the actors involved in implementation [23], categorized as implementers (executing the interventions) and beneficiaries (receiving the interventions).
4. *Intervention characteristics* refer to the features of the intervention influencing its implementation and sustainability [23], such as adaptability, design quality, and cost [23].
5. *Implementation process* pertain to the essential activities during the implementation, e.g., planning, engagement, execution, and reflection and monitoring [23].

Thus, this research uses several concepts and two theories concerning the research aim. The first framework is the impact pathway from NSA interventions to nutritional status. The second framework concerns the factors influencing the implementation and sustainability of NSA interventions.

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CHAPTER 3. RESEARCH METHODS



Two boys crossing a river using a boat. Transportation is a problem in Dacope, the study area in Bangladesh

3.1 Research questions

Previous chapters emphasize the need for more research on Nutrition-Sensitive Agriculture (NSA), highlighting its potential to address malnutrition. However, implementing NSA interventions is intricate due to its complex adaptive system (CAS) nature. Effectively implementing and scaling up this complex intervention requires substantial evidence. While existing research provides evidence on the impact pathways from agriculture to nutrition, studies specific to NSA, focusing on impact pathways and critical factors for successful implementation and sustainability, remain insufficient. Bridging this gap, as formulated in chapter 1, necessitates research aimed:

to gain insights into the impact pathways of NSA interventions on improving nutritional status and the factors influencing the implementation and sustainability of the interventions in low and middle-income countries.

To achieve the research aim, the following research questions are formulated:

1. *What is the impact of NSA interventions on diet and nutritional status, and what pathways lead from the interventions to improving these nutrition outcomes in low and middle-income countries?*

This research question focuses on discerning the impact pathways across: 1) the impact of NSA interventions on diet and nutritional status; and 2) the pathways that lead from NSA interventions to the impact. The impacts and the pathways are integrated to construct impact pathways together.

2. *What factors influence the implementation and scaling-up of NSA interventions in low and middle-income countries?*

This research question delves into understanding the elements that influence the implementation and sustainability of NSA interventions, an intervention package that features a CAS. The factors can either facilitate [facilitators] or hinder [barriers] implementation and sustainability of the interventions. Notably, as discussed in the previous chapter, sustainability and scaling-up both concern embedding the interventions and therefore, sustainability is viewed as an intrinsic component of scaling-up.

While this research covers a wide range of LMICs in the two systematic reviews, the empirical research will focus on two Asian countries: Bangladesh, and Lao People's Democratic Republic (hereafter: Laos).

3.2 Study design

This research used a multi-country mixed-methods design involving a multi-level investigation through

systematic reviews and multi-country case studies to understand the impact, pathways, and factors influencing NSA (barriers and facilitators). The cases in this study refer to the programs implementing NSA interventions in two Asian countries- Bangladesh and Laos, aimed at facilitating a robust analysis, thus enhancing the external validity of the findings [1, 2]. The research employed quantitative and qualitative methods to analyse both the outcomes and processes of NSA interventions [2].

3.3 Study setting

This study covered two categories of settings based on the type of data gathering: systematic reviews and country-specific case studies, as described in the following paragraphs.

We conducted two systematic reviews, which covered LMICs as classified by the World Bank in 2018 [2]. As described in the introduction, LMICs record a high prevalence of undernutrition and an inadequate diet. Low-income countries and lower-middle-income countries recorded 59.6% and 39.0% food insecurity, respectively. These regions also recorded a high prevalence of stunting and wasting in children under five years of age in 2020. The prevalence of stunting was 34.6% and 29.1% for low-income and lower-income countries, respectively. The prevalence of wasting was highest in lower-middle-income countries [9.9%] compared to low-income countries (6.9%) [3]. These countries also recorded a high prevalence of anaemia among women of reproductive age. The prevalence of anaemia in 2020 was 38.8% and 43.8% in low-income countries and lower-middle-income countries, respectively [3].

The country-specific case studies focused on the Asia region. Asia is the home to more than half of the undernourished (418 million) in 2020, 57 million more than in 2019 [3]. In 2020, the region also recorded the highest prevalence of wasting (9.3%, 32 million) as well as the highest number of stunted children (79 million) [3]. The region also comprised more than half of the total number of women of reproductive age with anaemia (380.7 million) in 2019 [3]. Food insecurity is also a highly prevalent problem in the region, as more than half of the total 2.37 billion people facing food insecurity (1.2 billion) live in the region [3] [4]. The region has the highest number of food-insecure populations. Indeed, the percentage of people with moderate or severe food insecurity in the region increased from 2017 onward [4]. Likewise, nutrient-rich diets are highly unaffordable for Asian populations. More than half of the total 3 billion people in the world who were not able to afford a healthy diet lived in Asia (1.85 billion) in 2019 [3].

The cases were narrowed further to two countries, namely Bangladesh and Laos. The rationale for this selection is grounded in four reasons: representation from diverse sub-regions, high prevalence of

undernutrition, the presence of NSA projects, and the willingness of project implementing partners. Firstly, the choice of Bangladesh and Laos aimed to achieve a balanced representation across sub-regions in Asia- Southern Asia (Bangladesh) and Southeast Asia (Laos). Both countries grapple with a significant burden of undernutrition. In Bangladesh, alarming rates of stunting and wasting among children below five years of age (30% and 9.8% respectively) and a substantial prevalence of anaemia among women of reproductive age (36.5%) underscores the severity of the issue [3]. Laos mirrors a similar concern, with significant proportions of stunting and wasting in children (30.2% and 9% respectively), and high rates of anaemia among women (39.5%) [3]. Thirdly, both countries were chosen due to the presence of NSA interventions. Bangladesh has achieved notable progress through a range of nutrition-specific and sensitive interventions, implementing various NSA programs such as homestead food production and biofortification [5] as well as reaching its policy commitments by endorsing several nutrition-related plans and policies [6]. The willingness to share lessons from Bangladesh's successful nutrition interventions highlights the potential for scaling up similar approaches in other countries [7]. Laos, too, has demonstrated its commitment to combat food insecurity and malnutrition through developing a road map as envisaged by the National Nutrition Strategy to 2025 and Plan of Action 2016–2020 as well as records substantial investments and multiple registered NSA projects [8]. Lastly, the willingness and active engagement of project implementing partners significantly influenced the selection. The established connections with key partners in Bangladesh (BRAC James P Grants School of Public Health, FAO) and Laos (SNV) facilitated the research process and strengthened the case selection. These four reasons justify the selection of Bangladesh and Laos for conducting case studies. Southern Bangladesh and Northern Laos were selected to represent topographical settings (see Figure 3.1).



Figure 3.1 Study setting (Southern Bangladesh in the left and Northern Laos in the right)

3.4 Case selection

The cases in this research refer to NSA programs implemented in Bangladesh and Laos. The programs were selected using two methods: exploratory interviews to identify NSA programs at the country level and case selection criteria to finalize at least one NSA program from one country. The exploratory phase was conducted to identify relevant cases by employing semi-structured exploratory interviews at the national level with stakeholders implementing NSA projects. The total number of interviews was thirty, comprising fourteen from Bangladesh and sixteen from Laos. The interviews were complemented with existing documents and guided by semi-structured tools. This phase resulted in a broad list of NSA projects implemented in Bangladesh and Laos. The interviews were conducted in Bangladesh and Laos in September-October 2018 and January 2019, respectively. The broad list of NSA programs selected in the exploratory phase was narrowed down to the selection of at least one program per country using an extensive methodology, as indicated in Box 3.1.

Box 3.1 Case selection criteria

1. Project characteristics

- NSA intervention: an agricultural project with an objective to improve nutrition, with at least one of the following outcomes: reduce undernutrition; improve dietary diversity.
- Nutrition activities: at least one project activity should include nutrition actions such as nutrition education and behaviour change communication.
- Target population: women and children from smallholder farming families
- Project duration: minimum project duration of three years

2. Availability of data: availability of baseline and endline quantitative data as well as all relevant documents for analysis

3. Stakeholders' willingness to support through the provision of data, technical/project-related information as well as non-monetary support during data collection and dissemination.

I played a pivotal role, in the capacity of an independent researcher to carry out the research independently but also utilizing the project generated data, reports, and information. The candidate utilized these resources to fulfil the objectives and requirements of their PhD thesis, leveraging the project's findings and insights to enrich the academic work with an aim to increase the societal impact of the studies we do by communicating findings to the project implementers.

The application of the criteria listed in box 3.1 resulted in the selection of three projects, of which one was a past NSA project, and two were ongoing NSA projects. The cases from Bangladesh were the

Integrated Agriculture and Health-Based Interventions (IAHBI) Project and the Sustainable Food Security, Agriculture, and Linkages (SaFaL) Program. The Enhancing Nutrition of Upland Farming Families (ENUFF) Project was selected from Laos. SaFaL Program from Bangladesh could not be included in the dissertation due to data and time constraints, resulting in two cases for inclusion: the IAHBI Project implemented in Bangladesh and the ENUFF Project implemented in Laos. Below, the cases are briefly described:

Case 1. The Integrated Agriculture and Health Based Interventions (IAHBI) Project, Southern Bangladesh

The IAHBI is a multisectoral project implemented by the Government of Bangladesh and an NGO partner, Sheba Manab Kallyan Kendra, with technical support from the Food and Agriculture Organization of the United Nations (FAO). The project was implemented in southern Bangladesh from September 2012 to September 2015. The implementation was led by the Department of Livestock Services of the Ministry of Fisheries and Livestock, with co-implementation by the Department of Agricultural Extension of the Ministry of Agriculture, the Food Planning and Monitoring Unit and the Directorate General of Food of the Ministry of Food, the Institute of Public Health Nutrition and the National Nutrition Services of the Ministry of Health, as well as the district and sub-district offices of the Ministry of Public Administration [9]. While the FAO provided technical support for NSA activities, the United Nations Children's Fund (UNICEF) provided technical support for nutrition-specific interventions [9]. The project received funding from the United States Agency for International Development (USAID)'s Feed the Future initiative [9].

The IAHBI project aimed to improve household food security as well as the nutritional status of children under five years of age, and pregnant and lactating women [9]. The project incorporated explicit nutrition objectives and actions within the agricultural activities of three agricultural sub-sectors (horticulture, livestock, and aquaculture). The project delivered integrated homestead food production gardens, training, nutrition education or behaviour change materials, demonstrations of healthy and diverse cooking, and community-based food preservation and processing [9]. The project area covered five sub-districts of southern Bangladesh for implementation: Dacope and Koyra of Khulna district, Muladi of Barishal district, and Assasuni and Shyamnagar of Satkhira district [9].

Case 2. The Enhancing Nutrition of Upland Farming Families (ENUFF) Project, Northern Laos

The Enhancing Nutrition of Upland Farming Families (ENUFF) Project aims to improve dietary practices among children under five years of age and women of reproductive age by: increasing the availability and

access to diverse nutritious foods, reducing the incidence of water, sanitation, and hygiene (WASH) related diseases, and strengthening the institutional framework at subnational levels [10]. Funded by the Swiss Agency for Development and Cooperation, the project is implemented by the Netherlands Development Organisation (SNV) together with Agrisud International, a local NGO named Rural Development Agency, and government partners [10,11]. The sub-national government offices, the provincial health departments and the district offices are involved in the implementation. The Provincial Agriculture and Forestry Office, Provincial Health Office and Lao Women's Union as well as their respective district offices implement the activities in the districts and villages by establishing the District Nutrition Team (DNT). The DNT comprises ten members from the District Health Office, the District Agriculture and Forestry Office, and the District Lao Women's Union. Village-level nutrition teams (VNTs) are also formed in each village to follow up on the beneficiaries' adoption of the project-promoted practices.

The ENUFF Project's convergence approach integrated agricultural production activities with social behaviour change communication to promote optimal nutrition and water, sanitation, and hygiene (WASH) practices [10, 11]. The agricultural activities mainly comprised crop production and livestock production activities. The focus of the crop activities was on home gardens and greenhouse activities and included fruit production and rice and legume production to a lesser extent. Nutrition and WASH social behaviour change communication (SBCC) was an integral component to enhancing nutrition sensitivity. Marketing and gender components were also included to some extent. The project activities are implemented in remote and ethnically diverse upland farming communities in four districts, Xiengkhor and Viengxay of Houaphanh province and Nga and Beng of Oudomxay province [10]. The project is implemented in two phases. While the first phase (April 2016–June 2020) targeted 4000 households from 40 villages [10], an additional 20 villages (2000 households) were added in the second phase (July 2020–June 2024) province [10]. For this case study, the results primarily draw from the first phase.

3.5 Participants and recruitment

Data for the case studies involved a broad range of stakeholders as participants aimed to collect holistic information on the project's impact pathways to nutrition as well as factors influencing the implementation and sustainability of NSA interventions. Key participants involved in the IAHBI Project case were project implementers from the government, NGOs and FAO, community members involved in the implementation and women beneficiaries from smallholder farming families. A total of 46 participants were recruited that represented different levels: implementers at the national, district and sub-district,

or union levels; community members indirectly involved in the implementation at the union level; and women beneficiaries (see Chapter 5).

This ENUFF project case involved four categories of participants that represented different geographical areas and levels: implementers, beneficiaries, school representatives and private sector representatives. The implementers were the stakeholders involved in project execution and represented government and non-government sectors at the national, provincial, district and village levels. A total of 101 participants were included, of which 58 were beneficiaries (see Chapter 6).

3.6 Data collection

The data collection method differed across systematic reviews and case studies.

Systematic reviews

The data for the systematic review studies were collected following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Guideline [12]. The data collection involved the extraction of existing studies using eligibility criteria (see Chapters 4 and 7). The data collected for systematic reviews covered two aspects: the project's effects on nutrition and barriers and facilitators to project implementation and /or sustainability. The data collection method used to study program effects slightly differed across the cases.

IAHBI Project case

The effects were analysed using secondary quantitative data collected by the IAHBI Project before [baseline] and after [end line] the implementation using household surveys (see Chapter 5). The qualitative data were collected using focus group discussions (FGDs) and semi-structured interviews (SSIs), guided by semi-structured tools. The tools were administered in the Bengali language. We conducted two FGDs with project beneficiaries, and 31 SSIs with implementers and community members indirectly involved in implementation. The qualitative data were collected from October, 2018 to January 2019.

ENUFF Project case

The ENUFF Project case also involved two categories of data (see Chapter 6). The effect on nutrition was analysed using five project documents. The qualitative data were collected to describe the factors

influencing the implementation of the ENUFF Project, using 11 FGDs and 34 SSIs. The FGDs and SSIs were guided by FGD tools and semi-structured tools, respectively, administered in the Laotian language. Translators were used in a few cases when beneficiaries only spoke the ethnic languages. The qualitative data were collected from January 2019 to February 2019.

3.7 Data analysis

The data analysis of two research questions is described in the following paragraphs.

Analysis of data relating to research question 1: Impact pathways

This research question was answered through an analysis that involved the integration of quantitative and qualitative methods, using a different approach for systematic reviews and case studies. The analysis of the impact and pathways mainly used variables and concepts outlined in the theoretical frameworks.

The variables and concepts mainly concerned two categories of data: impact on nutrition; and pathways leading from the interventions to the outcomes. The studies involved three broad nutrition outcomes: nutritional status measured using anthropometric measurements or micronutrient status; diet, health status, food consumption; and food access, care practices and healthy household environment [13]. The pathways' analysis initially hypothesized four pathways as indicated in the theoretical background [14-16] (see Figure 2.4): 1) food production; 2) agricultural income; 3) food prices; and 4) women's empowerment. The details on the outcome and pathways are presented in Chapters 4-6.

In the systematic review, data on impact were synthesized using studies that reported effects using quantitative methods. The impact pathways focused on the studies that applied either qualitative, quantitative, or both methods. The data were thematically analysed across the categories of outcomes and concepts of pathways described in the following paragraph.

While the data analysis in the case studies also integrated quantitative and qualitative components, the analysis slightly differed across the cases and included three key steps. The first step involved an analysis of the impact using either quantitative data or document analysis. In the case of the IAHBI Project, primary data analysis was carried out using IBM SPSS Statistics 27, employing two statistical tests. The Mann-Whitney test for non-normally distributed continuous dependent variables and binary logistic regression for categorical dependent variables. A P-value of less than 0.05 was considered statistically significant. In the case of the ENUFF Project, however, the data on the effects were analysed using the results reported in project documents rather than primary data analysis. The second step involved qualitative data analysis

on the pathways. The qualitative data collected in both projects were analysed in ATLAS.ti, employing both inductive and deductive approaches. The transcripts were first coded inductively without being guided by a framework. The codes were then deductively grouped into three pathways: food production, agricultural income, and women's empowerment. Any additional pathways identified were inductively coded and grouped into a different category. The pathways' analysis of the ENUFF Project involved an embedded case study that involved village-specific analysis merged into the overall analysis. The third step involved an integration of the quantitative aspects of the impact and the qualitative aspects of the pathways to construct impact pathways.

Analysis of data relating to the research question 2: Factors influencing the implementation and sustainability of NSA interventions

The concept of the factors used in the research was based on the consolidated framework for implementation research (CFIR), which categorized implementation across five domains: intervention characteristics, outer setting, inner setting, characteristics of individuals, and implementation process [17]. Chapters 7-9 address the research question within this framework, providing comprehensive insights into the factors influencing the implementation and sustainability. While the analysis used the CFIR, the analysis method differed across the systematic review and case studies. The systematic review first employed an inductive approach, followed by a deductive coding methodology. The systematic review focused the analysis on the first three domains of the implementation: intervention characteristics, outer setting, and inner setting. The case studies first involved inductive coding followed by deductive analysis. The transcripts were first coded openly without being guided by frameworks. The detailed factors that came through open coding were then categorized into the five domains by applying the CFIR [17].

A comparative analysis of the two cases was carried out to understand similarities and differences in the factors influencing the implementation and sustainability of NSA interventions. Any differences are discussed in the discussion of the dissertation.

3.8 Validity of research

Validity is an integral aspect of research, as it ensures whether the research is trustworthy and if it measures what it is supposed to measure [18]. This mixed-methods research involves various strategies to ensure its internal and external validity.

Internal validity “deals with the degree to which the researcher observes and measures what is supposed to be measured.” Pg. 258 [18]. This research used several strategies to enhance its internal validity. The inclusion of published peer-reviewed studies, mobilization of two independent researchers to select the studies and extract the data, and assessment of the quality of the studies aimed to improve the validity of systematic reviews. Case studies also involved different strategies to enhance the internal validity of data. The triangulation of data was achieved by involving multiple data collection methods such as FGDs, SSIs, and desk reviews, as well as quantitative data. The quantitative data used validated tools to collect data on nutrition outcomes. The recruitment of diverse participants, including implementers as well as beneficiaries, further enriched the quality of the data. Next, a peer examination was done, where technical experts in the field reviewed and commented on key findings. The use of participatory research with the involvement of experts on NSA also enhanced the validity of the research. Administration of the tools in local languages (Bangla in Bangladesh and Lao in Laos) and provision of adequate training to research assistants also enhanced the internal validity.

External validity concerns generalizability or the applicability of the study findings to other subjects or settings [18]. This research used different strategies to enhance the external validity of systematic reviews and case studies. Two systematic reviews conducted at the start of the research helped to understand the available knowledge about the NSA. The reviews resulted in theories on the impact pathways and the factors influencing implementation and sustainability. The link to theories from case studies also enhanced the basis for generalizability. A mixed-methods comparative case study of NSA projects located in two countries increases the basis for generalization [1, 2]. Impact pathway findings from this study can be extrapolated to similar intervention packages in different settings, along with factors that can resonate across multiple contexts. Furthermore, the selection of variables in the secondary quantitative data based on their validation in past studies also safeguarded their external validity.

3.9 Ethical Considerations

Three major strategies were applied to maintain ethical standards. First, the studies specific to Bangladesh and Lao PDR received ethical approval from their respective committees. The Bangladesh study received approval from the Institutional Review Board of the BRAC James P Grant School of Public Health, BRAC University (number 2018-019-ER). The study carried out in Lao PDR received approval from the National Ethics Committee for Health Research of the Lao Tropical and Public Health Institute under the Ministry of Health, Lao PDR (number 2019.5.MC). Second, written informed consent was obtained from the

participants. The participants were also provided with detailed information about the study including potential risks or harms, and they could withdraw from the study at any time without giving reason. Third, privacy and confidentiality were closely maintained while collecting and managing the data. The data were stored in a secure folder and were accessible only to the research team.

3.10 Outline of the studies

A total of six chapters [Chapters 4-9] report on individual studies conducted by applying the methods explained above. These chapters aim to answer two research questions listed in Chapter 2. The studies that aim to answer specific research questions are outlined in Table 3.1, as well as Chapters 4 to 9. These chapters are based on articles, of which four have already been published in international peer-reviewed journals.

Table 3.10 Outline of the studies

Research questions	Studies	Chapters
1. What is the impact of NSA interventions on diet and nutritional status, and what pathways lead from the interventions to improving nutritional status in low and middle-income countries?	1. Nutrition-Sensitive Agriculture: A Systematic Review of Impact Pathways to Nutrition Outcomes.	Chapter 4
	2. Pathways from integrated agriculture and health-based interventions to nutrition: A case from Southern Bangladesh.	Chapter 5
	3. Pathways to improving nutrition among upland farmers through nutrition-sensitive agriculture interventions: a case from Northern Laos.	Chapter 6
	4. Implementation and scale-up of nutrition-sensitive agriculture in low- and middle-income countries: a systematic review of what works, what doesn't work and why?	Chapter 7
2. What factors influence the implementation and sustainability of NSA interventions in low and middle-income countries?	5. What influences the implementation and sustainability of nutrition-sensitive agriculture interventions? A case study from Southern Bangladesh.	Chapter 8
	6. Factors affecting the implementation of nutrition-sensitive agriculture interventions: a case from Northern Laos.	Chapter 9

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CHAPTER 4. NUTRITION-SENSITIVE AGRICULTURE: A SYSTEMATIC REVIEW OF IMPACT PATHWAYS TO NUTRITION OUTCOMES



A vegetable plant on a farm in Southern Bangladesh

Published as

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Abstract

The role of agriculture in reducing undernutrition is widely recognized, yet there is also consensus on the need to make the sector nutrition sensitive. Evidence on the impact pathways from nutrition-sensitive agriculture [NSA] interventions-agricultural interventions with specific nutrition objectives and actions, detailing each temporal stage to reach nutrition outcomes, is limited, however. We thus synthesized study results regarding impact of NSA interventions on nutrition outcomes relating to undernutrition and constructed an impact pathway by mapping the evidence on each temporal stage from interventions to nutrition outcomes. We used Preferred Reporting Items for Systematic Reviews and Meta-Analyses to conduct and report our systematic review of studies on NSA interventions implemented in low and lower-middle-income countries [LMICs]. Forty-three studies that met the inclusion criteria were extracted and synthesized across impact and pathways analyses. We carried out a thematic analysis of the effect of NSA interventions using evidence-based indicators and constructed the pathways by adopting a published framework on agriculture to nutrition pathways. Our findings reveal that NSA interventions can significantly improve dietary practices and have the potential to enhance care practices and reduce occurrence of diseases, indicating their effectiveness in simultaneously addressing multiple determinants of undernutrition. However, NSA interventions have a lesser impact on nutritional status. NSA interventions lead to nutrition outcomes through five key pathways: food production, nutrition-related knowledge, agricultural income, women's empowerment and strengthening of local institutions. We emphasize the need to carefully design, implement and evaluate interventions with consideration for factors affecting impact pathways. Future research should focus on the effect of interventions combining multisector components, and pathways through non-food production-related income, women's empowerment, strengthening of local institutions, food prices at intervention level, and expenditure on healthcare.

4.1 Introduction

Undernutrition is a major global health problem, contributing to 45% of deaths among children under the age of five [1] and 21% of disability-adjusted life-years [2]. The effects of undernutrition are multifaceted and go beyond health and include reduced educational attainment and loss of productivity [3]. Children and women are most often adversely affected by undernutrition, with one in five children under the age of five having a low height for age, and 7.5% of children exhibiting wasting [4]. Likewise, anaemia among women remains globally high, with 32.8% anaemic in 2016, slightly increased from 31.6% in 2000 [4]. In addition, progress in addressing undernutrition is extremely slow, and countries are off-track in achieving the 2030 Sustainable Development Goals targets for reducing anaemia, childhood stunting and wasting [4]. More effective approaches are therefore needed to address the problem of undernutrition.

The agriculture sector can potentially play a crucial role in responding to undernutrition by directly addressing inadequate access to nutrient-rich food: a key underlying determinant of malnutrition [5-7]. Food- and agriculture-related factors contribute to a third of stunting [8], and the majority of the population in low and lower-middle income countries depends upon agriculture for their livelihoods [6, 9], which increases the role of agriculture sector to address the issue of undernutrition. The EAT-Lancet Commission also highlighted agriculture and the food system as a current major contributor to poor health and urged the transformation of food production and diets [10]. Past studies highlight the contribution of agriculture to nutrition outcomes through four key pathways: 1) agricultural production improving availability of and access to nutrient-rich foods [6, 8, 11-14], 2) agricultural income increasing purchasing power [6, 8, 11-14], 3) agricultural policies affecting food price [6, 11, 13] and 4) agricultural interventions empowering women to improve their nutrition outcomes and those of their children [12, 14].

There is a broad realization that agricultural interventions will have to become nutrition-sensitive to improve food access and attain global nutrition targets. One such approach has been the concept of nutrition-sensitive agriculture (NSA). NSA interventions go beyond the conventional idea of increasing food production by incorporating specific nutrition objectives and actions in the design and implementation of agriculture interventions [15, 16]. A review highlighted the potential of NSA interventions to address all underlying causes of undernutrition [17] identified in the framework of the United Nations Children's Fund (UNICEF): household food insecurity, inadequate care practices, lack of access to health services, and unhealthy household environments [7]. Thus, as a part of the broader multisectoral response to nutrition, NSA can shape not only dietary practices but also underlying health and environment-related causes that go beyond access to food [17].

While several studies published in the last 15 years have focused on agriculture interventions [6, 13, 14, 16, 18-25] and their impact on nutrition-related outcomes [6, 17-27], reviews have rarely explicated the impact pathways from agricultural interventions with specific nutrition objectives and actions detailing each temporal stage to reach nutrition outcomes. Five of these studies reviewed the impact and pathways of agriculture interventions to nutrition outcomes, irrespective of whether they included specific nutrition actions and objectives, and also have not detailed each stage from interventions to impact [13, 14, 19, 23, 27]. Some of these studies focused either on specific regions in South Asia [14, 19] or India [13], on a single pathway through women's empowerment [23] or on a single intervention on input subsidy [27]. Two reviews that looked exclusively at the interventions regarding specific nutrition objectives did not investigate temporal stage of pathways from interventions to nutrition outcomes [16, 22], while one of the two did not have a focus on LMICs [22]. Thus, there is limited evidence on the pathways depicting effect on each temporal stage from NSA interventions to nutrition outcomes: for example, from interventions to food production to income to food expenditure to dietary practices to nutritional status, or another pathway from interventions to women's empowerment to food expenditure to dietary practices to nutritional status. A couple of studies have also stressed the need for assessments of interventions that focus not only on their impact on nutritional status, but also on a full spectrum of underlying determinants [17, 25]. These include the effects such as food access, dietary practices, food security, women's empowerment, health environment and health status [17], and the pathways through which these interventions impact agriculture, nutrition-related practices and nutrition outcomes [17, 25].

To address these gaps, we systematically reviewed the evidence on agriculture interventions with specific nutrition objectives and actions. We synthesized the impact on nutrition outcomes relating to undernutrition, and constructed pathways by mapping the evidence on each temporal stage, from the interventions to the nutrition outcomes. Such evidence will help maximize the role agriculture can play in achieving long-term nutrition outcomes. Enhanced understanding of the impact pathways and their temporal progression can facilitate early identification of potential bottlenecks that may inhibit agriculture's full potential and stimulate adaptive actions during implementation of interventions. Furthermore, our evidence can prompt agricultural programs to pursue a broader spectrum of specific nutrition objectives beyond food production, thus simultaneously addressing multiple underlying causes of undernutrition.

4.2 Methods

4.2.1 Protocol and registration

We conducted this review using the guideline from Preferred Reporting Items for Systematic Reviews and Meta-Analyses [28], and registered the protocol in the International Prospective Register of Ongoing Systematic Reviews with number CRD42018108308 [29].

4.2.2 Search strategy

We systematically searched published studies in the electronic bibliographic databases PubMed, Embase, Web of Science and Scopus in three steps. First, we identified five search concepts: agriculture, nutrition outcome, multiple sectors, nutrition-sensitive interventions, and LMICs [29]. We then explored sub-concepts, for instance, homestead food production (HFP) [6, 14, 16, 18, 22], nutrition indicators, health sector, and countries within LMICs [30]. This resulted in the following general search syntax: ((agriculture general topic, value chains/value crops, (bio-) fortification, homestead production, livestock and dairy, water management, aquaculture, and agricultural extension) AND (food OR diet OR nutritional status) OR nutrition-sensitive interventions AND (multisector general topic, health, education, water, sanitation and hygiene, social protection, and natural resource management) AND LMICs). Third, we scanned the reference list of key articles, such as Ruel et al. (2018) [16], verified their inclusion in the search result, and expanded the syntax. Although this syntax may look complex, it allowed us to uncover a number of relevant and insightful articles not included in previous reviews, thus contributing to the body of evidence on this topic. The search strategy was piloted in PubMed in March 2019 and replicated in the other databases, as presented in the supplementary file of published chapter 4.

4.2.3 Eligibility criteria

As illustrated in Table 4.1, we used eight criteria to determine eligibility for inclusion: peer-reviewed, empirical studies published after 2000 in the English language, based on lower and middle-income countries, with specific participants, interventions, comparison, and outcomes [28]. The participants were women, children, or household members in general. Adapting from past reviews, NSA interventions were defined as, agriculture interventions with an objective to improve nutrition-outcomes and incorporate - specific nutrition actions to achieve the objective [6, 16]. We further limited the review to studies that used either a comparison between intervention and control, differences within a single population before and after interventions, or a cross-sectional comparison between beneficiaries and non-beneficiaries. The final inclusion criterion for studies was reporting on at least one of the three levels of outcomes

concerning undernutrition [17], namely: nutritional status, using biochemical or anthropometrical measurements; diet, health status/disease or food consumption; or food access, care practices and health environment.

4.2.4 Study selection

We exported search results to Endnote X8 software, where we removed duplicates, screened the titles and abstracts for eligibility, and read the remaining full texts for inclusion. The selection process, trialled by the first and second author during a preliminary search, yielded 25 articles and revealed a high inter-rater agreement. The preliminary search syntax included the effect on nutritional status and one other outcome, such as dietary practices. We subsequently refined the syntax, based on an insight from a past review that NSA interventions should measure impact on intermediate outcomes, such as dietary practices in addition to the nutritional status [17]. The selection that used the refined syntax was carried out by the first author and generated 43 articles for inclusion, including the original 25. We further grouped the studies into impact and pathways analyses, because not all studies reporting on impact detailed the elements of the pathways. That means we cannot say with a high level of certainty how and through which entry points (for example, food production, agricultural income) these interventions contributed to the nutrition outcomes (see Table 4.1). The impact analysis group included studies with a quantitative design that measured effects on nutrition outcomes, regardless of the information about the entry points to the pathways. The pathways' analysis, on the other hand, only included studies reporting two types of findings: 1) nutrition outcomes using either a quantitative or qualitative design, and 2) at least one entry point to pathways that led to nutrition outcomes, such as food production, agricultural income, food price and women's empowerment [6, 11, 13, 14, 16], or as emerged during data synthesis.

4.2.5 Data collection process

Data collection included the following information: publication details, study setting, study design, interventions, data collection method, study population, data analysis, nutrition outcome and pathways. The first two authors independently extracted data from 30% of the studies, with continuation by the first author in remaining studies and review from the second author.

4.2.6 Risk of bias assessment

We selected two tools to assess the risk of bias in reviewed studies. We used the tool developed by the Effective Public Health Practice Project for quantitative studies, as it uses a generic scale that is comparable across a range of study designs [31, 32]. Furthermore, we labelled the high-quality studies as

Table 4.1 Inclusion and exclusion criteria

Criterion	Included	Excluded	Screening phase applied	Rationale
Topic related to NSA	Topic relevant to NSA, such as nutrition, agriculture, or nutrition sensitive interventions.	Irrelevant topics, such as disease conditions, plant nutrient, arsenic contamination, etc.	Title screening	Relevance
Study characteristics				
Participants	Children and women of reproductive age or household-level impact in general, as reported by individual studies.	Populations with specific health conditions such as diseases, elderly and hospitalized patients.	Abstract and full text	Children and women are affected by undernutrition [5]. Household consumption is expected to affect maternal and child undernutrition [8]. Definition of NSA
Interventions	Agriculture interventions that incorporate specific nutrition-objectives and action; and addresses at least one of the following domains: health, environment [including WASH or natural resource management], education, and social and financial protection.	Agriculture interventions alone, without nutrition-specific objectives and action, and that do not go beyond agriculture sector.	Abstract and full text	interventions: incorporate specific nutrition-objectives and actions [6, 16], and address health, environment, education, social and financial dimensions [15].
Comparators	Studies comparing outcomes between different groups; or pre-intervention; or pre- and post-intervention within a single group.	One-time cross-sectional studies not comparing the effects between different groups; or same group before and after intervention	Abstract and full text	
Outcome	Impact on undernutrition: nutritional status using biochemical or anthropometrical measurements; diet, health status or food consumption; or food access, care practices or health environment, as described in protocol, based on evidence-based indicators [17].	Over nutrition status, such as obesity.	Abstract and full text	Presents evidence-based data on impact of agriculture on nutrition outcomes; evidence-based indicators [17].

Report characteristics			
Publication type	Peer-reviewed empirical studies	Meta-analysis and or reviews, grey literature, study protocols, opinion papers, discussion paper, commentaries, letters and editorials, conference abstracts.	Peer-reviewed articles are stronger in quality of content and methodology. Meta-analysis or reviews do not provide detailed insights on the empirical articles and therefore were excluded. The millennium development goals, a key milestone in nutrition, was endorsed in 2000.
Publication years	2000 and after		Abstract and full text
Language	English		Title screening
Location	LMICs, based on World Bank's classification [30].	Upper middle-income and high-income countries	Title, abstract, and full text
Inclusion for impact and pathways analysis ¹	The impact analysis included outcomes measured using correlation, chi-square, odds ratios [association], the difference in difference estimates, and treatment or intervention effects. We used p-values when the effect size was not available.		
Information on Impact	Studies reporting entry points of pathways from NSA to nutrition, such as food production, agricultural income, food price, women empowerment [11-14, 16], knowledge on nutrition, WASH and/or health.		
Information on pathways	Studies reporting on impact only without pathways		
			Full text
			Impacts alone do not give insights into the pathways

¹ This criterion emerged during analysis, because not all studies reporting on impact detailed on the elements of the pathways. For these, we cannot say with a high level of certainty how and through which entry points [for example food production or knowledge or income or women empowerment] these interventions contributed to the nutrition outcomes.

having a low risk of bias, medium quality as medium risk of bias, and low quality as high risk of bias. For qualitative studies, we applied the Critical Appraisal Skills Programme scale to rate the risk of bias as: 9-10 (low), 6-8 (medium) and <6 (high) [33].

4.2.7 Synthesis of results

We synthesized the impact and pathways analyses using two strategies. The impact analysis included the outcomes measured using correlation, chi-square, odds ratios (association), the difference in difference estimates, and treatment or intervention effects. We used p-values when the effect size was not available. The pathways' analysis involved a three-step process: 1) construction of pathways as reported in each study, 2) grouping individual pathways across similar intervention categories, and 3) merging interventions-based pathways into a consolidated framework. We constructed the pathways by adapting the framework of Kadiyala et al. (2014) [13] and mapped each element of the pathways across temporal stages. This framework recognizes six pathways: food production; agricultural income; food prices; women in agriculture, intra household decision-making and resource allocation; maternal employment in agriculture, childcare, and feeding; and women in agriculture and maternal nutrition and health status [13]. We repackaged the three gender-related pathways into one 'women's empowerment' pathway, as the studies reviewed focused on empowerment of women and lacked explicit information on agriculture-gender linkages.

We mapped the pathways constructed across each temporal stage of outputs; short-, medium- and long-term outcomes; and the impact using the logic model of the Strong Through Every Mile program [34]. Furthermore, we hypothesized that NSA interventions deliver outputs on food production [13, 35] and knowledge on nutrition, WASH or health [35], resulting in short-term outcomes on agricultural income/selling, food price, food preservation, processing and storage, nutrition-related attitude, and women's empowerment. The short-term outcomes precede the medium-term outcomes concerning the underlying determinants of malnutrition, namely care practices, household food security, household living environment, and services [7]. The medium-term outcomes contribute to long-term outcomes representing immediate causes of undernutrition and include dietary practices and diseases, eventually resulting in the impact on nutritional status [7]. For the elements not listed in the above category, we classified them as they emerged from the studies we reviewed.

4.3 Results

4.3.1 Study selection

The search of bibliographic databases retrieved 20,896 studies, resulting in the final inclusion of 43 articles that reported on the impact of NSA interventions [37] and their pathways to nutrition outcomes [29] (see Figure 4.1).

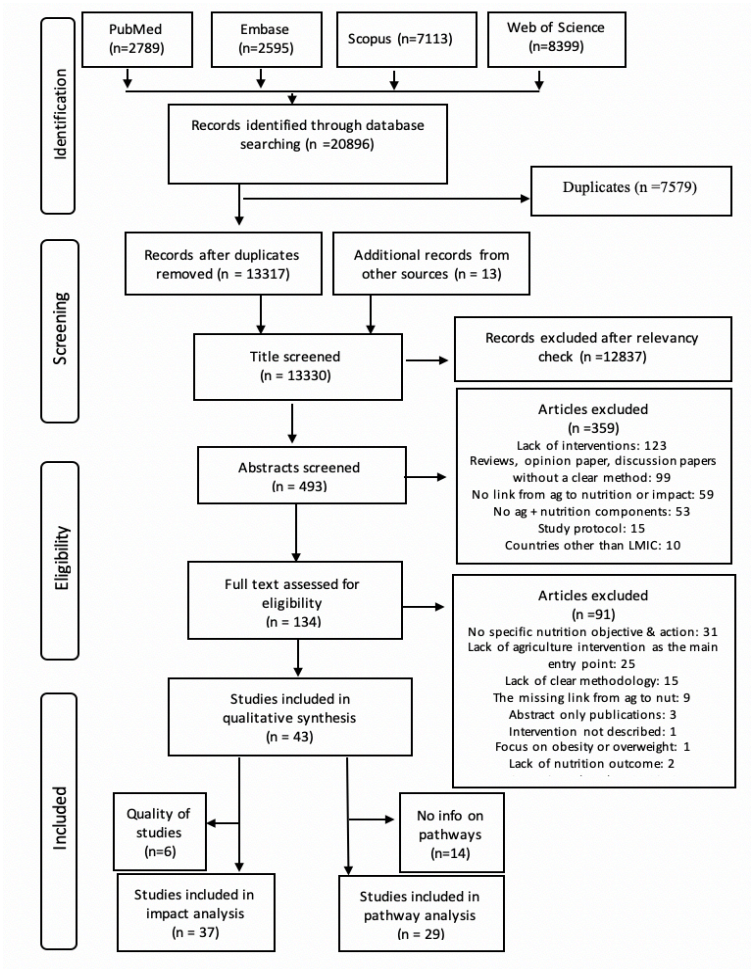


Figure 4.1. Study selection flow diagram

4.3.2 Study characteristics

Most studies used a quantitative design (n=39) and were published in 2017 (n=9). They represented 18 countries (see Figure 4.2) but were mostly from Mozambique (n=6). The quantitative studies included

randomized controlled trial/experiments (n=22), quasi-experiments (n=6), repeated cross-sectional designs (n=4), longitudinal/cohort studies (n=3), a one-time cross-sectional study comparing beneficiaries and controls (n=2), non-randomized interventions (n=1) and a pair-matched design (n=1). The studies reported 13 types of interventions and three categories of outcomes among children, women, men, adult, elderly, and sick persons. Thirty-six studies compared outcomes between intervention and control groups, or between beneficiaries and non-beneficiaries, while seven compared the effects within the same group before and after an intervention. Most studies using a quantitative design had a medium risk of bias (n=21), followed by high (n=15) and low (n=3) risk. All studies applying qualitative design had a medium risk of bias (n=3), and those employing mixed methods designs had a high risk of bias. Table 4.2 illustrates the study characteristics and findings, with details presented in the supplementary files of the published chapter 4.

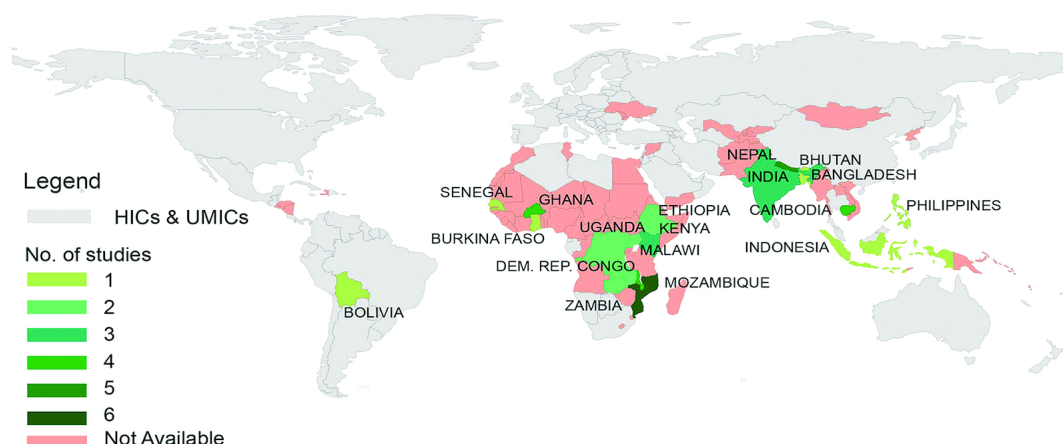


Figure 4.2 Distribution of studies across LMICs

4.3.3 Effects of NSA interventions on nutrition outcomes

The 37 studies included in the impact analysis reported 11 categories of interventions: HFP of vegetables and/or fruits and poultry (n=11); Orange-Fleshed Sweet Potato (OFSP) (n=8); HFP of vegetables and/or fruits, without poultry (n=4); vegetable and livestock (n=4); school garden (n=4); livestock focusing on the dairy goat (n=1); farm crop diversification (n=1); HFP of fish and vegetables (n=1); HFP of poultry (n=1); food production using a community-based early child development (ECD) centre (n=1); and mixed interventions on integrated food and livelihoods-based models, with nutrition-specific interventions and institutional delivery (n=1). All interventions included education or behaviour change communication (BCC) on nutrition; water, sanitation, and hygiene (WASH) and/or health, with some including gender,

health-service integration, and micronutrient supplementation.

The studies reported the effects of NSA interventions on outputs; their short-, medium- and long-term outcomes; and impacts. The outputs were food production, knowledge of nutrition/health/WASH, and service delivery. These outputs contributed to the short-term outcomes on agricultural income, attitude/preference on nutrition, women's empowerment, and household living environment. The interventions increased nutrition-related expenditure, household food security, and care practices in the medium term, which resulted in long-term outcomes on dietary practices and diseases, eventually contributing to the impact on nutritional status. The effects follow, with further details provided in Table 4.2 and the supplementary files of published chapter 4.

Outputs

The interventions reported on food production, knowledge on nutrition, WASH and health, and increased service delivery through increased opening days of the local institution. Twelve out of 14 studies reported improved production of at least one food item, but the effect varied across different food groups. The studies reported the increase in production of OFSP (3/3) [36-38] then vegetables (5/8) [39-43], legumes, nuts, and pulses (2/3) [37, 43], fruits (2/4) [39, 40] and animal source foods (ASF) [2/5] [37, 42]. Thirteen out of 14 studies reported improved knowledge of at least one topic related to nutrition, WASH or health, with diverse effects. All the studies reporting outcomes on knowledge of vitamin A [36, 44], general nutrition [38, 44-48] and health and nutrition-related diseases [44, 45, 49, 50] reported improvements. Only half of the studies looking at children's knowledge of nutrition (1/2) [51], and WASH (3/4) [40, 45, 51] documented improvements. Knowledge of Infant and Young Child Feeding (IYCF) varied across specific topics, with three out of four studies reporting improved knowledge on aspects of IYCF measured [37, 40, 43, 52]. Furthermore, an intervention delivered through a community-based childcare centre increased the number of opening days of the centre, with marginal improvement in enrolment of children [37].

Short-term outcomes

The interventions mostly improved income, nutrition-related attitude and preferences, and women's empowerment. Three out of four studies looking at the effect on income/selling showed improvements in food items, such as vegetables (2/3) [39, 43], OFSP [38] as well as a non-food item (cotton seed) [43]. Three studies reported changes in mothers' attitudes on meal preparation, mothers' ability to convince their children to eat vegetables (1/1) [45] and children's probability of consuming vegetables and fruits (2/2) [51, 53].

Table 4.2. Characteristics and findings of individual studies, NSA impact pathways to nutrition outcomes [*n* = 43]

Source; Country	Study design	Interventions	Results on pathways and impact	Impact analysis (n=38)	Pathway analysis (n=29)	Risk of bias
Berti & Cossio, 2017 (56); Bolivia	Non-randomized intervention	Poultry: inputs and training Nutrition education	<ul style="list-style-type: none"> ↑ Egg production (established in 80% of intervention HH²) ↑ Egg consumption, no impact on dairy, fruits, legumes, meat Iron: ↑ intake (mg/day), no change in mg/1000kcal; no impact on intake of energy, protein, calcium, zinc, thiamin, riboflavin, or niacin 	X	X	High
Birdi & Shah, 2015 (57); India	Longitudinal study (2-y follow-up)	Kitchen garden input IEC on nutrition	<ul style="list-style-type: none"> ↑ Kitchen garden practice (fruits & vegetables) in all seasons. ↑ GLV variety, no change in quantity ↑ Consumption of fruits and eggs, no change in variety of cereals & pulses No impact on using intervention plants in weaning 		X	High
Bushamuka et al., 2005 (39); Bangladesh	One time cross-sectional	Homestead gardening, nutrition education sessions and gender interventions	<ul style="list-style-type: none"> ↑ Production & diversification of vegetables & fruits ↑ Income and ↑ spending on food, health, education, clothing, productive assets, housing, and social activities ↑ WE: participation in group meetings, determining daily workload, visiting stores/markets, economic contribution to HH & decision-making. ↑ Consumption of vegetables & fruits at household 	X	X	High
Diana et al., 2014(46); Indonesia	Quasi-experimental study	1) Intervention: HG inputs & nutrition extension 2) Control: no interventions	<ul style="list-style-type: none"> No impact on size of home garden ↑ Nutrition knowledge in intervention group 	X	X	High

² AGP, acid glycoprotein; ARI, acute respiratory infection; ASF, animal source food; BCC, behaviour change communication; BF, breastfeeding; BMI, body mass index; ben., beneficiary; CBCC, community-based childcare centre; CDD, children's dietary diversity; CMAM, childhood management of acute malnutrition; CRP, C-reactive protein; DDS, dietary diversity score; DR, Democratic Republic; EBF, exclusive breastfeeding; EHFP, enhanced homestead food production; FCHV, female community health volunteer; F2F; Farmers-to-Farmers; FFS, farmer field school; GLV, green leafy vegetable; HAZ, height-for-age z-score; Hb, haemoglobin; HC, health centre; HDDS, household dietary diversity score; HFIAS, household food insecurity access scale; HFP, homestead food production; HG, home garden; HH, household; HW, health worker; IEC, information, education, and communication; IFA, iron-folic acid; IP, intense participation; IYCF, infant and young child feeding; IYCN, infant and young child nutrition; kcal; kilocalorie; KG, kitchen garden; LAZ, length-for-age z-score; LMICs, low and lower-middle-income countries; MAD, minimum acceptable diet; MAR, mean adequacy ratio; MDD, minimum dietary diversity; MMMA, minimum micronutrient density adequacy; MMF, minimum meal frequency; MUAC, mid-upper arm circumference; MNP, micronutrient powder; MUAC, mid-upper arm circumference; NSA, nutrition-sensitive agriculture; OFSP, orange-fleshed sweet potato; OWL, old women leader; PM2A, preventing malnutrition in children under 2 approach; RAE, retinol activity equivalents; RBP, retinol binding protein; RCT, randomized controlled trial; RP, reduced participation; SAM, severe acute malnutrition; VAD, vitamin A deficiency; WASH, water, sanitation and hygiene; WAZ, weight-for-age z-score; WDDS, women's dietary diversity score; WE, women empowerment; WEG, women empowerment group; WHZ, weight-for-height z-score; ↑, increase, positive difference; ↓, decrease, positive difference

Marquis et al., 2018; (63) Ghana	Cluster RCT	1) Intervention: Inputs and training on HG and poultry; nutrition & health education; 2) Control	<p>↑ Complementary feeding</p> <p>↑ Hand-washing practice of caregivers and children</p> <p>No impact on access to sanitation facility</p> <p>Pathways not reported</p> <p>↑ MDD, no change in consumption of egg</p> <p>↑ LAZ/HAZ score, ↑ WAZ score</p> <p>No difference in WIZ/WHZ score</p>	X		Low
Murty, Rao, & Bamji, 2016; (50) India	Repeated cross-sectional design	Training and inputs on HG, crop diversification & backyard poultry Health & nutrition messaging	<p>↑ Vegetables & fruits garden & poultry rearing</p> <p>↑ Knowledge on eating more food by pregnant women & cause of diseases</p> <p>↑ Income from veg, selling of fertilized egg</p> <p>↑ Frequency of GLV cooked & HH cooking GLV > 3 times</p> <p>↑ Egg consumption- frequency & quantity</p> <p>↑ Practices on IYCF (EBF, complementary feeding & ↓ pre-lacteal feeding)</p> <p>↑ Mother's hand washing with soap before child feeding</p> <p>No impact on access to bathroom & latrine</p> <p>↓ Underweight, no impact on birth weight</p>	X	X	High
Olney et al. 2009; (41) Cambodia	Repeated cross-sectional design	Training and inputs on homestead production (vegetable, poultry/duck) Nutrition education	<p>↑ Vegetables production, no impact on animal or fruits production or ownership</p> <p>Household: ↑ DDS, consumption of dark green leafy veg, not on consumption of non-dark leafy veg or ASF</p> <p>Children: No impact on DDS, ↑ Consumption of egg</p> <p>Children: No impact on Hb, anaemia or diarrhoea, ↓ Prevalence of fever</p> <p>No impact on stunting, wasting or underweight, or HAZ, WHZ, WAZ</p> <p>Women: no impact on DDS or consumption of micronutrient rich foods, No impact on Hb, diarrhoea, weight or BMI</p>	X	X	High
Olney et al., 2013 (35) Cambodia	Qualitative design	Training & inputs on homestead production (vegetable & poultry/duck) Health and nutrition education	<p>↑ Production of vegetable, fruits & poultry</p> <p>↑ Knowledge on BF, food to add in porridge, safe food prep., but limited knowledge on complementary feeding, need of more fluids to sick children</p> <p>↑ Knowledge on micronutrient, limited knowledge on anaemia</p> <p>↑ Income from vegetable, less income from fruits & poultry</p> <p>↑ Consumption of veg, poultry meat; less consumption of fruit & eggs from market</p> <p>Children: ↑ consumption rich-porridge, marginal ↑ handwashing practices</p>	X		Medium
Olney et al., 2015; (40) Burkina Faso	Cluster RCT	1) Control: without interventions 2) E-HFP incl. poultry, BCC-WE led by OWL 3) E-HFP incl. poultry, BCC-WE led by HC members	<p>↑ Production of Vitamin A rich fruits & veg & other fruits</p> <p>↑ Knowledge on need of liquid and semisolid at 6 mo</p> <p>↑ Knowledge on washing hands before feeding child, no change in other attributes of handwashing knowledge</p>	X	X	Medium

			Marginal ↑HDDS in group 3		
			Marginal ↑MDD (6-12.9 mo) in group 3, no impact on iron rich food intake ↑ Hb for 3-5.9 mo child & marginal ↑ Hb for 3-12.9-month child in group 3 ↓ Anaemia in group 3 (3-5.9 mo child), no impact in others ↓ Diarrhea for 3-12.9 mo child in group 3 Marginal ↓in wasting in group 3 (3-12.9 mo), no impact on stunting or underweight		
			WE: ↑ Total WE score, meeting with other women & purchasing decision, marginal ↑ health care decision, no impact on spousal communication, social support, family planning decision or decision on IYCF Household: Food expenditure, no impact on HDDS, ↑consumption of fish and seafoods, fruits, marginal ↑ consumption of meat & poultry, no impact on consumption of veg, milk & dairy, legumes, nuts & pulses, oils & fats Mothers: Marginal ↑ DDS, ↑consumption of fruit, cereals, grain marginal ↑intake of meat/poultry, no impact on consumption of veg, milk/dairy, eggs, fish & seafoods, oil, fats, legumes, nuts & seeds, roots & tubers Mothers: ↓underweight, ↑ BMI for underweight women in baseline	X	Medium
Olney et al., 2016; (55)	Cluster RCT	1) Control: without interventions 2) E-HFP incl. poultry, BCC-WE led by OWL 3) E-HFP incl. poultry, BCC-WE led by HC members Analysis: intervention 1 and 2 versus control			
Burkina Faso					
Osei et al., 2015; (64)	Prospective cluster RCT	1) EHFP including poultry and MNP supplementation 2) EHFP including poultry 3) control-no interventions	Pathways not reported No impact on fever, no significant ↓ on Hb or anaemia in children ↓ Diarrhoea in children for EHFP, no impact for EHFP+MNP No impact on fever, stunting, wasting or underweight in children	X	Low
Osei et al., 2017; (42)	RCT	Intervention: training and inputs on HG and poultry; Nutrition education by FCHVs; public health services participation Control: no interventions	↑ EHFP on veg & /or poultry ↓ No. of food insecure HHs Children: ↑ colostrum feeding & EBF, ↑ MDD, MMF & MAD ↓ anaemia among children 0-23 mo No impact on stunting, wasting or underweight Women: ↓ anaemia & underweight	X	Medium
Nepal					
Michaux et al., 2019; (65)	RCT	1) EHFP: HG training & inputs; BCC-nutrition, hygiene; WE, marketing 2) EHFP & fish training & inputs, pond establish /rehabilitate; 3) Control	Pathways not reported Children: marginal ↑ Hb in group 2, & 1, ↓ anaemia in group1, no impact on stunting, wasting or underweight Women: no impact on Hb or anaemia ↑ RBP concentration in group 2, no impact on ferritin, serum zinc, AGP, CRP No impact on women's underweight based on BMI	X	Medium
Cambodia					
Kuchenbecker et al., 2017; (66)	RCT	Control: agriculture only Intervention: Ag (inputs & training for crop and livestock);	No change in production Children: ↑ consumption of eggs & groundnuts, no impact on consumption of flesh food, fruits & vegetables, dairy products, legumes or other nuts	X	Medium
Malawi					

Kumar et al., 2018; (52)Zambia	Cluster RCT	Nutrition (IYCF and education sessions)	Children: ↑ MDD & MAD, no impact on MMF, ↑ access to improved sanitation, no change in the access to drinking water source Children: no impact on HAZ, WHZ or WAZ Mothers: no impact on BMI		
		1) Intervention: Ag-gender 2) Intervention: Ag-gender- BCC Ag: inputs & training on HG, & livestock; BCC: IYCF, hygiene, health seeking behaviour Gender: gender equity & WE 3) Control: standard government services	WE (for combined interventions vs. control): ↑ Social capital, asset access, financial empowerment & agriculture empowerment; no impact on decision-making, spousal relationship, gender equality, asset selling; decrease on buying power & time for domestic work & child care, ↑ agricultural time ↑ Knowledge on BF varying, no difference in practice (score) ↑ MMF: group 2 vs 1, no impact; MDD, MAD, iron-rich food consumption ↓cough/cold/diarrhoea/ for group 2 vs. 1, no differential impact on fever ↑ WHZ score: group 1 vs 3, no impact on HAZ score, wasting or stunting	X	High
		Pool all treatment survey 1) Intervention: Ag-gender 2) Intervention: Ag-gender- BCC Ag: inputs & training on HG, & livestock BCC: IYCF, hygiene, health seeking behaviour gender: gender equity & WE; 3) Control: standard government servicers only	↑ agricultural production diversity & production of groundnuts, rape, tomatoes, no increase in meat and fish production ↑ Cotton seeds production (not targeted by project) Income/selling from non-food-cotton and food-based agriculture from selling of targeted crops HH: ↑ Total food groups consumption, incl. pulses, legumes & nuts, meat & fish, no effect on egg or vegetables/fruits No impact on hunger scale & food insecurity Children: ↑ consumption of pulses, legumes & nuts, no effect on egg, vegetables or fruits, or total food groups consumption, or dietary diversity Women: no impact on total food groups consumption, or dietary diversity	X	High
Reinbott et al., 2015; (67) Cambodia	RCT	1) Intervention: Agriculture & nutrition Agriculture - inputs & training Nutrition: IYCF promotion & nutrition education sessions 2) Control: agriculture only	No impact on ownership of animals, access to fruit or HG No impact on HDDS Children: ↑ DDS & MAD, no impact on MMF Children: ↑ Consumption of vitamin A rich foods & other fruits & veg, no impact on the consumption of ASF No difference on introduction of semi-solid foods at 6 mos, or access to sanitation facility or drinking water source at endline No difference on fever, diarrhoea or ARI at endline, in children No difference on HAZ, WHZ or WAZ scores at endline, in children	X	Medium
		Interventions: agricultural component-OFSP vine distribution, extension & agronomics training, Nutrition education	Pathways not reported ↑ VA density in diet & dietary diversity, higher diversity for more intense participation in nutrition and agriculture ↑ MMDA, ↑ MMMA for HHs & women with nutrition promoters, ↑ Dietary diversity score-higher for ones with nutrition, promoter No impact on wasting/ WHZ score	X	Medium

		Groups: 1) intensive and; 2) less intensive treatments		
De Braw et al., 2018; (36) Mozambique Uganda	Randomized field experiments trial	1) OFSP vine distribution & nutrition training for 2 y 2) OFSP vine distribution for 2 y., nutrition training in y 1 only; 3) Control	<p>↑ OFSP adoption, total area for OFSP knowledge</p> <p>↑ Knowledge no. vitamin A & OFSP as a source of vitamin A</p> <p>Knowledge has no significant effect on adoption</p> <p>Children: ↑ dietary intake of vitamin A</p>	Medium
Girard et al., 2017; (44) Kenya	Longitudinal cohort study	1) Intervention: clinic-based nutrition counselling linked to OFSP & crop 2) Control group: clinic-based nutrition counselling	<p>↑ Knowledge: on nutrition, health & vitamin A, no impact on IYCF knowledge</p> <p>Women: ↑ consumption of VA rich fruits & veg, ↑ intake of B-carotene & VA, no impact on energy intake, or WDDS</p> <p>Women: ↑ VA adequacy, ↓ Odds of low RBP, no impact on mean RBP</p> <p>↓ Odds of anaemia in late pregnancy only, no impact for the overall follow-up period, no impact on Hb or mean MUAC</p>	Medium
Hotz et al., 2011; (69) Mozambique	Randomized, controlled effectiveness study	Intervention: OFSP vine, distribution, nutrition education & marketing 2 interventions: 1) Low-intensity: 1 y training; 2) High intensity 3 y training; 3) Control	<p>Pathways not reported</p> <p>Impact in children and women</p> <p>↑ OFSP consumption in both, ↑ vitamin A intake from OSFP in interventions</p> <p>Lower change inacin intake in grp 2 among 3-5.5 yrs. children</p> <p>No impact on children's intake of protein, lipid, ca, fe, Zn, vitamin C, thiamin, riboflavin or vitamin B12</p> <p>↓ Prevalence of inadequate VA intake in children (12-35 mo) & women</p>	Medium
Hotz et al., 2012; (70) Uganda	Randomized controlled effectiveness study	1) Intervention 1: OFSP vines, agriculture & nutrition & health BCC for 2 y (IP); 2) Intervention 2: OFSP vines for 2 y, nutrition & health BCC in y 1 only (RP); 3) Control	<p>Pathways not reported</p> <p>↑ OFSP & Vitamin. A intake in IP and RP</p> <p>↓ Prevalence of inadequate VA for children 6-35 mos</p> <p>No impact on prevalence of infection based on elevated CRP for children 3-5 y or women (IP vs control), ↓ Prevalence of low serum retinol for children in IP, No impact on serum retinol for women, ↓ prevalence of inadequate vitamin. A for women, no difference in treatment groups</p>	Medium
Jones & De Brauw, 2015; (47) Mozambique	Cluster RCT	1) Intervention: OFSP inputs (vines) & training; demand creation on OFSP, general health messages; & marketing; 2) Control	<p>Pathways not reported</p> <p>Impact in children</p> <p>↓ Prevalence of diarrhoea among children</p> <p>Children eating OSP were less likely to experience diarrhoea</p> <p>↓ Duration of diarrhoea among children < 3 y</p>	Medium
Low et al., 2007 (38) Mozambique	Quasi-experimental prospective longitudinal	1) Interventions OFSP production storage, & commercialization Nutrition and hygiene education, 2) Control	<p>↑ Production and selling of sweet potato</p> <p>↑ Knowledge on nutrition, more for intervention women & men</p> <p>Impact in children:</p> <p>↑ Consumption of OFSP, and intake of vitamin A, energy, protein, B-carotene,</p>	Low

Low et al., 2007 (48) Mozambique	Quasi-experimental intervention design	1) Interventions OFSP production storage, & commercialization Nutrition and hygiene education, 2) Control	<p>thiamin, riboflavin, vitamin B6, vitamin C, folate, iron; no change in ca intake ↑ Serum retinol, ↓Prevalence of low serum retinol, no impact on CRP ↓ Prevalence of wasting & underweight, no impact on stunting</p> <p>↑ OFSP production, preservation, storage & processing ↑ OFSP selling, ↑ OFSP purchase, mixed impact on expenditure ↑ Job opportunities, highest net returns to labour ↑ Nutritional knowledge Vitamin A ↑ Consumption of OFSP, dark GLVs, groundnuts, beans in children, but no change: chicken, fresh fish ↑ Intake of vitamin A, energy, B carotene, riboflavin, vitamin B6, vitamin C, thiamin, niacin, folate, iron, in children No impact on intake of vitamin B12, calcium, and zinc, in children ↑ Dietary diversity in children; diet diversification was limited by difficult agroecological conditions and low purchasing power.</p>	X	X	High
Kassa et al., 2003 (71) Ethiopia	Cross sectional surveys and qualitative methods	Dairy goat husbandry training, revolving credit 1) crossbred goat; 2) local goat; & 3) controls), animal HW support, & nutrition education	<p>↑ Ownership of goat, no impact on sheep, chicken ↑ Milk consumption in adults, less milk available for children, no impact on consumption of VA rich ASF ↓ Stunting and underweight in children, no impact on wasting</p>		X	High
Le Port et al., 2017; (49) Senegal	Cluster RCT	1) Intervention: iron fortification (yogurt value chain); ENA BCC, home visits, social mobilization; 2) Control: BCC	<p>↑ Knowledge on health consequences of anaemia & dietary sources of iron ↑ Hb concentration in children, more in intervention group, greater impact for boys, compared to girls No impact on prevalence of anaemia or severe anaemia</p>	X	X	Medium
Kerr, Berti, & Shumba, 2010; (72) Malawi	Quasi-experimental design	Interventions: Legume intercrops, gender & nutrition education sessions; & Control	<p>Pathways not reported ↑ WAZ score for longest involved villages & most intensely involved villages</p>	X		High
Kerr & Chilanga, 2016 (73) Malawi	Qualitative Quasi-experimental design	Agricultural & nutrition education, legume intercrops, gender & nutrition education (participatory/recipe day intervention)	<p>Knowledge: ↑ knowledge on nutrition and health Women empowerment: ↑ resource access, gender norms ↑ Consumption of variety of foods in children</p>		X	Medium
Agdeppa et al., 2019; (45) Philippines	Cluster RCT	1) School 1. Iron fortified rice supplementation 2) School 2. Non-fortified rice supplementation of Both schools: gardening,	<p>↑ Types and quantity of veg used in feeding ↑ HHs purchase fortified foods ↑ Post exam lessons on nutrition, food fortification, hygiene & health, no impact on the knowledge on foods needed by school children ↑ Attitude on meal preparation & cooking vegetables</p>	X	X	Medium

	health, hygiene & nutrition education, meal planning, preparation, and cooking		Knowledge & practices of the mothers associated with children's weight ↑ Mean Hb level in school 1; ↓ Prevalence of anaemia in school 1 ↓ Underweight (school 2), & stunting (school 1); no impact on wasting Mothers: ↑ Purchase of fortified foods, ↑ Practice of washing veg before use		
Erismann et al., 2017; (74)	Cluster RCT	1) Intervention: Agri inputs & training; WASH facilities; hygiene & nutrition training; treatment of anaemia or intestinal infections 2) Control: treatment of anaemia or intestinal infections	Pathways not reported ↑ Safe handwashing practices before eating ↑ use of latrines at school No impact on HH water quality parameter ↓ Intestinal parasitic infections but no impact on helminth infections No impact on anaemia reduction, weight gain or height gain	X	Medium
Burkina Faso					
Schreinemachers et al., 2017a; (51)	Cluster RCT	1) Intervention: school garden, curriculum on gardening, nutrition & WASH, nutrition promotion & handwashing; 2) Control	↑ Knowledge on sustainable agriculture, food, nutrition & WASH ↑ Preference of fruits & veg No impact on consumption of fruits & vegetables, or HAZ score	X	Medium
Nepal					
Schreinemachers et al., 2017b; (53)	RCT	1) Intervention schools: School garden; BCC/education on ag, nutrition & WASH; promotional 2) Control	↑ Awareness on sustainable agriculture and % of fruits & veg correctly named, no impact on knowledge on food, nutrition or WASH; ↑ Preference of fruits & veg Selling of garden produce to school meal program Children: ↑ Consumption of veg no impact on consumption of fruit, ↑ consumption of variety of veg & fruit for children with home garden No impact on HAZ score	X	Medium
Bhutan					
Gelli et al., 2018; (37)	RCT	1) Intervention: agriculture, nutrition, ECD Ag: Foods production & diversification; CBCC gardens; food processing; seeds & chicks' provision Nutrition: meal preparation & provision, feeding young children 2) Control: ECD only	↑ Crop production variety/diversity, production of OFSP, soya beans, pigeon peas & groundnuts, reduced production of brown bean ↑ Production of eggs & ownership of chickens No effects on household expenditures ↑ Care giver's IYCF knowledge; ↑ food groups knowledge score ↑ No. of days CBCC open & no. of meal providing days in CBCC, marginal ↑ CBCC enrolment, no impact on attendance ↑ Dietary intake of food quantity, energy, protein, iron, zinc, vitamin C, vitamin B 6, vitamin B 12, no impact on dietary intake of vitamin A/RAE ↑ dietary diversity & food variety ↓ Stunting among younger siblings- 6-24 mo, no impact in preschools (36-72 mo); no impact on underweight, WAZ score, wasting or WHZ score	X	Medium
Malawi					
Roche et al., 2017; (75)	Qualitative design	Establish local grain bank: processing techniques, home fortification, complementary	Production of processed grain banks flour, income, purchase of complementary food Mother's knowledge on complementary feeding, mother's perception on the	X	Medium

Ethiopia	food-entry point for IYCF (mobilization of health workers and women's groups)	benefit of grain bank food & grandmother's perception on the importance of IYCF time saving for women Flour consumption by pregnant & lactating women, elderly & sick person Complementary feeding practices Perceived decrease in prevalence of malnutrition		
Kalavathi et al., 2010; (76) India	Financial support (intercropping, nutrition gardening, nursery establishment, livestock rearing, azolla cultivation) Training on the production of high value products (baby foods & other nutritional foods from locally available raw materials)	<ul style="list-style-type: none"> ↑ Homestead backyard gardening, livestock/fish/ poultry rearing ↑ Income from intercropping, livestock & processing, poverty reduction ↑ Food processing, ↑ food security ↑ Consumption of fish, vegetables other than GLV, fruits, milk products Perceived ↑ nutrition security (NOT based on growth measurement) ↑ Egg consumption, ↑ Dietary diversity of children and adults 	X	High
Fanzo et al., 2010; (77) Kenya	Food & livelihood: livestock, fish, home grown school meal, school garden, food processing, storage & cooking, IYCF promotion, CWAM, school nutrition (e.g. deworming), growth monitoring, VA, IFA & zinc supplement, treatment of SAM, institutional delivery	<ul style="list-style-type: none"> Pathways not reported ↓ Food insecurity ↑ Daily consumption of VA rich animal product, no impact on VA rich plant products, ↑ Food variety score week, no. of daily meals & mean DDS No impact on vitamin A, supplementation in children ↓ VAD in children < 5 yrs., ↓ Stunting & Underweight in children < 2 yrs., no impact on wasting No impact on VAD in women 13-49 yrs. 	X	High

Four studies also reported improvement in at least one domain of women's empowerment. Specifically, the interventions improved women's involvement in decision-making (3/4) [39, 54, 55] on purchasing (3/3) [39, 54, 55]. However, interventions did not improve women's decision-making on health care [54, 55], family planning [54, 55], or IYCF [55], perception of gender equality, or control over selling [52]. Additionally, interventions improved women's agriculture empowerment score (1/1) [52], access to money or financial empowerment (1/1) [52], economic contributions to household income (1/1) [39], social status or social capital score (2/3) [39, 52], spousal communication and relationship (1/3) [54], and time allocation or self-determination of daily workload (1/1) [39]. One study reported increased time allocation in agriculture but decrease in time in domestic work and childcare practices and buying power [52].

Medium-term outcomes

In the medium term, the studies reported effects on household living environment, household food security, nutrition-related expenditure, and children's care practices. The impact on the household living environment was less strong, as only one of the four studies reported improved access to hygiene and sanitation facilities [66], with no impact on access to drinking water sources (0/2) [66, 67] or water quality (0/1) [74]. The interventions improved household food security (3/5) [42, 59, 77] increased expenditure on food (3/6) [39, 45, 55] and healthcare (1/1) [39], and reduced expenses for vegetables due to increased production (1/1) [46]. The interventions further improved children's care practices and IYCF, especially breastfeeding and complementary feeding (2/5) [42, 50] and handwashing (2/2) [62, 74]. However, studies lacked evidence regarding the effect on women's care practices, except for caregivers' handwashing practices (1/1) [62].

Long-term outcomes

NSA interventions had positive effects on long-term outcomes regarding dietary practices [food consumption, dietary diversity and nutrient intake] and diseases, with less strong effects among women compared to children. The interventions improved children's consumption of OFSP (4/4) [38, 48, 69, 70] and vegetables (3/7) [48, 53, 67], fruits (2/6) [48, 67], ASF (4/8) [41, 56, 60, 66] and pulses, legumes and nuts (2/3) [43, 60]. The studies reported improved household consumption of vegetables (3/7) [39, 41, 62], fruits (3/5) [39, 55, 62] ASF (3/6) [50, 55, 77] and pulses, legumes and nuts (1/2) [43]. The effect on consumption in women was reported for fruits (2/4) [44, 55], OFSP (2/2) [69, 70], vegetables (1/4) [44] or ASF (2/4) [56, 60]. The interventions also improved children's dietary diversity (9/13) [37, 42, 48, 58,

60, 63, 66-68], minimum acceptable diet (4/5) [42, 58, 66, 67], and minimum meal frequency (3/5) [42, 52, 58], followed by dietary diversity at the household level (3/6) [41, 59, 77], yet lacked a strong effect among women (0/5) [41, 43, 44, 55, 60]. Likewise, the effect on nutrient intake was also stronger for children compared to women. The interventions improved the nutrient adequacy ratio of children (1/2) [68], with no effect on women [60]. In children, the interventions further increased intake of vitamin A (6/7) [36, 38, 48, 68-70], iron (3/5) [37, 38, 48] vitamin B6 (3/3) [37, 38, 48], zinc (1/5) [37] thiamine and/or niacin (2/4) [38, 48], riboflavin (2/4) [38, 48], energy (3/4) [37, 38, 48] and protein (3/5) [37, 38, 48] with no change in calcium [38, 48, 56, 69]. Four studies reported nutrient intake for women, with improvements in vitamin A (3/3) [44, 69, 70] and B-carotene (1/1) [44], yet with no evidence of effect on the intake of energy [44, 56], iron, protein, calcium, zinc, thiamine, riboflavin, or niacin [56]. In children, a few studies documented reductions in diarrhoea (4/7) [40, 47, 52, 64], fever (1/4) [41] or acute respiratory infections/ colds and cough (1/2) [52] with a mixed effect on intestinal parasitic infections [74]. One study reported that children consuming OFSP were 15.9 percentage points less likely to experience diarrhoea [47]. Among women, one study reported no difference in the prevalence of diarrhoea [41]. Two studies reported mixed effects based on a combination of a third intervention component with agricultural production and nutrition-related education. An EHFP intervention alone reduced diarrhoea among children, while there was no effect after adding micronutrient powder [64]. Further, a school-based intervention integrating installation of WASH facilities reduced intestinal parasitic infections but not the helminth infection [74].

Impact

The impact of NSA interventions is less strong for nutritional status based on anthropometrical measurements compared to micronutrient status. Eight out of 12 studies reported improvements in childhood micronutrient status [38, 40, 42, 45, 49, 65, 70, 77], by either increasing haemoglobin (3/8) [40, 45, 49] or reducing anaemia (4/8) [40, 42, 45, 65] low serum retinol/vitamin A deficiency (3/3) [38, 70, 77]. For anthropometric indices among children, seven out of 21 studies reported improvements in nutritional status [37, 38, 45, 50, 63, 72, 77]. Studies reported the reduction of underweight/weight-for-age z-scores (6/16) [38, 45, 50, 63, 72, 77], followed by stunting/height-for-age z-scores (4/17) [37, 45, 63, 77] and wasting/weight-for-height z-scores (1/15) [38]. Among women, the interventions reduced anaemia (1/3) [42], inadequate vitamin A-levels (4/5) [44, 65, 69, 70], but lacked effects on haemoglobin [42, 44, 65]. Further, studies reported a reduction in underweight or improved BMI among women (2/5) [42, 55], but had no impact on their mid-upper arm circumference [44].

As with long-term outcomes, impact on nutritional status also varied for impact according to integration of intervention components. For example, adding micronutrient powder to EHFP marginally reduced anaemia, but EHFP alone did not bring the change [64]. An agriculture-gender intervention significantly improved the weight-for-height z-score among children, while adding a BCC component did not result in the same effect [52]. Likewise, EHFP intervention alone largely reduced anaemia among children, but adding a fish component did not bring the same effect [65].

4.3.4 Factors contributing to the effect of NSA interventions on nutrition outcomes

Studies indicated eleven factors that influence the effect of NSA interventions on nutrition outcomes. These factors are program participation intensity, program duration, nutritional status of the target population at baseline, age, and sex of children, access to roads, seasonality, agroecology, purchasing power, wealth status, and maternal education. The most intense program participation contributed to improved weight-for-age z-score [72] and higher coefficient of dietary diversity [68]. Villages with the longest program duration reported improved weight-for-age z-score of children [72]. Populations that were undernourished at baseline had the significant reduction of undernutrition, particularly regarding BMI in women [55] and stunting and underweight in children [45]. Furthermore, the interventions reduced undernutrition more among young children compared to older children. For example, studies reported reductions in stunting among children aged 6 to 24 months [37], and inadequate vitamin A among children between 12 and 35 months [70] with no effects on stunting among children 36 to 72 months of age [37] or inadequate vitamin A in 3- to 5-year-old children [70]. Similarly, gender played a part in the outcomes reviewed, with one study reporting higher haemoglobin status for boys than for girls [49]. Further, access to roads affected selling, as a greater mean quantity of sweet potato was sold in households closer to the main road [48]. Seasonality also affected outcomes: for example, increased expenditure during harvest season [48], and increased women's and children's dietary diversity in winter [61]. Furthermore, agroecology influenced the effect, as an intervention improved child dietary diversity in winter in the plains but had no effect in mountain regions [61]. Low purchasing power also adversely influenced dietary diversity [48], while maternal education and better wealth status had a positive impact on consumption of nutritious foods [67].

4.3.4 Impact pathways

The 29 studies included in the pathways analysis reported five pathways to nutrition outcomes from eleven categories of interventions. Most studies reported the effects of HFP of vegetables and /or fruits

and poultry (n=8) followed by crops and livestock (n=4), OFSP (n=4), HFP of vegetables and /or fruits (n=3), school garden (n=3), livestock focused on goats (n=2), farm crop diversification (n=1), HFP of poultry (n=1), food production using community-based ECD (n=1), community-based grain banks (n=1), and microcredit/financial support (n=1). The interventions integrated nutrition education (n=29), WASH education (n=9), linkages with health services (n=4), gender components (n=6) and micronutrient fortification/supplementation (n=3). The studies reported five pathways leading from agricultural production (n=21) [35-43, 45, 46, 48, 50, 56, 57, 62, 66, 67, 71, 75, 76], agricultural income (n=9) [35, 38, 39, 41, 43, 48, 50, 53, 75, 76], knowledge of nutrition, health and/or WASH (n=17) [35-38, 40, 44-46, 48-53, 62, 73, 75], women's empowerment (n=6) [39, 52, 54, 55, 73, 75], and strengthening of local institutions [37]. However, multiple combinations of these entry points were often reported within a single study. Most studies reported on two entry points to the pathways (n=11) (production and knowledge, production and income, knowledge and women's empowerment, and knowledge and income) followed by single (n=11), three (n=6) and four entry points (n=1). Figure 4.3 illustrates the pathways, with further details presented in Table 4.2 and the supplementary files of the published paper.

Production pathway

Fifteen studies reporting improved food production also noted improved dietary practices through greater food consumption, dietary diversity or nutrient intake (15/17) [35-39, 41-43, 48, 50, 56, 57, 62, 75, 76]. Of these, one study reported an association between greater vegetable production and improved dietary diversity [41]. Food production contributed to food consumption through preservation, processing, storage (3/3) [38, 62, 76], household preparation of food (3/3) [45, 50, 62] and household distribution of food products (2/2) [46, 53].

Income pathway

Five out of nine studies that looked at agricultural sales or income reported on expenditure [35, 39, 48, 62, 75]. Of these, four increased food-related expenditure [39, 62, 75] including purchases by non-intervention households (1/1) [62] and purchasing eggs from the market (1/1) [35]. One study also reported increased expenditure on healthcare, education, clothes, and productive assets [39]. Income also translated into a reduced need to borrow money for food, a common coping mechanism for food-insecure persons in LMICs (1/1) [76].

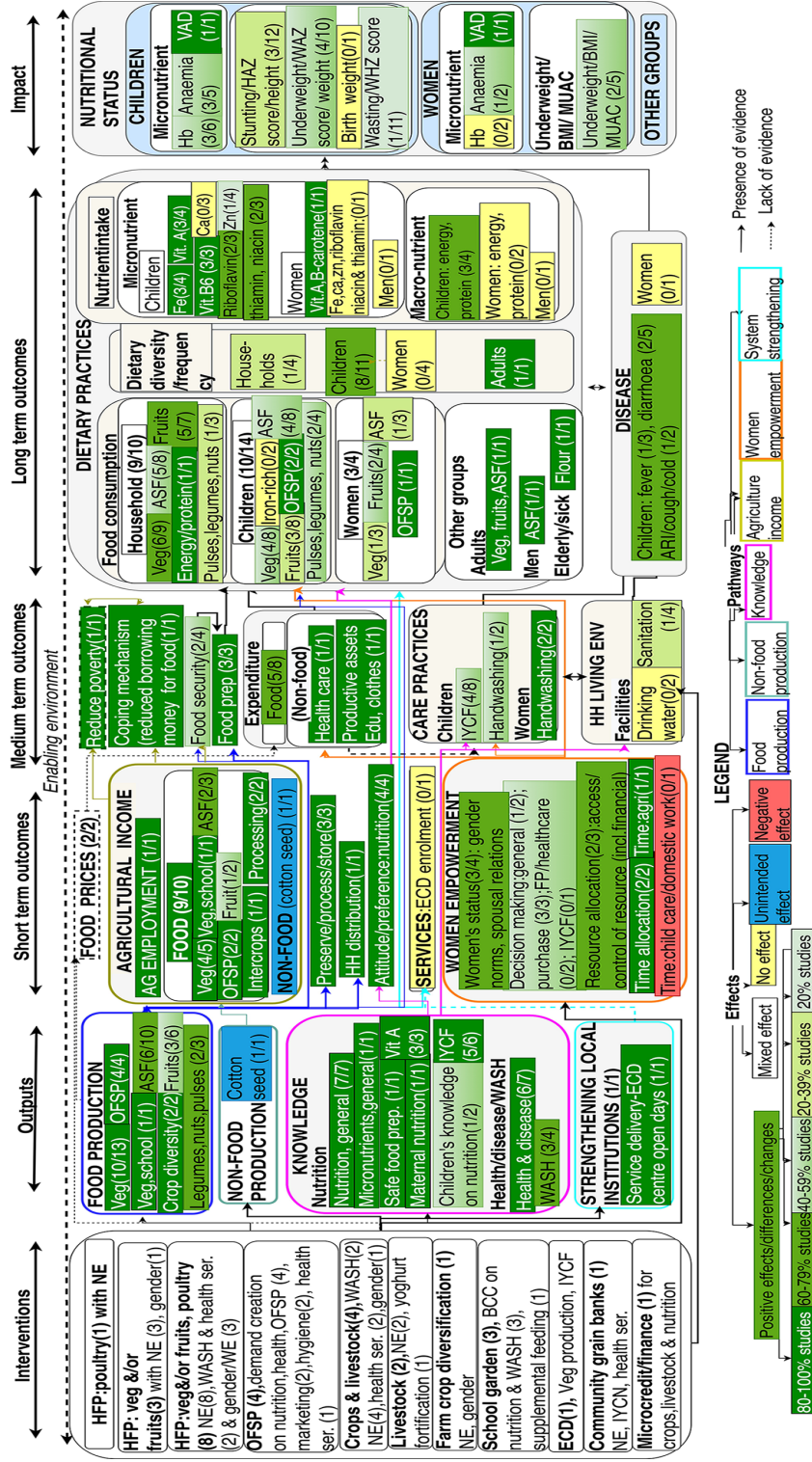


Figure 4.3. Impact pathways from NSA interventions to nutritional status

Knowledge pathway

Most of the interventions improving knowledge on nutrition, WASH, or health also contributed to improved dietary practices, and sometimes improved care practices. Eleven out of 15 studies reporting an increase of knowledge also recorded an improvement in at least one dietary practice [35, 36-38, 44, 48, 50, 52, 62, 73], and four reported children's care practices on IYCF (4/5) [35, 50, 62, 75] or handwashing (2/2) [50, 62]. Five studies specifically looked at the contribution of a knowledge pathway on dietary practices [52, 66], diarrhoea [40, 52] or nutritional status [45, 49]. Of these, three studies reported that adding nutrition-education/BCC improved children's dietary diversity [66] or minimum meal frequency [52], or reduced diarrhoea among children [40, 52]. One study reported improvement in haemoglobin, and reduction in diarrhoea and anaemia when BCC was delivered by health-centre members [rather than older women leaders], highlighting the role of BCC provider [40]. Two studies reported on the pathway to nutritional status. First, a study that compared BCC to the combination of micronutrient fortification and BCC in a dairy value chain program found improved micronutrient status in both groups, asserting that improved nutritional status may be the result of knowledge obtained from BCC [49]. The second study revealed an association between the nutrition-related knowledge among mothers and weight of their children [45].

Women's empowerment pathway

Six out of 29 studies that reported on gender interventions also described elements of women empowerment [39, 52, 54, 55, 73, 75] of which three studies reported two sub-pathways. The first sub-pathway emerged from intra household decision-making and resource allocation. A study revealed a 1.9 of the overall 7.5 percentage points reduction in wasting attributable to women's empowerment due to spousal communication as well as decision-making on purchases, healthcare, and family planning [54]. A second study that revealed increased weight-for-height z-score in the agriculture-gender group also reported improved women's financial empowerment, access to assets and agricultural empowerment [52] with no effect on decision-making, sale of assets or spousal communication [52]. The third study, using a qualitative approach, reported a case wherein a respondent (male) had knowledge about undernutrition and was involved in children's caring practices that led to a variety of food consumption. However, the study did not make explicit whether the change was because of the change in knowledge or gender norms or both [73]. The second sub-pathway was centred on women's time and appeared through a trade-off, wherein women spent more time in agriculture, leaving less time for domestic work

and childcare practices [52]. Although 4 studies reported an increase in self-determination amongst women in terms of prioritizing daily workload [39], financial empowerment [52] or decision-making on purchasing [39, 54, 55], only one assessed nutrition outcomes in women which reported reductions in undernutrition [55].

Strengthening existing institutions pathway

Out of the ten studies that reported on interventions involving local institutions on health, agriculture and, education/ ECD [35, 37, 40, 42, 44, 51-53, 66, 75] three hypothesized that strengthening service delivery would contribute towards nutrition outcomes [35, 37, 44]. One study reported lack of adherence to program design and inadequate qualification and motivation of staff, resulting in weaknesses in service delivery [35]. These studies suggested for the improved delivery of NSA interventions through local institutions—for example, ECD and health care service centres [37, 44]—and recommended strengthening program implementation and promoting higher participation to improve child nutrition outcomes [52]. One study reported the effect on stages of the pathway [37] and showed an increase in the number of opening days of a community-based childcare centre and the number of meals [37] offered by it. The intervention also increased dietary diversity and reduced stunting amongst children aged 6 to 24 months.

Findings on the pathways from dietary diversity to nutritional status are conflicting. A study integrating crops and livestock reported no significant association between children's dietary diversity and mean height-for-age z-scores [66]. An HFP intervention improved children's minimum dietary diversity and reduced anaemia but did not have impact on child growth [42]. Likewise, only one of the four studies reporting improved child dietary diversity improved the anthropometrical measurements [37]. The evidence on women is even more scarce, as only one study measured both dietary diversity and undernutrition. This research revealed reductions in underweight in women despite marginal improvements in dietary diversity [55]. As such, the link through which greater dietary diversity may consequently improve nutritional status is still unclear.

4.4 Discussion

4.4.1 Effects of NSA interventions on nutrition outcomes

The 37 studies on the impact of NSA interventions on nutrition outcomes concerning undernutrition indicate that these interventions have the potential to address multiple underlying determinants of

undernutrition yet have a weaker impact on nutritional status. In line with recommendation from a previous review that indicated the potential role of NSA in addressing determinants of undernutrition beyond food access, we reviewed NSA interventions using a system approach, encompassing all underlying causes of malnutrition [78], namely: 1) household food insecurity, 2) inadequate care practices, and 3) unhealthy household environments and insufficient health services [7]. The key effects of the interventions revolve around household food security, nutrition-related expenditure, nutrition-related knowledge and women's empowerment. There is lesser but potential contribution to household living environment and children's care practices on IYCF and handwashing, with no evidence on women's care practices. These contributed to improved dietary practices and, to some extent, prevention of diseases among children but not among women. Disease prevention could be linked to improvement in handwashing and sanitation practices resulting from the integration of a WASH component, as one-fourth of stunting among children aged 2 or younger is attributable to diarrhoea [79]. This indicates that NSA interventions have the potential to address multiple underlying causes of undernutrition. The effects of NSA interventions are strong for short-, medium- and long-term outcomes, but with a disconnect between long-term outcomes and impacts on nutritional status as measured in terms of underweight, stunting and wasting.

Our study confirms the weak impact of NSA interventions on nutritional status, with the lowest impact on stunting and wasting. Past studies on agriculture interventions also reported weak impact [19, 22, 25]. This can be attributed to three possible reasons. First, underlying causes beyond food access are inadequately addressed. An earlier study highlights the fact that agricultural programs that integrate multiple interventions can address a large number of immediate and underlying causes of child undernutrition [16] through coordination with multiple sectors including education, health, social safety nets, ECD, and schooling [6]. As only a few studies in this review have considered underlying causes of undernutrition beyond food access, such as inadequate care practices and poor health status, the effect may not be enough to improve nutritional status. The second reason for lower impact on nutritional status could be that the short implementation period of interventions is insufficient to bring changes in stunting, despite visible effects on dietary practices [16]. Among the studies included in this review, only one measured the effect of participation intensity and program duration on weight-for-age z-score, which found a positive correlation, suggesting further validation research is needed. The third reason could be a lack of strong research methods, as designs with inadequate power might fail to detect changes in growth measurements [16, 17, 22].

The evidence reviewed regarding integrating intervention components beyond agricultural production and nutrition-related education is varied. Past reviews have suggested the need to make the agriculture sector nutrition-sensitive through a multisectoral approach [14, 16]. Active engagement of multiple stakeholders and sectors [16] and attention to empowerment of women can improve nutrition outcomes, especially for women and children [14]. The majority of studies reviewed measured the effect of agriculture combined with a nutrition-related education component and found a positive effect on nutrition outcomes. Some studies also linked agricultural production to other sectors, such as ECD, nutrition-specific programs, financial support, and health services. However, the evidence on the effect of adding intervention components beyond food production and knowledge is heterogeneous, as the effect varies for different combinations. It could be the case that when there is a significant effect produced by one intervention component, the scope for improvements from other intervention components is reduced [80]. Evidence on how to operationalize the right mix of intervention components in different contexts, is overlooked, however, as also indicated by a past review [81]. This calls for further research on which of the multi-sectoral components can be best combined within agriculture interventions and how to achieve optimal outcomes.

4.4.2 Impact pathways

NSA interventions improve nutrition outcomes through five pathways: food production contributing to food access; knowledge on nutrition, WASH, and health improving dietary practices and health status; agricultural income for nutrition-related expenditure; women's empowerment contributing to nutrition outcomes in children; and strengthening of local institutions to enhance service delivery. The framework that we adapted does not explicitly mention the pathway of knowledge and strengthening local institutions [13] that emerged from our analysis of the studies reviewed. Past reviews have highlighted food price as a potential pathway [6, 12-14], but none of the studies reported on this, perhaps because food price has traditionally been considered at the policy rather than intervention level.

Although evidence on production is most dominant, the majority of studies reported on the combination of more than one entry point to the pathways to nutrition outcomes. Thus, the nutrition outcomes reported in this review should be considered to reflect the combined effects of multiple pathways that interact with each other to achieve nutrition outcomes [12]. The evidence reviewed suggests that stimulating a combination of these impact pathways would result in the most significant effects on nutrition outcomes. As there is now consensus that agriculture can contribute to addressing both forms of malnutrition [82], NSA can potentially contribute to addressing both forms of malnutrition as well.

Nevertheless, this review explicitly focuses on undernutrition, and hence excludes the outcomes on obesity or overweight that some past studies have explored [83, 84].

Most studies reported on production pathway, followed by knowledge. The production pathway, however, differs across food items, thus necessitating careful design and implementation across products. Many recent studies have begun to consider a knowledge pathway, as they tend to integrate nutrition education and BCC activities with agricultural production interventions. A previous review also highlighted integration of nutrition-related BCC as a key strategy to enhance the impact of agriculture on nutrition outcomes [16]. Therefore, the pathway leading from the knowledge-based behaviour change component should be considered an essential part of the design, implementation, and evaluation of NSA interventions.

Our review also confirms the pathways from agricultural income and women's empowerment, although these are less evident compared to the production and knowledge pathways. Interventions can contribute to food-related expenses through an income improved by selling food products. However, the evidence base lacks the role of income from non-food production or agricultural wages, and the contribution to healthcare expenses. The studies reviewed highlight two sub-pathways from women's empowerment contributing to nutrition outcomes: women's social status, decision-making and resource allocation, and women's time in agriculture, of which the former is less evident. Trade-offs occur, because an increase in the time allocated to agriculture appears to mean less time for domestic work and childcare practices. This calls for measures safeguarding women's time in agriculture [16] that ensure that such interventions do not contribute to an increased time and labour burden [12]. However, as highlighted by other studies, this pathway is less evident in research of NSA interventions [13, 14]: specifically, the contribution of women's empowerment to their own care practices and nutritional status is less evident. Most of the studies reporting gender in their interventions examined the effects on women empowerment without describing how the interventions influenced the underpinning gender dynamics that empowered women and consequently led to nutrition outcomes. Some other studies on underlying gender dynamics on NSA were excluded from this review since they did not report on nutrition outcomes [85, 86].

One study we reviewed provided evidence on the temporal stages of the pathway to improved nutrition outcomes, through the strengthening of local institutions, and two other studies recommended mobilizing the institutions to improve implementation and service delivery [44, 52]. Integrating nutrition into agriculture, however, requires the establishment and strengthening of an enabling institutional environment conducive to achieving nutrition objectives [87]. This necessitates integrating nutrition into

all elements of food systems, from food production to utilization [15, 16], but also requires an understanding of implementation quality to design pathways, and to measure implementation and service delivery [16]. Future research could therefore apply a combination of impact assessment along with process evaluations investigating implementation quality in terms of capacity, resources, supportive environment and potential for scaling up the interventions.

Addressing undernutrition through NSA interventions requires careful design, implementation, and evaluation considering several factors. The factors are: types of food group, program participation intensity, program duration, nutritional status of the target population at baseline, children's age, children's gender, access to roads, seasonality, agroecology, purchasing power, wealth status and maternal education. More efforts are required to address the confirmed factors, for example, undernutrition in children aged 3 to 5 years, the seasonality, and mountainous areas. In addition, multisectoral interventions are required to improve purchasing power, wealth status, women's education, and access to roads. Factors with mixed results, such as program intensity and duration, should be further studied. There is also a need to study success and failure factors within NSA interventions, as well as external barriers and facilitators to achieving positive effects. We can thus say that NSA interventions to address undernutrition require a tailor-made approach to fit the specific context and the needs of the target population [23, 61].

4.4.3 Strengths and limitations

Two aspects of this review that distinguish it from similar reviews and the studies included are an explicit focus on agricultural interventions with specific nutrition objectives and actions to achieve these objectives; and construction of temporal stages of their pathways to nutrition outcomes. Inclusion of studies reporting agriculture interventions with nutrition objectives and actions, however, does not imply that other interventions do not improve nutrition outcomes. Four limitations may have affected our findings. First, several studies reported on effects on outcomes without providing information on entry points to the pathways, such as food production, knowledge, or income. This limited the construction of pathways representing all studies included. To address this, we further selected and mapped a sub-set of studies reporting on both effects and the pathways. Nevertheless, a lack of information should be understood as a lack of evidence, and not the absence of pathways. The second limitation is the fragmentation of research findings regarding the same intervention across different articles: we identified studies reporting on the same interventions to the best of our ability. Third, the results should be carefully interpreted due to the heterogeneity of study design, indicators used and methodological quality. For this

reason, we assessed the risk of bias to facilitate interpretation of findings. It should be noted that the risk ratings only indicate methodological rigour through which the findings were produced and are not meant to weigh the studies as a whole. Furthermore, the majority of these studies have a moderate and high risk of bias, which might be due to the nature of nutrition interventions being implemented in communities, where it is difficult to fully control the study through randomization and blinding. Fourth, we did not search grey literature, which could have provided additional relevant, unpublished articles on the same topic.

4.5 Conclusions

While current evidence suggests that NSA interventions can contribute to nutrition outcomes throughout the short-, medium- and long-term temporal stages, there is a disconnect between long-term outcomes and impact on nutritional status based on anthropometric measurements. The increasing volume of publications on NSA testifies to their potential to improve food access but indicates that they can also address other underlying causes of undernutrition, namely unhealthy household environments and inadequate care practices. These outcomes are achieved through five main pathways: food production, agricultural income, nutrition-related knowledge, women's empowerment and strengthening of local institutions. The impact pathways, however, vary across the type of food group consumed, agroecology, seasonality, access to roads, age, and sex of children, wealth status, women's education, program intensity, program duration, and integration of multisectoral domains. Reconciling this complex mix of factors requires tailor-made interventions that are cognizant of barriers and facilitators to achieving their impacts. Further research is required to better describe the pathways through which women's empowerment can contribute to women's own nutritional outcomes. Research is required to better describe the effect of income from non-food production and agricultural work, food-price changes at the intervention level, and strengthening of local institutions. We also recommend the research on the impact of integrating other multisectoral intervention components within agriculture production and nutrition-, WASH- or health-based education. In addition to targeting children, NSA intervention research should also focus on the impact on, and the pathways to, improved women's nutrition outcomes, to contribute towards addressing undernutrition in LMICs.

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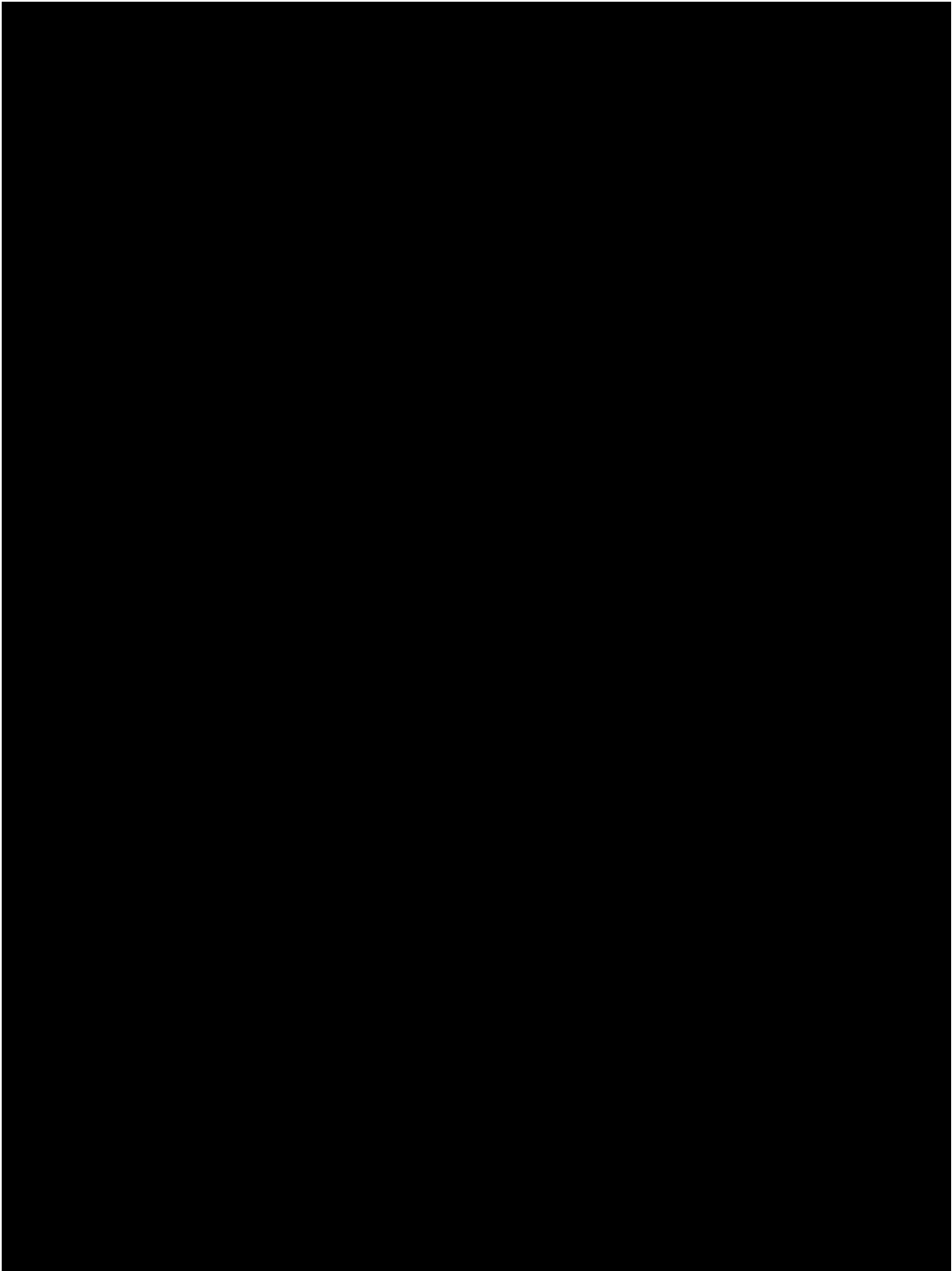
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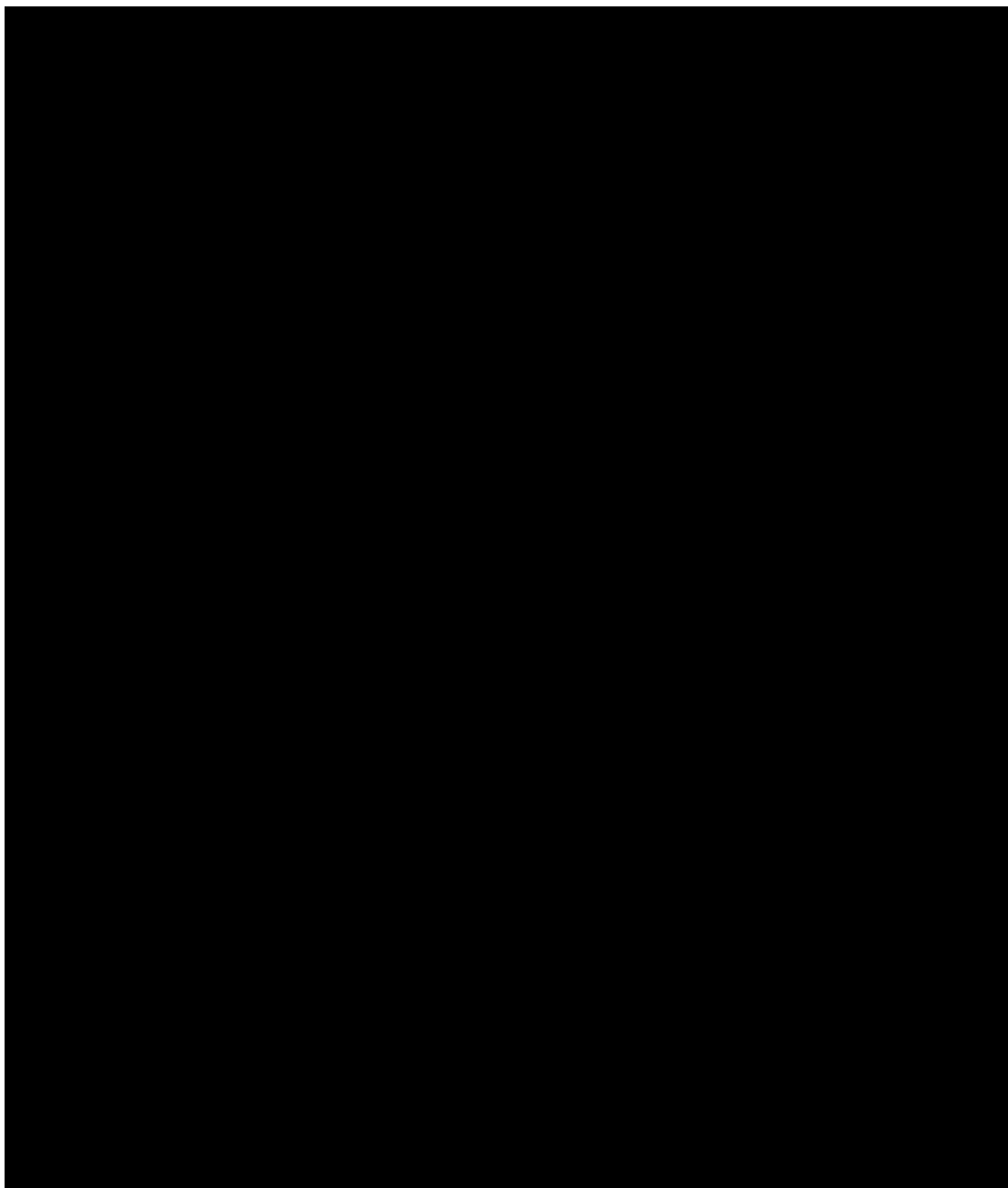
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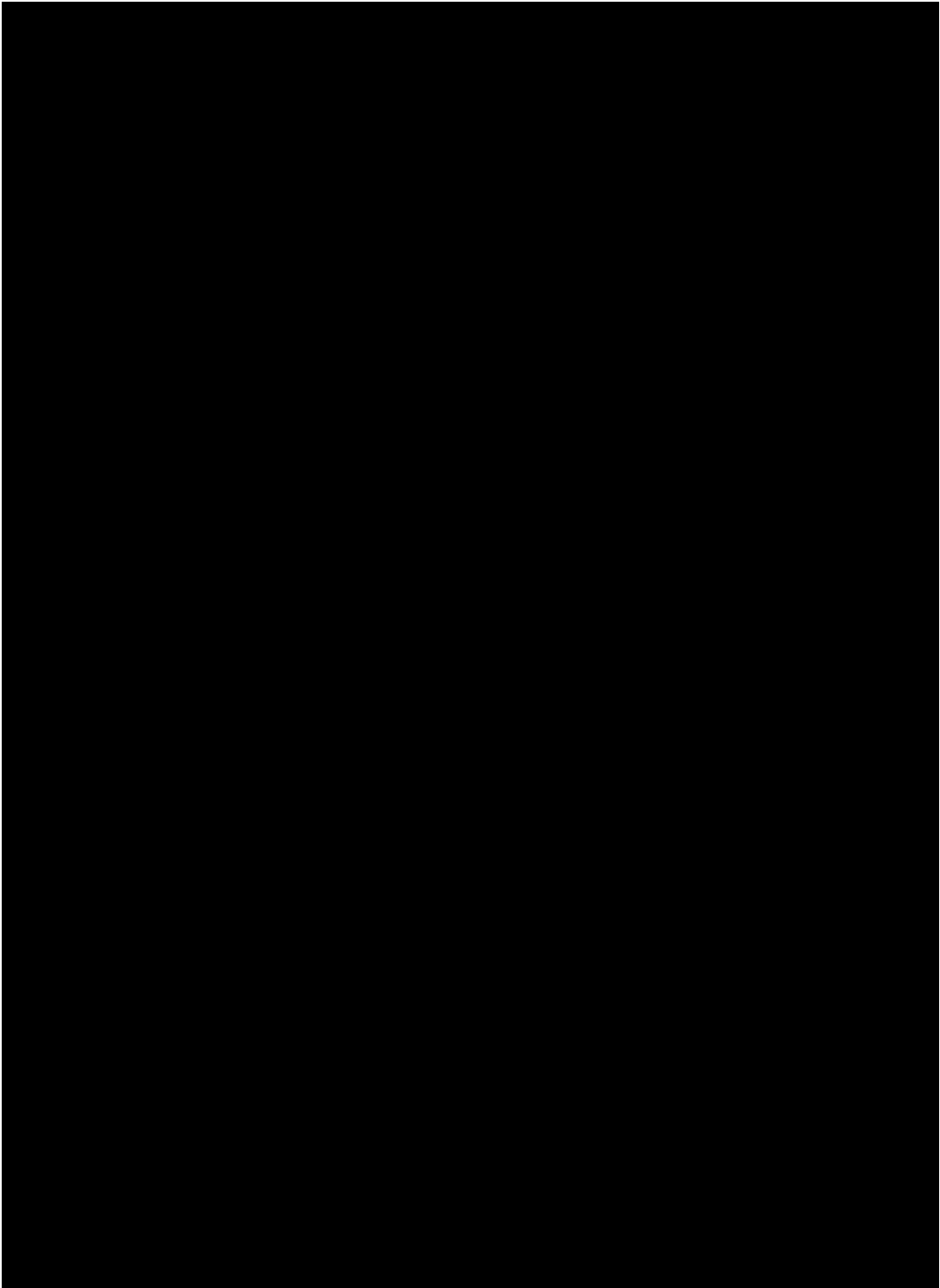
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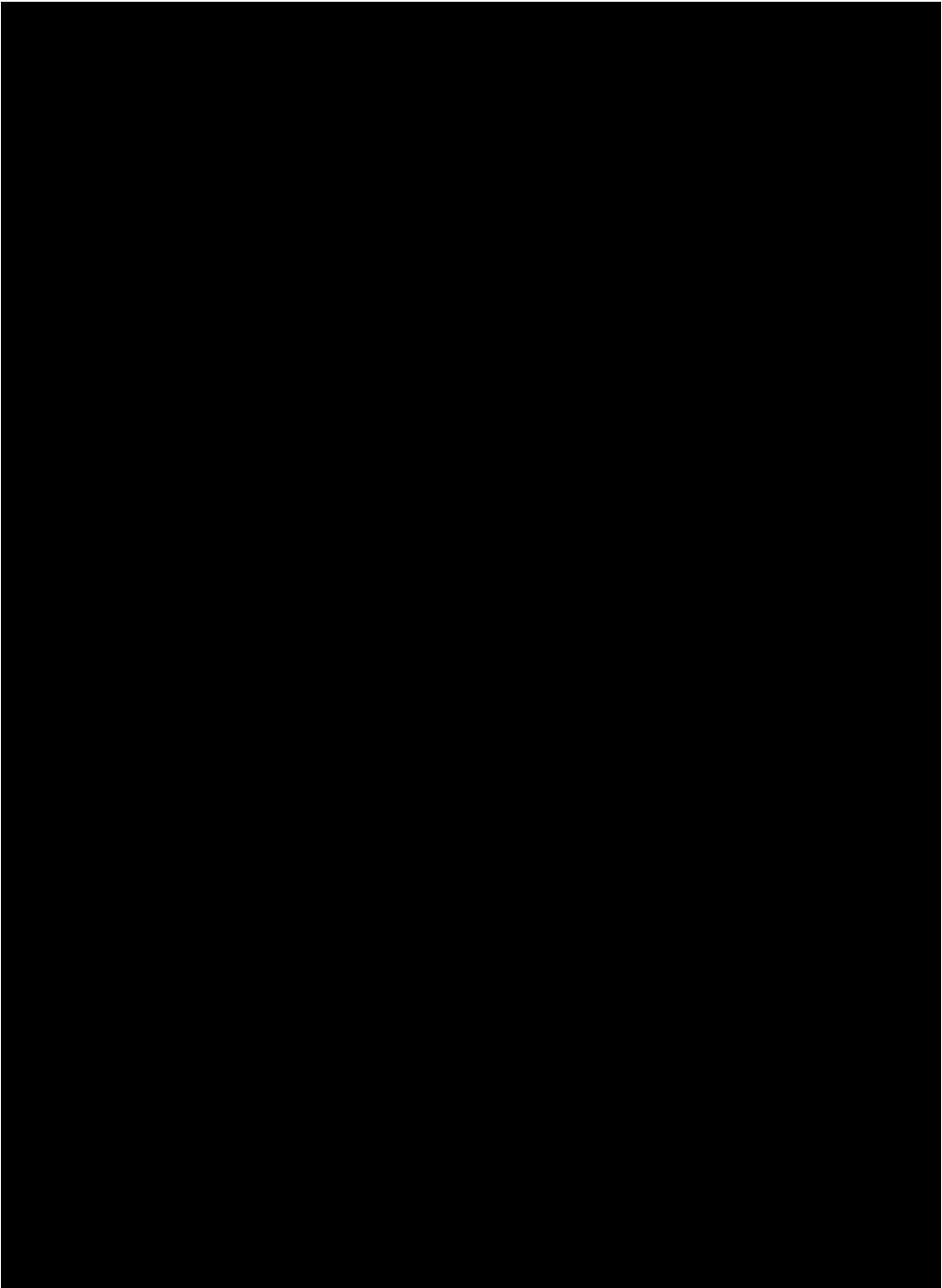
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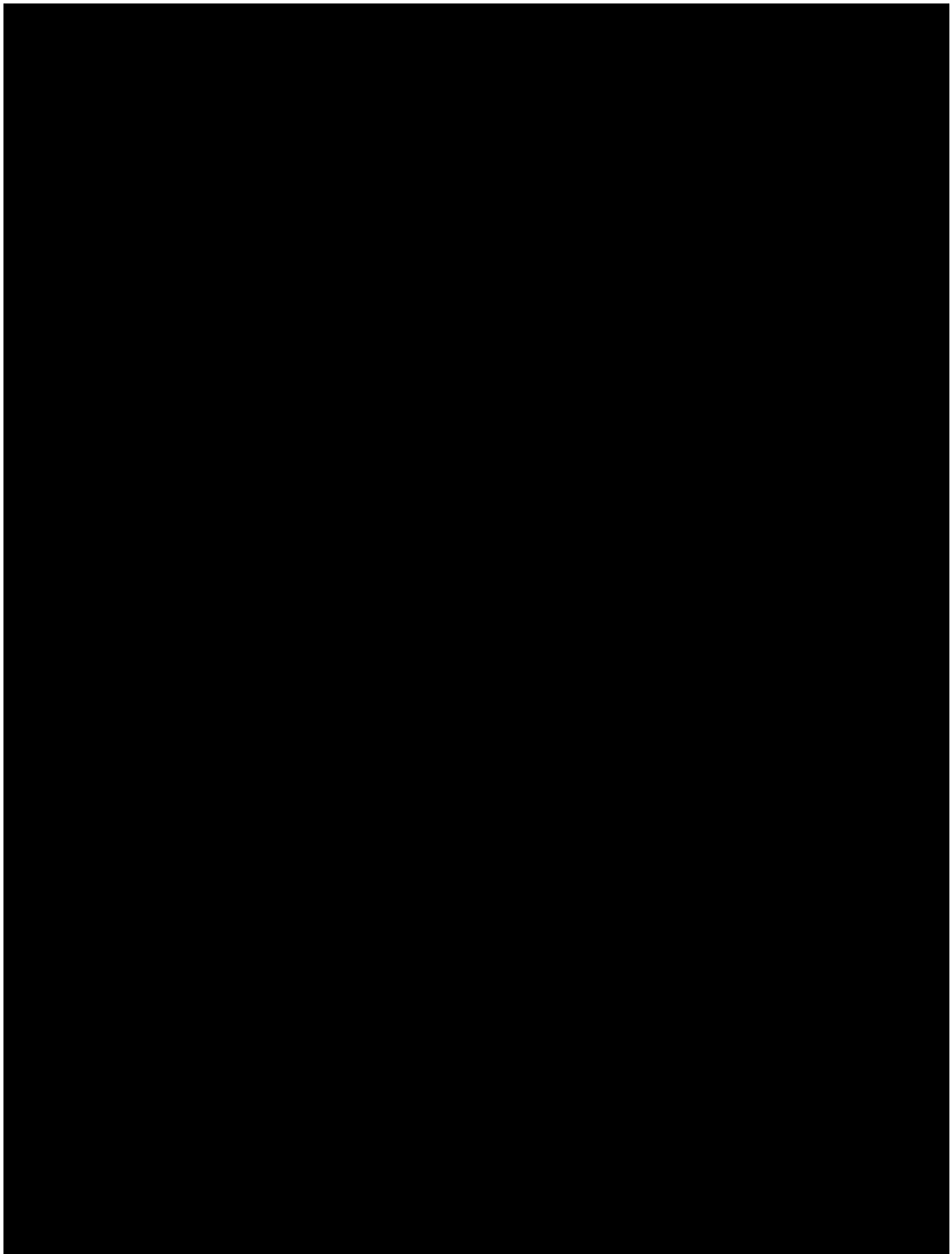
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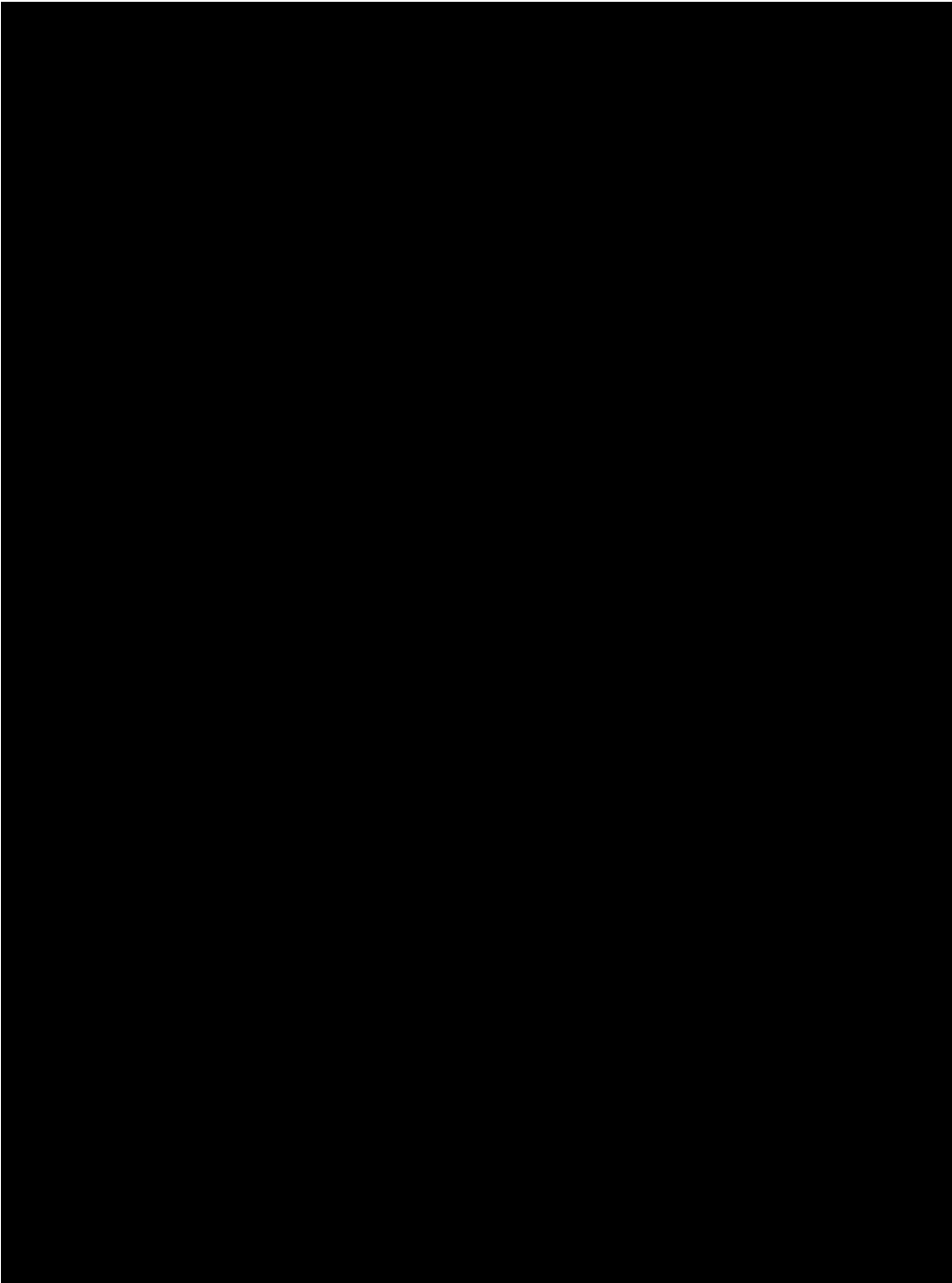


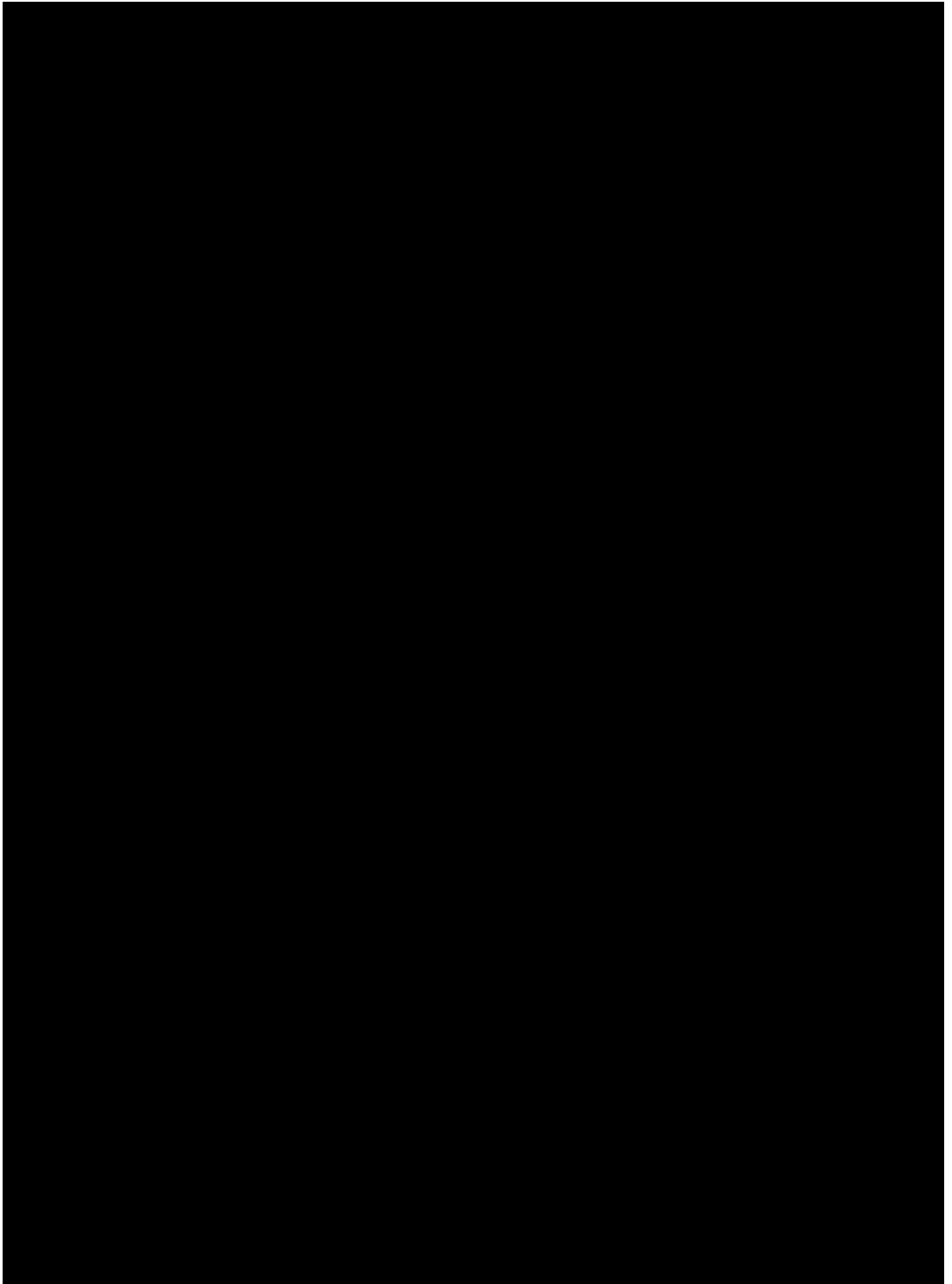


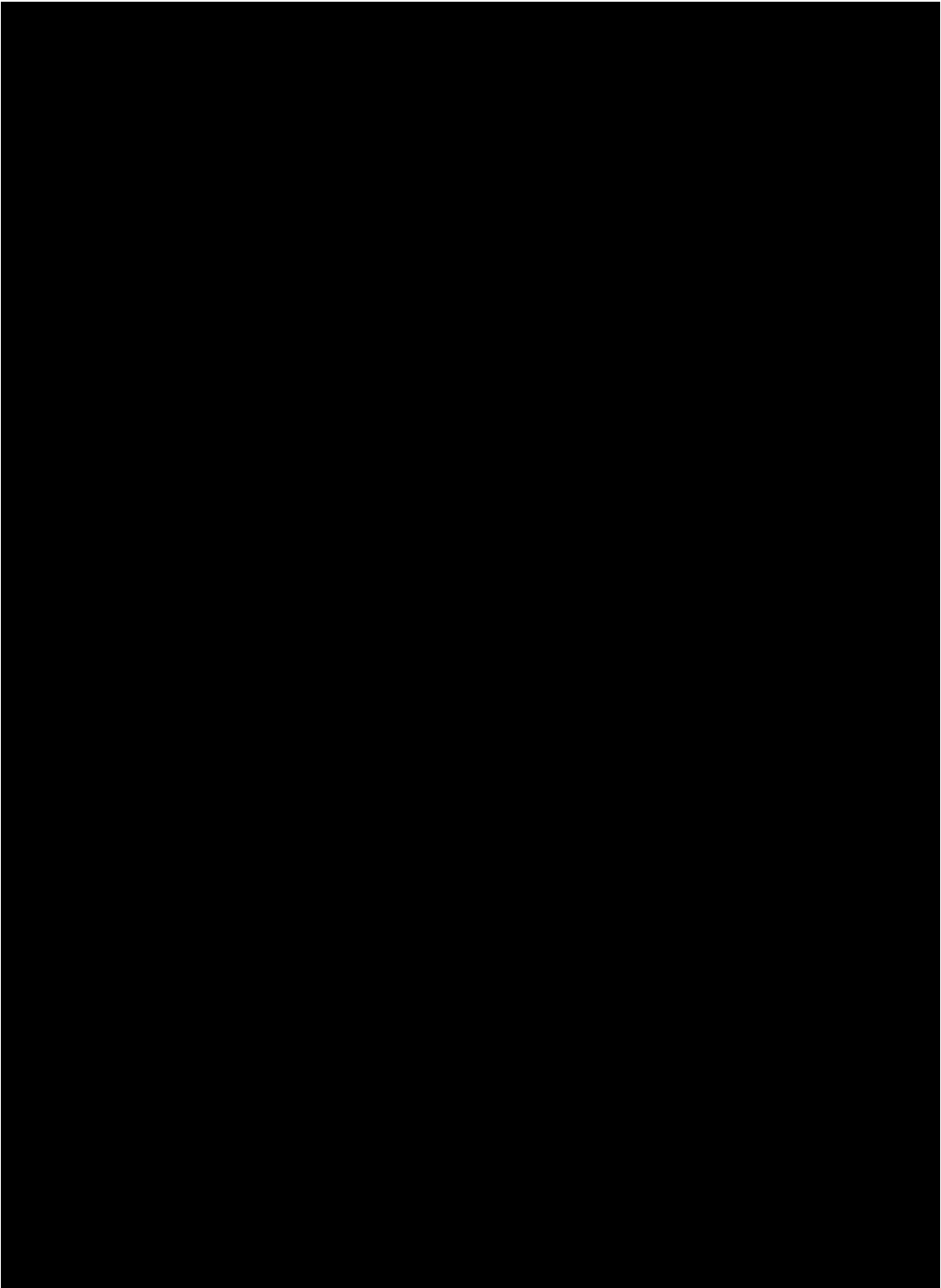


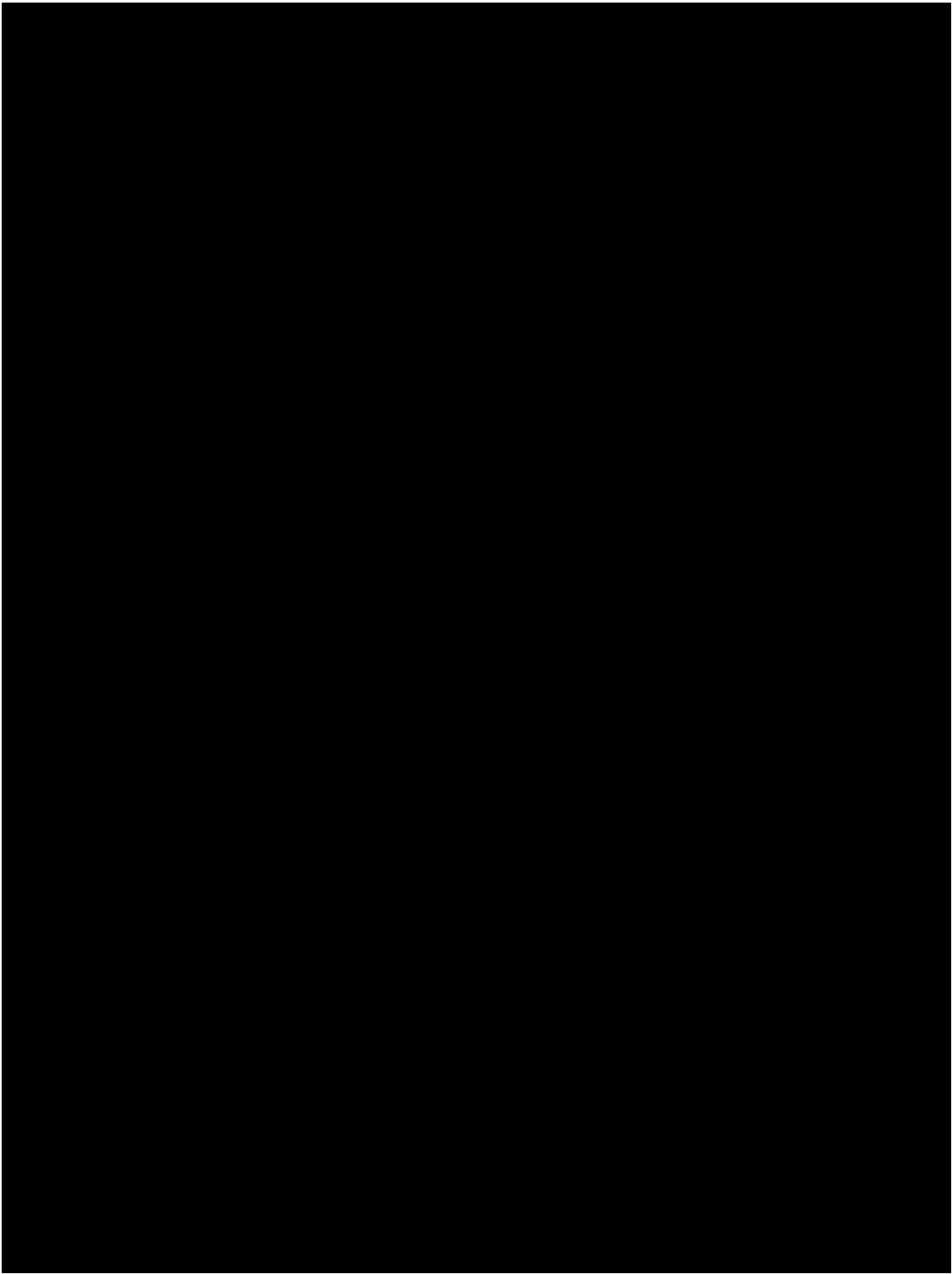


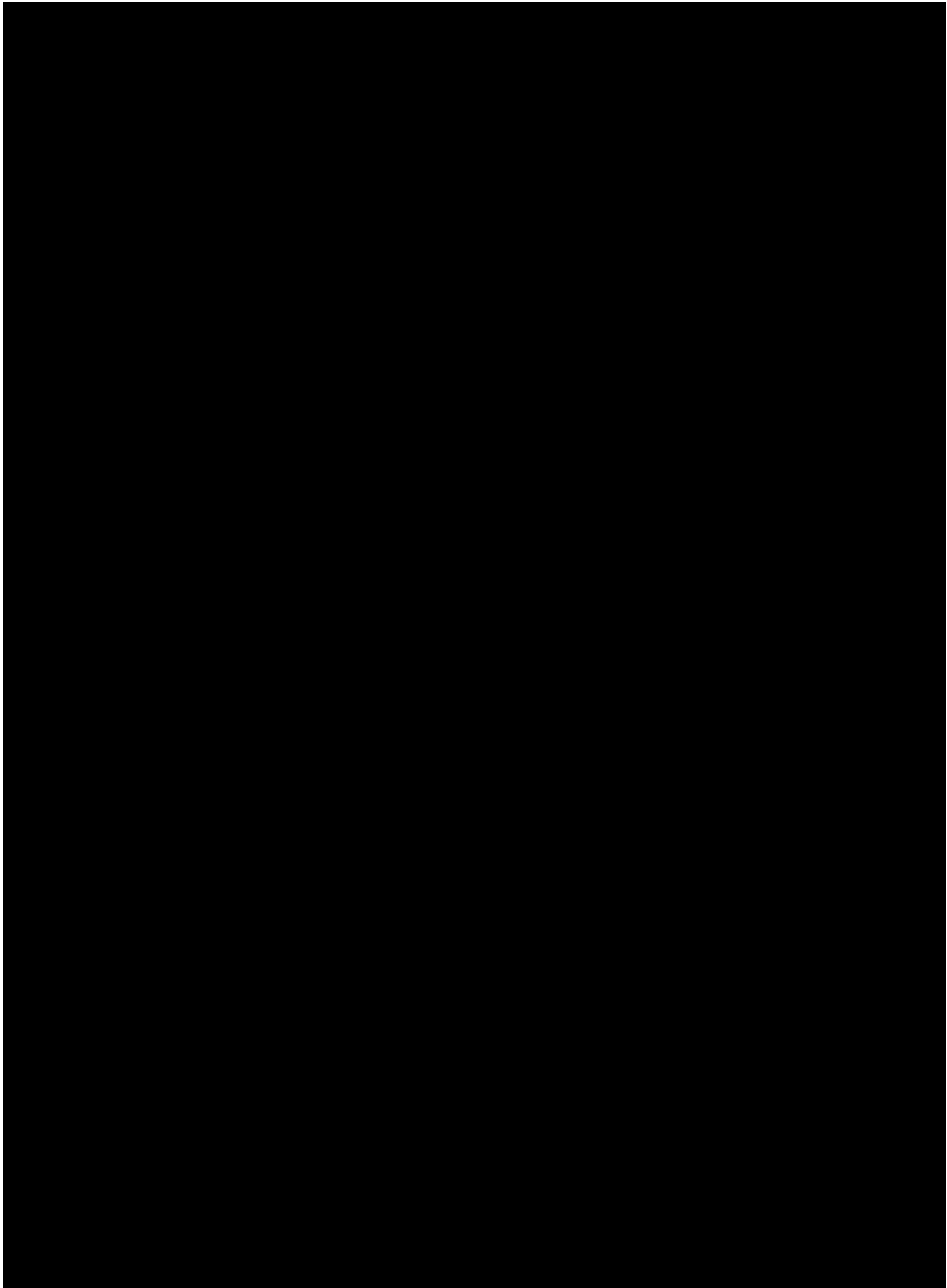


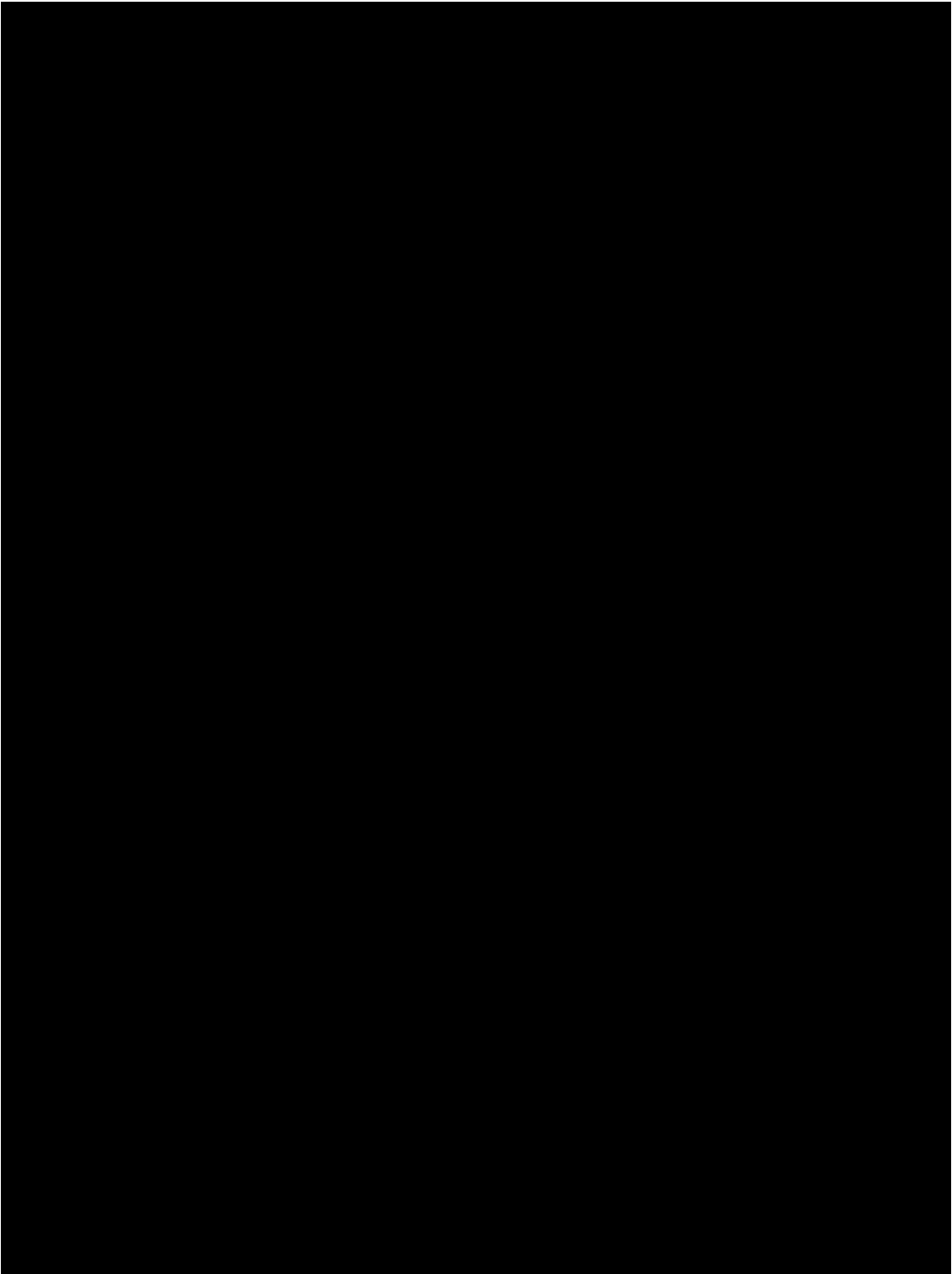


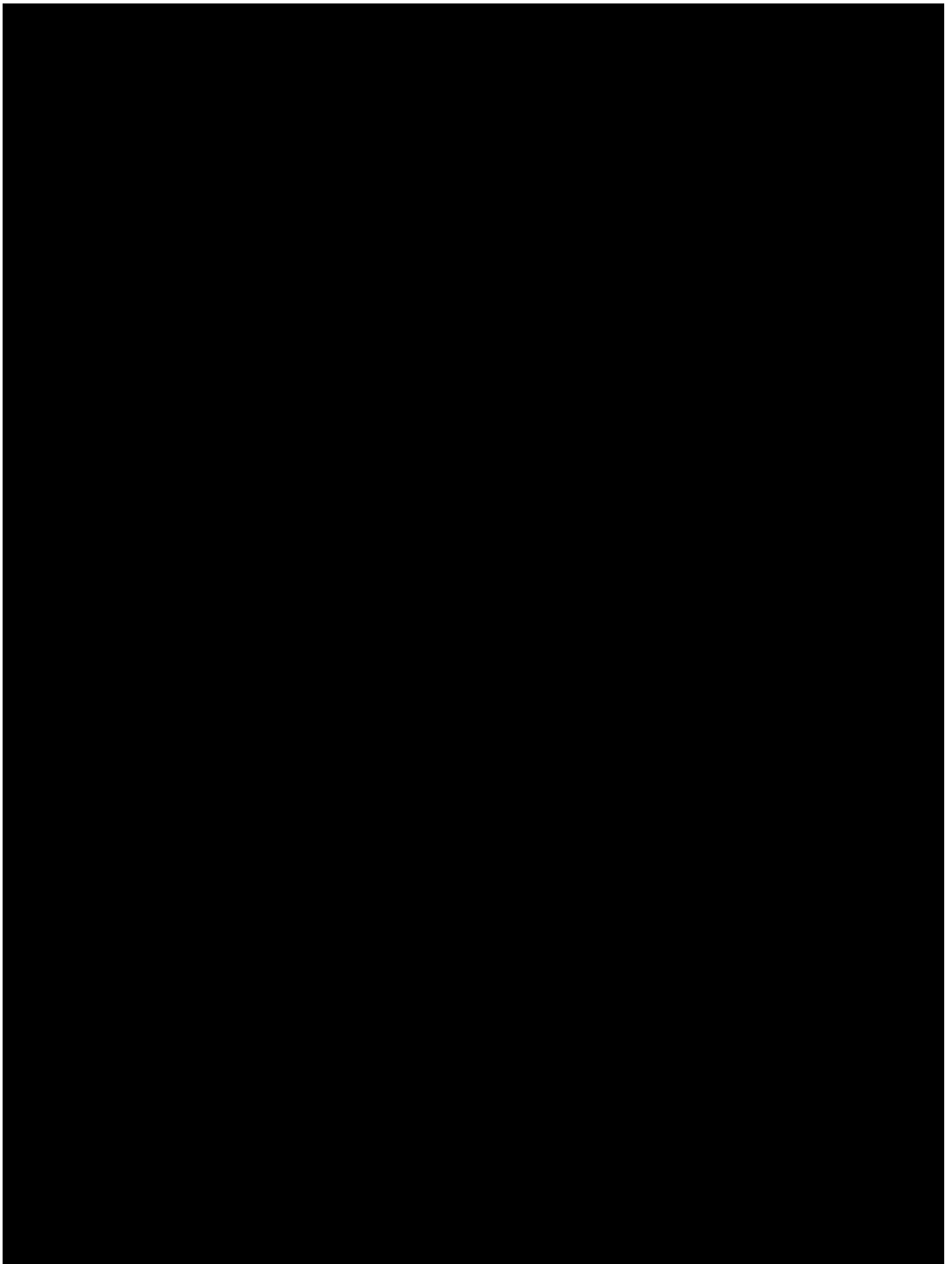


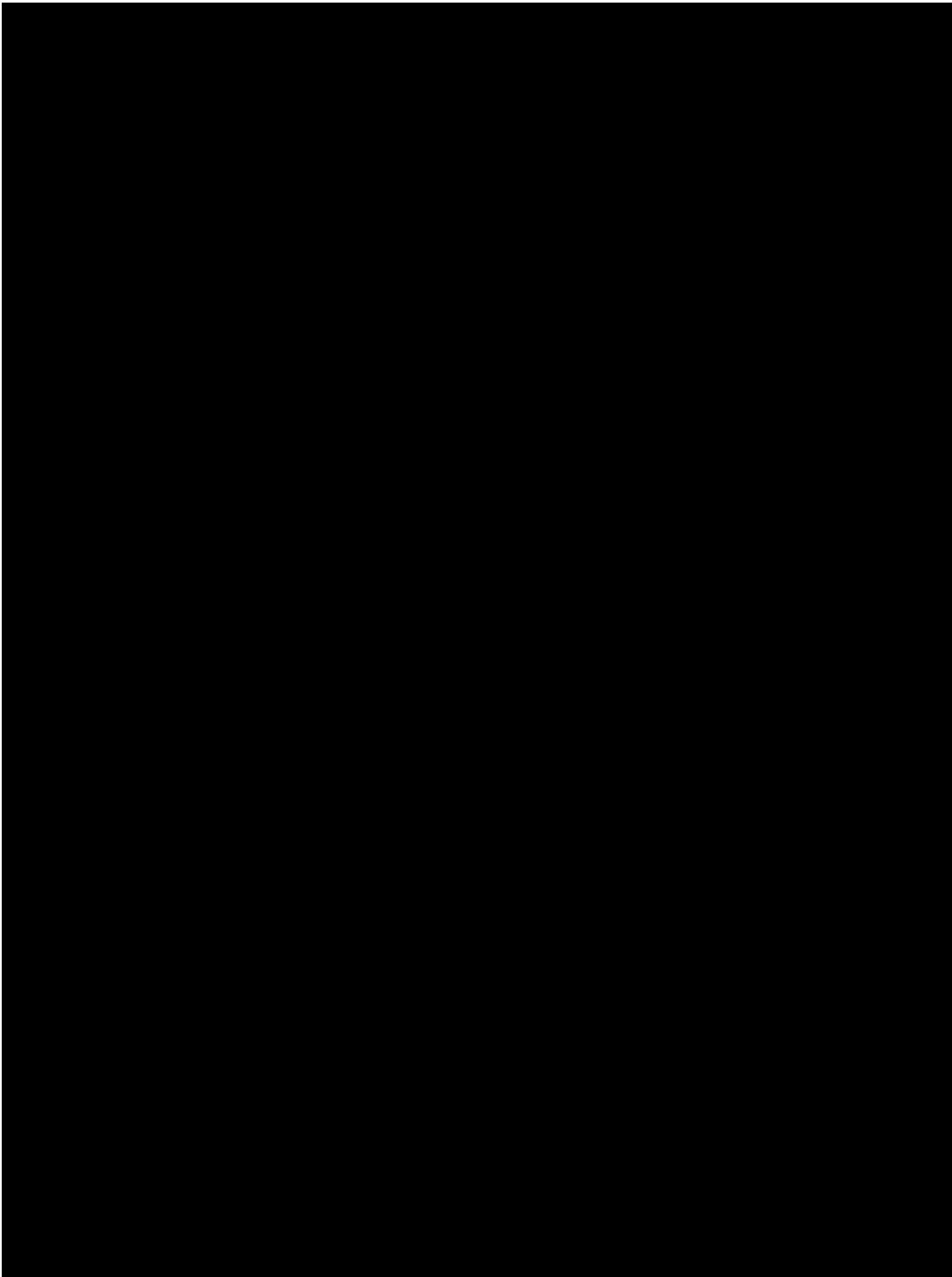


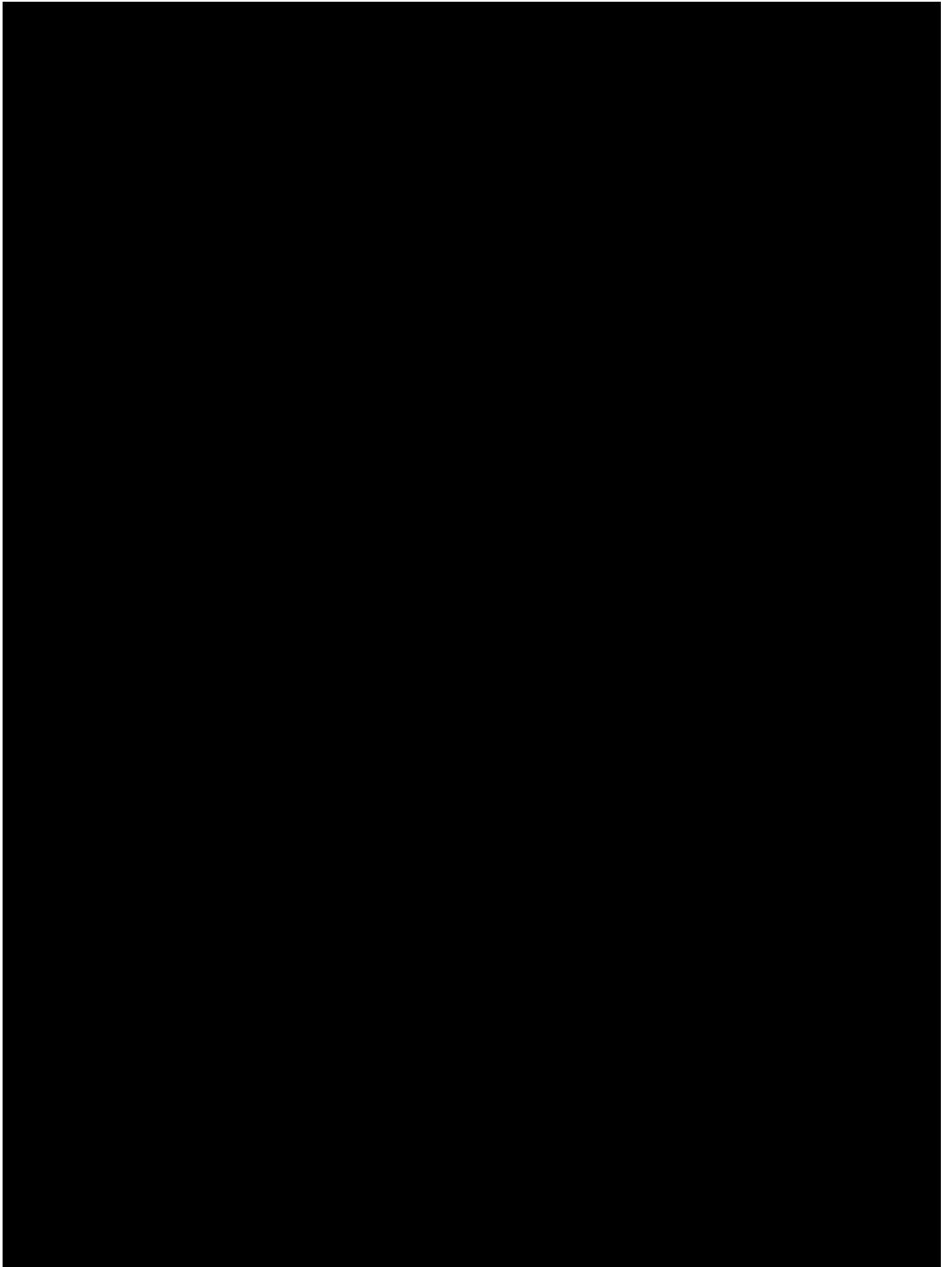


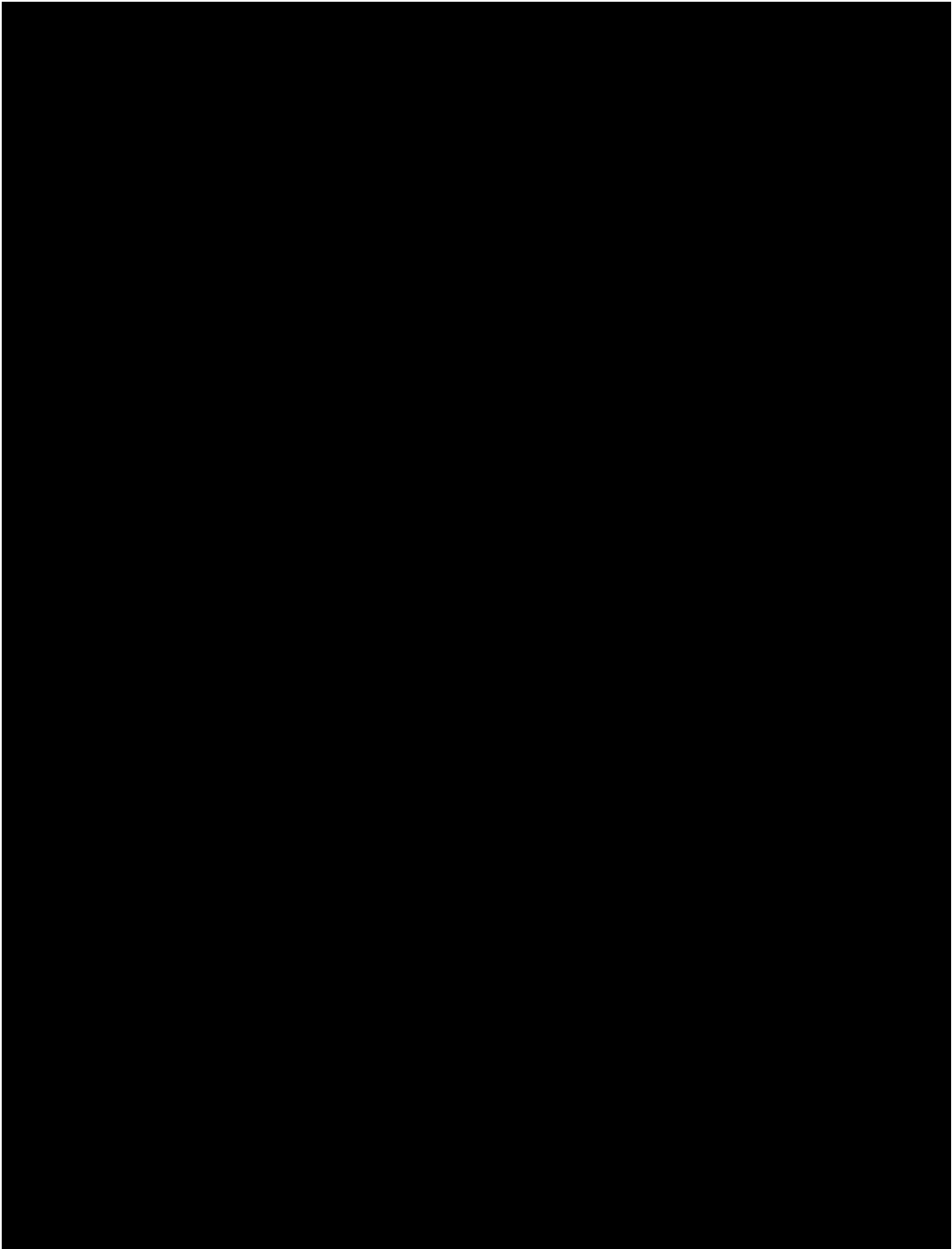


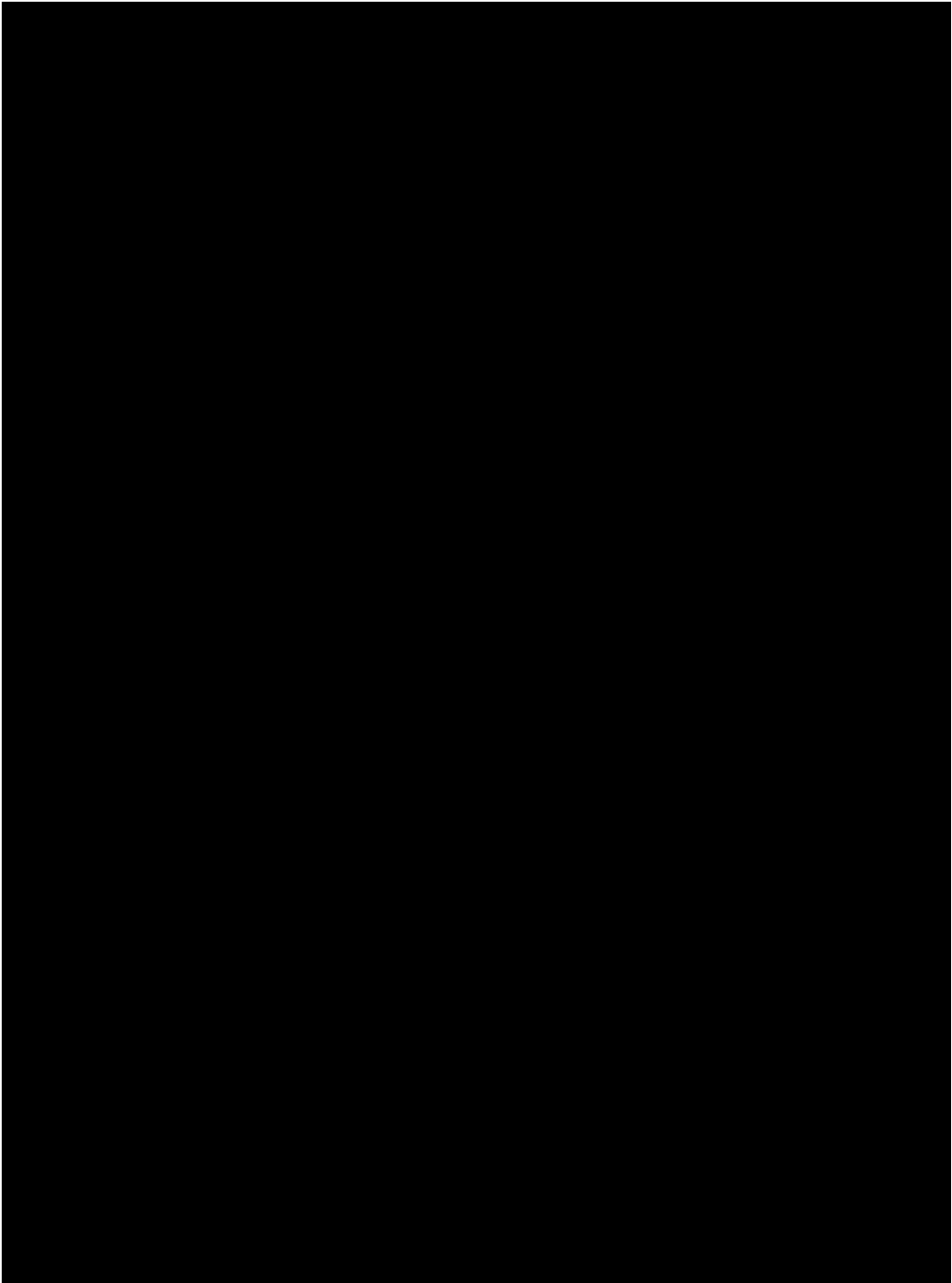


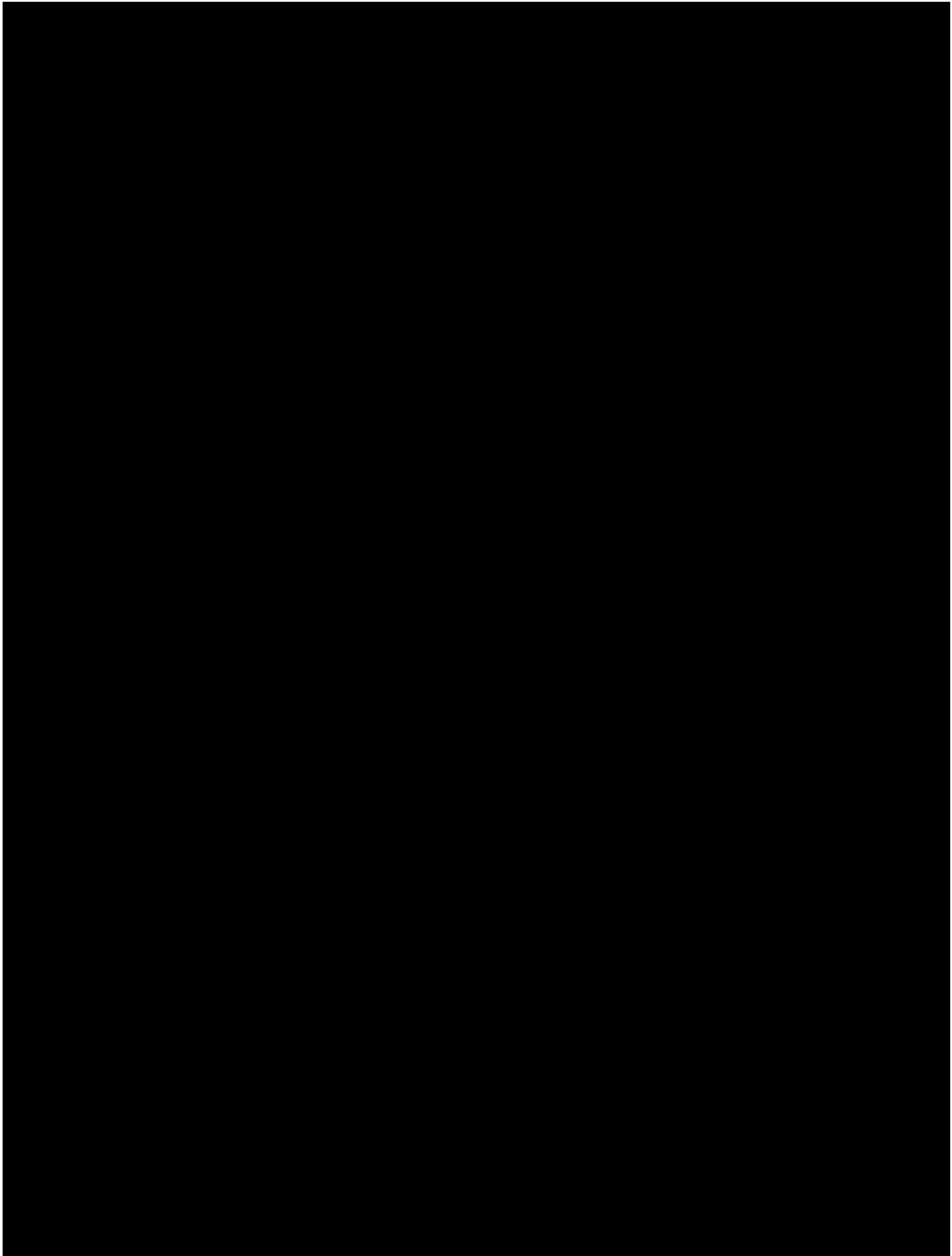


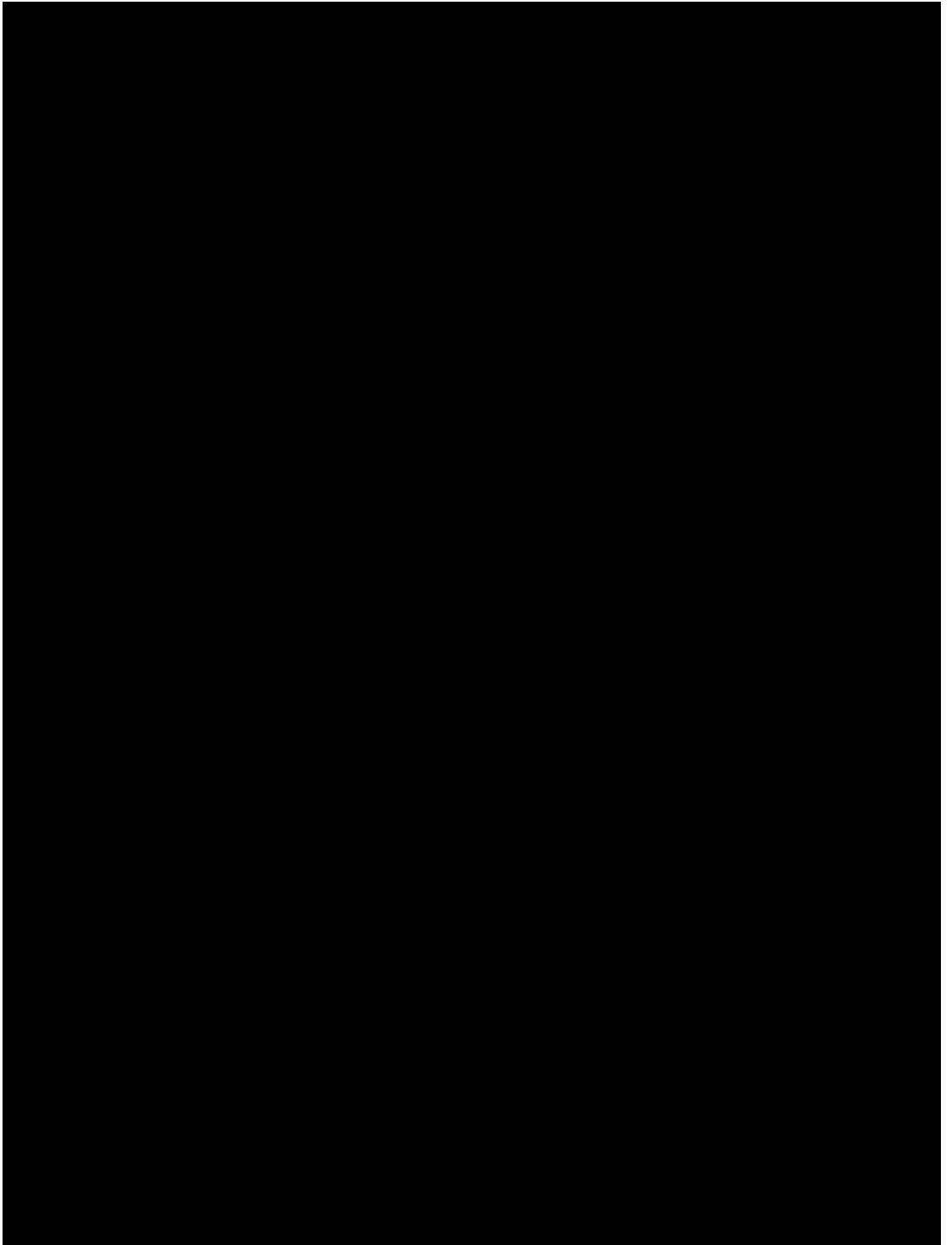


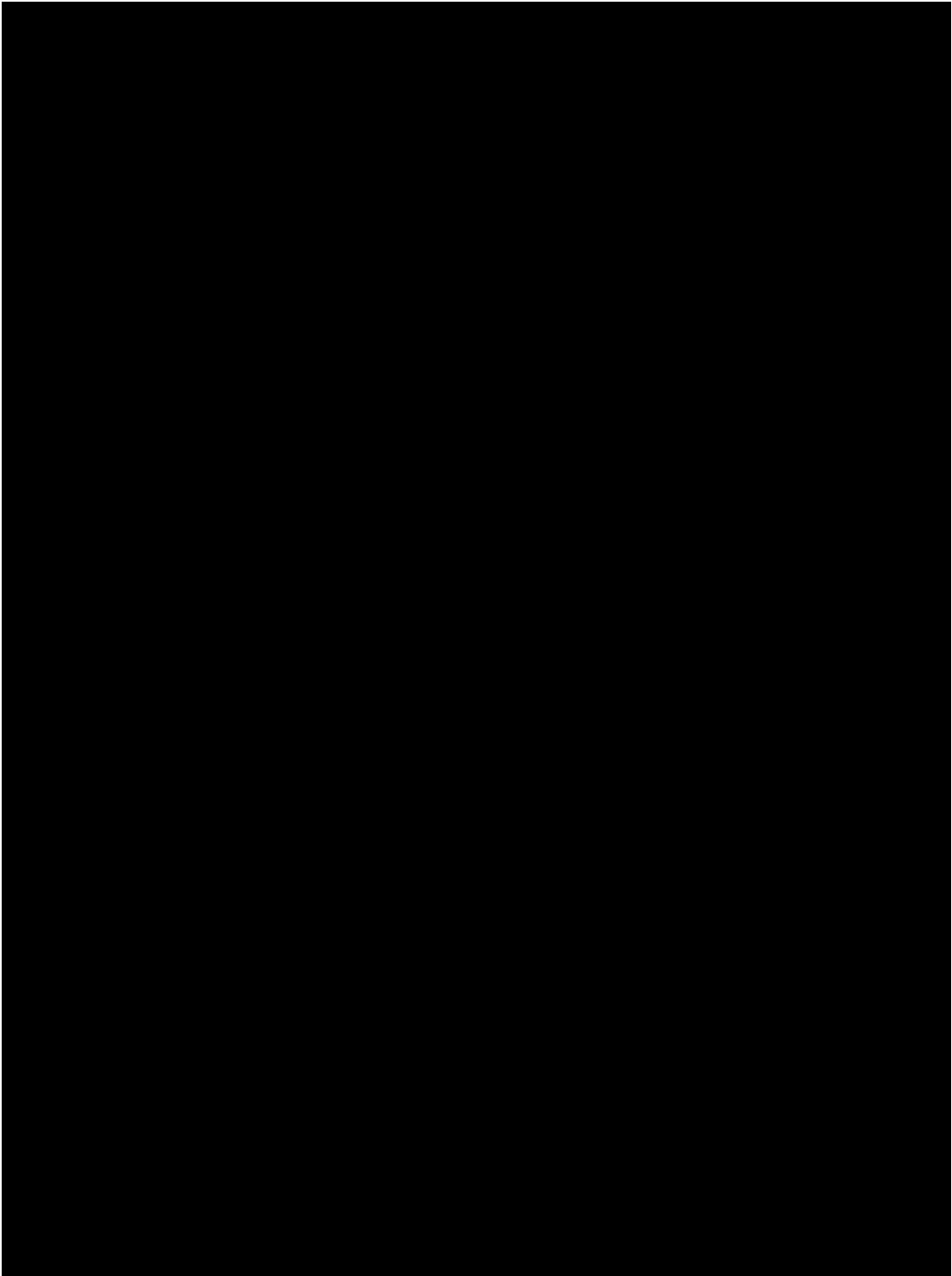


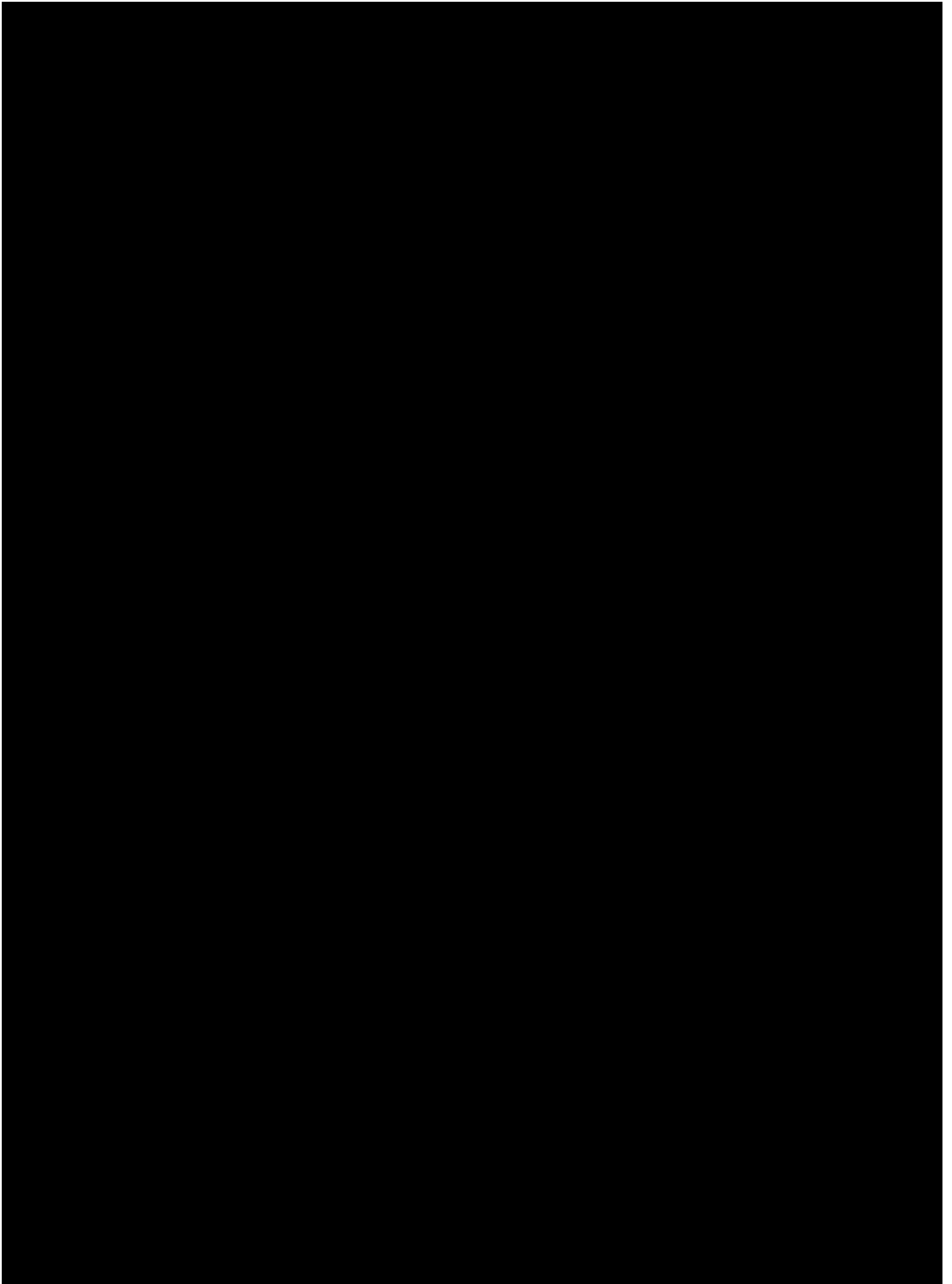


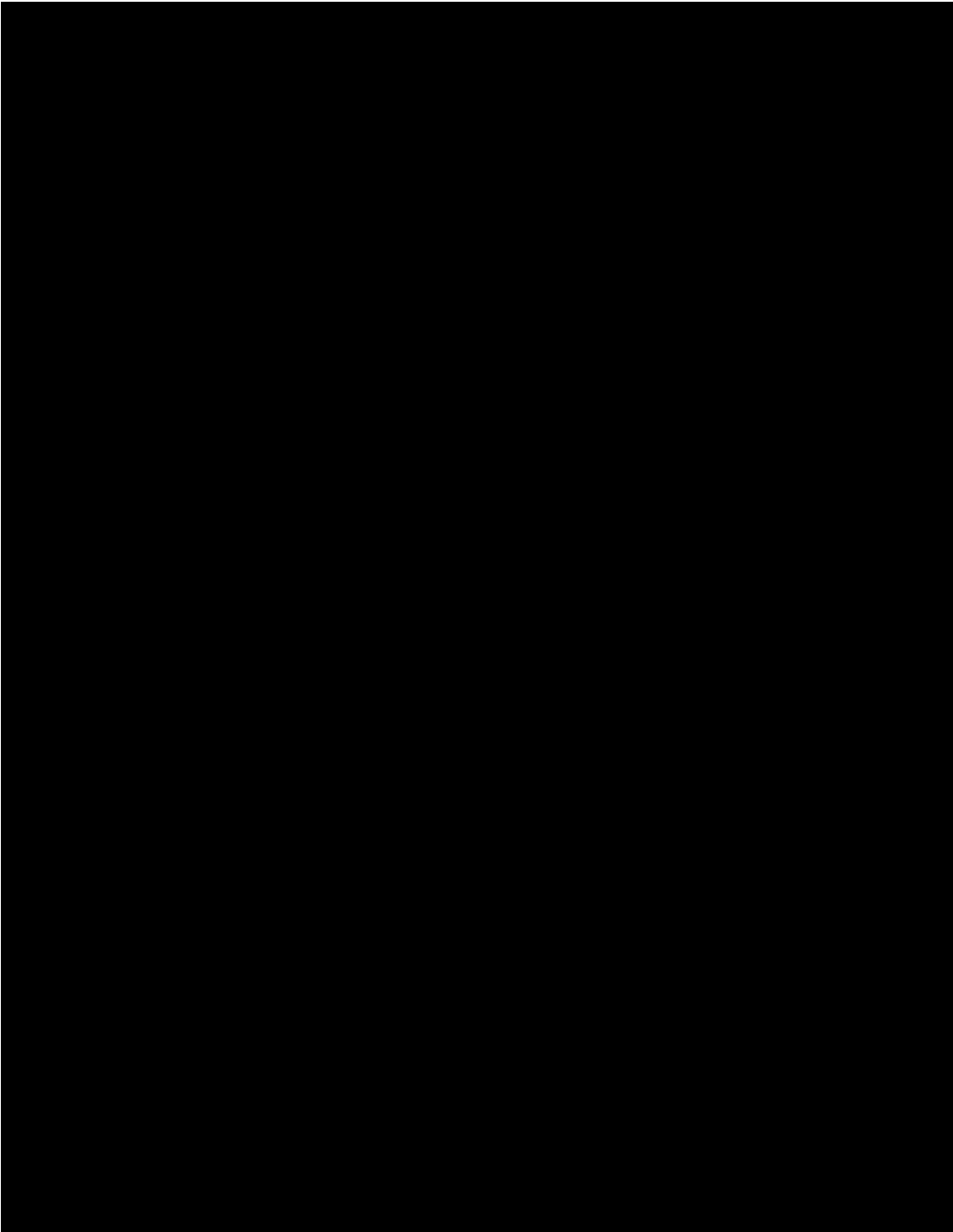


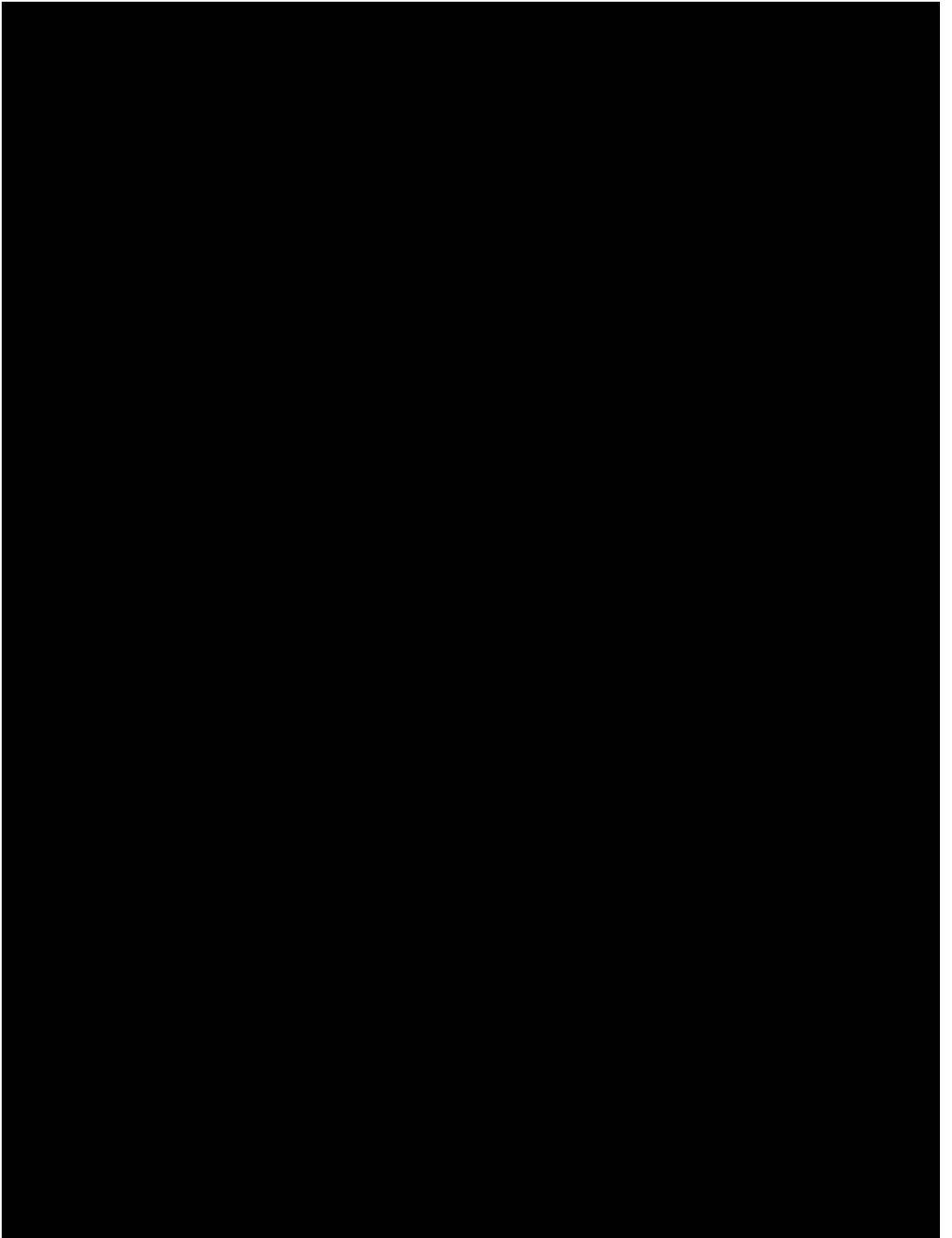


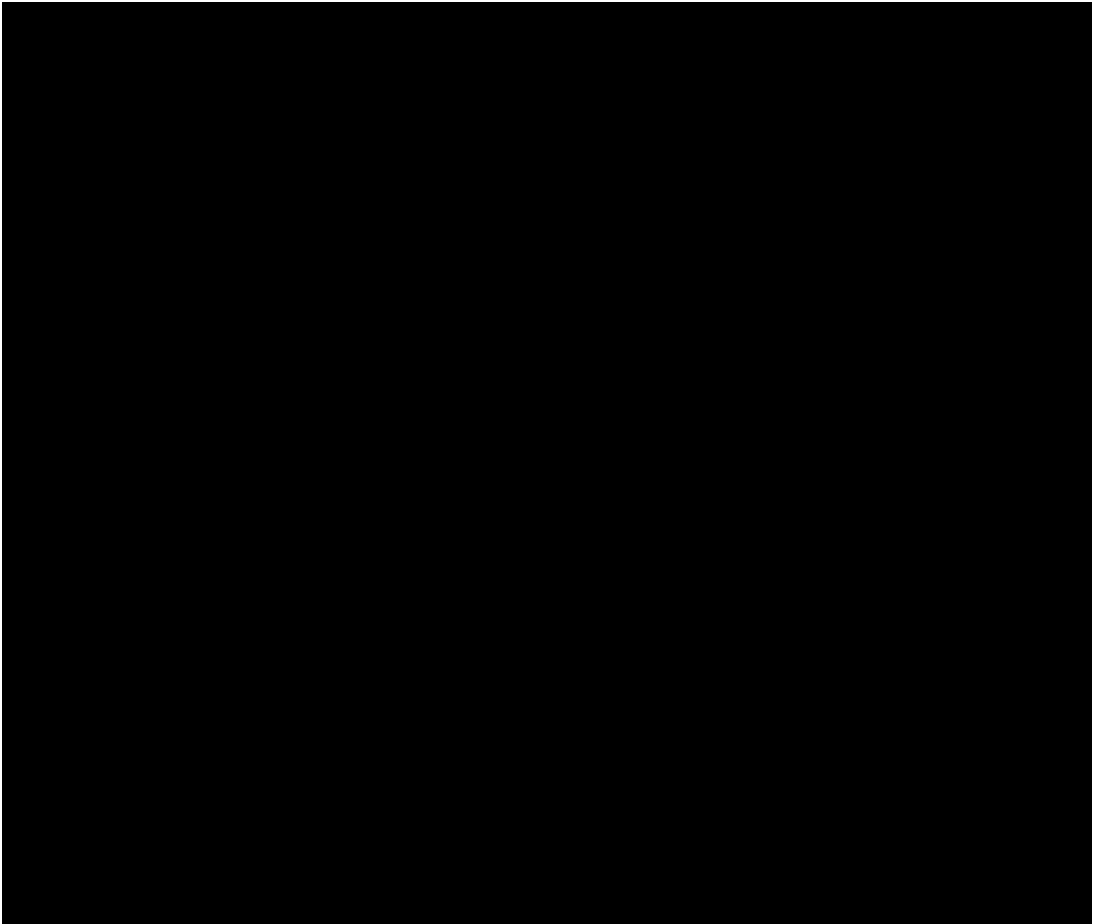


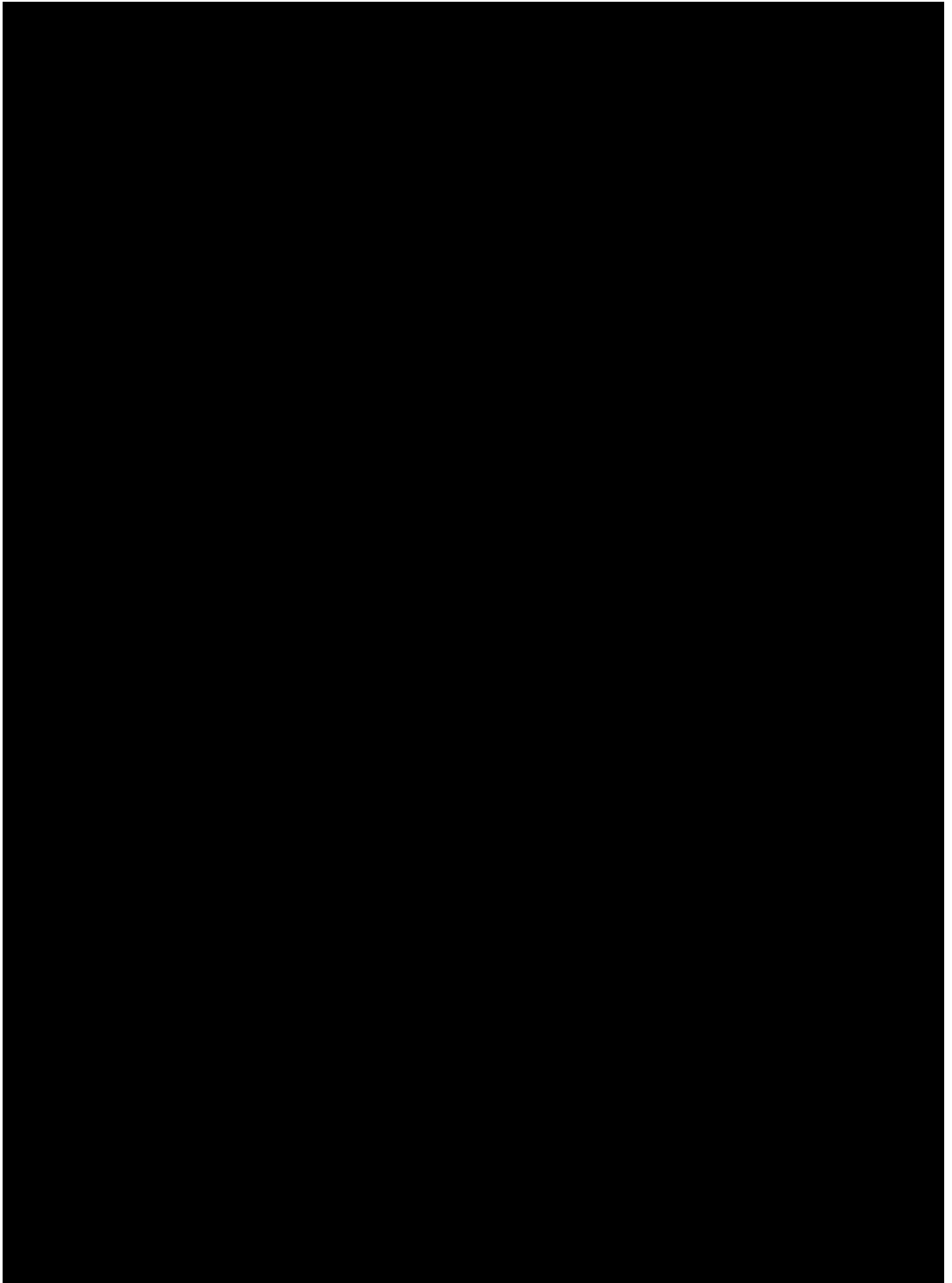


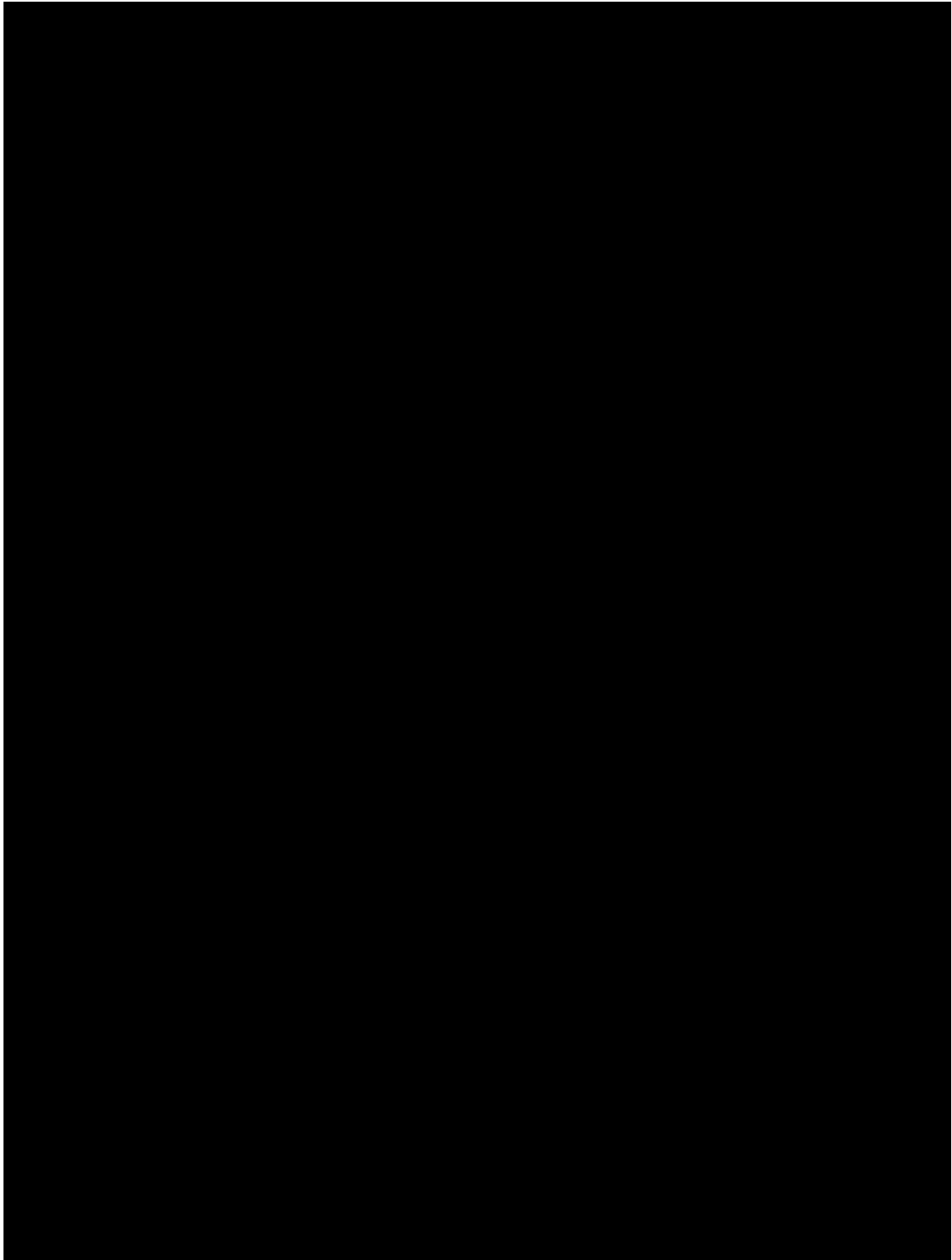


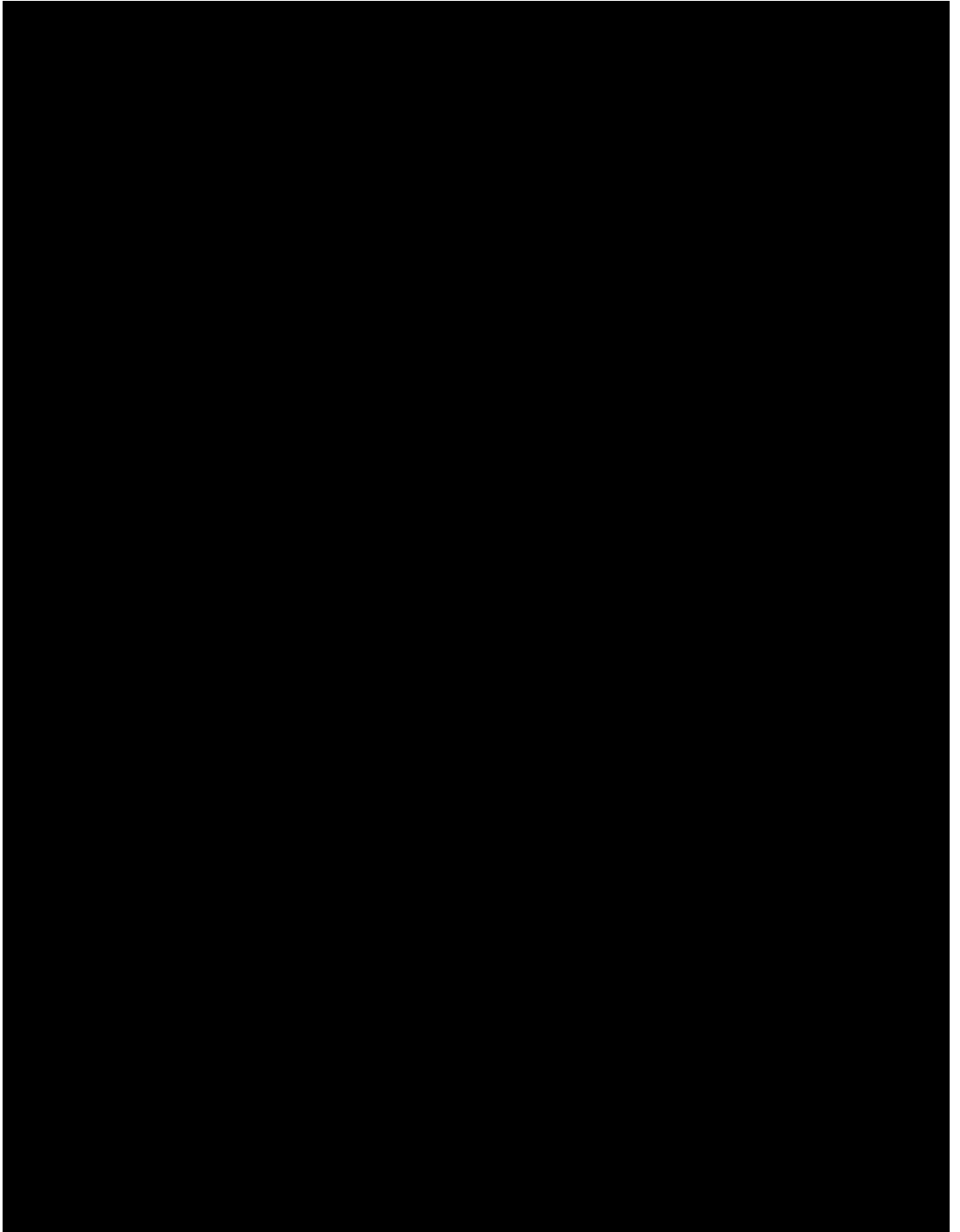


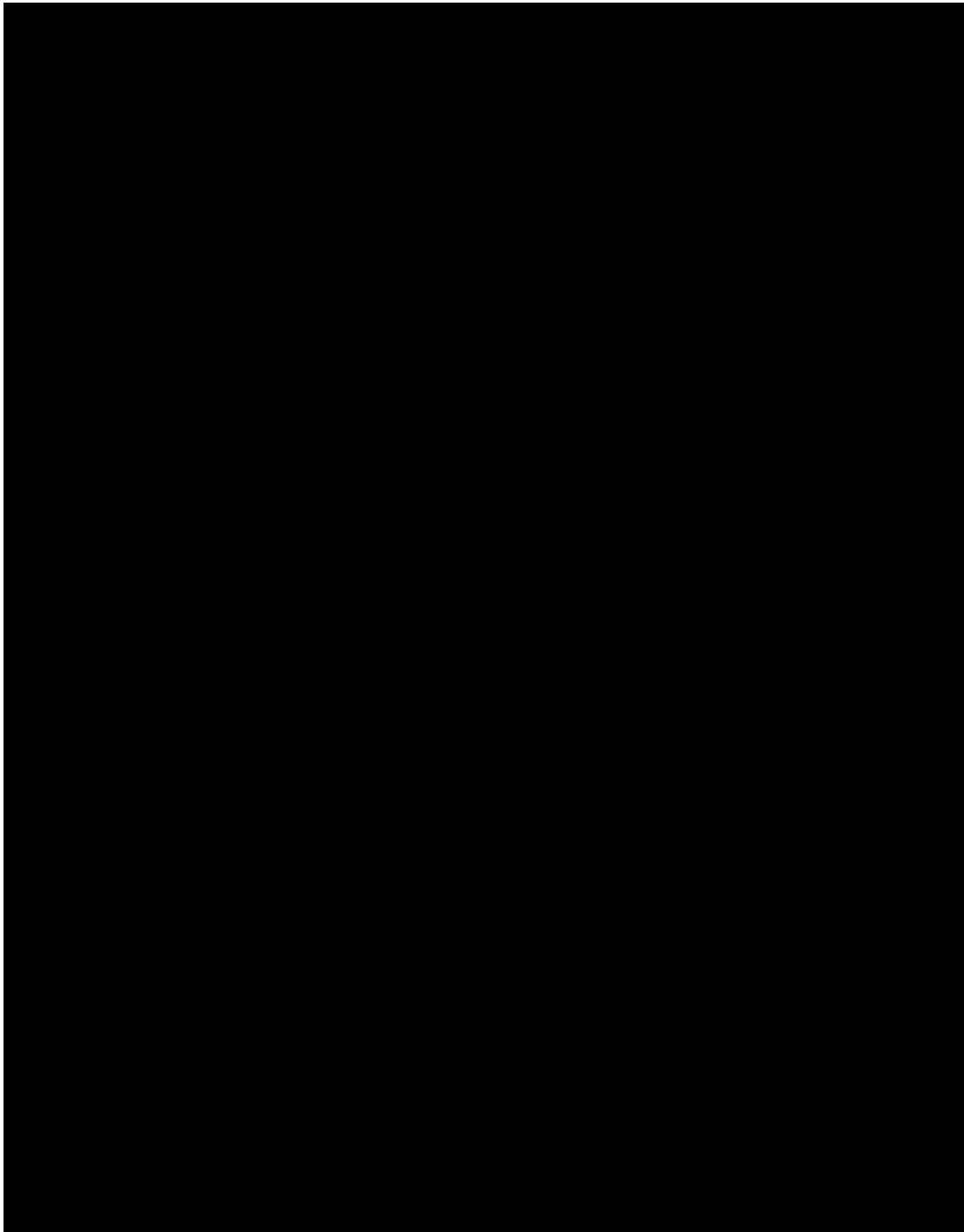


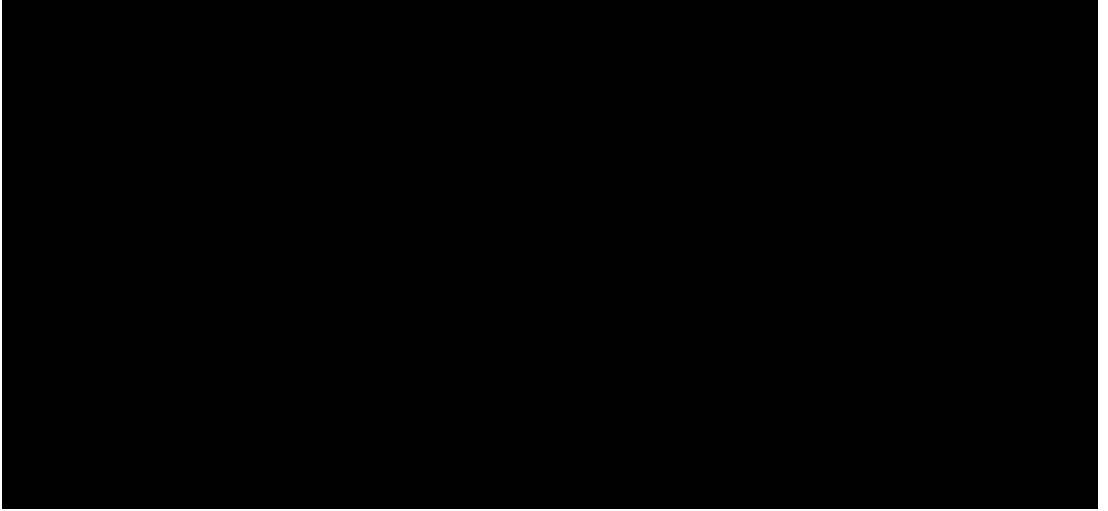












CHAPTER 6. PATHWAYS TO IMPROVING NUTRITION AMONG UPLAND FARMERS THROUGH NUTRITION-SENSITIVE AGRICULTURE INTERVENTIONS: A CASE FROM NORTHERN LAOS



A community in Northern Laos

Published as

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Abstract

While there is an increased awareness of the role of nutrition-sensitive agriculture (NSA) interventions on nutrition, the studies that investigate holistic pathways from interventions to nutrition outcomes are inadequate. We aimed to understand these pathways to improved nutrition from the Enhancing Nutrition of Upland Farming Families (ENUFF) Project implemented in northern Laos. We applied an embedded case study design by recruiting 101 participants representing implementers, school and private sector representatives, and beneficiaries, of which 34 participated in interviews and 68 participated in 11 FGDs. This was supplemented by a desk review of project documents. We analysed the data using a directed content analysis across five pathways using a published framework on impact pathways from NSA interventions to nutrition outcomes. The project contributed to nutrition mainly through three core pathways-food production, nutrition, and WASH- related knowledge, and agricultural income, supported by strengthening local institutions within the project's scope. While it is evident that the project contributed to empowering women by saving their time and increasing income, further study is needed to investigate the translation of these aspects to nutrition-related practices. We also suggest the need to sustain the capacity of local institutions and their engagement beyond the project cycle. To enhance the effectiveness of NSA interventions on nutrition, there is a need to design and implement an intervention package with multiple pathways and tailored strategies based on nutrition outcomes, the envisaged pathways, geographical context, and factors affecting these.

6.1 Introduction

The role of the agriculture sector in addressing poor diets and consequent malnutrition has been previously studied [1,2]. Optimizing the contribution of agriculture to address malnutrition requires a nutrition-sensitive approach in designing and implementing the interventions, simultaneously addressing its multiple determinants [3,4]. There is, therefore, the need to make the agricultural sector nutrition-sensitive by redesigning conventional agricultural interventions to nutrition-sensitive agriculture (NSA) interventions, which explicitly incorporate nutrition objectives and actions [2,5].

Past studies have suggested that NSA can address malnutrition through multiple pathways [2,3,5]: improving food production [2,3,5], raising income level enabling the purchase of nutritious foods [2,3,5], empowering women to make nutrition-related decisions [2,3,5], increasing nutrition-related knowledge [3], strengthening local institutions [3] and food price [2]. NSA can appropriately fit in the context of low- and middle-income countries [LMICs], as most of the population depends on agriculture as the primary source for their livelihood [2,6].

While there is abundant evidence on the impact of NSA interventions on nutrition and specific pathways to such effects, studies that investigate a holistic examination of impact pathways are limited. Our recent review highlighted research gaps on the pathways on women's empowerment, income-expenditure and strengthening of local institutions, suggesting more research [3]. Furthermore, fragmentation of the evidence-based intervention package across multiple studies has limited the understanding of the holistic pathways and the effects [3]. There is thus a need to map the comprehensive impact pathways that lead from NSA interventions to better nutrition outcomes by assessing the effects of the interventions on nutrition and detailing the pathways from the interventions to the effects.

In this article, we report on a case study conducted in Lao PDR (hereafter Laos). Laos is one of the LMICs facing a high burden of malnutrition, with undernutrition rates higher than the global average. As per the Lao social indicator survey 2017, 33% of children under the age of five years are low height-for-age (stunted), 21% are low weight-for-age (underweight), and 9% are low weight-for-height (wasted) [7]. These rates are higher than global average rates of undernutrition, for example, 21.9% of children under the age of five years are low height-for-age and 7.3% have a low weight-for-height [8]. Despite the reduction in poverty and significant economic growth over the last decade [9], the country experiences slow progress in reducing malnutrition among children and women [10]. Moreover, 40% of women of reproductive age are anaemic [11]. Persisting geographical and economic inequalities further exacerbate

the problem. The country faces one of the highest inequalities in malnutrition rates by wealth and location. The difference in stunting rates between the richest and poorest, and urban areas and rural areas are 40.9% and 21.2%, respectively [8].

There is a need for the agriculture and food (agri-food) system in Lao PDR to be more nutrition-sensitive to address inadequate diet and malnutrition. The traditional agri-food system in Laos exhibits subsistence production, with rice as the main staple [12]. The food system in upland villages in northern Laos traditionally relies on shifting cultivation to produce food [13]. Subsistence production is transitioning to commercialized agriculture focused on annual cash crops cultivation and is developing as a means for livelihoods [13,14]. The insufficient production diversity seems to be a reason for inadequate diet. A study found that more than half of the study population were food insecure [15]. The study highlighted that eighty-eight percent of average calorie intake per capita came from rice whereas there was less consumption of other foods such as meat, eggs, fats, and oils [15]. Wild foods are important sources of subsistence, as several populations depend on such foods to fulfil their nutrition needs as well as income [14]. Food diversification and increased access to nutrient-rich foods, such as vegetables, meat, and fish, is necessary to address inadequate diet and consequent malnutrition in Lao PDR [12]. NSA approach can tap into the traditional agri-food system to make the system nutrition-sensitive [16] by incorporating nutrition across the pathways from food production to food consumption.

The government of Laos has committed to achieving the second Sustainable Development Goal—end hunger, achieve food security and nutrition by 2030 [17]. It has developed a road map to promote people's health by eliminating food insecurity and malnutrition, as envisaged in the National Nutrition Strategy to 2025 and Plan of Action 2016–2020 [10]. NSA is one of the priorities of the National Nutrition Strategy to 2025 and Plan of Action, as the country recorded a significant investment of USD 27.2 million on NSA in 2018 and is home to over 11 registered NSA projects [18].

Despite the implementation of several NSA interventions in Laos, studies on the pathways from NSA interventions to nutrition outcomes are surprisingly scarce. The country-specific studies related to NSA are centred on agricultural production [13,19,20]. To our knowledge, only one paper investigated the role of home gardens in improving nutrition in 2004 [21]. However, as NSA interventions and their effects are context-specific, decision-making on designing and implementing the interventions to address malnutrition can benefit from more contextual evidence on impact pathways [22]. Furthermore, none of the studies reviewed by a recent systematic review on NSA interventions' impact pathways represented Laos [3]. It is, thus, crucial to understand, through what pathways and how, such interventions are

progressing towards achieving nutrition outcomes in Laos.

This study aims to understand impact pathways from NSA interventions to improved nutrition outcomes in upland farming areas of northern Laos, using the Enhancing Nutrition of Upland Farming Families (ENUFF) Project as a case. Since April 2016, the ENUFF Project has been implementing a multi-sectoral programme, including NSA interventions in Northern Laos to improve nutrition outcomes in remote and ethnically diverse upland farming communities [23]. We expect that the results of this research will contribute to enhancing the effects of NSA interventions on nutrition outcomes in the context of the ENUFF Project, Laos, and other LMICs.

6.2 Materials and Methods

6.2.1 Study Design

We used an embedded qualitative case study design to explore the pathways from ENUFF's NSA interventions to nutrition outcomes. Because of the embedded case study design [24], we analysed four villages as separate units of analysis. These were later embedded into a holistic case. The case study was conducted using qualitative data supplemented by a desk review of key project documents. The qualitative data were collected by purposively sampling four groups of participants: project implementers, beneficiaries, school representatives and private sector representatives.

6.2.2 Project Description

The ENUFF Project aims to improve dietary practices among children under five years of age and women of reproductive age by increasing availability and accessibility of diverse nutritious foods; reduce the incidence of water, sanitation & hygiene [WASH] related diseases; and strengthen a conducive institutional framework at the subnational levels [25]. The project activities are divided into two phases. The first phase (April 2016–June 2020) targeted 4000 households from 40 villages [25]. The second phase (July 2020–June 2024) includes 2000 additional households from 20 more villages [25]. All these villages belong to remote and ethnically diverse upland farming communities of four districts: Xiengkhor and Viengxay districts of Houaphanh province and Nga and Beng districts of Oudomxay s province [25]. This research is based on the interventions from the first phase. Funded by the Swiss Agency for Development and Cooperation (SDC), the Netherlands Development Organisation (SNV) implemented the project together with Agrisud International, a local NGO named Rural Development Agency (RDA), and

government counterparts. The government partners involved at the sub-national level are the Provincial Health Departments, Provincial Agriculture and Forestry Offices and Lao Women’s Union [25]. The respective district offices of these provincial offices implement the activities by establishing the District Nutrition Team that comprises ten members from District Health Office, District Agriculture and Forestry Office, and District Lao Women’s Union. The project also established a village-level nutrition team (VNT) that comprises seven volunteers responsible for following up on the adoption of practices by beneficiaries.

ENUFF Project’s convergence approach combines agricultural production activities with social behaviour change communication to promote optimal nutrition and water, sanitation, and hygiene (WASH) practices [23]. Besides the target households, the project provided school gardening support and nutrition and hygiene WASH education during the first phase. The school-based activities were terminated for a certain period as collaboration with the Department of Education could not be established. Box 6.1 gives a summary of the activities; more information can be accessed from elsewhere [23,25–27].

6.2.3 Research Sites

The primary data of this embedded case study was collected from ENUFF project beneficiaries in selected implementation villages as well as implementers representing the village, district, province, and national levels. The villages selected for this study are Namkhong and Phonsa At from Beng district and Mokloy and Phouko from Nga district. As indicated in Table 6.1, these villages were selected based on three criteria: high rates of stunting, villages’ typology, and equal representation of the districts [28]. The villages represented three typologies: a remote village with extensive upland agriculture, an accessible village with intensive commercial agriculture, and a subsistence-oriented village with lowland agriculture. One more remote village with extensive upland agriculture was selected to make the selection representative to the districts, which led to four villages meeting the inclusion criteria.

Table 6.1. Characteristics of villages selected for study

SN	Village	Stunting [25]	Village type [25]	District
1	Namkhong	60%	Type 1 Remote villages with extensive upland agriculture	Beng
2	Phonsa At	71%	Type 2 Accessible villages with intensive commercial agriculture	Beng
3	Mokloy	77%	Type 3 Subsistence-oriented villages with lowland agriculture[paddy]	Nga
4	Phouko	61%	Type 1 Remote villages with extensive upland agriculture	Nga

Box 6.1 Brief description of different components of the ENUFF project

Agricultural component: The agriculture component comprised of crop and livestock production.

- *Crop production*—The project delivered intensive training on *home gardening* and provided inputs to a few motivated pilot farmers who possessed sufficient land near household premises and labour to take care of the garden. Furthermore, a few beneficiaries who had sufficient resources—land, water, labour, and equipment—received inputs for establishing a *greenhouse*. The project provided training on *fruits production* and saplings of banana, mango and papaya trees, and also delivered rice and legumes production activities to some extent.
- *Livestock production:* Livestock activities comprised training on rearing livestock and inputs such as fence and fodders and paid vaccination.

Marketing component: The project also imparted knowledge on the importance of selling surplus agricultural products for income to make nutrition-related expenses.

Nutrition and WASH social behaviour change communication component: This comprised four activities triggering to educate all community members on nutrition; monthly cooking demonstrations targeted to pregnant women and caretakers of children under five years of age; counselling on optimal nutrition and WASH practices to households with pregnant women and children under two years; and WASH infrastructural support. The WASH infrastructures support comprised rehabilitation or construction of water systems (gravity-fed water systems) in selected villages and provision of training on toilet construction to village-based volunteers.

Women empowerment component: The project also integrated gender to increase women's participation in activities and their empowerment.

6.2.4 Participants and Recruitment

To gain holistic perspectives on the pathways, we ensured geographical and stakeholder representation. We recruited four categories of participants from different geographical sites and levels representing: implementers, beneficiaries, school representatives and private sector representatives (vegetable- or seed-sellers). The implementers were the participants involved in the execution of the project. They represented government and non-government sectors and covered the national, provincial, district and village levels. The school and private sector representatives were not involved in the implementation. We could access a private sector representative from one district only and a seed seller at the village level

who was also a beneficiary. The beneficiaries participated in at least one of the following activities: information session on agriculture production and nutrition/WASH communication for triggering, intensive training, and inputs on home gardening and/or greenhouse, cooking demonstration and/or nutrition/WASH communication. Some of the beneficiaries were indirect beneficiaries, as they did not directly participate in the activities but received benefits either through their parents who benefited from the project or through information materials. While we contacted the project implementers to identify the implementers and some beneficiaries, we also applied the snowball method to recruit more beneficiaries and key informants. As indicated in Table 6.2, we recruited 101 participants representing four levels, national, provincial, district, and village. Of these, 58 were beneficiaries, comprising 57 females and one male. The male member was the husband of a female beneficiary and a beneficiary of greenhouse activities, recruited to learn about vegetable production and women empowerment as recommended by the female beneficiary. The labelling of the participants mentioned in Table 6.2 is based on each category of participants and will also be used in the results sections:

- INI: Implementers at national level—interview*
- INF: Implementers at national level—FGD*
- IP: Implementers at the province level*
- ID: Implementers at the district level*
- IV: Implementers at village level*
- PR-Private sector representative*
- SR-School representative*
- BI-Beneficiaries—interview*
- BF-Beneficiaries—FGD*

Table 6.2 Study participants

Levels→	National	Province	District						Village									
Data collection method ↓	Implementers (IN)	Implementers (IP)	Implementers (ID)	Private (PR)	Implementers- the VNT (IV)				School (SR)	Beneficiaries (B)								
					Phoko	Mokloy	Namkhong	Phonsa At		Phoko	Mokloy	Namkhong	Phonsa At					
					FGDs (n=11)	1					1	1	1	1	1	2	2	
					FGD participants	4					6	7	5	5	7	7	16	11
					Interviews (n=34)	1	4	8		1	0	1	0	0	2	2	6 (1 male)	3
Total (n=101)	5	4	8	1	6	7	5	5	2	9	14	19	17					

6.2.5 Data Collection

The primary data were collected using 11 focus group discussions (FGDs) and 34 semi-structured interviews (SSIs). The FGDs were administered at the national level with the project implementers and the village level with VNTs and beneficiaries. The SSIs involved project implementers at all levels, key informants, and beneficiaries. The FGDs and SSIs were guided by semi-structured tools refined based on the collected information. The tools mainly covered two aspects: the effects of the project on food security and nutrition; and barriers and facilitators to project implementation. The tools can be accessed from another paper [16]. While this paper focuses on the impact pathways, factors, i.e., either barriers or facilitators to the project implementation will be presented in another paper.

We administered the tools in the Laotian language. When beneficiaries only spoke the ethnic languages, such as Hmong, we mobilized local translators. Data were collected by trained researchers and tape-recorded. We stopped collecting the data when there was saturation, i.e., when no new information on the pathways emerged. The average duration of the FGDs with implementers and beneficiaries was around 90 min. The interviews with implementers, beneficiaries, school representatives, and private sector representatives lasted on average 78, 57, 43, and 40 min, respectively. The duration of the interviews differed because of differences in the involvement of the participants in the project. School representatives and private sector parties had less knowledge about the project, and hence, the interview with them was shorter.

The primary data were supplemented by a desk review of ENUFF Project documents. The main objective of the desk review was to support theory building and triangulation [29]. The review contributed to building effects on nutrition outcomes, as these are best studied by quantitative methods. The documents' analysis also served to triangulate data on pathways. The desk review involved four key steps. The first was the identification of all documents of the ENUFF Project reporting on its results on nutrition (or WASH)- related outcomes or pathways. We identified five documents to include in the review. Of these, three were either end-line reports or learning briefs that used quantitative data on effects and/or pathways [25,27,30]. One was a learning brief that used both qualitative and quantitative approaches [26]. The remaining one was a gender and social inclusion analysis report 2019 that applied qualitative methods [31]. The documents included in the desk review are as follows:

1. ENUFF Project learning brief No. 5, Nutrition-sensitive agriculture for improved dietary diversity, June 2021 [25]
2. ENUFF project end line report, July 2020 [30]

3. ENUFF Project learning brief No. 4, Water, Sanitation, and Hygiene (WASH) related determinants of undernutrition, June 2020, [27]
4. ENUFF Project learning brief No. 3, Promoting positive behaviours in nutrition through community volunteers, June 2020 [26]
5. ENUFF Gender and Social Inclusion Report, November 2019 [31]

For clarity in interpretation, data from desk reviews that are not covered by primary data are linked to the respective documents in the results section.

The three remaining phases of the desk review process were skimming of documents, thorough reading, and interpretation [29]. We integrated the data from the desk review with the primary data during data analysis. The data extracted from the documents are illustrated in supplementary files of published chapter 6.

6.2.6 Data Analysis

The audio recorded FGDs and interviews were transcribed and translated from Lao to English at the same time by the person involved in data collection and fluent in both languages. The transcripts in the local ethnic language were first translated into Lao and then to English. A directed content analysis of this embedded case study was carried out using ATLAS.ti version 8.4.4 in four phases. In the first phase, the FGDs and interviews were cumulatively coded by reading the transcripts thoroughly to develop initial codes on the effects of interventions on nutrition and the pathways to the outcomes using a framework by Sharma et al. (2021) [3]. Two researchers were involved in the coding. The coding on the effects focused on five themes—household living environment, care and WASH practices, dietary practices, the prevalence of diseases, and nutritional status of children. Similarly, we coded the pathways to these outcomes from interventions across five themes: i) food production, ii) nutrition-related knowledge, iii) agricultural income and nutrition-related expenditure, iv) women's empowerment, v) and strengthening of local institutions [3]. In line with the scope of the ENUFF Project, we considered the first three as core pathways, whereas women's empowerment and strengthening of local institutions supported the core pathways. We further adopted the nutrition and WASH-related knowledge pathway to the 'nutrition and WASH-related knowledge and WASH infrastructural development' pathway based on the project's scope and available data. During the second phase, we supplemented the primary data with the results of the desk review, which was also analysed using the same coding structure. While the primary qualitative data dominated the results on pathways, the findings on the effects mainly came from quantitative data used

in the desk review. In the third phase, we created impact pathways for each village. As this was an embedded case study, the subunit of analysis for coding was each of the four villages.

By the end of the third phase, all four villages had their pathways. In the fourth phase, we construct a general pathway by integrating village specific data and the data from the district, province, and national levels.

6.2.7 Ethical Considerations

Our research involving the primary data collection received ethical clearance from the National Ethics Committee for Health Research, Lao Tropical and Public Health Institute under the Ministry of Health, Lao PDR. We obtained written informed consent from all the participants.

6.3 Results

In this section, we first present the effects of the ENUFF project on nutrition-related outcomes and then describe the pathways to the effects. Together, they make the impact pathways from the project activities to nutrition. Figure 6.1 provides an overview of the overall impact pathways, and village-specific pathways are detailed in supplementary files accompanying published Chapter 6.

6.3.1 Effects on Nutrition-Related Outcomes

This section describes the effects on five levels of outcomes: household living environment, care and WASH practices, dietary practices, the prevalence of diseases, and the nutritional status.

Household Living Environment

The project recorded an improvement in the household living environment in terms of sanitation facilities. The number of ‘open defecation free’ villages and the proportion of households with access to improved sanitation facilities increased from 3 to 24 [27], and 75% to 92% [30], respectively. The reasons for some of the houses not having a toilet were traditional belief, lack of interest or lack of resources such as money, water, or labour. According to an implementer,

“Some of the villages don’t have water access such as Phouko where the water access is very limited and some of the villagers don’t even have water access or too far from the water source or no equipment or money, then that’s just how it is. [...] Their own usual habit, which is to open-

defecate in the forest because they think it is convenient and that they don't need to wash it." [ID-3]

The proportion of households with access to an improved water source, however, decreased from 98% in the baseline to 90% in the end line [30]. Nevertheless, 2 out of 4 study villages had access at 100% [30]. Of the villages, Phouko had the least accessibility to water. The main reasons mentioned for this are either change in the climate, drying up the sources or destruction of gravity-fed water systems by natural disasters [30]. Qualitative data also stresses a lack of water or improper management of water as an important problem.

Care and WASH Practices

The project contributed to improve care practices concerning exclusive breastfeeding and sanitation and hygiene practices among mothers. The proportion of exclusively breastfed children and the practice of safe disposal of child faeces increased from 53% to 97%, and 32% to 67%, respectively [30]. Qualitative data also reveals exclusive breastfeeding practices, improved handwashing practices, and improved use of a toilet.

Dietary Practices

The project recorded an improvement in dietary practices at three levels: household, children, and women.

At the household level, the mean dietary diversity score (DDS) increased from 2.7 at baseline to 3.9 at end line [30]. These findings are well-supported by qualitative accounts. Several beneficiaries reported that they changed their food consumption by adding variety to their meal. Most of these beneficiaries used at least three food groups, as indicated in the following quote.

"[About] five food groups, sometimes they are not complete. [...] When there are some, found some, we would have complete five groups but if not, there would only be about three groups." [B12]

End line comparison across intervention and non-intervention villages showed a significantly higher score in Houaphanh province only and not in Oudomxay [25]. The reasons for limited dietary diversity are: lack of food, money, or knowledge in a few cases. The project recorded an overall improvement in children's dietary practices, with variations across villages and types of indicators [30]. The mean dietary diversity score of children 6–23 months of age increased from 2.8 in baseline to 4.0 in end line [30]. Similarly, the

PATHWAYS TOWARDS NUTRITION OUTCOMES

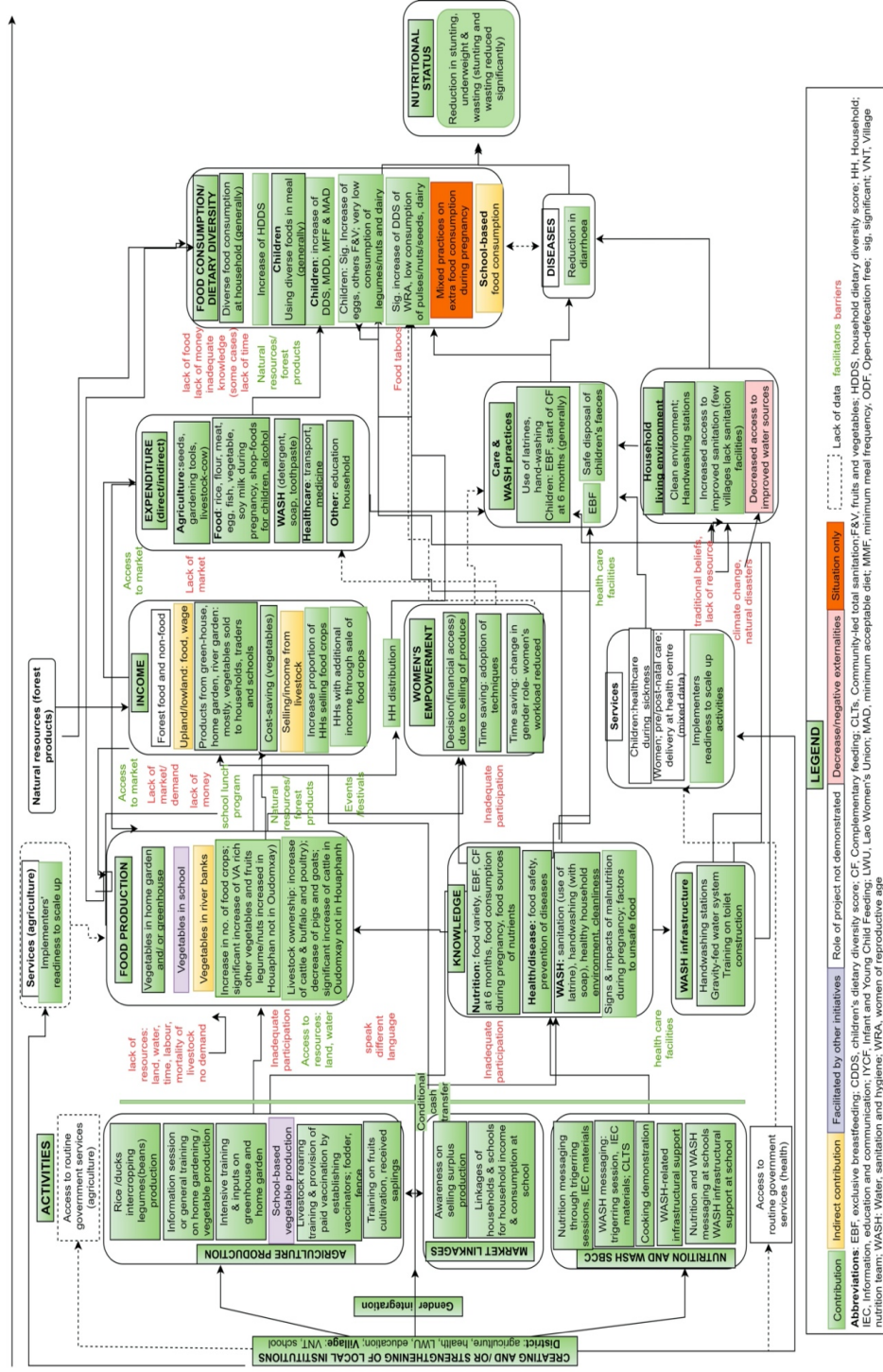


Figure 6.1. Results on pathways from ENUFF Project's NSA interventions towards nutrition outcomes, using Sharma et al., 2021 [3]

proportion of children practising minimum acceptable diet, minimum meal frequency, and minimum dietary diversity increased from baseline to end line with the following changes: 1% to 59%, 14% to 66%, and 23% to 72%, respectively [30]. However, the practices varied across four villages. While all four villages recorded an improvement in the minimum acceptable diet, other indicators either progressed or remained the same or declined in some villages [30].

Among children, the disaggregated data on food consumption based on end line comparison across intervention and non-intervention villages varied across geographical areas and food groups [25]. The consumption of eggs and other fruits & vegetables was significantly higher in intervention villages. Children frequently consumed grains, roots & tubers, flesh foods, and breast milk [25]. However, the consumption of legumes & nuts, and dairy was extremely low. The effect on DDS also varied across the province with the significant improvement in Houaphanh province (4.16 vs. 3.46, $p < 0.05$) whereas Oudomxay showed no significant change (3.98 vs. 3.89, $p > 0.05$) [25]. The reasons behind the inadequate dietary diversity explored through qualitative data were lack of time, food, money, or knowledge. Nevertheless, there was an overall improvement in the feeding practices. As discussed during an FGD in Phonsa At,

“No, I didn’t do the same [before and after the project] after the staff came and did the demonstration, I would often cook it.” [P1] “When they are 0–6 months, I would only give breastmilk, and after 6 months, I would cook rice porridge for the baby. [...] Put in the rice, vegetable, and sliced pork, also pumpkin, and a bit of salt.” [P3] [BF-3]

End line report does not provide information on women’s dietary practices. Comparative assessment of the DDS between intervention and non-intervention households in the end line indicates the significantly higher DDS of women of reproductive age in intervention villages in both provinces ($p < 0.05$), Houaphanh (5.00 vs. 3.89) and Oudomxay (4.22 vs. 3.37) [25]. The women mostly consumed grains, roots and tubers, vegetables, and meat, poultry, and fish. However, there was a very low consumption of pulses, nuts and seeds, dairy, and eggs.

Qualitative data did not provide information on the effects but only on the situation on practices before and during pregnancy. The data illustrates mixed practices, as some participants increased consumption during pregnancy while others did not. Health care facilities during antenatal care check-ups facilitated the consumption by providing information. However, lack of food and money and prevailing food taboos hindered food consumption during pregnancy and/or postnatal periods. According to a beneficiary,

“[The consumption pattern] was like usual. The extra thing I added was when I had money, I would go and buy some fruits to eat. Of course, I increased my consumption of fruits and anything that would be beneficial for the baby. Buying Anne-Mum [maternal milk] as well. When I don’t have money, then I don’t buy.” [BF-3]

Prevalence of Diseases

The incidence of diarrhoea among children less than 2 years of age reduced from 24% at baseline to 13% in the end line [30] with all four villages reporting the reduction. One FGD also indicated a reduction in diseases among children, as stated in the following passage,

“Of course, it [reduction in diseases] has increased. Why? It is because, one, it has built our immune system to be better so that we don’t get sick, for our children to grow bigger and better. [...] Our children get to attend school, and they have no sickness.” [P2, IV-2]

Nutritional Status

The project contributed to an overall reduction in undernutrition [30]. The prevalence of stunting, underweight, and wasting reduced from baseline to end line with the following values: 42.3% to 37.7%, 28.6% to 23.1%, and 10.7% to 5.2%, respectively [30]. Of these, stunting and wasting were significantly reduced in the end-line compared to baseline ($p < 0.05$) [30]. However, effects varied across villages, as illustrated by descriptive data [30]. While all four villages witnessed a decrease in stunting, change in underweight and wasting varied across the villages. Prevalence of underweight decreased in Phonsa At but increased in Namkhong [30]. Likewise, the prevalence of wasting decreased in Phonsa At, Mokloy and Phouko but increased in Namkhong [30].

An FGD and an interview indicated an improvement in the nutritional status of children based on their anthropometry. According to a VNT,

“Previously, children were thin, malnourished. After the project came, they have access to vegetables and meat for their children to eat and when they did their height and weight measurement, and they passed [...] Yes, for this we have seen from the results.” [P1, IV-4]

6.3.2 Pathways from NSA Interventions to Nutrition Outcomes

As depicted in Figure 6.1, the different units of the analysis together expose five pathways present from the interventions to nutrition-related effects described in an earlier section. These pathways encompass food production, agricultural income, nutrition-related knowledge, women’s empowerment, and the

strengthening of local institutions. Detailed village-specific pathways can be found in the supplementary files accompanying published Chapter 6.

Food Production

The project contributed to the adoption of vegetable production techniques that increased the variety and quantity of vegetables in the home garden and greenhouse. The production was better in the greenhouses, where beneficiaries could produce throughout the year. Beneficiaries mostly used the produce for consumption, and some beneficiaries also sold surplus to generate income, as illustrated in the following quote.

“We all had a little bit before the project came. Only enough for family consumption” [P3] “Just a little one until the project came, then we expanded and did more. It’s now enough for both consumption and for selling ...” [P7] “Compared to last year, they look nicer ...” [P4] “They came, trained us, and provided some seeds, hoe and watering can. They grow much better and can be sold and consumed by many families.” [P7] [BF-5]

More households owned home gardens and poultry and produced more quantity and variety of crops, including vitamin A-rich and other fruits and vegetables. While the production of legumes or nuts also improved, this recorded very low production with significant improvement in the Houaphanh province only [25].

In the livestock category, beneficiaries raised cows, buffaloes, pigs, goats, dogs, chickens, and ducks. The training on livestock production and paid vaccinations improved livestock ownership to some extent.

“[Translator] she said she’s been raising them before ENUFF came, but she didn’t have many and then after ENUFF came, they taught ways to take care of the livestock and so it has been improved.” [BI-7]

The end-line report reveals increased ownership of cattle and buffalo, goat, and poultry, whereas the ownership of pigs decreased [30]. When compared across intervention and non-intervention households at the end line, both Houaphanh and Oudomxay provinces recorded significantly higher ownership of poultry, whereas big livestock ownership was significantly higher in Oudomxay province only [25].

The pathway leading to livestock production was constrained due to the mortality of livestock, mostly poultry. A few participants suggested the need for a better focus on livestock because of their high mortality. A need to focus on livestock in the households that lack land to produce vegetables was also stated. According to an implementer,

“Pigs and others are still okay. When we visited some of the villages, they all said their poultry died.” [ID_2]

The production varied across villages and specific agricultural products. Several beneficiaries in the lowland commercial village had a home garden before the project, and some households in remote upland started the gardens as a result of the project’s activities. Most of the beneficiaries who already had a home garden expanded it, applying the lessons, and produced more. A few beneficiaries, however, stated that the production remained the same. The household food security based on end line comparison across intervention and non-intervention households also saw varying effects, with significant positive results in Oudomxay but contradictory results in Houaphanh [25]. Based on end line descriptive data, all four study villages recorded an increase in the mean number of food crops and ownership of cattle/buffalo, goat, and poultry [30]. However, three of these villages recorded a decrease in the proportion of households producing food crops or owning pigs [30].

The attempt to make the beneficiaries adopt and/or continue the home gardening practices were affected by several barriers. Adapting home gardens and producing its produce was influenced by low participation of women in training, lack of resources such as land, time, labour, or water, and poor access to buyers/lack of demand. The insufficient access to land and/or water led to gardening near riverbanks for some households. The following quote highlights lack of time as a barrier,

“First of all, I have to make money for my children, secondly for our house, family, and our livestock, plus the food is also dependent on me. However, I still do it [home garden] but only once or twice, only this dry season that I do not have enough time to do it yet. I still did it, sold two sets already, but I have not started the third set yet.” [BI-1]

A few beneficiaries mentioned the spill-over effects of the production of vegetables experienced in two ways: diffusion of production-related knowledge, skills, or inputs from pilot farmers to other beneficiaries; or application of seeds in the gardens at riverbanks or upland/lowland farms. For example,

“Since my vegetables didn’t look as nice, I went to see theirs, and they told me about the methods on how to grow them nicely with good quality and I would follow the methods that they’ve taught me. The result was that the products look better now [...] I was able to sell and consume some as well.” [BF-1]

It is noteworthy that agricultural production at upland and lowland farms and forests were sources for food consumption and income. In the upland and lowland farms, beneficiaries cultivated crops such as

grains, legumes, nuts, vegetables and fruits, and some raised livestock. Some beneficiaries revealed a reduced yield of products in these fields, especially of rice due to heavy rainfall preventing traditional fertilization methods (slash and burn), weeds, or the death of crops. Besides producing the food in the farms, the beneficiaries also relied on the forest to forage vegetables, meat, and fish.

The contribution of the production pathway to dietary diversity varied across target populations and specific production-related indicators [25]. The number of food crops and food security resulted in better dietary diversity of women of reproductive age [25]. However, the variables on the production of food crops or livestock considered by the study included in the desk review did not predict children's DDS. Furthermore, several other included variables, such as having a home garden or livestock ownership, did not influence any of these DDS scores. This highlights the role of NSA, and that agricultural production alone may not improve dietary diversity [25].

Agricultural Income and Nutrition-related Expenditure

Besides being a source of food, agriculture was also a source of income that allowed beneficiaries to make nutrition-related expenses. There was an increase in income from the products grown at the home garden and greenhouse in two ways. First, growing food instead of spending money to buy led to savings. Second, the better yield of diverse and quality crops contributed to increases in the selling of vegetables, mostly among greenhouse recipients. Besides the increase in the production of vegetables, the end line report indicates an increase in the proportion of households selling food crops [30]. Almost half of the participants of qualitative research who sold the products linked it to the project's contribution. There were also some who responded that they do not sell any products, while a few reported a decline in selling due to reduced demand.

"Before this, there were about 4–5 families that were selling vegetables and after the project was implemented, we could see that there are more families who are selling vegetables." [P5]

"More than 20 families [are selling]" [P5]. "About 50 families actually" [P1] [IV-2]

Beneficiaries reported three channels for selling: other villagers for home consumption or special events such as festivals and weddings, schools for the school lunch program, and mobile traders (in Phonsa At village). Recipients of the greenhouse experienced the most benefit as they could produce and sell the products throughout the year. They also benefited from high food prices during the lean period. According to a greenhouse beneficiary,

"Now it [income from selling vegetables] has increased to [double] [. . .] [Particularly] the Chinese

cabbage because nobody in the village has any. Only us. So, they would come and buy from us.”

[BI-12]

Regarding income from livestock, a few beneficiaries reported selling livestock such as buffalo, pigs, and goats occasionally to invest in productive assets such as a house, tractor, rice mill or a cow, while buying for own consumption in small quantities from the market. Big livestock was generally kept as a means for financial safety [25]. A few participants also indicated the consumption of poultry meat which they themselves produced, and the qualitative data lack information on the selling of poultry. Although there was an increase in livestock ownership, the impact on selling or income from livestock was not clear from the qualitative data.

The income contributed to nutrition-related expenses, such as food, transportation to access health care, WASH, and agricultural production. The expenditure on food by the beneficiaries was made for meat, salt, herbs and spices, vegetables, fish, soy milk during pregnancy, packaged foods, or candies for children available at shops, rice, flour, egg, legumes/beans, fruits, and alcohol. Beneficiaries also used the income on water and electricity [bills], clothes, education for children and other household purposes. The following saying from a greenhouse beneficiary illustrates how she used the income from selling vegetables to purchase other food items.

“When I sell vegetables and earn some money, I use that money to buy meat or eggs if we feel like it.” [BI-14]

The income to expenditure pathway was affected by access to the market, which varied across villages. In Phouko, a very remote and upland village, beneficiaries scantily practised selling. When they sell the vegetables, they had to take them to the open ground and yell, “please buy vegetables from me”. In Mokloy village, beneficiaries practised exchanging amongst themselves due to the lack of external buyers. These villages also lacked a market to buy meat. In Namkhong, several beneficiaries were willing to sell but did not have external buyers due to which they were not able to sell all the surplus products. The lack of buyers demotivated them to produce a surplus. The selling was better in Phonsa At, a lowland village with road access, as beneficiaries could sell vegetables to external traders. Both Namkhong and Phonsa At villages also had access to meat and/or fish supplied by mobile traders.

The significant sources of income for several beneficiaries were upland/lowland farm, forest, and wage labour. They practised selling food and non-food items collected from these areas. Some of them also earned money from wage labour in farms. Although these sources are beyond the direct scope of the

project, they facilitate the income-expenditure pathway. Food-related expenditure was also affected by access to money.

Nutrition and WASH-Related Knowledge and WASH Infrastructural Development

Several beneficiaries learned about at least one of the nutrition and WASH-related topics. The topics were: diverse food consumption, extra food consumption during pregnancy, breastfeeding, complementary feeding, harmful effects of using foods produced using chemicals, proper cooking techniques/procedures, and food sources of nutrients such as vitamins and protein (few beneficiaries). The participants knew about the need to eat varieties of food. The specific knowledge of the required number and name of the food groups was, however, inconsistent. The WASH-related knowledge gain comprised topics of hygiene, clean household environment, consequences of open defecation or use of the toilet, and washing hands with soap. Beneficiaries' knowledge of nutrition and WASH varied across villages [30]. The following passage shows how knowledge influenced food consumption.

"They said for each day, we should consume six food groups or if we don't have all the groups then at least 4 groups. If today we are eating vegetables, the [meal] should also include meat, potatoes, corns, etc. However, I am trying to consume at least four groups: vegetables, meat, bamboo shoots. [...] If there is no rice, then we can use corns as a substitute, or potatoes or taros as a substitute. The vegetable oil replacement types are peanuts. Animal oil or peanuts. [...] I just know when the project came." [BI-13]

There was an improvement in the acquired knowledge. The knowledge of the nutrition pathway was, however, constrained due to three reasons. First is the lack of knowledge acquisition by the beneficiary because the information did not reach them due to a lack of participation of women or a lack of sharing from other household members who participated in the activities. Second, some participants admitted having forgotten some nutrition-related messages. The third reason is the inadequate translation of the acquired knowledge into practice. Dietary diversity was affected by a lack of production, money, market, or time. Likewise, knowledge of sanitation alone did not motivate some beneficiaries to construct a toilet.

There were a few cases of diffusion of knowledge, either from the direct participants to non-participants or from other sources to the project participants. A few beneficiaries who did not participate in the cooking demonstration knew about diverse food consumption from their parents or other women participating in the activity. Furthermore, a government implementer also delivered some knowledge to non-target villages while executing regular activities. A few beneficiaries also gained knowledge from

healthcare facilities during antenatal care visits, school, or television.

The project improved access to WASH facilities, such as toilets, handwashing stations and water systems. The village recorded an improvement in access to sanitation facilities, with the number of open defecation-free villages also increasing to 24 in 2019 compared to 3 in 2016 [27]. The project rehabilitated and/or constructed new water systems (gravity-fed water systems). Still, several households had not constructed toilets due to lack of money, insufficient labour, traditional beliefs, or perception that the project would provide materials. According to an implementer,

“Their own usual habit, which is to open-defecate in the forest because they think it is convenient and that they don’t need to wash it.” [ID-3]

The contribution of nutrition-related education or having WASH facilities on nutrition outcomes varied across indicators. For example, women’s education and access to improved water source were associated with DDS among women of reproductive age. However, they did not affect children’s DDS [25]. Similarly, the contribution of WASH on nutrition outcomes also varied across specific practices or outcomes. Reduced open defecation, or improved access to safe water, reduced diarrhoea [27]. Absence of animal faeces in household premises resulted in improved height-for-age z-scores [27]. Some other(s) did not play a role [27].

Women Empowerment

We identified two sub-pathways leading from women’s participation to women’s empowerment: intra-household decision-making and resource allocation; and saving in time spent to access food or perform household work. Although the full impact on nutrition outcomes was not clear, we describe the change in the pathways in the following paragraphs.

Women’s participation in the project activities is a crucial entry point to their empowerment. While several women participated in the activities, there were many occasions when other members of the household participated. The reasons for not participating were that women were busy with household or farm work; language was also a barrier. Furthermore, a few participants provided a perception of gender inequality:

“Because they are based on the fact that if they depend on the women, they wouldn’t understand that well if I have to be truly honest. That’s how we are most of the time. They would just be like, okay, just let the men go because the women wouldn’t understand what they talk about. [...] Most of the time it would be men.” [P2, IV-3]

Men went to the activities on numerous occasions but failed to share their acquired knowledge with their wife, while she is the one taking care of the home gardens and preparing food for the household.

Regarding intra-household decision-making, women could decide on selling agricultural products and making household purchases using the money earned from selling food products, irrespective of the project intervention. The beneficiaries, however, started selling more after the project intervention, making them more financially empowered. GESI analysis states that women have a lesser hold in financial decision-making, especially on larger investments (>50,000 kips) [31]. During an FGD, participants indicated that, in a different context, deciding to construct a toilet was dependent upon the approval from the husband despite the interest of women beneficiaries.

A lack of own participation or a lack of information sharing from other household members who participated also affected nutrition-related decisions making, as indicated by the following quote.

“And after he went to the training, did he come back home and cook for your children or change the way you used to cook or prepare food for your children?” [interviewer] “He is a man, so he does not really know how to cook. Mostly for dinner, it is me and the kids who would cook for him.” [P1] “And he didn’t tell what to put and all?” [interviewer] “No, he didn’t.” [P1] [BF-6]

The project contributed to saving women’s time in two ways. First, the adoption of techniques such as home gardens or greenhouses saved time that was spent looking for vegetables from upland and lowland farms, forests, or the market. Second, a few participants stated that a greater awareness of gender equality led to husbands’ contribution to household work. As a result, women were less involved in heavy workloads allowing more time for family. The following quote indicates saving in women’s time.

“We have vegetables in our home garden, so if we want to eat some, we can just go and collect from our home garden and don’t need to go to the forest to find some. Save time so we can work for the family.” [P1, BF-3]

The translation of saving time may have contributed to better nutrition of their children, as a lack of time was indicated as a key barrier for doing so. This translation needs further validation.

Key barriers on this pathway were gender inequality leading to low participation of women, dependency upon men to access services such as antenatal care [for transportation] or men having final say on decision-making [31]. The gender inequalities were more prominent in the Oudomxay province [31].

Strengthening the Local Institution

This pathway appears as a pathway to stimulate the previous four pathways. The project established a system at the village level and enhanced the technical capacity of provincial and district-level institutions on nutrition-sensitive agriculture. In the villages, the VNTs monitored beneficiaries' practices on food production and nutrition.

The village veterinary worker also provided paid vaccinations to the livestock. The provincial and district team was also aware of the agriculture-nutrition integration. An important challenge affecting this pathway was coordination across sectors and levels. A few VNTs also asked for more capacity to conduct activities and follow up with the beneficiaries. The following quote by a VNT demonstrates increased involvement in the field activities.

“Ever since the project came, Health office, Agriculture office and the Lao Women Union came to provide training on nutrition for the women and children under two so that they know how to cook properly for their children that will benefit them and for their growth development.” [IV-4]

The project also integrated five project learnings into policy dialogue and increased the readiness of implementing partners to scale up the activities [30]. The involvement of the volunteers from VNT in counselling households also improved the relationship between the village and district-based teams [30].

6.4 Discussion

To contribute to addressing malnutrition in Northern Laos, ENUFF Project employed NSA interventions—agricultural interventions that integrated nutrition objectives and actions through a convergence approach. This enabled us to explore these pathways to nutrition outcomes using framework from Sharma et al. (2021) [3]—food production, agricultural income, nutrition and WASH-related knowledge, women's empowerment, and strengthening of local institutions. Using our qualitative research approach, we found that ENUFF's NSA interventions contributed to improving nutrition outcomes via three core pathways—food production, nutrition-related knowledge and WASH infrastructural development, and agricultural income, supported by strengthening of local institutions. Concerning women's empowerment, the interventions helped save their time and also contributed to their income. Our research does not capture a concrete translation of women's empowerment to nutrition-related practices, which need further investigation. We recommend sustaining the strengthened capacity of local institutions beyond the project cycle. NSA requires consideration of multiple pathways with a contextualized and tailored

approach based on geographical context to address contributing barriers. Our research contributes to food system theories through a focus on the pathways from nutrition-sensitive food production to food consumption. Because of the scope of this research and the ENUFF Project, we do not capture other stages of food systems outlined by other studies such as, processing, distribution, or disposal [32,33].

ENUFF Project improved nutrition, viz. improved care and dietary practices and reduced diarrhoeal diseases and undernutrition. The outcomes that varied need particular attention, for example, household living environment. Despite improvement in some hygiene and sanitation-related outcomes, inadequate sanitation facilities and a reduction in access to water need further attention as incorporating WASH in NSA interventions can enhance nutrition outcomes [5]. Other outcomes requiring attention are dietary practices, especially in children in Oudomxay; the least consumed food groups such as legumes and nuts, dairy products, and eggs; and underweight. The low consumption can be due to the traditional dietary practices in which Lao people do not like milk livestock, or dry beans and consume them as legumes. Improving the change in the diet requires a shift from traditional dietary practices to a more nutrient-rich diet.

Our result on the significant reduction in stunting and wasting is different from past studies that highlight the strong effect of NSA on intermediate outcomes such as improving dietary diversity but limited impact on reducing stunting, wasting, or underweight [3,5]. The reduction in our study may be due to the integration of components beyond food production that can address multiple determinants of determinants [5], such as nutrition-related social and behaviour change communication or WASH infrastructures. Nevertheless, the evaluation design without control groups at baseline and end-line may have biased the results, which recommends a rigorous evaluation design.

The project contributed to improved nutrition mainly through three core pathways-food production, agricultural income, and nutrition and WASH-related knowledge. Past studies also reported on some of these pathways from similar nutrition-sensitive home gardening projects, for example, food production and consumption [34–39], agricultural income and food-related expenditure [35,36,39], and nutrition-related knowledge and dietary practices [36,37,39]. The project also empowered women that led to financial access and savings in their time. The translation of empowerment to nutrition, however, is inconclusive from our research and needs further inspection. The project strengthened the capacities of local institutions and multisectoral coordination to deliver NSA interventions, while contributing to other pathways within the project's scope.

The five pathways require further attention to maximize their contribution to nutrition. An important strategy for enhancing production would be to prioritize inadequate produces such as legumes/nuts and dairy, as well as address the mortality of livestock. Livestock can also be a viable option for households that lack land to produce vegetables. The income contributed to nutrition-related expenditure across multiple determinants of malnutrition highlighted by UNICEF [40]. There is, however, a need to foster this pathway through sufficient income and access to the market. Likewise, enhancing the knowledge pathway requires more participation from beneficiaries and means to apply the knowledge. As strengthening of local institutions can lead to improved service delivery [3,39,41,42], we recommend sustaining the developed institutional capacity and mechanisms beyond the project cycle to enhance agriculture and nutrition-related service delivery. Women empowerment needs special attention that we discuss separately in the next paragraph.

To further empower women and translate it to nutrition-related practices, we recommend strategies across stages from their participation to their empowerment to nutrition outcomes. Low participation of women can be addressed by designing NSA programs that require mandatory participation [31]. Within this pathway, the project contributed to saving women's time and increasing their income. More efforts are required to safeguard their time available for nutrition, as a past study reported that NSA can experience a trade where women spend more time in agriculture, resulting in insufficient time for domestic work and children's care [43]. Managing these trade-offs is crucial in the upland farming areas, where women have less time due to their high mobility to upland and lowland farms. Further, it is important to translate these aspects of women's empowerment to their nutrition-related practices, such as allocating saved time for their own or children's care and feeding or deciding the income to make nutrition-related purchases. This may require changes in the intra-household dynamics on gender inequality, as well as community sensitization. A concrete translation of these aspects of women empowerment to nutrition-related practices is not captured by our research. Comparatively, less clarity on this pathway could also be because gender issues were not factored across all project components in the first phase, whereas the second phase explicitly incorporated gender equality across all project components. We suggest further study on the translation of women's time saving and their access to income to nutrition-related practices.

We highlight the need to combine multiple pathways to bring optimal nutrition outcomes [3]. Improving nutrition entails more than just access to food [5] to address multiple determinants of malnutrition. Furthermore, one pathway affects other(s). The pathways on production, income, knowledge, or women's

time influence each other to contribute to intermediate practices on care, diet, or WASH, eventually influencing undernutrition. NSA interventions, therefore, need to be strategic on how all beneficiaries at all times can adhere to nutrition-related behaviours. This might require contextualizing the best possible combination of the pathways. The pathways are, thus, interconnected and do not bring the desired effect on nutrition, in silo.

A tailored approach is required as the progress of the pathways and effects were highly contextual based on the specific indicator and implementation context. Past studies also highlighted the need for a contextual response [3,5,16,22]. The knowledge, production, and income pathways developed better in the areas with access to roads and markets, which could be due to the greater availability of foods and market outlets [14,44]. Although the dietary diversity is affected by distance to market and village-type [25], a few indicators did not progress even in the villages closer to roads. Notably, indicators within the single pathway or outcome category varied across geographical areas, for example, knowledge, production of legumes/nuts, and ownership of big livestock. This leads to another argument that the pathways and effects are contextual across target areas, as they are subject to several factors. Therefore, we stress the need to address multiple barriers influencing the pathways and effects such as low participation of women, lack of access to land, money, labour, water and market, mortality of livestock and food taboos. Some of these factors are consistently reported elsewhere, such as land [39,45,46], water [34,46], money [47,48] or market [14,35,44,49]. Addressing the barriers may benefit from a comprehensive analysis of the factors from an implementation perspective.

This study offers two main strengths. First, this is the first study on NSA that looks specifically at the context of the Lao PDR. A focus on the upland farming families, who have not been specifically covered by past studies, further adds to the knowledge. Second, the study uses multiple data sources to complement and/or validate the data. The use of quantitative data from desk review to describe effects and the use of qualitative data to explore pathways together contributed to mapping the pathways from interventions to nutritional status holistically. Likewise, the use of qualitative and quantitative techniques on the pathways enabled the triangulation of the data. The research findings may have been affected by four limitations. The first limitation is the lack of generalizability of the conclusions made from the qualitative interviews and FGDs. To mitigate the limitation, we reviewed project documents to validate or supplement the findings, which added strength to the research. Second, the documents included in the desk review can be subject to bias. Inadequate data on the pathways, the evaluation design without matching control groups, seasonal differences in data collection period at baseline and end-line,

probability of selection bias in the end line due to COVID-19 situation [30], and a lack of control over participants or methods make the quantitative data used in the desk review less rigorous. Third, mobilization of implementers as translators due to unforeseen language barriers may have affected beneficiaries' responses, leading to social desirability bias. The fourth limitation is the lack of a complete triangulation of primary data and desk review, as they came from different periods. However, this choice was rational because, while the end-line quantitative data can portray actual effects, the pathways, and their mechanisms can be well studied during the implementation. We have also reported the desk review data source with corresponding references in the results section to allow readers to interpret accordingly.

6.5 Conclusions

The ENUFF Project's NSA interventions contributed to improved nutrition mainly through three core pathways-food production, nutrition and WASH-related knowledge and agricultural income, supported by strengthening local institutions within the project's scope. Concerning women's empowerment, the interventions helped save their time and contributed to their income. Further study is needed to investigate the translation of these aspects to nutrition-related practices. We suggest the need to execute strategies to sustain the mechanisms of engaging local institutions and their capacity. As these pathways influence each other, a combination of these can produce better nutrition outcomes. A contextualized design and implementation tailored based on geographical context, contributing factors, and effects and pathways can contribute to addressing malnutrition in Laos and similar LMICs.

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CHAPTER 7. IMPLEMENTATION AND SCALE-UP OF NUTRITION-SENSITIVE AGRICULTURE IN LOW- AND MIDDLE-INCOME COUNTRIES: A SYSTEMATIC REVIEW OF WHAT WORKS, WHAT DOESN'T WORK AND WHY?



A community settlement in Northern Laos

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Abstract

Evidence is rapidly growing on the impact pathways through which nutrition-sensitive agriculture (NSA) contributes to improving nutritional outcomes. However, to harness NSA's full potential, it is equally important to understand why impacts are achieved (or not) and which factors play a role. Evidence on success and failure factors, as well as external barriers and facilitators that influence the implementation and scale-up of NSA in low- and middle-income countries (LMICs) is still limited. To address this gap, we reviewed empirical evidence (since 2000) on factors influencing NSA implementation and scale-up. The Consolidated Framework for Implementation Research (CFIR) guided the analysis and synthesis of this systematic review. Eighty-five studies that met the inclusion criteria were extracted and synthesized across the five domains of the CFIR; here we report findings from three of the domains: NSA interventions, inner setting, and outer setting. Many factors related to each of the domains were identified: intervention-specific factors (clustered in seven subdomains and 23 themes), local contextual factors (in six subdomains and 23 themes), and factors related to the broader enabling environment (in five subdomains and 12 themes). A strong interplay among factors across the three domains was observed. This review highlights key areas for attention to enhance the success of NSA programs: learning from past successes and failures; appropriateness and acceptability based on context knowledge; project flexibility in addressing design limitations and coping with unforeseen hindrances; strengthening local structures, community empowerment and increasing resilience; supportive policy and governance. Our findings can help decision-makers at multiple levels to strengthen ongoing/future NSA programs and anticipate possible pitfalls to maximize NSA's potential to reduce undernutrition in LMICs.

7.1 Introduction

Undernutrition remains a persistent problem despite the increased political and financial commitment at global level (Heidkamp et al., 2021). Its determinants are embedded in our interconnected food systems, which continually reproduce the problem (Kok et al., 2019). Dominant food systems fail to provide sustainable, affordable, and healthy diets for a growing population (Allievi et al., 2019; Fanzo, 2019; Willett et al., 2019). The problem is particularly visible in low- and middle-income countries (LMICs) where the prevalence of child and maternal undernutrition remains unacceptably high (Black et al., 2013; Smith and Haddad, 2015). After the encouraging, though modest, results in reducing undernutrition in LMICs since 2000 (Victora et al., 2021), recent findings show an inversion in the trend in certain sub-regions, particularly in Africa (FAO/IFAD/UNICEF/WFP/WHO, 2019). The COVID-19 pandemic has further increased the risk of offsetting the limited and slow progress made in the past two decades (FAO/IFAD/UNICEF/WFP/WHO, 2020; Heidkamp et al., 2021; Victora et al., 2021) and undermining the chances to achieve SDG2 (zero hunger) and SDG3 (good health and well-being) (FAO/IFAD/UNICEF/WFP/WHO, 2020; Heidkamp et al., 2021).

Evidence shows that marginal or incremental adjustments of the current food systems will not suffice to eradicate the undernutrition problem; major changes are needed (Fanzo et al., 2020; FAO/IFAD/UNICEF/WFP/WHO, 2020; Swinburn, 2019; Willett et al., 2019). There is also a growing consensus that nutrition-specific approaches on their own are not able to address the persistent challenge of undernutrition (Bhutta et al., 2013; Hossain et al., 2017) and that system-wide complementary nutrition-sensitive approaches involving multiple sectors and stakeholders are needed (Dijkhuizen et al., 2019; Gillespie et al., 2018; Ruel and Alderman, 2013). Such nutrition-sensitive approaches consider both the policies concerning the macrolevel availability/access to nutritious food and the household/individual-level determinants of improved nutrition (Pingali and Sunder, 2017).

Nutrition-sensitive agriculture (NSA) is regarded as an effective approach, given the crucial role agriculture can play in the transition towards sustainable food systems and healthy diets (Ruel and Alderman, 2013), particularly in remote rural areas where market access to nutrient-rich food is limited (Ruel et al., 2018). NSA has been described as an inter-sectoral, multi-level food-based system approach intended to maximize agriculture's contribution to improved nutrition (NSA project, 2017). It aims to *"narrow the gap between available and accessible food and the food needed for a healthy and balanced diet for all people"* (Jaenicke and Virchow, 2013). NSA underpins the idea of a preventive approach to

nutrition insecurity benefitting the entire household/community, rather than a therapeutic approach at an individual level. NSA uses agriculture as a delivery platform but includes other sectors, such as health, education, social protection, environment, and natural resource management, to address the interlinked underlying determinants of undernutrition (Olney et al., 2019; Ruel and Alderman, 2013). For that purpose, NSA often encompasses the integration of nutrition-sensitive and nutrition-specific actions.

Over the last decade, international agencies, national governments, research foundations and NGOs have increasingly invested in the research, implementation and scaling up of the NSA approach (Ruel et al., 2018; Wesley et al., 2019). Proof-of-concept, as in the case of biofortification, and the characterization of the multiple pathways from agriculture to nutrition have been instrumental in stimulating new initiatives and investments (Ruel, 2019). To this end, priority has been given to gathering and assessing empirical evidence on the effectiveness of agriculture-nutrition programs (highlighting the need for better program designs and more rigorous evaluation designs) and/or on the pathways to impact, as documented by reviews published in the last twenty years (Berti et al., 2004; Bird et al., 2019; Carletto et al., 2015; Dizon et al., 2021; Fiorella et al., 2016; Masset et al., 2012; Pandey et al., 2016; Ruel, 2001; Ruel and Alderman, 2013; Ruel et al., 2018; Sharma et al., 2021; Webb-Girard et al., 2012; Webb and Kennedy, 2014; Wordofa and Sassi, 2020). While the body of evidence on the impacts of NSA interventions and the pathways through which NSA can contribute to the improvement of nutritional outcomes is growing, there is still limited insight into the implementation and scaling-up processes of complex NSA programs (Gillespie et al., 2015a; Nordhagen et al., 2019; Ruel et al., 2018) and the factors influencing them (Ezezika et al., 2021; Gillespie et al., 2013; McDermott et al., 2015; Olney et al., 2013; Ruel et al., 2018; Sharma et al., 2021).

Driven by the findings of the 2013 Lancet series on Maternal and Child Nutrition, attention has been given to the enabling environment for effective implementation of actions aimed at reducing undernutrition (Gillespie et al., 2013). Policy and governance related factors (including multilevel and multi-sectoral coordination), knowledge and evidence on nutrition, human and institutional capacity and adequate financial resources all contribute to the environment needed to translate commitments at multiple levels into actions and finally to impact (Gillespie et al., 2013). Specific insights on the enabling environment for NSA were generated by the research conducted in the framework of the Leveraging Agriculture for Nutrition in South Asia (LANSA) and in East Africa (LANEA) initiatives (Gillespie et al., 2015b, 2019a, 2019b; Gillespie & van den Bold, 2017) and the Agriculture for Nutrition and Health (A4NH) program (Aryeetey and Covic, 2020). This research provided a deeper understanding of the political, policy, institutional and socio-economic factors influencing the development of the NSA approach and, to a lesser extent, of

factors related to the context in which NSA interventions are implemented. Conversely, only a few reviews have explicitly drawn attention to contextual and/or intervention-related factors influencing the implementation and scaling up of NSA (Berti et al., 2004; Fiorella et al., 2016; Pandey et al., 2016; Ruel et al., 2018; Sharma et al., 2021). However, the analysis of such factors was not an explicit objective of these reviews, except for Fiorella et al. (2016) and Ruel et al. (2018). The central focus of the latter was on impacts of NSA interventions, although the authors did consider pathways, mechanisms, as well as contextual factors. Knowledge on context-specific factors influencing the food systems/agriculture-nutrition-health nexus and knowledge on NSA intervention-specific factors is highly needed but still scant (Fiorella et al., 2016; Gillespie et al., 2019a; McDermott et al., 2015; Ruel et al., 2018; Sharma et al., 2021). In the past few years, there has been a surge in publications on NSA which can provide additional evidence to address this gap.

To harness the full potential of NSA, it is important to understand not only the impacts of NSA programs/projects (hereafter referred to as 'projects'), but also why impacts are (not) achieved, and what factors can exert leverage on the implementation and scale-up of NSA. In fact, project outcomes result from the interplay among intervention-specific factors, local contextual factors and factors related to the broader enabling environment. To our knowledge, while past reviews and synthesis studies on NSA have contributed insights on some of these aspects, at present, none have provided a consolidated overview of factors at multiple levels. The objective of this systematic review is to identify and analyse key intervention, contextual and external factors that influence the implementation and scale-up of NSA. A better understanding of what works (or doesn't work) and why (at different levels) could support the decision-making of multiple actors (e.g., practitioners, researchers, policymakers) in the design, implementation, and scale-up of NSA programs. The ultimate goal is to maximize NSA's contribution to reducing undernutrition in LMICs.

7.2 Theoretical framework

The Consolidated Framework for Implementation Research (CFIR) guided the analysis and synthesis of this systematic review. CFIR is a model from implementation science which provides a pragmatic structure to understand what works where and why and to organize findings across studies (Damschroder, 2009). This framework consolidates the conceptualized factors believed to influence the effectiveness of implementation. The identified factors are categorized in five general domains. As recent reviews on nutrition-related interventions show, the CFIR is intrinsically flexible to fit a diverse range of interventions

and contexts (Ezezika et al., 2021; Middel et al., 2019). Since the focus of our study is on the factors that, at different levels, enable or constrain NSA (approach and related interventions), the CFIR was adapted to fit the broader scope. The theoretical framework is visualised in Fig. 7.1. and conceptualized in Box 7.1.

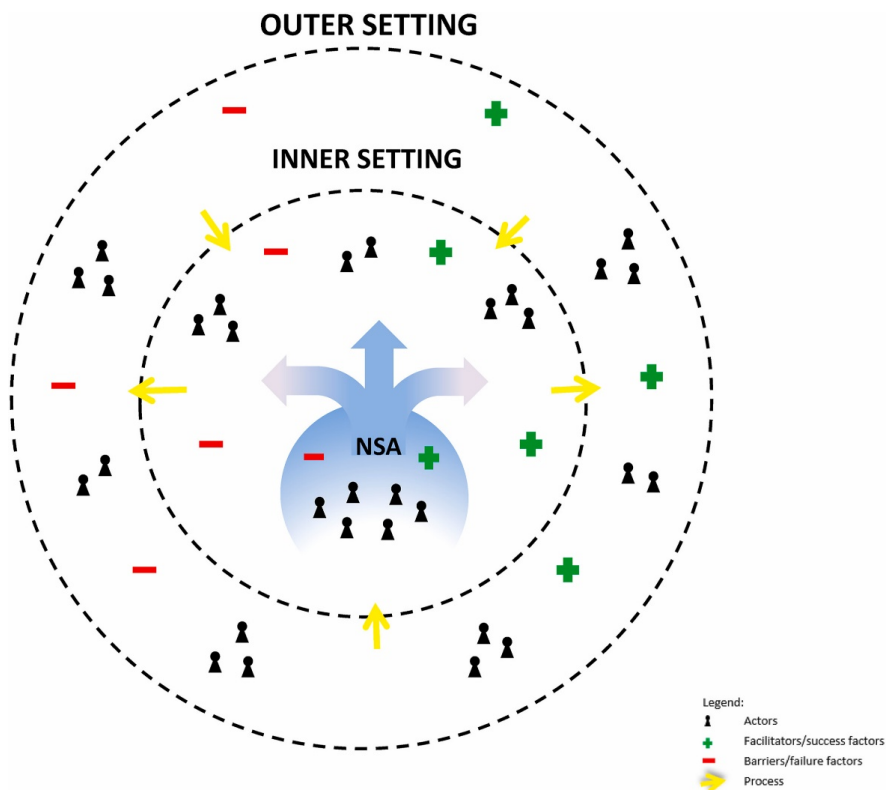


Figure 7.1. Visualisation of the theoretical framework. A simplified illustration of NSA in the context of a complex system

The black figurines represent the actors; the shaded blue circle represents NSA as an emerging niche; the arrows represent the processes occurring at different levels. Factors exerting positive (+) and/or negative (–) influence exist in all domains. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

In this paper we focus on factors related to the first three domains: NSA interventions, inner setting and outer setting. Each of these domains is further described below. Another article on factors related to process (such as targeting in the project design phase or inputs in execution), and actors (such as attitude and motivation) is foreseen.

7.2.1 NSA interventions domain

As mentioned above, the ‘NSA interventions’ domain concerns the figurative space demarcated by the NSA projects implemented at local level. All projects are expected to achieve the final goals of adoption, sustainability and possibly scaling-up.

Box 7.1. Conceptualization of factors influencing NSA were categorized across the five CFIR domains

- 1. NSA interventions** – this domain pertains to the NSA programs, projects, and interventions as implemented at local scale. For simplicity, we bundled and labelled them NSA interventions;
- 2. Inner setting** – the more confined context in which the NSA interventions are implemented. Since the focus of our research is on LMICs, the inner setting of most NSA projects, particularly in more remote and isolated areas, largely coincides with local food systems where foods are mostly produced locally or harvested from nature, and there is little or no interaction with outer setting food systems;
- 3. Outer setting** – the broader (economic, political, social) context outside the implementation setting where NSA projects operate. This environment is shaped by the interplay of macro-level factors (such as demographic, socio-cultural, economic, institutional, political, governance and environmental factors) and relevant societal systems (for instance food, health, education and social protection) that may influence, directly or indirectly, the implementation and scale-up of NSA;
- 4. Process** – relates to different phases and spans from implementation (design/planning; engagement; execution; monitoring, reflection, and evaluation) to scaling (broadening and embedding) of NSA interventions; and
- 5. Actors** – individuals or entities with agency, whose actions can facilitate or hinder the implementation and scale-up of NSA. Some actors may operate in more than one setting.

To pursue these goals, projects need to put suitable strategies in place at an early stage. Strategies may be adapted or newly introduced, based on learning from implementation. In the NSA interventions domain, we consider factors that implementers should keep in mind when developing strategies for successful adoption, sustainability, and scale-up of NSA projects. These intervention factors are defined as factors internal to an NSA project that influence implementation and scale-up. In the context of this study, intervention factors, such as acceptability, flexibility, and feasibility, that are demonstrated to have worked well are labelled as ‘success factors’, while those that were found not to have contributed to reaching the goals are referred to as ‘failure factors. In our conceptual framework, such factors are

positioned within the artificial boundaries of NSA projects, with the assumption that implementers have a significant level of influence and control over them.

7.2.2 Inner setting domain

The inner setting represents the local context in which NSA projects are implemented. Factors in this domain are defined as contextual factors or context-related factors influencing the implementation and scale-up of NSA. Examples are taken from the culture and social environment, local capacity, and the bio-physical environment. They are theoretically located outside the boundaries of NSA projects which implies that, in principle, implementers have limited (or no).

7.2.3 Outer setting domain

The outer setting is the broad environment surrounding the implementation context in which NSA projects operate. This domain comprises outer setting factors or external factors shaping the enabling environment for the implementation and scale-up of NSA projects, or posing barriers that constrain such projects.

In this study, for both inner and outer setting domains, factors with a positive influence are described as ‘facilitators’, while factors with a negative influence are referred to as ‘barriers’.

7.3 Methods

We conducted this systematic review according to the Preferred Reporting Items for Systematic review and Meta-Analysis (PRISMA) protocol (Moher et al., 2015). Guidelines on evidence-focused reviews in international development were also considered (Hagen-Zanker and Mallett, 2013). The review protocol was registered in the International Prospective Register of Ongoing Systematic Reviews with ID number CRD42018109863.

7.3.1 Search strategy

The search strategy was built around three main concepts (NSA approach, NSA interventions, and factors influencing NSA) and five search topics (agriculture, nutrition outcomes, multi-sector, nutrition-sensitive, low and lower middle-income countries). Details on the search strategy, concepts, and topics are provided in supplementary files of the published chapter 7. The search topics were used in the following

combination: {[agriculture] AND (food or diet or nutrition) AND multi-sector] OR nutrition-sensitive} AND low or lower middle-income countries. The search terms (and synonyms) were tested in various iterations to assess the effectiveness of the syntax in retrieving the relevant literature. A search string with terms related to factors influencing NSA, such as “barrier” or “facilitat*”, was also tested but ultimately not included as it reduced the power of the syntax, leaving out a number of relevant pre-identified articles. The full-fledged syntax is presented in supplementary files of the published chapter 7.

The development of the search strategy and the identification of the terms used in the syntax was informed by three main sources: (1) milestone reviews such as Ruel et al. (2018), Fiorella et al. (2016), Gillespie et al. (2015a), Ruel and Alderman (2013); (2) other relevant literature on the topic especially a set of eight articles potentially eligible for this study that were identified during an exploratory literature search (Haselow et al., 2016; Hodge et al., 2015; Kjeldsberg et al., 2018; Muehlhoff et al., 2017; Olney et al., 2013; Roche et al., 2017; Talukder et al., 2000; van den Bold et al., 2015); and (3) topical presentations by authoritative sources, such as FAO, IFPRI and WFP, during the National Nutrition Symposium and the Scaling Up Nutrition (SUN) Civil Society Alliance meeting held in Laos in November 2017 and the expert meeting of the Netherlands Working Group on Nutrition organized in collaboration with the Food & Business Knowledge Platform in The Netherlands in May 2018.

It should be noted that the core elements of the search syntax for this review were also used as a foundation for a different review on NSA impact pathways to nutrition outcomes by the same authors (Sharma et al., 2021).

7.3.2 Selection criteria

Nine criteria were formulated to decide on the eligibility of the studies for this review. A summary of the selection criteria is presented in Box 7.2 while a detailed description, including the rationale for exclusion, is provided in supplementary files of the published chapter 7.

7.3.3 Selection process and output

We searched for published peer-reviewed studies in four electronic bibliographic databases: PubMed, Embase, Web of Science and Scopus. EndNote X9 software (Clarivate Analytics) was used to export the articles and remove duplicates. Two authors (SDP and IKS) independently screened the articles by title and abstract for eligibility. Subsequently, SDP and EPW carried out an independent screening of full texts for inclusion. Any discrepancies during the selection process were resolved through discussion

with a third author. We also performed a bibliography search by screening title, abstract and eventually full text of articles in the reference list of the included studies and relevant reviews. Furthermore, alerts were set in all four bibliographic databases and any relevant article retrieved after the day of download was also screened independently by two authors (SDP and EPW) per title, abstract and (if necessary) full text to decide on inclusion. The search was run up until the data extraction started (November 4, 2019), when the pool of articles for review was finalized.

Box 7.2 Summary of selection criteria

To be selected, the studies had to:

- investigate the NSA approach and/or related interventions for their potential to improve nutrition outcomes vis-a-vis the reduction of the ` undernutrition burden;
- describe NSA interventions, which were defined as agriculture interventions with a “clearly stated objective of improving nutrition” and that “incorporate specific nutrition interventions to achieve this goal” (Ruel et al., 2018). NSA interventions could be either co-located (different sectoral interventions by different programs/projects located in the same target areas/communities) or integrated (multi-sectoral interventions are clustered under the same umbrella program/project) (Ruel and Alderman, 2013; Ruel et al., 2018). In the context of this study, both co-location and integration should be envisioned as part of the original program/project design.
- indicate agriculture as a key entry point or core component of the NSA intervention, as long as the agricultural component, for example home gardens or biofortification, is combined with one or more components from other sectors, often health, education, social protection, natural resource management, women’s empowerment or water, sanitation and hygiene (WASH). The agricultural component (even when the focus was on later stages of the food value chain such as processing) had to be related to the local food production, as in the case of dairy value chains, grain banks or home-grown school feeding.
- report intervention and/or inner-setting and/or outer-setting factors influencing the implementation and scale-up of NSA, as defined in the theoretical framework.
- Only peer-reviewed, original studies available in full-text, in English, published after January 1, 2000, and with geographical focus on LMICs, based on the World Bank’s classification (World Bank, 2018), were eligible for review. Meta-analyses, literature reviews, systematic reviews, review of reviews or study protocols, were excluded.

7.3.4 Data extraction

General information was gathered from all the articles: authors' names, study setting, study objective and design, study participants, data collection and data analysis methods. Specific information was also gathered about the NSA projects from those articles focused on implementation of interventions: project name, objective, project description, components of the intervention package, types of NSA interventions based on the main agricultural component (such as homestead food production or biofortification), outcomes of the interventions, co- location or integration of NSA interventions, implementing organization(s), sectors involved, duration, budget and funding agency (if reported). These data were extracted by SDP (55% of the studies) and IKS (45%). The central part of the data extraction focused on the factors influencing the implementation and scale-up of NSA at intervention and/or inner setting and/or outer setting level. SDP extracted this data from all the selected articles. For validation, EPW independently reviewed the extraction of factor-related data of 47% of the articles while IKS reviewed 35% of the studies. Discrepancies were resolved through discussion with the fourth author (ES).

7.3.5 Quality assessment

Two tools were used to conduct the quality assessment. For quantitative studies, we applied the Effective Public Health Practice Project tool, as it uses a generic scale that is comparable across a range of study designs (EPHPP, 2009; Thomas et al., 2004). Low quality studies were regarded as having a high risk of bias, medium quality studies as medium risk of bias and high-quality studies as low risk of bias. The Critical Appraisal Skills Programme tool was used for the qualitative studies (CASP, 2018). The scale used to rate the risk of bias was: 9–10 (low), 6–8 (medium), and <6 (high). To ensure consistency in quality assessment, SDP and IKS independently carried out the assessment of the studies with a quantitative study design, while SDP and EPW did those with qualitative study design. Results of the quality assessment are included in the synthesis.

While the selected tools for quality assessment proved to be highly appropriate for the great majority of the studies, they penalized articles that were content-rich but whose focus was such that the information required to assess the underpinning methods was absent. For these reasons, and in agreement with all authors of this review, 11 articles out of the selected 85 were not subjected to quality assessment, as they had very limited or no information on methods. The absence of a methodology section could be compatible with the purpose of the article – a narrative compilation of lessons learnt throughout the evolution of a program - as in the case of Haselow et al. (2016). The richness of their content and the fact

that the external, contextual and intervention factors stemming from these articles were aligned with other studies in the review led the research team to include those articles, despite their limitations with regard to quality assessment.

Finally, as this review comprises subjective evidence on barriers, facilitators, success and failure factors, an overall assessment of the strength of the body of evidence was not deemed appropriate.

7.3.6 Analysis and synthesis of results

A thematic synthesis, structured around the five domains of the theoretical framework, was used to summarize the findings, supported by the ATLAS.ti software. Here we report findings from the thematic synthesis of three of the five domains: NSA interventions, inner setting and outer setting.

Thematic synthesis is frequently used to synthesize qualitative research but is also applied in systematic reviews (Middel et al., 2019; Thomas and Harden, 2008). Our analysis combined inductive and deductive approaches. We started deductively, using the five domains of our theoretical framework to define the boundaries of the analysis, then proceeded inductively with open coding of relevant text in the 'results', 'discussion' and whenever available 'description of interventions', 'lessons learnt' and 'recommendations' sections of the articles. As we coded each new study, we built and refined our codebook. About every five articles, SDP re-examined the assigned codes and the corresponding text in the original studies together with EPW (47% of the studies) and IKS (35%), to check consistency of interpretation regarding the identified factors. During this step of analysis, the authors also cross-checked the categorization of factors (barriers, facilitators, and success and failure factors) across the domains. Authors were generally in agreement about the interpretation and/or categorization of factors. Any discrepancies were resolved through discussion with the fourth author (ES).

The identified factors included both 'actual' factors, drawn directly from experience and based on evidence of results, and 'potential' factors, which were described as a result of the experience of what did and did not work or on a hypothesis derived from available information. In the domain of NSA interventions, the potential factors are described either as pre-implementation propositions to be tested, or as post- implementation recommendations based on project experiences, and proposed for future interventions. Classification of actual or potential was made according to the description in the original texts.

After the first level of analysis was completed, SDP clustered the codes into a hierarchical tree structure. The codes stemming from the original data ('primary codes') were clustered under higher level 'descriptive themes' which were then used to generate 'analytical themes'. EPW critically reviewed this part of the analysis. To synthesize the 'analytical themes', the content of the underpinning 'descriptive themes' was summarized in tables, thus providing an overview of the factors in each domain of the framework. SDP developed the narrative (and accompanying tables) of the thematic synthesis in close collaboration with EPW. The other authors critically reviewed the subsequent versions of the narrative.

It is important to note that some factors could overlap between domains (particularly "inner setting" and "NSA interventions") and some factors could be suitably located in more than one analytical theme. The authors' decision on the positioning of a certain factor was based on its relevance and relatedness to other factors contributing to the synthesis of each domain or analytical theme. Though this choice entailed a certain level of subjectivity, the bias was minimized through consensus among the authors. Finally, although some findings could be applicable to other types of (multi-sectoral) programs, we selected articles reporting them explicitly in relation to NSA.

7.4 Results

This section begins with an overview and a brief characterization of the articles reviewed. It continues with a synthesis of the findings on the factors influencing NSA implementation and scaling up, structured according to the three domains of the theoretical framework underpinning this study (NSA interventions, inner setting and outer setting). Table 7.1 provides an overview of the 85 reviewed articles.

7.4.1 Characterization of the reviewed articles

Out of the 24,772 articles retrieved through the combined search in the bibliographic databases and the reference lists of relevant bibliographies, 85 were selected for inclusion in this systematic review. The PRISMA flow diagram in Figure 7.2 illustrates the selection process and final output.

Of the 85 articles included in the review, 64 were published between 2015 and 2019, confirming the relatively recent upsurge of interest in this field of research. As to geographical coverage, a slight majority of the studies (49) focused on Sub-Saharan Africa, followed by Asia (South, East and Central) with 33 articles and South America with one article. Two studies had a multi-country focus in more than one

geographical region; one reported finding from Sub-Saharan Africa and Asia (Central and South), while the other included Sub-Saharan Africa, Asia (Central and South) and South America. For categorization purposes, those articles that had a multi-country focus in the same region (7) were included in the corresponding geographical group. The distribution of the studies is presented in table 7.1. The total number of studies per country is increased by the articles with a multi- country focus.

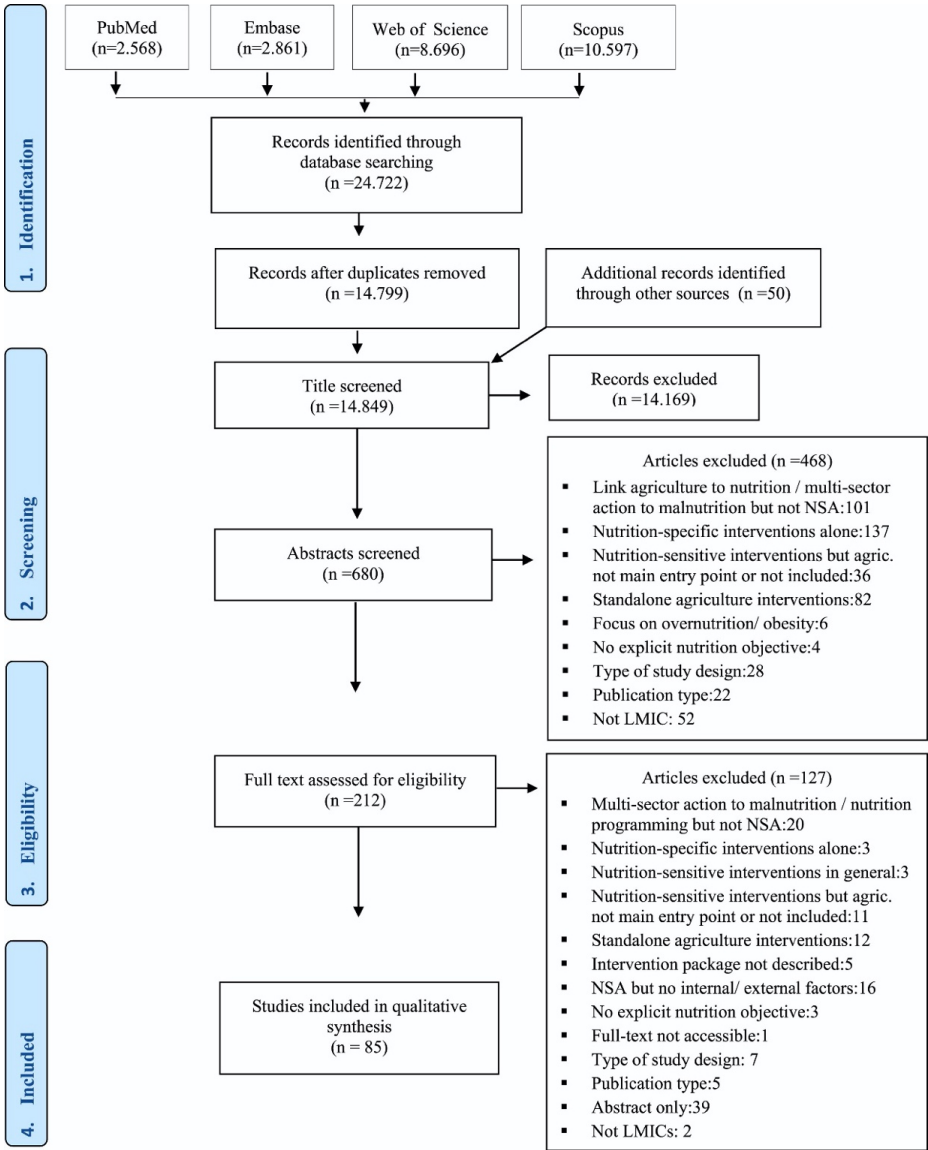


Figure 7.2. Flow diagram of the publication selection process

The search identified articles in the two main categories of analysis: the NSA approach (five articles) and the implementation of NSA projects (eighty). The combination of these two sub-sets provided a comprehensive insight into the factors influencing NSA from intervention to system level. The first category included articles that, through evidence from national consultations and interviews with key stakeholders or case studies, outlined the enabling environment for the NSA approach. The second category included two studies at pre-implementation stage (exploratory phase, prior to the design, when candidate NSA interventions were being assessed against the needs and potential of the target population), 17 during implementation (from early implementation stages to mid-term evaluation) and 61 at post-implementation (in the final phases of the project or after it ended). Among the articles about the implementation of NSA projects, a large number did not specify the name of the project under investigation (24) or generically reported that it was an (enhanced) homestead food production (HFP or EHFP) project (8).

The combined pool of post-implementation and during- implementation articles (78) comprised a diverse range of NSA intervention types. Based on the main agricultural entry point to the intervention, the following types were identified: HFP/EHFP in 47 articles; orange flesh sweet potato (OFSP) in 12 articles; school gardens in six articles; home-grown school feeding (HGSF) in three articles; grain banks in two articles; on-farm crop diversification in two articles; biofortification of staple cereals in one article; and dairy value chain in one article. Finally, four articles fit into a mixed category, with multiple agricultural entry points as part of the same NSA intervention package, for example HFP in combination with school and community gardens. Almost all the articles about the implementation of NSA projects concerned integrated NSA interventions clustered under the same umbrella project. The cases of co-location by design were very few, highlighting the fact that while co-location of interventions may occur spontaneously and opportunistically once the implementation of different projects is in the hands of the same local partners, co-location is more rarely envisaged as part of the original project design.

With regard to quality assessment, 34 articles fit in the category of medium risk of bias. This group comprised 22 studies with quantitative design, 11 studies with qualitative design and one mixed method study. Out of the 28 articles with a high risk of bias, 27 were quantitative studies while one used mixed method. The low risk of bias category (8) included an equal number of studies with quantitative (4) and qualitative (4) design. Four mixed methods studies showed different results depending on the design; three had a high risk of bias in relation to the quantitative design and medium for the qualitative, while one had a high risk of bias for the quantitative and low for the qualitative design. Eleven articles were not subjected to quality assessment, as described in Methods.

Table 7.1. Overview of reviewed articles

The reference numbers of the articles in the synthesis follow the notation presented in this table (first column)

No.	Reference	Publication category (AP/IM) ³	Location	Type of NSA intervention based on main agricultural entry point	Domains for factors	Riskof bias
1	Hodge, J., Herforth, A., Gillespie, S., Beyero, M., Wagah, M., & Semakula, R. (2015). Is there an enabling environment for nutrition-sensitive agriculture in East Africa? Stakeholder perspectives from Ethiopia, Kenya, and Uganda. Food and Nutrition Bulletin, 36(4), 503–519.	AP	Multi-country: Ethiopia, Kenya, Uganda	n/a	Outer setting and inner setting	Medium (qual.)
2	Lachat, C., Nago, E., Ka, A., Vermeylen, H., Fanzo, J., Mahy, L., ... Kolsteren, P. (2015). Landscape analysis of nutrition-sensitive agriculture policy development in Senegal. Food and Nutrition Bulletin, 36(2), 154–166.	AP	Senegal	n/a	Outer setting, inner setting, and NSA interventions	Medium (qual.)
3	Poole, N., Echavez, C., & Rowland, D. (2018). Are agriculture and nutrition policies and practice coherent? Stakeholder evidence from Afghanistan. Food Security, 10(6), 1577–1601.	AP	Afghanistan	n/a	Outer setting and inner setting	Low (qual.)
4	Van Den Bold, M., Kohli, N., Gillespie, S., Zuberi, S., Rajeev, S., & Chakraborty, B. (2015a). Is there an enabling environment for nutrition-sensitive agriculture in South Asia? Stakeholder perspectives from India, Bangladesh, and Pakistan. Food and Nutrition Bulletin, 36(2), 231–247.	AP	Multi-country: India, Bangladesh, Pakistan.	n/a	Outer setting and inner setting	Medium (qual.)
5	Zamora, O. B., de Guzman, L. E. P., Saguiguit, S. L. C., Talavera, M. T. M., & Gordoncillo, N. P. (2013). Leveraging agriculture to improve nutrition in the Philippines. Food Security, 5(6), 873–886.	AP	Philippines	n/a	Outer setting, inner setting, and NSA interventions	n/a (qual.)
6	Angeles-Agdeppa, I., Monville-Oro, E., Gonsalves, J. F., & Capanzana, M. V. (2019). Integrated school based nutrition programme improved the knowledge of mother and schoolchildren. Maternal & child nutrition, 15, e12794.	IM (post-implementation)	Philippines	School garden	NSA interventions	Medium (quant.)
7	Ayele, Z., & Peacock, C. (2003). Improving Access to and Consumption of Animal Source Foods in Rural Households: The Experiences of a Women-Focused Goat	IM (post-implementation)	Ethiopia	HFP (vegetable gardens; poultry and goats raising)	Inner setting and NSA interventions	High (quant.)

³ AP: article on NSA approach; IM: article on implementation of NSA projects

16	Blakstad, M. M., Bellows, A. L., Mosha, D., Canavan, C. R., Mlalama, K., Kinabo, J., ... Fawzi, W. W. (2019). Neighbour home gardening predicts dietary diversity among rural Tanzanian women. <i>Public Health Nutrition</i> , 22(9), 1646–1653.	IM (post-implementation)	Tanzania	HFP (home garden for vegetables production)	Inner setting	High (quant.)
17	Boedecker, J., Odhiambo Odour, F., Lachat, C., Van Damme, P., Kennedy, G., & Termote, C. (2019). Participatory farm diversification and nutrition education increase dietary diversity in Western Kenya. <i>Maternal and Child Nutrition</i> , 15(3), 1–12.	IM (post-implementation)	Kenya	HFP (home garden, particularly traditional leafy vegetables and legumes; poultry raising)	Inner setting and NSA interventions	High (quant.)
18	Bushamuka, V. N., de Pee, S., Talukder, A., Kiess, L., Panagides, D., Taher, A., & Bloem, M. (2005). Impact of a homestead gardening program on household food security and empowerment of women in Bangladesh. <i>Food and Nutrition Bulletin</i> , 26(1), 17–25.	IM (during implementation)	Bangladesh	HFP (home garden)	Inner setting and NSA interventions	High (quant.)
19	Chakravarty, I. (2000). Food-based strategies to control vitamin A deficiency. <i>Food and Nutrition Bulletin</i> , 21(2), 135–143.	IM (post-implementation)	India	HFP (home garden for fruit and vegetables production)	NSA interventions	n/a (quant.)
20	Cole, D. C., Levin, C., Loechl, C., Thiele, G., Grant, F., Girard, A. W., ... Low, J. (2016). Planning an integrated agriculture and health program and designing its evaluation: Experience from Western Kenya. <i>Evaluation and Program Planning</i> , 56, 11–22.	IM (post-implementation)	Kenya	OFSP - biofortification	Outer setting, inner setting, and NSA interventions	n/a (qual.)
21	Daidone, S., Davis, B., Dewbre, J., Miguez, B., Niang, O., & Pellerano, L. (2017). Linking agriculture and social protection for food security: The case of Lesotho. <i>Global Food Security</i> , 12(December 2016), 146–154.	IM (post-implementation)	Lesotho	HFP (home garden for vegetables production)	NSA interventions	High (quant.)
22	De Brauw, A., Eozenou, P., & Moursi, M. (2015). Programme Participation Intensity and Children's Nutritional Status: Evidence from a Randomised Control Trial in Mozambique. <i>Journal of Development Studies</i> , 51(8), 996–1015.	IM (post-implementation)	Mozambique	OFSP - biofortification	NSA interventions	Medium (quant.)
23	De Brauw, A., Eozenou, P., Gilligan, D. O., Hotz, C., Kumar, N., & Meenakshi, J. V. (2018). Biofortification, crop adoption and health information: Impact pathways in Mozambique and Uganda. <i>American Journal of Agricultural Economics</i> , 100(3), 906–930.	IM (post-implementation)	Mozambique Uganda	OFSP - biofortification	NSA interventions	Medium (quant.)

24	Diana, R., Khomsan, A., Sukandar, D., & Riyadi, H. (2014). Nutrition extension and home garden intervention in posyandu: Impact on nutrition knowledge, vegetable consumption and intake of vitamin A. <i>Pakistan Journal of Nutrition</i> , 13(2), 88–92.	IM (post-implementation)	Indonesia	HFP (home garden for vegetables production)	Inner setting and NSA interventions	High (quant.)
25	Doocy, S., Emerson, J., Colantouni, E., Strong, J., Mansen, K. A., Caulfield, L. E., ... Menakuntuala, J. (2018). Improving household food security in eastern Democratic Republic of the Congo: a comparative analysis of four interventions. <i>Food Security</i> , 10(3), 649–660.	IM (post-implementation)	Democratic Republic of Congo	HFP: home garden in the PM2A - prevention of malnutrition in children under two approach; processing/ income-generating activities and goat raising in the WEG -women's empowerment groups	Inner setting and NSA interventions	Medium (quant.)
26	Doocy, S., Emerson, J., Colantouni, E., Strong, J., Amundson-Mansen, K., & Menakuntuala, J. (2019). Evaluating interventions to improve child nutrition in Eastern Democratic Republic of Congo. <i>Public Health Nutrition</i> , 22(1), 3–14.	IM (post-implementation)	Democratic Republic of Congo	Same as reference above	Inner setting	Medium (quant.)
27	Dulal, B., Mundy, G., Sawal, R., Rana, P. P., & Cunningham, K. (2017). Homestead Food Production and Maternal and Child Dietary Diversity in Nepal: Variations in Association by Season and Agroecological Zone. <i>Food and Nutrition Bulletin</i> , 38(3), 338–353.	IM (during implementation)	Nepal	EHFP (home garden for vegetables production; poultry raising)	Inner setting and NSA interventions	High (quant.)
28	Erismann, S., Diabougou, S., Schindler, C., Odermatt, P., Knoblauch, A. M., Gerold, J., ... Cissé, G. (2017). School children's intestinal parasite and nutritional status one year after complementary school garden, nutrition, water, sanitation, and hygiene interventions in Burkina Faso. <i>American Journal of Tropical Medicine and Hygiene</i> , 97(3), 904–913.	IM (post-implementation)	Burkina Faso	School garden	Inner setting and NSA interventions	Medium (quant.)
29	Fanzo, J., Remans, R., Pronyk, P. M., Negin, J., Wariaro, J., Mutuo, P., ... Sachs, J. D. (2010). A 3-year cohort study to assess the impact of an integrated food-and livelihood-based model on undernutrition in rural western Kenya. Combating Micronutrient Deficiencies: Food-Based Approaches, 76–91.	IM (post-implementation)	Kenya	Mixed: school gardens and home-grown school meals; improved seeds and fertilizer for staple crops, crop diversification for income and diet diversity, livestock rearing, fish farming, introduction of high-value crops and agro-processing	Inner setting and NSA interventions	High (quant.)

30	Fernandes, M., Galloway, R., Gelli, A., Mumuni, D., Hamdani, S., Kiamba, J., ... Drake, L. (2016). Enhancing Linkages between Healthy Diets, Local Agriculture, and Sustainable Food Systems: The School Meals Planner Package in Ghana. <i>Food and Nutrition Bulletin</i> , 37(4), 571–584.	IM (during implementation)	Ghana	HGSF	Outer setting, inner setting and NSA interventions	n/a (qual.)
31	Girard, A. W., Grant, F., Watkinson, M., Okuku, H. S., Wanjala, R., Cole, D., ... Low, J. (2017). Promotion of Orange-Fleshed Sweet Potato Increased Vitamin A Intakes and Reduced the Odds of Low Retinol-Binding Protein among Postpartum Kenyan Women. <i>The Journal of Nutrition</i> , 147(5), 955–963.	IM (during implementation)	Kenya	OFSP	Inner setting and NSA interventions	Medium (quant.)
32	Ha, T. T., Luoh, J. W., Sheu, A., Thuy, L. T., & Yang, R. (2019). Vegetable Diversity, Productivity, and Weekly Nutrient Supply from Improved Home Gardens Managed by Ethnic Families - a Pilot Study in Northwest Vietnam. <i>Food Ethics</i> , 4(1), 35–48.	IM (post-implementation)	Vietnam	HFP (home garden for vegetables production)	Inner setting and NSA interventions	High (quant.)
33	Hagenimana, V., Low, J., Anyango, M., Kurz, K., Gichuki, S. T., & Kabira, J. (2001). Enhancing vitamin A intake in young children in Western Kenya: Orange-fleshed sweet potatoes and women farmers can serve as key entry points. <i>Food and Nutrition Bulletin</i> , 22(4), 376–387.	IM (post-implementation)	Kenya	OFSP	Inner setting and NSA interventions	High (quant.)
34	Haselow, N. J., Stormer, A., & Pries, A. (2016). Evidence-based evolution of an integrated nutrition-focused agriculture approach to address the underlying determinants of stunting. <i>Maternal and Child Nutrition</i> , 12, 155–168.	IM (post-implementation)	Multi-country: Bangladesh, Cambodia, Indonesia, Nepal, Philippines.	EHFP (home gardens for fruit and vegetables production; small animal rearing, mostly poultry)	Outer setting, inner setting and NSA interventions	n/a (qual.)
35	Hotz, C., Loechl, C., De Brauw, A., Eozenou, P., Gilligan, D., Moursi, M., ... Meenakshi, J. V. (2011). A large-scale intervention to introduce orange sweet potato in rural Mozambique increases vitamin A intakes among children and women. <i>British Journal of Nutrition</i> , 108(1), 163–176.	IM (post-implementation)	Mozambique	OFSP	Inner setting and NSA interventions	Medium (quant.)
36	Hotz, C., Loechl, C., Lubowa, A., Tumwine, J. K., Ndeezi, G., Nandutu Masawi, A., ... Gilligan, D. O. (2012). Introduction of β-Carotene-Rich Orange Sweet Potato in Rural Uganda Resulted in Increased Vitamin A Intakes among Children and Women and Improved Vitamin A Status among Children. <i>The Journal of Nutrition</i> , 142(10), 1871–1880.	IM (post-implementation)	Uganda	OFSP	Inner setting and NSA interventions	Medium (quant.)

37	Hotz, C., Pelto, G., Armar-Klemes, M., Ferguson, E. F., Chege, P., & Musinguzi, E. (2015). Constraints and opportunities for implementing nutrition-specific, agricultural and market-based approaches to improve nutrient intake adequacy among infants and young children in two regions of rural Kenya. <i>Maternal and Child Nutrition</i> , 11, 39–54.	IM (pre-implementation)	Kenya	n/a (based on the listed candidate intervention strategies the focus was going to be on production of green leafy vegetables, beans, millet, small fish, milk)	Inner setting and NSA interventions	High (quant.) Medium (qual.)
38	Jones, K. M., Specio, S. E., Shrestha, P., Brown, K. H., & Allen, L. H. (2005). Nutrition knowledge and practices, and consumption of vitamin A-rich plants by rural Nepali participants and nonparticipants in a kitchen-garden program. <i>Food and Nutrition Bulletin</i> , 26(2), 198–208.	IM (post-implementation)	Nepal	HFP (home garden for fruit and vegetables production)	Inner setting and NSA interventions	High (quant.)
39	Jones, K. M., & de Brauw, A. (2015). Using Agriculture to Improve Child Health: Promoting Orange Sweet Potatoes Reduces Diarrhea. <i>World Development</i> , 74, 15–24.	IM (post-implementation)	Mozambique	OFSP -biofortification	Inner setting and NSA interventions	Medium (quant.)
40	Kalavathi, S., Krishnakumar, V. P., Thomas, R. J., Thomas, G. V., & George, M. L. (2010). Improving food and nutritional security of small and marginal coconut growers through diversification of crops and enterprises. <i>Journal of Agriculture and Rural Development in the Tropics and Subtropics</i> , 111(2), 101–109.	IM (post-implementation)	India	Mixed: nutrition gardening, intercropping of cash and food crops, nursery establishment, livestock rearing, production of high value products, recycling of coconut and other crop wastes through vermicomposting, mushroom production and azolla cultivation with microcredit support	NSA interventions	High (quant.)
41	Kerr, R. B., Berti, P. R., & Shumba, L. (2010). Effects of a participatory agriculture and nutrition education project on child growth in northern Malawi. <i>Public Health Nutrition</i> , 14(8), 1466–1472.	IM (post-implementation)	Malawi	On-farm crop diversification (legume intercropping)	Inner setting and NSA interventions	High (quant.)
42	Kerr, R. B., Chilanga, E., Nyantakyi-Frimpong, H., Luginaah, I., & Lupafya, E. (2016). Integrated agriculture programs to address malnutrition in northern Malawi. <i>BMC Public Health</i> , 16(1), 1–14.	IM (post-implementation)	Malawi	On-farm crop diversification (legume and tuber intercropping)	Inner setting and NSA interventions	Medium (qual.)
43	Khammounheuang k, Saleumy P., Kirjavainen L., Nandi B.K., Mahlberg Dyg P., B. L. (2004). Sustainable livelihoods for human security in Lao PDR: home gardens for food security, rural livelihoods and nutritional well-being. <i>Regional Development Dialogue</i> , 25(2), 203–228.	IM (post-implementation)	Lao PDR	HFP (home garden for fruit and vegetables production; small livestock, poultry and pig, raising; fish production)	Inner setting and NSA interventions	n/a (quant.)

44	Kjeldsberg, C., Shrestha, N., Patel, M., Davis, D., Mundy, G., & Cunningham, K. (2018). Nutrition-sensitive agricultural interventions and gender dynamics: A qualitative study in Nepal. <i>Maternal and Child Nutrition</i> , 14(3), 1–9.	IM (post-implementation)	Nepal	EHP (home gardens for vegetables production; poultry raising)	Inner setting and NSA interventions	Low (qual.)
45	Kuchenbecker, J., Reinbott, A., Mtimuni, B., Krawinkel, M. B., & Jordan, I. (2017). Nutrition education improves dietary diversity of children 6-23 months at community-level: Results from a cluster randomized controlled trial in Malawi. <i>PLoS ONE</i> , 12(4), 1–19.	IM (post-implementation)	Malawi	HFP (fruit and vegetables production; livestock)	Inner setting	Medium (quant.)
46	Kumar, N., Nguyen, P. H., Harris, J., Harvey, D., Rawat, R., & Ruel, M. T. (2018). What it takes: evidence from a nutrition- and gender-sensitive agriculture intervention in rural Zambia. <i>Journal of Development Effectiveness</i> , 10(3), 341–372.	IM (post-implementation)	Zambia	HFP (home garden for vegetables, legume, and tubers production; chickens and goats raising)	Inner setting	High (quant.)
47	Le Port, A., Bernard, T., Hidrobo, M., Birba, O., Rawat, R., & Ruel, M. T. (2017). Delivery of iron-fortified yoghurt, through a dairy value chain program, increases hemoglobin concentration among children 24 to 59 months old in Northern Senegal: A cluster-randomized control trial. <i>PLoS ONE</i> , 12(2), 1–17.	IM (post-implementation)	Senegal	Dairy value chain (micronutrient-fortified yoghurt)	Inner setting and NSA interventions	Medium (quant.)
48	Levin, C. E., Self, J. L., Kedera, E., Wamalwa, M., Hu, J., Grant, F., ... Low, J. W. (2019). What is the cost of integration? Evidence from an integrated health and agriculture project to improve nutrition outcomes in Western Kenya. <i>Health Policy and Planning</i> , 34(9), 646–655.	IM (post-implementation)	Kenya	OFSP	NSA interventions	n/a (quant.)
49	Low, J. W., Arimond, M., Osman, N., Cunguara, B., Zano, F., & Tschirley, D. (2007a). A Food-Based Approach Introducing Orange-Fleshed Sweet Potatoes Increased Vitamin A Intake and Serum Retinol Concentrations in Young Children in Rural Mozambique. <i>The Journal of Nutrition</i> , 137(5), 1320–1327.	IM (post-implementation)	Mozambique	OFSP	Outer setting, inner setting, and NSA interventions	Low (quant.)
50	Low, J. W., Arimond, M., Osman, N., Cunguara, B., Zano, F., & Tschirley, D. (2007b). Ensuring the supply of and creating demand for a biofortified crop with a visible trait: Lessons learned from the introduction of orange-fleshed sweet potato in drought-prone areas of Mozambique. <i>Food and Nutrition Bulletin</i> , 28(2 SUPPL.), 258–270.	IM (post-implementation)	Mozambique	OFSP-biofortification	Inner setting and NSA interventions	High (quant.)

51	Marquis, G. S., Colecraft, E. K., Kanlisi, R., Aidam, B. A., Atubi-Yeboah, A., Pinto, C., & Aryeetey, R. (2018). An agriculture–nutrition intervention improved children's diet and growth in a randomized trial in Ghana. <i>Maternal and Child Nutrition</i> , 14(August), 1–10.	IM (post-implementation)	Ghana	HFP (home garden for vegetables production; poultry raising)	Inner setting and NSA interventions	Low (quant.)
52	Matturi, K., & Pain, C. (2016). Managing an Integrated Project - Experiences from the Realigning Agriculture to Improve Nutrition project. <i>Project Management Research and Practice</i> , 3, 5035.	IM (during implementation)	Zambia	HFP (home garden for fruit and vegetables production; small animals rearing)	Outer setting and NSA interventions	n/a (qual.)
53	Mensah, C. (2018). Incentivising smallholder farmer livelihoods and constructing food security through home-grown school feeding: Evidence from Northern Ghana. <i>Brazilian Journal of International Law</i> , 15(3), 491–504.	IM (during implementation)	Ghana	HGSF (combined with local grain banks)	Outer setting and NSA interventions	Medium (qual.)
54	Michaux, K. D., Hou, K., Karakochuk, C. D., Whitfield, K. C., Ly, S., Verbowski, V., ... Green, T. J. (2019). Effect of enhanced homestead food production on anaemia among Cambodian women and children: A cluster randomized controlled trial. <i>Maternal and Child Nutrition</i> , 15(S3), 1–11.	IM (post-implementation)	Cambodia	EHFP (home garden for fruit and vegetables production; fish production)	NSA interventions	Medium (quant.)
55	Miller, L. C., Neupane, S., Joshi, N., Lohani, M., Rogers, B. L., Neupane, S., ... Webb, P. (2019). Multisectoral community development in Nepal has greater effects on child growth and diet than nutrition education alone. <i>Public Health Nutrition</i> , 23(1), 146–161.	IM (post-implementation)	Nepal	HFP (goat raising)	Inner setting and NSA interventions	Low (quant.)
56	Muehlhoff, E., Wijesinha-Bettoni, R., Westaway, E., Jeremias, T., Nordin, S., & Garz, J. (2017). Linking agriculture and nutrition education to improve infant and young child feeding: Lessons for future programmes. <i>Maternal and Child Nutrition</i> , 13(September 2016), 1–12.	IM (during implementation)	Multi-country: Cambodia, Malawi.	HFP (home garden for fruit and vegetables production)	Outer setting, inner setting and NSA interventions	Low (qual.)
57	Murty, P. V. V. S., Rao, M. V., & Bamji, M. S. (2016). Impact of Enriching the Diet of Women and Children Through Health and Nutrition Education, Introduction of Homestead Gardens and Backyard Poultry in Rural India. <i>Agricultural Research</i> , 5(2), 210–217.	IM (post-implementation)	India	HFP (home garden for fruit and vegetables production; poultry raising)	Inner setting and NSA interventions	High (quant.)
58	Nielsen, J. N., Olney, D. K., Ouedraogo, M., Pedehombga, A., Rouamba, H., & Yago-Wienne, F. (2018). Process evaluation improves delivery of a nutrition-sensitive	IM (during implementation)	Burkina Faso	EHFP (home garden for fruit and vegetables production; poultry raising)	Inner setting and NSA interventions	Medium (quant. & qual.)

agriculture programme in Burkina Faso. Maternal and Child Nutrition, 14(3), 1–10.						
59	Nordhagen, S., & Klemm, R. (2018). Implementing small-scale poultry-for-nutrition projects: Successes and lessons learned. <i>Maternal and Child Nutrition</i> , 14(July), 1–10.	IM (post-implementation on)	Multi-country: Burkina Faso, Tanzania, Senegal, and Cote d'Ivoire.	EHP (home garden for fruit and vegetables production; poultry raising)	Inner setting and NSA interventions	High (quant.)
60	Nordhagen, S., Thiam, K., & Sow, S. (2019a). The sustainability of a nutrition-sensitive agriculture intervention: a case study from urban Senegal. <i>Food Security</i> , 11(5), 1121–1134.	IM (post-implementation on)	Senegal	EHP (micro-garden tables for vegetables production; poultry raising)	Inner setting and NSA interventions	High (quant.) Low (qual.)
61	Nordhagen, S., Nielsen, J., van Mourik, T., Smith, E., & Klemm, R. (2019b). Fostering CHANGE: Lessons from implementing a multi-country, multi-sector nutrition-sensitive agriculture project. <i>Evaluation and Program Planning</i> , 77(November 2018), 101695.	IM (post-implementation on)	Multi-country: Burkina Faso, Tanzania, Senegal, and Cote d'Ivoire	EHP (home garden or micro-garden tables for vegetables production; poultry raising)	Inner setting and NSA interventions	n/a (qual.)
62	Ogoye-Ndegwa, C., Abudho, D., & Aagaard-Hansen, J. (2002). "New learning in old organisations": Children's participation in a school-based nutrition project in western Kenya. <i>Development in Practice</i> , 12(3–4), 449–460.	IM (post-implementation on)	Kenya	School garden	Outer setting, inner setting and NSA interventions	Medium (qual.)
63	Okello, J. J., Kwikiriza, N., Muoki, P., Wambaya, J., & Heck, S. (2019). Effect of Intensive Agriculture-Nutrition Education and Extension Program Adoption and Diffusion of Biofortified Crops. <i>Journal of Agricultural and Food Information</i> , 20(3), 254–276.	IM (during implementation on)	Kenya	OFSP - biofortification	Inner setting and NSA interventions	High (quant.)
64	Olney, D. K., Talukder, A., Iannotti, L. L., Ruel, M. T., & Quinn, V. (2009). Assessing impact and impact pathways of a homestead food production program on household and child nutrition in Cambodia. <i>Food and Nutrition Bulletin</i> , 30(4), 355-369.	IM (post-implementation on)	Cambodia	HFP (home garden for fruit and vegetables production; poultry raising)	Inner setting	High (quant.)
65	Olney, D. K., Vicheka, S., Kro, M., Chakriya, C., Kroeun, H., Hoing, L. S., ... Roopnaraine, T. (2013). Using program impact pathways to understand and improve program delivery, utilization, and potential for impact of Helen Keller International's Homestead Food Production Program in Cambodia. <i>Food and Nutrition Bulletin</i> , 34(2), 169–184.	IM (during implementation on)	Cambodia	HFP (home garden for fruit and vegetable production; poultry raising)	Outer setting, inner setting and NSA interventions	Medium (qual.)

66	Olney, D. K., Pedehombga, A., Ruel, M. T., & Dillon, A. (2015). A 2-Year Integrated Agriculture and Nutrition and Health Behavior Change Communication Program Targeted to Women in Burkina Faso Reduces Anemia, Wasting, and Diarrhea in Children 3–12.9 Months of Age at Baseline: A Cluster-Randomized Controlled Trial. <i>The Journal of Nutrition</i> , 145(6), 1317–1324.	IM (post-implementation)	Burkina Faso	EHFP (home garden for fruit and vegetables production; poultry raising)	Inner setting and NSA interventions	Medium (quant.)
67	Olney, D. K., Bliznashka, L., Pedehombga, A., Dillon, A., Ruel, M. T., & Heckert, J. (2016). A 2-Year Integrated Agriculture and Nutrition Program Targeted to Mothers of Young Children in Burkina Faso Reduces Underweight among Mothers and Increases Their Empowerment: A Cluster-Randomized Controlled Trial. <i>The Journal of Nutrition</i> , 146(5), 1109–1117.	IM (post-implementation)	Burkina Faso	EHFP (home garden for fruit and vegetables production; poultry raising)	Inner setting	Medium (quant.)
68	Omer, A., Mulualem, D., Classen, H., Vatanparast, H., & Whiting, S. J. (2018). A Community Poultry Intervention to Promote Egg and Eggshell Powder Consumption by Young Children in Halaba Special Woreda, SNNPR, Ethiopia. <i>Journal of Agricultural Science</i> , 10(5), 1.	IM (post-implementation)	Ethiopia	HFP (poultry raising)	Inner setting and NSA interventions	High (quant.)
69	Osei, A. K., Pandey, P., Spiro, D., Adhikari, D., Haselow, N., De Morales, C., & Davis, D. (2015). Adding multiple micronutrient powders to a homestead food production programme yields marginally significant benefit on anaemia reduction among young children in Nepal. <i>Maternal and Child Nutrition</i> , 11, 188–202.	IM (post-implementation)	Nepal	EHFP (home garden for fruit and vegetables production; poultry raising)	Inner setting	Low (quant.)
70	Osei, A., Pandey, P., Nielsen, J., Pries, A., Spiro, D., Davis, D., ... Haselow, N. (2017). Combining Home Garden, Poultry, and Nutrition Education Program Targeted to Families with Young Children Improved Anemia among Children and Anemia and Underweight among Nonpregnant Women in Nepal. <i>Food and Nutrition Bulletin</i> , 38(1), 49–64.	IM (post-implementation)	Nepal	EHFP (home garden for fruit and vegetables production; poultry raising)	Inner setting and NSA interventions	Medium (quant.)
71	Pradhan, A., Sathanandhan, R., Panda, A. K., & Wagh, R. (2018). Improving Household Diet Diversity Through Promotion of Nutrition Gardens in India. <i>American Journal of Food Science and Nutrition</i> , 5(2), 43–51.	IM (post-implementation)	India	HFP (home garden for fruit and vegetables production)	Inner setting and NSA interventions	High (quant. & qual.)

72	Reinbott, A., Schelling, A., Kuchenbecker, J., Jeremias, T., Russell, I., Kevanna, O., ... Jordan, I. (2016). Nutrition education linked to agricultural interventions improved child dietary diversity in rural Cambodia. <i>British Journal of Nutrition</i> , 116(8), 1457–1468.	IM (post-implementation)	Cambodia	HFP (vegetables, rice, cash-crop production; poultry raising)	Outer setting, inner setting and NSA interventions	Medium (quant.)
73	Ridolfi, R., Stormer, A., & Mundy, G. (2019). Transforming data into action – Implementing gender analyses in nutrition-sensitive agriculture interventions: An experience from Cambodia. <i>Advances in Gender Research</i> , 27, 89–113.	IM (during implementation)	Cambodia	EHFP (home gardens for fruit and vegetables production; small animal husbandry, mainly poultry)	NSA interventions	Medium (qual.)
74	Roche, M. L., Sako, B., Osendarp, S. J. M., Adish, A. A., & Tolossa, A. L. (2017). Community-based grain banks using local foods for improved infant and young child feeding in Ethiopia. <i>Maternal and Child Nutrition</i> , 13(2), 1–15.	IM (during implementation)	Ethiopia	Grain banks	Inner setting and NSA interventions	Medium (qual.)
75	Rosenberg, A. M., Maluccio, J. A., Harris, J., Mwanamwenge, M., Nguyen, P. H., Tembo, G., & Rawat, R. (2018). Nutrition-sensitive agricultural interventions, agricultural diversity, food access and child dietary diversity: Evidence from rural Zambia. <i>Food Policy</i> , 80(June), 10–23.	IM (post-implementation)	Zambia	HFP (home garden for vegetables, legume and tubers production; chickens and goats raising)	Outer setting, inner setting	High (quant.)
76	Sako, B., Leerlooijer, J. N., Lelisa, A., Hailemariam, A., Brouwer, I. D., Tucker Brown, A., & Osendarp, S. J. M. (2018). Exploring barriers and enablers for scaling up a community-based grain bank intervention for improved infant and young child feeding in Ethiopia: A qualitative process evaluation. <i>Maternal and Child Nutrition</i> , 14(2), 1–11.	IM (post-implementation)	Ethiopia	Grain banks	Outer setting, inner setting and NSA interventions	Low (qual.)
77	Schreinemachers, P., Patalagsa, M. A., Islam, M. R., Uddin, M. N., Ahmad, S., Biswas, S. C., ... Takagi, C. (2015). The effect of women's home gardens on vegetable production and consumption in Bangladesh. <i>Food Security</i> , 7(1), 97–107.	IM (during implementation)	Bangladesh	HFP (home garden for vegetables production)	Inner setting	High (quant.)
78	Schreinemachers, P., Patalagsa, M. A., & Uddin, N. (2016). Impact and cost-effectiveness of women's training in home gardening and nutrition in Bangladesh. <i>Journal of Development Effectiveness</i> , 8(4), 473–488.	IM (post-implementation)	Bangladesh	HFP (home garden for vegetables production)	Outer setting, inner setting and NSA interventions	Medium (quant.)
79	Schreinemachers, P., Bhattarai, D. R., Subedi, G. D., Acharya, T. P., Chen, H. pu, Yang, R. yu, ... Mecozzi, M. (2017a). Impact of school gardens in Nepal: a cluster randomised controlled trial. <i>Journal of Development Effectiveness</i> , 9(3), 329–343.	IM (post-implementation)	Nepal	School garden	Inner setting and NSA interventions	Medium (quant.)

80	Schreinmachers, P., Rai, B. B., Dorji, D., Chen, H. pu, Dukpa, T., Thinley, N., ... Yang, R. Y. (2017b). School gardening in Bhutan: Evaluating outcomes and impact. <i>Food Security</i> , 9(3), 635–648.	IM (post-implementation)	Bhutan	School garden	Inner setting and NSA interventions	Medium (quant.)
81	Schreinmachers, P., Quedraogo, M. S., Diabougba, S., Thiombiano, A., Kouamé, S. R., Sobgui, C. M., ... Yang, R. Y. (2019). Impact of school gardens and complementary nutrition education in Burkina Faso. <i>Journal of Development Effectiveness</i> , 11(2), 132–145.	IM (post-implementation)	Burkina Faso	School garden	Inner setting and NSA interventions	Medium (quant.)
82	Singh, S., & Fernandes, M. (2018). Home-grown school feeding: promoting local production systems diversification through nutrition sensitive agriculture. <i>Food Security</i> , 10(1), 111–119.	IM (during implementation)	Ghana	HGSF	Inner setting and NSA interventions	High (quant.)
83	Talukder, A., Kiess, L., Huq, N., De Pee, S., Darnton-Hill, I., & Bloem, M. W. (2000). Increasing the production and consumption of vitamin A-rich fruits and vegetables: Lessons learned in taking the Bangladesh homestead gardening programme to a national scale. <i>Food and Nutrition Bulletin</i> , 21(2), 165-172.	IM (post-implementation)	Bangladesh	HFP (home garden for fruit and vegetables production)	Inner setting and NSA interventions	n/a (quant. & qual.)
84	Talukder, A., Haselow, N. J., Osei, A. K., Villate, E., Reario, D., Kroeun, H., ... & Quinn, V. (2010). Homestead food production model contributes to improved household food security and nutrition status of young children and women in poor populations. Lessons learned from scaling-up programs in Asia (Bangladesh, Cambodia, Nepal and Philippines). <i>Field Actions Science Reports. The journal of field actions</i> , (Special Issue 1).	IM (post-implementation)	Multi-country: Bangladesh, Cambodia, Nepal and the Philippines.	HFP (home garden for fruit and vegetables production; small animal husbandry, mainly poultry)	NSA interventions	High (quant.)
85	Van den Bold, M., Dillon, A., Olney, D., Quedraogo, M., Pedehombga, A., & Quisumbing, A. (2015b). Can Integrated Agriculture-Nutrition Programmes Change Gender Norms on Land and Asset Ownership? Evidence from Burkina Faso. <i>Journal of Development Studies</i> , 51(9), 1155–1174.	IM (post-implementation)	Burkina Faso	EHPF (home garden for fruit and vegetables production; poultry raising)	Inner setting	High (quant.) Medium (qual.)

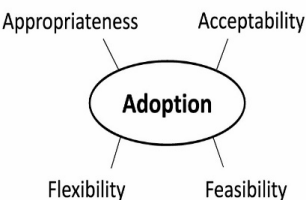
7.4.2 Factors influencing NSA implementation and scale-up

This section summarizes the actual and potential factors reported to influence the implementation and scale-up of the NSA approach and related interventions. The findings of the thematic analysis are structured according to the three domains of the theoretical framework included in this article: NSA interventions, inner setting, and outer setting. The reference numbers of the articles in the synthesis of results follow the notation presented in Table 7.1 (first column) and are reported between square brackets.

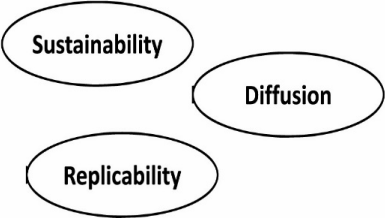
NSA interventions domain

For synthesis purposes, we will first present factors affecting project strategies for adoption, related to appropriateness, acceptability, flexibility, and feasibility. We will then introduce factors affecting project strategies for long-term goals with a particular focus on those related to sustainability, as illustrated in Figure 7.3. Success factors (actual and potential) appeared to be more prominently reported than failure factors, especially in the analytical themes related to appropriateness, acceptability, and sustainability. Further, it was noted that individual factors could be classed as either success or failure factors, depending on how they were described by the authors. Finally, we observed a close link between actual failure factors and potential success factors because devising ways to address the first category often translates into potentially successful solutions. The overview of the findings for the NSA interventions domain and the identified sub-domains is presented in supplementary files of the published chapter 7.

Factors affecting project strategies
towards adoption



Factors affecting project strategies
towards long-term goals



Program planning, management and coordination

Figure 7.3. Framework for the synthesis of factors in the NSA Interventions domain

Of the 85 articles reviewed, 72 reported intervention factors (Table 7.2). Most insights were provided by the articles on the implementation of NSA projects with limited but relevant input especially from two of the five articles about the NSA approach [2,5].

Table 7.2 Overview of the 72 studies reporting NSA interventions factors

Sub-domains	Analytical themes (no. of studies)	Studies reporting success and failure factors
Appropriateness	Fit-to-context (41)	2, 5, 11, 12, 15, 19, 20, 23, 24, 25, 27, 28, 30, 32, 34, 35, 36, 37, 40, 41, 42, 43, 47, 48, 49, 50, 52, 53, 56, 58, 59, 60, 61, 63, 68, 73, 74, 76, 81, 82, 83
Acceptability	Acceptance of/resistance to project recommendations and guidelines by beneficiaries (28)	5, 6, 7, 9, 11, 13, 14, 23, 32, 33, 35, 36, 37, 38, 40, 42, 49, 50, 53, 54, 56, 61, 62, 68, 71, 74, 76, 81
	Effective communication (31)	5, 9, 12, 19, 20, 21, 22, 23, 30, 31, 33, 34, 35, 37, 42, 48, 50, 52, 56, 58, 59, 60, 61, 62, 63, 65, 66, 68, 71, 74, 76
Feasibility	Project management (7)	13, 20, 52, 55, 65, 73, 76
	Alignment of project design with capacity of implementers (3)	56, 65, 76
	Alignment of project eligibility requirements with capacity of beneficiaries (5)	7, 25, 54, 56, 61
	Project duration (16)	15, 18, 27, 28, 31, 34, 41, 54, 55, 56, 58, 61, 66, 70, 72, 76
Flexibility	Cost of interventions (10)	30, 35, 36, 37, 48, 49, 55, 65, 79, 80
	Scale of interventions (1)	12
	Project adaptability (12)	20, 24, 30, 41, 42, 47, 56, 58, 61, 65, 80, 83
	Reliance on project support (7)	5, 34, 56, 59, 65, 71, 74
Sustainability	Strengthening of local structures (21)	6, 9, 12, 18, 19, 21, 31, 33, 34, 51, 52, 55, 56, 59, 60, 61, 65, 68, 76, 79, 83
	Community empowerment and ownership of interventions (17)	5, 17, 19, 34, 40, 42, 43, 54, 55, 56, 61, 62, 68, 71, 74, 76, 83
	Beneficiaries' capacity to sustain activities (19)	7, 10, 12, 18, 23, 24, 32, 33, 40, 44, 56, 57, 58, 60, 65, 71, 74, 76, 83
	Social capital development among multiple stakeholders (4)	8, 12, 55, 61
	Market development (20)	10, 13, 18, 33, 37, 40, 43, 44, 48, 49, 50, 53, 59, 60, 61, 65, 74, 82, 83, 84
	Resilience of local (food) systems (16)	5, 7, 15, 29, 32, 34, 38, 43, 48, 50, 55, 56, 57, 65, 71, 83
	Sustainable funding sources (3)	5, 52, 53
	Cost-effectiveness (7)	22, 23, 35, 36, 39, 78, 83
Diffusion	Communication channels (2)	58, 63
	Farmers' capacity (1)	63
Replicability	Project implementing modality (3)	7, 23, 55
	Unique favourable conditions or similar conditions compared to other contexts (4)	20, 33, 49, 74

Appropriateness

Appropriateness strategies deal with the fit- to-context, defined as the perceived fit of NSA interventions to the project setting, the target group, or the problems/needs to be addressed. Of the 72 articles reviewed in the NSA interventions domain, 41 reported intervention factors related to appropriateness, mostly as actual and/or potential success factors.

The importance of understanding the local context and adapting interventions to the local culture and agro-ecological conditions were reported as actual success factors [34,52,83], with the fit-to-context being described in terms of knowledge of and sensitivity to local cultures including language, (religious) beliefs and practices [5,68,83]. Others included gender norms [20,42], as well as intergenerational and broader community engagement [42,56]. For instance, Kerr et al. [42] described the successful experience of intergenerational sharing on traditional food knowledge during ‘recipe days’, emphasizing the importance of an appropriate entry point to communities, in this case the elderly. Fit-to- context appeared through another culturally related aspect, the respect and valuing of existing structures at community level, particularly women’s groups [11,83]. Bernet et al. [12] remarked that working through rural service providers, who have context-appropriate knowledge and expertise and are trusted and recognized within their communities, was an actual success factor to address the specific needs of remote communities otherwise difficult to reach. Appropriateness was also described as a good match of the interventions with the specific conditions of the target groups/areas. For instance, Le Port et al. [47] reported the suitability of a nutrition-sensitive dairy value chain intervention in Senegal for the targeted semi-nomadic population affected by high anaemia rates and having limited access to nutrient-rich foods and health services. The suitability of crops to local farming practices, agro- climatic conditions, and dietary preferences was also identified as an actual success factor [24,35,36,40,58,63]. A good example was given by the introduction of OFSP in countries, such as Mozambique and Uganda, where sweet potatoes have long been common staple foods. In these sweet potato producing countries, the fit-to-context of the intervention contributed to a smooth progressive substitution of less nutrient-rich sweet potatoes with the beta-carotene-rich orange varieties [35,36]. Other studies highlighted the importance of appropriateness through the use of local ingredients to produce context-appropriate food products [40,56,74] such as OFSP bread [50].

The intervention factors mentioned above were also reported as potential success factors (see examples in Box 7.3), with several articles explicitly recommending tailoring interventions to the needs and preferences of the targeted communities [15,27,32,40,42,53,83]. With regard to future NSA

interventions, Bernet et al. [12] remarked on the need for “the right mix of actions to improve nutritional status in varying contexts”, urging to look beyond pre-defined intervention packages. Similarly, Dulal et al. [27] stated that a homogeneous approach, even within the same country, may not be the best approach, and that appropriateness is a matter of context but also of timing activities to take field realities into account.

Box 7.3. Examples of potential success factors regarding the match of interventions with the specific conditions of target groups/areas

- Nordhagen et al. [61], in a multi-country EHFP intervention, identified a potential success factor in adapting the NSA approach to the unique features of each project area. In the project site in Tanzania, given the limited availability of land for gardening, instead of using village model farms as in the other project countries, they identified “resource farmers” to demonstrate best practices;
- Mensah [53] envisaged a better suitability of grain banks in the implementation of HGSP programs in areas lacking reliable markets and prone to food insecurity, advocating the importance of customised home-grown schemes;
- Schreinemachers et al. [81] pointed out that school garden projects would be better suited to areas where basic WASH infrastructure is already available, year-round agricultural production is viable and malnutrition rates are higher, offering greater impact potential;
- Low et al. [49] remarked on the suitability of OFSP as a less labour-intensive crop in countries with high HIV/AIDS prevalence, but also in areas with high prevalence of vitamin A deficiency, with the recommendation to explore OFSP suitability where they could potentially be produced but sweet potatoes have not been cultivated before;
- Nordhagen & Klemm [59] suggested that implementing EHFP projects in settings where household poultry raising is common can act as a potential success factor and may justify the choice to use local breeds in areas with poor veterinary services and limited availability of quality feed. Improved breeds would be more viable in urban settings where they can be raised intensively and where access to inputs and markets is not a constraint.

A few articles (six) reported actual failure factors in relation to appropriateness [40,43,48,60,61,76], covering a range of examples: a project focused on vegetables was compatible with two targeted communities but not with a third which clearly showed preference for non- vegetarian diets [40]; additional strain on water resources as a result of project gardening activities in areas where water

constraints were already known [61]; and the incorrect assumption of a consumption pathway being more relevant than an income pathway in an urban context with good access to markets [60]. As much as the actual success factors, the above-mentioned points offer important lessons on the importance of fit-to-context in prospective NSA projects.

Acceptability

Interventions may be designed to be appropriate, but that is not a guarantee that they will be accepted. Acceptability, in this context, refers to the perception of implementers that a given intervention is agreeable/satisfactory to the beneficiaries, based on their feedback, and may ultimately result in adoption. Forty-four of the 72 articles reviewed in the NSA interventions domain reported intervention factors related to acceptability.

Twenty-eight studies referred to the acceptance of/resistance to project recommendations by beneficiaries of which 27 remarked on acceptance being fostered by the alignment of project targeting and recommendations with socio-cultural norms, needs, practices and preferences of beneficiaries as (actual and/or potential) success factors. A subtle but relevant distinction emerged from the thematic analysis: on the one hand, acceptability may be high because of design choices in line with existing local conditions (appropriateness) and on the other hand, design choices may include promotion activities aimed at fostering acceptability of ideas that are new to the local context. Overall, our findings showed that the most effective way to achieve acceptability is by making choices that fit with existing conditions; when the planned intervention is not a close fit with local context, it is necessary to invest in design choices that foster the acceptability of the new ideas to be introduced.

In relation to acceptability being achieved as a result of project design choices that fit with existing conditions, eight articles reported actual success factors [5,32,33,35,36,40,49,56]. For instance, Muehlhoff et al. [56] emphasized the strategic importance of community sensitization and mobilization, with context-appropriate approaches, from the very early stages of the project to ensure greater community buy-in. Acceptability would be confirmed by the communities' satisfaction with their own leading role and perceived feeling of control over the activities. Hotz et al. [35,36] remarked on the acceptability of OFSP as a context-appropriate vitamin A-rich food source that can easily replace the commonly cultivated yellow or white sweet potato varieties in the production system and the local diet. Addressing consumers' preferences, in terms of taste and agronomic traits, in the selection of suitable OFSP varieties was an important step towards acceptance.

In relation to design choices aimed at fostering acceptability of new ideas in the local context, seven articles reported actual success factors [7,9,11,53,62,71,74]. Differently from other initiatives promoting complementary food with the use of imported or donated foods as inputs, the innovative idea of a community-based grain bank producing flour using grains and pulses produced mainly by the beneficiary women underpinned the pride in, and acceptance by, the local communities [74]. The pride was associated with the cultural value of local food (also in terms of quality and safety) and the economic potential (limited cost fluctuation of local inputs and saving labour). Another relevant example was provided by Bauchspies et al. [11] about the use of whole grains and related processing techniques in Mali. Through project design choices, such as the “cuisines collectives”, the long-known but stigmatised use of whole grains was re-introduced into a community, demonstrating multiple benefits (such as improved health status, decreased time and labour requirements, easy processing techniques, and increased food volume) that supported increased acceptance and changes in consumption habits.

The two typologies of factors mentioned above could co-exist within the same project. Actual success factors combining the two were reported in seven studies [14,38,42,50,61,68,76] covering a wide range of NSA intervention types (Box 7.4).

Actual and potential failure factors in relation to acceptability were reported in 13 articles. Some, but not all, represented the other side of the coin of the above-mentioned success factors. The few examples of actual failure factors leading to missed acceptability included: resistance to whole grains due to cultural norms or laborious techniques [11]; resistance to bartering system based on the expectation of free distribution of food by NGOs [76]; resistance by mothers (and grandmothers) who felt unfairly excluded from the grain bank activities when participation was targeted to those already engaged in existing social networks or with access to the health system [74]; and in the same study, resistance to the idea of giving the nutritive grain bank flour only to children, although it could benefit other vulnerable family members such as pregnant and lactating women.

Key strategies to increase acceptability rely on effective communication. Projects make use of communication strategies to stimulate the adoption of interventions. Thirty-one studies indicated that communication-related factors were important to influence NSA; the majority were success factors, actual and/or potential. Twenty-two of the 31 articles in this group reported success factors on the suitability of communication channels in promoting adoption. Actual success factors on the appropriateness of the selected communication channels to deliver project messages were described in five articles [42,50,56,62,68]. Fourteen other studies expanded on the concept of suitability, highlighting

the importance of using multiple channels to reinforce the messages, in some cases targeting multiple entry points from family members to community leaders.

Box 7.4. Examples of actual success factors regarding both typologies of acceptability factors

- In the study by Sako et al. [76] about a community-based grain bank project in Ethiopia, the bartering system, introduced as a new idea in the pilot, was maintained in the scale-up phase given its wide acceptance justified by its simplicity, appreciation of benefits by both the caregivers and husbands and the type of contributions required (labour and cereals at household disposal). The same study remarked on the important role of the local implementers as champions, particularly the health extension workers who were highly respected by the communities - a design choice that fit well with the existing conditions.
- Kerr et al. [42] reported that the local acceptance of the NSA intervention was achieved through the involvement of the community and key influencers, such as village leaders and elders, from the onset, and in respect to the local norms and practices, creating a sense of ownership in contrast with most agriculture and nutrition programs which “*just tell people (us) what to do*”. The design choice to offer a community-wide health and nutrition education through “recipe days” fostered broader acceptability of the intervention through changes in gender roles and responsibility, namely a more prominent role for men in childcare and nutrition. Moreover, as pointed out under “appropriateness”, the recipe days, with their intergenerational learning approach, favoured acceptability by the elderly and transmission of traditional food knowledge to the younger generations.
- Nordhagen et al. [61], in relation to a multi-country EHFP intervention, offered interesting insights into the community buy-in, in the case of implementation-research projects. Using narrow targeting criteria fit with the research design, but not the local context; it raised challenges in project participation in Burkina Faso and Tanzania, due to the inequity perceived by those excluded. The broader targeting based on widely accepted criteria in Senegal and the “all-included” approach for women’s enrolment in Cote d’Ivoire ensured broader community acceptability. The same study reported an *actual success factor* regarding the sequencing of project components - a design choice promoting acceptance of new ideas. The decision to implement the poultry and horticulture components prior to the nutrition and WASH social and behaviour change communication, in three of the four project countries, proved to be more successful, as the agricultural outputs stimulated further participation and, pragmatically, provided local ingredients for the cooking demonstrations.

The diversification of communication channels was reported as an actual success factor in eight studies [5,9,19,30,33,50,63,71] and as a potential one in six [20,21,34,35,58,65]. Overall, the integration of practical, interactive sessions in the communication toolbox was highly valued [9,42,50,56,58,62,63,68,71,74]. Another dimension of the suitability of communication channels concerned the actors delivering the messages, with seven articles reporting on the critical role of community-level implementers for adoption as an actual success factor [20,58,62,63,66,74,76]. Nine studies stressed the importance of delivering context-appropriate, convincing and clear messages that are consistent across sectors/activities and appropriately targeted as an actual success factor [5,9,12,30,33,48,50,59,71]. For instance, Nordhagen & Klemm [59] provided useful insights regarding the use of positive deviance examples, motivational messages (such as economic benefits of being healthy), associative messages such as “the child’s chicken”, bi- dimensional messages (for example not discouraging the sale of eggs or chickens, if beneficiaries have that preference, but stressing the need to use the income earned to buy other sources of animal protein). The use of suitable messages was also reported as a potential success factor [23,34,37,52,60,61,65]. Valuable suggestions on how to strengthen project messaging were found in Nordhagen et al. [61]: the switch of message focus from NSA interventions as an individual responsibility to a “shared household responsibility”, to prevent undue appropriation of benefits, and cross-trained staff able to deliver/reinforce messages in an integrated manner.

Feasibility

The adoption of NSA interventions relies greatly on their feasibility – a term which describes the extent to which an intervention can achieve its objectives in a given setting and timeframe. Factors affecting feasibility strategies were identified in different thematic areas: project management, (dis-) alignment of project design with the capacity of implementers and/or beneficiaries, project duration, cost, and scale of interventions.

Seven articles reported intervention factors related to project management, of which two remarked explicitly on access to funds as an actual success factor for the feasibility of a project [20,65]. Olney et al. [65] recounted that, due to the lack of funding, the program was stopped after two years but thanks to new funds, could be resumed after a six- month hiatus. The perpetuation of silo implementation in spite of the planned convergent design of the project was reported in two articles, of which one reported it as an actual failure factor. Matturi & Pain [52], regarding an HFP-based intervention in Zambia, reported that the NGO’s effort “to overcome the default silo approach” with a more integrated design did not produce

the expected results, as frontline staff and project managers “continued to operate within their own sectors in a business-as-usual manner”. Sako et al. [76] described actual failure factors related to the complexity of a project management system. They remarked that the feasibility of the community-based grain bank project in Ethiopia was undermined by: complex management structures, staff turnover, insufficient risk assessment at inception, and unrealistic timeframe with consequent problems in terms of sequencing and coordination of activities, especially given the involvement of different partners at multiple levels. In the same analytical theme, three studies [20,55,73] emphasized the resource-intensive nature of complex, multi- sectoral programs, such as NSA, with a longer time needed at each stage of the process, particularly planning, being perceived as a potential failure factor, considering the common timespan of donor-funded projects. For Berti et al. [13], the prospective capacity of interventions to achieve the expected production and nutrition objectives with the resources and time available was pivotal in the preliminary selection of candidate interventions, thus recognizing feasibility aspects as potential success (or failure) factors.

Feasibility could be undermined by a dis-alignment of the project design with the capacity of the implementers. Two of the three articles in this group described an unsuitable match with the training capacity of local implementers as an actual failure factor [76] that required remedial actions [56]. Five studies reported on the alignment of project eligibility requirements with the capacity and interest of beneficiaries, of which two described it as an actual success factor [7,61]. Potential failures factors in this analytical theme were also reported [25,54,56,61].

Project duration was a recurrent theme in the feasibility sub- domain, with 16 studies reporting it. Five described the limited duration of the exposure to the interventions or a timeline of interventions inadequate to realize the expected outcomes as actual failure factors [15,58,61,66,76]. For example, Olney et al. [66] listed the short duration of implementation (two years) among the reasons for the relatively modest impact on child nutritional status achieved by an EHFP program in Burkina Faso. Time-related failure factors were also reported as potential [27,28,31,34,56,70,72]. Three of the 16 articles in this group referred to a longer project duration or exposure to interventions associated with better project results as actual success factors [18,41,55] while eight studies reported them as potential success factors [27,28,31,34,54,61,66,76]. The group reporting potential success factors offered useful insights for design of future NSA projects, because they were based on factors thought to have contributed to actual failures. According to Michaux et al. [54] extending beyond the conventional five-year donor funding may be particularly relevant when NSA projects aim at improving the nutritional status of women

and/or children. In the case of stunting, which is the result of a cumulative intergenerational process, both earlier and longer program exposure play a role [66] which, as highlighted by Michaux et al. [54], may entail the involvement of women prior to their pregnancy and through the first 1000 day- window. On a different note, Nordhagen et al. [61] advocated for longer start-up periods, particularly in implementation-research projects.

Within the feasibility sub-domain, all ten studies reporting on the cost of interventions featured factors that were potential. Among the seven articles describing potential failure factors, two referred to the high cost of NSA interventions [55], especially when intensive [49]. Out of the seven, five remarked on the challenges of program costs becoming higher than originally intended for a variety of reasons: service delivery through village health volunteers being less efficient and more resource- demanding than expected [65]; additional efforts needed to train parents in gardening and nutrition as part of school garden projects [79,80]; correct use of food measures designed for the school meal planner resulting in a cost per meal higher than the allowance received [30]; and integration of interventions across sectors and actors being the costliest program component [48]. Reducing the cost of interventions was perceived as a potential success factor to be realised, for example, through economies of scale or integration of activities into routine services [48]. The study by Hotz et al. [35] demonstrated that the additional cost of direct community contact may not be justified after the first year, when OFSP is introduced in sweet-potato-producing areas. Their findings suggested that selection of interventions with a better fit-to-context may reduce the need for continued investment after the initial introduction of OFSP.

Finally, Bernet et al. [12] identified the scale of interventions as an important factor for feasibility. The implementation of what they called “micro-interventions”, as part of the project’s bottom-up approach, proved to be successful and was referred to as a driver of change.

Flexibility

Flexibility during the implementation process refers to the capacity of a project to adapt to a situation or to changes occurring in the project environment and its surroundings which may be needed for multiple reasons. Of the 12 articles reporting factors in this sub-domain, five highlighted the project flexibility in addressing design limitations as actual success factors [41,42,58,61,83]. The study by Nordhagen et al. [61], in particular, offered several examples of factors related to project adaptability. Among the actual success factors, cross- program learning, namely building on lessons learnt from the implementation of a project that used different approaches in different countries, and the effective and timely use of monitoring evidence to improve the project design were particularly relevant. According to Nordhagen et

al. [61] “real-time learning from implementation and monitoring can lead to numerous revisions in approaches – but only if there is sufficient flexibility in the workplan, budget and staffing”. They also emphasized the importance of flexibility in complex contexts, especially when unforeseen hindrances arise, which may delay project activities. In such contexts, strict fidelity to the original design would restrain the possibility of using continuous learning to adapt interventions. Nielsen et al. [58] and Talukder et al. [83] made a link between partnership and flexibility - the close collaboration and sharing of information among partners being instrumental for the successful and timely revision of the project. Referring to an implementation-research project, Nielsen et al. [58] remarked that the challenges of combining research and implementation of a “complex, multisectoral intervention programme” were compensated for by the benefits of the mid-term revisions and the increased effectiveness of the intervention model. Finally, two studies [20, 65] stressed how the development and use of a “theory of change” enhanced project adaptability by making bottlenecks visible and facilitating the identification of suitable solutions in discussion with stakeholders.

Project adaptability driven by implementers’ openness and willingness to operationalize the learning from implementation and monitoring was also reported as a potential success factor [20,30,47,56,80]. While adaptability factors had a prominent positive connotation, there were also three studies in which flexible actions undertaken to address design limitations were not as successful as hoped [24,56,61]. As an example of actual failure factors, Nordhagen et al. [61] described how small-scale adaptations to address exacerbated water constraints jeopardising gardening activities were not sufficient, while the already-allocated budget could not accommodate large-scale solutions.

Sustainability

Sustainability strategies strive to ensure that the promoted interventions and related activities, practices, services as well as intended outcomes are maintained/continued beyond the project funding period. Key factors affecting sustainability strategies were categorized into nine thematic areas: reliance on project support, strengthening of local structures, community empowerment and ownership of the interventions, beneficiaries’ capacity to sustain activities, social capital development among multiple stakeholders, market development, resilience of local (food) systems, sustainable funding sources, and cost-effectiveness.

Seven studies reported intervention factors related to the reliance on project support. Two of them described how activities got discontinued once the project support was reduced or ended as an actual failure factor [59,65]. In reference to the poultry component of an EHFP program in Burkina Faso and

Senegal, Nordhagen & Klemm [59] reported a considerable decline in chicken vaccination once the project stopped providing the subsidized service. The link established by the project between the participants and the existing local suppliers (village vaccinators) was not sustainable once the free-of-charge service came to an end. Potential failure factors in relation to this point were also reported [56,74]. Two articles highlighted that reduced reliance on projects where local structures could provide continued support was an actual success factor [5,34]. One of them, using evidence-based experience, provided recommendations for future projects about the need for a clear “entry and exit strategy”. According to Haselow et al. [34], while participatory and learning approaches are particularly important in the entry strategy, as they encourage community participation and ownership, for the exit strategy, capacity building of local resources is crucial, as it prepares communities to continue activities with little support.

Strengthening of local structures was a recurrent theme in the sustainability sub-domain with 21 studies reporting almost exclusively (actual and/or potential) success factors. Five of the 21 articles in this group remarked on the integration of interventions into local structures/institutions (for example agriculture and health extension systems and community-based groups), and/or the importance of building their capacity as actual success factors [12,55,60,76,83]. For example, Bernet et al. [12] emphasised the advantages of working with and through rural service providers who are “well established and trusted in their communities”. Their role was particularly meaningful in remote mountainous areas. Building on the experience, competences and network of contacts of rural service providers to develop the micro-interventions proved successful. The empowered service providers were perceived not only as key agents of change in the communities but also, prospectively, as advocates of the NSA approach able to influence policy discussions in the local arena and beyond. A close collaboration between rural service providers and local authorities, suggested by the same authors, would further consolidate the integration of interventions into existing local structures and influence local policymaking. The integration of interventions into local structures/institutions was also highlighted as a potential success factor in 11 studies [18,19,31,33,34,51,59,61,65,68,79] while potential failure factors in this area were reported in two studies [52,56]. As illustrated by Muehlhoff et al. [56], project-based strengthening of local capacity, while desirable, may not be sustainable if there is no system in place in the inner setting to maintain and make use of it. Four articles referred to the link or integration of NSA interventions with on-going local (development) programs as a relevant factor for sustainability; one study reported it as an actual success factor. In the case presented by Balcha [9], it was a win-win solution to fit a nutritional program into the Area Development Programs regularly run by the local implementing NGO, as they shared similar

activities and the built-in program could benefit from staff already trained in relevant disciplines, thus highlighting the importance of synergy.

Other important factors towards sustainability were related to community empowerment and ownership of interventions, on which 17 articles reported; in ten they were actual success factors [5,17,34,42,43,55,62,74,76,83]. Six articles explicitly attributed the perceived sense of ownership and empowerment to the participatory nature of the project and the fact that the communities were actively involved in decision making and shared responsibility from the onset [17,34,42,62,76,83]. As highlighted by Kerr et al. [42] important aspects of the participatory approach were “the explicit and inclusive focus on both men and women” and, as remarked also by Ogoye-Ndegwa et al. [62], the involvement of other key community stakeholders such as the education authorities, parents and teachers committee and the community opinion leaders. Some of the studies reported similar potential success factors, such as the engagement of community members as active partners and their mobilization as resource persons for a project [19,40,43,56,62,71]. Further, Michaux et al. [54], based on the experience with an EHFP project in Cambodia, recommended enhancing ownership and sustainability through (financial) co-contribution by beneficiaries. Similarly, Nordhagen et al. [61] referred to the use of a cost-sharing mechanism, while Roche et al. [74] and Sako et al. [76] described contributions in-kind to a grain bank project.

Closely linked to community empowerment and ownership of interventions is the theme: beneficiaries’ capacity to sustain activities. Of the 19 articles reporting factors on this theme, six pointed out that strengthening the capacity of beneficiaries was an actual success factor towards sustainability [7,10,18,40,60,83]. For instance, Ayele & Peacock [7] stressed the importance and the positive long-term impacts of having built capacity, particularly of poor rural households, through asset creation as well as adult literacy and numeracy trainings aimed at improving their management of microfinance initiatives. Conversely, Roche et al. [74] and Sako et al. [76] described actual failure factors related to the limited capacity of beneficiaries to sustain activities. Both remarked how challenging it was for rural households, particularly the poorer and more food insecure who are more vulnerable to the vagaries of climate and season, to contribute agricultural inputs as well as material and financial resources to the grain bank. Seven studies explained how the increased women’s workload and time commitment associated with the NSA interventions actually undermined their capacity to uptake and sustain the activities [24,32,44,56,58,65,74]. Providing incentives or fair compensation for the time invested, as in the case of grain bank activities [74], or the involvement of husbands in gardening and nutrition-related activities [58], were perceived as potential success factors for increased sustainability. According to Bushamuka et

al. [18] and Nordhagen et al. [60] the capacity to sustain activities is also dependent on the beneficiaries' ability to experiment and adapt the interventions to best suit their needs. Examples of actual success factors in Nordhagen et al. [60] were local adaptation of the original poultry and micro-gardening components – the beneficiaries' exploration of alternative solutions with better fit contributed to self-sustaining of the interventions. Finally, sustaining activities is also dependent on whether beneficiaries continue to give them priority during and after the project ends, which may affect production of food as well as selling, purchasing, and consumption. Bernet et al. [12] described prioritization as an actual success factor, reporting that small but significant diet-related behavioural changes were mostly due to "changed priorities in food purchasing and consumption". The same point was identified as a potential success factor by other authors [57,60]. Somewhat counterintuitive was the case presented by Murty et al. [57], in which consumption of less popular nutritious green leafy vegetables gained priority when other vegetables, consumed previously, increased in marketability.

Sustainability could be further strengthened through the development of social capital among the multiple stakeholders involved in the interventions as evinced by four articles reporting it as a potential success factor [8,12,55,61]. According to Miller et al. [55], community and social capital development in combination with other factors, such as women's empowerment, provide a supportive framework, a fertile substrate, which stimulates faster uptake and potential sustainability of the activities.

Market development was largely perceived as an actual and/or potential success factor for sustainability, with only four of the 20 studies in this group reporting failure factors. Four studies identified actual success factors associated with the supply side of market development [18,40,44,60] while five others reported success factors in both market supply and demand [48,49,50,53,84]. The main actual success factors were: an increase in production of nutrient-rich foods leading to the sale of surplus [49,50] and income generation [18,40,44,60,84], and the existence of a market ready to absorb the (surplus) production, as in the cases of a HGSF program [53] or OFSP vines [48]. In relation to the demand side, Mensah [53] referred to a social pricing mechanism that encouraged caterers of a school feeding program to buy from local farmers as an actual success factor, while other articles reported potential success factors such as: the marketability of processed products made with nutrient-rich crops [37,50]; the use of social-marketing techniques to stimulate demand for OFSP vines [33]; and the improvement of packaging and labelling as well as distribution of samples to promote the nutritious grain bank flour [74]. Four articles reported failure factors.

While Olney et al. [65] indicated that a lack of production surplus can be an actual hindrance to market development, others reported potential failure factors. For example, Nordhagen & Klemm [59] remarked that “participants rarely sell chickens and even less frequently sell eggs, even when production levels would allow this”. The same authors acknowledged the importance of market-related approaches for the long-term sustainability of interventions, especially in urban contexts. However, doubts about market potential in rural areas may limit the impact of such approaches within NSA interventions. Berti et al. [13], referring to the selection of candidate interventions, advocated the inclusion of a market development component as part of an NSA intervention package only if production increases enough that households became more food secure. Based on past experience, the same authors argued that an increased emphasis on markets would likely shift farmers’ production priority to non-food crops, putting local food security in jeopardy. Furthermore, since the income generated from selling non-food crops does not necessarily lead to improved diets, local nutrition security would also be at risk. Finally, three studies described potential success factors related to the improvement of local value chains [37,82,83]. Based on the lessons learnt from their study, Hotz et al. [37] supported the enhancement of “women-centred” food value chains, as well as development of dairy and vegetable value chains, to ensure a supply of nutritious food at competitive prices as well as year-round access. Singh & Fernandes [82] envisaged that “HGSF procurement could be used to strengthen value chains through enhanced linkages with smallholder farmers and localized procurement at the district level”. Thanks to the HGSF procurement system, it could be possible to shorten the supply chain of foods frequently used in school menus, such as tomatoes, through direct links with farmers’ organizations, while at the same time reducing post-harvest losses and incentivizing on-farm storage.

Sixteen studies reported success factors related to the resilience of local systems to seasonal challenges and shocks, with all but one drawing attention to key aspects of the local food systems. Of the eight studies noting the importance of diversifying agricultural production, one described it as an actual success factor. Zamora et al. [5] stated that bio-diverse production systems safeguard the resilience of local food systems against climate shocks as well as seasonal variations. Seven other articles reported this point as a potential success factor, emphasizing the need to establish diverse, integrated systems with a context-appropriate mix of crops, livestock, fish or other small animals like frogs and insects [7,15,32,34,43,56,65]. In particular, three studies [7,34,65] stressed the need to diversify sources of animal protein, also in view of unpredictable shocks such as an outbreak of avian influenza. The resilience of local food systems is also very dependent on the existence of local, reliable sources of agricultural inputs. Project support to establish small local enterprises, such as “agrovet” businesses [38] or “OFSP vine multipliers” [48], as well

as community-based structures, such as village nurseries [83], proved to be actual success factors for sustainability. Five other articles referred to a local source of reliable and affordable inputs as a potential success factor [34,50,55,57,71]. Low et al. [50] remarked that the conservation of OFSP vines and their timely availability in the planting season are crucial aspects for sustainability. They noted that “the common practice of free vine distribution may perversely discourage investment by farmers in vine conservation”, creating a need to improve vine multiplication and conservation systems especially in drought-prone areas. Finally, by strengthening the resilience of local systems particularly in the most disadvantaged communities [34], NSA programs could potentially help to mitigate the impact of external shocks, such as increases in the global prices of food and agricultural inputs [29].

Access to long-term funding sources was recognized as an actual success factor for sustainability in two of the three studies in this group. Matturi & Pain [52] documented the successful fund-raising experience of the implementing NGO and recommended identifying a reliable stream of long-term funding, diversifying the sources by supplementing a regular flow of public funds with private sector funds. Furthermore, Zamora et al. [5] remarked that successfully implemented and scaled-up NSA projects had been funded by government organizations that had prioritized NSA. As a potential success factor, Mensah [53] pointed out the importance of timely and stable disbursement of government funds to sustain HGSP programs. Finally, the usual short-term (3–5 year) funding window was reported as an actual failure factor for sustainability in many projects run by NGOs and civil society organizations [5].

For long-term sustainability, it is crucial not only that an intervention works well, but it should also be cost-effective compared to other alternatives, considering relative costs and health/nutrition outcomes. This is particularly important in LMICs, where resources and funds are always limited. Success factors (actual and/or potential) were identified in five of the seven articles in this group. Actual success factors associated with cost-effectiveness of interventions were: the integration of agricultural activities with other health and development services of the implementing NGO [83]; and the increased scale of the project, though with a cautionary note about the opportunity cost of women’s time [78]. Potential success factors were reported in three studies, with cost-effectiveness being related to: the implementation of interventions in areas with higher potential for impact, such as sites with high prevalence of vitamin A deficiency [39]; a broader diffusion of the intervention, with farmers being actively encouraged to share the OFSP vines with non-beneficiaries [23]; and the intensity of participation [22]. In the latter example [22], the extension worker-mother promoter model, which entailed a more intense and direct contact, had a larger impact than the subsequent promoter-beneficiary mothers’ interaction. Finally, two studies

described potential failure factors. Hotz et al. [35,36] showed that a longer period of direct contact between promoters and extension workers may increase costs but not necessarily translate into greater impact. The additional cost of extended direct community contact may not be justified after the first year, when OFSP is introduced in sweet potato producing areas [35].

Diffusion

In the context of project development, implementers aim to achieve the diffusion of interventions by putting in place strategies that could accelerate the spread of evidence-based practices (Dearing, 2009) to population groups beyond the intended beneficiaries. Five articles made explicit reference to factors influencing the diffusion of NSA interventions. Okello et al. [63] referred to the suitability of selected communication channels, namely health talks and mother-to-mother support clubs, in promoting diffusion of OFSP by sharing vines with neighbouring farmers. The actual success factor was attributed to the good match between the sensitization sessions on the benefits of OFSP technology and the practical demonstrations. On the same topic, Nielsen et al. [58] envisaged a potential success factor for diffusion stemming from inviting non-beneficiary households who showed interest in joining the project refresher trainings aimed at community-level implementers and beneficiaries. Other actual success factors concerned the influential role of the asset/capital endowment of farmers in OFSP diffusion decisions [63] and project implementation modalities, such as the in-kind methods of paying back a goat loan [7]. As a recommendation for future projects, De Brauw et al. [23] advocated for project implementation modalities that actively induce OFSP beneficiaries to share planting materials with non-project farmers.

Replicability

At the onset of a project, implementers can also strategize on ways to ensure replicability, here defined as the capacity and the extent to which an intervention (or some of its components) can be implemented in other contexts, obtaining comparable results. Intervention factors related to replicability were identified in four articles. The unique favourable conditions from which certain projects benefited were interpreted as potential failure factors when their replicability in other settings was highly unlikely. For example, in an NSA project promoting biofortified OFSP in Kenya, Cole et al. [20] described how material support (time and resources) as well as the conceptual and methodological alignment of the project team, partners and the donor agency, had been instrumental in the successful implementation. Other examples of potential failure factors were provided by Roche et al. [74] in relation to subsidization of community-based grain banks by external donors, and Low et al. [49] on the intensive package of activities which helped prove the potential for successful OFSP introduction. Conversely, Hagenimana et al. [33], referring

to an OFSP-based intervention in Kenya, suggested that replicability and achievement of comparable results could be expected in contexts with similar conditions, such as agricultural economies with “high rates of subclinical vitamin A deficiency”.

Inner setting domain

The inner setting represents the local context in which NSA projects are implemented. The contextual factors (barriers and facilitators) in the inner setting are theoretically located outside the boundaries of NSA projects. Thus, in principle, implementers have limited (or no) influence over these factors, unless the planners were familiar with them, and were able to internalise them into the strategy and design of a project, as explained above in the ‘NSA interventions’ domain. For synthesis purposes, inner setting factors were clustered in six sub-domains: population characteristics; culture and social environment; local capacity; bio- physical environment; food environment; and horizontal and vertical coherence (Fig. 7.4).

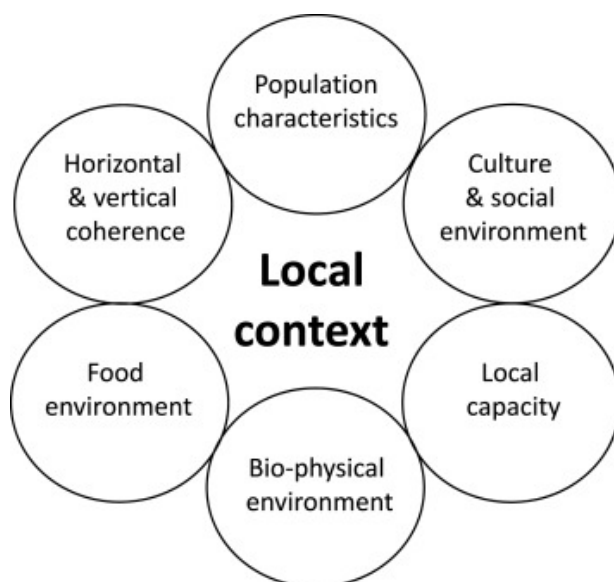


Figure 7.4. Framework for the synthesis of contextual factors in the inner setting domain

Barriers were more prominently reported than were facilitators in this domain, especially in relation to culture, bio-physical environment, and food environment. The overview of the findings for the inner setting is presented in supplementary files of the published chapter 7.

Table 7.3 Overview of the 73 studies reporting inner setting factors

Sub-domains	Analytical themes (no. of studies)	Studies reporting facilitators/barriers
Population characteristics	Socio-economic factors (18)	1, 9, 13, 25, 26, 29, 37, 50, 51, 56, 57, 58, 60, 63, 66, 72, 74, 76
	Demographic factors (25)	3, 4, 9, 10, 14, 18, 25, 27, 32, 36, 39, 44, 47, 49, 50, 55, 56, 57, 58, 60, 64, 67, 69, 70, 72
Culture and social environment	Psychosocial factors (6)	10, 17, 20, 28, 74, 76
	Cultural and social norms (31)	1, 4, 7, 9, 11, 13, 15, 16, 18, 20, 26, 31, 32, 33, 37, 38, 42, 44, 56, 57, 58, 59, 60, 61, 64, 65, 67, 70, 74, 77, 85
	Culture-related practices and preferences (20)	3, 7, 11, 13, 37, 38, 41, 43, 45, 56, 59, 62, 64, 65, 67, 69, 72, 74, 77, 78
	Security and stability (3)	3, 25, 29
Local capacity	Social protection programs (1)	4
	Capacity of local institutions (14)	1, 2, 3, 4, 20, 29, 30, 31, 36, 46, 56, 76, 80, 81
	Capacity of communities (20)	1, 3, 5, 7, 10, 13, 14, 26, 27, 36, 46, 47, 49, 51, 56, 65, 67, 71, 83, 85
Bio-physical environment	Availability of/access to natural resources (24)	1, 4, 5, 9, 13, 14, 15, 24, 28, 32, 37, 50, 58, 61, 62, 63, 64, 65, 71, 76, 77, 81, 83, 85
	Agro-climatic conditions (24)	1, 3, 4, 8, 9, 14, 15, 24, 25, 27, 32, 33, 35, 37, 44, 45, 50, 58, 62, 76, 78, 79, 80, 85
	Seasonality (15)	12, 15, 27, 32, 37, 47, 57, 60, 62, 65, 71, 76, 78, 80, 81
	Unpredictable and predictable shocks (11)	1, 9, 10, 24, 33, 34, 57, 59, 65, 68, 78
	Diversity of local conditions (3)	1, 3, 4
	Distance from serviced areas (5)	27, 50, 76, 79, 80
	Infrastructures (15)	3, 4, 5, 13, 14, 26, 29, 32, 37, 38, 44, 46, 57, 75, 81
Food environment	Food availability and access (19)	1, 4, 13, 27, 32, 37, 45, 51, 56, 62, 66, 67, 72, 74, 75, 76, 79, 80, 82
	Inputs (18)	1, 4, 9, 16, 24, 29, 32, 50, 56, 57, 59, 60, 65, 71, 77, 78, 83, 85
	Technology (6)	4, 10, 11, 32, 56, 83
	Market environment (20)	1, 3, 5, 13, 25, 27, 29, 30, 37, 38, 44, 45, 50, 51, 56, 57, 59, 65, 72, 75
Horizontal and vertical coherence	Food safety (4)	1, 3, 37, 45
	Multi-sectoral/multi-stakeholder collaboration & coordination (12)	1, 2, 3, 4, 5, 20, 34, 46, 56, 65, 72, 76
	Multi-level coordination	(See outer setting)

Of the 85 articles reviewed, 73 reported on context-related factors (Table 7.3). Both the articles on the NSA approach and those about the implementation of NSA projects contributed to this domain, with an extensive range of actual and potential barriers and facilitators.

Population characteristics

This sub-domain comprises socio- economic, demographic and psychosocial factors observed in the inner setting population, often representing pre-set (enabling or disabling) conditions for the implementation of NSA projects. It should be noted that this sub-domain does not include factors, such as attitude and motivation, because they are part of the 'Process' and 'Actors' domains.

Eighteen studies reported factors related to the socio-economic status of people residing in the inner setting, of which 12 studies described high levels of poverty [25,26,29,51,56], low purchasing power [50] as well as financial constraints [58,66,74,76] in combination with limited income opportunities [37,57] as actual barriers to the uptake of NSA interventions. Conversely, better wealth conditions, also exemplified by capital/asset endowment or income sources, were generally perceived as actual facilitators [9,63,72,74]. An exception is the study by Nordhagen et al. [60], in which the lower wealth group was the most likely to continue the table-type gardening activities promoted by the project.

Twenty-five studies indicated that demographic factors were important influencing factors for NSA. Outmigration, often for work- related reasons, was highlighted as an actual barrier in three of the six studies in this group [4,14,56]. One study [44] referred to ethnicity and caste hierarchy as potential barriers. A smaller household size, allowing the garden produce to satisfy the nutrient requirements of the entire family, was mentioned in one study [32] as an actual facilitator. Furthermore, women's seniority, accumulating community status as age increases [10,18], as well as a higher level of education, especially among women [55,57,72], were perceived as actual facilitators. A poor health status among local community members, specified as the prevalence of infections/illnesses, was reported both as an actual barrier [36,49,50] and a potential barrier [64,69,70].

Lastly, six studies reported barriers related to psychosocial factors, mainly concerning communities' openness to change. For instance, in the study by Roche et al. [74], resistance to change was an actual barrier, exemplified by reluctance to engage in a new grain bank project (or any other project) after disappointing experiences with previous initiatives. Similarly, in Sako et al. [76] widespread expectation of free distribution of food by NGOs led to resistance to change and thus created a barrier.

Culture and social environment

Factors related to local culture (including beliefs, social norms, practices and preferences) and other aspects of social systems, such as peace and security, that affect people's welfare, food security and nutrition, play a central role in implementation and scale-up of NSA. For synthesis purposes, factors connected to the "culture and social environment" were clustered in four analytical themes.

Thirty-one studies reported factors associated with cultural and social norms, of which 16 highlighted the negative or positive influence of traditional beliefs related to food, diet during- and post-pregnancy, infant feeding and childcare. Six studies recognized the respect for traditions (also when mandated by religion or caste) and the re-enactment of culturally accepted behaviours observed in other community members as actual barriers to the adoption of recommended practices [11,38,57,58,61,65]. Eight more studies reported them as potential barriers, of which two [13,74] referred explicitly to the tension that may arise from challenging elders' knowledge and values. The majority of relevant cultural beliefs were related to food perceptions, which could be actual barriers, such as food taboos [57] and food avoidance [38], or were described as potential barriers, such as superstitions [15,20,59]. For example, working in Kenya, Cole et al. [20] remarked on the common perception of nutrient-rich foods as "sick person's foods", because they are often provided to people affected by HIV or AIDS. Another study [11] pointed out the social stigma of poverty and laziness associated with whole-grain food in Mali as an actual barrier. Furthermore, traditions related to the local dietary culture and cooking methods may be potential barriers to NSA [31,37] which become actual barriers when they reduce the contribution of animal source foods to diets, even in households that produce them [38]. Traditional beliefs can also be important facilitators, as confirmed in five studies. The most frequently mentioned actual facilitators were the traditional holidays and rituals [7,11,38] during which prized commodities, such as meat, would be consumed, while the embeddedness of children's consumption of animal milk in the local culture was reported by Ayele & Peacock [7] and Hotz et al. [37] as a potential facilitator.

Fifteen of the 31 articles in this group emphasised the negative (or positive) influence of social norms on gender. Ten of them identified actual barriers related to gender inequity in different areas: roles, responsibilities and workloads [32,42,44,56,85]; decision making in both family and production matters [44,74]; access to and use of resources including rights to inherit land [33,77,85]; and autonomy of movement for example to go to the market or participate in groups' activities [11,44,56]. Most of the above-mentioned aspects, especially in relation to gender roles, were characterized by the social construct of "hegemonic masculinity" reinforced by peer and social pressure, as illustrated by Kerr et al. [42]. Communities that were empowered as a result of more egalitarian gender social norms [44] were described as an actual facilitator and a fertile ground for NSA interventions, while other studies [1,64] envisaged better access and control over resources by women as a potential facilitator. Beyond gender social norms, local cultures founded on principles of social solidarity, community cohesion and reciprocity [11,16,33] which already embedded basic elements of NSA interventions [9,11,37], such as home

gardening and collective cooking, hold potential for the successful implementation and scaling of NSA. Interestingly, all six articles in this group reported experiences from Africa.

Another analytical theme in this sub-domain concerned culture- related practices and preferences. Four of the 20 articles in this group reported socially disrupting practices as actual barriers, such as crops stolen by people [77], fences damaged when wood is taken for fuel [62] or corruption at lower administrative levels [3]. Household and community level practices and preferences with regard to knowledge sharing, food production and consumption, food processing, hygiene and childcare can also present actual and potential barriers, as reported in 16 studies. For instance, at the household-level, Bauchspies et al. [11] described that mother shared knowledge from collective cooking practices with their own daughters but not their daughters-in-law; this was an actual barrier and a missed opportunity, closely related to cultural norms. Furthermore, in some contexts, giving children food from the family meals with no special attention to their nutrition requirements [56,65,74] or leaving children with no food while mothers work in the field all day [56] are culturally accepted practices but actual barriers to NSA. Potential barriers were also identified as suboptimal local care and hygiene [64,69] or feeding practices, for example, giving children low- nutrient density food like plain porridge and processed snacks [13,37,41,72]. Conversely, household-level practices that prioritize the food and nutrition security of women and children [67], such as giving goat milk preferentially to children [7], may be important potential facilitators for NSA. Community-wide, cultural preferences for locally produced [37,43] and preserved food [38] can act as potential facilitators, while the general preference of not eating chicken meat and eggs but rather selling the animals to raise income or saving the eggs to produce chicks [59,64,65] were seen as potential barriers, when the goal was to increase the consumption of own-produced nutrient-rich food.

In relation to other aspects of social systems affecting people's welfare, food security and nutrition, three articles made explicit reference to the lack of peace and security as a critical actual barrier. In the context of the Democratic Republic of the Congo, Doocy et al. [25] described the disabling environment in post-conflict areas characterized by insecurity, political instability, and population displacement. Similarly, Poole et al. [3] noted that the lack of security in Afghanistan negatively affected the implementation of projects as well as the functioning of the markets and the delivery of public services. Another example was given by Fanzo et al. [29] in relation to post-election political violence in Kenya in 2007–2008, which further exacerbated poverty and food insecurity in the affected areas.

Finally, on a related note, van den Bold et al. [4] reported the existence of social safety net programs, especially in rural areas, that ensure access to (nutritious) food as an actual facilitator. Though the need

for peace and security and for social protection programs would be a common denominator in many LMICs, it is valuable that the cited studies highlight their relevance in relation to NSA.

Local capacity

The implementation and potential scale-up of NSA is also influenced by factors related to both the institutional capacity of formal structures in the inner setting and the capacity of local communities.

Factors related to institutional capacity were reported by 14 articles. The actual barriers were mostly associated with limited human resource capacity as a result of, for example, low literacy [76], lack of technical skills and relevant training [1,4,20,56] especially in more remote areas [3], limited nutrition knowledge [1,2,4], high workloads [20,76,80,81], lack of transportation [20], and unstable employment [4]. Other actual barriers were a limited understanding of agriculture- nutrition-health linkages [2,3,4] and inadequate budgets for salaries [31] and for implementing activities [1,56]. All the facilitators mentioned in this sub-domain were potential. They stressed the importance of building capacity with relevant trainings and training manuals [1,3,4,30,46,56], particularly through sustained government efforts, because better knowledge on nutrition, healthcare, WASH, and agriculture-to-nutrition pathways would enable field staff to better implement integrated (NSA) programs. Improved awareness and a shared understanding of nutrition multi-sectorality was also envisaged as a necessary step to mainstream NSA in the inner setting [2,4]. Finally, improvement in the functioning of health systems, for example, increased coverage of vitamin A supplementation or introduction of vaccines, was identified as a potential facilitator [29,31,36,46].

Twenty articles reported factors related to the capacity of the local communities, of which 13 referred to the availability of/access to socially relevant resources (other than the natural ones covered under the sub-domain bio-physical environment). Four studies remarked specifically on the availability of human resources (or a lack thereof) in the inner setting. The reliable presence of human resources in the communities was an actual facilitator for NSA interventions [14] as well as other types of interventions. Both Dulal et al. [27] and Pradhan et al. [71] recognized the unavailability of labour as an actual barrier and related it to seasonal issues such as work-related migration taking people temporarily away from implementation areas, or absorption of human resources (in paid labour) during peak growing seasons. While access to credit was predominantly described as a potential facilitator [1,5,51,83], Ayele & Peacock [7] remarked on the actual enabling role of matching funds provided by local savings and credit associations in kick-starting small businesses, which in turn allowed households to spend more money on nutrient-rich food. Limited access to knowledge on agriculture, marketing and nutrition in the inner

setting was reported as an actual constraint by three studies [56,65,71], while the need to improve knowledge building based on past efforts [13,46] and the role of local authorities and NGOs in facilitating access to knowledge [85] were highlighted as potential facilitators in three more articles. Another group of nine studies in this analytical theme reported contextual factors concerning the access to health and agricultural public services (or a lack thereof). Seven of the nine articles considered access to a basic package of services, especially in relation to health care, as a potential facilitator for NSA. Muehlhoff et al. [56] pointed out that “explicitly co- targeted services can ensure that caregivers with young children benefit from multiple sectors’ work”. Finally, three articles illustrated how the existence (or absence) of local community structures, such as informal local councils, can act as both barriers and facilitators. Olney et al. [65] considered the lack of cooperatives, due to lack of trust among community members, as an actual barrier to NSA. Conversely, the same study envisaged the establishment of local cooperatives as a potential facilitator, given their prospective benefits in terms of better prices negotiated for collective homestead production and more affordable transportation costs to go to markets.

Bio-physical environment

This sub-domain encompasses factors related to the natural environment, such as natural resources, climate, and remoteness of sites, as well as the man-made environment (infrastructure). Of the seven analytical themes in this sub-domain, three (availability of natural resources, agro-climatic conditions and seasonality) were closely interconnected with respect to water issues.

Twenty-four studies reported factors related to availability of/access to natural resources. Of the 14 articles that identified actual barriers, nine referred to water constraints, mostly for production, but also for hygiene [4,9,32,58,61,62,65,77,81], highlighting a dependence on rainfed agriculture, while five studies referred to limited access to (and ownership of) land [4,24,37,71,85]. Availability of water [9,15] and land suitable for cultivation [32,50,63,64] were also recognized as important actual facilitators for NSA. Among the six articles reporting potential facilitators, the greater emphasis was on water access [1,5,32,65,83].

Agro-climatic conditions concerned unfavourable rainfall, climate, elevation and gradient of the agricultural fields, or soil fertility and were predominantly reported as actual challenges to devising appropriate NSA programs; 24 studies confirmed this finding, of which a few [9,27,33] also emphasized the actual facilitating role of suitable growing conditions.

Seasonality was another prominent analytical theme in this sub- domain. Seasonal challenges and opportunities were identified in 15 studies, of which eleven described actual production constraints

experienced during a dry and hot season [15,27,32,37,47,57,65,71,76,78,81] which prevented year-round access to nutrient-rich food such as vegetables or milk. Seasonal water scarcity was the link with the previous two analytical themes. Another actual seasonal barrier was related to a lack of available land, for instance to grow vegetables during the rainy season in India, as priority was given to other crops [71]. The predominance of seasonality as an actual barrier validates the statement in Sako et al. [76] that “nutrition interventions that require food contributions should account for seasonality in their design”.

While water scarcity may be recurrent and follow a seasonal pattern, thus becoming predictable to a certain extent [actual barrier: 9,33], other weather-related shocks such as droughts and floods may be less predictable [potential barriers: 10]. A similar conclusion can be drawn for other predictable and unpredictable shocks related to pests and animal diseases. In fact, while pests and mortality of birds due to diseases are well-known actual barriers [1,24,57,59,65,68,78] for which management strategies should be included in the design of NSA interventions, other more unpredictable shocks, such as an outbreak of avian influenza [34], are actual barriers more difficult to anticipate.

The few studies reporting on the diversity of local conditions [1,3,4] remarked that applying a blanket approach, that does not consider the heterogeneous conditions of the inner setting, represents an actual barrier for the implementation of NSA programs. The impact of the multiple and interlinked agriculture-to-nutrition pathways depends on the recognition of the (un)favourable mix of local agro- climatic conditions, livelihoods, food availability, public services, natural resource availability, and more. As stated by Hodge et al. [1], such awareness “would make some pathways and interventions more relevant than others depending on the region”.

Remoteness and difficult-to-reach implementation sites in the inner setting were reported as actual barriers in four studies [27,76,79,80], while a reasonable distance to a market and choosing an implementation area within 10 km of a major road, were potential facilitators in a program focusing on market development for OFSP [50].

Finally, of the 15 articles reporting factors related to infrastructures, six referred specifically to WASH facilities and ten to other types of infrastructure. Absence of, or poor access to, WASH facilities was predominantly an actual barrier [14,26,57,81], while better WASH facilities or access to them was an envisioned potential facilitator [4,14,46]. Only Murty et al. [57] remarked on the access to safe drinking water from reverse osmosis plants established at village level as an actual facilitator. Several articles pointed out the need to improve other physical infrastructures relevant for agriculture and nutrition, such as farm- to-market roads, irrigation, post-harvest facilities, energy and telecommunication infrastructures

[potential facilitators: 3,4,5,32]. Lastly, poor infrastructures to serve transportation [13,44,75], energy [3,75] and irrigation [13,37] were cited as actual barriers.

Food environment

Factors affecting the availability, accessibility, affordability and safety of food, particularly (but not only) from a market perspective, were clustered in five analytical themes under the heading: food environment. It is interesting to note that none of the articles reviewed reported barriers or facilitators concerning the natural/wild food environment, in spite of its recognized relevance in many LMICs. Attention was largely on the on-farm and market food environments.

Year-round availability and access to (nutrient-rich) food, in terms of both quantity and quality, can be limited by several factors, as indicated in previous sub-domains of the inner setting (poverty, religion, human resources, natural resources, seasonality, weather shocks, and pests). Nineteen articles reported factors in this theme, of which 11 described actual barriers. Additional factors, not reported in previous sub-domains, were related to the perishability and short shelf-life of certain foods, such as green leafy vegetables, as in the case of a HGSF intervention [82], inadequate storage [75] or the top-down impact of outer setting policies which resulted in local food systems with limited agricultural diversification and prevalent staple foods [56]. The bottom line is that without adequate availability of nutrient-rich food in the inner setting (homes, schools, communities), it is not realistic to promote or scale-up NSA interventions [74,76,79,80]. Thirteen of the 19 studies in this group considered an improvement of the supply side a crucial potential facilitator or even a pre-condition to increasing demand for nutritious food. Several options were put forward to ensure that food was not the limiting factor. Hodge et al. [1] envisaged agricultural diversification with emphasis on nutrient-rich crops as a key first step. Schreinemachers et al. [80] remarked on the importance of increasing supply and stimulating demand in parallel, at both household and community level. Hotz et al. [37] and Roche et al. [74] referred to the need to expand and diversify the channels for sourcing food (own production, purchase or trade). Other studies [4,37,82] highlighted the need to develop and strengthen local value chains, giving particular emphasis to post-production phases (storing and processing), starting from the household level [1,32,67].

A significant category of factors influencing food availability, worth specific attention, concerned the cost and availability of agricultural inputs. Fifteen of the 18 articles mentioning this theme reported actual barriers. Apart from a few studies referring to an overall lack of agricultural inputs [56,60,85] and their cost [16] as a primary barrier to production, most of the articles referred to specific type of inputs: seeds and planting materials [1,9,50,57,65,71,77,78], fertilizers [24,29], and vaccines [59]. Schreinemachers et

al. [77] remarked on the hindrance caused by the unavailability of seeds in small packs suitable for home production. As for the potential facilitators, three studies [4,9,83] highlighted the need for reliable and accessible local sources of seeds, to minimize the reliance on expensive imported seeds, while one study [56] advocated access to a diverse pool of seeds and planting material to promote food diversification and “align agriculture to dietary requirements”. Furthermore, Low et al. [50] envisaged the increased availability of drought-resistant varieties to match specific local agro- climatic conditions, while Ha et al. [32] remarked on the motivational effect that subsidized, high-yielding vegetable seed kits suited for different regions could have on the adoption of home gardens.

Access to technology was reported as an actual barrier in a few cases: distance to the nearest mill discouraged the use of whole grains [11]; a focus on staple foods contributed to poor agricultural diversification [56]; and an increased use of chemical pesticides in homestead production raised concerns for human and animal health [10]. New technologies, such as biofortification, and the development of higher- yielding and more nutrient-dense varieties, would represent important potential facilitators [4] while the use of sustainable land management technologies could be instrumental for year-round production in home gardens [32,83].

Twenty studies reported factors associated with the market environment either in terms of market access and/or food prices. The limited access to market was primarily acknowledged as an actual barrier in eight articles, some of which elaborated on the underpinning reasons, such as transportation costs [65], distance to market [27,44] or poor physical infrastructure [44,59], that increase transaction costs and marketing risks. Such barriers affect not only the supply side but also the demand side. In fact, the lack of, or poor access to, markets was an actual constraint to obtaining the variety of ingredients needed for a diverse and nutritious diet [56,75], enhancing the risk of monotonous, nutrient-poor diets and reliance on mobile vendors, especially in remote areas. Hodge et al. [1] envisaged that, in addition to increasing the production of nutrient-dense foods, improvement of market access and related infrastructure would be a potential way to enhance the nutrition-sensitivity of agriculture. The enabling role attributed to market access by seven studies and the assumption that “markets could be improved within the life of a project” [13], make this potential facilitator a very powerful factor to leverage with multiple actions at inner setting level, including (NSA) projects with strong market development components [50]. Nevertheless, the existence of surplus production is an essential condition for development of local markets. The price of food was reported as an actual barrier in six studies, three of which remarked specifically on the prohibitive cost of animal source foods [30,38,59], reducing the contribution of fish,

meat and eggs in the diet. Food affordability was reported to be a key potential facilitator in four studies but depended on a number of aspects. It is context-dependent; for example, Reinbott et al. [72] remarked that fish is commonly available and affordable in rural Cambodia, making it part of the daily diet. It also depends on the existence of agricultural subsidies that lower the price of food [1] or on diversification of food sources, for instance purchasing from local producers who sell at lower prices than in markets [37]. In a more dynamic market scenario, the establishment of public-private collaborations for production of nutrient-rich foods, such as formulated porridge mixes for young children using local ingredients, could offer another potential route towards more affordable food [37].

Food safety was explicitly mentioned in four studies. In the case of Afghanistan, a market food environment highly reliant on low quality food imports poses an *actual barrier* with serious health and safety risks [3]. In other contexts, aflatoxin contamination and lack of pest-free storage could also *potentially* affect food safety [37,45]. An improvement in post-production strategies to ensure the hygienic preservation and storing of food is recommended [1].

Horizontal and vertical coherence

Two interlinked analytical themes were identified in this sub-domain. Horizontal coherence deals with the multi-sectoral/multi-stakeholder collaboration and coordination. Of the 12 articles reporting on it, six identified the lack of horizontal coherence in the inner setting as an *actual barrier*. It was exemplified by a “silo approach” due to rigid administrative divisions and task allocation [1,2,4,76], duplication of efforts by agriculture and health staff due to lack of synergy [20] as well as a lack of coordination and accountability across sectors, leading to ineffective program implementation [3,4]. Most of the articles (eleven) reported *potential facilitators*, such as establishment of dedicated multi-sectoral nutrition units at lower administrative levels [4,5,46], and harmonization of key health- and nutrition-related messages disseminated by agriculture and health extension staff [1,65], made possible through development of integrated training materials. Five articles referred more generally to factors such as multi-sectoral collaboration, accountability, and links between relevant programs/stakeholders at local levels [1,3,4,34,65], which need improvement to increase ownership and coordination of NSA, prevent duplication, make efficient use of limited resources and maximise nutrition outcomes. Muehlhoff et al. [56] and Reinbott et al. [72] were the only ones to get closer to the idea of co-location of interventions by design, advocating “integrated programs/explicitly co- targeted services” and “joint programs”, as *potential facilitators*, to ensure that beneficiaries could take full advantage of multi-sectoral efforts.

Vertical coherence deals with the multi-level coordination of NSA and captured factors, such as the existence of vertical sectoral links, the alignment of local priorities with national policies, the institutional architecture and information flows, linking the inner setting with the outer setting. For synthesis purposes and to avoid duplication of results, these factors are reported in the outer setting domain to provide a full overview in relation to vertical coherence.

Outer setting domain

The outer setting represents the broad environment surrounding the implementation context in which NSA projects operate (Figure 7.5).

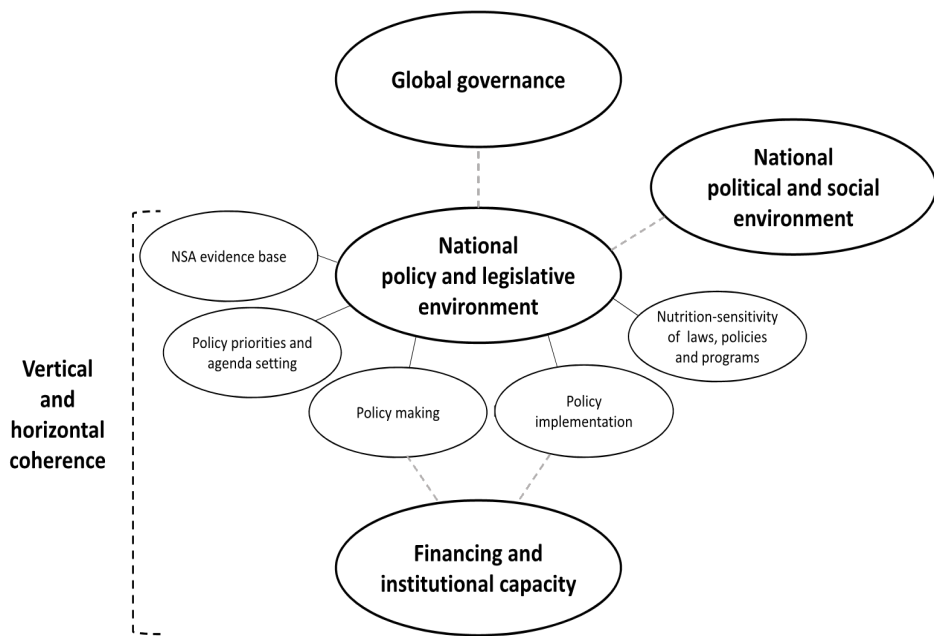


Figure 7.5. Framework for the synthesis of external factors in the outer setting domain

Of the 85 reviewed articles, 22 reported external factors pertinent to this domain (Table 7.4). The great majority of these factors were derived from the five articles focusing on the enabling environment for the NSA approach. While these articles reported on both actual and potential facilitators, the barriers were almost exclusively actual hindering factors. Articles that reported on actual barriers generally included potential facilitators to counteract the perceived constraints. Five sub- domains emerged from the thematic analysis and were used to cluster outer setting factors: global governance; national political and social environment; national policy and legislative environment; financing and institutional capacity; and

vertical and horizontal coherence. The overview of the findings for the outer setting is presented in supplementary files of the published chapter 7.

Table 7.4. Overview of the 22 studies reporting outer setting factors

Sub-domains	Analytical themes (no. of studies)	Studies reporting facilitators/barriers
Global governance	Global advocacy (9)	1, 2, 3, 4, 12, 30, 49, 52, 56
National political and social environment	Stability of the social environment (2)	3, 4
National policy and legislative environment	Political commitment (6)	1, 2, 3, 4, 76, 78
	NSA evidence base (4)	1, 2, 3, 4
	Policy priorities and agenda setting (11)	1, 2, 3, 4, 5, 9, 20, 52, 56, 75, 78
	Policy making (5)	1, 2, 3, 4, 8
	Nutrition-sensitivity of existing laws, policies and programs (6)	1, 2, 3, 4, 5, 53
	Policy implementation (7)	1, 2, 3, 4, 5, 13, 30
Financing and institutional capacity	Financial resources (12)	1, 2, 3, 4, 5, 8, 20, 30, 53, 56, 62, 65
	Institutional capacity (7)	1, 2, 3, 4, 5, 8, 20
Vertical and horizontal coherence	Multi-level coordination (3)	1, 3, 4
	Multi-sectoral/multi-stakeholder collaboration and coordination (11)	1, 2, 3, 4, 5, 8, 12, 34, 56, 65, 72

Global governance

This sub-domain comprised factors related to international/multi-national advocacy working to stimulate cooperative action in support of nutrition security, including NSA. Global advocacy was highlighted as an actual facilitator in seven of the nine studies in this group. Six articles related advocacy to the country's official signing up for the Scaling Up Nutrition (SUN) movement – a relevant global forum for actors engaging in NSA. In van den Bold et al. [4], the SUN membership was referred to as an important advocacy step towards “an increasingly nutrition-sensitive policy environment”, while Hodge et al. [1] remarked on the official commitment to address nutrition and the impetus for the formation of (country-based) multi-sectoral platforms that followed endorsement of the SUN movement. Fernandes et al. [30] referred to an outcome of advocacy efforts, namely inclusion of HGSP as key intervention under the food security pillar of the Comprehensive Africa Agriculture Development Programme. Similarly, Hodge et al. [1] observed that as a result of the prioritization of NSA by the global community, donor interest in such initiatives appeared to increase, with a cascading positive effect on policy making. Finally, two studies [12,49]

inferred that linking NSA with other hot topics on the global agenda, such as climate change and HIV/AIDS, could potentially create a positive leverage for NSA advocacy.

National political and social environment

Factors related to the political sphere and the stability of social systems at national level were clustered in two analytical themes. Regarding the social environment, two articles highlighted well-known actual constraining factors, namely corruption and lack of security in post-conflict areas [3] as well as issues of class division [4].

Regarding the political environment, four of the six articles in this group reported a favourable political environment to NSA as an actual facilitator. The supportive environment was qualified by strong political will, commitment through official endorsement [1,78], leadership and accountability [4], which as illustrated by Sako et al. [76], may lead to government buy-in. However, a number of actual barriers were also recounted. Firstly, nutrition is not perceived as a vote-winner in politics; more “tangible” programs, such as infrastructures (roads and schools) or job creation, are often prioritized because of their quick impact and budget availability within a political cycle [1,4]. Secondly, decentralization and staff turnover may reduce incentives, and in turn political will [4]. Thirdly, lack of political leadership on nutrition at government level, in particular within a Ministry of Agriculture, is a recognized challenge [1,3] and, as described by van den Bold et al. [4], may be exacerbated by a resistance to change.

National policy and legislative environment

Five analytical themes were identified in this sub-domain: NSA evidence base; policy priorities and agenda setting; policy making; nutrition-sensitivity of existing laws, policies and programs; and policy implementation.

Four studies elaborated on factors associated with NSA-related evidence of which three [1,3,4] concurred with the lack of good quality evidence on NSA policies and programs, especially about what works, and about cost-effectiveness. They described it as an actual barrier and underlined that existing evidence is scattered (mostly from pilot projects or agricultural interventions with specific nutrition outcomes), data is often of low quality (inaccurate, incomplete or outdated), not harmonized across sectors (collected independently and not integrated enough to understand the linkages among agriculture, nutrition and health), not sufficiently disaggregated to understand potentials and limitations of different contexts, and costly to obtain. Hodge et al. [1] pointed out that poor dissemination of evidence is another important actual barrier. Concerns exist regarding the capacity of ministries and other stakeholders to design

effective and appropriate policies and programs when they are not even aware of the existence of relevant findings and recommendations or, as in the case of policy makers, evidence is not available in a form that they can readily use. The bottom line is that without convincing evidence, it is difficult to get donors and policymakers' support, leading to a situation in which policies are often disconnected from reality as their formulation is not supported by evidence. The importance of research-based evidence to influence policy making, and its role as actual facilitator, is evinced from the impact of past research, such as the Lancet series, the Cost of Hunger studies and the IFPRI reports [1]. Furthermore, to strengthen research and the evidence base, timely and integrated food and nutrition monitoring systems with interlinked nutrition/health and agriculture/food security indicators should be in place [1]. Policy makers are particularly interested in evidence about cost-effectiveness of interventions, what works at scale (pilot projects that can be replicated), real-life stories and case studies, and successful policies and programs, also from other countries [4]. Consensus on appropriate metrics and indicators and who should be accountable for them has yet to be reached [1].

Eleven studies reported factors related to policy priorities and agenda setting. Five of the 11 articles in this group remarked on the lack of emphasis on NSA-relevant priorities. This actual barrier was related to the agricultural sector's limited understanding of the multiple dimensions of nutrition and its conventional focus on the food supply side [2]. Similarly, public health policies are largely oriented to disease prevention and cure, but not linked to longer-term food-based strategies [3]. Furthermore, as highlighted by van den Bold et al. [4] nutrition appeared to gain attention only when there was political pressure or when incentives were provided. Among the five studies that presented an increased emphasis on nutrition and NSA-relevant priorities as a potential facilitator, Muehlhoff et al. [56] explained it by a perceived need to align agriculture with dietary requirements, while Lachat et al. [2] referred to the potential and need of agriculture to address both undernutrition and overnutrition. Other actual barriers to policy priorities and agenda setting were: i) a dominant policy focus on increased production of staple crops and market-oriented commodities, which contrary to expectations may have undermined the food and nutrition security of local communities [1,4,75] and the sustainability of food systems [5]; and ii) a current policy focus on nutrition-specific interventions based on the widespread perception of nutrition as a health issue often in association with emergency situations [1,3]. The issue of an externally driven agenda reliant on the financial support of international donors and powerful (private sector) lobbies was also pointed out as an actual barrier [1,3,4]. This was a sensitive point, as donor influence does not necessarily have a negative connotation and as remarked in the same studies, other actors, such as NGOs, researchers and civil society, can also influence policy decision-making. Finally, van den Bold et al. [4]

emphasized the importance of milestone events, for example the 2011 New Delhi conference “Leveraging Agriculture for improving Nutrition and Health”, as actual facilitators and catalysts for agenda setting, gaining attention for the importance and urgency of sustainable food-based approaches such as NSA.

Five studies reported factors related to the policy making process. An actual barrier was identified by Poole et al. [3] in relation to what is known as “parallel governance”, which occurs when policy is being developed in silos by different sectors or, as in the case of Afghanistan, by not only the government but also non-governmental actors (development agencies and international NGOs) without mutual involvement. Linking back to the NSA evidence base theme, three studies indicated that policies are often formulated or revised without being informed by evidence. Van den Bold et al. [4] explained the main reasons underpinning this actual barrier, namely: lack of incentives due to poor accountability, the fact that policy makers often lack capacity and have no time to wait for and to scrutinize evidence, and the experience that academic publications may not be a suitable vehicle to provide evidence to policy makers. Hodge et al. [1] mentioned the interests of individuals or powerful lobbies prevailing over evidence as an additional reason. Potential facilitators were envisaged in the increased use of evidence to inform policy [1], a less centralized consultation process for policy formulation [3], the enhanced capacity of policy makers to use evidence [2], and the need for continuous engagement with policy makers, employing more effective communication tools [4]. Apart from not being informed by evidence, policies seemed also to neglect the heterogeneity of social, economic, political and agro-ecological conditions in a country [1,3,4,8], which was perceived as an actual barrier. Poole et al. [3] pointed out that in some cases, the lack of policy contextualization was due to policies being adopted or adapted from other countries. A more context-sensitive approach in policy formulation would be potentially beneficial for NSA [1,3]. Finally, the lack of policy continuity due to staff turn-over at government or donor agency level was also mentioned as an actual barrier in the policy making process [3,4]. Frequent staff rotation perpetuates a culture of short-termism which is not compatible with the long-term vision required for food-based approaches.

Factors related to the nutrition-sensitivity of existing national laws, policies and programs were identified in six articles. Among the four studies that referred to the nutrition-sensitivity of relevant laws, Hodge et al. [1] clearly described the lack of a supportive legal framework for NSA as an actual barrier. This is quite a crucial point because, as reported by Zamora et al. [5], an enabling legislative environment proved to be an actual facilitator which contributed to the success of NSA projects by providing legitimacy and access to funds. Four studies in this group referred to the nutrition-sensitivity of existing policies as an actual facilitator for NSA. However, as remarked by van den Bold et al. [4], the development of multi-

sectoral nutrition- sensitive policies is a relatively recent undertaking. The lack of integrated agriculture and nutrition policies at most levels of governance remains a recognized actual barrier [3]. Although some authors reported finding more policy documents containing nutrition objectives [2], others reflected that nutrition is often implied but seldom explicitly mentioned in agricultural policies [1]. Another aspect concerned the nutrition-sensitivity of existing national agricultural programs, with two studies reporting actual reasons for limited nutrition-sensitivity. Firstly, among the agriculture-to-nutrition pathways, most emphasis still lies on increasing food production (especially quantity) and income from agricultural sales and employment and on lowering food prices, neglecting other dimensions of nutrition-sensitivity, especially those related to women's empowerment [3]. Secondly, incorporating nutrition objectives and indicators in agricultural programs can be challenging, which inhibits their use as delivery platforms for nutrition- related interventions [2]. This last challenge could be more easily overcome in agricultural programs focused on food processing and safety that are run in collaboration with food scientists [2], or in the context of smaller agricultural projects implemented by NGOs [3]. A potential barrier was also envisaged concerning the fact that integration of nutrition in agricultural programs may be on paper to meet governments or multi-national authorities' requirements but is not seen in practice [1].

Issues related to policy implementation were highlighted by seven studies. Even though the commitment to nutrition has progressively been translated into policies, all seven remarked on the gap between policy making and implementation as an actual barrier. The most common problem concerned "how to operationalize", as evinced by the lack of strategies and guidelines for implementation, often leading to blanket approaches with ineffective targeting [1,2,13]. A lack of incentives was another reason given [1]. As described by Lachat et al. [2], the translation of policy commitments into action, potentially, would require "a coherent policy environment across the food system that aligns recommendations for each level with local action on the ground". This would also entail: more inclusive consultative processes, not just at the implementation stage (when policies have already been formulated) but also in the policy making process [3], as well as incentives for those tasked to operationalize the integrated, multi-sectoral policies [1,5], and purposive targeting [2,5]. According to Hodge et al. [1] and van den Bold et al. [4], to reduce the gap between policy making and implementation, it would also be necessary to enhance the nutrition sensitivity of agricultural programs by promoting nutrition-sensitive value chains and biofortified crops, but most of all, a diversification of agricultural production which emphasizes nutrient-rich crops over cash-crops. These actions, among others, would contribute to a transformation of the agri- food systems that should, to be inclusive of the most vulnerable groups, provide affordable (or free of charge) inputs and technologies [5]. Finally, from the point of view of policy implementation, the fact that the

number of NSA programs implemented is increasing [1,4], combined with the expectation that a shift from short-term interventions to longer-term food-based programs is needed [3], holds promise for the future of NSA.

Financing and institutional capacity

Another group of articles relates to the financing of NSA and the capacity of institutions, especially of human resources, in the outer setting. Concerning the financial resources, seven of the 12 studies in this group reported underfunding or poor management of financial resources as actual barriers. Uncertainties on the availability of funds, due to system variables such as funding cycles and currency fluctuations, have a direct impact on NSA projects [8] as exemplified by delayed government payments halting or slowing down implementation of field-level activities [53,56]. Five studies referred to the mobilization of financial resources in support of NSA-related activities as an actual facilitator. It should be noted that the increase in NSA-dedicated funds is a relatively recent development [2,4,5]. However, as a potential facilitator, improvement is needed in resource management, in terms of timeliness, adequacy and prioritization [4,62].

Limited institutional capacity is a common constraint. Six of the seven studies in this group reported the lack of capacity at multiple levels (from field to system) and across stakeholders (policy makers, researchers, NGOs, extension workers, among others) as an actual barrier. The largest gap was in terms of human resource capacity, mostly exemplified by the limited manpower and the lack of qualified personnel [1,2,4,20]. In the context of Afghanistan, Poole et al. [3] indicated that lack of security, physical remoteness, high prevalence of illiteracy and generally inadequate salaries further exacerbated the institutional capacity gap. Five studies highlighted actual barriers related to the limited understanding/knowledge of the agriculture-nutrition linkages at different levels and across sectors. The barrier was particularly frequently noted in the agriculture sector [1,2,4]. A relevant concern expressed by Poole et al. [3] was the use of food security and nutrition terminology to secure funds, but without real insight on these concepts. Potential facilitators were envisaged in the strengthening of technical, operational, and strategic capacity [1,4]. Furthermore, three studies advocated development of a shared understanding of the multi- sectorality of nutrition [1,2,4] with emphasis on evidence-based awareness [4]. The availability of NSA-relevant trainings across countries, as in the case of North-South and South-South exchange programs, and at different levels (PhD, Master or lower) was reported as a promising actual facilitator [1,2,4]. For example, Lachat et al. [2] referred to the two-year MSc programme in nutrition offered by a University in Dakar to students with a variety of backgrounds including agronomy

and veterinary sciences. Along with review of official academic curricula in agriculture, Hodge et al. [1] stressed the importance of including nutrition in more informal training, such as that offered to agricultural extension workers and in Farmer Field Schools. Strengthening of capacity is potentially needed not only on agriculture and nutrition but also on WASH, healthcare, gender roles, and child feeding [4]. Actual barriers in relation to training materials, such as production costs, translation into local languages, access and dissemination, will also need to be addressed [1,4,20].

Vertical and horizontal coherence

Similarly, to what was described above for the inner setting, also in the outer setting a number of factors are related to multi-level coordination as well as multi- sectoral/multi-stakeholder collaboration and coordination. Three studies provided insights on multi-level coordination. Hodge et al. [1] remarked on the existence of weak vertical links (national to local) regarding the coordination of nutrition, especially within the Ministry of Agriculture, as an actual barrier. The other two studies discussing issues of limited vertical coherence also reported actual barriers in relation to decentralization of authority and responsibility for agriculture and nutrition to lower administrative levels. The constraints were related either to delayed implementation [1], limited expertise at local level [3] or difficulty in accessing relevant resources in local languages [4]. Vertical coherence becomes even more challenging when, as in the case of Afghanistan, implementation is delegated to international NGOs and consultancy firms, which operate in line with central government directives but are usually not locally accountable [3]. More generally, lack of accountability due to ineffective monitoring and evaluation (M&E) frameworks was reported as a critical actual barrier [1,3,4]. According to Hodge et al. [1], a potential facilitator for the improvement of NSA vertical coordination could be the alignment of local priorities with national policies and plans. However, improvements in vertical coordination are affected by the complexity of the institutional architecture (formal and informal). Identification of key nodes/authorities in the institutional structure, such as provincial governors' offices, as well as improved information flows and knowledge management moving towards e-governance could be powerful potential facilitators [3].

Eleven studies reported factors related to multi-sectoral/multi- stakeholder collaboration and coordination at the level of the outer setting. Three articles highlighted actual barriers in relation to the ownership of the NSA agenda. Hodge et al. [1] and van den Bold et al. [4] remarked that, in the common perception, nutrition is the mandate of the health sector, while production is the mandate of the agriculture sector. This consolidated perception perpetuates a 'silo approach'. Collaboration between sectors becomes even more challenging when, as in the case of Kenya, the implementation of a Food and

Nutrition Security Plan “falls under two ministries with distinct mandates” undertaking independent initiatives and competing for limited resources [1]. Giving agriculture a more explicit role in nutrition action plans [1] and facilitating a results-oriented dialogue between the agriculture and health sectors [2] are envisaged as potential facilitators towards a shared vision for NSA. Furthermore, in relation to multi-sectoral/multi-stakeholder collaboration, six studies described the existence of dedicated nutrition units in NSA-relevant ministries and/or cross-sectoral coordinating bodies on nutrition (or a lack thereof) as important influencing factors. According to Hodge et al. [1], the SUN membership was a catalyst for the formation of (national) multi-sectoral platforms. While the presence of a nutrition unit within the Ministry of Health is to be expected, the creation of such a unit within the Ministry of Agriculture [1] as well as the establishment of cross-sectoral coordinating bodies on nutrition [2,3,5] are relatively recent developments, perceived as actual facilitators. In particular, the enabling environment for NSA is strengthened when the functions and multi-sectoral composition of the national coordinating authorities, such as National Nutrition Councils, are replicated at the lower administrative levels [5]. Even though there are signs of improvements, ineffective collaboration remains a problem, especially with regard to NSA-relevant sectors beyond agriculture and health, such as education. As pointed out by Hodge et al. [1], the underpinning actual barrier is the lack of a common language among sectors, which in turn hinders the type of information sharing needed to address persistent malnutrition problems [8]. To promote convergence and take the NSA agenda forward, a concerted effort should be made to improve collaboration not only among sectors [4,56,72], but also among relevant programs [4,65] as well as stakeholders such as governments, academia, international organizations, NGOs, private sector, and civil society [1,3,5]. Improving that collaboration was perceived as a potential facilitator. For example, in the context of a conflict-ridden country such as Afghanistan, a Government-NGO partnership was perceived as a viable alternative to compensate for the limited capacity of the public sector to implement projects and deliver public services [3]. Finally, eight of the eleven studies in this group reported factors related more specifically to multi-sectoral/multi-stakeholder coordination. Three studies remarked that ineffective coordination and a lack of M&E and accountability across sectors are actual barriers to integrated nutrition actions [1,3,4]. The pervasive nature of these barriers is confirmed by those articles advocating strengthening the cross-sectoral coordinating mechanisms [1,2,4] and linked M&E systems [1,2,3] as potential facilitators to maximise the impact of NSA interventions. Improved communication as well as harmonization of nutrition-related messages across sectors was thought to have an important potential role [1,3,65] in enhancing horizontal coordination of NSA.

7.5 Discussion

This systematic review contributes to fill in the gap on what works, doesn't work and might work in relation to the implementation and scale-up of NSA in LMICs with a rich body of evidence mostly derived from the large number of studies published on the topic in recent years (2015–2019). To our knowledge, this is the first study that takes a holistic system approach, in line with the lessons that emerged from the LANSa research (Gillespie et al., 2019a), to identify and analyse intervention, contextual and external factors influencing NSA. Our findings across the three domains can help decision-makers at multiple levels to strengthen future NSA programs/projects and anticipate possible pitfalls to maximise NSA's potential to reduce undernutrition in LMICs.

From our findings, it became clear that, very frequently, studies report influencing factors as "potential". While actual factors carry a heavier weight as they are drawn directly from experience (based on empirical evidence and lessons learnt), the value of potential factors should not be underestimated. In our study, many factors, though formulated as "potential", were derived from the project experience of what did and did not work and were presented as post-implementation recommendations for future interventions, proposing how to make them work better. Based on our experience, potential factors could enrich the NSA knowledge base and should be considered in the development of future projects.

In our review, the findings at domain level, to a certain extent, confirm results of previous reviews and more recent literature on NSA and multi-sector nutrition programming. Specific examples of the identified barriers and facilitators shaping the NSA enabling environment (Aryeetey and Covic, 2020; Coile et al., 2021; Gaihre et al., 2019; Gillespie et al., 2015a, 2015b, 2017, 2019b; Wesley et al., 2019) and the inner setting (Broaddus-Shea et al., 2020; Fiorella et al., 2016; Gaihre et al., 2019; Gillespie et al., 2015a, 2017; Ruel et al., 2018; Wesley et al., 2019) were similar to those already described. Individual success and failure factors in the NSA interventions have also been reported (Fiorella et al., 2016; Ruel et al., 2018). However, several interesting and valuable learnings emerged from the overarching insights at the interface among the three domains: NSA interventions, inner and outer settings. We focus our discussion on these overarching reflection points which transcend specific types of NSA interventions.

7.5.1 Interface inner setting and NSA interventions domains

It became noticeable that the demarcation between the domains 'NSA interventions' and 'inner setting' can be very subtle, because factors of the inner setting can become part of the interventions domain, if

they are ‘internalized’ by intentional integration in the strategy and design of a project. This possibility explains the potential overlap of certain factors between the two domains.

NSA is not a silver bullet

Despite many advocating NSA as a solution to the food insecurity and nutrition problems of poor and vulnerable communities, the empirical evidence supporting our findings confirms that poverty remains a key obstacle to equality and eligibility for inclusion in NSA projects. Similar to what is observed in most development projects, the resource-poor, even when explicitly targeted, cannot fully benefit and often drop out as a result of the additional strain NSA projects put on their already limited resources (Nichols, 2020; Okello et al., 2021). There is some evidence, however, that even when NSA-related agricultural activities take up more of women’s time, it may not have detrimental effects on maternal or children nutrition and health outcomes, as shown in an Enhanced Homestead Food Production programme in Burkina Faso (van den Bold et al., 2021). A situation analysis describing the main malnutrition-related problems and the groups most affected is a crucial first step to identify the key priorities in different contexts (Coile et al., 2021). The recommendation is to take a systems approach in conducting such a nutrition situation analysis to ascertain barriers and opportunities across different sectors, actors and levels (Bose et al., 2019). Furthermore, for NSA projects to be effective, integration or co-location with other interventions aimed at improving livelihood/income opportunities of the very poor and/or ensuring social protection should be envisaged (Gillespie et al., 2019a). As tested by Alam et al. (2020) adding unconditional cash transfers to the mix of agriculture-nutrition interventions could also amplify the benefit for rural women.

NSA is not a blanket solution

It is common for international agencies and Governments to promote solutions that can be widely and readily applied to meet their targets. However, we found that the impact of NSA interventions depends on the recognition of the favourable or unfavourable mix of local conditions, as also indicated in previous research (Fiorella et al., 2016; Gillespie et al., 2019a; Ruel et al., 2018). Therefore, a homogeneous approach using pre-defined intervention packages may not be the best (Ezezika et al., 2021), even within the same country (Broaddus-Shea et al., 2020; Busse et al., 2017). Appropriateness is crucial and is a matter of context but also timing. Our findings showed that the most effective way to achieve acceptability is by ensuring that intervention design fits with existing conditions. However, when the planned intervention aims to introduce ideas that are new to the local context, it is necessary to invest in design choices that foster the acceptability of the new ideas.

Building on previous experience

Although the context is specific for each project, our findings demonstrate the relevance of the lessons learnt and recommendations from past experience in other projects, which can provide useful guidance. The importance of experiential learning, documentation, and access to lessons from different contexts to enhance evidence-based implementation of multi-sectoral nutrition actions and impact on the ground was highlighted in previous studies (Gillespie et al., 2017, 2021). For example, Gillespie et al. (2015a) acknowledge the importance of monitoring and evaluation in generating evidence and stimulating learning about the scaling-up process beyond context-specific experiences. Our results show that on many aspects critical for the success of NSA projects, ranging from local culture and acceptability to seasonality and access to resources, there is already sufficient evidence to avoid “reinventing the wheel” and on how to avert predictable risks and pitfalls. Project implementers are frustrated when targeted beneficiaries diverge from the original project design, but there is always a reason, valid for those involved, which is often related to a misalignment between the project plan and people’s actual needs, preferences, and capacities.

Predictable and unpredictable risks

In the implementation of a complex project, such as NSA interventions, there are risks that it will not be implemented as planned and that it might not succeed in reaching its objectives. The risks we identified included a lack of resources (human, financial) and infrastructure, or a mismatch between intervention activities and the local needs. We also found that risks may result from unexpected changes in the local situation, for example, because of weather events or political changes. When planning a project, the potential risks should be considered carefully. For those factors that cannot be avoided or planned for, solutions can be found by increasing flexibility in the design of projects as well as building capacity and resilience at local level. However, risk analysis and mitigation often receive inadequate attention not only at project level but also at national level in the framework of the multi-sectoral nutrition plans (Coile et al., 2021). The importance of this aspect has become particularly evident since the COVID-19 pandemic further exacerbated the pool of existing risks (SUN Movement, 2020).

In-built flexibility

Although the most effective way to achieve adoption and sustainability of the NSA interventions is by making choices that fit with existing conditions, this requires a thorough and often long-term knowledge of the context. Our findings highlighted that when such knowledge is lacking, it is even more important to ensure flexibility in the design of the project to allow sufficient margins for changes in the planned

interventions, especially in case obstacles arise (Nielsen et al., 2018). The use of a theory of change in combination with sound and timely monitoring and evaluation as part of an iterative learning process can provide a solution (Olney et al., 2013; Ruel-Bergeron et al., 2019). However, the demands of rigorous research to enhance the evidence base could be in conflict with such a flexible project implementation and slow down the process with negative consequences on the overall impacts; finding the right balance is the key.

Tension as a result of interventions

Even well-intended and well-designed projects/interventions can cause friction. Interventions aim to change things with the goal of improving (elements of) the dominant system, in the case of NSA interventions, the food system. They are often motivated by a perceived need or vision for positive change (Gillespie et al., 2015a). NSA interventions often involve changes that affect the existing culture, structure and practice which may raise the level of tension to a point that undermines (rather than maximizes) the overall impact of the intervention. As shown in our results, the level of tension is affected by the degree of community engagement at different stages. It is important to strike a balance on the acceptable level of tension, enough to stimulate sustainable and replicable positive changes. For that to happen, intermediate (often sub-optimal) solutions may be a safer path in the transition. Similarly, a balance must be struck between the fit-for-purpose of an intervention (appropriateness to achieve the intended objectives) and its fit-to-context (appropriateness to the context in which it is implemented), to set realistic expectations on the acceptable margins of change.

Building on existing structures

Integration of interventions into existing (formal and informal) local structures/institutions, such as community groups and extension services, can be a powerful strategy to minimize the friction and increase acceptability while also enhancing long-term sustainability. As shown in our findings, recognizing the value of existing structures and strengthening of their capacity are crucial aspects of this strategy. However, as pointed out by Muehlhoff et al. (2017), strengthening of local capacity through projects, while desirable, may not be sustainable if there is no system in place in the inner setting to maintain and make use of it.

Short-term versus long-term

Our findings underline the recurrent tension between expectations and results in the short and the long term - a trade-off recognized also in relation to scaling-up impact on nutrition (Gillespie et al., 2015a). The tension between short and the long term is largely influenced by the limited resources of donor-funded

programs and prospects of their impacts, sustainability, and potential scalability. Factors most reported as resulting in a lack of success were short project duration and inadequate financing. Interventions aimed at reducing undernutrition by changing behaviours, empowering communities, and strengthening local structures need a longer timeline than conventional funding cycles (Wesley et al., 2019). Furthermore, for long-term sustainability and scalability, it is crucial not only that an intervention works well, but it should also be cost-effective compared to other alternatives, considering relative costs and health/nutrition outcomes. This is particularly important in LMICs, where resources and funds are usually limited. Finally, success depends on the alignment of the NSA program nutrition objectives with the approach applied, including targeting (areas/groups with higher potential for impact) and the length of time needed to achieve these objectives (Ruel, 2019). However, as noted by Gillespie et al. (2015a) reasons for success derived from small-scale implementation may not apply when interventions are scaled-up due to increased complexity, different contexts, or intervention characteristics.

Additional tensions arise when projects provide free inputs and financial incentives for participation in project activities in the interest of achieving results in the short project timespan. Examples from our findings of problems created by these common practices are: resistance to a bartering system caused by the expectation of free distribution of food by NGOs; the distribution of free OFSP vines discouraging investments in vine conservation; or the decline in chicken vaccination once the project stopped providing the subsidized service. In contrast, investing in local capacity and making use of locally available resources increase self-reliance and are more likely to lead to long-term success.

When projects support the establishment of local enterprises/ community-based structures as a reliable, affordable source of inputs, such as village nurseries, reliance on external sources was reduced and sustainability enhanced. While projects should strive to achieve both short- and long-term results, the choices are complex and a challenge for project design.

Transition strategy

The idea of a clear “entry and exit strategy” may be sound in the framework of conventional short-term projects (5 years at the most) as described by Haselow et al. (2016). However, from our review it appears that the shift towards long-term, multi-sector food-based system approaches such as NSA may call for a different type of strategy, namely a “transition strategy”. This strategy involves progressively expanding on the scope of interventions and targeted population, and introducing new elements as initial objectives are met and new needs are identified. In this evolving scenario, the need to combine process evaluation studies with rigorous impact evaluations become even more urgent to understand why and how impact

has (not) been achieved (Olney et al., 2013; Ruel-Bergeron et al., 2019). The type and timing of transition strategy will depend on the readiness and capacity of the local structures (Aryeetey and Covic, 2020).

7.5.2 Interplay among domains: NSA interventions, inner and outer settings

The interplay is largely influenced by the flow of information among these levels. Policies based on priorities at national and international level provide context for inner setting decisions. These decisions, including allocation of resources, affect each aspect of implementation. Ideally, evidence from the results of interventions will, in turn, inform local up to national policies.

Complexity of multi-sector, -level, -actor interplay

Horizontal and vertical coherence

Despite the well-known difficulties associated with inter-sectoral collaboration and coordination and many efforts to address them, our review shows that the problem persists, and few effective solutions have been documented. The “silo approach” with rigid administrative divisions, duplication of efforts and a lack of coordination and accountability across sectors is still predominant and leads to ineffective program implementation (Gillespie et al., 2015b). Dedicated nutrition units in NSA-relevant ministries and cross-sectoral coordinating bodies on nutrition were described as important factors whose value has not yet been proven, although encouraging examples have been reported (Bach et al., 2020). The ownership of the NSA agenda, giving agriculture a more explicit role in nutrition action plans, and facilitating a results-oriented dialogue among sectors could encourage a shared vision for NSA. However, the lack of a common language among sectors restricts the types of information sharing, while the lack of M&E and accountability across sectors is a barrier to integrated nutrition actions (Gillespie et al., 2015b). The enabling environment for NSA might be strengthened when the functions and multi-sectoral composition of the national coordinating authorities are replicated at the lower administrative levels. Decentralization of authority and responsibility for agriculture and nutrition to lower administrative levels can limit vertical coherence, especially when there is a dis-alignment of local priorities with national policies and lack of capacity in mid-level institutions (Kennedy et al., 2020). Identification of key nodes in the institutional structure and improved information flows could contribute to improvements. Based on the SUN experience, Civil Society Organizations could play an important role, especially due to their strong links with local contexts (Busse et al., 2020).

Integration vs co-location

Integration of multiple interventions may come at a high price, and low effectiveness, especially when a deeply rooted barrier such as poverty has to be addressed as part of an already complex NSA project design. Not only is complexity difficult to manage, but also, projects based on donors' conventional requirements can seldom afford the time, human capacity, and budget necessary for such endeavours. Ruel et al. (2018) described the challenges of implementing, monitoring and scaling-up these complex multi-sectoral programs. The cost-effective implementation as well as the sustainability and scale-up of NSA projects will require rethinking of NSA programming at all levels and devising meaningful forms of co-location by design, based on long-term partnerships rather than one-off collaborations. In our review, the cases of co-location by design were very few, highlighting the fact that while co-location of interventions may occur spontaneously and opportunistically once the implementation of different projects is in the hands of the same local partners, co-location is more rarely envisaged as part of the original project design. The potential suitability of co-location in different contexts could be further investigated (Ruel, 2019).

Top-down impact of outer setting policies

Decisions made at international and national level on NSA programming strongly influence the design and implementation of interventions at local level. Translation of policy commitments into action would require that policies affecting food systems and nutrition align their recommendations for each level with local action on the ground (Ayana et al., 2017; Ezezika et al., 2021; Warren and Frongillo, 2017). One example concerns the development of markets both as a source of nutritious foods and as a place to sell agricultural products to increase income. Market-related approaches can be important for the long-term sustainability of interventions, especially in urban contexts. Doubts exist about market potential in rural areas, where limited access to market affects not only the supply side but also the demand side. Although NSA is potentially suitable in remote contexts lacking markets (Murendo et al., 2018), market development should only be a part of an NSA intervention package if household food and nutrition can be secured either through production or income (Ruel et al., 2018). There is a risk that an increased emphasis on markets may shift farmers' production priority to cash crops especially when outer setting policies stimulate limited agricultural diversification and commercialization, while subsidizing certain products and not others (Fiorella et al., 2016). For this reason, NSA needs to focus on strengthening local markets for nutrient-rich foods rather than increasing agricultural productivity (Gillespie et al., 2018). Furthermore, even in favourable conditions, it may prove difficult to establish a local market system and

related infrastructure within the project lifetime especially if not supported by official local development policies.

From policy to practice

Enabling environment

Our findings confirm the importance of an enabling environment for the implementation and scaling-up of NSA. Global advocacy on nutrition can be a driver in gaining momentum for both political and financial commitment (Gillespie et al., 2019b). However, concrete actions are needed to move beyond rhetorical commitment of actors in nutrition networks (Baker et al., 2018, 2019; Gillespie et al., 2019b). Participation in an international movement such as SUN strengthened both policy priorities and operationalization of nutrition interventions regardless of the country's economic status (Fracassi et al., 2019). It has also been noted that international nutrition-sensitive aid reduced child stunting, especially in countries with high burdens of malnutrition (Khalid et al., 2019). A more context-sensitive approach in policy formulation would be potentially beneficial for the implementation and scaling of approaches, such as NSA, addressing malnutrition in all its forms (Gillespie et al., 2021). Building an enabling environment requires robust and timely information about the conditions and challenges in a given setting. However, little is known about the financial investments required to shape such an enabling environment (Gillespie et al., 2015a).

Working with evidence

Research-based evidence is recommended to guide policy making and programming. The limitations to evidence-based policy development are well known and were recurrent barriers in the reviewed articles. Policies are often formulated or revised without being informed by evidence (Gillespie et al., 2015b). The evidence that policy makers want – cost-effectiveness of interventions, what works at scale, case studies, and successful policies and programs, also from other countries – is often limited (Gillespie et al., 2015b). There are, however, promising developments. Olney et al. (2019) described a process in which research could provide better evidence to support nutrition-sensitive programming that requires stronger partnerships between implementation and research. Systematic data collection on the success of OFSP interventions in Sub-Saharan Africa contributed to the recognition of biofortification as a policy priority and generated investments for scaling (Low and Thiele, 2020). Application of the Strengthening Economic Evaluation for Multisectoral Strategies for Nutrition to an NSA intervention in Malawi revealed that the benefits of the program were high compared to the investment, and that the question of cost-benefit is not simple to address (Margolies et al., 2021). Webb et al. (2021) used data from three countries to model cost-effectiveness of food-based programs to reduce malnutrition, demonstrating an alternative

approach to better inform policy choices where empirical evidence is limited. The need for more rigorous evidence bases to inform NSA-related policies and programming is evinced by the recent publication of a number of design protocols (Haghighparast-Bidgoli et al., 2019; Wendt et al., 2019) also emphasizing the need for a transdisciplinary approach (Estrada-Carmona et al., 2019; Gaihare et al., 2019). A recent cluster-randomized trial of a nutrition-sensitive agro-ecological intervention aimed at improving child dietary diversity in Tanzania emphasized the wide range of indicators needed to assess such complex interventions, particularly those related to the intermediate outcomes (Frongillo and Leroy, 2021; Santoso et al., 2021). However, attempting to satisfy the demand for evidence from different sectors and actors with different cultures of evidence may detract resources from the actual implementation and increase the burden on program and evaluation staff.

As NSA programs expand in scope it would become essential to integrate the monitoring and research systems (Ruel-Bergeron et al., 2019). While research during implementation contributes to program management, adherence to strict research protocols can limit the flexibility needed for effective implementation.

7.5.3 Strengths and limitations

One major strength of this paper is that it covers a large number of publications. The breadth of the aspects covered is also quite extensive, in terms of projects, study designs and types of intervention. The scientific rigour was increased by triangulation at different points in the process, from study selection to analysis. There are however limitations. One is that the choice was made to select only peer-reviewed publications, which means that information presented in the grey literature, which might have contributed additional points of view, are excluded. However, we expect that many of the results reported in the grey literature, especially the most rigorous and most important, have also been detected in the publications included in this review. Another point is that the search for articles ended in November 2019; however, we have used literature published since then to inform the discussion section. No new themes emerged from the more recent literature (35 articles) and had these papers been included in the review, there would have been changes in the number of examples, but not in the types of factors. Although the syntax used may look complex, it did allow us to uncover a number of insightful articles which have not been included in previous reviews, adding to the evidence available on this topic. The choice of framework is another potential limitation for the different determinants that we identified and grouped. While frameworks such as the CFIR are not flawless, they are useful to support conceptualization of barriers and

facilitators. The assignment of domains was necessarily somewhat subjective, as there is some overlap among sub-domains and themes, but discussion and agreement among the different authors helped to reduce this as a weakness. We assessed the methodological quality of included papers, but the available instruments did not always fit well with the articles. That made it difficult to interpret the importance of the findings. However, these assessments focus on the methods used to identify the findings, and a lower score does not necessarily mean that the study and results are not meaningful and useful. Most of the reported studies had a moderate or high risk of bias, which would undoubtedly be influenced by the fact that agriculture/nutrition interventions are implemented in communities, where randomized controlled studies and blinding are seldom possible.

7.6 Conclusions

This systematic review has identified what worked, did not work, and might work in relation to the implementation and scale-up of NSA in LMICs, revealing the need for a holistic approach. Reviewing these factors entails accounting for both sides of the same coin; the same factor (s) that led to success in one case, when not addressed appropriately, led to failure in another case. To design a program with a better probability of success, attention should be paid to: 1) learning from past successes and failures; 2) appropriateness and acceptability based on context knowledge; 3) project flexibility in addressing design limitations and coping with unforeseen hindrances; 4) strengthening local structures, community empowerment and increasing resilience; 5) supportive policy and governance. Certain areas require further research, most notably cost-effectiveness, co-location of interventions, and horizontal and vertical coherence. Our findings across the three domains can help decision-makers at multiple levels to strengthen future NSA programs/projects and anticipate possible pitfalls to maximise NSA's potential to reduce undernutrition in LMICs.

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CHAPTER 8. WHAT INFLUENCES THE IMPLEMENTATION AND SUSTAINABILITY OF NUTRITION-SENSITIVE AGRICULTURE INTERVENTIONS? A CASE STUDY FROM SOUTHERN BANGLADESH



A water canal in a study location in Southern Bangladesh

Published as

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Abstract

Nutrition-sensitive agriculture (NSA) provides a promising pathway for addressing malnutrition. Fulfilling this promise needs a better understanding of the implementation and sustainability of NSA interventions because of their overly complex nature. This study aimed to explore the factors affecting the implementation and sustainability of NSA interventions. A case study design was employed using two focus group discussions with beneficiaries ($n = 15$), semi-structured interviews with beneficiaries ($n = 13$), and actors involved in implementation ($n = 18$). Factors were analysed thematically using both deductive and inductive approaches adapting the consolidated framework for implementation research. A complex interaction of the factors across the five domains was found: outer setting—nutrition sensitivity of policies, institutional framework; inner setting—culture, social and economic environment, biophysical environment, local capacity, other programs or projects; characteristics of actors—beneficiaries, family members, household capacity, implementers; intervention characteristics—adaptability, design quality, cost of interventions; and, implementation process—fit-to-context, integration and multisectoral collaboration, continuous motivation through engagement, monitoring. Implementing and sustaining NSA needs consideration of multiple factors, with careful analysis of the absorptive capacities of local institutions and beneficiary households. Future studies should explore which mechanisms created for adoption can be continued beyond the project funding cycle, and how.

8.1 Introduction

There is a growing awareness that malnutrition is one of the main challenges to global health and development [1]. Malnutrition affects health and results in a loss of productivity and reduced educational attainment, eventually slowing overall national development [2,3]. The agricultural sector plays a key role in addressing malnutrition, through increased production and access to nutrient-rich diets. This sector, however, needs to become more nutrition-sensitive to maximize its contribution by going beyond the conventional approach of food production. This can be achieved through nutrition-sensitive agriculture (NSA) which incorporates nutrition objectives and actions in agricultural interventions [4,5]. The NSA interventions have the potential to address multiple determinants at multiple levels [6]. NSA is considered a promising approach to address inadequate diet and malnutrition in low and lower-middle-income countries.

Past studies have highlighted the need to consider relevant contextual factors during the design and implementation of interventions [6,7]. Investigating such contextual factors is crucial because of the overly complicated nature of NSA, as it integrates multiple interrelated and complex components at various levels. Furthermore, the traditional food system where NSA interventions are implemented may feature a complex combination of several factors that influence food production, consumption and resulting health and nutritional status [8]. Understanding such complexity helps gain practical insights and maps potential factors for their appropriate and timely address. Some of these factors can be the adaptability of the intervention, knowledge, and perception of individuals; the process of planning, execution, engagement, and monitoring; the setting where implementation occurs; and the external context [9]. The factors that affect the implementation of NSA interventions are, however, inadequately researched. The studies that go one step beyond the implementation and explore the influence on sustainability are even scarcer, as they focus on a specific funding cycle of the interventions. This article, therefore, focuses on the factors that influence the implementation and sustainability of NSA interventions.

Bangladesh, the setting of this study, has been a fertile ground for NSA [3,10–16]. Bangladesh is one of the few countries that made laudable progress in economic development by significantly dropping poverty levels [17]. Despite this development, malnutrition remains a significant problem [17]. As reported by the Bangladesh Demographic Health Survey 2017–2018, the proportion of stunting, underweight and wasting among children less than five years of age is 31%, 22% and 8%, respectively

[18]. Furthermore, micronutrient deficiencies are highly prevalent in Bangladesh. For instance, 40% of women of reproductive age are anaemic [19] and a high proportion of pre-school aged children are deficient in vitamin A, zinc, vitamin D, iron, and suffer from anaemia [20]. Inadequate food production diversity seems to be a barrier to addressing malnutrition in Bangladesh. The food system in Bangladesh has traditionally focused on rice as the main staple crop [3,21] with some production of other crops such as pulses, vegetables, fruit and oil seeds [21] or non-crop products such as fish (aquaculture), and livestock [3]. Home gardens are also important sources of food consumption and income in rural Bangladesh [22]. Although the country has experienced increased production of nutrient-rich foods, such as meat, milk, aqua products, vegetables and fruit, the growth is not sufficient to meet dietary requirements [23]. While the production of vegetables and fruit is increasing, the produced quantity is insufficient to meet the dietary requirements of the Bangladeshi population [21,23]. Meeting the daily WHO requirements for vegetables and fruit needs either a significant increase in production in the country, or large net imports [23]. Therefore, it is evident that the agriculture and food system in the country has not fulfilled adequate production diversity. Even though production diversity could increase, translating it into consumption within the local food system is linked to, besides agricultural production, multiple aspects such as nutrition-related knowledge and education, income, empowerment of women, and strengthened local institutions [6]. As a result, the government of Bangladesh has prioritized an integrated response to addressing food insecurity and malnutrition [24]. This calls for strengthening the mainstreaming of nutrition components into the local agriculture and food system to diversify food production and enable the consumption of diverse nutrient-rich foods. NSA can play a significant role in diversifying food production and diet by tapping into the food system, such as the traditional homestead food production system.

This study aims to explore the factors that influence the implementation and sustainability of NSA interventions. To that end, the Integrated Agriculture and Health-Based Interventions (IAHBI) Project implemented in Bangladesh was studied as a case within the local food system in Southern Bangladesh. The objective of the IAHBI project was to improve household food security and nutritional status of children under five years of age, and pregnant and lactating women, in Southern Bangladesh [25,26]. The project focused on diversifying the traditional food production system as well as incorporating nutritional education or behaviour change activities to enhance nutrition-sensitivity. The project targeted 50,000 households to use an innovative method that involved integrating nutrition activities within agricultural production and health services to make the interventions nutrition sensitive.

From the perspective of the impact on nutritional status, the project can be considered a success as it contributed to significantly reduced underweight [25]. The results of this case study are particularly relevant for countries such as Bangladesh where small-scale community-based programs are rarely scaled-up, and systems to deliver nutrition-related services are inadequate [27]. The findings can facilitate policy makers and implementers to design and implement strategies for enhancing the implementation and sustainability of NSA projects to improve diets and nutrition.

8.2 Materials and Methods

8.2.1 Study Design and Context

This study used a qualitative approach to investigate the factors influencing the implementation and sustainability of the IAHBI Project. The case study design helped the authors gain in-depth information on the processes and mechanisms of interventions [28]. The data covered national, province/district, sub-district, and union levels.

We investigated the implementation of the IAHBI project mostly based on the local agriculture and food system of Kamarkhola and Sutarkhali unions of the Dacope sub-district situated in the Khulna district of the greater Khulna region in Southern Bangladesh (see Figure 8.1). Food production in the region is dominated by rice and fish and has the lowest crop diversity index in the Dacope sub-district [29]. Frequent natural disasters have further adversely affected the system. The country's unique geographical position has made it more vulnerable to natural disasters such as floods, cyclones, storms, drought, and landslides [30]. The selected unions in the sub-district are highly vulnerable and exposed to climate extremes because of rainfall, natural disasters, and elevated temperature [31]. One such disaster was cyclone Aila that hit the southwest coast of the country on 25 May 2009 [30], which had adverse effects on not only the lives of people but also on the production of rice crops, vegetables, aquaculture, and livestock [30]. These unions have the lowest adaptive capacity to such disasters in terms of income, infrastructure, roads, and agriculture [31].

8.2.2 Description of the IAHBI Project

IAHBI is a multisectoral project under the Feed the Future initiative, led and funded by the United States Agency for International Development (USAID), implemented in Bangladesh from September 2012 to

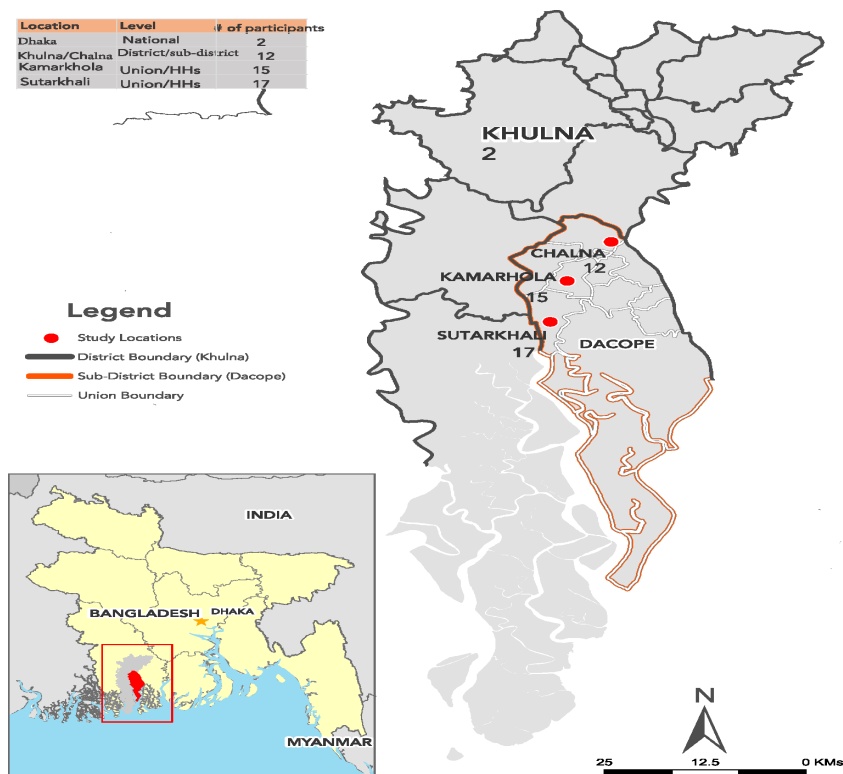


Figure 8.1 Study location

September 2015 by the Government of Bangladesh, partners, and an NGO partner, Sheba Manab Kallyan Kendra [25]. Implemented in close partnership with the Department of Livestock Services of the Ministry of Fisheries and Livestock, the project also involved the Department of Agricultural Extension of the Ministry of Agriculture; Food Planning and Monitoring Unit, and the Directorate General of Food, of the Ministry of Food; Institute of Public Health Nutrition and National Nutrition Services of the Ministry of Health; and the district and sub-district administrations of the Ministry of Public Administration [25]. The Food and Agriculture Organization of the United Nations (FAO) provided technical support for NSA activities, whereas the United Nations Children’s Fund (UNICEF) supported nutrition-specific interventions [25]. The project was implemented in five sub-districts: Dacope and Koyra of Khulna district, Muladi of Barishal district, and Assasuni and Shyamnagar of Satkhira district.

The agricultural interventions focused on the provision of training on improved technologies and inputs for three sub-sectors—horticulture, livestock, and aquaculture—that incorporated explicit nutrition

objectives and actions [25]. The project used FAO's group-based approach by forming farmers' field schools (FFSs) where, "farmers with common interests engage together in a season-long study program with weekly meetings and practical demonstrations to improve the productivity of their crops, livestock, and fishery operations but also how to specifically improve nutrition" (p. 7) [25]. The FFS members received input and training on food production techniques, and messages on optimal nutrition. The members later rolled out similar training to women farmer groups (WFGs) [25].

The project delivered integrated homestead food production gardens, training materials, nutrition education or behaviour change materials, demonstration of healthy and diverse cooking, and community-based food preservation and processing [25]. Along with the provision of knowledge, skills and inputs, the project had also planned strategies to sustain the adoption of the promoted practices through formal registration of FFS groups into cooperatives, follow up of the FFS by government extension workers, and handover of input packages at Union Parishad to the FFS. The project also delivered nutrition-specific components to increase the coverage and outreach of iron-folic acid supplementation for pregnant women and de-worming for children six to 23 months old [32]. The project has contributed to the significant reduction in underweight, from 30% in the baseline to 24% in the endline [25]. The details of the project interventions are published elsewhere [25].

8.2.3 Participants and Recruitment

To maximize the diversity of perspective, participants were recruited from multiple levels with multiple roles. They represented implementers at the national, district and sub-district, or union levels; members involved in implementation in the union level; and beneficiaries. The Dacope sub-district and Kamarkhola and Sutarkhali unions were selected for the research. Beneficiaries were from either FFSs or WFGs. Participants were identified through two methods: a list of implementers and FFS leaders provided by the implementing organizations; and the snowball method. With the snowball method, the FFS leaders assisted in identifying other beneficiaries, and implementers linked the researchers to other implementers or community members involved in the implementation. Forty-six individuals participated in the research of which 28 were beneficiaries (see Table 8.1). As the project targeted women, all beneficiaries included in the study were female. The beneficiaries' ages ranged from 23 to 48 years (average age was 33 years) and their educational attainment ranged from no education to secondary school certificates. The abbreviations indicated in Table 8.1 were used to identify the participants for reporting the respective quotes and continue to be used in the results section.

Table 8.1. Study participants

Participant's level and characteristics	Data collection		
	Method	Number	Number of respondents
Implementers at the national level (IN)	Interview	2	2
Implementers at district and sub-district level (ID)	Interview	12	12
Implementers or members involved in implementation at Union Parishad (IUP)	Interview	4	4
Beneficiaries:FFS leaders (BL); FFS and WFG members (BM)	Interview	13	13
	FGD	2	15
Total			46

8.2.4 Data Collection

Data was collected from October 2018 to January 2019, three years after the project ended. Thirty-one semi-structured interviews were conducted with both implementers or community members involved in implementation (n = 18) and beneficiaries (n = 13), and two focus group discussions (FGDs) with the beneficiaries (n = 15) (see Table 8.1).

Separate semi-structured tools for interviews and FGDs explored three aspects: their participation in the project, perceived effects on nutrition outcomes (what effects and how the effects or pathways), and the factors affecting implementation and sustainability (barriers and facilitators). The tools guided the data collection and were flexible enough to explore the details. Separate tools were applied for implementers and beneficiaries. Key themes included in the implementers' tools were background questions about the project and their participation, perceived effects on food security and malnutrition, and facilitators and barriers to implementation and scaling-up as well as sustainability. The tools for beneficiaries explored background information on their participation in the project, perceived changes in malnutrition and food security, facilitators and barriers to implementation, and sustainability of the project interventions (see online the supplementary file of the published chapter 8). While this article focuses on the factors influencing implementation and sustainability, a separate paper will present the pathways from the interventions to nutrition outcomes. Trained researchers conducted the interviews, and FGDs and a note-taker also accompanied the FGDs. The duration of interviews and FGDs was around 20–70 min and 51–62 min respectively. All FGDs and interviews were recorded with permission and transcribed by research assistants and supplemented with field notes. Data saturation determined the number of interviews [33]. Recruitment of participants stopped when no new information on the factors could be derived, which led to a total of 46 participants.

8.2.5. Data Analysis

Both inductive and deductive approaches were used to analyse the data. First, the transcripts were read in detail to openly code the factors that affected implementation or sustainability. Then the open codes were assigned to five categories of factors by applying the consolidated framework for implementation research (CFIR) [9] which outlines implementation across the following domains: outer setting, inner setting, characteristics of individuals, intervention characteristics, and implementation process. This article theorized that within the given enabling context at the global or national level (outer setting), and with consideration of the implementation setting (inner setting) and the characteristics of involved actors, the NSA interventions with specific characteristics were implemented to achieve the project objective (see Table 8.2). In the third phase, different factors within the domains were grouped into concepts. The concepts within the five domains were adapted from the CFIR framework [9], and partly based on Di Prima et al. [34], which is under review.

Table 8. 2. Adapted concepts of the CFIR framework [9], partly based on Di Prima et al. [34]

Domains	Adapted definition
<i>Outer setting</i>	Factors across global and national levels, which are beyond the implementation area [9], e.g., nutrition sensitivity of existing policies and national legislative environment [34].
<i>Inner setting</i>	Aspects of the local agriculture and food (agri-food) system where the implementation occurred [9], e.g., culture and social environment, local capacity, and biophysical environment [34].
<i>Characteristics of individuals</i>	Those who either implement or receive the interventions also influence the project implementation, e.g., individual characteristics of beneficiaries and their family members as well as household capacity and characteristic of implementers [9].
<i>Intervention characteristics</i>	The attributes of the intervention itself that affect its implementation or sustainability, e.g., adaptability, design quality and cost [9].
<i>Implementation process</i>	The essential activities of the implementation process are planning, engagement, execution, and reflection & monitoring [9].

Factors were defined as the attributes that aided (facilitators) or hindered (barriers) the capacity of the implementing institutions to implement or sustain the interventions or practices [35]. Data was managed and analysed using ATLAS ti software version 8.4.4 and Microsoft-Excel software 16.16.25.

8.2.6 Ethics

Ethical approval was obtained from the Institutional Review Board of BRAC James P Grant School of

8.3 Result

The factors affecting the implementation and sustainability of NSA interventions across five domains—outer setting, inner setting, characteristics of actors, intervention characteristic and implementation process—are illustrated in Figure 8.2. Although these domains are described separately, these factors seem to be related in several sections reported hereafter. Some of these connections are: the institutional frameworks in the outer setting and existing projects and programs; the biophysical environment in the inner setting and fit-to-context in the implementation process; and household capacity in the characteristics of actors and the cost of interventions in intervention characteristics.

8.3.1 Outer setting

The factors in the outer setting mentioned by the respondents concerned nutrition sensitivity of existing policies and institutional framework.

Nutrition sensitivity of existing policies in terms of the overarching multisector policies, and nutrition in agriculture policies, are important facilitators. These constituted the multisector nutrition plan (National Plan of Action on Nutrition), agriculture sector specific policies such as the National Agriculture Policy 2018, and the Country Investment Plan. Such policies shaped project design and implementation and/or sustainability through the existence of other projects that built on such policy environment. While agricultural policies are nutrition-sensitive due to their focus on increased production of nutrient-rich products, there is also a need to expand the horizon of such policies beyond food production to translate production diversity into consumption diversity. According to an implementer:

“Different sectors have their own agenda. Like, agriculture has its own agenda i.e., based on the recent agriculture policy 2018, they will try to ensure food and security through the sustainable increase in production of nutritious food [. . .] there is an important challenge to make it nutrition-sensitive [consumption aspect]”. [IN1].

The **national institutional framework** affected the institutional capacity at the local level. Bangladesh has a largely top-down vertical service delivery environment, and the existing public institutional arrangement is structured such that access to the grassroots level is inadequate. In line with this arrangement, local institutions have limited capacity to implement and sustain the interventions, as indicated by the following quote.

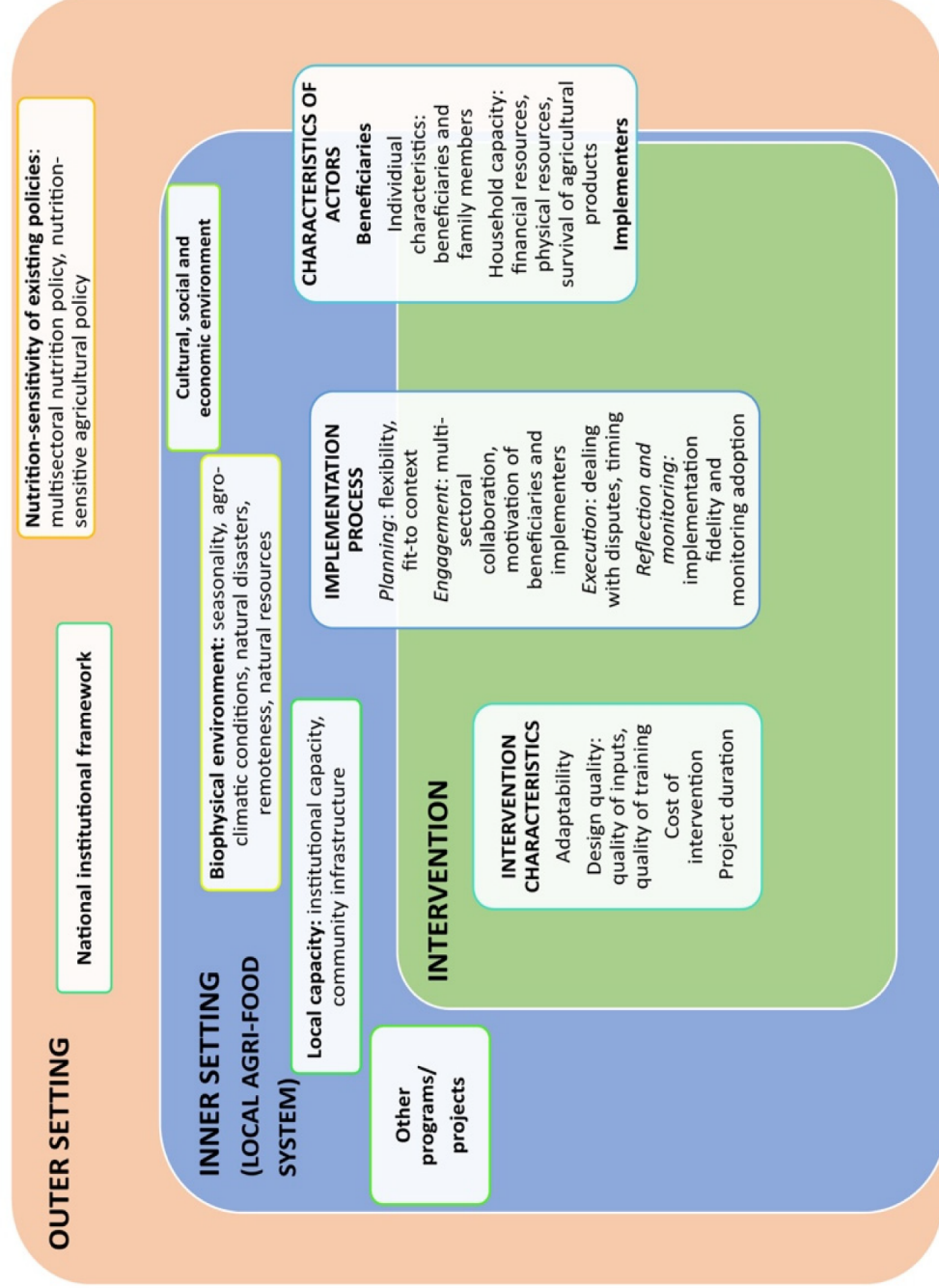


Figure 8.2 Factors affecting implementation and sustainability of IAHBI Project's NSA interventions, adapting the concepts of the CFIR framework [8]

Below sub-district, there are some activities [staffs] only in the agriculture department, but fisheries [and livestock], are only up to sub-district or district level. [...] in health, there are some points, Upazila [sub-district] health [...] [and] around 13,000 community clinics, but most of the department has no office below sub-district level. [...] it is not possible to only want. government sectors [to follow-up]". [IN1]

Nevertheless, non-governmental organizations (NGOs) try to fill this gap:

"The involvement of local NGOs was [is] high in the root level up to the sub-district level in Bangladesh". [IN1]

The country features a large network of NGOs that assist the government to implement its policies and strategies to achieve nutrition outcomes. Such assistance is mostly time-bound and provided through several programs and projects on nutrition, which will be explained in the inner setting.

8.3.2 Inner Setting

The factors at the inner setting, the local agri-food system of the Dacope sub-district, consisted of cultural, social, and economic environment; local capacity; other programs and projects; and the biophysical environment.

Cultural, social, and economic environment influenced access to resources. Persistent *cultural and social norms* such as gender inequality and food-related traditional beliefs were prevalent in the communities. While the project contributed to financial empowerment among women through increased access to finance obtained by selling agricultural commodities, deeply rooted gender beliefs hindered their self-empowerment and decision-making. According to an implementer:

"They [women] are not supposed to go outside or to the market to sell or buy things [...] they mostly stay at home whereas men go to the market for selling or purchasing". [ID2]

Their confinement to household chores and less control over decision-making affected their access to resources and nutrition-related decision making. Food-related beliefs, such as the tradition of not consuming sheep's milk, in a few households, affected their diet.

The factors within the economic environment concerned the income opportunities available to beneficiaries beyond the agriculture sector, such as wage labour, and small businesses, such as a furniture shop or saloon. While the income opportunities generally increased purchasing capacity, an implementer also highlighted trade-offs in the time that beneficiaries from very low-income households spent in wage

labour instead of participating in project activities.

Biophysical environment-related factors constituted seasonality, agro-climatic conditions, natural disaster, remoteness, and natural resources. Seasonality was not a direct factor, but practices varied across the season.

The project had acknowledged seasonal effects that led to the design of strategies in the intervention that facilitated implementation. Delivery of season-specific inputs (seeds or fingerlings) or the execution of FFS sessions are examples of how this consideration translated to implementation. The seasonality still affected production, access to water, food price volatility, and delivery of project activities. Agro-climatic conditions such as salinity, rainfall variability, and soil quality also influenced the implementation and/or sustainability. The project used strategies to supply inputs based on the salinity of water, which facilitated production, for example, through the provision of salt water friendly aqua products. However, salinity had adverse effects on access to safe drinking water and agricultural production, with beneficiaries stressing the high mortality of ducks due to salinity. An implementer also mentioned that the chickens in the coastal belt were severely affected by the salinity. Some participants also stated that they coped against mortality by selling their poultry just before the flood season when the salinity of the water would be high. According to an interview with a beneficiary:

“From them [IAHBI, we got] 8 hens. Every day hens were laying 5–6 eggs. In the flooding, saltwater came, they drank that salty water, and they died [...] Out of 8 ducks. 2 died. We ate some, some were lost. Most of the time in our pond when the salty water comes, that times ducks don’t stay alive. [...] Now, in the sweet [fresh] water the ducks gave 11 babies. So, when the salty water comes, before that I sell them. [...] Yes. I sold all”. [BM8]

Salinity, however, had mixed effects on the survival of aquaculture products. Aqua products such as shrimp and lobster required salty water, whereas some others needed fresh or less-salty water.

The frequent occurrence of natural disasters, such as cyclones (Aila) and flooding, was a significant barrier to production in Southern Bangladesh, including the local agri-food system. A few beneficiaries reported flooding during the implementation. Cyclone Aila, that occurred before the project started, devastated the local food and agriculture system and infrastructures with the effects seen during the project phase and beyond, as indicated by the following quote.

“After the cyclone Aila, all the lands here got salty. And the amount of rainfall was too poor. That’s why farming on a large scale was not possible. What they did after learning the

techniques was that they arranged the outer space of their home nicely and then they implemented the methodology in that piece of land". [IUP1]

Remoteness hindered the execution of project interventions, follow up of post-project cycle, and development of infrastructure for market and transportation systems. This was compounded by a lack of road connection, with only water as a means of transport to reach the sub-district from the two unions. According to an implementer:

"The place was near to the Sundarbans. So, you can easily realize how remote the place was. If you start for the place even early in the morning, you cannot come back here on the same day. So, there was some interruption in the training". [ID5]

The availability of natural resources, particularly agricultural products from forests or canals, or water availability for irrigation or drinking, affected implementation and sustainability. While access to natural resources, for instance, fish or crabs from water streams in the forest, facilitated consumption and selling, limited access to water for irrigation and drinking was a persistent barrier to production and WASH practices, as indicated in the following quote.

"The problem of food security [in this area] will not be addressed unless the problem of drinking and irrigation water is solved" [ID4]

Local capacity concerning institutional capacity as well as community-based infrastructure affected implementation and sustainability. The *inadequate institutional capacity* of government institutions in terms of human resources and monitoring systems was a barrier to implementing interventions but mostly affected sustainability. During the implementation, institutions sometimes delegated tasks to different people for different activities of the same project, as indicated in the following quotes.

"During the project days, a single person whatever is his/her post has to do a lot of jobs. Budget is not a problem. [...] but a shortage of human resources becomes the main issue." [ID4]

"Sometimes, a sub-assistant agriculture officer needs to deliver training for livestock and fisheries because of lack of livestock and fisheries staffs at field level because there were no livestock and fisheries field-level staff". [ID10]

The shortage of human resources affected sustainability, in terms of following-up activities in the post-funding cycle. While implementers from NGOs stated that it was the role of the government to follow up during the post-project phase, government implementers highlighted a lack of feasibility to follow up within the given institutional arrangement, with limited human resources. Following up project activities

was rarely reported except in the case where grassroots level staff followed up health and hygiene practices or the government followed up through other projects implemented in the area. Implementation was also affected by the capacity of local institutions in terms of community infrastructure such as road transport and market access. Some trainers had to train beneficiaries located in remote areas with no proper road access. Especially in the rainy season, this led to delays in the delivery of training activities. This is reflected in the following quote.

“The transport system is very bad there. [...] If the system was good then I would have given them [beneficiaries] more training. I had to stay there and wouldn’t return the same day. It is a backward place, near to the Shundarban, need to go there by a trawler”. [ID5]

High local taxes on transportation, in addition to poor transportation, also deterred the transportation of vegetables, which can be highlighted as another infrastructural barrier. According to an implementer:

“The transport system is so poor [in the Dacope sub-district]. Taxation is the problem. A bus has to pay 120 takas to cross the bridge, but a small pickup carrying vegetables should pay 800 takas”. [ID4]

Although beneficiaries could sell vegetables in the local market due to an increase in demand, a lack of access to the external market affected not only access to and selling of food items, but also food price, as beneficiaries were either getting a lower price for their products or had to pay a high price to buy food for poultry, as indicated in the following quote.

“No, [the ducks the project gave are not alive] [...] no, they did not die because of disease, they died because they were not fed with the proper food. [...] Because none had rice before, now 1 kg broken rice costs 10 takas [per kg] in this month, but it increases in other months, it costs 15–20 takas per kg. That’s why not everyone could feed them” [BF2]

A small number of beneficiaries indicated the *availability of unhealthy foods in the local market*, such as, packaged, and processed foods high in fat and sugar and unsafe vegetables that used chemicals. However, an implementer believed that the lack of market facilitated food consumption, as beneficiaries had no choice but to consume their products. Similarly, the perception of unsafe vegetables in the market facilitated homestead production of vegetables.

The *existence of other programs or projects* implemented in the implementation area during or after the project cycle generally facilitated the implementation and sustainability by contributing to addressing malnutrition. Such interventions included publicly delivered health and agriculture extension services as well as time-bound programs or projects on credit support, livelihood improvement, water quality

improvement, provision of water filters, and disaster management. According to a beneficiary:

“During that time [Aila, the cyclone], our situation was so bad, we got this home and also [support for] a toilet with it [from another project]”. [BM1]

Several other projects were implemented after the IAHBI funding cycle. One such project was National Agricultural Technology Project which incorporated nutritional messages within agriculture. Likewise, Nabojatra Project delivered multisectoral interventions such as nutrition, agriculture, water, sanitation and hygiene, and livelihoods. Post project cycle also included several other sectoral programs that could contribute to improving nutrition. Notably, an FFS leader stated that food supplementation was a barrier to adopt or sustain food production among low-income households, as indicated in the following quote.

“Those people [poor] had organizations from which they received the rice, many agencies are supplying foods such as rice and oil, so they ate those things and store some foods and say that let it [production] be”. [BL2]

8.3.3 Characteristics of Actors

This domain mainly concerns the attributes of two types of actors involved in the implementation. Most of the characteristics cover the first category, the actors in the inner setting that benefited from the interventions, labelled as beneficiaries. This included individual characteristics of beneficiaries and their family members as well as household capacity. The second category was actors providing interventions to the beneficiaries, labelled as implementers.

Beneficiaries’ characteristics- demographics, self-motivation and perception affected the implementation and/or sustainability. Women who were young and relatively educated, participated more in the project activities, as implicit in the following quote.

“At the beginning, people did not join, they gave us excuses; they did not come timely etc. However, after a few days, young women started to join, aged women did not. Young women were educated so they felt interested”. [ID5]

Beneficiaries’ self-motivation or interest also affected implementation and sustain- ability. While training design and delivery were interactive, an implementer stressed that training (in general) was affected as women were distracted by their small babies who tagged along with them or were interested in tangible support instead of information. Lack of interest was also one of the reasons why beneficiaries did not continue the meetings post-project cycle. However, some beneficiaries were interested in continuing the adoption of production techniques such bed-making or continuity in the production of poultry. According

to an FFS Leader:

“Some people try to do like me, but they can’t. My hens were 5–6 kg each. [...] They ask me how you do this. [...] If I see that they are sick, I take them to the [veterinary]. I bring Napa for them and give them. They don’t, they come to me and ask do you have the medicine for ducks and hens. They want to take in free”. [BL2]

Notably, self-motivation was also dependent upon income level, access to resources and/or dependency upon projects for inputs.

Beneficiaries’ perceptions also influenced the implementation. The perception that food purchased at the market contained chemicals enabled household production of vegetables.

Three **characteristics of family members** that influenced implementation or sustainability were: perception of gender norms, traditional beliefs, and food preferences. While some family members facilitated the implementation by permitting women to participate in project activities, some did not allow them to participate. Because of traditional beliefs, mothers-in-law influenced food consumption, as stated by an FFS Leader.

“ The mothers-in-law say that we didn’t eat those before, first those things were not here. [...] from my opinion in the families with mothers-in-law, [it is difficult to do anything]. The neighbour beside me, I can’t make them understand”. [BL2]

Food preference among children affected their dietary diversity. Specifically, their preference for packaged and processed foods and beverages high in sugar, which was readily available in the local markets, hindered the consumption of nutrient-rich foods among children. According to a beneficiary:

“Children insist on eating foods [such as] tea-biscuit, juice, tiger [drink high in sugar] [...] I tell them not to eat these [...] still, if they get the money, they eat those, they do not listen to us”. [BM6]

Household capacity to adopt and sustain the resources was a significant factor, which mainly concerned access to financial and physical resources, and the survival of agricultural products. The project had considered poverty by targeting poor households and integrating messages that encouraged the selling of surplus and/or high-value aqua products to increase income, which facilitated the implementation. Inadequate access to financial resources, however, was a persistent barrier as it limited access to household resources required for production, food consumption and water, sanitation, and hygiene (WASH) practices. Insufficient land and limited power to afford water infrastructure and the purchase of nutritious foods, were the main effects. Due to this, a few beneficiaries practiced a trade-off between nutrition and other household needs. According to an implementer:

“To ensure that my child has a better diet, I should have either a space for farming or enough money to buy whatever I need. So many people do not have space to do farming [...] They do not even have the money to purchase rice, pulse, or vegetables to make khichuri for their children”. [IUP2]

Access to physical resources at the household level, such as land and water, sanitation, and hygiene-related facilities and resources, also affected adoption and sustainability. The land inadequacy hindered food production as some beneficiaries could not use vegetable seeds, grow vegetables, or raise livestock due to lack of space for shelter or grass, or cultivate fish due to lack of space for ponds. According to an implementer:

“ They don’t get grass the right way. They buy grass or they buy straws and feed. They have less affordability to buy those. They have their own homes like maybe they have 2–3 hectares of land or they have 5 hectares of land. In those [lands], they can’t cultivate [grass for cattle]. And if they give then it doesn’t grow grass because this is salty territory. The main problem is if we go to cultivate cattle then we have lack of food”. [ID10]

The lack of water facilities hindered WASH practices and food production. The project had provided awareness on WASH and training to establish *tippy-tap*, an arrangement to preserve water, made up of an empty bottle and a rope to serve as a hand-washing station. However, the persistent lack of water hindered access to safe drinking water, as some beneficiaries had to depend on rainwater and pond water for household purposes.

The survival of agricultural products was an important factor within physical resources. The death of ducks, hens, goats, sheep, and vegetables were the barriers. Several beneficiaries reported high mortality of poultry due to disease, the salinity of water, lack of food or proper shelter, and poor adaptation or sickness during transportation. Less than a couple of beneficiaries reported mortality of vegetables, as beneficiaries had continued preparing and applying the pesticides, whereas one beneficiary stated loss of gourd. The mortality mainly occurred in livestock, mostly poultry, as indicated in the following quote.

Only 2–3 out of 7–8 babies survived [...] traditional shelter was too wet that the bacteria could cause disease. Also, they were putting hens or ducks together [despite we taught on coop maintenance]. [ID8]

Characteristics of implementers, diversity of implementation team, and availability of nutrition experts involved in the agricultural production interventions, facilitated the implementation as stated by the

following quote.

“For the first time in this locality, some nutrition experts came to train the people specifically only on nutrition”. [ID3]

The capacity of implementing organizations in terms of human resource adequacy was a crucial factor. A shortage of human resources led to task shifting, described as limited institutional capacity in the inner setting. The respondents did not indicate it whether and how this may have constrained implementation.

8.3.4 Intervention Characteristics

This domain possessed the design-related characteristics of interventions that were aimed at addressing food insecurity and malnutrition within the context of the inner and outer setting explained in previous sections. Such factors included adaptability, design quality, and feasibility.

Adaptability is the extent to which the project interventions were adaptable to the needs of the local context, facilitated the implementation. The implementation area was heavily affected by cyclone and salinity, a key factor in the outer setting. The interventions were, therefore, designed; accordingly, for instance, through the provision of aquaculture products tolerant to salinity and elevated temperature, or consideration of soil quality that aimed to address some of the barriers in the outer setting. For example,

“The lobster was cultured considering saline water. Besides this, mono sex tilapia was cultured for its high productivity and temperature tolerant nature”. [ID3]

A few participants highlighted the challenges of low adaptation of poultry, either due to transit problems or adaptation to biophysical factors, as indicated in the following quote

“When they gave the ducks, they were small and they were from sweet water, those ducks which are from sweet [fresh] water can’t be alive in saltwater”. [BF2]

Design quality, the perceived quality of how the intervention was assembled and presented, was an important factor that mainly concerned nutrition integration in agriculture, quality of training sessions, quality of inputs, and project duration. The integration of nutrition in agriculture was a facilitator as it allowed beneficiaries to improve not only the production of food, but also change behaviour, through nutrition-related activities. According to an implementer:

“While agriculture generally concerns about production [...] this project worked to increase production and [consumption] in an integrated way, [as it] had BCC [behaviour change communication] activities such as the cooking demonstration” [IN1]

Regarding the quality of training, the provision of interactive and practice-oriented training was an important facilitator. Beneficiaries recalled the practice-oriented activities such as production using vegetable bed-making, preparation and application of fertilizers and pesticides, rearing techniques, and cooking demonstrations. According to a beneficiary:

“[I liked] things they showed and cooked. [...]. Other projects tell in the mouth, this project showed the design by cooking which we didn’t know before. By this training, many children’s mothers became aware”. [BM7]

While training design and delivery were interactive, an implementer stressed that in many cases, the effectiveness of training targeted to women (in general) was hindered as they became distracted by their small babies who were also present.

The quality of inputs, especially, the provision of varieties with high-yield production was an important facilitator, as indicated in the following quote.

“Ducks were growing and laying eggs fast. So, the outcome was rapid”. [IUP1]

A couple of participants reported low quality of some inputs supplied by the vendors, such as fruit saplings, hens, and small fish. Participants also mentioned the duration of the project. Several participants high- lighted the need for a longer project duration to enhance its effects on nutrition.

The **cost of intervention** affected its implementation and sustainability. The cost of intervention concerned two levels—the cost incurred for implementing organizations, and the cost required for beneficiaries to adopt and sustain. The cost of interventions incurred for organizations determined the prioritization of interventions and targeting of beneficiaries, as indicated in the following quote.

“[Horticulture costs] very less price, maybe just [...] but for aqua livestock, it is about 5000 6000 taka per beneficiary [...] both aquaculture and livestock require more money. So lesser bit number [of beneficiaries]”. [ID9]

The second was the cost required for beneficiaries to adapt and/or sustain the techniques promoted by the project. Applications that required none or lower financial inputs such as knowledge, or practices of vegetable production techniques (fertilizer and pesticide making, bed-making), some fish production techniques, or to some extent the techniques countering poultry disease, were more feasible to adopt

or sustain than those requiring a comparatively high cost. This attribute was also related to household capacity concerning financial resources described in the ‘characteristics of actors’ domain. According to a beneficiary:

“That time it was seen that they gave 10 ducks and 10 kg foods [for the ducks], so it [the food] ran for 20 days. [...]. For them, it is too hard to collect their own foods. Then how they will buy ducks food? [...]. No, no, they can make the foods [using the techniques taught by the project] but they have to buy [ingredients] with money. [Therefore], they mixed some rice and some chaff. The ducks’ condition became so bad” . [ID10]

8.3.5 Implementation Process

The aspects of **planning** that facilitated implementation of the NSA interventions were flexibility and fit-to-context. Although there existed a general guideline to design and implement the activities, the flexibility in planning the activities based on local needs in line with the available resources facilitated the implementation. This flexibility also allowed the planning of activities and strategies as per the local context, as indicated in the following quote:

“Although the project objectives were not possible to change, we did the priority setting under each activity to match the local context and needs. [...] For example, we first allocated a budget for providing one goat to a farmer but when we went to actual implementation, we learned that we should deliver at least two goats per household otherwise they will not survive” . [ID10]

A few participants highlighted the need to address persistent problems related to household capacities such as poverty through the provision of income-generating activities. According to an implementer:

“You must be more practical when you are working on a rural level. I can assure you that they would have been truly satisfied if they were given sewing machines as per their need. It could create an opportunity of earning money for them” . [IUP2]

The factors within the **engagement** sub-domain were multisectoral coordination, and motivation of beneficiaries and implementers for their continuous engagement. The multisectoral collaboration between agriculture and health sectors to deliver integrated interventions was an important facilitator to implement. However, the continuation of the collaboration between sectors was mostly confined to specific projects’ scope. Several projects implemented in the area enhanced sustainability as they contributed to achieving the common nutrition outcome. An implementer also mentioned that nutrition

was incorporated within agriculture in projects such as the National Agricultural Technology Project, wherein some of the lessons learnt from IAHBI were applied. In the project, agriculture, fisheries, and livestock departments collaborated and were responsible for providing awareness about the consumption of products promoted by the respective departments, such as meat, milk and egg, by the department of livestock services. However, the health sector was not involved in the project. Notably, the project had an objective to increase income and reduce extreme poverty, a significant factor noted in the household capacity within 'characteristics of actors' domain. Multisectoral action was also recommended to sustain some of the activities. An implementer suggested mobilizing community clinics to conduct follow-up sessions with beneficiaries after the project cycle.

Increasing the motivation of beneficiaries and implementers to ensure their continuous engagement was another factor. The motivation of beneficiaries acquired through knowledge and skills contributed to the adoption and sustainability of the practices. The beneficiaries had knowledge of nutrition and continued using some of the techniques acquired during the project, such as vegetable production technologies, illustrated in the following quote.

"Women were not so motivated. Now women are motivated behind this, and they say that they have to do this. If we don't then our child also will not get nutrition. That's why we always plant vegetables". [BM3]

The withdrawal of the project led to the reduced motivation of beneficiaries to sustain production practices such as poultry rearing, or to continue the mechanisms established for long-term learning through FFS. Some of the FFS members were also part of groups created by other nutrition-related projects implemented after the IAHBI funding cycle. The reasons to not continue the FFS meetings by the beneficiaries, were lack of meeting initiation, incentives, interest, or time. According to a beneficiary:

"First when the dada [meeting/training facilitator-male] was coming, we were told that they will teach us these things for our good [so] we have to go, and if we don't go it won't work. [...] We could learn, and they were giving some money for our snacks. [...]. And now they are not coming so what will you go for? Before they used to go but now no one sits together. [...] But it's not that they are only interested in money". [BM9]

Concerning implementers, the influence of supervisors and the provision of incentives affected the motivation for continuous engagement. The presence of agriculture extension officers during training motivated the officers to implement project activities, as indicated in the following quote:

“Had they [supervisors] not been invited, they would have later not allowed their staff to work on these project activities”. [ID10]

While the incentives for execution during the project cycle facilitated the implementation, the consequent withdrawal, compounded by workload, hindered continuation of the activities, as the following quote illustrates.

“Government sectors are also included in many projects, and they also get some of the benefits directly or indirectly and they conducted the training, they get some [budget]. But when project support withdraws, this is gradually losing the [motivation]”. [ID9]

An implementer also recommended a strategy to provide incentives to the staff to enhance continued motivation to sustain the activities.

The factors concerning the **execution** sub-domain included dealing with disputes and timing of the execution of the exit strategy. Some communities faced disputes while conducting project activities, especially during the distribution of inputs. The participants provided varying reasons for the conflict. While some mentioned that the distribution was politically biased, others stated that the beneficiaries who did not receive the inputs created the disputes. An implementer noted that:

“We tried to summarize the yearly activities. And most importantly, there were some unwanted situations we had to face. [...] had to arrange Salish to solve these issues [...] tried to settle the issues on our own [...] Again, this went up to the Upazila level”. [ID4]

Concerning the influence of timing, an implementer perceived that a delay in executing exit strategies hindered sustainability as indicated by an implementer as follows.

“We need to start [planning about] the sustainability, such as any cooperative or some- thing from the starting or middle of the project so that [...] we can find [identity] the challenges and [identify] problems to sustain. [...] Because we give all the things, and we disappear [because] we do not know what is happening now”. [ID10]

Regarding the **reflection and monitoring** sub-domain, a few implementers high- lighted the role of implementation fidelity and monitoring adoption as a facilitator to implement. The implementers monitored the quality for early detection of deviation from the project design and subsequent correction, as indicated in the following quote.

“Hens supplied by a supplier were a little bit undersized. That time I was into a big problem. When I measured and matched, I saw that 1–2 kg weight was less. Then I asked them to give 2–3 more hens. They were obliged to give”. [ID8]

The project also monitored household practices such as cooking procedures, including monitoring of adding salt at a precise time. While the implementation fidelity and monitoring of adoption facilitated the implementation, the lack of a system to follow-up continued adoption hindered sustainability.

8.4 Discussion

NSA is recommended as a promising approach to improve nutrition outcomes. However, implementing and sustaining this multifaceted intervention package in a local agri- food system is subject to a complex interaction of factors acting as either facilitators or barriers. To gain better insight into these factors, the IAHBI Project was studied, which was a unique NSA exercise that incorporated nutrition in agricultural production through linkages of service delivery structures amongst community-based farmer field schools and women farmer groups. Although the domains of the factors were presented separately according to the CFIR [9], the factors across domains featured a complex interaction amongst the outer setting, inner setting, characteristics of actors, intervention characteristics and implementation processes.

Implementation of NSA projects within the local agri-food system in Southern Bangladesh was shaped by the outer context. Bangladesh has an enabling political environment, such as the National Agricultural Policy 2018 that aims to achieve sustainable food and nutrition security. Achieving the aspired nutrition security requires strategies to translate the production diversity into consumption diversity, for instance, by incorporating nutrition education [5,6]. Bangladesh has an extensive network of NGOs that assist the government to implement policies by designing and implementing several models. These facilitate materialization of NSA for the benefit of communities, especially when government actors work actively in partnership during implementation to enhance service delivery, as was the case in the IAHBI. However, these projects are generally time-bound and dependent on donor funding which makes it hard to harness innovative models to scale up. Sustaining and scaling up such projects within the public delivery system is further constrained by limited institutional capacity and lack of dedicated resources beyond the project funding cycle. Past studies also emphasized that the country has inadequate systems to deliver nutrition-related services, and also that small-scale community-based programs are rarely scaled [24,27,36]. It can be said that Bangladesh has an enabling environment to initiate small-scale projects but seems to have inadequate capacity to sustain and scale them up within the public delivery system.

Sustaining and scaling projects may be achieved by aligning and embedding them with public service delivery institutions during and beyond implementation, enhancing institutional capacity to scale up the

interventions, and improving coherence between these projects. This may require collaboration between all relevant stakeholders such as government, non-government, communities, and donors during the design, implementation, and execution of exit strategies. This analysis shows that the inner setting and characteristics of actors related to household capacity feature several barriers that span the agri-food sector and beyond. These barriers mainly include natural disasters [30,37], seasonality and climatic conditions [30,38], institutional capacity [15,39], household capacities [40], remoteness, and access to water, transport and market. The IAHBI Project was also able to partly address some of the effects of such barriers through the fit-to-context approach. Nevertheless, climatic conditions, lack of infrastructure and household and institutional capacities were important barriers. Addressing these barriers may need a multisectoral response that addresses not only multiple determinants of nutrition [5,6,41] but also the contextual barriers or their effects. However, the question remains on how to combine multisectoral activities within the agriculture sector. One past study also raised the question as to whether the integration of sectoral activities is required to address malnutrition, or whether co-targeting of the same beneficiaries would also bring similar effects [5]. Given the limitation of public institutional capacity, Bangladesh could benefit from a strong coherence between projects, ensuring that they are not implemented *in silo*, and that future projects use established platforms such as FFS.

Addressing barriers related to household capacities, which is a significant factor within the characteristics of actors, requires a tailored approach. Although the IAHBI project and NSA interventions in general are effective in supporting poor communities, it is argued that NSA may not be a silver bullet for the ultra-poor households that do not have minimum resources to absorb the practices. Consistent with a past study [40], this study highlights the lack of household resources as a significant barrier to adopt and sustain interventions. Ultra-poor households that severely lacked household resources, such as income and land, were significantly constrained to adapt and/or sustain NSA practices such as food production, WASH, and food consumption. Thus, even within poor communities, the ultra-poor require additional arrangements, such as minimum income, and/or land, which are critical to adopt NSA interventions. NSA projects, therefore, need to acknowledge and thoroughly reflect on such capacities with tailored strategies for poor and ultra-poor households. Addressing the needs of the ultra-poor may require widening the scope of the NSA-income-nutrition pathway in two ways. The first could be the provision of income-generation activities beyond own production such as establishing microentrepreneurs through involvement in school feeding programs, food-processing, or as collectors or traders to connect food production to market. The second is to acknowledge that such ultra-poor beneficiaries need primary interventions beyond NSA's direct pathways to nutrition. In the latter case, NSA projects can

play a crucial role to collaborate with co-located projects that focus on ultra-poor populations through income generation activities beyond agriculture, or social protection actions such as nutrition-sensitive food supplementation or cash transfer. Explicit consideration of household contexts affects the success of interventions, and hence there exists a need for a tailored approach [36] ultimately making NSA 'equity sensitive'.

The IAHBI project interventions and their implementation process facilitated the initial adoption through several factors such as adaptability of interventions, integration of nutrition and agriculture through multisectoral coordination, quality of design, and motivation of actors. Some of these have previously been suggested, such as fit-to-context reported from Bangladesh [42], and quality of inputs reported from Cambodia [43], Ethiopia [39] and Burkina Faso [44], or incentives for participation of the extreme poor [40]. Some of the attributes that contributed to the sustainability of the project were design quality and better motivation through practice-oriented information and skills. However, the sustainability of some of the mechanisms created for long-term adoptions, especially FFS meetings and multisectoral collaboration, were rarely evident. Although some members of FFS were also part of groups created by other projects following the IAHBI project cycle, the continuation of the FFS meetings facilitated by the project was rarely evident. Collaboration within agricultural departments and nutrition incorporation in agriculture was evident through another project implemented after the IAHBI project cycle. However, sustained collaboration with the health sector could not be established from our research. There seems to be a trade-off between some measures to facilitate the initial adoption of mechanisms and contribution to sustained adoption.

This study found that, while some resource-intensive measures, such as incentives for participation, or feed for poultry, facilitated adoption in the short term, a lack of these affected sustainability in the post-funding cycle. The reason could be linked to a past study that reported the trade-offs between the requirement to bring short-term effects versus sustained impacts [36], which needs further exploration. To scale up the interventions within the existing public institutions and bring about change, this study stresses the need to strengthen local institutions [6]. The challenge lies in determining which of the practices should be taken up by the government. There is, therefore, a need to revisit existing institutional arrangements and line ministry functions to understand which of the mechanisms should be sustained and how they can be made viable beyond the project phase. Some viable options could be the integration of nutrition in the training curriculum and/or job description of agricultural staff [25], strengthening cross-sectoral collaboration, such as mobilizing community clinics, and an integrated

monitoring system [45]. As mentioned earlier, this study also recommends increased alignment between NGOs and (local) public institutions and coherence across different projects to sustain interventions. Future funding on NSA should focus on strengthening local institutions to scale up evidence-based good practices, enhance alignment with public service delivery institutions, and enhance coherence across different co-located projects.

The main strength of this research is that it investigates the factors that affected both the implementation and sustainability of the interventions through an exploration of the participants' perceptions three years after the end of the project funding cycle. Two limitations might have affected the results that have been presented. The first is the lack of generalizability evident in other qualitative studies. Restriction of the data collection to one sub-district might have led to an inadequate representation of the entire implementation area. Further, several factors within the outer and inner settings on national institutional arrangements are largely contextual and may not be fully applicable to other countries. The second limitation is the possibility of information bias. As data was collected three years after the project ended, the possibility of recall bias and difficulties in finding respondents due to their transfer could have led to some information being biased or overlooked. The study, however, took precautions specifically to address recall bias, by capturing all possible data through focus group discussions.

8.5 Conclusions

Effective implementation of NSA interventions and their sustainability within a traditional agri-food system requires consideration of complex factors that span across multiple domains—outer setting, inner setting, characteristics of actors, intervention characteristics, and implementation process. Achieving sustainable impact will require considering local capacity and household capacity to absorb the interventions and sustain the adoption. Further, there is a need to study which mechanisms established to facilitate adoption can be continued, and how to enhance sustainability. This should mainly address how to scale-up small-scale initiatives and make the interventions more inclusive for the ultra-poor. Consideration of the factors can contribute to enhancing the effectiveness and sustainability of practices that contribute towards addressing malnutrition in Bangladesh.

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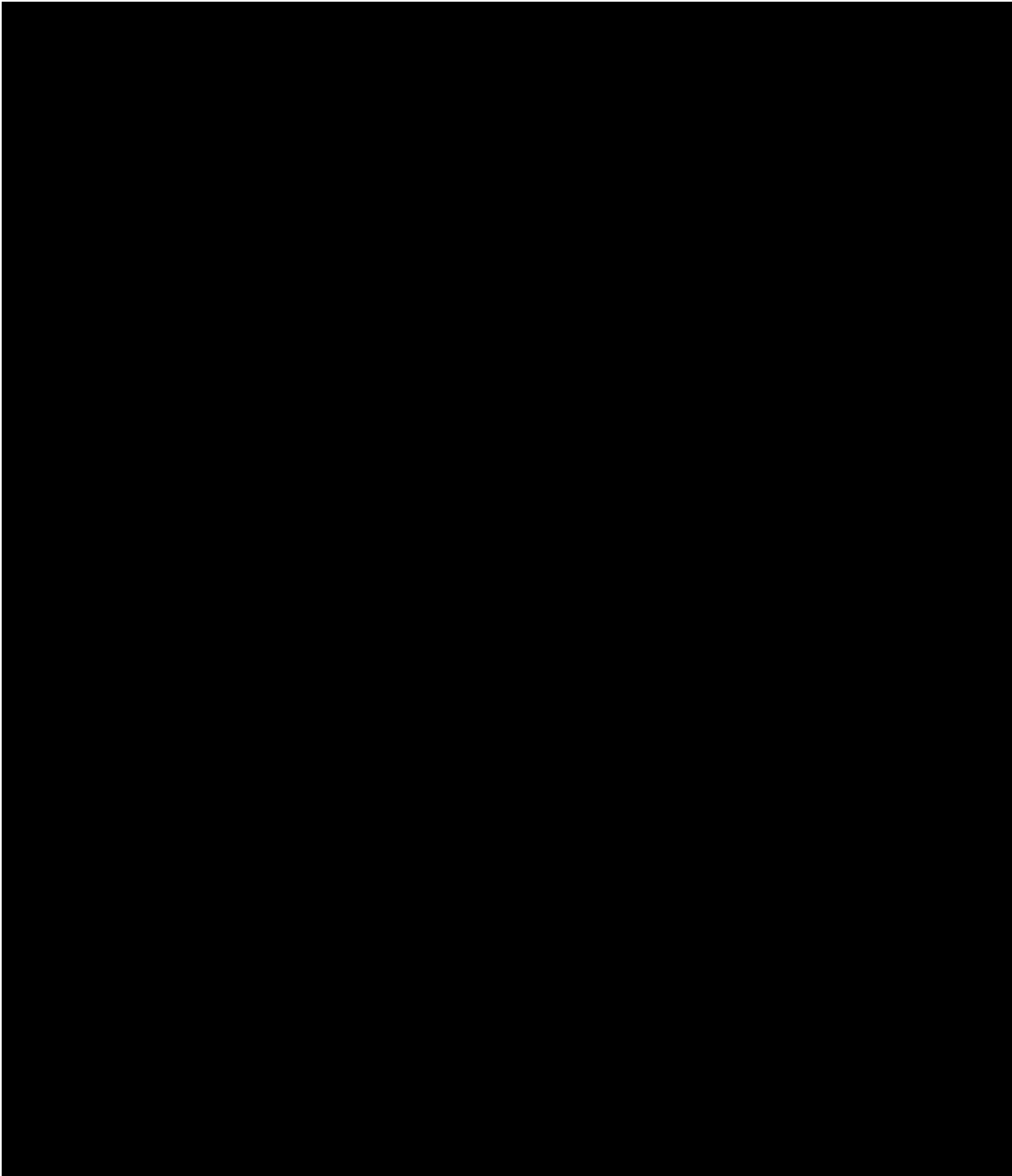
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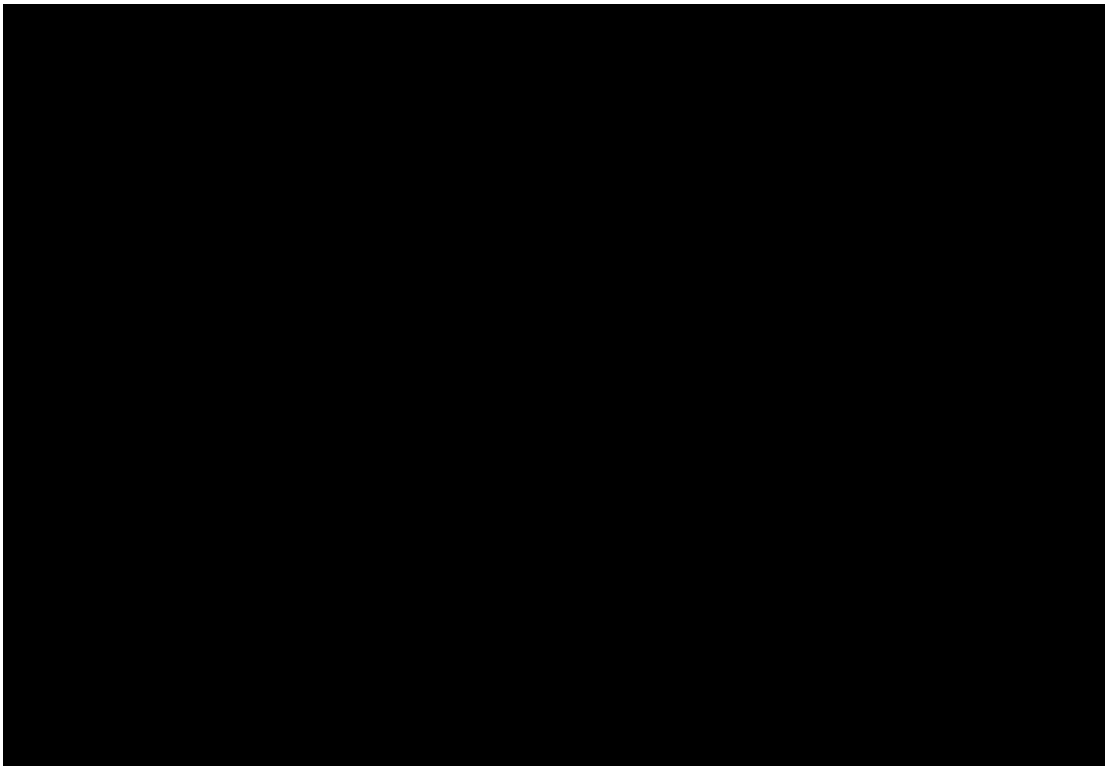
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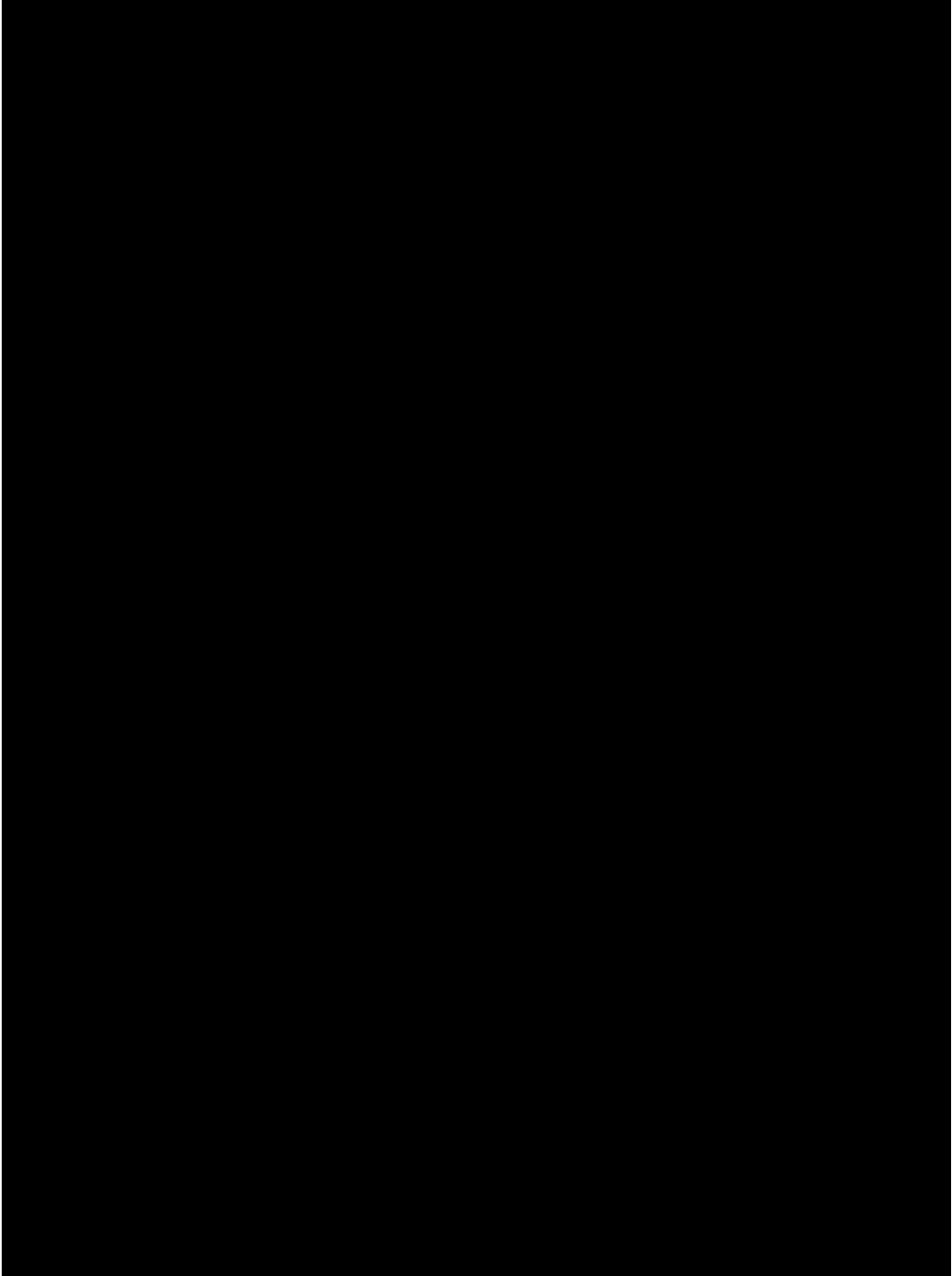
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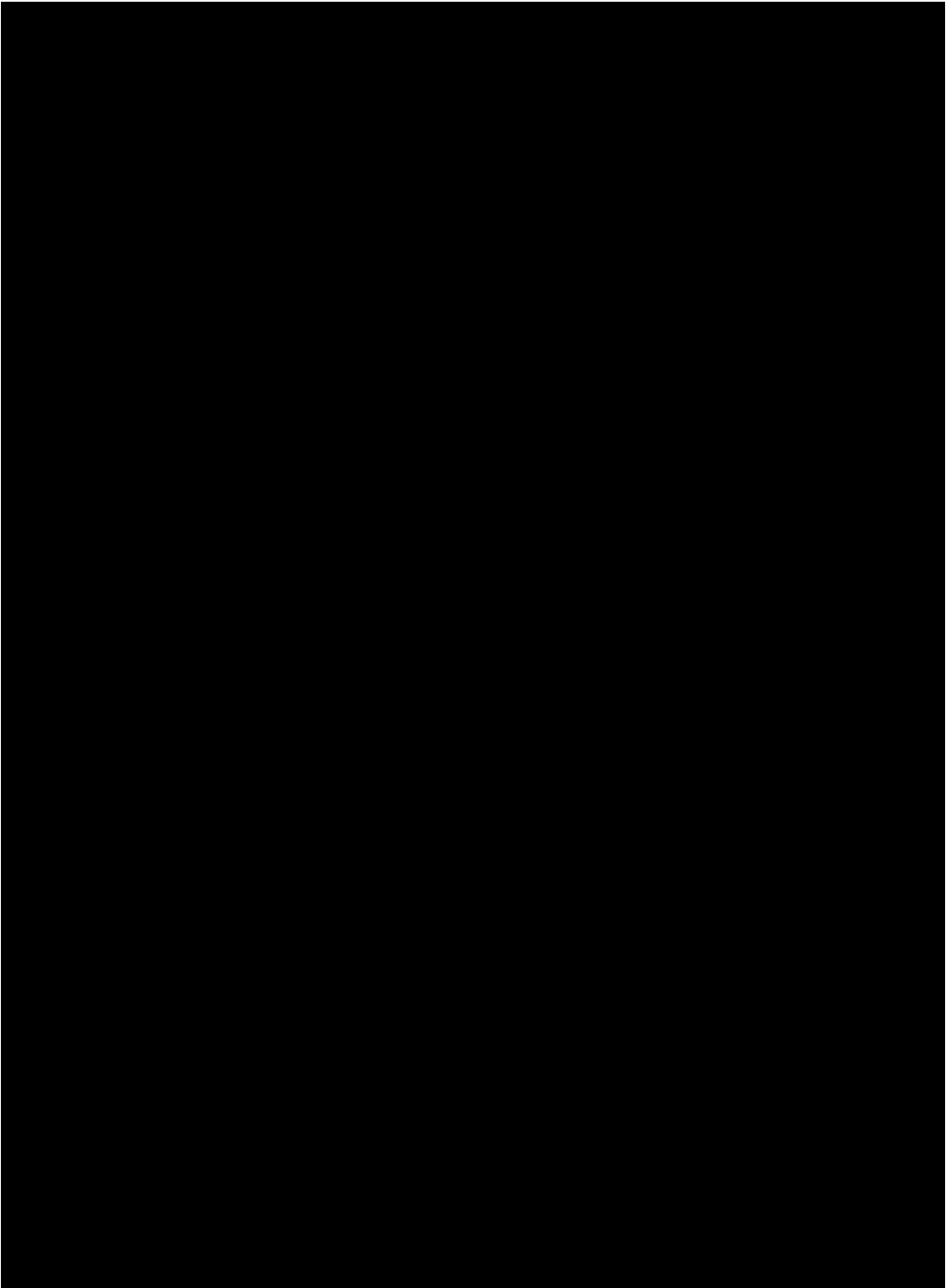
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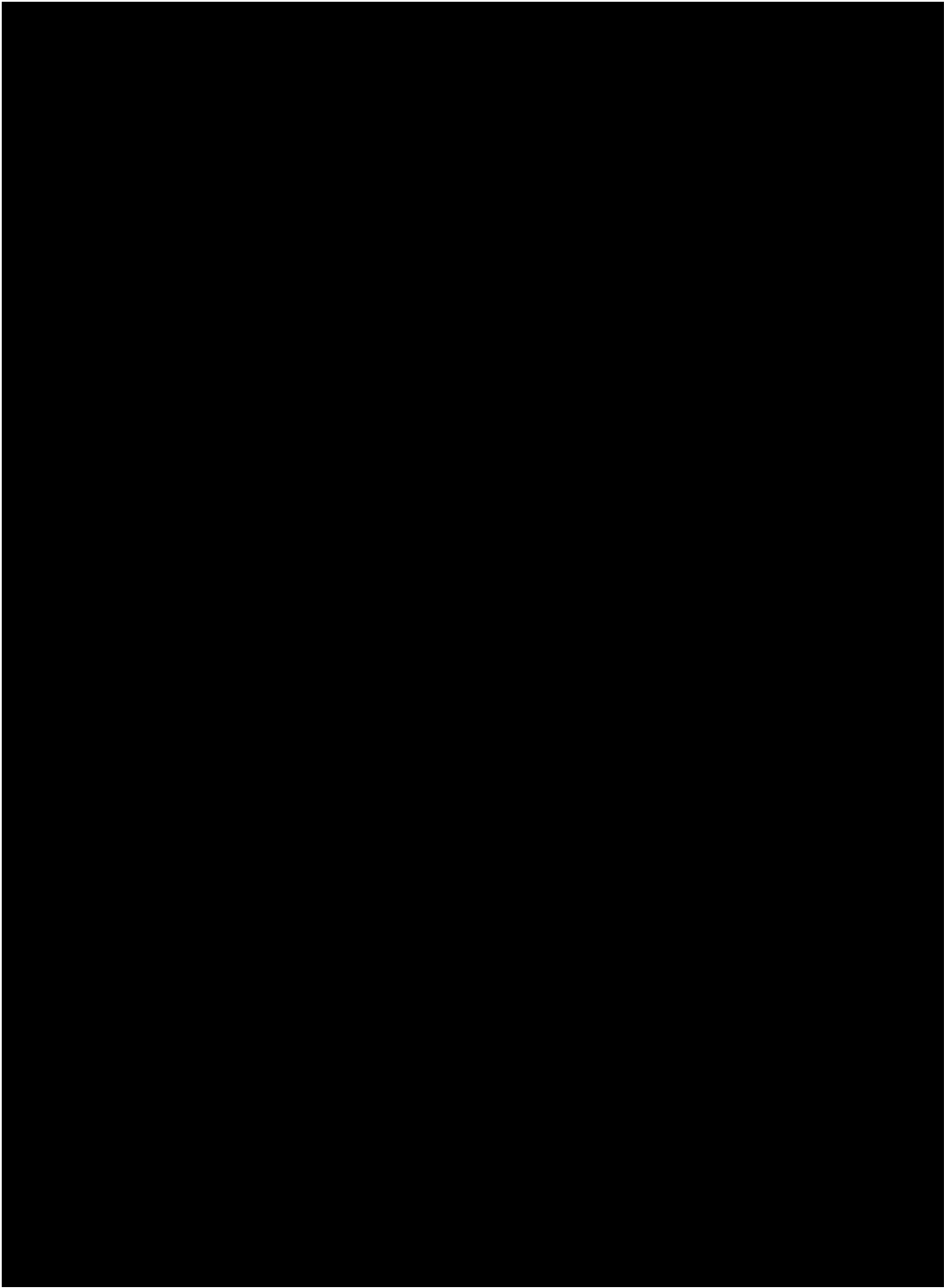
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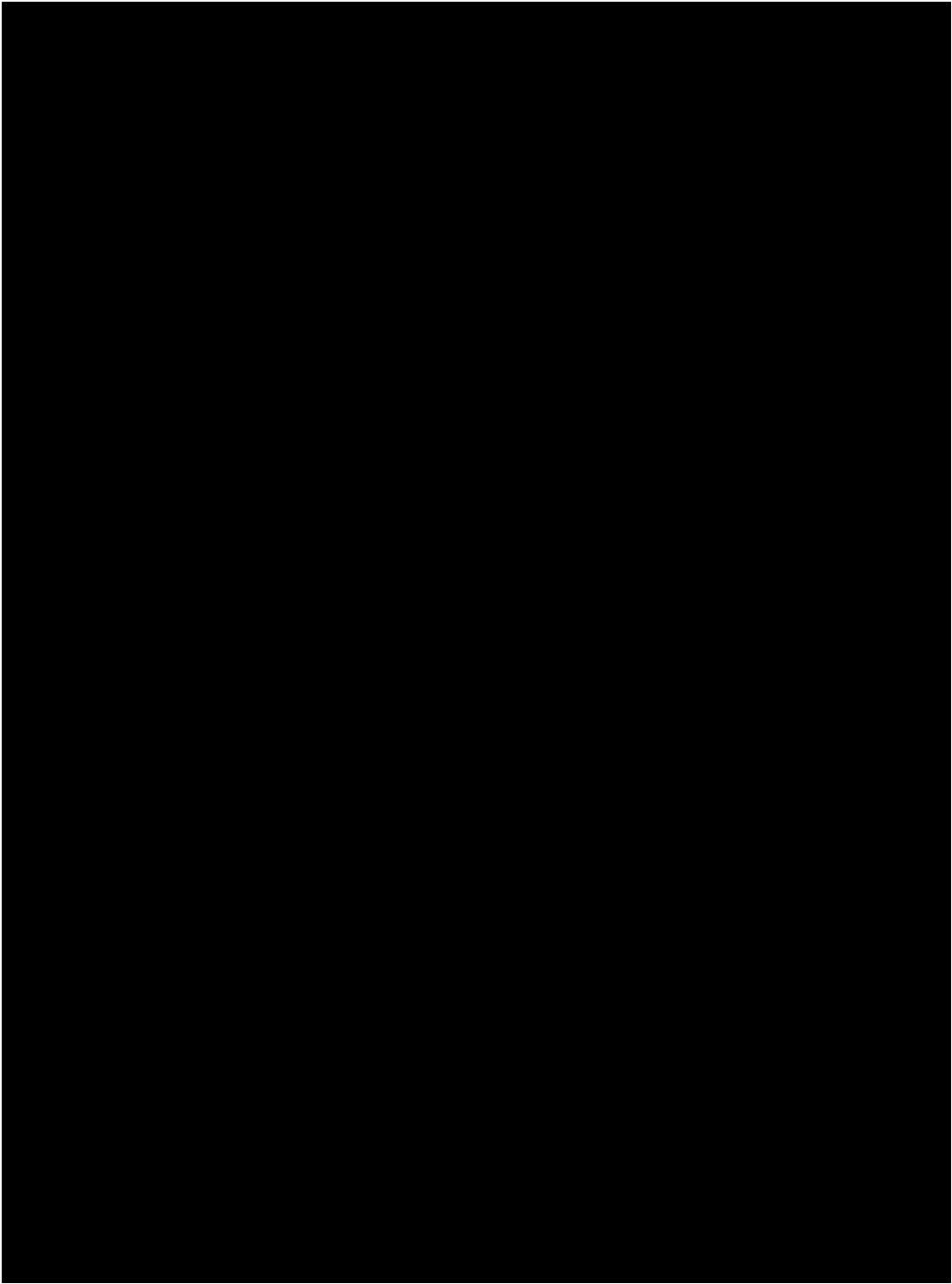


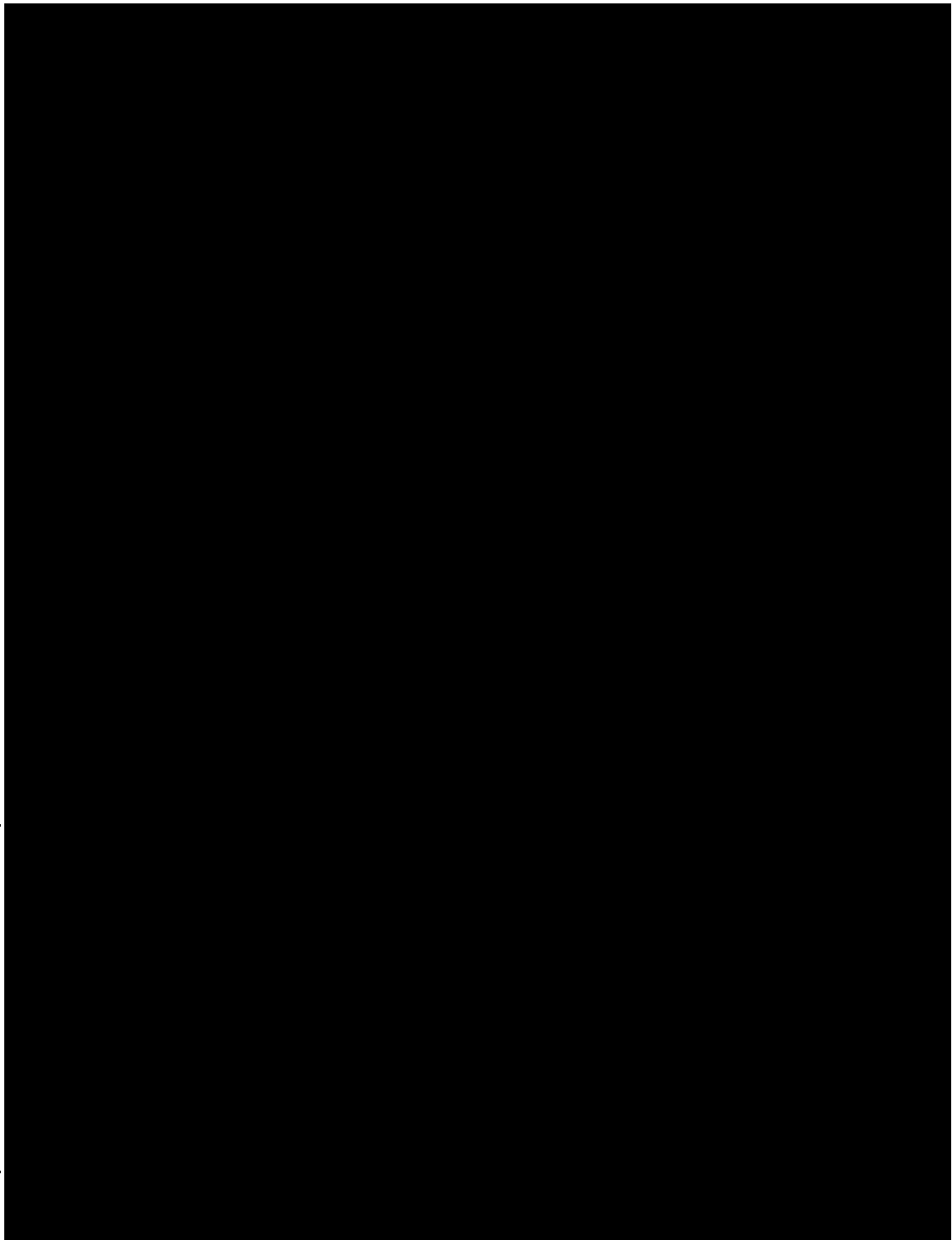


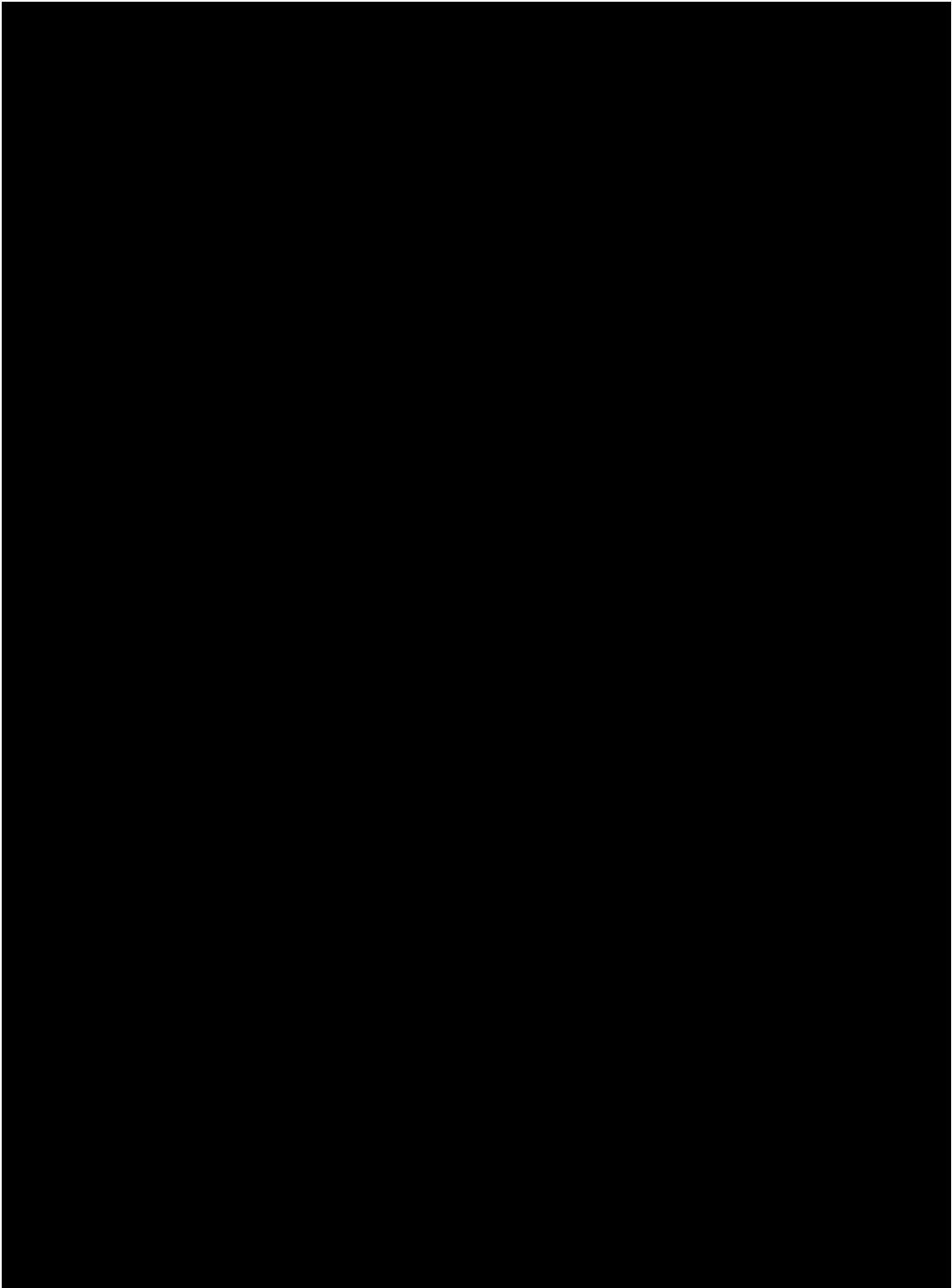


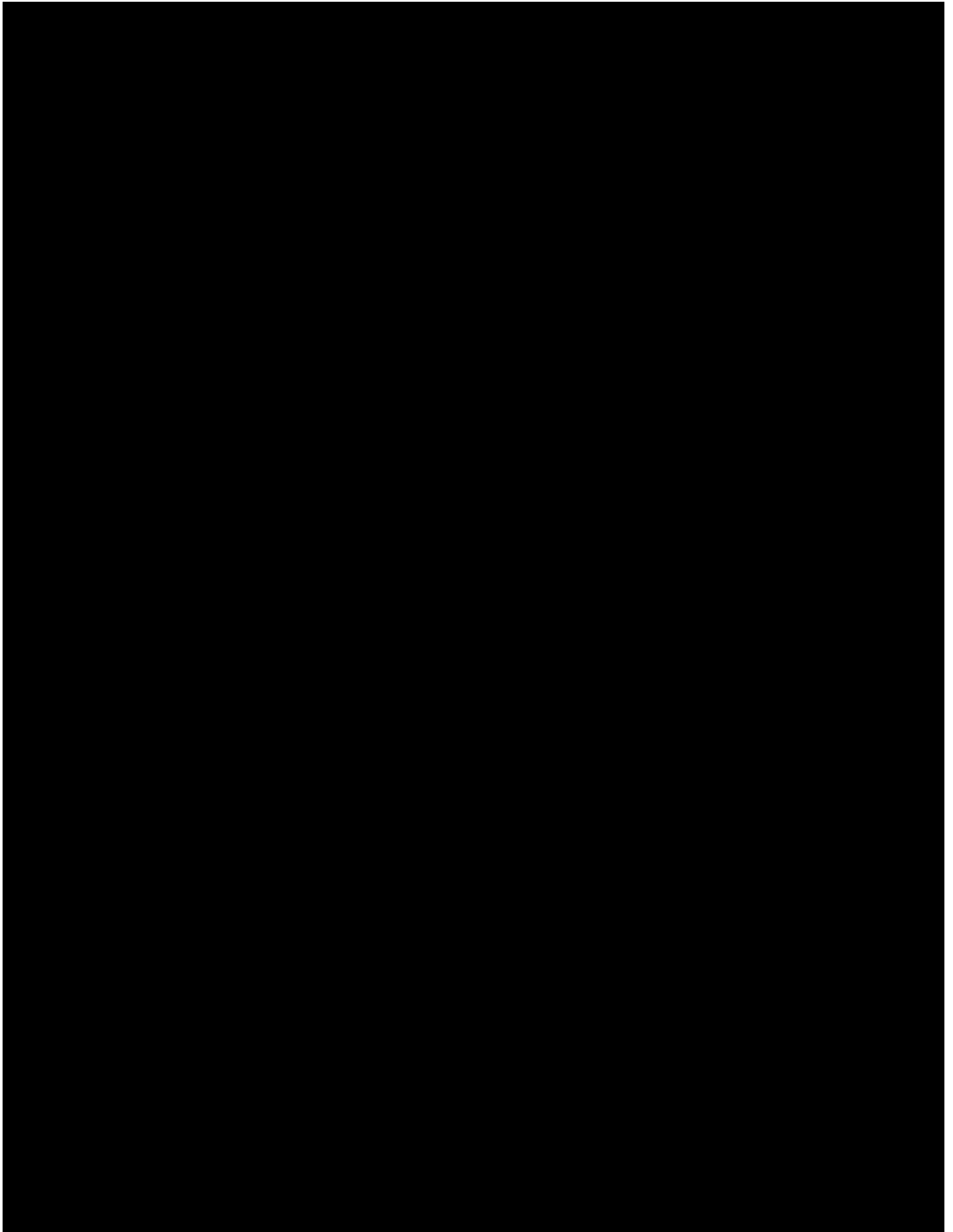


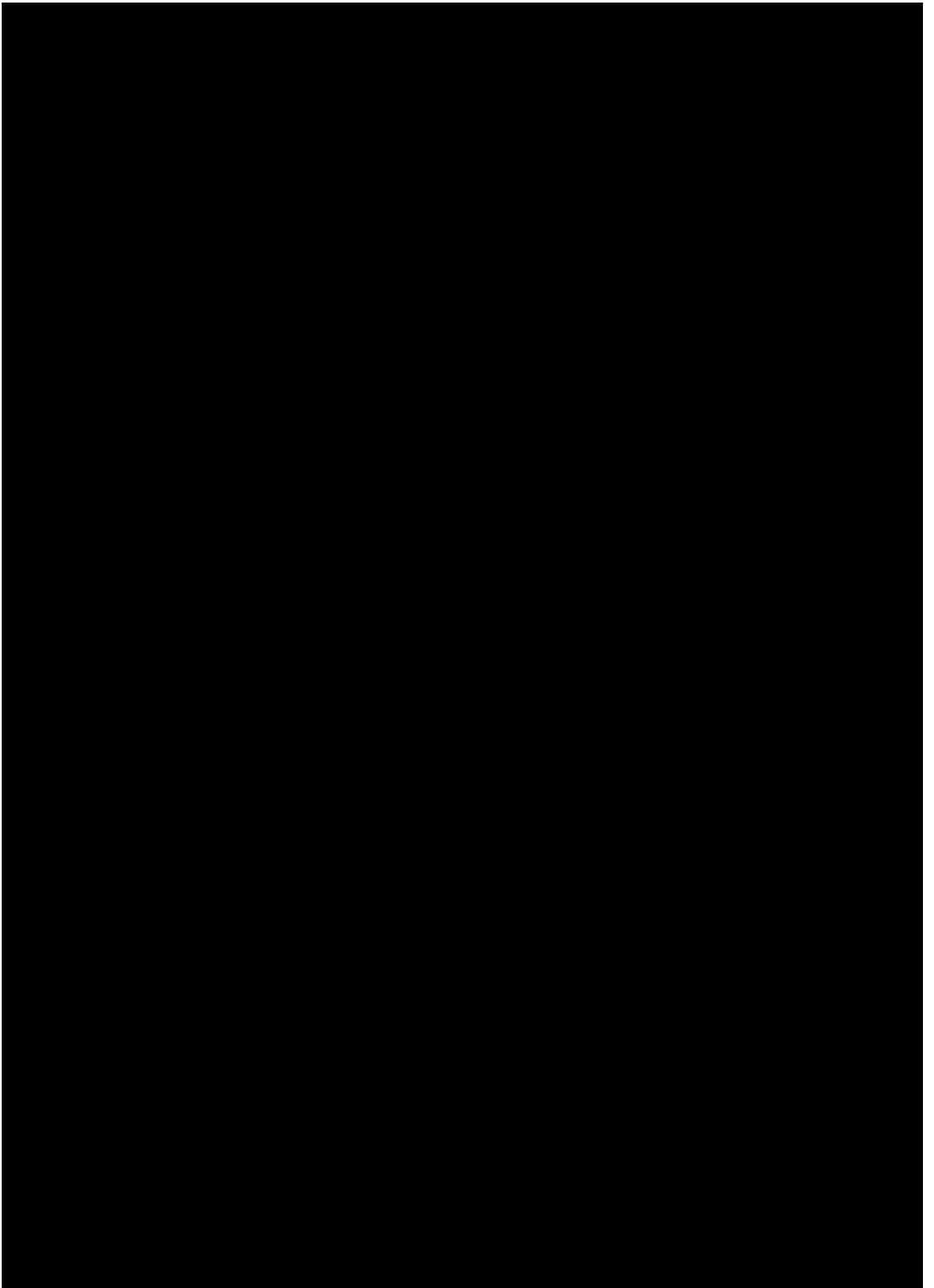


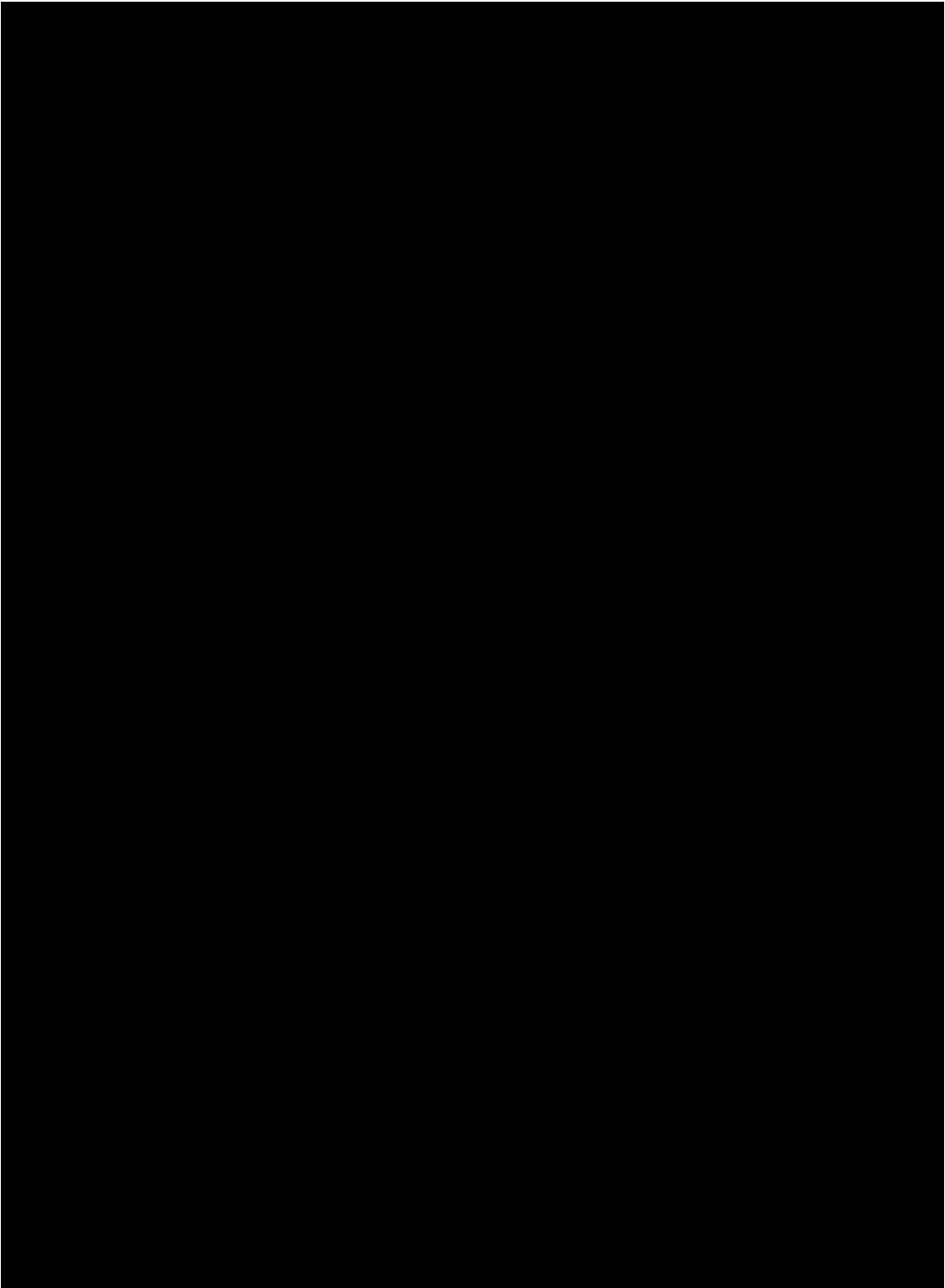


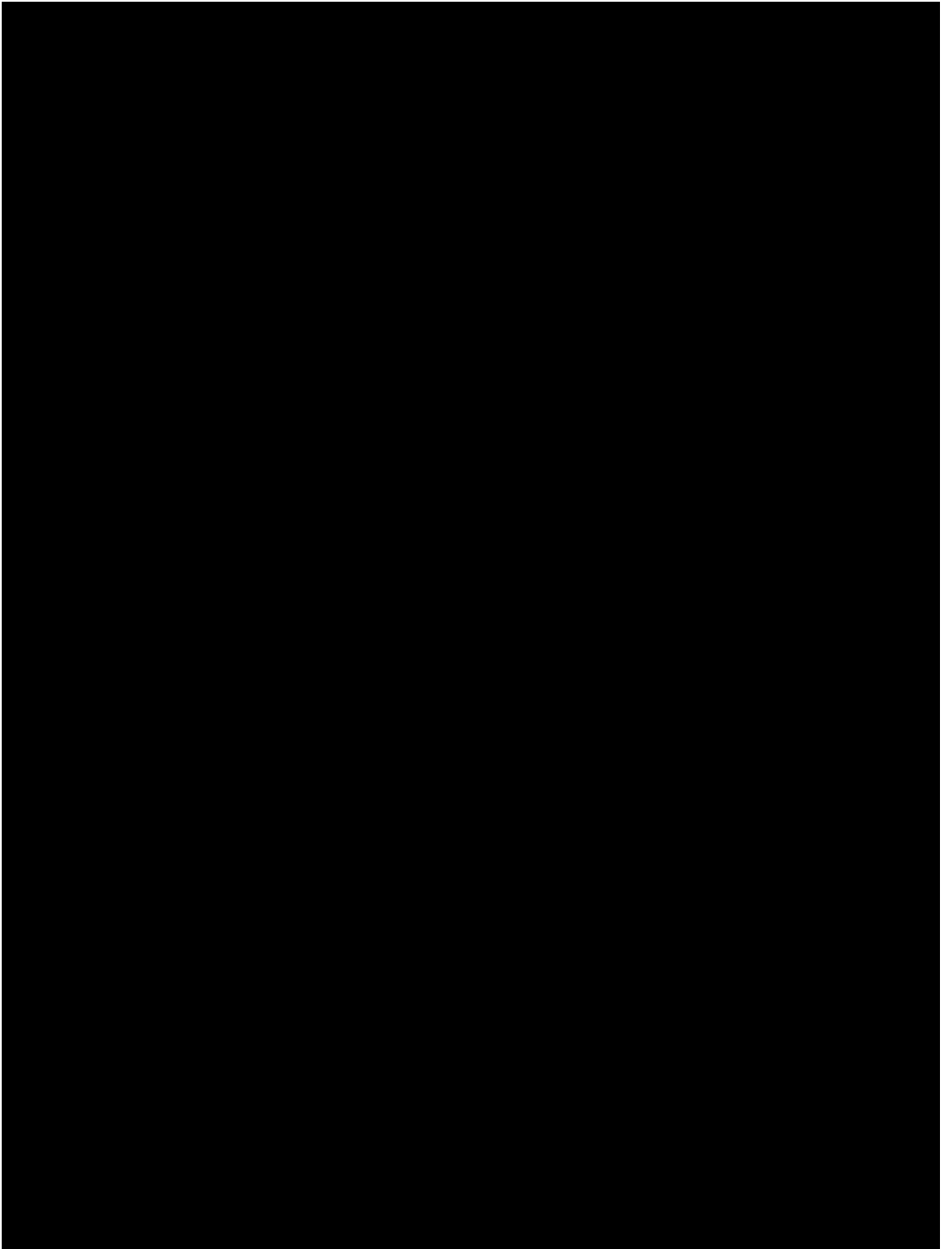


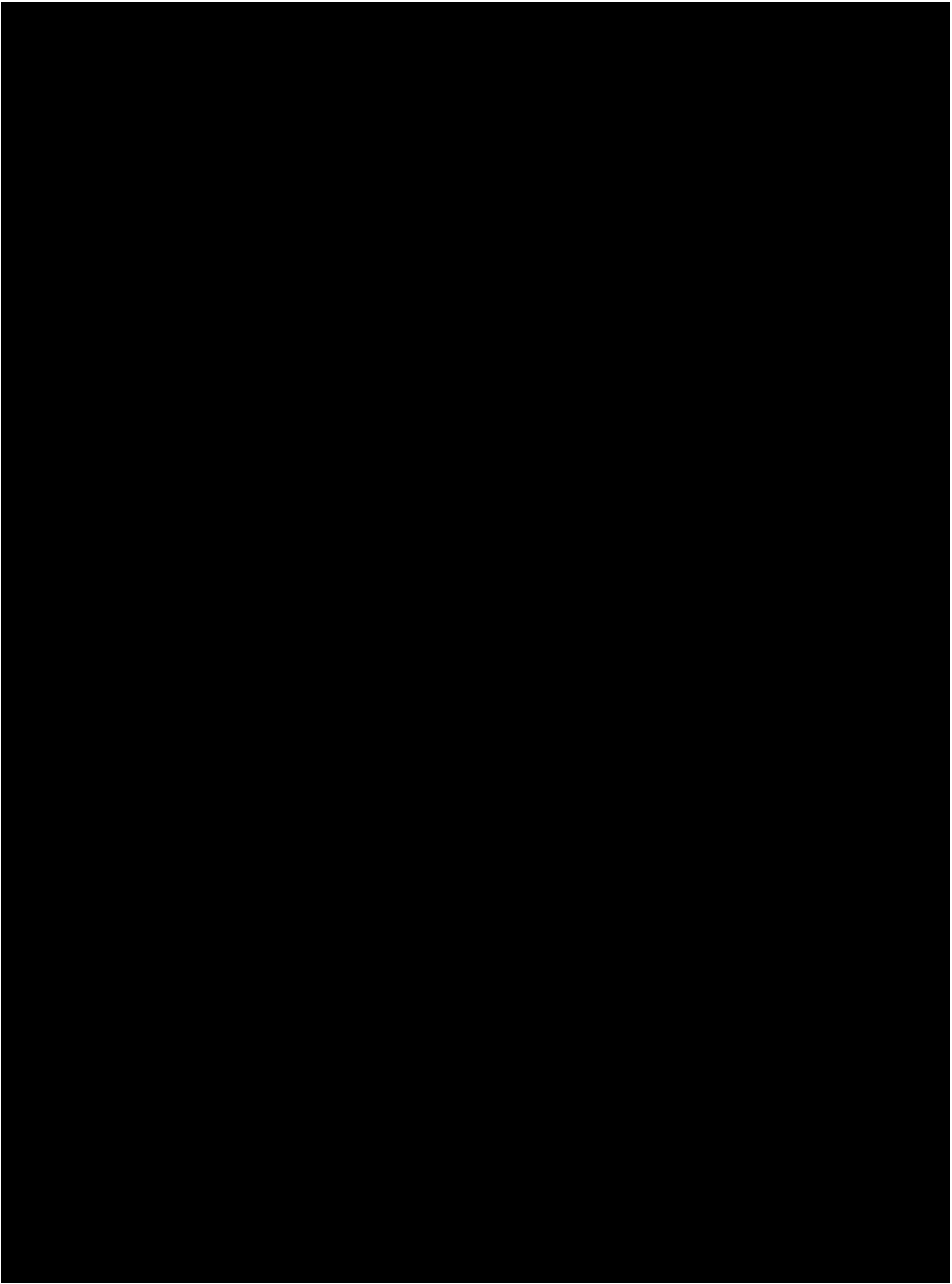


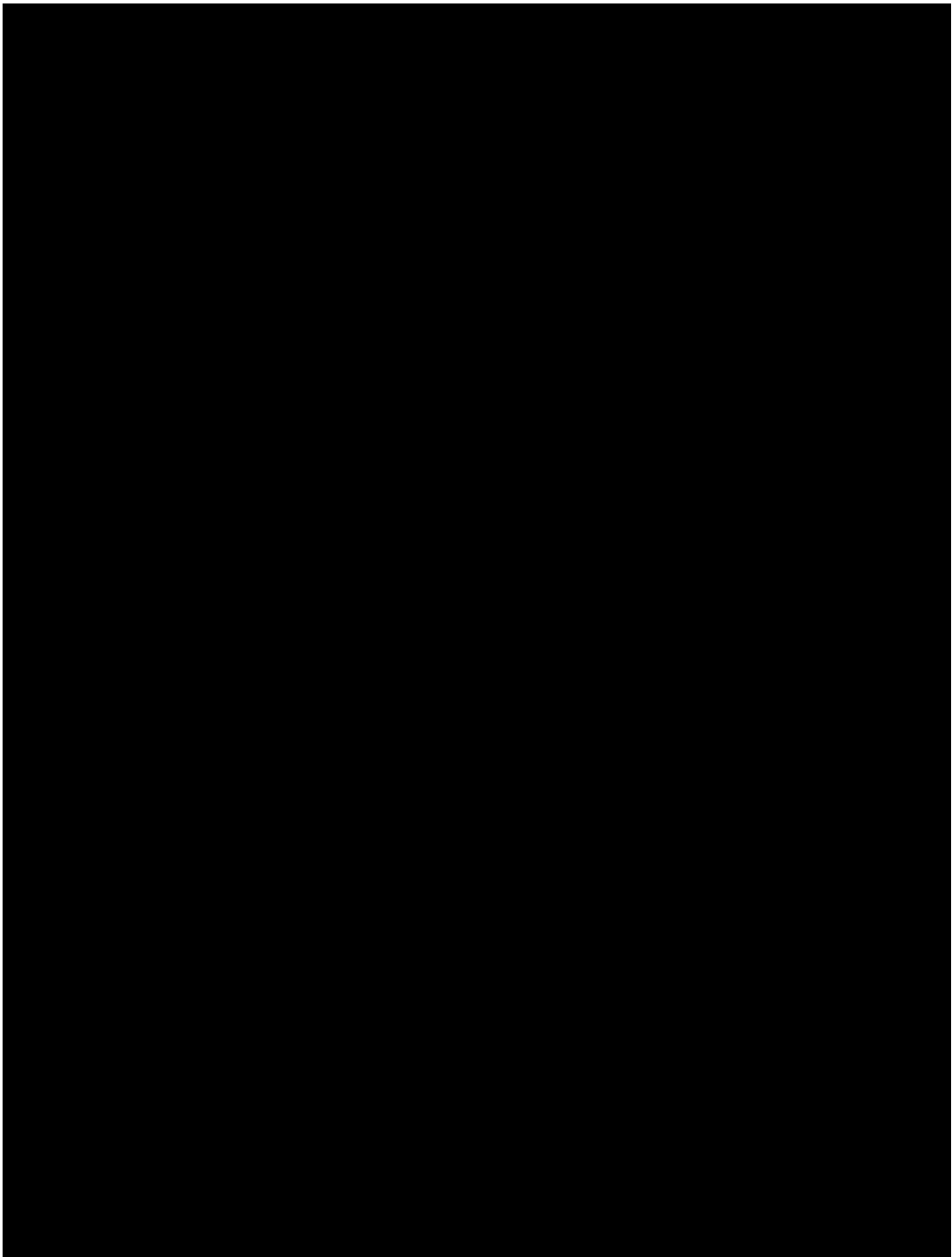


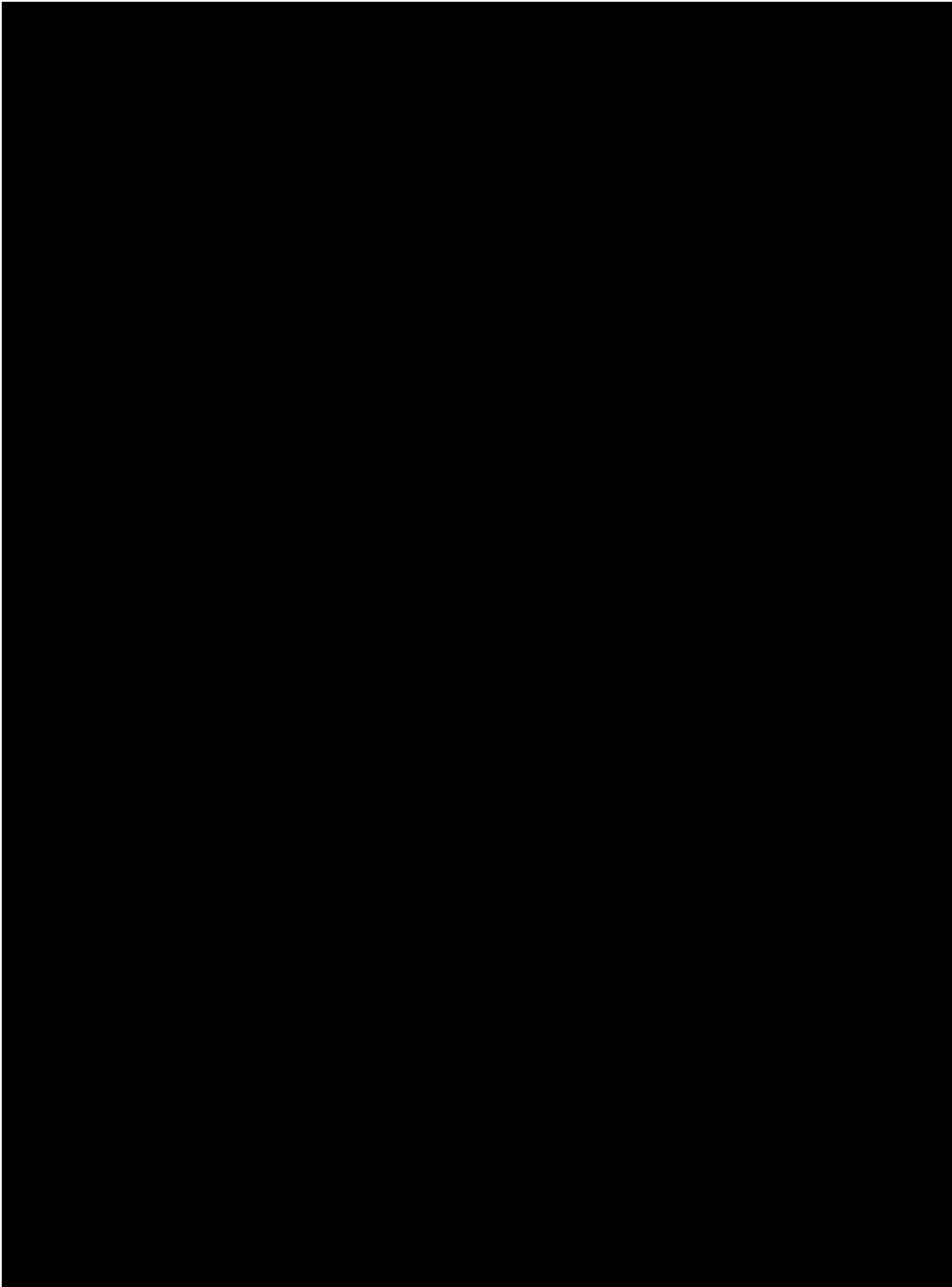


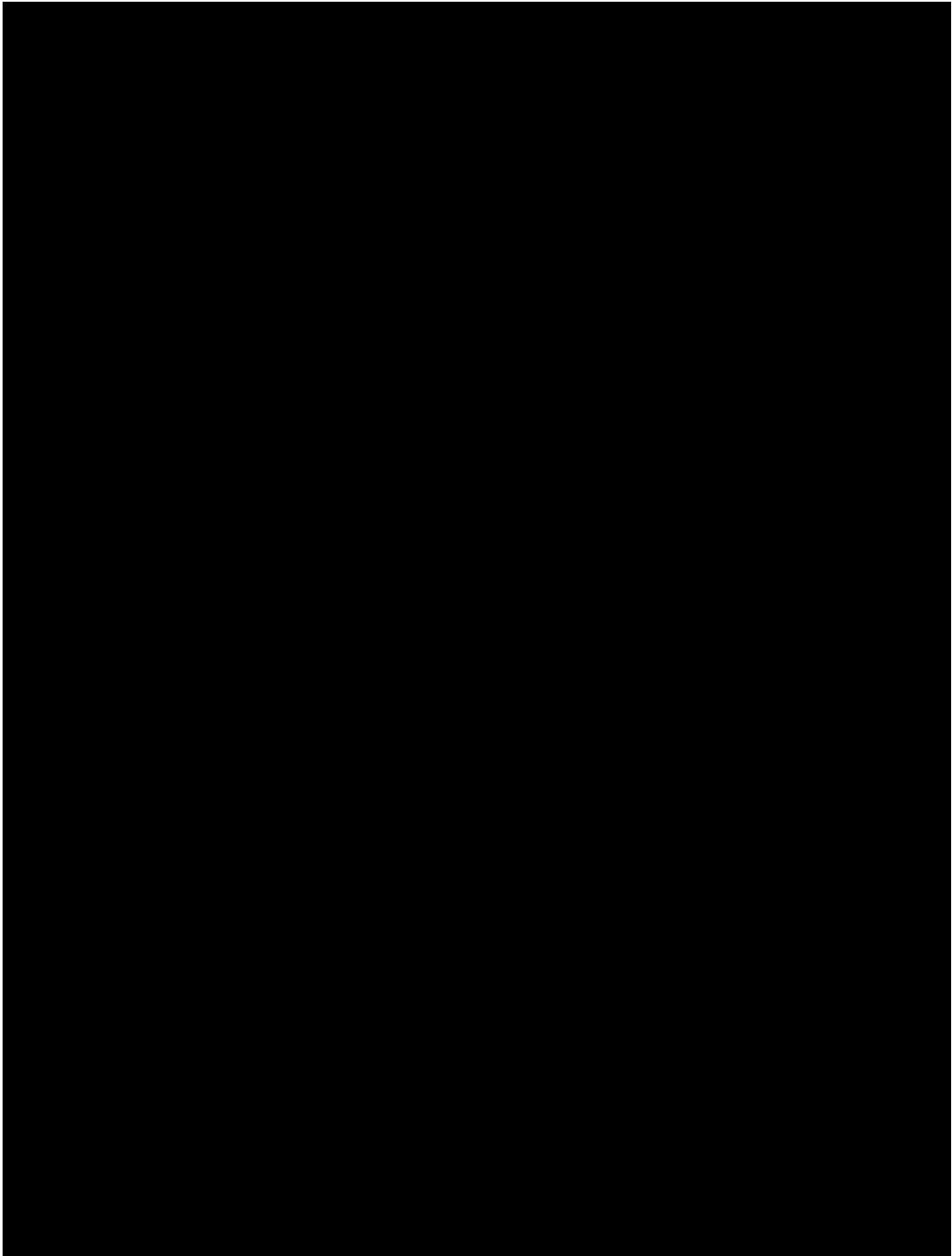


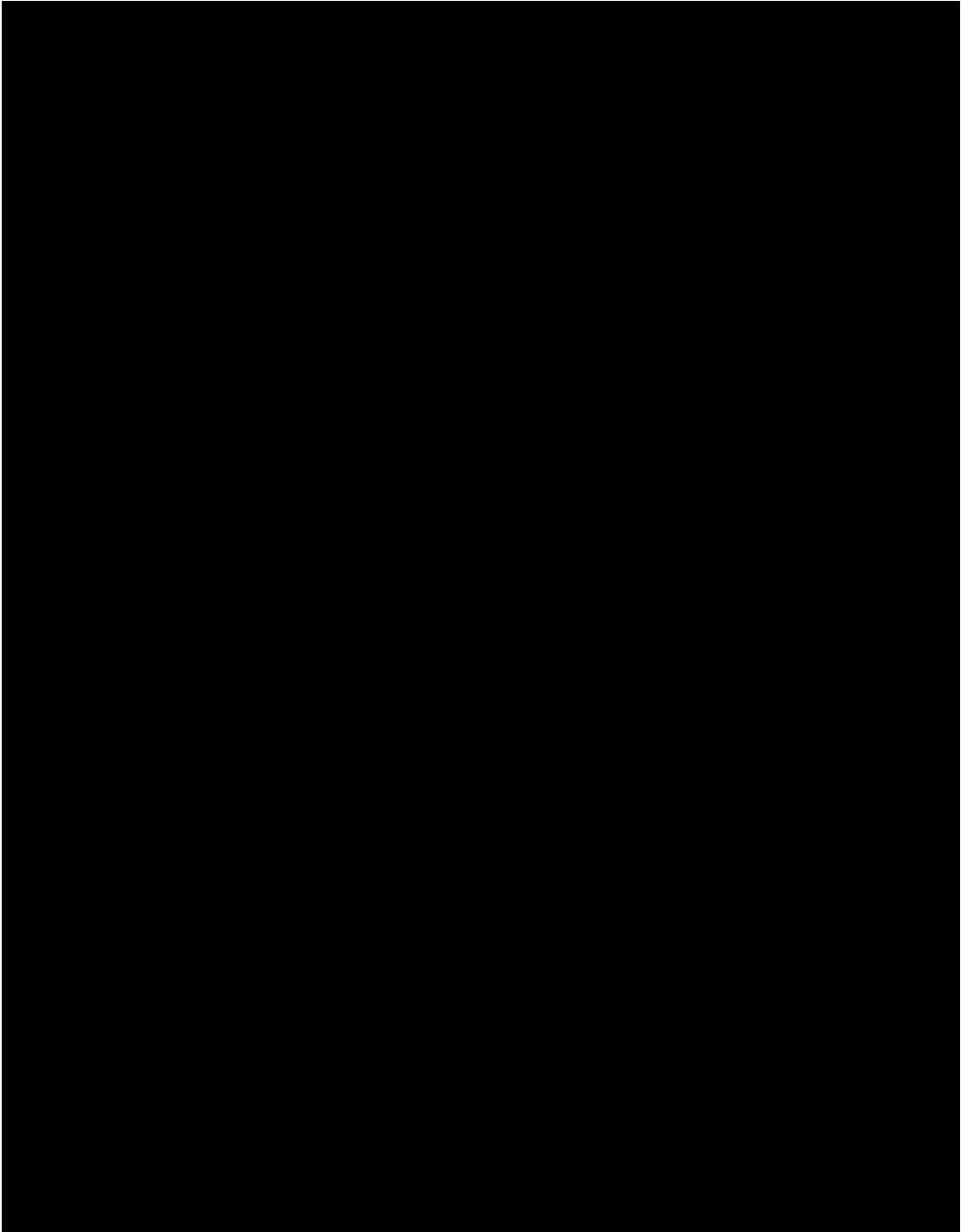


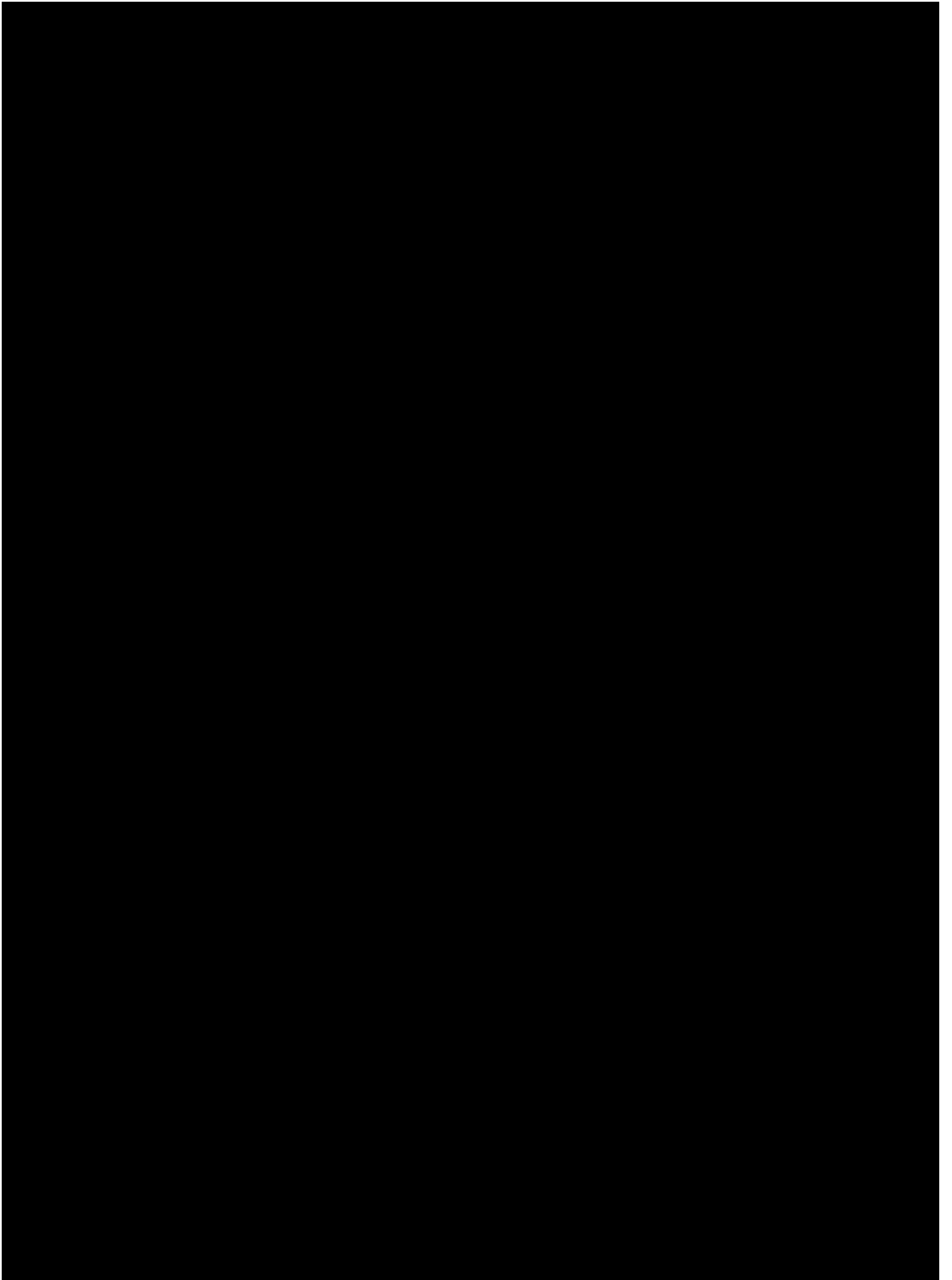


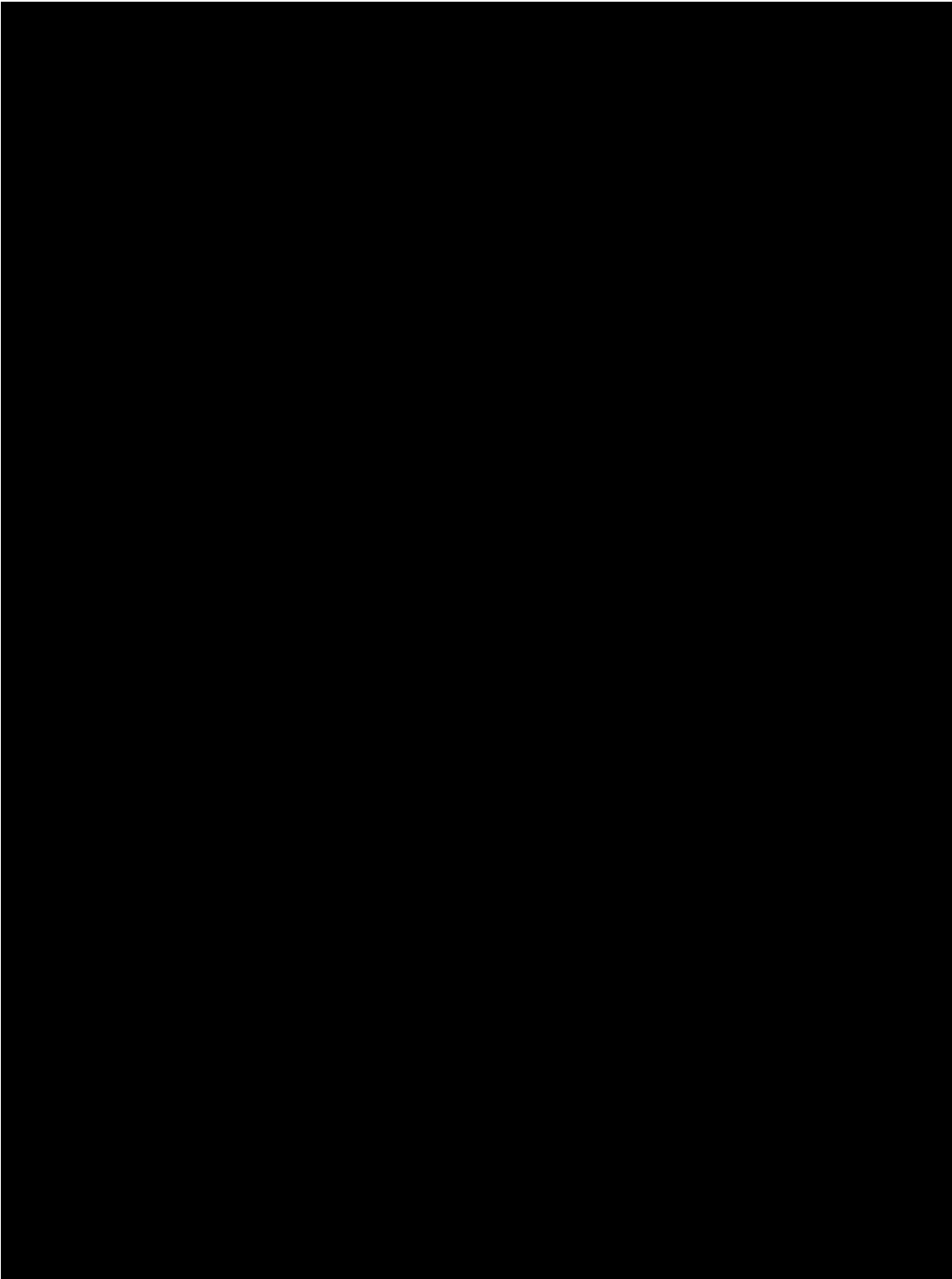


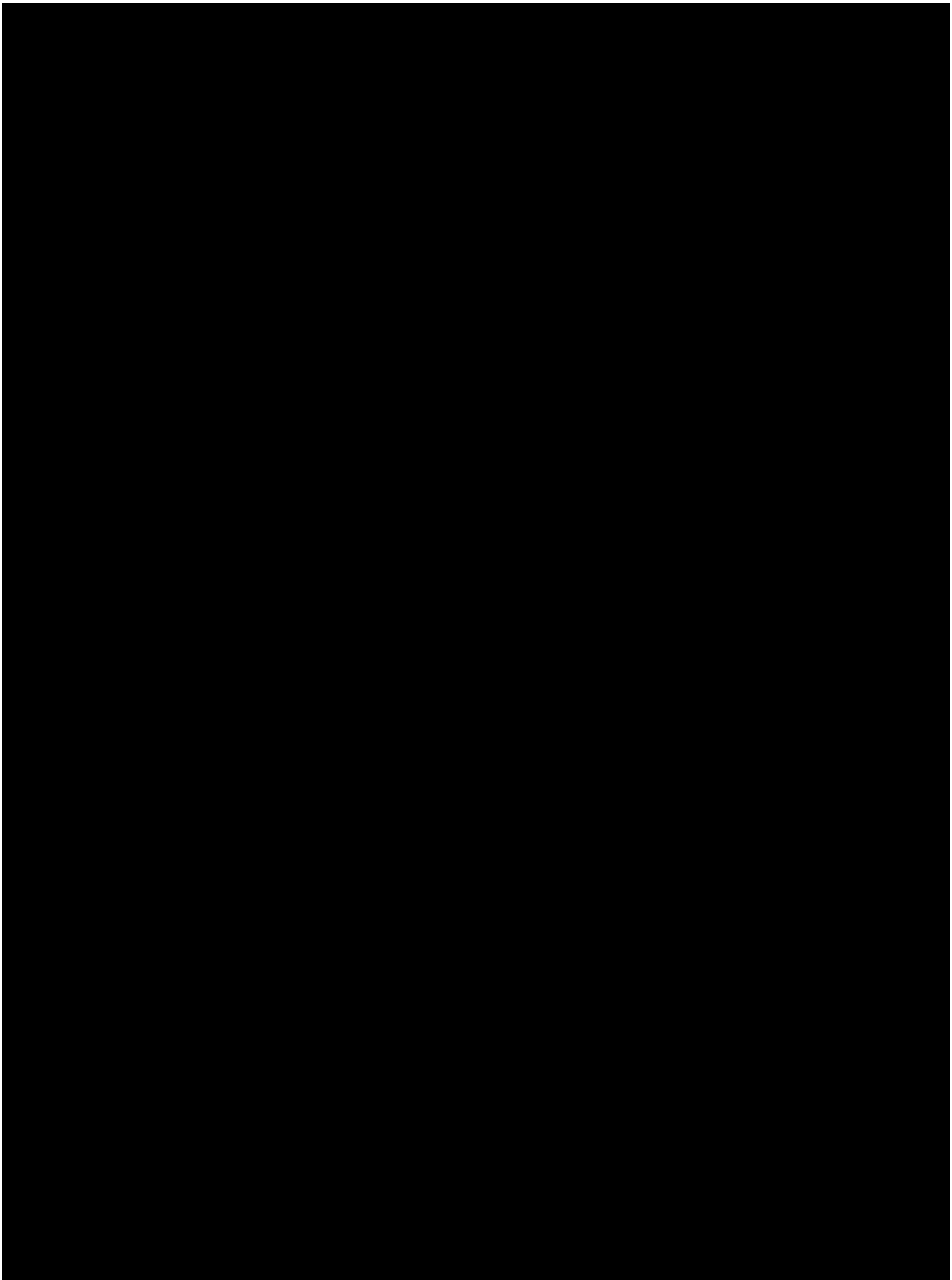


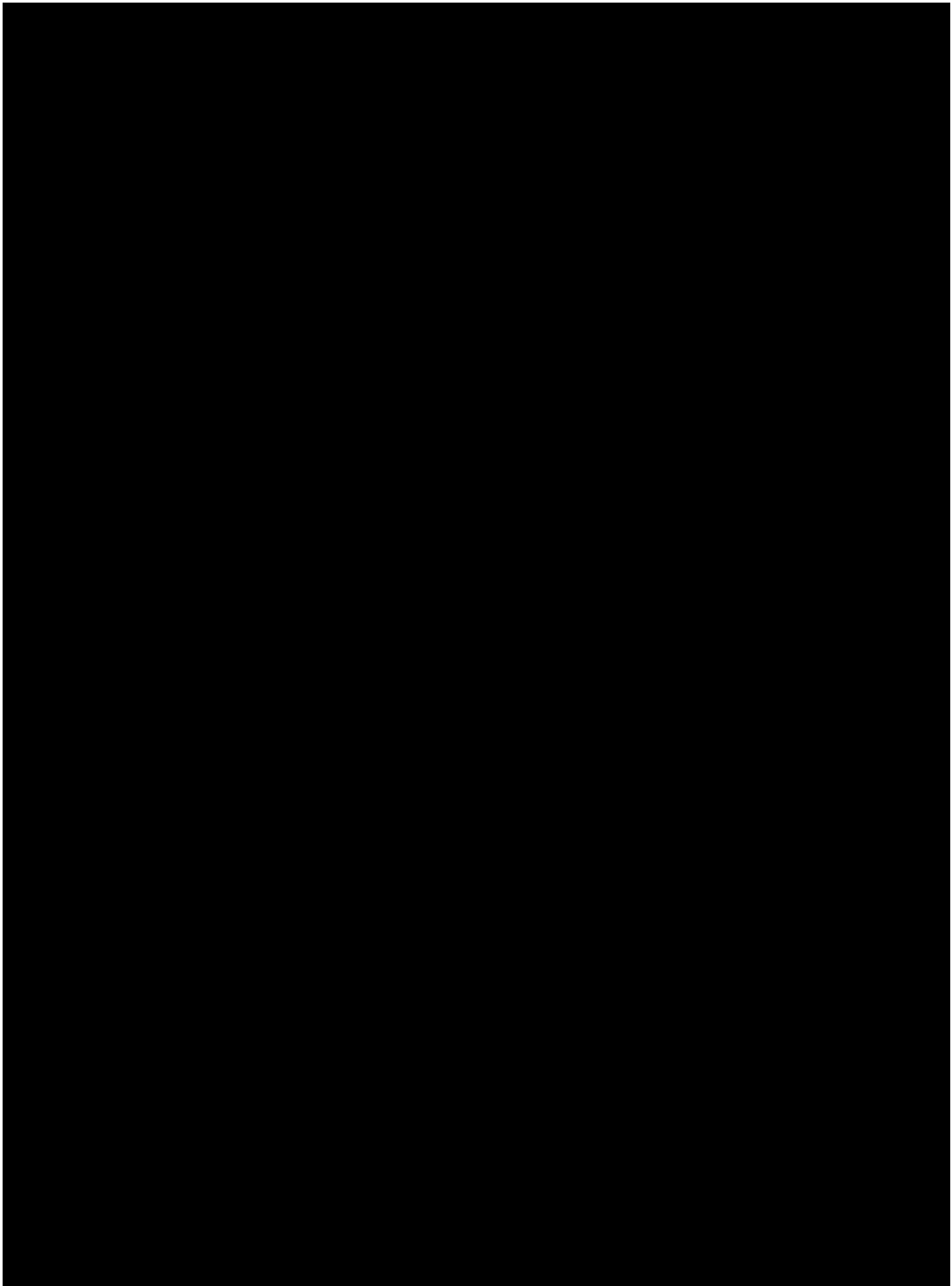


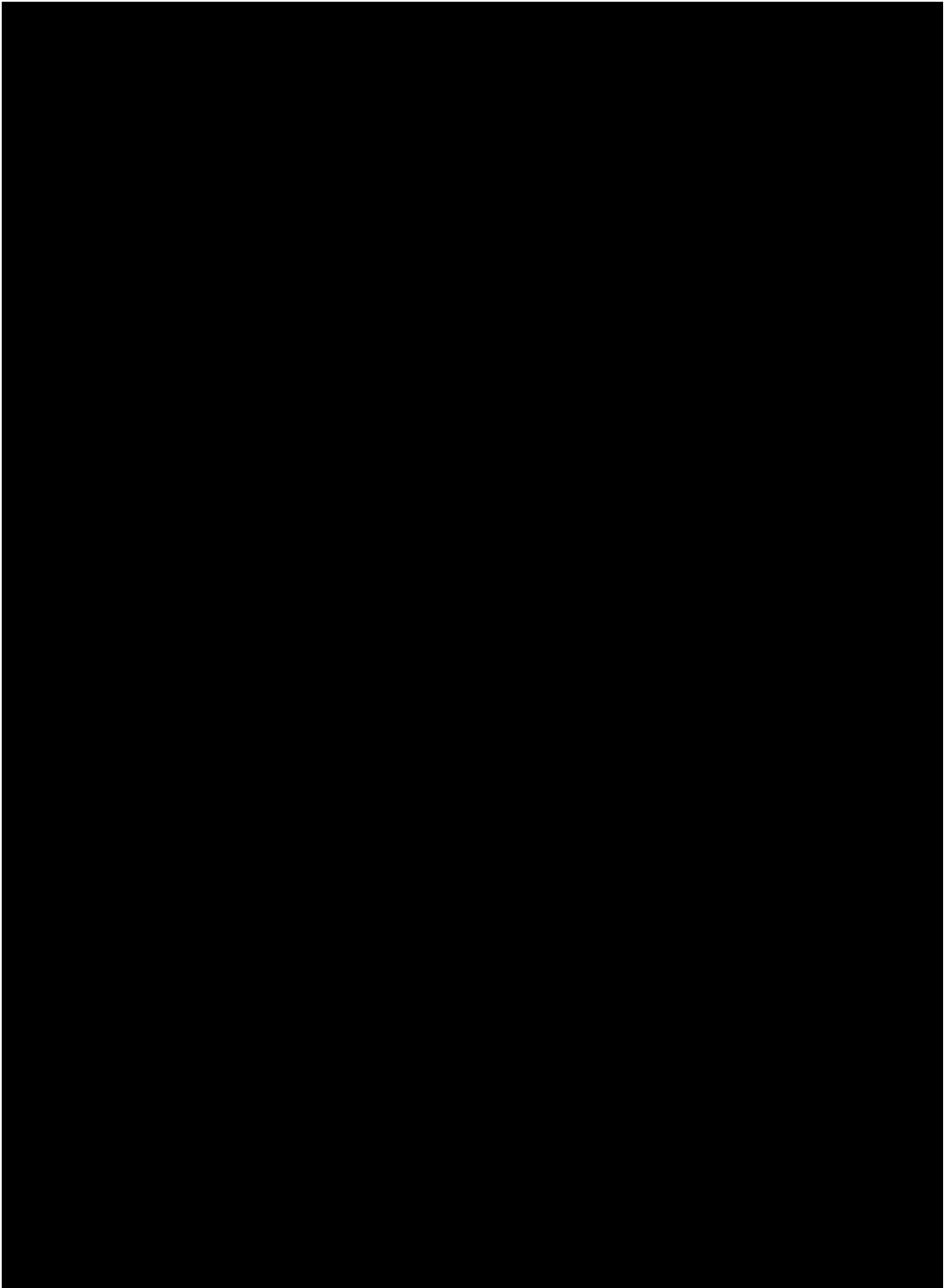


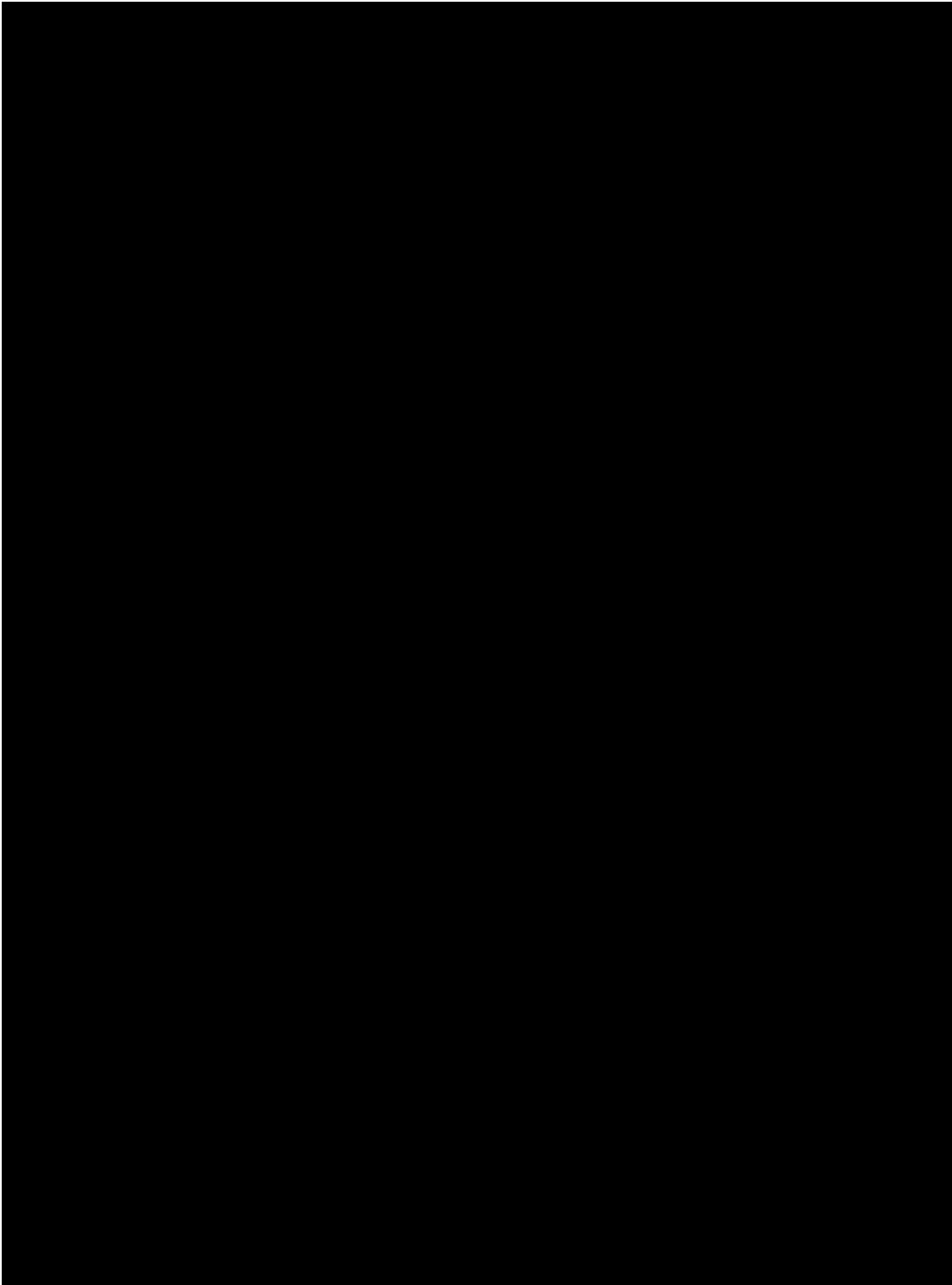


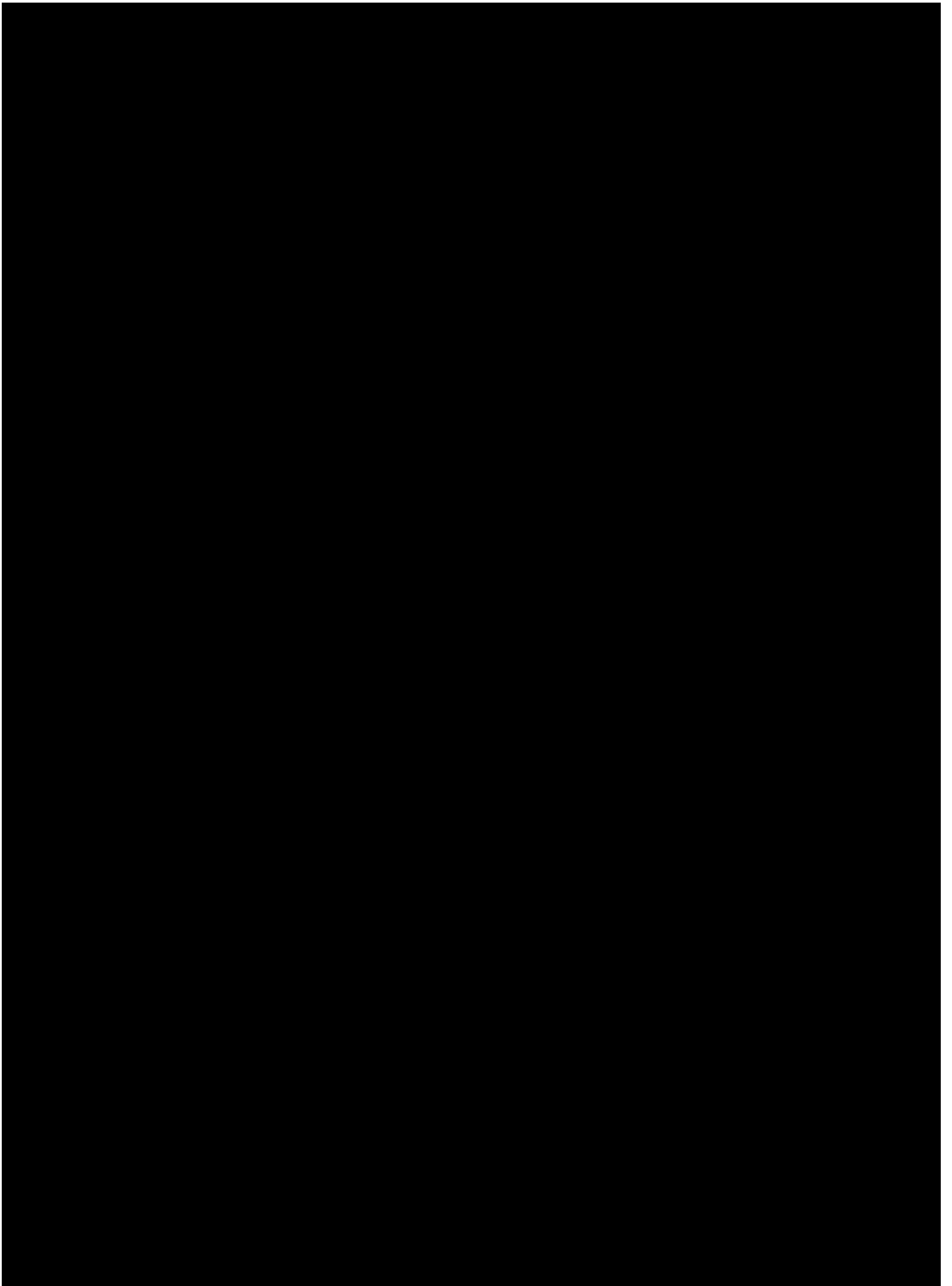


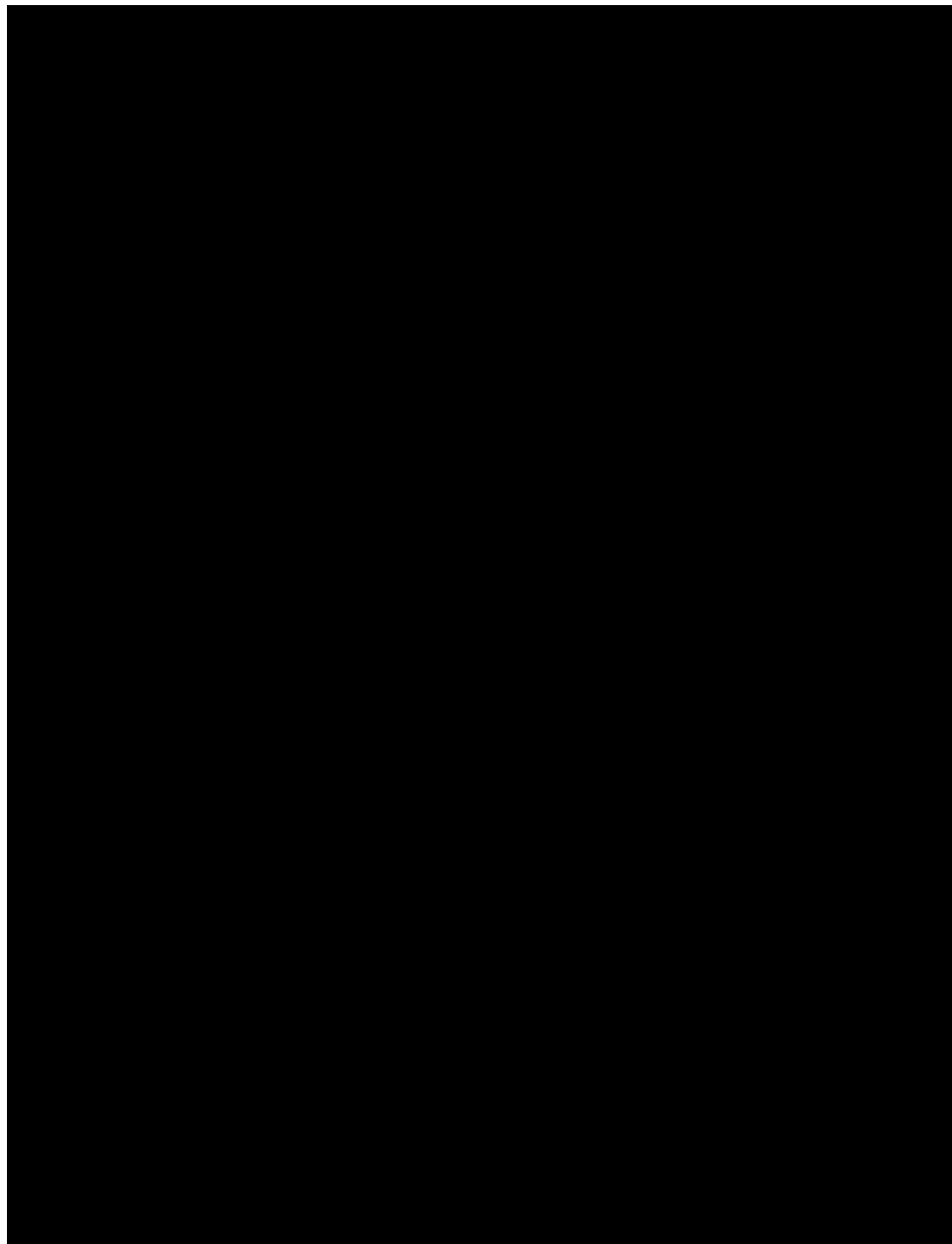


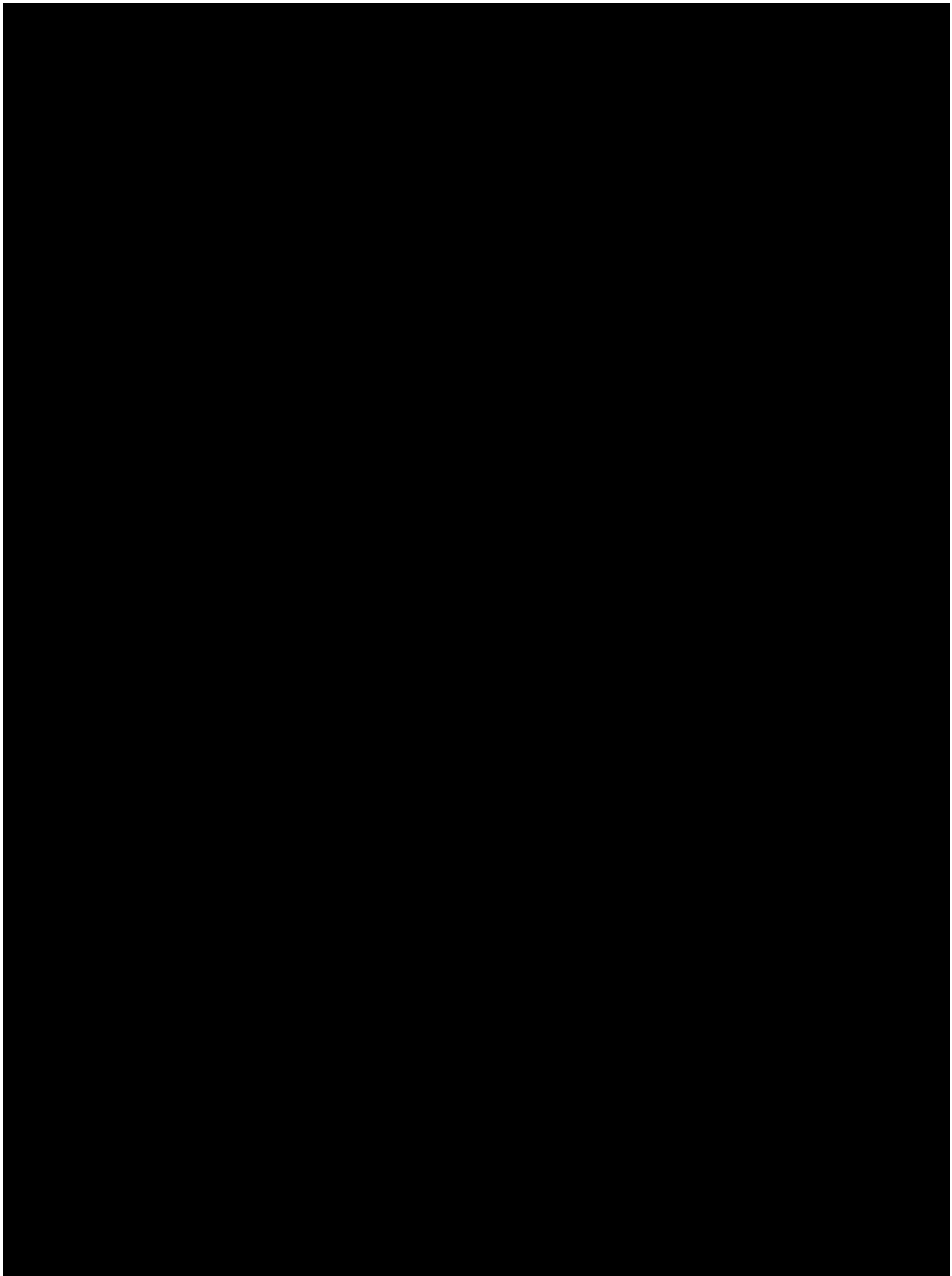


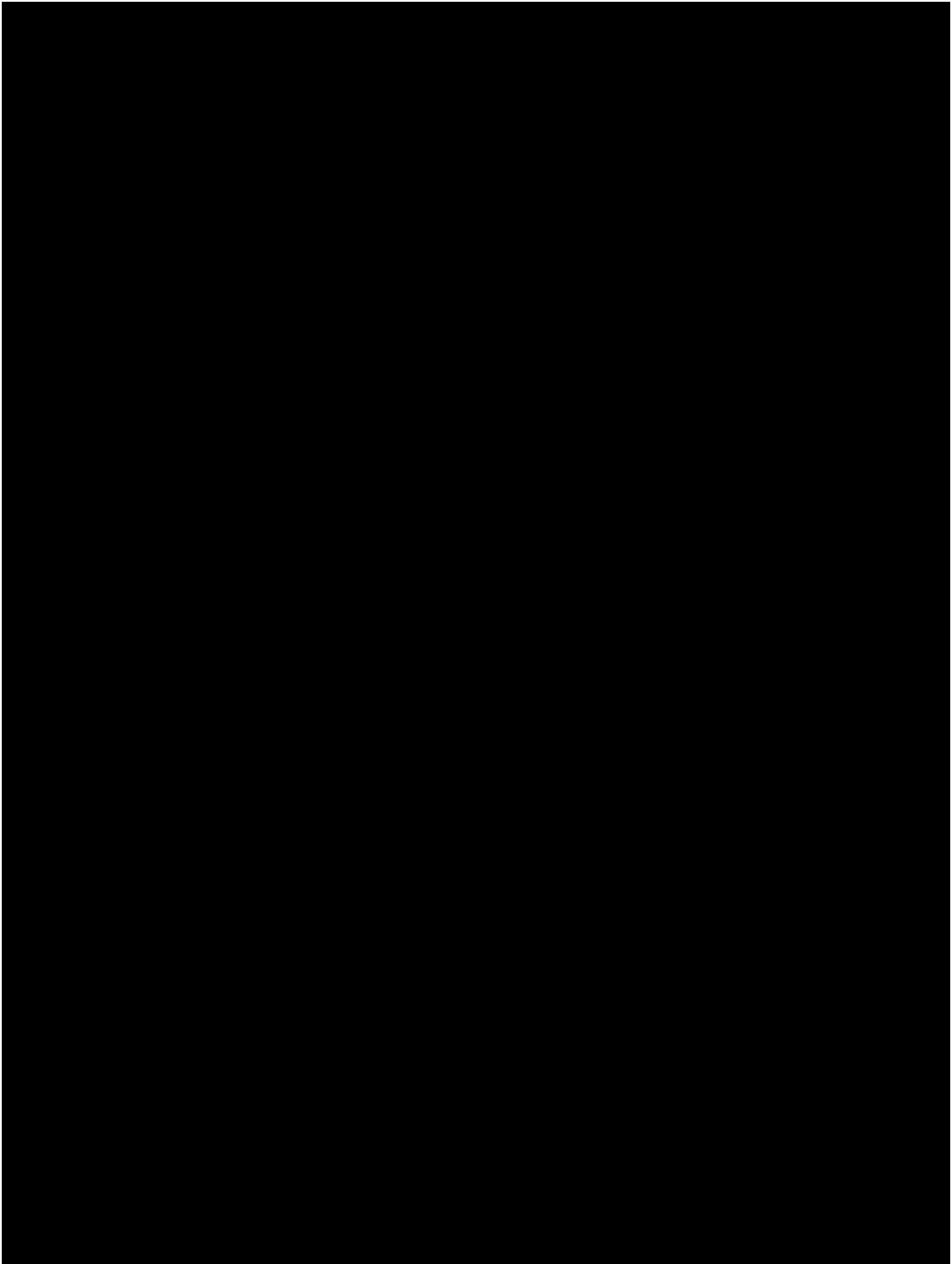


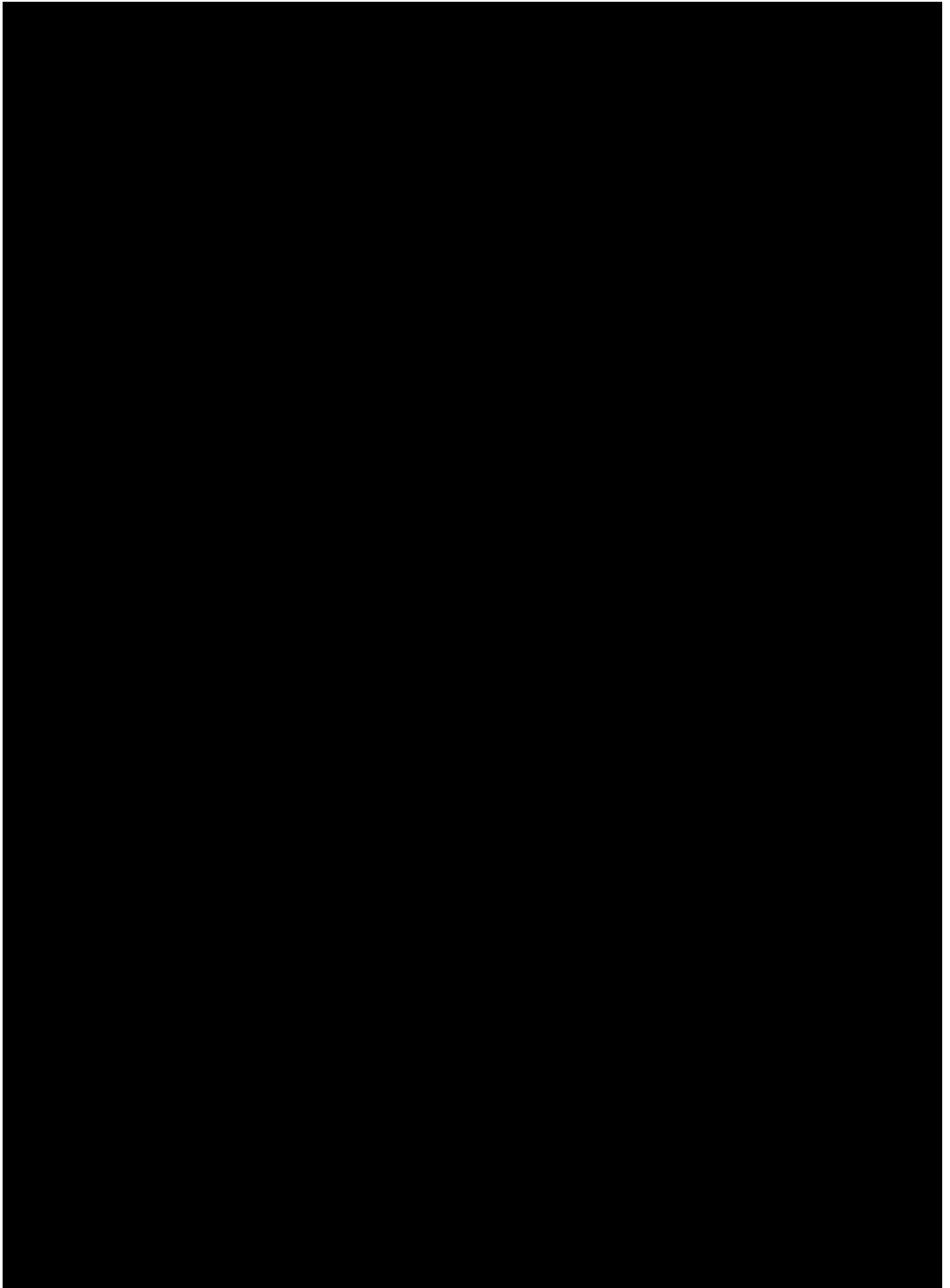


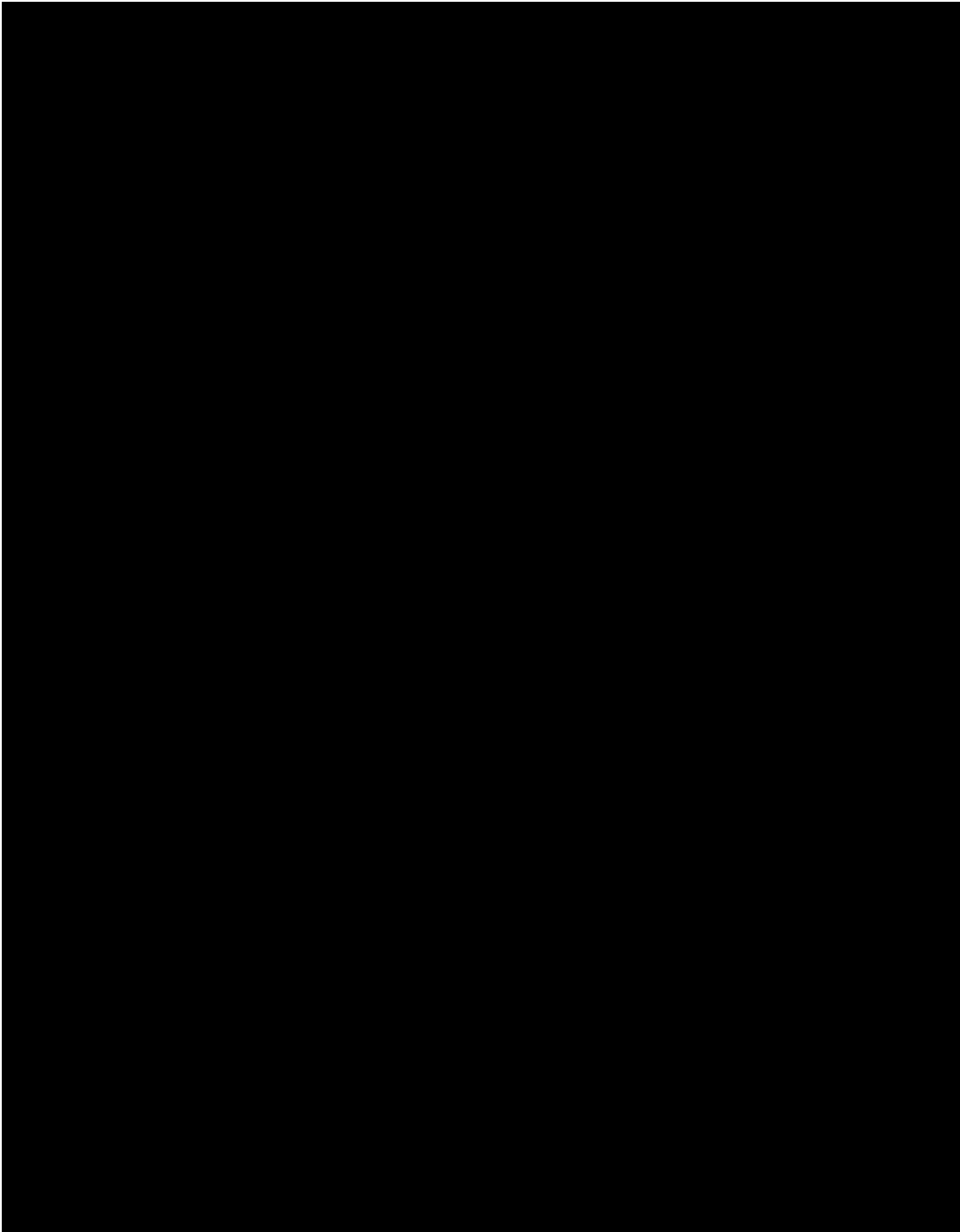


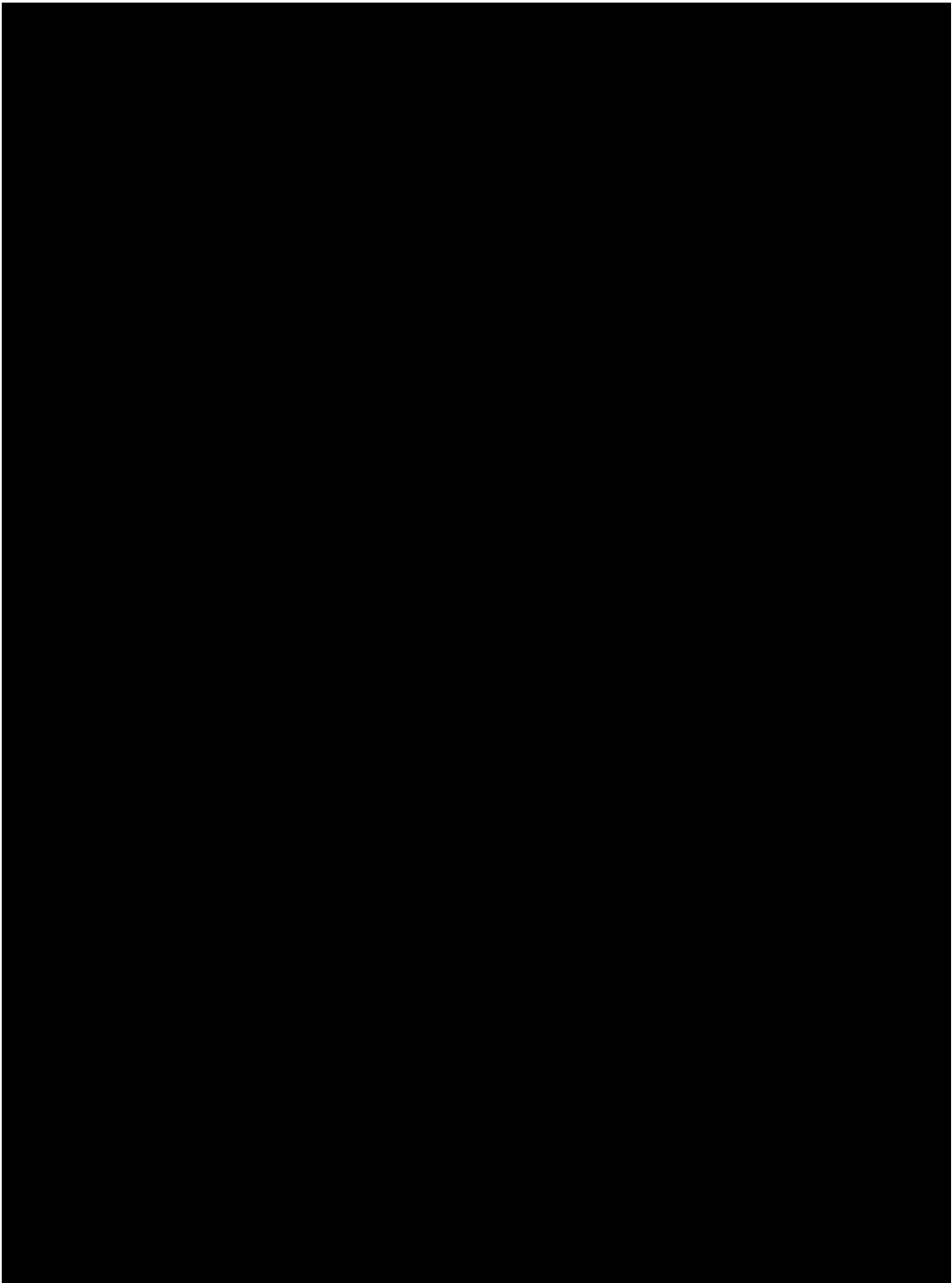


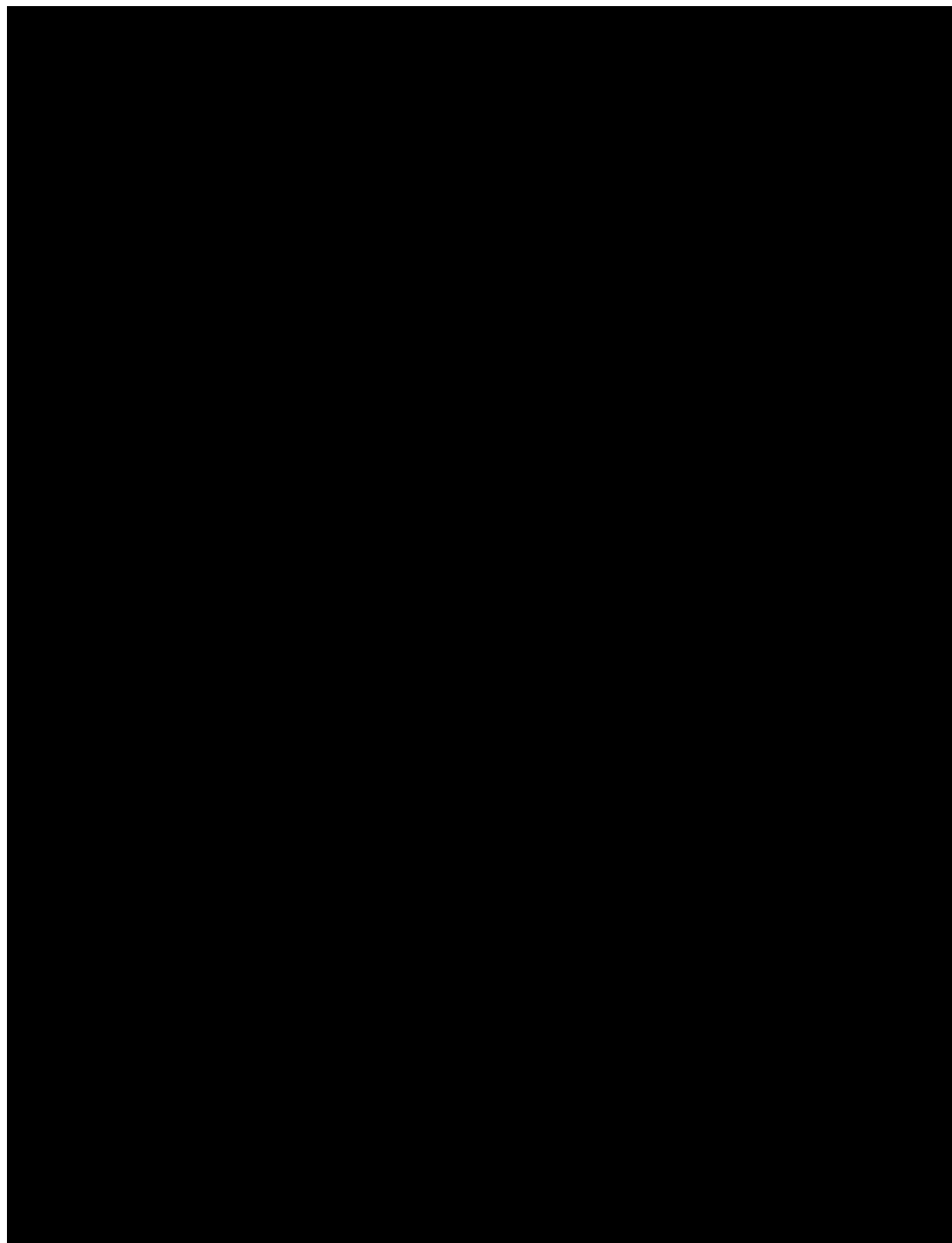


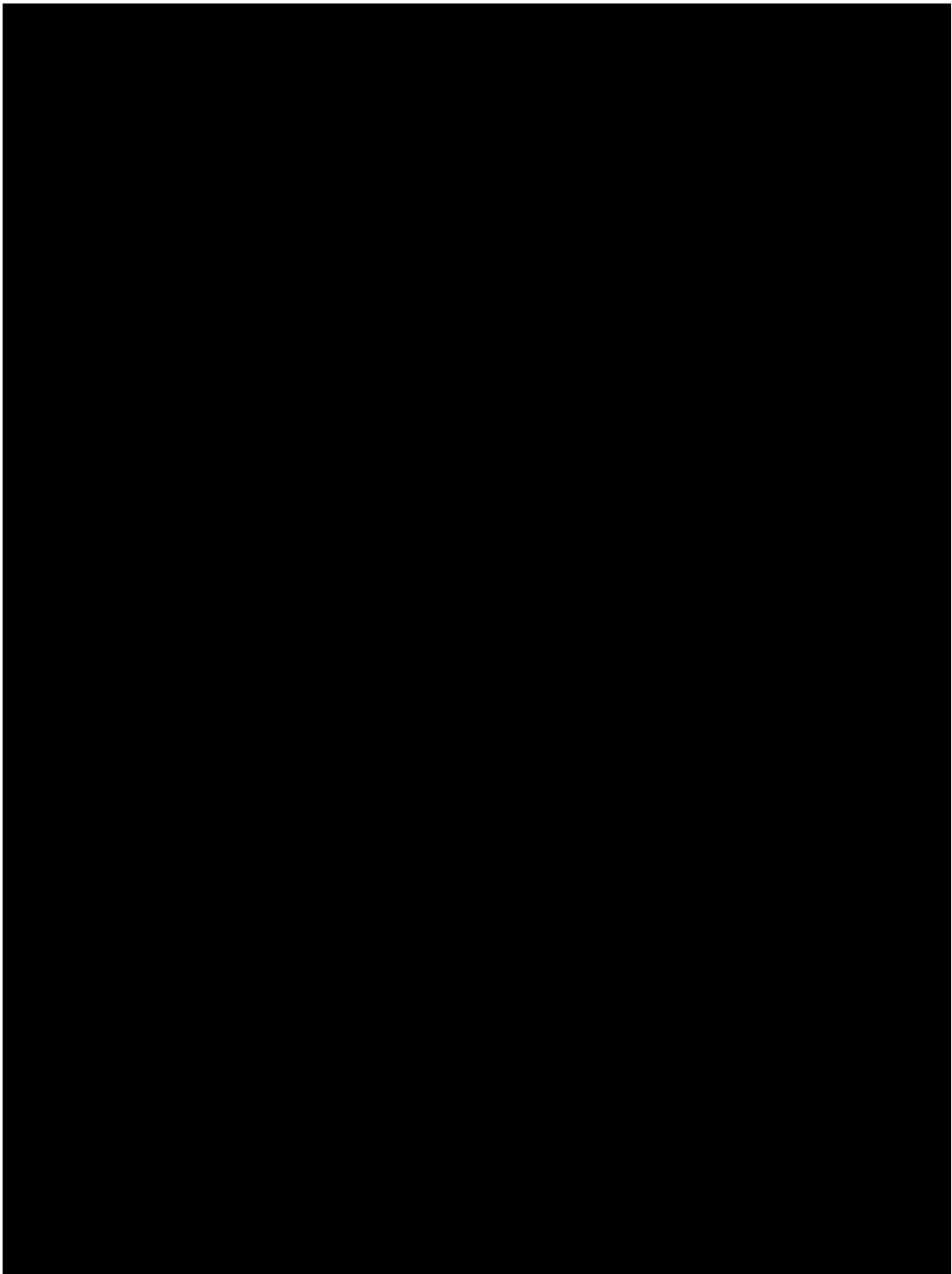














CHAPTER 10. DISCUSSION AND CONCLUSION



A food market in Northern Laos

This PhD research aimed to gain insights into the impact pathways of NSA interventions to improving nutritional status and the factors influencing the implementation and sustainability of the interventions in low and middle-income countries (LMICs). The multi-country mixed-methods research design explained in Chapter 3 aimed to achieve the research aim, by answering two research questions. The first research question concerns the impact of NSA interventions on nutrition and the pathways that lead from the interventions to improving nutrition. The second research question focuses on understanding the factors influencing the implementation and scaling-up of NSA interventions. Chapters 4-9 addressed these research questions, with Chapters 4-6 addressing the first research question, and Chapters 7-9 answered the second research question. This chapter will first describe the main lessons learned in relation to the overall aim of the PhD research, highlighting the contribution and implication of critical findings concerning the two research questions, followed by a theoretical reflection on NSA. Next, the recommendations for policies and programs will be presented. Furthermore, I will discuss the limitations of the research and future research priorities, and I will end this chapter with some concluding remarks.

10.1 Impact of NSA interventions on diet and nutritional status and the pathways from the interventions to improving nutrition outcomes

In this section, I discuss the impact of NSA interventions on nutrition and pathways that lead from the interventions to improving nutrition (see Figure 10.1).

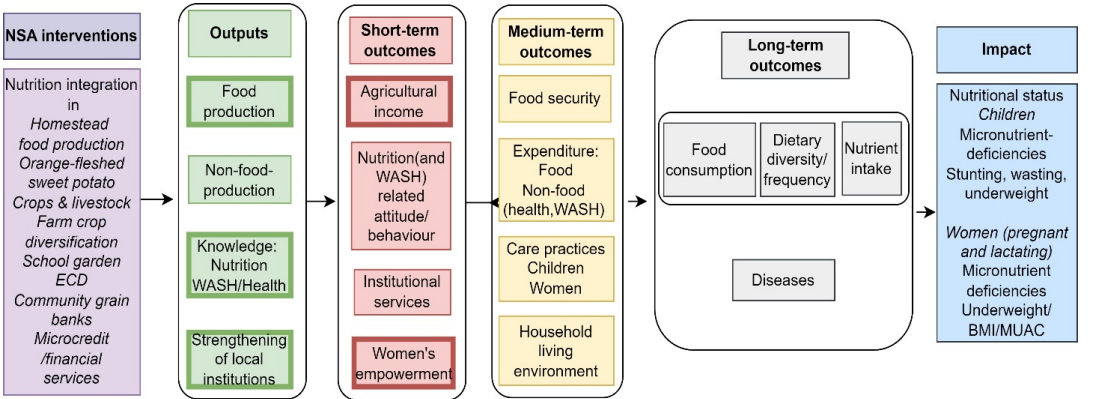


Figure 10.1. Simplified impact pathways from NSA interventions to nutrition outcome

10.1.1 Impact of NSA interventions on nutrition outcomes

While past studies have mainly focused on the effect of NSA interventions on selected nutrition outcomes such as nutritional status or diet [1-14], this research identified effects across temporal stages of the pathways from the interventions to nutritional status. In Chapters 4-6, we have found largely positive changes on dietary diversity, and micronutrient deficiencies. The systematic review (Chapter 4) and both case studies from Bangladesh and Laos (Chapters 5 to 6) reported positive changes on the dietary diversity of women as well as households in general. The review also indicated positive effects on children's dietary diversity, but this was not supported by findings from the case study from Bangladesh. Achievement of the diet-related impact could be linked to reductions in household food insecurity, accompanied by increased nutrition knowledge and improved dietary behaviour through nutrition education and behaviour change communication (BCC). It was further demonstrated in Chapters 4-6 that water, sanitation and hygiene (WASH) -related outcomes such as hand washing improved. This can be attributed to the integration of WASH into agricultural interventions. However, as water constraints are a crucial issue affecting food production as reported in Chapters 6 to 9, this research stresses the need to integrate multipurpose water systems that can serve household and agricultural purposes along with WASH-related BCC.

NSA interventions particularly reduced micronutrient deficiency and to a lesser extent underweight. Chapters 4 and 5 highlight the significant contribution of NSA interventions on improving micronutrient status and reducing micronutrient deficiencies (including vitamin A deficiency and iron deficiency anaemia). The consumption of micronutrient-rich foods may have resulted in an improvement in micronutrient status. As reported in Chapters 4 and 5, the interventions also reduced underweight, but the effects on stunting and wasting were limited, as only a few studies reviewed demonstrated the positive change. The Bangladesh-based case study in Chapter 5 reported a reduction in underweight children, with insignificant effects on stunting or wasting. The study conducted in Chapter 6, however, did report a reduction in children's stunting and wasting in Laos. As the cases included integrated multiple components such as BCC, agricultural production, and WASH, this may have contributed to the positive impact of reducing underweight.

A comparatively weaker effect on anthropometric indices may have been due to a lack of interventions addressing all underlying causes of malnutrition [15,16], a short project duration [17,18], or interventions targeting later stages of foetal life [18]. Agricultural interventions, if combined with nutrition and/or WASH-related knowledge and BCC, have the potential to affect multiple determinants of malnutrition,

such as children's care and hand washing practices, household environments, and reductions in diarrheal diseases (see Chapter 4). Furthermore, past studies have highlighted that a longer duration of the intervention is needed to demonstrate significant changes in the anthropometric indicators [18,19]. Additionally, improving anthropometrical measures may require careful selection of the target group. NSA interventions that aim to improve nutritional status, especially, stunting, should probably start targeting at least the start of pregnancy or before since the risk of stunting already develops in foetal life [18].

10.1.2 Impact pathways from NSA interventions to nutrition outcomes

The effects of NSA interventions discussed above are the outcomes of multiple pathways that translate from agriculture to improving nutritional status. As described in Chapters 4 to 6, this research highlights five such key pathways at the intervention level (see Figure 10.1): 1) Food production pathway; 2) Knowledge and BCC pathway; 3) Agricultural income pathway; 4) Women's empowerment pathway; and 5) Strengthening of local institutions pathway. While past studies have mainly focused on production, income, and women's empowerment [3,16,19-22], this PhD research contributes to the body of knowledge on NSA by identifying a novel pathway from strengthening of local institutions to improving nutrition. The findings also highlight nutrition-related knowledge and BCC being established as a pathway, although this was included as an NSA program component in past studies. Although this dissertation discusses the pathways separately, it is important to note that improved diet and nutritional status require a combination of multiple pathways. Below, I will first discuss the findings on these pathways followed by their sustainability as reported in the Bangladesh case.

Food production pathway

Consistent with past studies [1-13], we reiterate that food production is the central pathway in NSA interventions (Chapters 4-6). The production of higher quantities and diverse varieties of food because of NSA interventions' agricultural techniques and inputs led to an improved diet and income through the sale of surplus food. Food production can improve diets through preservation, processing, storage, household preparation, and household distribution (Chapter 4). Production can also lead to increased income due to the sale of surplus products. However, as reported in systematic reviews and various cases, the production effects varied across different products. For example, most of the studies reported the production of vegetables while only a few showed a positive effect on increased production of fruits (Chapter 4). While the production of vitamin A-rich and other vegetables was good, the low production

of legumes in Laos is a concern (Chapter 6). Moreover, producing food alone is insufficient, as it requires sufficient knowledge of the consumption of nutrient-rich food.

Nutrition knowledge and Behaviour Change Communication (BCC) pathway

Although several past studies stress the need for knowledge and BCC as a component in food production interventions [15,16,20,22], we argued that nutrition knowledge and BCC should be considered a separate pathway for agricultural production to be nutrition sensitive. The knowledge/BCC activities contributed to the awareness of several subjects on nutrition and WASH, which resulted in improved dietary and care practices through a change in behaviour or nutrition-related attitude (Chapter 4). Case studies in Chapters 5-6 also reiterated the role of this pathway in improving dietary intake and WASH practices. Integration of this pathway with the agricultural production pathway is essential to convert food production into consumption of nutrient-rich diets through an increase in demand for such diets from beneficiaries, accompanied by sufficient income.

Agricultural income pathway

Despite the crucial role of income in nutrition, the income pathway is still relatively underdeveloped in both programming and research. Although a few participants reported a change in income [12,23,24], results on how the income was translated into nutrition-related expenses are limited. Although both the cases selected for this research provided little attention to this pathway, the review and case studies, suggest its role in contributing to expenses on food, WASH, and children's education, intervening in multiple determinants of malnutrition (Chapters 4 to 6). However, the translation of income to nutrition varied across the countries, with the beneficiaries in Bangladesh prioritizing less nutrient-rich foods than Laos. Future investments in both interventions and research should prioritize this pathway to address poverty and affordability-related barriers to nutrition. For instance, a healthy diet in Bangladesh costs USD 3.064 per person per day and in Laos USD 4.14 per person per day, which many people cannot afford [25]. We suggest the need to maximize the contribution of income pathway to increasing affordability.

Women's empowerment pathway

We have found limited evidence on the full pathway from women's participation in interventions to their empowerment, eventually leading to better nutritional outcomes. However, our studies did indicate positive changes in the elements of the pathway through increased access to resources, improved decision-making, and protected time. While several past studies have reported changes in women's empowerment-related domains [3,26-29] or effects of empowerment on reducing wasting [3], these studies did not report a complete pathway from interventions to nutrition. Although the cases included

in this research did not explicitly focus on this pathway, this PhD research highlights two sub-pathways emerging from the participation of women in NSA interventions to nutrition. First, NSA interventions can enhance women's intra-household decision-making and access to resources (Chapters 4 and 6). This sub-pathway leads to nutrition from financial empowerment and access to resources through participation in gender-sensitive agricultural interventions and gender-transformative approaches. The NSA project in Laos engaged the husband to change gender roles. The second sub-pathway concerns the contribution of interventions to saving women's time. There are some indications of reductions in women's time spent in finding vegetables as they have access to the home gardens. However, it remains unclear what its effects are on nutritional status (Chapters 4 and 6). The translation of resource access and saved time on nutrition was, however, not conclusive in our studies. A recent study highlighted the lack of effects on food expenditure despite some changes reported in decision-making [29]. Making women's empowerment work for nutrition, thus, requires not only empowering women, but also intervening across all elements from the domains of empowerment to nutrition-related expenditure, nutrition-related decision-making, or using more time for one's own and children's care.

Strengthening of local institutions pathway

Strengthening local institutions is a novel pathway that we identified in this PhD research. As LMICs transform the food system toward more nutrition sensitive system, it requires a structural and sustained change at the system level, from food production to processing to distribution to consumption. Enhancing agriculture's effect on nutrition necessitates strengthening the capacity of local institutions in relation to NSA to achieve the nutrition objective not only in the short term, but also in the long term. A shift from the traditional status quo of staple-based production to a more nutrition-sensitive food system requires leveraging nutrition in agriculture programs, as seen in the cases of Bangladesh and Laos. In the case of Bangladesh, the interventions strengthened existing health institutions that enhanced the delivery of services such as iron supplementation (Chapter 5). Likewise, strengthening agricultural services by training vaccinators resulted in enhanced extension services (Chapter 5). Despite its benefits in improving access to services, the strengthened capacity was, however, not sustained after the project funding cycle. This also calls for the intervention in Laos to invest in the sustainability of the interventions beyond the funding cycle, as the project is still ongoing (Chapter 6). This pathway, therefore, stresses strengthening the capacity of agriculture institutions to integrate nutrition into their daily practices, not only at the project level, but embedded in the system. Transforming into a more nutrition-sensitive food system necessitates this pathway. From a CAS perspective, improving institutions is critical, as it increases the likelihood that NSA interventions can be embedded in and change the food system. These institutions can contribute to

designing and delivering the NSA interventions, as well as sustaining and scaling-up interventions within the food system.

Sustainability of the pathways

The sustainability of NSA interventions and their pathways is a rarely explored topic. In Chapter 5, the Bangladesh case reveals the continuation of food production practices, especially of vegetables, and their understanding of nutrition-related knowledge. Our finding on the relatively lower sustainability of poultry is different from those of Senegal [30]. The low sustainability of poultry in Bangladesh could be attributed to poor adaptation to climatic conditions or diseases or the absence of project-provided feed. In addition to the project interventions, different co-located time-bound programs contributed to sustaining the knowledge and production pathways. The sustainability of income and women's empowerment pathways is inconclusive as the cases selected only indirectly focused on these pathways, which needs further investigation. NSA projects have mainly focused on strengthening the agricultural system combined with nutrition knowledge and the BCC pathway during the funding period, as was also evident in the cases of Bangladesh and Laos (Chapters 5-6). However, the discontinuation of the mechanisms created to facilitate initial adoption, such as the provision of free inputs, farmers' field schools and multisectoral coordination, urges special attention. Bangladesh has been facing the challenge of a lack of sustainability beyond the project period due to inadequate institutional capacity namely, human resources, technical capacity, and budget limitations. Enhancing sustainability requires strengthening the capacities of local institutions so that they can continue the project activities beyond the funding period (Chapter 8).

10.2 Factors influencing the implementation and sustainability of NSA interventions in low and middle-income countries

Shifting from the traditional status quo of agricultural programming to delivering nutrition-sensitive activities means implementing a complex package of interventions that combine food production activities with nutrition-related actions. Such a shift involves complex agriculture nutrition linkages, as they are interconnected within several sectors. Such complexity is further increased due to the complicated setting where the interventions are delivered, mostly in hard-to-rich communities in LMICs. Gaining insights into the factors that affect the implementation and scaling up of NSA interventions in subsistence farming communities in the LMICs is therefore highly relevant. The systematic review (Chapter 7) and two case studies from Bangladesh (Chapter 8) and Laos (Chapter 9) suggest that implementing such interventions is greatly influenced by various factors interconnected across the five

domains of the conceptual framework: outer setting, inner setting, characteristics of actors, intervention characteristics, and implementation process (see Figure 10.2). The factors in the outer setting include the nutrition sensitivity of existing policies and the national institutional framework. The inner setting comprises the biophysical environment, cultural, social, and economic environment, and local capacity. The characteristics of individuals that affect implementation are mainly the capacity of beneficiaries. Key factors in intervention characteristics are adaptability, relative advantage, acceptability, design quality, and complexity. Several implementation process-related factors, including fit-to-context, targeting, multisectoral collaboration, and engagement with actors, also influenced the implementation.

Below, I will discuss the main lessons learned, highlighting the contribution of key findings on the factors influencing the implementation and sustainability of interventions.

Policy in the outer setting and institutional capacity in the inner settings

A disconnect between the policy in the outer setting and the institutional capacities in the inner context resulting in inadequate implementation on the ground is a significant challenge (Chapters 7 to 9). Past studies have highlighted the facilitating role of policies and the hindering effects of lack of institutional capacity [31,32]. This research stresses the need for enhancing institutional capacity to facilitate the design, implementation, and sustainability of evidence-based interventions and to contribute to policy implementation. Having a nutrition-sensitive policy is a facilitator to enhancing nutrition sensitivity, as it guides program design and implementation (Chapter 7-9). Several LMICs are experiencing a high level of political commitment through existing nutrition-sensitive policies [15] and thus starting to leverage nutrition in agriculture, as evident in the case studies from Bangladesh and Laos. However, numerous barriers hinder the implementation of such policies on the ground in both countries. A lack of coordination between sectors, insufficient and incapacitated human resources, and disconnect in targeting by agriculture and nutrition are key issues affecting policy implementation (Chapters 8 and 9). The issues seem to be mainly due to a lack of capacity of local institutions, particularly to support the continued application of the new practices. The alignment between policies and institutional capacity is thus imperative for having fertile ground for NSA interventions.

On the other hand, policies in other areas may act as a barrier to NSA interventions. For example, in Laos (Chapter 9), poor access to land to adopt home gardens was the result of land planning and resettlement policies (see Figure 10.3). Although a few past studies have linked the relocation of villages with influences on land and livelihood [33,34], this PhD research goes beyond the linkage and demonstrates the effects of the relocation on the implementation of NSA interventions as well (Chapter 9).

OUTER SETTING

Nutrition sensitivity of existing policies : nutrition-related policies and campaigns, village resettlement

INNER SETTING

Biophysical environment: natural resources, seasonality, agro-climatic condition, mortality of livestock, natural disasters, remoteness

Cultural, social and economic environment: traditional practices, gender inequality, events and festivals, community groups, income opportunities

Local capacity: Community infrastructure (market and road), Community based programs and projects, Institutional capacity, Local policies

INTERVENTION

INTERVENTION CHARACTERISTICS

Adaptability
Relative advantage
Acceptability
Design quality
Complexity
Cost

IMPLEMENTATION PROCESS

- Planning: fit-to context, targeting
- Execution: timing
- Engagement: Coordination, engagement with beneficiaries, implementers, private sector
- Reflection and monitoring: implementation fidelity & monitoring adoption

CHARACTERISTICS OF INDIVIDUALS

- Beneficiaries:
- Individual characteristics: ethnicity, self motivation, dependency,
 - Household capacity (financial, labour and time, and physical resources)
- Implementers:
- motivation
 - skills

Figure 10.2 Factors affecting the implementation of NSA intervention, integrating results from Bangladesh and Laos

Thus, nutrition-sensitive policies facilitated the implementation through the design of the interventions, but implementing these policies requires strengthening institutional capacity. It is also significant to ensure that agriculture and nutrition policies and those beyond do not constrain the implementation of NSA interventions.



Figure 10.3 Houses in the study area [Laos] are closely located due to resettlement, limiting the space for home gardens

Multisectoral design, an intervention characteristic

The literature review showed that convergence of multiple sectors facilitates addressing the malnutrition challenges of vulnerable populations [35, 36]. Such a response goes beyond agricultural production to a food system approach to the nutrition-sensitive value chain across different stages from production to food consumption. A convergence across health, education, livelihood, natural resources, and forestry sectors, as well as stakeholders, such as governments, (international)NGOs, private sectors, and donors, may help address the nutrition challenges. Both the cases in Bangladesh (Chapter 8) and Laos (Chapter 9) converged sectors beyond agriculture to provide an integrated response to addressing malnutrition, which facilitated the initial design.

Multisectoral coordination at the implementation process

A multisectoral intervention design necessitates multisectoral coordination during implementation. However, inadequate multisectoral collaboration at the implementation level limited the studied NSA projects in Laos and Bangladesh. The main issues were scheduling conflicts, differences in targeting (Chapter 9), and a lack of continuation of the project-based collaboration beyond the funding cycle (Chapter 8).

Biophysical and sociocultural factors in the inner setting

Several biophysical and sociocultural factors in the inner setting affected the implementation in both countries, Bangladesh, and Laos. The factors that persisted in both countries were seasonality, agro-

climatic conditions, remoteness, natural disasters, natural resources, local capacity, co-location of programs, and socio-cultural and economic environments. Some of these factors have also been reported in past studies [37-40]. Factors could, however, be quite context specific. For instance, conditions such as cyclones and water salinity significantly affected the southern Bangladesh context (Chapter 8). Access to natural resources and upland farming were predominant factors in Laos (Chapter 9). Likewise, cultural factors in terms of ethnicity highly affected beneficiaries' participation in Laos (Chapter 9), but gender inequality affected both countries (Chapters 8 and 9). A significant barrier in Laos was that a few ethnic communities could not understand the language used by district-level implementers, which hindered their participation (Chapter 9). These contextual factors strongly affect the success of NSA interventions, and their context specificity calls for tailored strategies to address the barriers.

Incorporating the context of local food system in the inner setting

Incorporating the context of the local food system as an important intervention characteristic can facilitate the implementation. The system-related capacity in the inner setting concerns market access, the presence of other programs, access to natural resources, and institutional capacity, which were key factors in both Bangladesh (Chapter 8) and Laos (Chapter 9). Although the role of the market, institutional capacity and natural resources in implementation were reported in past studies [31,40-42], this research highlights the nuances across different cases. Also, due to the nature of the topography, having abundant access to the coastal zone in Bangladesh seemed to be a facilitator for boosting the fishery sector and improving food security. In the case of Laos, proper management of access to natural resources (forest products including wild food) and upland land could provide opportunities to boost food security. NSA should, therefore, build upon the existing implementation context of traditional practices to reorient them toward nutrition sensitivity and motivate beneficiaries to adopt improved food production and optimal nutrition practices. An important step forward in the case of northern Laos could be to examine how the forests in the mountainous agro ecosystem can be sustainably incorporated into NSA to improve its effects on nutrition (Chapter 9). A success factor reported from Laos (Chapter 9) was the role of community engagement. Consistent with a past study that has also suggested the role of involving local influencers to facilitate implementation [43], we highlight that engaging the community may support not only the execution of activities but also generate resources to facilitate and sustain implementation. Interventions should, therefore, be adaptable to the implementation context, some of these facilitators are evident in our case studies (Chapters 8 and 9).

Characteristics of actors

The characteristics of participating households and communities strongly determine the success of NSA interventions. As reported from Bangladesh [Chapter 8] and Laos [Chapter 9], making pathways from interventions to nutrition effective depends upon their absorptive capacities. Agriculture components of NSA interventions mostly target households that have access to some resources (e.g., land, water, time, labour, and money) to start the adoption of food production practices. These households are still considered poor but have more access to resources than the poorest households within their community. In Chapters 6 to 9, we highlighted that these inclusion criteria constrain NSA from targeting the most nutritionally vulnerable households. Past studies have reported on a few of these factors – a lack of land and water, in particular [43-45]. For instance, almost 77% of small-scale farms are in water-scarce regions [46]. This implies that targeting nutritionally vulnerable populations, the desired trait of NSA programs [47], will not be fulfilled if those without resources are excluded from agricultural interventions.

Implementation and characteristics of actors

Implementation design and processes should enhance the targeting of agriculture and nutrition BCC components. While agricultural interventions target households with access to land, nutrition-BCC targets nutritionally vulnerable households irrespective of resources. The lack of full convergence may restrict the nutritionally vulnerable to benefit from the agricultural production component, making it an urgent issue constraining the nutrition sensitivity of agriculture (Chapter 9). Additionally, the inadequate participation of targeted beneficiaries is a critical barrier affecting their participation and adoption of interventions. A lack of participation by women from minority ethnic groups in programs and the involvement of other household members rather than the women themselves were barriers (Chapter 9). Therefore, intervention design should consider strategies to increase women's participation while at the same time ensuring that they are not overburdened (Chapter 9).

Dilemma in achieving adoption on the short term versus sustainability on the long term

A focus on initial adoption with less attention on sustainability or scaling-up was found to negatively affect continuation of the interventions after the project period. Furthermore, as reported in Chapter 8, the sustainability of some mechanisms created for long-term adoption, such as beneficiaries' groups and multisectoral collaboration, was rarely evident post-project cycle. The discontinuation of resource-intensive inputs or activities beyond the project funding cycle may hinder sustainability. For example, in the Bangladesh case, a lack of incentives for participation and funding support for agricultural inputs beyond the project period hindered the long-term adoption of interventions. Trade-off between

measures to facilitate initial adoption and sustainability could originate from the need to achieve time-bound short-term targets, thereby neglecting sustained impact [48]. Nevertheless, some mechanisms can continue within the role of new projects implemented in the areas after the specific project cycle through coordination with different sectors and nutrition integration in agriculture (Chapter 8). However, it is also important to note that these enabling environments are context specific. While NGOs, through time-bound projects, generally fill the human resource gap in Bangladesh, Laos' institutional mechanism is such that government institutions directly implement the interventions at the field level. The presence of small-scale time-bound projects that are dependent upon donor funding, however, makes it difficult to scale up or sustain the interventions beyond the project cycle. This is because of the lack of dedicated resources and limited public service institutional capacity (Chapter 4).

10.2 Theoretical reflections on NSA as part of a complex adaptive system

Taking a complex adaptive system (CAS) perspective in our analysis, implies we look at NSA interventions as novelties introduced in the food system; a system that will need to undergo long-term and structural changes [49] to embed nutrition in the agriculture sector's culture (thinking), structure (organizing), and practice (doing). Throughout the chapters, and as hypothesized in Chapter 2 of this dissertation, we learned that embedding NSA *practices* requires a shift in: 1) culture towards nutrient-rich diverse food production and consumption rather than focusing on a mono-diet, targeting children and women; and 2) structure incorporating nutrition objectives and developing institutional capacity that ensures not only the production of diverse agricultural products but also reaching diverse diets; and an increasing role for multisectoral working. However, as discerned from the cases in Bangladesh and Laos, food systems are very robust and resilient, which makes these shifts highly complex. As mentioned above, while several beneficiaries adopted NSA practices during the project implementation, there were instances of relapse in home garden practices in the case of Laos (Chapter 9), and we further found limited sustainability of the mechanisms created for long-term adoption in Bangladesh (Chapters 5 and 8).

While the interventions created positive feedback loops and changed practices during the implementation, the system tended to bounce back to 'doing business as usual' with only the adoption of a few practices imparted by the project. During the implementation, positive feedback loops reinforced 'new' patterns that indeed contributed to structural change. For instance, nutrient-rich food consumption emerged due to the production of nutrient-rich food, knowledge of nutrition, and market or income. Demand for vegetables emerged owing to increased production (Chapters 6 and 9). Access to training

reinforced the adoption of the home garden for the families that had resources (Chapter 10.2). Several barriers, in particular a lack of resources such as land, water, labour, and time, resulted in negative feedback loops that prevented the continuation of practices. Access to knowledge and production of limited specific food groups could not fully translate into adequate food consumption due to a lack of market (Chapters 6, 7, and 9) [51]. Furthermore, increased production of food affected the marketing of produce, discouraging participants from producing surplus food. External factors, such as the land policy that constrained adopting home gardens, also had an impact on the implementation of NSA interventions.

Although the system changed within pilot settings, we observed that only a few components of NSA interventions were sustained, such as vegetable growing techniques and nutrition-related knowledge. Others were partly or completely discontinued, e.g., the mechanisms of learning and reflection such as Farmers' Field Schools, multisectoral coordination, and extension of the project-supported veterinary services (Chapter 5 and Chapter 8). I, therefore, argue that food systems tend to bounce back to the stage where only a few practices are embedded in the system.

Bringing long-term adoption or sustainability to the food system requires a change in the mechanisms within the system to alter the dominant culture, structure, and practice across all elements of the food system. Changing the culture, structure, and practice requires strengthening the local institutions that can go beyond the time-bound project period, the fifth pathway (see 10.1). Specific projects in this research contributed to sustained vegetable production practices because knowledge, techniques, and income from selling surplus, motivated the farmers to continue these practices. Likewise, the sustained understanding of nutrition and vegetable production practices was the result of the continued motivation of farmers that was provided through technical support by the project and other projects implemented in the same area after the funding cycle. After the project cycle, new external forces or other NSA projects implemented in the project area also contributed to sustaining knowledge and some production practices. NSA innovations that aim to change traditional food production practices through the adoption of nutrition-sensitive interventions must focus on strengthening the existing local institutions that deliver agriculture interventions.

10.3 Recommendations for policy and practice

In this section, I will first highlight policy-related suggestions, followed by recommendations for the design and implementation of NSA.

10.3.1 Recommendations for policy

Translating policy to practice

Both Bangladesh and Laos have developed agricultural policies that incorporate nutrition. Implementation of these policies, however, requires technical and financial investment to increase the readiness of local institutions for implementation. The agriculture sector ministries, external development partners, and non-government organizations should focus on strengthening the capacity of institutions responsible for delivering agricultural services. The government institutions mainly concern ministries and departments of agriculture sectors (horticulture, livestock, and fisheries sub-sectors) and their sub-national counterparts in Bangladesh. Similarly, the institutions in Laos should include the ministries, departments, and their sub-national institutions representing agriculture, land management, livestock and fisheries, forest, and Lao women. The development of policy implementation guidelines with clear action plans, the allocation of budget and human resources, and the establishment of monitoring and evaluation systems to make agriculture accountable can be some entry points. Nutrition message integration in agriculture extension to communicate with farmers can be a strategy to promote NSA accompanied by sufficient extension workers to reduce their workload can be an entry point. Strengthening the capacity should also be the priority of donors or future funding agencies, development partners and all related institutions to leverage nutrition across all levels from national to grassroots.

Policy coherence

Government at agriculture, land and forest-related ministries and other stakeholders should improve coherence across natural resources – agriculture, land, water, and forest – to ensure synergy as well as mitigate possible harms to NSA interventions. In Laos, the Ministry of Agriculture and Forestry enhances the coherence of policies and programmes focused on land, water, and forest resources.

Enhancing coordination across sectors and projects

Governments should create a mechanism to facilitate multisectoral coordination at all levels. Some strategies to enhance the coordination could include strengthening existing multisectoral platforms, such as nutrition coordination committees at national and subnational levels, harmonizing targeting, and establishing accountability mechanisms for sustaining the multisectoral collaboration beyond the project period. Effective coordination requires accountability structures in all sectors [89]. As Bangladesh and Laos record several time-bound programs and projects aimed at altering determinants of malnutrition, improving coherence across these projects from design to evaluation can help sustain good practices.

10.3.2 Recommendations for NSA practice

Revise targeting

NSA program designers should revise targeting in two ways. First, the agricultural interventions and nutrition BCC should both target nutritionally vulnerable households with women and children so that agriculture considers the need of the vulnerable populations to benefit from agricultural production activities. This particularly applies to cases where agriculture mainly targets households with sufficient resources for produce food. Second, program designers should tailor interventions based on economic status of the households through an 'equity lens'. NSA projects should acknowledge that certain groups, such as those without land, will probably not benefit unless land leasing is arranged. In such cases, NSA should widen its scope beyond food production by including income pathways or connecting to broader sectors such as income-generation activities, land-leasing interventions, or linkages with social protection programs.

Integrate multiple intervention components

As nutrition is a multisectoral agenda, agriculture interventions that integrate nutrition-related BCC, WASH infrastructure and income-related activities can contribute to improved food security as well as hygiene and sanitation, thereby addressing multiple underlying barriers to achieving adequate diet and nutrition. However, addressing multiple barriers may not always be possible through agriculture alone. Therefore, the integration of different activities in agriculture such as social safety nets, or co-targeting and collocating the same beneficiaries by different programs or sectors is recommended.

Strengthen agriculture income to nutrition pathway

Future investments should provide special attention to income pathways to address poverty and affordability-related constraints, as most rural poor rely on agriculture as their primary source of livelihood. Improving nutrition through agricultural income requires diversifying income options in production and off-farm sources through strategies such as employment in input selling, food processing, food distribution, and other off-farm livelihood options. The private sectors can play a crucial role by not only buying or selling agricultural products, but also engaging vulnerable households in value chain activities.

Empower women and incorporate gender transformative approach

This research suggests more attention to gender equality and women's empowerment in three ways. The first is the need to increase the participation of women in NSA program's activities. Inequality in

participation related to intersectionality between gender and ethnicity, which was a significant issue in Laos. This needs a gender transformative approach that carefully examines gender dynamics and norms and promotes equality by intentionally creating and shifting culture, structure, and practices for equality [52]. Such a transformative perspective also addresses the following three critiques of the current gender approach to nutrition: focus on visible effects such as training or input supply rather than addressing social constraints; reversible effects after the end of the project cycle; and perverse outcomes, such as an increase in the workload of women because of participation in interventions. The transformative approach should be accompanied by proper nutrition-related BCC and sufficient income so that women's participation leads to empowerment and decision-making on nutrition.

Contextualize interventions

Program designers and implementers should contextualize interventions across different geographical locations. NSA should build upon the existing implementation context of traditional practices to reorient them to be more nutrition sensitive. Having abundant access to the coastal zone in Bangladesh seemed to be a facilitator in boosting the fishery sector and improving food security. In the case of Laos, proper management of access to natural resources [forest products including wild food] and upland land could be an opportunity to boost food security. Interventions should be co-designed with households and communities so that they prioritize the interventions that address barriers to participating in the NSA intervention as well as the adoption of NSA practices.

Enhance sustainability

NSA designers and implementers should carefully analyse and strengthen the absorptive capacities of target populations to facilitate the continuation of the interventions beyond the project cycle. Program designers should consider sustainability during the design of the interventions rather than midway through to ensure that pressure in achieving short-term adoption does not harm long-term sustainability. Participation of beneficiaries, communities, and institutions in design, implementation, and evaluation can help design strategies to sustain the interventions. The design should consider enhancing institutional capacity and agriculture's ownership of nutrition and developing an accountability structure, such as dedicated resources and a monitoring and evaluation system.

10.4 Strengths and limitations of the research

The mixed-methods research offers various strengths. The use of multiple methods, countries, and data sources contributed to the triangulation of data within and between the studies, which enhanced the internal and external validity of the research. The use of systematic reviews, document analysis, qualitative and quantitative data, and the inclusion of two countries with different topographical features enhanced the robustness of the findings. As indicated in sections 10.1 and 10.2, several results are validated in more than one chapter of the dissertation. Likewise, this research provides a comprehensive analysis of interventions from a systems' perspective that captures the whole pathway from interventions to outcomes, as well as barriers and facilitators affecting implementation and sustainability. Such a comprehensive investigation allowed for the exploration of various nuances of NSA interventions within the complex adaptive food system. Replicating successful strategies and learning from challenges identified in the study countries will guide future initiatives, improving nutrition programs in other LMICs for the benefit of women and children globally.

Four key limitations may have affected the study findings' internal validity. First, the reliance upon secondary quantitative data to assess the effects in both case studies makes the data less rigorous due to differences in the data collection period at baseline and end-line, and a lack of control over participants or methods. The COVID-19 pandemic impacted various aspects of the research, including the quantitative endline survey in Laos. The necessary precautions and restrictions imposed due to the pandemic may have influenced the data collection process and potentially impacted the study findings. Second, because of unforeseen language barriers, this research engaged local translators involved in Laos programme implementation, which may have resulted in social desirability bias. The third is the limitation of the theoretical framework used. Although the CFIR used to analyse the factors is comprehensive, it does not identify interactions between different factors [53]. However, I have described all possible interactions in the results and discussed the findings. Fourth, readers should cautiously interpret the results for the specific NSA package. As the NSA intervention package may vary across the combination of different activities, their effects and pathways may also differ depending on the NSA package.

10.5 Future research priorities

This section will identify and highlight research priorities relating to the two research questions: impact pathways and factors.

10.5.1 Impact pathways

This research recommends three areas for future research on the impact of NSA interventions on nutrition, as well as the pathways from the interventions to improving nutrition. The first is the effect of the combination of intervention packages. While this research suggested improvement in nutrition outcomes in general, the effect varied across different outcomes. The systematic review findings also suggested differences in the impact of the interventions based on the intervention package. Therefore, future research should investigate how different intervention components can be mixed to develop an NSA package that can provide the most optimal effects on nutrition [54]. The second research avenue is to examine further how the four specific pathways, which have so far received much less attention than the two main pathways, can be enhanced: income, women's empowerment, strengthening of local institutions, and food prices. For instance, future research can investigate how the income pathway can be strengthened in order to address poverty and affordability-related constraints on nutrition [8]. The third is the need for research that analyses the impact pathways at a two-point period, during the implementation as well as a few years after the program funding cycle, to provide robust information on the sustainability of impact and the pathways.

10.5.2 Factors influencing implementation and sustainability

The identification of factors that influence the implementation and sustainability of NSA interventions led to five key research areas for future research. The first is to identify strategies to manage trade-offs across different aspects: traditional food systems versus improved practices, targeting of agricultural production component and nutrition BCC, and the need to bring short-term adoption and sustained adoption of the interventions. As there seems to be pressure to achieve targets for initial adoption [48], sustainability may have been influenced. This leads to the second area for future research, focused on identifying strategies to facilitate sustaining the agencies created for initial adoption. The focus should be on developing actionable strategies jointly with the actors in the food system to strengthen the system so that the mechanisms created during implementation, such as multisectoral coordination or extension services, continue beyond the funding period.

The third area is to develop effective strategies to address the disconnect in targeting agricultural production and nutrition BCC activities and to ensure adequate participation of the targeted household members [43]. The disconnect between targeting and participation also urges a study to develop interventions and strategies that enable vulnerable populations to participate and adopt NSA

interventions. The fourth research area concerns the need to assess the feasibility of an informal or formal market in subsistence farming. A lack of buyers during the high production season and an inadequate supply of vegetables during the lean period contributed to food price volatility. Therefore, future studies could assess the feasibility of establishing a market in such settings. The fifth area could be to examine how the forests and uplands in the mountainous agroecosystem can be best incorporated into NSA to maximize effects on nutrition. For example, in the case of northern Laos, access to food from the uplands and forests contributed to food security. However, the easy access also prevented some women from practising home gardening. Access to forests may have also contributed to unintentional adverse effects that depleted the forest environment. A study of actionable pathways from such natural resources to nutrition in the case of NSA is suggested.

10.6 Concluding remarks

This research has illustrated that NSA interventions can improve several nutrition outcomes by simultaneously addressing multiple determinants of malnutrition - beyond inadequate diet and its underlying cause of insufficient access to food- such as WASH practices and related diseases and income-related barriers. While the interventions demonstrated a reduction in micronutrient deficiency and underweight, the decline in stunting and wasting was less evident. The change in nutrition outcomes because of NSA interventions was mainly achieved through food production, nutrition and WASH-related knowledge and BCC, and to some extent, agricultural income, and the strengthening of institutions. The pathway to women's empowerment was quite unclear, possibly because of the limited focus of NSA projects on this pathway.

The implementation of NSA, a complex intervention package, was influenced by a range of complex interconnected factors. While nutrition-sensitive agricultural policies facilitated their implementation, a lack of institutional capacity acted as a barrier. Effective implementation of NSA was also determined by the capacity of beneficiaries and the implementation context to adopt and sustain the practices. As implementation was highly contextual, acknowledging the local food system is crucial. Maintaining multisectoral coordination, especially, on the ground, was extremely challenging. The inadequate coherence to the targeting of agricultural productions and nutrition-related BCC activities was a crucial issue. Finally, trade-offs between the adoption of the interventions in the short term and their sustainable implementation in the long term should be acknowledged and managed.

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SUMMARY

1. Introduction

Malnutrition stands as a pressing issue affecting both human health and economic development globally. Its profound impact on health makes it a significant contributor to the overall burden of disease worldwide. Despite notable progress in poverty reduction over the last five decades within low and middle-income countries (LMICs), undernutrition rates persist at disproportionately high levels in these regions. The burden of undernutrition weighs heaviest on the poorest households within these areas.

Agriculture plays a pivotal role in addressing malnutrition by addressing the challenges of food insecurity and inadequate access to food. However, the sector has historically been fixated on producing staple crops, overlooking a diverse range of nutritious foods. Additionally, the crucial pathways through which food production could enhance food and nutrition security have been largely neglected in research and programming efforts. Hence, a pivotal shift towards a more nutrition-sensitive approach within the agriculture sector is imperative.

Despite the recognized importance of nutrition-sensitive agriculture (NSA), there is a notable dearth of evidence regarding the specific pathways connecting NSA interventions to improved nutritional status and the factors that impact the successful implementation and sustainability of such interventions. This PhD research aimed to:

Gain insights into the impact pathways of NSA interventions for improving nutritional status and the factors influencing the implementation and sustainability of the interventions.

2. Theoretical Background

NSA, a food system intervention, aims to *bridge the gap between available and accessible food and the food required for a healthy, balanced diet for all*. [8]. This concept involves agricultural interventions with a clear objective of improving nutrition and integrating actions to achieve this goal. Five specific pathways have been identified through which NSA interventions contribute to enhancing food and nutrition security (see references 11-13 in chapter 2):

- *Food production*: Agricultural interventions by producing nutrient-rich foods can contribute to increasing food access, which can result in reducing malnutrition.

- *Agricultural income*: Income raised from agricultural income (selling products or wage labour) can contribute to nutrition-related expenses.
- *Food prices*: A change in the price of food due to changes in supply and demand and /or policies affects purchasing power through either a decrease in the price or an increase in the price.
- *Women's empowerment*: Women's participation and empowerment in agriculture may lead to either positive or negative outcomes in nutrition.

While previous studies offer valuable theoretical insights into the agriculture to nutrition pathways, there remains a notable empirical gap on the pathways from NSA i.e., nutrition is deliberately integrated into agriculture. Additionally, it is unclear which factors influence these pathways in improving nutrition. In this thesis, we explored factors in five domains of the interventions (see reference 23 in chapter 2):

1. *Outer setting*: the factors across global and national levels beyond the implementation area
2. *Inner setting*: the factors within the local food system where implementation occurs
3. *Characteristics of individuals*: the attributes of the actors involved in implementation, categorized as implementers and beneficiaries
4. *Intervention characteristics* refer to the features of the intervention influencing its implementation and sustainability
5. *Implementation process* pertain to the essential activities during the implementation

This chapter further utilises theory of complex adaptive food system (CAS) where NSA interventions are situated in, characterized by interconnections, feedback loops, dynamism, self-organization, and resilience.

3. Research Methods

This research aims to address the following inquiries:

1. What is the impact of NSA interventions on diet and nutritional status, and which pathways lead to these outcomes in low and middle-income countries?
2. What factors influence the implementation and sustainability of NSA interventions in low and middle-income countries?

To answer these questions, a multi-country mixed-methods approach was employed, including systematic reviews and case studies conducted in Bangladesh and Laos.

The research began with exploratory interviews conducted at the national level. These interviews were pivotal in identifying relevant NSA programs, laying the foundation for the subsequent selection of significant case studies. Two specific cases—the Integrated Agriculture and Health-Based Interventions (IAHBI) Project in Bangladesh and the Enhancing Nutrition of Upland Farming Families (ENUFF) Project in Laos—were thoughtfully chosen based on predetermined case selection criteria.

Data collection regarding impact pathways and factors influencing implementation and sustainability primarily relied on qualitative research methods. Semi-structured interviews and focus group discussions were conducted, involving project implementers and beneficiaries. These participants were purposefully chosen to ensure a diverse representation across geographical areas and levels.

In addition to qualitative data, the research also incorporated an analysis of secondary quantitative data to evaluate the effects of NSA interventions.

The analytical frameworks outlined in Chapter 2 played a crucial role in guiding a thorough analysis of the data. This approach provided valuable insights into the impact pathways and the intricate array of factors influencing the successful implementation and sustainable outcomes of NSA interventions.

4. Findings

In six articles (4 already published), we explain the effects of NSA interventions, the pathways to the effects, and the factors influencing their implementation and sustainability. A summary of these is as follows:

Part 3.1 Impact Pathways from NSA Interventions to nutritional status

Three studies presented in Chapters 4-6 answer this research question. These chapters demonstrate that NSA interventions can address the multiple determinants of malnutrition, significantly improve diet, reduce micronutrient deficiency, and, to a lesser extent, reduce underweight. This research reports less evidence on the impact of interventions on wasting and stunting. This PhD research confirms that NSA interventions can contribute to nutrition through pathways of agricultural production, agricultural income, and women's empowerment. In addition, this study puts forward the idea of labelling nutrition-related knowledge and behaviour change communication (BCC) as a separate pathway and identifies the strengthening of local institutions as a novel pathway. Several target participants benefitted from a combination of these pathways, which illustrates merit in the synergies among these.

In Chapter 5, the thesis examines the sustainability of the pathways. Beneficiaries sustain vegetable production and nutrition knowledge post-funding. This signifies knowledge sustainability, although additional knowledge from post-project initiatives might also contribute. To promote women's empowerment, adopting gender-transformative approaches to reshape power dynamics is essential. However, sustaining the strengthened local institutions in Bangladesh remains a challenge due to limited capacity and resources, particularly within the Ministry of Livestock and Fisheries.

Part 3.2 Factors Influencing the Implementation and Sustainability of NSA Interventions

The findings from systematic reviews and case studies (Chapters 7 to 9) emphasize crucial interlinked factors that significantly influence both implementation and sustainability. The thesis employs a comprehensive conceptual framework, encompassing the outer setting, inner setting, characteristics of actors, intervention attributes, and the implementation process domains. These factors encompass a discrepancy between policies and institutional capabilities, a lack of coordination between sectors, and biophysical and social factors such as seasonality, agro-climatic conditions, remoteness, and cultural aspects. Moreover, incorporating existing traditional practices and engaging the community are vital aspects. The absorptive capacities of participating households and communities were identified as a key factor influencing the success of NSA interventions. However, targeting the most nutritionally vulnerable households is challenging due to inclusion criteria in agricultural interventions favouring those with some resources. These factors are context-specific and necessitate tailored strategies to overcome barriers. Additionally, striking a balance between the initial focus on adoption and ensuring sustainability poses a challenge, as often short-term adoption measures may inadvertently overlook long-term sustainability.

5. Discussion

Chapter 10 of the dissertation comprises discussions on key findings, theoretical reflections on Nutrition-Sensitive Agriculture (NSA) as a component of a complex adaptive food system, policy and program recommendations, strengths and limitations, areas for future research, and concluding remarks.

NSA interventions offer the potential to enhance nutrition through five primary pathways: food production, agricultural income, nutrition-related knowledge, women's empowerment, and the strengthening of local institutions. To optimize nutrition outcomes, a combination of these pathways is essential, given their synergistic effect. While interventions primarily focus on food production and nutrition knowledge via behaviour change communication (BCC), other critical pathways, such as

agricultural income, women's empowerment, and strengthening local institutions, have been relatively underexplored.

This dissertation emphasizes six key messages regarding the complex and interconnected factors influencing the implementation and sustainability of NSA interventions. These messages underscore the disconnect between policy and institutional capacity, the need for enhanced multisectoral coordination, adaptation to the local food system, recognition of local institution and beneficiary characteristics, coherence in targeting agriculture and nutrition behaviour change activities, and the challenge of balancing short-term adoption with the long-term sustainability of interventions.

The theoretical depiction of the food system as a complex adaptive system is a vital aspect of the debate. The food system is intricate and adaptable due to its interlinked systems, open nature, emergent order, feedback loops, robustness, and resilience.

Furthermore, this research offers practical recommendations for policy and practice, as well as suggestions for future research. These recommendations include aligning policies with institutional capacity, allocating future funding to strengthen institutional capacity, considering the context and capacities of beneficiaries and institutions, ensuring coherence between agriculture and nutrition behaviour change communication, and tailoring interventions based on the implementation setting. Sustaining interventions beyond project cycles necessitates strengthening institutional capacity, with a specific focus on enhancing the agriculture sector's role in nutrition.

For future research, the study identifies critical areas of focus, including the effectiveness of multisectoral interventions, income-related factors, women's empowerment, local institution strengthening pathways, and the sustainability of NSA interventions. Key priority areas involve managing trade-offs, enhancing sustainability, addressing targeting discrepancies, feasibility studies related to establishing formal or informal markets, and exploring the incorporation of forests in mountainous agroecosystems within NSA interventions.

To conclude, this PhD research has demonstrated that NSA interventions can improve several dietary outcomes, and reduce micronutrient malnutrition and underweight. The interventions also have the potential to improve various underlying determinants of malnutrition through the combination of nutrition actions. The impact is achieved through five main pathways-food production, agricultural income, nutrition-related knowledge and BCC, women's empowerment, and the strengthening of local institutions.

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ABOUT THE AUTHOR

Indu Kumari Sharma, from Nepal, brings with her a wealth of experience spanning a decade in food security and nutrition programs in policy-making, research, and implementation while working with diverse several national and international organizations as well as research institutions. Her expertise extends across various countries, prominently including Nepal, Bangladesh, and Laos.

Her academic journey is marked by the successful attainment of a Master of Public Health degree from the University of Melbourne in Victoria, Australia. This educational achievement underlines her dedication to the field of public health.

Indu completed her Erasmus Mundus joint doctorate in TransGlobal Health, specializing in Nutrition-Sensitive Agriculture, from the esteemed Athena Institute at Vrije Universiteit of Amsterdam and the Barcelona Institute for Global Health at the University of Barcelona. This educational trajectory highlights her steadfast commitment to advancing knowledge and expertise in the domain of nutrition-sensitive agriculture—a fundamental component in the collective effort to bolster food security and nutrition.

Throughout her career, Indu has been recognized with prestigious awards, including the ADB-Japan Scholarship, the Erasmus Mundus Joint Doctorate Program, and various presentation awards. Additionally, she has authored several influential papers on topics encompassing nutrition, public health, and food security. These accolades underscore her academic excellence and enduring contributions to the field.

In her current capacity as a Postdoctoral Fellow in the cross-CGIAR Asian Mega-Deltas (AMD) research Initiative for International Water Management Institute (IWMI), Indu is actively contributing to research focusing on inclusive governance and nutrition-sensitive agri-food systems. Specifically, her dedication is directed towards ensuring that deltaic food systems can sustain and enhance nutrition security in an equitable manner, while also advocating for inclusive governance of natural resources crucial to diverse food systems. Indu's efforts in this role exemplify her dedication to addressing critical global challenges in the realm of food security and nutrition.



