CGIAR

RESEARCH PROGRAM ON Agriculture for Nutrition and Health

Submitted by IFPRI

PROPOSAL FOR PHASE II

2017–2022

Contents

Abbreviations and Acronyms

3C	Capacity, Collaboration, Convening
A4NH	Agriculture for Nutrition and Health
ACIAR	Australian Center for International Agricultural Research
AFS-CRP	Agri-Food Systems - CGIAR Research Program
AIM	Amsterdam Initiative for Malnutrition
AMR	Antimicrobial resistance
ANGeL	Agriculture, Nutrition, and Gender Linkages
ANH	Agriculture, nutrition and health
ANLP	Africa Nutrition Leadership Programme
ARENA	Advancing Research on Nutrition and Agriculture
ASF	Animal source foods
AU	African Union
AUC	African Union Commission
AVRDC	World Vegetable Center
AWARD	African Women in Agriculture Research and Development
BIDS	Bangladesh Institute of Development Studies
Bioversity	Bioversity International
BMGF	Bill and Melinda Gates Foundation
BPI	Biofortification Prioritization Index
CAADP	Comprehensive Africa Agriculture Development Program
CapDev	Capacity development
CCAFS	Climate Change, Agriculture and Food Security
CCE	Country Coordination and Engagement
CCEE	CRP-Commissioned External Evaluation
CCNFSDU	Codex Committee on Nutrition and Foods of Special Dietary Use
CCT	Conditional cash transfer
CDI	Centre for Development Innovation at Wageningen UR
CEA	Cost-effectiveness analysis
CEO	Chief Executive Officer
CFP	Center Focal Points
CIAT	International Center for Tropical Agriculture
CIMMYT	International Maize and Wheat Improvement Center
CIP	International Potato Center
CKM	Communications and Knowledge Management Division
CoA	Cluster of Activity
COMESA	Common Market for Eastern and Southern Africa
CoP	Community of practice
CRP	CGIAR Research Program
CSA	Climate Smart Agriculture
CSSP	Country Strategy Support Program

CTA	Technical Centre for Agricultural and Rural Cooperation
DANS	Data Archiving and Network Services
DC	Dublin Core
DCL	Dryland Cereals and Legume Agrifood System
DDG	Deputy Director General
DFID	Department for International Development, UK
DG	Director General
DHS	Demographic and Health Survey
DRC	Democratic Republic of Congo
EAC	East African Community
ECOWAS	Economic Community of West African States
EU	European Union
EVIDENT	Evidence-informed Decisionmaking in Nutrition and Health
FAIR	Findable, Accessible, Interoperable, Re-usable
FAO	Food and Agriculture Organization of the United Nations
FBD	Foodborne disease
FERG	Foodborne Disease Epidemiology Reference Group
FP	Flagship Program
FTA	Forests, Trees and Agroforestry
GAAP2	Second phase of the Gender, Assets, and Agriculture Program
GAIN	Global Alliance for Improved Nutrition
GAP	Good Agricultural Practices
GCARD	Global Conference on Agricultural Research for Development
GEE	Gender, Equity and Empowerment
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GMO	Genetically modified organism
GREAT	Gender-responsive Researchers Equipped for Agricultural Transformation
HANCI	Hunger and Nutrition Commitment Index
HFPP	Homestead food production program
HKI	Helen Keller International
IAC	Independent Advisory Committee
IARC	International Agency for Cancer Research
ICDDR,B	International Centre for Diarrhoeal Disease Research, Bangladesh
ICN2	2nd International Conference on Nutrition
ICRAF	World Agroforestry Centre
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
ICRP	Integrated CRP
IDO	Intermediate Development Outcome
IDRC	International Development Research Centre
IDS	Institute of Development Studies
IEA	CGIAR Independent Evaluation Arrangement
IFAD	International Fund for Agricultural Development

IFPRI	International Food Policy Research Institute
IITA	International Institute of Tropical Agriculture
ILRI	International Livestock Research Institute
IMMANA	Innovative Methods and Metrics for Agriculture and Nutrition Actions
INGO	International Nongovernmental Organization
IPES	International Panel of Experts on Sustainable Food Systems
IPG	International Public Good
IPM	Integrated pest management
ISC	Independent Steering Committee
ISPC	Independent Science and Partnership Council
ITM	Institute of Tropical Medicine
IVM	Integrated vector management
JCR	Journal Citation Reports
JEV	Japanese Encephalitis virus
KM	Knowledge Management
LAC	Latin America and the Caribbean
LANEA	Leveraging Agriculture for Nutrition in East Africa
LANSA	Leveraging Agriculture for Nutrition in South Asia
LCIRAH	Leverhulme Centre for Integrative Research on Agriculture and Health
LMIC	Low- and middle-income countries
LOD	Linked Open Data
LSHTM	London School of Hygiene and Tropical Medicine
LSMS	Living Standards Measurement Survey
M&E	Monitoring and evaluation
MEL	Monitoring, Evaluation, and Learning
MELIA	Monitoring, Evaluation, Learning, and Impact Assessment
MERS	Middle East respiratory syndrome
MLA	Monitoring, Learning and Assessment (HarvestPlus)
MoU	Memorandum of Understanding
NWO	Netherlands Organisation for Scientific Research
N4G	Nutrition for Growth
NARS	National Agricultural Research System
NGO	Non-Governmental Organization
NSAP	Nutrition-Sensitive Agricultural Programs
OA	Open Access
OADMP	Open Access and Data Management Policy
OARPS	Open Access and Research Publication Support team
OIE	World Organization for Animal Health
OPAC	Online Public Access Catalog
PACA	Partnership for Aflatoxin Control in Africa
PIM	Policies, Institutions and Markets
PMC	Planning and Management Committee

PMU	Program Management Unit
POSHAN	Partnerships and Opportunities for Strengthening and Harmonizing Actions on Nutrition in India
PPA	Program Participant Agreement
PPP	Public-private platforms
Pro-WEAI	Project level Women's Empowerment in Agriculture Index
RBM	Results-based management
RDM	Research Data Management
REACH	Renewed Efforts Against Child Hunger and undernutrition
REC	Regional Economic Community
ReSAKSS	Regional Strategic Analysis and Knowledge Support Systems
RVF	Rift Valley fever
SARS	Severe acute respiratory syndrome
SCORE	Supporting Countries through Research on Enabling Environments
SDG	Sustainable Development Goal
SLO	System Level Outcomes
SMART	specific, measurable, attainable, relevant, time bound
SME	Small and medium-sized enterprises
SPEAR	Supporting Policies, Programs, and Enabling Action through Research
SRF	Strategy and Results Framework
SSRN	Social Science Research Network
SUN	Scaling Up Nutrition
SUSFANS	European Sustainable Food And Nutrition Security
T&C	Training & Certification
TDR	Trusted Digital Repositories
ToC	Theory of Change
ToR	Terms of Reference
TSC	The Sustainability Consortium
UN	United Nations
UNFCC	United Nations Framework Convention on Climate Change
UNICEF	United Nations International Children's Emergency Fund
UNSCN	United Nations System Standing Committee on Nutrition
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
VC	Value Chains
VCN	Value Chains for Enhanced Nutrition
W1	Window 1
W2	Window 2
W3	Window 3
Wageningen UR	Wageningen University and Research Centre
WASH	Water, sanitation and hygiene
WEAI	Women's Empowerment in Agriculture Index

WELI	Women's Empowerment in Livestock Index
WINGS	Women Improving Nutrition through Group-based Strategies
WFP	World Food Program
WHO	World Health Organization
WLE	Water, Land, and Ecosystems
WTO	World Trade Organization
ZARI	Zambia Agriculture Research Institute
ZELS	Zoonosis and Emerging Livestock Systems

1.0 CRP Narrative

1.0.1 Rationale and Scope

Overarching case for a CRP on agriculture, nutrition and health

Agricultural development has enormous potential to make significant contributions to reducing malnutrition and ill health. With a growing global population, rising incomes, and increased constraints on the natural resources available for the production of food, realizing this potential in increasingly urgent. The need for agriculture to support better nutrition and health is reflected in the discussions leading up to the United Nations' (UN) 2030 Agenda for Sustainable Development[1] and in the new CGIAR Strategy and Results Framework[2] (SRF). Regionally, it is reflected in the initiative to support countries in integrating nutrition interventions into their Comprehensive Africa Agriculture Development Programme (CAADP) investment plans, from design through implementation.

Since beginning in 2012, the CGIAR Research Program (CRP) on Agriculture for Nutrition and Health (A4NH) has provided an innovative perspective on the relationships between agriculture, nutrition, and health through research that strengthens the knowledge base and through new partnerships that lead to outcomes. Annual reports on the progress of A4NH research, partnerships, and other efforts to support development outcomes are available at www.a4nh.cgiar.org. Listed below are some examples of our achievements to date.

- ***New frameworks and tools for understanding the multiple pathways through which agricultural development influences nutrition outcomes:*** (Gillespie, Harris, and Kadiyala 2012; Kadiyala et al. 2014) and how gender mediates the pathways (Herforth and Harris 2014). The findings have implications for how to support nutrition-sensitive interventions in value chains (Gelli et al. 2015), and enabling policy environments (Gillespie et al. 2013). Researchers, donors, non-governmental organizations (NGOs) and governments have widely adopted these frameworks and tools to inform and guide programs and investments. The agriculture-nutrition pathways have informed agriculture-nutrition strategies in the United States Agency for International Development (USAID) and the Bill & Melinda Gates Foundation (BMGF). The World Food Programme (WFP) and the International Fund for Agricultural Development (IFAD) are piloting the nutrition-sensitive value chain framework.

- ***More evidence of the impacts of agriculture on nutrition- and health-related outcomes:*** Rigorous impact evaluations documented the effects of nutrition-sensitive agricultural programs, including orange flesh sweet potato, on maternal and child diets and nutrition and child health outcomes (Hotz, Loechl, Lubowa, et al. 2012; Hotz, Loechl, de Brauw, et al. 2012; Olney et al. 2015), women's empowerment (Quisumbing et al. 2015; N. L. Johnson et al. 2016; van den Bold et al. 2015). Nutritional efficacy has been demonstrated for crops biofortified with vitamin A (maize (Gannon et al. 2014), cassava (Talsma et al. 2016)) and iron (bean (J. Haas et

[1] The new Agenda calls on countries to begin efforts to achieve 17 Sustainable Development Goals (SDGs) over the next 15 years. Two SDGs are focused on nutrition and health: #2 End hunger, achieve food security and improved nutrition, and promote sustainable agriculture and #3 Ensure healthy lives and promote well-being for all at all ages and others are related to parts of A4NH work (#1, #5, 6, #13, #15, and #17).

[2] The new System Level Outcome (SLO) devoted to nutrition and health is: #2 improved food and nutrition security for health.

al., n.d.), pearl millet (Finkelstein et al. 2015), rice (J. D. Haas et al. 2005), with zinc efficacy results expected in 2016.

- ***Support to evidence-based decisionmaking for agriculture-health programs and investments:*** A4NH has conducted evidence reviews and analysis for the UK Department for International Development (DFID) on priority zoonoses for the Zoonosis and Emerging Livestock Systems (ZELS) initiative, livestock and fisheries-linked antimicrobial resistance (AMR), and food safety in developing countries for DFID Livelihood Officers (Grace 2015b; Grace 2015a; Grace et al. 2012).

- ***Partnerships with the public and private sectors for making innovations available and used at scale:*** The two most promising cases to date relate to the development and application of aflasafe,™ a biocontrol technology designed to control aflatoxin in maize production, in two countries in Africa, and the delivery of biofortified planting materials to 2 million farmers in nine countries in Africa and South Asia.

- ***Integrating gender and nutrition into agricultural research for development:*** A4NH convened a community of practice (CoP) on gender, agriculture, and nutrition to support gender researchers and monitoring and evaluation (M&E) specialists in other CRPs achieve their nutrition-related Intermediate Development Outcomes (IDOs). The CoP held two workshops which were attended by about 40 researchers from A4NH, 11 other CRPs and 10 partner organizations. A monthly Gender-Nutrition Idea Exchange (GNIE) blog hosted on the A4NH website featured contributions from researchers inside and outside A4NH on how to conduct high-quality agricultural research that considers gender and nutrition issues. The blog had over 12,500 unique page views in 2015.

Despite these many successes of A4NH, much of CGIAR's potential to improve nutrition and health for all has yet to be realized. More work is needed to identify and develop nutrition-enhancing production technologies, institutional innovations that support sustainable access to and/or application of these technologies, and policy options that can increase the contribution of agri-food systems to nutrition and health. There is also an urgent need for additional research on how proven approaches to improving nutrition and health can be scaled and sustained in specific countries and contexts.

Key challenges in achieving the agriculture, nutrition, and health development goals by 2030

A4NH has positioned the CGIAR as being an important contributor to reducing undernutrition, both micronutrient deficiency and child growth, through integrated agriculture-nutrition programs and policies and biofortification. Important progress is being made, however, as summarized in the Global Nutrition Report (International Food Policy Research Institute (IFPRI) 2014; IFPRI 2015), achieving the nutrition and health-oriented targets in the Sustainable Development Goals (SDGs) by 2030 will require sustained investment, informed by research. While a focus on undernutrition will continue, the SDGs, CGIAR SRF, and other development processes have identified additional challenges. Through expanded research on agriculture, nutrition, and health in Phase II, A4NH will support CGIAR to respond to additional challenges, including:

- Overweight and obesity. Even as undernutrition has declined in some parts of low- and middle-income countries (LMICs), the proportion of children and adults who are overweight or obese has increased (Ng et al. 2014). At the Second International Conference on Nutrition (ICN2), ministers of health and agriculture from 170 countries agreed that under- and overnutrition should be addressed together, by promoting diversified, balanced and healthy diets in

sustainable, equitable, accessible and resilient food systems (Food and Agriculture Organisation of the United Nations (FAO) and World Health Organization (WHO) 2014). CGIAR work on value chains and agri-food systems needs to be informed by and aligned to this approach.

- Food safety. In 2015, a global study by WHO Foodborne Disease Burden Epidemiology Reference Group (FERG) confirmed that foodborne disease (FBD) is a significant health burden, comparable to malaria, HIV/AIDS, and tuberculosis and largely borne by developing counties (Havelaar et al. 2015). The FBD burden is likely to grow in the future as incomes rise, demand for high-risk, perishable foods like meat, milk, fish and vegetables grows, and climate change affects the growth and distribution of pathogens (Grace and McDermott 2015). Managing food safety in developing country contexts and in informal markets, within a healthy and sustainable food systems framework, will be essential to achieving both nutrition and health goals.

- Infectious diseases. There is increasing emphasis on mitigating important health risks from animals. Many emerging diseases have reservoirs in animals (Ebola, Middle East respiratory syndrome (MERS), avian influenza) and animal agriculture practices have given rise to emerging health challenges, such as AMR. Also agriculture will need to intensify, particularly in Africa, where growing demand for food cannot be met just by expanding land and water use. This could lead to health benefits from higher incomes and better diets but also to increased risk of vector-borne and zoonotic diseases. Understanding and optimizing overall benefits from agriculture and health will require close partnership between researchers in clinical medicine, agriculture, public health and social science.

- Inequality. It is increasingly recognized that inequality related to gender or other social categories is a development objective in its own right (SDG5)[3] and an important condition for achieving other development objectives (Meinzen-Dick et al. 2011), particularly related to nutrition (Smith and Haddad 2014) and health (Krishna 2004).

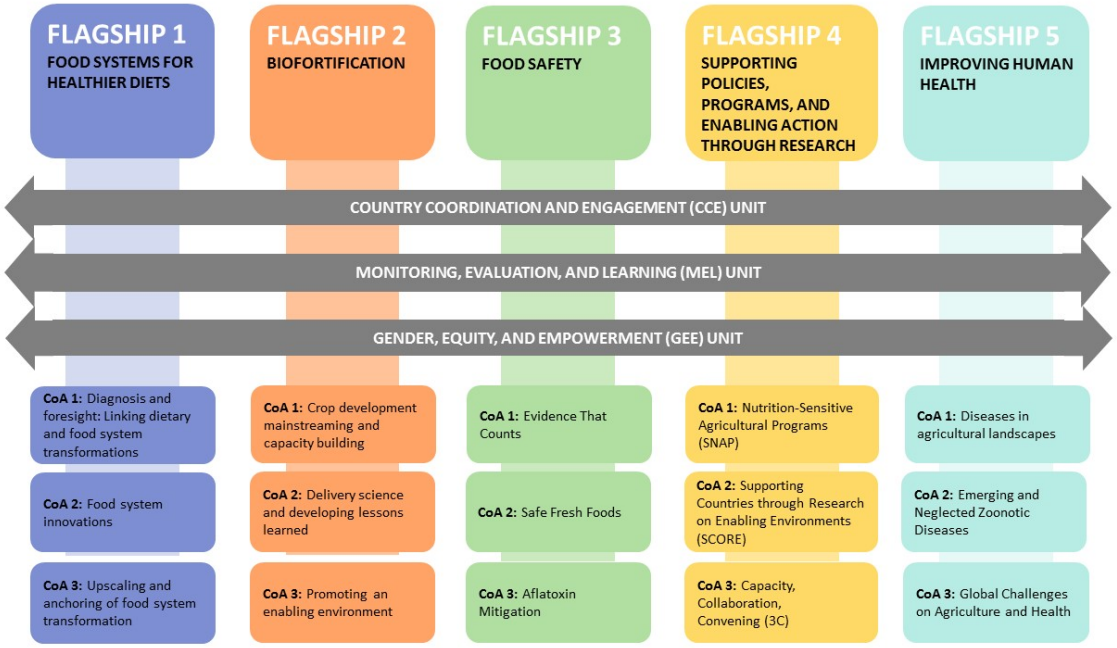
Implications for how A4NH will work in Phase II

To meet the challenges CGIAR has prioritized in the new SRF (2016-2030), A4NH is committed to strengthening the contribution of CGIAR to nutrition and health outcomes in three ways: though joint research with other CRPs, particularly in a subset of priority countries identified by CGIAR; through networking and mutual learning with other CRPs and partners; and by bridging the space between CGIAR and the nutrition and health research, development, and policy communities. These Phase II activities are part of our responsibilities as an Integrating CRP (ICRP) to create and enhance the enabling conditions for delivery of CGIAR research outcomes in terms of nutrition and health.

For its second phase, A4NH proposes five flagship research programs (FPs) and three cross-cutting units (see **Figure 1.1**).

[3] SDG #5 is: Achieve gender equality and empower all women and girls.

Figure 1.1. A4NH Program Structure



FP1: Food Systems for Healthier Diets will contribute to the goal of healthier diets for poor and vulnerable populations through better understanding of food system-diet dynamics and through identifying and enabling innovations in value chains and polices. This FP has a strong focus on building innovative partnerships between researchers inside and outside CGIAR, as well as private, public, and civil society actors in national and sub-national food systems in four target countries.

FP2: Biofortification will contribute to reducing micronutrient malnutrition by reaching 20 million households with biofortified crops, and by doing research on how delivery can be scaled and sustained and on how biofortification can be mainstreamed into public policy and crop breeding.

FP3: Food Safety addresses the growing FBD burden through research on technological and institutional solutions and appropriate policy and regulatory options that align public health goals with country priorities and capacities to ensure that food is both safe and equitable for the poor. The FP will focus on mitigating aflatoxin contamination in key staples, and on managing risks in informal markets for nutrient-rich perishables like meat, milk, fish, and vegetables.

FP4: Supporting Policies, Programs, and Enabling Action through Research (SPEAR) will contribute to better nutrition outcomes for nutritionally-vulnerable populations , especially mothers and young children, through understanding, evaluating, and strengthening nutrition-sensitive agricultural programs and policies, analyzing the political economy of leveraging agriculture for nutrition and health, and on cultivating and sustaining enabling environments for nutrition in South/Southeast Asia and Africa.

FP5: Improving Human Health is an innovative collaboration between public health and agriculture researchers to mitigate risks and optimize benefits for human health from agricultural systems. It will focus on managing diseases in intensifying agricultural landscapes, on emerging and neglected zoonotic diseases, and on emerging global challenges such as anti-microbial resistance.

Country priorities are driving the 2030 development agenda and national leadership, in concert with regional and global initiatives, will be the key to delivering on it. With scarce resources and a broad range of development objectives, policymakers will need to carefully consider how to maximize synergies and minimize trade-offs associated with alternative policy and investment options**.** Appropriate strategies will vary by country depending on the priorities and resources as well as political, social, economic, and agro-ecological contexts. A4NH's role is to generate knowledge, develop technologies, and design innovative approaches that will support decisionmakers in making informed choices that help them achieve development goals and priorities.

In order to improve our country engagement on nutrition and health issues and fulfill our ICRP role, we will designate three cross-cutting units: Country Coordination and Engagement (CCE), Gender, Equity and Empowerment (GEE), and Monitoring, Evaluation, and Learning (MEL). The CCE unit will initially support in-country research teams comprised of partners from inside and outside CGIAR in five of the CGIAR Site Integration countries – Bangladesh, Ethiopia, India, Nigeria, and Vietnam. The GEE unit will conduct strategic research and support a CoP on gender and nutrition to strengthen capacity within A4NH FPs, other CRPs and key partners. The MEL unit will work with FPs and units on results-based management (RBM) and learning, driven on theories of change, and will work closely with the other ICRPs and the CGIAR MEL CoP.

IFPRI will continue as Lead Center for A4NH in Phase II. Our managing partners will be four CGIAR Centers: Bioversity International, the International Center for Tropical Agriculture (CIAT), the International Institute of Tropical Agriculture (IITA), and the International Livestock Research Institute (ILRI) – plus two non-CGIAR institutions: Wageningen University and Research Centre (Wageningen UR) and the London School of Hygiene and Tropical Medicine (LSHTM).

Box 1.1. Definitions for concepts in A4NH[4]

Nutrition-sensitive agricultural programs	Agriculture programs that have specific nutrition goals and integrate nutrition interventions (e.g. behavior change communication, distribution of micronutrient-fortified products, etc.) to achieve them (Ruel and Alderman 2013). They may or may not also integrate other types of interventions from other sectors such as water, sanitation and hygiene (WASH) or health (e.g. immunization, promotion of use of health services, etc.).
Food system	The full set of processes, activities, infrastructure, and environment that encompass the production, processing, distribution, waste disposal, and food consumption. Food systems are multidimensional, including sociocultural, economic, environmental, and political aspects, and complex, with multiple actors managing multiple linked and nested agri-food value chains within dynamic and interactive food environments.
Gender	Social category usually associated with being a man or a woman. It encompasses economic, social, political, and cultural attributes and opportunities as well as roles and responsibilities.
Equity	Based on the idea of moral equality i.e. the principle that people should be treated as equals and that despite many differences, all people share a common humanity or human dignity. The three principles of equity are: equal life chances, equal concern for people's needs and meritocracy.
Empowerment	Expansion of people's ability to make strategic life choices, particularly in contexts where this ability had been denied to them.

[4] Sources for definitions: Nutrition-sensitive (Ruel and Alderman 2013) gender (Rubin, Manfre, and Barrett 2009) equity (Jones 2009) and empowerment (Kabeer 2001).

1.0.2 Goals, Objectives, Targets

The goal of A4NH is to strengthen the capacity of CGIAR to contribute globally to the second System Level Outcome (SLO2) on improved food and nutrition security for health and the 2030 Agenda for Sustainable Development (**Table 1.1**).

A4NH will contribute to all four IDOs under the SLO on *improved food and nutrition security for health* (**Figure 1.2**). Through four of its FPs, A4NH will contribute to specific IDOs under SLO1 on *reduced poverty.* Together with the CRPs on Water, Land, and Ecosystems (WLE) and Climate Change, Agriculture, and Food Security (CCAFS), we will contribute to specific IDOs under SLO3 on *improved natural resource management and ecosystem services.* The four CGIAR cross-cutting issues — *gender and youth, policies and institutions, climate change and capacity development*—will be integrated into all A4NH FPs. We will collaborate with CCAFS on *climate change*, with special emphasis on healthy, sustainable food systems, WLE on sustainability of food systems, and Policies, Institutions, and Markets (PIM) on gender and youth and policies and institutions. The cross-cutting issues of *gender and youth,* as well as *policies and institutions* have been central to the A4NH Results Framework since Phase I and we have had a strong emphasis on capacity development for agriculture, nutrition and health research, program implementation and enabling.

FIGURE 1.2. A4NH PHASE II RESULTS FRAMEWORK

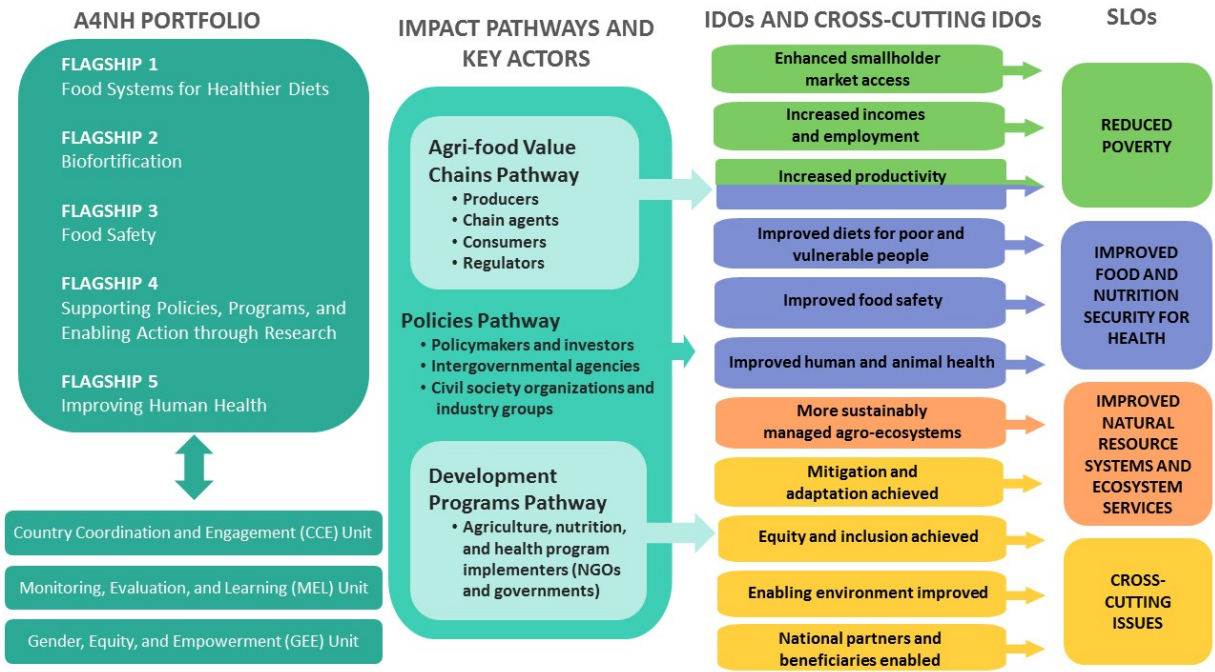
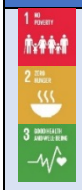


Table 1.1. A4NH contributions, by FP, to the SDGs and the CGIAR SRF

SDGs	SLOs	IDOs	Sub-IDOs	Expected Flagship Contributions by 2022 (x) and beyond (*)				
				FP1	FP2	FP3	FP4	FP5
	Reduced poverty	Enhanced smallholder market access	Reduced market barriers			x		
		Increased incomes and employment	Diversified enterprise opportunities	x				
			Increased livelihood opportunities				x	
		Increased productivity	Closed yield gaps through improved agronomic and animal husbandry practices		x			
	Improved food and nutrition security for health	Improved diets for poor and vulnerable people	Increased availability of diverse nutrient-rich foods	x	x		x	
			Increased access to diverse nutrient-rich foods	x	x		x	
			Optimized consumption of diverse nutrient-rich foods	x			x	
		Improved food safety	Reduced biological and chemical hazards in the food system			x	*	
			Appropriate regulatory environment for food safety			x	*	
		Improved human and animal health through better agricultural practices	Improved water quality				*	
			Reduced livestock and fish disease risks associated with intensification and climate change				*	x
			Increased safe use of inputs				*	x
	Improved natural resource systems and ecosystem services	More sustainable managed agro-ecosystems	Increased resilience of agro-ecosystems and communities- especially those including smallholders					x
			Enhanced adaptive capacity to climate risks	*				x
	Climate Change	Mitigation/ adaptation achieved	Enabled environment for climate resilience				x	
	Gender and youth	Equity and inclusion achieved	Gender-equitable control of productive assets and resources			x	x	
			Improved capacity of women and young people to participate in decisionmaking	x	x		x	x
	Policies and institutions	Enabling environment improved	Increased capacity of beneficiaries to adopt research outputs			x	x	
			Increased capacity of partner organizations…		x		x	
			Conducive agricultural policy environment	x	x		x	
			Conducive environment for managing shocks and vulnerability…					x
	Capacity development	National partners and beneficiaries enabled	Enhanced institutional capacity of partner research organizations	x	x	x	x	x
			Enhanced individual capacity in partner research organizations…			x	x	x
			Increased capacity for innovation in partner research organizations	x			x	
			Increased capacity for innovation in partner development organizations…				x	

During Phase II, A4NH will make significant contributions to three of the SRF's SLO targets for 2022, as described in Table A of the Performance Indicator Matrix:

- 20 million more farm households in at least 12 countries will have adopted improved varieties, breeds or trees and/or improved management practices (FP2: Biofortification and FP3: Food Safety);
- 150 million more people, of which 50% are women, in at least 14 countries will be without deficiencies of one or more of the following essential micronutrients: iron, zinc, iodine, vitamin A, folate, and vitamin B12 (FP2: Biofortification and F4: SPEAR); and
- 10% fewer women of reproductive age will be consuming less than the adequate number of food groups in Ethiopia, Bangladesh, Vietnam and Nigeria (FP1: Food Systems).

To achieve these and future goals, A4NH FPs will achieve the following outcomes by 2022 (Table B of the Performance Indicator Matrix and more details in the FP sections):

FP1: Food Systems will ensure that:

- Partners and other CRPs incorporate nutrition, health, and gender in agri-food value chains and food systems programs;
- Partners, including value chain actors, use evidence from impact evaluations when making operational and investment decisions; and
- Public-private partnerships formed to promote implementation of A4NH strategies for agri-food value chain/food system innovations and interventions at scale.

FP2: Biofortification will demonstrate that:

- High-yielding micronutrient enhanced varieties are developed and released in target and expansion countries;
- Biofortification is mainstreamed into CGIAR and National Agricultural Research System (NARS) breeding efforts;
- High-yielding micronutrient enhanced varieties are delivered at scale in target and expansion countries;
- Evidence on nutritional efficacy and impact informs value chain actors, as well as national and international investors; and
- Biofortification is supported by global institutions and incorporated into plans and policies by stakeholders.

FP3: Food Safety will demonstrate that:

- Key food safety evidence users (donors, academics, international NGOs (INGOs), national policymakers, regulators, civil society, and industry) are aware of and use evidence to formulate and/or implement pro-poor and risk-based food safety approaches;
- Market-based food safety innovations are delivered at scale in key countries, along with understanding of their impact and appropriate use; and
- Biocontrol and good agricultural practices (GAP) delivered at scale in key countries, along with understanding of their impact and appropriate use.

FP4: SPEAR will demonstrate that:

- Development program implementers and investors (governments, NGOs, UN institutions) use evidence, tools, and methods to design and implement cost-effective nutrition-sensitive agricultural programs at scale;
- Researchers and evaluators, including in CGIAR and other CRPs, use evidence, tools, and methods to design high-quality evaluations of nutrition-sensitive agricultural programs and other multisectoral programs, and continue to build evidence;
- Regional, international, and UN agencies and initiatives as well as investors use evidence, tools, and methods to inform decisions and investment strategies to guide and support nutrition-sensitive agricultural programming and nutrition-sensitive policies;
- National policymakers and shapers, and stakeholders from different sectors, civil society and industry use evidence to design effective nutrition-sensitive policies and ensure quality implementation; and
- Stakeholders from different sectors, civil society, and industry, including CGIAR and other CRPs, have improved capacity to generate and use evidence to improve nutrition-sensitive agricultural programming, nutrition-sensitive policymaking, and implementation.

FP5: Improving Human Health will demonstrate that:

- Agricultural research initiatives, including those in farming communities, measure health risks and benefits;
- Agricultural and public health policymakers and implementers deliver coordinated and effective solutions to cysticercosis and other zoonotic threats; and
- Public and private sector policymakers implement measures to reduce health risks from AMR in hotspot livestock systems.

1.0.3 Impact Pathway and Theory of Change

The A4NH Results Framework **(Figure 1.2**) describes our impact pathways, reflecting the different ways in which A4NH research activities and outputs, including knowledge, technologies, capacity, and stakeholder engagement, contribute to outcomes in food systems. In some cases, A4NH research provides value chain actors with technologies and capacity to enhance and protect the nutritional content of foods, while mitigating key food safety risks (**agri-food value chains pathway**). We also provide evidence and tools to development implementers to increase the effectiveness of their nutrition- and health-sensitive agricultural programming (**development programs pathway**). Finally, we support governments and donors to improve an enabling environment and create better-informed, better-targeted, and better-implemented policies (**policies pathway**). Value chains, policies and programs are key components of the food system, and while we seek to have impact through individual pathways, it is always with an eye toward how the changes in the pathway(s) will influence the system as a whole. The three food system pathways are mutually reinforcing, with the policy pathway underlying and sustaining the other two.

Agri-food value chains pathway

There are several points along agri-food value chains where actors can use A4NH research outputs to contribute to nutrition and health outcomes. At the **farm level,** a traditional area of strength in CGIAR, two FPs work closely with public- and private-sector actors, mainly in input supply, to demonstrate and

learn from the delivery at scale of two technologies to improve nutrition and health (biofortified varieties by FP2: Biofortification, and biocontrol and GAP by FP3: Food Safety). The delivery at scale of biofortified varieties represents an important part of A4NH's contribution to the SRF targets on micronutrient deficiency, but together, the two technologies represent our main contribution to this target. The impact pathways for these farm-level technologies go from on-farm production either directly to consumption by the farm household members or through sale to traders and, in some cases, processors, to eventual purchase and consumption by target consumers. All along the pathway, there are important assumptions underlying expected outcomes. Gender and equity issues are key in most of the outcomes, from deciding what crops to plant and sell or what foods to purchase, to determining intra-household food allocation. The detailed ToCs developed for each of these cases (N. Johnson, Guedenet, and Saltzman 2015; N. Johnson, Atherstone, and Grace 2015), together with assessments of the strength of existing evidence for the assumptions, will guide decisions about delivery and support learning about the potential for on-farm technologies to contribute to improvements in nutrition and health. This work will take place within each FP and in collaboration with the agri-food system CRPs (AFS-CRPs), and with CCAFS to consider the impacts of climate change on the effectiveness of technologies and practices.

Another point along the value chain where A4NH research can contribute to improved nutrition and health outcomes is through **improving trader practices**. [5] This is especially important in value chains for perishable foods, which can lose their nutritional value or even become a risk for foodborne infections or zoonotic pathogens, such as avian influenza, if not handled properly. FP3: Food Safety is working on proof of concept of an institutional innovation for traders called 'training and certification' (T&C), designed to improve the quality and safety of livestock products in informal and formalizing value chains. T&C provides traders with the capacity and incentives to improve their practices in contexts where enforcement of regulations through penalties is challenging. The ToC describes the conditions under which T&C can lead to increases in consumption of safer animal source foods (ASF) by target consumers, as well as the conditions under which such a scheme can be sustainable and scalable (N. Johnson et al. 2015). The T&C innovation is currently being implemented at scale in dairy value chains in India and Kenya, reaching 6.5 million consumers. Based on lessons learned from this experience, A4NH is adapting the approach to markets for other livestock products in collaboration with the CRPs on Fish, Livestock, and, with WLE, on vegetables. Gender and equity issues are important along the pathway, in particular because risk of FBD often varies by gender when men and women play different roles along the value chain, from production through slaughter and processing, to sale.

Agricultural value chain analysis and interventions have typically focused on the supply side, but if the goal of value chain development is to improve diets, then analysis needs to extend to the demand side. Changing **consumer behavior** will need to become a key entry point for improving value chain performance (keeping in mind that in many of our contexts, consumers may also be producers and traders). In Phase I, a conceptual framework was developed (Gelli et al. 2015) and is being validated with development partners such as WFP and IFAD. In Phase II, more research will build upon these initiatives. FP1: Food Systems will work closely with public and private actors (through Global Alliance for Improved Nutrition (GAIN), business schools (e.g. Desautels Faculty of Management at McGill University) and other CRPs to integrate diet into the indicators used to assess value chain performance and food system interventions and innovations. Our work with CCAFS on sustainable food systems and on the

[5] We use the term traders, but this could be any group of intermediaries between what's produced on the farm and the consumer.

environmental implications for changing diets (Gill et al. 2015) will be particularly important, and is expected to have impacts on both under- and over-nutrition. It will be through this consumer-oriented work on improving value chains in a food systems context that we expect to achieve our SRF target on improving dietary quality and diversity.

Development programs pathway

Markets are the drivers of agricultural development, but development programs that successfully integrate agriculture, nutrition, and health also represent an important avenue for reaching key target beneficiaries cost-effectively (Masters et al. 2014). **Nutrition-sensitive agricultural programs** are important for reaching two critical target populations: pregnant women and children under two years of age. These groups are particularly vulnerable to poor nutrition, and improvements in nutrition can have life-changing impacts on a child's physical and cognitive development and future potential. Similarly, integrated agriculture and health programs can be cost-effective options for achieving both public health and agricultural development objectives, especially in poor, rural areas. The disease, cysticercosis, is a priority example, where elimination is possible with coordinated and sustainable control efforts between public health and agricultural programs linked with value chain incentives and interventions (Maurice 2014).

During Phase I, FP4: SPEAR (known then as Integrated Programs and Policies) began building an evidence base on *how* and *how much* integrated agriculture and nutrition programs can improve nutrition outcomes, working closely with both development programs and with the governments and donor agencies that fund them. Findings from these studies are being incorporated into the design of new programs and the scale-up of future programs, enhancing their coverage and effectiveness. For example, on the basis of emerging evidence on gender-agriculture-nutrition linkages, the Ministry of Agriculture of Bangladesh is investing in a large-scale evaluation of alternative approaches to integrating nutrition and gender into agricultural extension. This work constitutes an important part of A4NH's contribution to the SRF target on reducing micronutrient deficiencies.

Policies pathway

A4NH research provides the evidence base, knowledge, tools, and technical inputs to help decisionmakers make smarter policy choices and better (and bigger) investments. All FPs have policy objectives, but these vary. For example, the first three FPs will focus on national and sub-national policies and regulations that influence farmers, market agents and small and medium enterprises along and, especially, across agri-food value chains to support safe, healthy and sustainable food system transformation. FP4: SPEAR will focus on national processes and capacities of national actors to shape public policy and programs so that improved nutrition and health outcomes can be achieved through agriculture. Key assumptions that underlie the pathway from policy commitment to implementation and impact on the ground relate to the availability of (1) knowledge and evidence, especially about implementation at scale, (2) cross-sector political commitment both from supporting integrating ministries such as finance, planning and science and technology and fostering understanding on potential synergies from ministries that compete for funding such as social development, health and agriculture, and (3) sufficient capacity and resources, which often requires careful prioritization of actions (Gillespie et al. 2013; Gillespie, Menon, and Kennedy 2015). A4NH expects that that half of its commitment to the SRF target on reducing micronutrient deficiencies (as well as to other country priorities such as stunting and anemia) will come from improvements in the enabling environment. While the challenge for undernutrition is converting policy commitment to action, the challenge for other health and nutrition issues is to get on the policy agenda. The agriculture sector has not seen

health as a priority (and vice versa), but this is changing as more evidence becomes available on the burden of agriculture-associated diseases, the incidence and impacts of FBDs (Havelaar et al. 2015), and on the availability of cost-effective policy options. Similarly, the availability of better data on changes in diets at the national and subnational level and on links between diets and food systems is expected to influence policies that shape food systems. Getting these issues on the policy agenda will be a key objective for FP1: Food Systems, FP3: Food Safety and FP5: Improving Human Health in Phase II and will involve engaging with key stakeholders in agriculture, health, and other sectors. It will also involve building country-level capacity for cross-sector policy analysis so that analysts can identify and assess appropriate policy options. The policy pathway is expected to lead to important reductions in exposure to FBDs and other agriculture-associated diseases and in overnutrition. Indicators and targets will be set for these impacts.

In addition to the three food systems pathways described above, as an ICRP A4NH contributes indirectly to outcomes through the support it provides to other CRPs, by facilitating networking and mutual learning through CoPs and learning platforms. While we expect these contributions to be reported through other CRPs, following the advice of the A4NH external evaluation and true to the role of an ICRP, we will develop ToCs for our investment in networking, co-learning and bridging work in order to be more systematic about monitoring and learning from these investments. This has already been done for the gender-nutrition CoP which was established in Phase I and will be done for others once they are operational.

1.0.4 Gender

Gender is widely recognized as an integral part of the different systems of agriculture, nutrition, and health. Women are traditionally thought of as the guardians of household food security and nutrition, yet decisions about what foods to produce and how to produce them, which foods are sold and purchased, and how foods are prepared and allocated to different household members can be made by both men and women. These household decisions have varying effects on agricultural outcomes and on the health and nutritional status of household members, and are therefore fundamental to A4NH research and impact. This section is based on the A4NH Gender Strategy, which summarizes existing (A4NH and other) research on the role of gender in agriculture-nutrition-health (ANH) pathways to identify evidence gaps and research priorities. The Gender Strategy sets out the ways in which the GEE unit[6], one of the three cross-cutting units within the Program Management Unit (PMU), will ensure that gender is integrated into the research and activities of the CRP. This section should be read along with the gender annex (Annex 3.3), which provides more details on how research and evidence on gender in Phase I informed A4NH's research priorities for Phase II, the gender milestones A4NH research hopes to achieve in Phase II, and the resources needed to do so.

How is gender reflected in the A4NH agenda?
All A4NH FPs expect to contribute to the IDO on gender, and in particular, to the sub-IDOs on *gender-equitable control of productive assets and resources* and *improved capacity of women and young people to participate in decisionmaking*. Findings from Phase I research revealed three priority areas for

[6] In Phase I, GEE was referred to as the Strategic Gender Unit. The name change reflects a recommendation of the A4NH External Evaluation to pay more attention to equity issues. See Annex 3.3 for definitions and additional information.

research where evidence gaps remain about how agricultural research can contribute to outcomes (details can be found in the A4NH Gender Strategy):

- Impact of **gender-based differences** on nutrition- and health-related outcomes;
- Improving nutrition through **women's empowerment;** and
- Avoiding **unintended consequences** to women's well-being and empowerment.

These translate into specific research questions in each FP (Table 1.2).

Table 1.2. Gender research priorities in each of the A4NH FPs

A4NH FP	Fundamental gender research questions
FP1: Food Systems for Healthier Diets	How can healthy food systems benefit both women and men, as consumers and value chain agents (**Gender-based differences; Women's empowerment**), while avoiding harm to women's time, work burden, and health status (**Unintended consequences**)? Does information about healthier diets reach target beneficiaries and do their knowledge changes lead to behavior changes? (**Gender-based differences; women's empowerment**)
FP2: Biofortification	How can we ensure that delivery of biofortified crops meets men, women, and girls' preferences and nutritional needs (**Gender-based differences**), supports gender-equitable decisionmaking in production and consumption decisions (**Women's empowerment**), and avoids harm to women's time, work burden, and health status (**Unintended consequences**)? How can we promote adoption of biofortified crops by targeting appropriate household decisionmakers, including women and men?
FP3: Food Safety	How do exposure to agricultural diseases, strategies to manage risk, and the impacts of disease vary by gender? (**Unintended consequences; Gender-based differences**)? How can measures to improve food safety proactively include women and support them to engage in emerging formal markets? (**Gender-based differences**)?
FP4: Supporting Policies, Programs and Enabling Action through Research (SPEAR)	How are gender dynamics (relations between women and men) and women's decisionmaking power associated with improved child and women's nutrition outcomes (**Women's empowerment**)? How can agricultural development interventions enhance women's status (**Women's empowerment**) while avoiding harm to women's empowerment, time, and health (**Unintended consequences**)? How can policymakers develop cross-sectoral, gender-responsive policies? (**Gender-based differences; Women's empowerment; Unintended consequences**) How can nutrition-sensitive agriculture programs engage men and sensitize them about the importance of gender equity? (**Gender-based differences**)
FP5: Improving Human Health	How do the health risks and benefits of agriculture vary by gender (**Unintended consequences; Gender-based differences**)? How can measures to improve human health proactively include women (**Gender-based differences**)? How can women be more involved in decisions about how to improve management of agricultural intensification to improve health outcomes (**Gender-based differences**)? How can integrated agricultural and health development interventions engage women and girls while avoiding harm to women's time and health (**Unintended consequences**) and engage men to play a greater role in supporting better health (**Gender-based differences**)?

How is gender operationalized in A4NH?

Gender research in FPs

Many FP research teams include gender expertise, and they are responsible for framing gender research questions for the overall FP and for ensuring that gender is integrated within the FP. The GEE unit supports these researchers through workshops, webinars, blogs and other gender-related capacity development activities. FPs with weaker gender capacity can use funds allocated for gender research to hire gender experts or to establish strategic partnerships with other FPs or with other external institutions with the required gender skills. The external evaluation of A4NH noted that the reported gender focus of projects in A4NH increased over the course of Phase I. More details of how each FP has set its gender research priorities can be found in Annex 3.3.

In addition to gender researchers in each FP team, A4NH has worked with other CRPs to recruit gender postdoctoral fellows, funded in part by the Consortium. One fellow is working with the CRPs PIM and HumidTropics on building capacity within CGIAR on indicators of empowerment; another fellow is working with CRPs Livestock and Fish and Grain Legumes on evaluating the gender and nutrition impacts of value chains; and a third fellow will work with the CRPs Grain Legumes and Dryland Cereals to investigate gender issues in varietal selection, breeding, and adoption processes.

Gender at the CRP level

In addition to supporting gender research in the FPs, the GEE leads cross-cutting research on strategic issues relevant to the overall research program. These topics fill major knowledge gaps, build evidence on key conceptual and methodological questions (such as survey experiments on decisionmaking), and develop and validate indicators, tools, and metrics that can be used to measure gender outcomes. An example of such cross-cutting research is the second round of the Gender, Assets, and Agriculture Program (GAAP2) which is working towards adapting the Women's Empowerment in Agriculture Index (WEAI) and validating it for the use in agricultural development projects, including nutrition-sensitive agricultural interventions. Along with this validated tool (pro-WEAI), lessons from GAAP2 on how agriculture projects can empower women and improve gender equity and nutrition and health outcomes will be useful for research projects across A4NH FPs.

Four priority research themes have been identified for cross-cutting research. Across these themes, explicit attention will be paid to how gender interacts with other sources of inequity, including:

- How women's empowerment affects nutrition and health;
- How to engage men in nutrition and health;
- How to target youth, especially adolescent girls (see also Annex 3.4); and
- Linkages between gender, agriculture, health, and nutrition.

For background research and further details on how these areas were selected, please refer to the A4NH Gender Strategy.

Strengthening research capacity on gender, nutrition, and health

A4NH will build on the internationally recognized research capability of IFPRI and its partners in studying the implications of gender for agricultural research, and food and nutrition security.[7] The gender

[7] Notable examples include a multicountry program on gender and intrahousehold research that "shifted the burden of proof" by demonstrating that households do not behave as monolithic units with common interests and preferences (Alderman et al.

specialists in A4NH work closely with those in PIM, ensuring there is cross-CRP exchange of methods and learning; a number of projects cut across both CRPs. In line with recommendations from a recent portfolio review, which emphasized the need to continue building gender research and M&E capacity across CGIAR and its external partners, A4NH will continue providing gender methods training and support through the following activities:

- *Annual Gender-Nutrition Methods Workshop:* A4NH has conducted two workshops to date, attended by about 40 researchers belonging to A4NH, other CRPs with a nutrition focus, and partner organizations. The first workshop focused on establishing common frameworks, while the second workshop focused on women's empowerment and decisionmaking. These workshops were well attended, and participants expressed continued demand for future workshops.[8] In lieu of a third workshop in 2016, A4NH participants were invited to the GAAP2 Inception Workshop, which focused on different approaches to empowerment in agricultural projects and developing project-level indicators for measuring women's empowerment (pro-WEAI). Selected sessions from the workshop were recorded and shared with A4NH gender researchers and the larger gender CoP within CGIAR.
- *Gender Nutrition Idea Exchange (GNIE):* A monthly blog hosted on the A4NH website features contributions from researchers on how to conduct high-quality agricultural research that considers gender and nutrition issues. The blog has a large and growing readership[9] and offers a space for highlighting newer research topics, such as the relationship of gender to agriculture and health and linkages between agriculture, climate change, and gender (a post which was cross-posted on the Agrilinks USAID website).
- *Learning events and other outreach activities for gender researchers:* A4NH will reach out to gender researchers in A4NH and other CRPs to help identify and support specific needs for capacity building. Activities could include, for example, holding workshops on specific topics or methods, organizing panels at major conferences to showcase gender research in A4NH, and establishing a rotating webinar series.
- *Small grants for gender research:* A number of small grants will be provided to A4NH-mapped research projects that will build the evidence base around strategic gender research priorities. These grants will be combined with technical advising from the GEE unit. A more detailed process for providing targeted support will be developed for Phase II in consultation with the Planning and Management Committee (PMC) conditional on the availability of an uplift budget.

Tracking gender

Gender in ToC

In addition to gender being integrated in FP-level ToCs, a ToC was developed specifically for the support to gender research[10] carried out at the CRP-level to clarify how our gender activities are expected to make changes that lead to desired outcomes (**Figure 1.3**). The primary target audience for our gender activities and outputs will be the CGIAR gender researchers, who will be reached through various modes

1995; Quisumbing 2003); the background research drawn upon for the FAO SOFA 2011 (Quisumbing et al. 2014); the background paper on gender for GCARD1 (Meinzen-Dick et al. 2011); and the development of the WEAI, and numerous guides for collecting sex-disaggregated data and conducting gender analysis.

[8] In the future, we will explore alternative ways of extending the reach of these trainings, including providing access to workshop videos, webinars, and other virtual platforms.

[9] The blog had 12,500 unique page views in 2015

[10] This was one of the recommendations for the GEE by the external evaluation.

of communication, including direct participation in A4NH events [1][11]. We will use web analytics, attendance lists, and evaluation forms to track access and participation for each type event or output. These activities will help increase the capacity of these target researchers to conduct high-quality gender-nutrition-health research [2].

To achieve these first two outcomes—reaching researchers and improving their capacity – we need to make sure that we are reaching the right people in the FPs and other CRPs and that our activities are designed to address their most pressing capacity gaps. Details on how we will use our monitoring system to track progress are outlined in the following section, and our capacity-strengthening plans have already been discussed above [a1, a2].

Once researchers have increased their capacity to conduct high-quality gender research, we expect that they will incorporate new knowledge, skills, and tools into their work [3]. However, if they are engaged in projects that are unable to incorporate new gender components, perhaps due to resource constraints or other reasons, then there may be a significant lag between the time that capacity is built and the integration of gender into projects [a3]. To help shorten this lag and to maintain momentum and interest in our capacity-building activities, we propose to provide a number of small grants combined with technical advising from the GEE unit, targeted to A4NH-mapped research projects that participate in the CoP. This will provide immediate opportunities for researchers to incorporate gender considerations in existing projects. As they gain more experience in using their new skills and tools, we also expect that this will increase the likelihood that researchers will propose and design future projects that are more gender-responsive.

If researchers conduct more gender-responsive research, their research outputs will be more likely to benefit women and promote gender equity [4]. This implies that using a gender-responsive approach yields new insights that would otherwise not be revealed [a4], which is very likely given the growing evidence that shows that inattention to gender is not benign, and may even derail success. Even if new insights exist, however, decisionmakers in A4NH FPs and other CRPs must be willing to use this information in their programming decisions [a5]. More details on how this will be monitored can be found in the following section.

Monitoring and evaluation of gender integration in A4NH research

Gender research priorities and fundamental gender research questions aim to close evidence gaps (Table 1.2), informed by each FP's ToC. While gender is well-integrated at the planning stage for Phase II, we will continue to monitor projects throughout the research process to ensure that gender dimensions do not get lost in implementation and are appropriately reflected in research outputs. Monitoring will also help us gather periodic feedback from projects to identify what types of support they may require from the GEE unit.

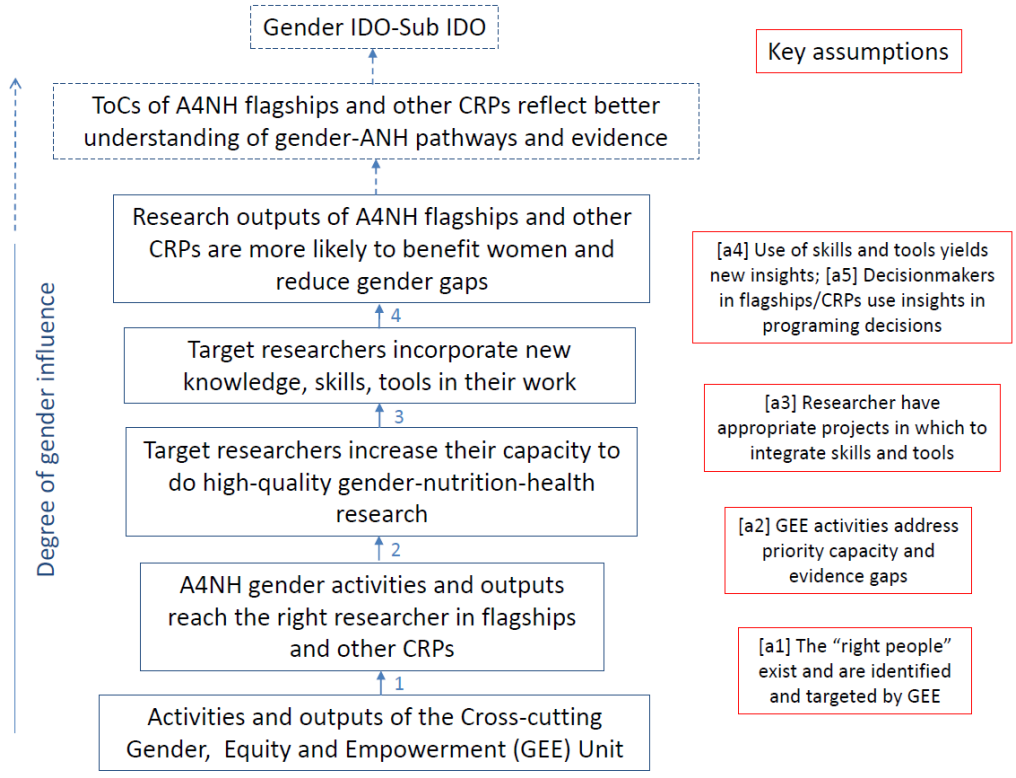
In 2014, A4NH started systematically collecting information on the gender research focus of projects mapped to A4NH (from all funding sources). All projects are asked to report whether or not there is a gender research dimension to the project (and if not, why not), the gender research questions to be addressed, the types of sex-disaggregated data collected, the level of gender focus of each project

[11] Numbers in brackets in this section refer to the numbers in the ToC diagram (**Figure 1.3**)

deliverable (none, some, significant), and the name of the person responsible for gender research[12]. Responses to these questions enabled us to assess how well the gender research questions identified are reflected in project deliverables, and track progress over time. The information gathered at the work planning stage will be reviewed by the GEE to help advise research teams on improving gender research before research plans are implemented. As deliverables are completed, the GEE will review completed deliverables to assess the quality of gender analysis in our research products.[13] A4NH is also working with PIM to harmonize its M&E systems for tracking progress on the integration of gender in research. Further guidelines and updates to the gender section of the work plan template are expected to be used as part of future work planning processes. See more in Annex 3.5.

Beyond monitoring the gender focus of research outputs, projects that focus solely on women or that collect but do not analyze sex-disaggregated data are particularly important to identify because they have the potential for doing more gender analysis, such as expanding analysis to include men and/or using sex-disaggregated data to conduct gender analyses. Such projects can be targeted for additional technical assistance, linking up researchers with gender experts and providing small grants to add a gender component or to collect gender-relevant data.

FIGURE 1.3. THEORY OF CHANGE FOR INTEGRATION OF GENDER IN A4NH RESEARCH



[12] We have developed standardized definitions for each category and plan to expand the "levels of gender analysis" in deliverables to reflect increasing depth in gender analysis: 0) None, 1) Woman-focused, 2) Sex-disaggregated data reported but no gender research questions, 3) Some gender analysis but not main focus of research, and 4) Significant gender analysis is main focus of research.

[13] This will be based on a random sample of completed deliverables per flagship; actual sample size will depend on available resources.

1.0.5 Youth

The recognition and integration of youth[14] issues in agriculture, nutrition, and health research is an under-explored topic. A4NH can learn from and build on experiences with sex- and age-disaggregated data collection, analysis and targeting, and with integrating gender issues, in order to make A4NH research teams more cognizant of incorporating youth issues when defining outcomes, setting and implementing the research and partnership agendas, and identifying and validating impact pathways. Within agri-food systems, young people play a range of roles (e.g. producers, employees, consumers). Youth is a time of transition and is a crucial window for interventions focusing on changing knowledge, attitudes, and practices about dietary choices, gender roles, agricultural production, and other issues that could influence for nutrition and health outcomes. Adolescent nutrition, specifically for girls, is important with respect to the life cycle approach to nutrition because it has implications for maternal nutrition. Age is also an important factor in intra-household decisionmaking, as young people, especially young wives or daughters-in-law, may not be empowered to make decisions that affect nutritional and health outcomes.

Some A4NH projects already use age-sensitive approaches (e.g. innovative behavior change communication strategies targeted at different age groups); in Phase II, we aim to make age-sensitive methodologies more explicit and informative.

A4NH youth issues will fall under the mandate of the GEE unit. To develop and implement our youth strategy (Annex 3.4), we will build on our experience integrating gender conceptually (e.g. through agriculture-nutrition pathways) and operationally in A4NH research projects. Projects will be expected to treat youth as a distinct social group, reporting if data collected and analyzed are disaggregated by age groups, and identifying the youth-centered research questions in their study design.

1.0.6 Program Structure and Flagship Programs

A4NH has made some important changes in program structure that reflect lessons learned from Phase I and the increased emphasis on health in the new SRF. As a result, we have three aims for Phase II:

- Increase the attention to consumption and diet quality, and expand the value chains for enhanced nutrition approach to a food systems approach that look across individual commodities and value chains. Thus, we will launch a new partnership with Wageningen UR, and benefit from its disciplinary expertise and experience in food system analysis and private sector partnerships.
- Give greater importance to engaging with countries around nutrition-sensitive agricultural programs and policies, and on new food systems research. This builds on major successes in Phase I creating and supporting an enabling environments for nutrition. Important IFPRI policy vehicles, such as Regional Strategic Analysis and Knowledge Support System (ReSAKSS) and Country Strategy Support Programs (CSSPs) are increasingly being asked for knowledge and evidence on agricultural solutions for improving nutrition and health. We will also provide

[14] Youth is defined as ages 15 – 24

support to country M&E activities, strengthen capacity for cross-sectoral nutrition and health engagement, and support leadership in national policy processes.

- Expand our work on agriculture and human health to respond to emerging threats where agriculture may have a role, such as the use of antibiotics in livestock and its contribution to AMR. Consequentially, we need to strengthen CGIAR's relationships with public health research institutions. The new partnership with LSHTM will help us engage the public health research community in joint research with CGIAR. Appropriately, the four A4NH FPs from Phase I will be adjusted to form five FPs in Phase II (**Figure 1.1**), which fit together to create a portfolio of research designed to catalyze the development of nutrition- and health-sensitive agriculture and food systems.

FP1: Food Systems will focus on food systems through a value chain impact pathway and the associated policy enabling required to accelerate food system innovation, scaling, and anchoring. This FP responds to concerns about global diet trends, and demands from countries for systemic solutions that address problems, such as food insecurity, undernutrition, and overnutrition. By focusing on how food systems establish the food environment in which consumers make dietary choices, A4NH will engage with the AFS-CRPs and complement the sustainable food systems approaches of CCAFS and WLE. It will build upon and expand the research progress from the Phase I FP on Value Chains for Enhanced Nutrition, such as the framework on value chains for nutrition (Gelli et al. 2015) as well as mechanisms for strengthening integration of nutrition into other CRPs (e.g. work with systems CRPs around nutrition-sensitive landscapes and the small-grants scheme). This FP will play an important role in building capacity within CGIAR in food systems approaches and in integrating diet, nutrition, and equity concerns through a learning platform, which will draw upon expertise from across A4NH and partners. Since food systems lies outside CGIAR's traditional expertise, A4NH has invited Wageningen UR to lead this FP.

FP2: Biofortification will continue building on its highly successful phases of discovery (2003-2007) and development (2008-2013), and progress on the ambitious delivery phase, which started in 2014. While this FP still has important nutrition efficacy and effectiveness research to do, the main research questions for Phase II are not around whether biofortification works, but rather, how it can work at scale for specific crops and crop-country combinations. Innovative research in the delivery phase will focus on identifying and addressing technical, social (including gender), and institutional constraints associated with reaching hundreds of millions of micronutrient-deficient women and children, learning lessons for reaching 1 billion by 2030. Rarely have agricultural researchers, especially in CGIAR, focused on delivery science, and the HarvestPlus experience represents important opportunities to generate lessons and methods with potential application well beyond biofortification to other issues in A4NH. This FP works with crop AFS-CRPs with CCAFS and PIM.

FP3: Food Safety builds on Phase I achievements related to cross-Center (IFPRI, ILRI, IITA, the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)), and cross-CRP (Fish, Grain Legumes, Livestock, MAIZE) collaboration, and on new global evidence of the burden of FBD. This FP takes an impact-oriented approach to food safety in markets for staples and perishables through appropriate technologies, market innovations, policies, and regulations. While there are proven strategies for managing food safety in commercial food systems, these are often inappropriate and ineffective in informal markets, where the majority of poor people buy and sell food—especially nutrient-rich perishable, like meat, milk, fish, and vegetables. FP3: Food Safety will conduct research on technological and institutional solutions and appropriate policy and regulatory options that align public health goals with country priorities to ensure that food is both safe and equitable for the poor.

FP4: SPEAR will continue important research in strengthening the evidence base for agricultural solutions to improve nutrition and health. It will build on faster-than-expected progress on ANH policy, and will pro-actively respond to demands for cross-sectoral capacity and engagement at country and global levels. This FP includes a solid portfolio of evaluations that will help answer key questions about program impacts and cost-effectiveness in Phase II. Methods and findings from impact and process evaluations will have an important influence on future directions of research and investment in this area. FP4: SPEAR builds on Phase I research on creating and sustaining enabling environments that deliver impact at scale as well as on Phase I involvement with the Scaling Up Nutrition (SUN) movement, the Africa Union's CAADP investment planning process, and the 2014 and 2015 Global Nutrition Reports. This FP will provide greater guidance to other FPs and CRPs on cross-sectoral policy process analysis and engagement, and play a greater role in representing CGIAR in national and regional nutrition and health policy processes.

Phase I included limited research on human health risks associated with agricultural production. Starting in the Extension Phase, A4NH began engaging with a select group of public health research institutes and donors to explore (and ultimately confirm) interest in partnering on a new FP on agriculture and health. We conducted a series of regional consultations with public health partners, which culminated in a consultation in London in June 2015. To bridge agriculture and public health research and facilitate integrated actions to improve human health, A4NH has invited LSHTM to co-lead **FP5: Improving Human Health** with ILRI. Research priorities include health effects of ecosystem changes (e.g. large-scale agricultural water use), shared disease risks and their control between people and animals, and opportunities to increase health benefits, in addition to emerging challenges, such as AMR and chemical resistance, requiring coordinated health and agriculture actions.
While each FP has distinct research questions, impact pathways, and partnerships, cross-FP collaboration is expected to enhance efficiency and effectiveness. FPs will also work closely with three cross-cutting units: CCE, GEE, and MEL.

1.0.7 Cross CRP Collaboration and Site Integration

A4NH has a dual role in providing a strong research program on ANH in CGIAR's portfolio as well as an integrating role as the CGIAR lens on nutrition and health (SLO2). For this integrating role, A4NH seeks to work with CGIAR Centers and other CRPs in three main ways:

- Joint research with other CRPs, particularly in CGIAR Site Integration countries;
- Networking and mutual learning, including capacity strengthening, conducted through FP-led learning platforms or CRP-led communities of practice; and
- As a bridge to global, regional, and national nutrition and health communities.

All of A4NH's FPs in Phase II will collaborate with other CRPs in one or more of the ways listed above. The specific activities are described in detail in Annex 3.6. Some illustrative examples for each FP are listed below.

- **FP1: Food Systems** will conduct joint research with several AFS-CRPs linking value chain innovations to changes in diet quality, including with CCAFS and WLE on sustainability issues in food systems, and with PIM on agriculture and economic development issues in food systems.

This FP will also host a new learning platform for networking and mutual learning around food systems for healthy diets with other CRPs.

- For **FP2: Biofortification**, this CGIAR-wide function pre-dated A4NH (Challenge Program) and has continued with strong and well-funded joint research and, in Phase II, a focus on mainstreaming nutrition into breeding.
- **FP3: Food Safety** will add a food safety perspective to value chain research conducted by the AFS-CRPs on Dryland Cereals and Legume Agrifood System (DCL), Fish, Livestock, and MAIZE.
- **FP4: SPEAR** will collaborate with two FPs in PIM to do research on integrating social protection with complementary agricultural interventions and on understanding and supporting cross-sectoral policy processes.
- **FP5: Improving Human Health** will host a Platform for Public Health and Agriculture Research Collaboration, convened by LSHTM, which will serve as a resource for other CRPs looking to collaborate on agriculture and health. For its work on irrigated cropland and health, research sites will be coordinated with RICE, and scientists from WLE will consult with scientists from this FP on health risks and benefits in expansion of irrigation in Africa.

CGIAR Site Integration intends to improve the alignment of research, the coordination of delivery, and improve country-level collaborations. Improving partnerships with country-level stakeholders is also a central objective of the second phase of A4NH. A4NH has identified five focus countries for Phase II, four of the highest priority countries for CGIAR Site Integration (Bangladesh, Ethiopia, Nigeria, and Vietnam) plus India. In these countries, the new A4NH CCE unit will support country teams comprised of A4NH FP researchers, other CRPs, and partners who will carry out joint research and take responsibility for the Site Integration Plans (when developed). The country teams will each be managed by one A4NH managing partner (IITA in Nigeria, ILRI in Ethiopia, CIAT in Vietnam, and IFPRI in Bangladesh and India). Given our strong emphasis on country strategy and planning, we will coordinate with IFPRI's CSSPs (in Bangladesh, Ethiopia, and Nigeria), and in the focus countries in Africa through the ReSAKSS network. For the other Site Integration countries where A4NH is active, responsibility for the Site Integration Plans will be managed by individual FPs. For example in Kenya, most A4NH research is in FP3: Food Safety and FP5: Improving Human Health, which are led or co-led by ILRI; ILRI will be responsible for linking A4NH with Site Integration. All of this is detailed in Annex 3.6.

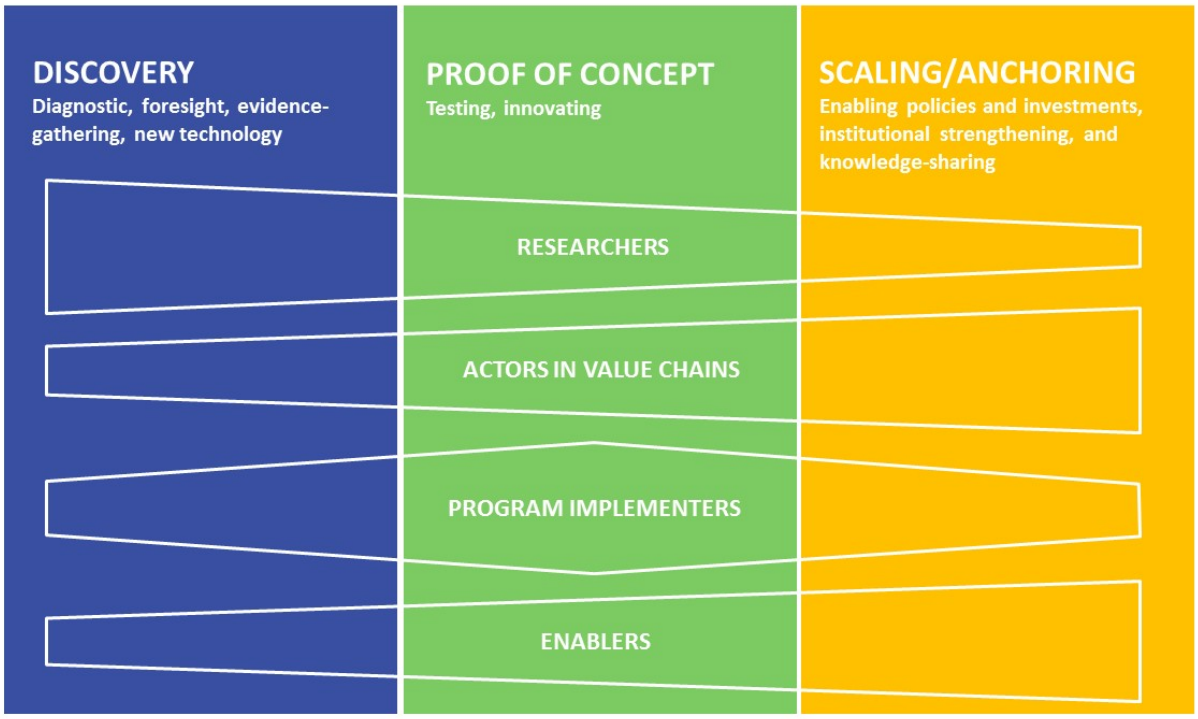
1.0.8 Partnerships and Comparative Advantage

A4NH partners with four broad categories of individuals or organizations: researchers, actors in value chains, development program implementers, and enablers. The relative level of involvement varies (e.g. grows, reduces, or maintains) based on the stage of research (**Figure 1.4**).

More than 30% of the total budget was expended by non-CGIAR partners in Phase I, and this is expected to continue to increase as A4NH scales up its work and invests in strengthening national partnerships, especially in our five focus countries.

In terms of CRP functions, partners fall into three categories in Phase II: managing partners, strategic partners, and collaborating partners.

Figure 1.4. Partner involvement at each stage of research



Managing partners will include the five CGIAR Centers (Bioversity International, CIAT, IFPRI [as Lead Center], IITA, and ILRI) plus Wageningen UR and LSHTM. They will be represented on the A4NH PMC, will recruit and co-manage FP and cluster leaders and researchers, and will actively support CRP-level resource mobilization, communication, and advocacy.

Strategic partners will conduct joint research and will carry out country coordination activities in our five focus countries. They will participate in at least one FP, dedicate human and financial resources to the FP, and will actively engage in research with other A4NH partners.

Collaborating Partners represent all others working with A4NH to make research for development contributions. These are usually partnerships for specific research, country activities, or communication. For more detail on partners and partnership modalities, see Annex 3.1

Comparative advantage of CGIAR and A4NH on nutrition and health

The A4NH external evaluation cited A4NH's considerable comparative advantage in ANH research. CGIAR is the world's leading international agricultural research for development organization, and IFPRI, our Lead Center, has a unique comparative advantage within CGIAR as having a critical mass of leading nutritionists and economists evaluating nutrition-sensitive programs and policies that link to global processes, such as SUN. For regional and national policy engagement and relevance on nutrition-sensitive agriculture, A4NH is well-positioned to work through IFPRI's ReSAKSS and CSSPs. The other managing partners have experience managing multi-institutional programs in particular sectors and regions. To address the emerging challenges in Phase II, A4NH will go outside the CGIAR to seek expertise in two key areas: food systems and public health. As described above, Wageningen UR and

LSHTM will play leadership roles in two FPs, bringing with them research excellence, partnership skills and collaborator networks.

Delivering International Public Goods (IPGs)
Our Phase I FPs delivered important IPGs in the form of publications, technologies, and datasets, which are described in the respective FP sections of this proposal. In Phase II, we expect our IPG potential to expand, as more advanced FPs (including FP2: Biofortification, FP3: Food Safety, and FP4: SPEAR) begin to produce comparative and meta-analyses and syntheses based on breeding, nutrition, and impact work. Scientific results will be translated into tools and guidelines to facilitate widespread uptake and use. For FP1: Food Systems, there will be multi-country assessments and analyses of food systems to better understand the drivers of diet change, food system and nutrition transformation for improved health, as well as innovative methods and metrics for looking at nutrition and health issues in value chains and food systems. Research from FP5: Improving Human Health will fill important evidence gaps on key global issues, such as agriculture's role in AMR and generating important data sets such as linking detailed spatial data from agriculture and health. A4NH will also support three platforms and a community of practice to share findings, strengthen capacity and build stronger networks between the CGIAR and nutrition and public health communities.

1.0.9 Evidence of Demand and Stakeholder Commitment

Nutrition is at an historic high on the global policy agenda. Through the SUN movement, donors and national leaders from 56 countries have made commitments to reducing malnutrition. Agriculture and food systems play key roles in the solution. In Africa, there has been an explicit recognition of the important role of agriculture, as evidenced by the food and nutrition security pillar of CAADP, which represents 20 of the 34 countries with the highest burden of malnutrition. These high-level commitments are stimulating demand for evidence of what works and what can be cost-effectively scaled out. In Phase I, even intermediate A4NH research products such as presentations of initial results and discussion papers were quickly translated into guidance and manuals by platforms such as Ag2Nut and Secure Nutrition, nutrition strategies of donors and countries, and the Global Nutrition Report that supports countries to monitor and improve nutrition performance.

Despite obvious linkages between agriculture and health, and between health and nutrition outcomes, the health sector is not as closely aligned to agriculture development as nutrition currently is. The one exception is around One Health thinking, particularly on the control of zoonoses that have human epidemic or pandemic potential (Severe Acute Respiratory Syndrome (SARS), avian flu). The new SRF increases the focus on generating evidence and raising awareness of the potential for agriculture to contribute to improved health outcomes. Collaboration between the agriculture and health sectors, not only on food safety issues—which are likely to move quickly up the global health agenda during Phase II on the basis of new evidence on the size of the burden of FBD (Havelaar et al. 2015) —but also on other emerging global health threats, such as AMR, vector and pest resistance, and misuse of chemicals, can help meet the growing demand for better evidence and more effective, sustainable solutions. Our public health partners have expressed strong interest in engaging agriculture not only for its role in reducing the risk of diseases, but also for more sustainable prevention of disease in the face of drug and chemical resistance.

As a reflection of demand for A4NH research, our bilateral funds have grown dramatically from roughly $30 million in 2012 to over $70 million in 2015. Much of this has been in our proven research areas, such as FP2: Biofortification, FP3: Food Safety, and FP4: SPEAR. We have documented this expanded grant portfolio to show how the current grants fit into a coherent research program and included it with our full proposal (see "Funding the A4NH Agenda" in Other Annexes). Our Phase II portfolio addresses demands from target countries for solutions that are not yet identified, but urgently needed. Given the complexity of the challenges, the solutions will likely lie outside the traditional areas of CGIAR expertise, requiring new partnerships and investment to build capacity and networks among researchers and other stakeholders. Countries are looking for comprehensive food system solutions, including options for leveraging private sector investments that not only combat undernutrition, but also address food safety concerns in domestic markets and mitigate the growing problem of overweight and obesity. FP1: Food Systems will engage directly with these issues. Countries and donors are also placing high priority on preventing and treating infectious disease, an area with minimal effective collaboration between public health and agricultural researchers to date. LSHTM in FP5: Improving Human Health will convene a platform of public health and agriculture researchers to collaborate in research areas such as EcoHealth and AMR in which collaboration is essential, but has been limited.

1.0.10 Capacity Development

1. CapDev role in impact pathway	
Capacity development is a critical part of the overall A4NH impact pathway and the impact pathways of individual FPs. The A4NH Capacity Development Strategy (Annex 3.2) is based on the A4NH results framework and places particular emphasis on building capacity among *researchers* to develop and use the innovative methods and metrics necessary for the multi-sectoral nature of ANH research; among *actors in value chains*, including farmers, to test and use technologies and other innovations that improve the nutritional quality and safety of crops and food; among development *program implementers* to apply evaluation results, including technologies, practices, and programming modalities, in the design of more effective ANH programs; and among *policymakers*, including research leaders and policy analysts in national institutions, to build and sustain enabling environments that support country performance for improving nutrition and health through agriculture. A4NH cannot achieve these results alone. In Phase II, we will invest in working with partners, other CRPs, and those outside CGIAR, through a variety of mechanisms, which are described more fully in Annexes 3.1, 3.2, and 3.6. As an ICRP, A4NH has a role to play in strengthening capacity across CGIAR and adding value to other CRPs to enhance contributions and reduce risk of unintended negative consequences to the SLOs. Our commitment to strengthening capacity is demonstrated by the CoPs and learning platforms we will host and our co-investments in the ANH Academy. A sample of the strategic capacity development actions A4NH will prioritize in Phase II are summarized below and described in more detail in Annex 3.2.	
2. Strategic CapDev actions (see CapDev Framework)	

3. Intensity of implementation of chosen elements (Please indicate High, Medium, Low)		**Give an indication of how chosen elements will be implemented**	**Indicators that can be used to track progress and contribute to CapDev Sub-IDOs**
1.Capacity needs assessment and intervention strategy design	Medium	Provide more focused response to countries and networking between countries on essential capacities that will allow key nutrition champions to participate more actively in strategy design (FP4: SPEAR); inform activities of learning platforms and CoPs.	Proportion of FP4 focus countries with identified nutrition champions reporting participation in country strategy designs # of countries that have engaged in or plan to engage in processes to address barriers and constraints (including capacity) to an enabling environment for nutrition-sensitive agriculture among focus countries.
2. Design and delivery of innovative learning materials and approaches	High	Working groups (TBD) on metrics and methods through the ANH Academy (all FPs)	# of training institutions in focus counties who adopt the tools/methods used as part of professional training programs, long or short term
3.Develop CRPs and Centers' partnering capacities	Medium	Identify and build the capacity of partners at the national, regional, and global levels to work across sectors to increase the effectiveness of research and development partnerships (all)	# of collaborations (e.g. joint research, joint training/workshops, shared funding arrangements, common membership of multi stakeholder platforms) with partner organizations
4. Developing future research leaders through fellowships	Medium	Support future multi-disciplinary research leaders, in partnerships with regional academic institutes and programs and form a community of practice across this broad research area through the ANH Academy (all)	# of scientific publications accepted with co-authorship with fellows # of post-doc (or early career researchers) citing membership or participation in the ANH Academy in bio/CV # of AWARD fellows or CGIAR gender research fellows affiliated with A4NH
5. Gender-sensitive approaches throughout capacity development	Medium	Expand gender and nutrition CoP to help evaluation and gender staff in other CRPs apply state-of-the-art methods and tools (all)	# of CRP research projects/evaluations using state-of-the-art methods and tools
6. Institutional strengthening	High	Convene annual global and regional events to look at both innovation and on development	# of countries who have developed or are developing evidence generation and use cycles/systems

		outcome demands between agriculture research and nutrition and health policy and advocacy communities with European Union- UN Children's Fund (EU-UNICEF), SUN Civil Society and other networks (FP5: Improving Human Health). As part of new Phase of CAADP, work with selected countries in developing the National Agricultural strategies part of country strategy support programs	by collaborative engagement involving two or more stakeholders. CRPs and CGIAR Centers reporting enhanced nutrition sensitivity of programs. # of national agriculture strategies that include nutrition as specific development outcome and integrate nutrition goals in agriculture.
7.M&E of capacity development	Medium	A4NH will monitor its capacity contribution using the indicators identified in this table as part of its M&E	We will keep track of participation in and conduct evaluations of CapDev events. In some FPs, like FP3 and FP4, the effectiveness of alternative means of building capacity is actually a research issue and will be tracked and assessed.
8.Organizational development	Low	Strengthen national level nutrition taskforces and committees to better integrate nutrition in the national agricultural investment plans in selected countries (e.g. through CAADP) Collaborate with NARS in select countries to change knowledge, attitudes and practices as they relate to mainstreaming biofortification (FP2: Biofortification) and managing food safety risks (FP3: Food Safety)	# of CAADP investment plans that incorporate A4NH research results in selected country programs National systems with better organizational capacity for bio-fortification National systems with improved organizational capacity for food safety research
9.Research on capacity development	Low	Learn from current capacity building approaches (in Evidence Informed Decision-making in Health & Nutrition (EVIDENT) and African Nutrition Leadership Programme (ANLP), for example) and apply to approaches in this FP and across CGIAR	Review methods used for strengthening capacity in A4NH to improve their effectiveness and scalability
10. Capacity to innovate	Medium	Innovation opportunities to strengthen nutrition policy	# of collaborators / partner who are using innovative approaches in

		process will be explored as part of FP4: SPEAR; food system innovation in FP1: Food Systems.	their research outreach and communication activities during and after collaboration with A4NH researchers

1.0.11 Program Management and Governance

The **Lead Center** for A4NH will continue to be IFPRI. This choice reflects IFPRI's research excellence and global leadership in nutrition and its demonstrated capacity to govern and manage A4NH in Phase I. A4NH's governance arrangements will follow CGIAR principles, including the CRP governance and reporting structure described, and practices recommended by the A4NH external evaluation. IFPRI will continue to have overall fiduciary and operational responsibility for the implementation of A4NH. The Board of Trustees and Director General (DG) of IFPRI will be accountable for the overall execution and for the effective engagement of the different partners in A4NH. IFPRI will be responsible for the overall CGIAR reporting requirements. Along with the other six managing partners (Bioversity, CIAT, IITA, ILRI, LSHTM, and Wageningen UR), IFPRI will have responsibilities for FP management and country coordination. All the managing partners will have members on the A4NH PMC and agree upon responsibilities and budgets with IFPRI through program participant agreements.

The member composition of A4NH's current Independent Advisory Committee (IAC) fits CGIAR's requirements of an **Independent Steering Committee (ISC)**. In Phase II, the IAC will be reconstituted as the ISC to enable it to take on a more active governance role. The ISC will not only provide advice on strategic direction and priority-setting for the overall program as the IAC did, but it will undertake a formal review and approval of A4NH's annual plan of work and budget, plans for program evaluations, and strategies. Per the CGIAR principles, the ISC will take part in assessing the performance of the CRP Director by providing advice to the IFPRI DG, who is responsible for the CRP Director's review. As in Phase I, there will be eight independent members of the ISC. There will be three ex-officio members: the IFPRI DG, one Director from among the six managing partners, and the CRP Director. The ISC will report to the IFPRI Board annually with recommendations and proposed management responses. Potential conflicts between the governance role of the ISPC and the IFPRI Board will be managed and documented based on CGIAR principles.

In Phase II, a larger **PMC** for A4NH is proposed. We plan to enhance the role of CGIAR managing partners by having the five CGIAR managing partners represented on the PMC at the Deputy DG (DDG) or Program Director level. The two external managing partners—Wageningen UR and LSHTM—will also have high-level institutional representatives on the PMC. Each managing partner's representative will report on the managing partner's responsibilities, which would include FP/CoA and country coordination leadership to the PMC. The five FP leaders, plus the A4NH Director, as well as one member of the GEE unit and one member of the MEL unit, will be members. The 15 members of the PMC will meet face-to-face twice annually and virtually on a monthly basis.

Individual FPs will be encouraged to have their own management groups. For the three FPs with continuing leadership from Phase I, management will build on past systems. For the two FPs with external leaders (Wageningen UR) or co-leaders (LSHTM), the FP leader will have a reporting relationship to the lead institution(s) and the CRP Director. The A4NH external evaluation found that in Phase I most FP leaders had limited authority and incentive to manage aspects of their FP that fell

outside their own institution or research program. To address this in Phase II, FP and CoA leaders will have more control over budgets and over which projects are mapped to the FP than they did in Phase I. Phase II RBM and MEL systems will help and support them to manage programmatically, based on FP and CoA ToCs. FP leaders will have the support of research coordinator.

John McDermott will continue as A4NH Director and leader of the PMU. The PMU has two main functions: to support FP leaders, the ISC, and the PMC in all aspects of program implementation, and to coordinate CRP-level programming for monitoring, evaluation, reporting, and learning; strategic partnerships; capacity development; knowledge management; and communications. Following advice from the A4NH external evaluation, we plan to specifically strengthen MEL to support our RBM approach and our internal CRP communications in Phase II. Key members of the PMU will continue in their positions, specifically senior staff Nancy Johnson, Hazel Malapit, and Agnes Quisumbing (see CVs in Annex 3.7).

Two of the five FP leaders who are currently leading existing programs will continue as leaders: Delia Grace, and Stuart Gillespie. Both are outstanding research leaders with demonstrated capacity for leading multi-institutional research for development partnerships. In November 2015, Howdy Bouis announced his retirement as director of HarvestPlus. The search for his replacement is ongoing, but his successor will be hired before or soon after Phase II begins, and will lead FP2: Biofortification. For FP5: Improving Human Health, the co-leads, ILRI and LSHTM, have proposed Eric Fèvre, who currently holds a joint appointment with ILRI and the University of Liverpool, as the FP leader. For FP1: Food Systems, we have proposed new partnership arrangements across multiple institutions and will recruit a new FP leader (see draft Terms of Reference (ToRs) in Annex 3.7).

1.0.12 Intellectual Asset Management

IFPRI is in compliance with the CGIAR Principles on the Management of Intellectual Assets, which deal with the dissemination of intellectual assets for maximizing global accessibility and impact. The majority of A4NH intellectual assets include knowledge, databases, publications, and other information products. All FPs may produce intellectual assets that include improved germplasm, plant variety rights, trademarks, diagnostic tests and other technologies. Management of those intellectual assets takes place at the managing or strategic partner level, in compliance with CGIAR Principles. All information products produced by A4NH are, wherever possible, disseminated using open access principles, with clear branding to recognize those responsible for producing the intellectual asset. In the cases where particular copyrights apply (e.g., in the case of some high impact journal articles), A4NH abides by the copyright rules of the publishing party. When working with private sector entities, A4NH will clarify that it is committed to open access on knowledge products and will abide by any rules that are placed on the partnership. Final products will be made public in accordance with the agreements.

For FP2: Biofortification, intellectual assets are managed through the Centers contracting with HarvestPlus. For FP3: Food Safety, intellectual assets related to food safety technologies and innovations (e.g. aflasafe™) are managed by IITA and ILRI. For FP1: Food Systems and FP5: Improving Human Health, intellectual asset management would be through the managing partners, Wageningen UR, ILRI, LSHTM, and their partners. ILRI's intellectual assets policy and guidelines provide a good model for managing partner responsibility and compliance with CGIAR principles. More details are in Annex 3.9.

1.0.13 Open Access Management

A4NH seeks to ensure that all research data and other information products produced by A4NH are managed to enable further research, development, and innovation, leading to the best possible impact on target beneficiaries in accordance with our mission. Our approach is consistent with the CGIAR Open Access and Data Management Policy (OADMP), meaning that information products generated under A4NH will be made available for indexing and interlinking, so that research outputs are open via FAIR (Findable, Accessible, Interoperable, Re-usable) principles. More details are in Annex 3.8.

At the CRP-level, open access management will include making partners aware of policies and providing systems and structures for partners to follow the policies. This will be operationalized through FPs and CoAs where research outputs will follow CGIAR requirements and primarily be hosted on existing platforms that CGIAR, IFPRI, or other partners manage (e.g. CGSpace, Dataverse, etc.). A4NH will continue to rely on IFPRI, as the Lead Center, and their dedicated resources and capacities through the Knowledge Management team, and will work more closely with technical experts from our participating Centers in Phase II to overcome some of the Phase I challenges described in Annex 3.8. Of particular importance is strengthening partner data collection and archiving to facilitate the rapid availability of high-quality data.

1.0.14 Communication Strategy

Strategic communication is central to A4NH and CGIAR as a whole. Rigorous, high-quality research and evidence must first be accessible, then shared, discussed, adapted, and used to achieve outcomes outlined in the SRF. The A4NH communication strategy plays a key role in achieving this, not only by raising visibility and demonstrating accountability, but also by making evidence, tools, and resources available to those who can use them to design more nutrition-sensitive policies and programs and to create enabling environments for nutrition and health.

Four communications objectives developed during Phase I with input from the PMC and IAC help guide the A4NH: 1) Influence food and agriculture development agenda; 2) support decisionmakers with the information, evidence, and tools they need to make change; 3) generate and promote high quality evidence on nutrition-sensitive agriculture; and 4) increase visibility and demonstrate accountability of A4NH and CGIAR.

A4NH employs a combination of six communication elements in its communication strategy: engaging in policy dialogue to scale up results; engaging with actors on the ground to scale out technologies and practices; communicating the program, the science, results, and progress towards targets; communicating and engaging with partners for effective development impact; promoting learning and sharing of information to improve collaboration within and across CRPs; and making CRP information and resources open and accessible. Within these elements and others, A4NH implements the following types of activities: participating in high-level policy engagement platforms (e.g. policy briefings, discussions, webinars, and research dissemination events); translating A4NH knowledge and findings into useful formats (e.g. briefs, slides, posters, blogs, and videos) tailored for specific audiences; making A4NH evidence, tools, and resources open and accessible; and ensuring consistent and accurate CRP visibility, among others.

1.0.15 Risk Management

Based on Phase I experience and Phase II expectations, three main risk classes are expected in A4NH: partnerships, funding, and operational practices and procedures.
Partnerships are both a great opportunity and a large source of risk. In Phase II, there will be more emphasis on country-level engagement, which will complement the broader CGIAR Site Integration effort. A key factor in country coordination success will be the presence of in-country A4NH team members who can work effectively with national partners and within the overall CGIAR Site Integration effort. This will require A4NH to align better with CGIAR Centers in specific countries and to manage partnership expectations through a clear plan that appropriately manages expectations and provides sufficient human and financial resources. Engagement plans for our five focus countries will be developed with partners, in the context of the finalizing the CGIAR Site Implementation plans during 2016 and early 2017. More detail is in Annex 3.6.

Several important new research partnerships have been proposed for Phase II. Wageningen UR will lead a new area of research on food systems. For agriculture and human health, there will be a new partnership with public health research institutes, coordinated by LSHTM. The new partners are high-performing and create comparative advantage for A4NH in newer research areas. Beyond their research quality, Wageningen UR and LSHTM have excellent experience leading and participating in research consortia, but, as with any new partnership, considerable care will be required to clarify roles, responsibilities, and joint working relations.

In Phase I, the importance of aligning participating Centers to agreed objectives, outcomes, and operations was a critical challenge. More recently, A4NH has made considerable investment in documenting Center performance and key facets of participation in A4NH for such alignment discussions. Given the importance of effectively mobilizing partners to manage for results, we will engage a smaller group of partners to be actively engaged in A4NH management (managing partners). This arrangement should strengthen partners' commitment to plan, effectively manage human and financial resources, enhance research quality and monitor, evaluate and learn more effectively together.

From Phase I, a major risk in 2015 and 2016 was the volatility of funding. Funding from Window 3 (W3)/bilateral sources was consistently obtained for more mature research areas, but this comes from considerable effort and organization. However, funds for newer research areas have been much more difficult to obtain and thus planning is more difficult. A number of actions have been put in place to increase fundraising success, most importantly improving A4NH's comparative advantage with new external partners. CGIAR funding, particularly Window 1 (W1) funding, has been extremely volatile, particularly in 2016. Despite consistently effective resource mobilization from W3 and bilateral grants and relatively consistent support from Window 2 (W2) donors in Phase I, A4NH funding has been volatile, particularly for new research areas in 2016, due to much greater cuts in W1 funding. The practice of blending W1 and W2 funding is a disincentive for donors and researchers and a major constraint to more predictable funding. We can expect this will be resolved in Phase II.

1.1 CRP Budget Narrative

1.1.1 General Information

CRP Name CGIAR Research Program on Agriculture for Nutrition and Health

CRP Lead Center International Food Policy Research Center (IFPRI)

1.1.2 Summary

Total CRP budget by flagship (USD)

Flagship Name	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Total
FP1-Food Systems for Healthier Diets	13,251,008	14,931,727	15,718,761	15,554,575	16,516,943	17,310,977	93,283,991
FP2-Biofortification	36,699,398	37,016,445	37,818,589	38,637,143	39,428,036	40,457,629	230,057,241
FP3-Food Safety	10,678,892	13,071,134	13,720,142	14,727,796	13,524,524	13,489,203	79,211,691
FP4-Supporting Policies, Programs and Enabling Action through Research	21,831,429	22,380,840	23,027,447	23,800,884	24,298,808	25,080,115	140,419,523
FP5-Improving Human Health	5,905,671	7,834,163	9,035,365	9,761,006	10,682,666	11,506,552	54,725,423
Management & Support Cost	3,000,008	3,160,051	3,299,462	3,480,363	3,640,105	3,820,084	20,400,072
Strategic and Competitive Research Grant	0	0	0	0	0	0	0
	91,366,407	**98,394,361**	**102,619,765**	**105,961,767**	**108,091,081**	**111,664,560**	**618,097,940**

Given the significant contributions from bilateral grants, the two largest FPs (FP2 and FP4) are far less reliant on W1/W2 funding relative to the other FPs. As explained in the proposal, W1/W2 was relatively evenly distributed to all FPs (except FP5). There are also three crosscutting units on Gender, Equity and Empowerment (GEE); Monitoring, Evaluation and Learning (MEL); and Country Coordination and Engagement (CCE) in five A4NH focus countries (Bangladesh, Ethiopia, India, Nigeria, and Vietnam) that receive W1/W2 funding and also have bilateral grants (under management). Management costs (detailed below) are approximately 1.6% of the total budget with a similar but slightly larger amount for cross-cutting research units. Newer, smaller FPs are expected to grow bilateral grants faster.

The W1/W2 distribution leads to large variations in the percentage of W1/W2 in the total budget - from 9% for FP2 to 15% for FP4 and 30-35% for the other FPs. Funding targets present a formidable challenge to all FP teams. Large-scale development outcomes from newer FPs would largely occur after 2022 (earlier for FP1 than FP5). In Phase II, the A4NH Director and Managing Partners in the PMC will play a greater role in planning and coordinating resource mobilization across A4NH.

For achieving outcomes, the most critical cost drivers will be personnel and partnerships, particularly for new FPs. These drivers are also the most sensitive to large annual swings in funding. While funding uncertainties can be built into contracts, we will pay special attention to financial strategies for key people and partners.

In Phase II, A4NH will allocate a budget at the CRP-level for coordination within the CGIAR site integration in our five focus countries. For other countries, there are fewer projects, usually in one or two FPs and FPs will manage country engagement and links with CGIAR site integration. In all countries, FPs have also included country activities in their budgets.

1.1.3 CRP Funding Plan

Total CRP budget by sources of funding (USD)

Funding Needed	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Total
W1+W2	20,006,258	20,852,772	21,778,345	22,748,028	23,761,943	24,809,981	133,957,330
W3	300,000	250,000	250,000	200,000	0	0	1,000,000
Bilateral	71,060,147	77,291,588	80,591,419	83,013,737	84,329,137	86,854,578	483,140,610
Other Sources	0	0	0	0	0	0	0
	91,366,405	**98,394,360**	**102,619,764**	**105,961,765**	**108,091,080**	**111,664,559**	**618,097,940**

Funding Secured	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Total
W1+W2(Assumed Secured)	20,006,258	20,852,772	21,778,345	22,748,028	23,761,943	24,809,981	133,957,330
W3	0	0	0	0	0	0	0
Bilateral	45,484,437	30,255,092	19,684,270	5,892,183	0	0	101,315,982
Other Sources	0	0	0	0	0	0	0
	65,490,695	**51,107,864**	**41,462,615**	**28,640,211**	**23,761,943**	**24,809,981**	**235,273,312**

Funding Gap	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Total
W1+W2	0	0	0	0	0	0	0
W3	-300,000	-250,000	-250,000	-200,000	0	0	-1,000,000
Bilateral	-25,575,710	-47,036,496	-60,907,149	-77,121,554	-84,329,137	-86,854,578	-381,824,628
Other Sources	0	0	0	0	0	0	0
	-25,875,710	**-47,286,496**	**-61,157,149**	**-77,321,554**	**-84,329,137**	**-86,854,578**	**-382,824,628**

Funding history and expected changes

In Phase I, A4NH managed a relatively large and growing portfolio of W3/bilateral grants. All W3/Bilateral grants have been negotiated and contracted between donors and individual centers, without distinction whether it is provided directly or through the CGIAR fund W3. In these grants only center and not CRP management costs are included. Provision of CRP management funding would need to be agreed with the contracting parties. In all budget calculations and descriptions, W3 and Bilateral are combined as bilateral grants.

In Phase II, we are expecting slower growth in grants for FP2 and FP4 and faster growth for other FPs. In the case of FP1 (led by Wageningen UR) and FP5 (co-led by ILRI and LSHTM), A4NH has increased its comparative advantage through new partnerships to address research areas of greater prominence in the CGIAR SRF.

Secured Funding

For 2017, over 70% of grants are secured for FP2 and FP4. This is the expected rate for a mature program in which median grant lengths are 2-3 years. For FP3, a less mature FP, secured funding is approximately 50%. Secured funding is lower for FP1 and FP5. For all FPs, FP leaders and research teams are developing a portfolio of research proposals.

Fundraising plan

Fundraising across A4NH, is primarily the responsibility of FP teams and their lead institutions and managing partners. It will be given much greater emphasis by the PMC and PMU. A4NH communication and events will increasingly respond to the requirements of donors, countries and partners for knowledge, evidence and innovation that responds to global and national development priorities. For FP2 and FP4, fundraising has been successful and will largely continue. For other FPs, the A4NH Director and FP leaders will work closely with the FP lead institutions. In focus and some engagement countries,

the A4NH Director and responsible managing partner will coordinate efforts to support fundraising for national partners.

1.1.4 CRP Management and Support Costs

Management Costs

A4NH has a dedicated Program Management Unit (PMU) based at IFPRI headquarters. The PMU consists of five staff: Director; Program Manager; Administration/Finance Coordinator and Contracts Manager; Program Assistant; and Communications Specialist. The PMU includes other members of crosscutting units - a Senior Research Fellow for Evaluation (from the MEL unit), and a Gender Coordinator, Gender Associate Research Fellow and Research Analyst shared between the MEL and GEE unit. The PMU is responsible for the performance of the cross-cutting units as well as monitoring, reporting and CRP-level evaluation; convening and supporting the PMC and ISC, and coordinating CRP and FP management through the managing and strategic partners. Beyond Personnel, management costs include:

1. costs for PMC and ISC meetings (2 annual face-to-face and several virtual meetings)
2. costs for required CRP-commissioned external reviews (as per the schedule in the Annex on RBM)
3. travel costs for Director and PMU
4. shared costs to maintain an integrated online platform to support MEL for all ICRPs
5. costs for communication materials such as annual reports
6. IFPRI administrative support costs:
    - Fringe benefits - primarily includes leave, health, and pension costs.
    - Service centers – necessary services to support research activity. The cost of the services is allocated to benefiting projects based on utilization of these services measured by the number of direct labor hours incurred for each project. IFPRI's service centers are comprised of computer, facility, library, and research support.
    - Indirect - cost associated with overall administration, including finance, human resource, internal audits well as well Director General and Board of Trustees oversight. Budgeted indirect rates are applied to all projects during the course of the year and adjusted to actual rates based on actual costs at the end of the year.

Management costs are budgeted from W1/W2 funding. The crosscutting units are funded by a combination of W1/W2 and W3/bilateral funding (starting at 60% W1/W2 in 2017). All W3/Bilateral grants have been negotiated and contracted between donors and individual centers, without distinction whether it is provided directly or through the CGIAR fund W3. In these grants only center and not CRP management costs are included. Provision of CRP management funding would need to be agreed with the contracting parties.

Management and Support Costs Details

COST COMPONENT		AMOUNT BUDGETED						
		2017	2018	2019	2020	2021	2022	6-year Total
A. Basic components as were given in the guidance document	**Subtotal:**	**1,562,060.06**	**1,681,952.67**	**1,736,206.54**	**1,802,351.11**	**1,879,918.98**	**1,957,565.64**	**10,620,055.00**
A.1 Management fee charged by the Lead Center to handle CRP Finance and Administrative matters (Finance, accounting, reporting, contracts management, legal, HR, IT, communication-if handled by Lead Center) Indirect cost/Over head	Amount:	435,898.55	459,152.75	479,408.94	505,693.74	528,904.08	555,054.95	2,964,113.00
A.2 Combines three of the basic components to protect confidentiality of staff salaries – the sum total of these three component should be reported as a single amount:	Amount:	707,725.89	794,266.01	819,001.47	852,928.53	891,523.55	931,968.71	4,997,414.16
· CRP director including related cost – benefits and on-cost if customary (computer, vehicle lease and office space) based on percentage time allocation								
· Infrastructure and general and administrative charges if CRP leader is not located at the Lead Center (part of Overhead cost)- covered by the indirect cost								
· Financial and administrative support based on time allocation								
A.3 Flagship leader and regional coordinators only if a significant percentage time (>50%) is dedicated to managerial activities.	Amount:	0	0	0	0	0	0	
A.4 CRP Management Committee and related costs - Planning and Management Committee meetings 2/year	Amount:	60,000.00	60,000.00	60,000.00	60,000.00	70,000.00	70,000.00	380,000.00
A.5 Independent Steering Committee (or Science Committee) and related costs - Independent advisory committee meetings 2/year includes business class travel and honorarium	Amount:	100,000.00	100,000.00	100,000.00	100,000.00	100,000.00	100,000.00	600,000.00
A.6 Communication activity related specifically to CRP communication and webpage (not if handled by Lead Center) - 1 full time comm. Specialist, Reproduction and other communications costs	Amount:	148,435.63	158,533.91	162,796.13	168,728.83	174,491.35	185,541.99	998,527.84
A.7 CRP internal audit by the CGIAR Internal Audit Unit, or its future equivalent in the new System governance structure (part of Overhead cost)- covered from indirect cost	Amount:	0	0	0	0	0	0	-
A.8 CRP internal and external reviews (e.g. CCEEs and other evaluations and reviews), as well as impact assessments - Annex 3.5	Amount:	110,000.00	110,000.00	115,000.00	115,000.00	115,000.00	115,000.00	680,000.00

COST COMPONENT		AMOUNT BUDGETED						
		2017	2018	2019	2020	2021	2022	6-year Total
B. CRP-level cross-cutting components not mentioned in the guidance document	Subtotal:	**1,437,947.61**	**1,478,098.58**	**1,563,254.97**	**1,678,011.72**	**1,760,185.59**	**1,862,518.39**	**9,780,016.85**
B.1 CRP special events (e.g. CRP-wide program meetings) - covered under A4	Amount:							
B.2 CRP leadership meetings (e.g. country coordinators, flagship leaders, cross-cutting coordinators) Global Coordination	Amount:	75,000.00	75,000.00	90,000.00	90,000.00	90,000.00	100,000.00	520,000.00
B.3 CRP M&E coordination and systems (not including external evaluations and impact assessments) as per annex 3.5-RBM (includes MARLO maintenance)	Amount:	519,726.91	530,461.42	551,625.30	574,984.26	584,479.54	609,667.29	3,370,944.73
B.4 CRP communications, open access, IP assets, KMIS - Annex 3.8 & 3.9 (including Lead Centre staff budgeted as direct costs not allowed under A.8 above)	Amount:	80,000.00	80,000.00	100,000.00	120,000.00	110,000.00	110,000.00	600,000.00
B.5 CRP capdev coordination - Annex 3.2	Amount:	100,000.00	100,000.00	100,000.00	100,000.00	100,000.00	100,000.00	600,000.00
B.6 CRP gender and youth coordination - Annex 3.3	Amount:	313,220.70	317,637.16	321,629.66	393,027.46	425,706.04	492,851.10	2,264,072.13
B.7 CRP site integration support - $40 to 50K/Country for 5 focus countries	Amount:	200,000.00	225,000.00	250,000.00	250,000.00	250,000.00	250,000.00	1,425,000.00
B.8 Other: Partnership - Annex 3.1	Amount:	150,000.00	150,000.00	150,000.00	150,000.00	200,000.00	200,000.00	1,000,000.00
GRAND TOTAL		**3,000,007.67**	**3,160,051.25**	**3,299,461.50**	**3,480,362.82**	**3,640,104.57**	**3,820,084.04**	**20,400,071.85**
		AMOUNT BUDGETED						
		2017	2018	2019	2020	2021	2022	6-year Total
C. Funding source: MSC budget is assumed funded from W1/2. Some CRPs have been successful in mobilizing W3/bilateral funding to support CRP-level cross-cutting initiatives. These are listed below: (add rows as needed)								
C.1 Grant: (note name, donor; purpose in this cell) Additional funding for gender and youth and future gender projects to be developed Gender, Agriculture and Assets Project Phase II (GAAP2)- Bill and Melinda Gates Foundation	Amount:	1,250,000.00	1,435,000.00	1,500,000.00	1,500,000.00	1,500,000.00	1,500,000.00	8,685,000.00

1.1.5 CRP Financial Management Principles

Please describe

1) the allocation process of the CRP 2017-2022 budget to the flagships for W1+2

Following the overall base budget determined by the CGIAR, the PMU proposed W1/W2 amounts for each of the five flagships for the initial year (2017). The PMU also developed a growth scenario with a modest inflation increase of 5% each year for future years. Although this assumption is used to help the FP teams build a six-year budget, allocation from 2018 onwards will depend on intermediate results and demonstrated action on progress monitoring leading to achievement of targeted outcomes.

2) the level of budget ownership of the flagship leaders (tracking, reporting, revising, etc.)

The PMU helped FP leaders with assumptions about growth rates for FP base and uplift budgets. FP teams developed their budgets within the envelopes provided, deciding on cluster of activities (CoA) and partner budget distributions.

3) Rules and expectations around annual variances for flagship and participating partners budgets

Normally variances of 10% of budget are acceptable for FP2 and FP4. This could be relaxed for smaller and newer FPs to 20% (for example FP5) and also depending on volatility of W1/W2 funding.

4) Expected major capital investments (>$25,000)

A4NH does not expect to have a major capital investment from W1/W2.

1.1.6 Budgeted Costs for Certain Key Activities

	Estimate annual average cost (USD)
Gender	10,732,722
Youth (only for those who have relevant set of activities in this area)	3,167,455
Capacity development	8,976,841
Impact assessment	4,545,097
Intellectual asset management	403,429
Open access and data management	2,543,033
Communication	3,790,210

1.1.7 Other

At CRP-level, W1/W2 funding is used for the essential CRP governance and management functions as described above. The A4NH PMU also manages 3 cross-cutting units (GEE, MEL and CCE) to enhance synergies across flagships and with other CRPs. These units are funded with the combination of W1/W2 and bilateral grants. The budget is prepared based on considerable assumptions about success in fundraising given the large reliance on W3/bilateral resources for all FPs. W3/bilateral fundraising risks are greatest for newer and smaller FPs, at least initially. These risks are being managed by building A4NH's comparative advantage through new partnerships and more closely coordinating resource mobilization efforts with the FP lead institutions / FP leaders and PMU. This strategy will be monitored carefully by PMC and formally reviewed annually by ISC. The PMC will manage work plans and budgets with a rolling 3-year medium-term plan and more detailed annual plans of work and budget for the next year.

An additional 50% of the overall CRP budget ($309M) has been proposed for uplift. This is a combination of uplift sheet in PIM table B $263M) plus $46M in uplift over 6 years for the 3 cross-cutting units (GEE, MEL and CCE) at CRP-level. In the on-line tool there is no provision for uplift of cross-cutting research outside FP budgets so we are noting this uplift request here. The cross-cutting unit uplift budget will be used to accelerate and expand on outcomes proposed for these units, particularly in expanding support to other CRPs and national partners. Additional W1/W2 funding would be allocated to FPs and cross cutting units as proposed by PMC and agreed by ISC.

2. Flagship Programs

2.1 Flagship Program (FP1) on Food Systems for Healthier Diets

2.1.1 Flagship Program Narrative

2.1.1.1 Rationale, scope

Food systems, encompassing the production, processing, distribution, waste disposal, and consumption of food (see **Box 2.1.1** and **Figure 2.1.1**) can help ensure that people have access to affordable, nutritious foods at all stages of life (Global Panel on Agriculture and Food Systems for Nutrition 2014). Limited access to and consumption of healthy diets among the poor are at the root of the triple burden of malnutrition: persistent chronic undernutrition and micronutrient deficiencies in early childhood exist in the poorest segments of populations, especially in low- and middle-income countries in Africa and South Asia, alongside rapidly rising rates of overweight, obesity, and diet-related non-communicable diseases (Lim et al. 2012; Popkin and Hawkes 2015).

Food systems and the natural resource base are under increasing pressure to provide sufficient, safe, nutritious, and affordable food for all. In recent decades, food systems have undergone major transformations (Reardon et al. 2012). Food production has become more capital-intensive and supply chains have grown longer as basic ingredients undergo multiple transformations towards becoming final food products (Hawkes et al. 2012). At the same time, diets are changing quickly, often driven by the rapid urbanization in many developing countries (D. L. Tschirley et al. 2015).

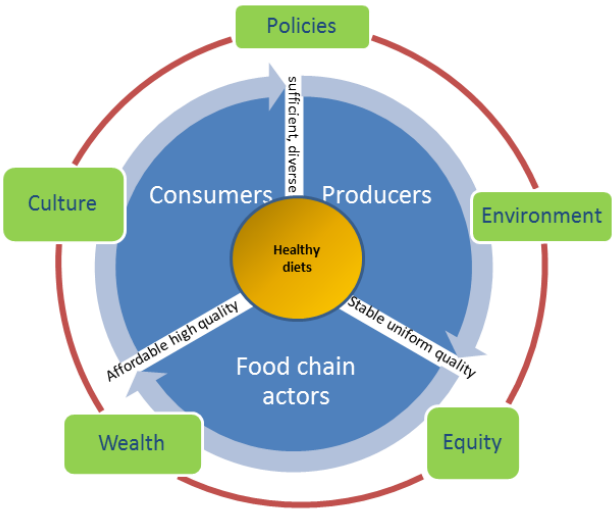


Figure 2.1.1. Food systems, actors, and drivers

The urban poor and emerging middle-class households tend to reduce their consumption of cereals, roots, and tubers while increasing demand for refined grains and flours, sugar, salt, and fats. Demand for processed and convenient foods at supermarkets, fast-food restaurants, and for informal street foods becomes increasingly important. For middle-class population groups, demand for fruits, vegetables, and animal-source foods (ASF), such as dairy, poultry, eggs, meat, and fish, strongly increases(D. Tschirley et al. 2015). Especially in high- and middle-income countries, consumption of healthier foods has grown in the past two decades, but particularly in low-income countries, consumption of less healthy foods, such as processed meats and sugars, is rising even faster (Imamura et al. 2015).

Improving diet quality by changing interactions and feedbacks between food systems components is considered an essential element of sustainable efforts to alleviate malnutrition and nutrition-related diseases worldwide (Popkin and Hawkes 2015). As they undergo transformation and seek to respond to dietary changes, local and regional food systems must resolve tradeoffs between nutritional, social,

economic, and environmental objectives and constraints. In particular, food systems must: (1) meet consumers' food quality and safety demands; (2) develop effective value-chain linkages; and (3) reduce pressure on aquatic and terrestrial ecosystems, while increasing their capacity to respond to climate change.

Box 2.1.1. Definitions for concepts in FP1: Food Systems for Healthier Diets

The term ***Food System*** refers to the full set of processes, activities, infrastructure, and environment that encompass the production, processing, distribution, waste disposal, and food consumption. Food systems are multidimensional, including sociocultural, economic, environmental, and political aspects, and complex, with multiple actors (food producers, food-chain actors, and consumers) managing multiple linked and nested agri-food value chains within dynamic and interactive food environments (Figure 2.1.1*).*

Food system thinking is an approach that considers how all components and actors of the food system are interrelated and can be affected by (targeted) incentives or interventions that change final (nutrition) outcomes (Herforth, Lidder, and Gill 2015).

Food system research includes the governance and political economy of food production and consumption (access and equity), sustainability, effects on health and well-being (nutrition and food safety), and links between food production and the natural environment.
Diet quality is central to healthy diets and encompasses aspects of both adequacy and moderation. Adequacy refers to getting enough of desirable foods or food groups (whole grains, fruits, vegetables, fish, meat, nuts and seeds, beans and legumes, milk, eggs, and dietary fiber), energy, macro- and micronutrients. Moderation refers to restriction of unwanted foods, food components or nutrients such as fat (especially saturated fat), cholesterol, sugar, sugar-sweetened beverages, and sodium(Herforth et al. 2014; Alkerwi 2014).

Strategic rationale and scope

The dietary implications of food system transformations for health in developing countries and the need to support food systems to produce and supply appropriate nutritious, safe foods for healthy lives are increasingly recognized by governments, businesses, and civil society groups (WHO/FAO 2003; International Food Policy Research Institute (IFPRI) 2014; Access to Nutrition Foundation 2016) and by international forums, including the 2nd International Conference on Nutrition (ICN2) in 2014, the International Panel of Experts on Sustainable Food Systems (IPES Food) in 2015, the Global Panel on Agriculture and Food Systems for Nutrition in 2014, and the WEF Global Agenda Council on Food and Nutrition in 2015. These forums generally seek some input from CGIAR to gain a better understanding of (1) how food systems can be guided to become healthier and more sustainable; (2) the driving forces and the dynamics of food system changes, including foresight tools; and (3) of how the private sector and civil society can collaborate to identify food system innovations at different scales and nutrition-sensitive scaling approaches at the national food system level.

FP1 will directly address Sustainable Development Goal (SDG) 2 and SDG 3. Better nutrition boosts adult productivity (Strauss and Thomas 1998), and better nutrition of females is associated with empowerment of women in agriculture (Malapit et al. 2015; Malapit and Quisumbing 2015). Improvements in nutrition, including reduction in undernutrition, micronutrient deficiencies, and overweight and obesity, all lead to declines in nutrition-related mortality, infectious diseases at a young age, and non-communicable diseases later in life (Black et al. 2013). This FP will also contribute to SDG 4

and SDG 5: better nutrition is vital for early child development and education, and it improves the ability of girls, adolescents, and women to perform well at school and become empowered in the workforce and wider society (Victora et al. 2008). FP activities will also contribute to SDG 14 and SDG 15 by aiming to reduce pressure of food systems on these aquatic and terrestrial ecosystems.

In this context, this FP will focus on a dynamic analysis of the transformation of food systems and diet transitions. It will seek to understand not only the impacts and effectiveness of specific types of policy interventions and business innovations in relation to the food system for different target populations, but also their possible environmental and economic trade-offs. Our research will be organized in three clusters of activities (CoA):

- CoA 1: assessing regional and subregional drivers of food system transformation, and options and constraints for dietary change (**diagnosis and foresight**),
- CoA 2: testing concrete agri-food value chains innovations and interventions for improving diet quality and diversity (**food system innovations**), and
- CoA 3: supporting the scaling up of successful actions through effective engagement of multi-stakeholder platforms and multisectoral mechanisms (**scaling up and anchoring**).

2.1.1.2 Objectives and targets

The overarching goal of FP1 is to understand how changes in food systems can lead to healthier diets, and to identify and test entry points for interventions to make those changes. We focus on measuring changes in diet quality among (young) women, their children, and vulnerable populations, who are most at risk for malnutrition. This FP's contribution to the 2022 CGIAR target is a 10% reduction in consumption of less than the adequate number of food groups among women of reproductive age and their children in the four target countries (Performance Indicator Matrix – Table A). In addition, this FP will contribute to development outcomes in three ways:

1. By providing evidence on drivers of and constraints to diet changes among target populations and food system performance related to healthier diets, to inform policy discussions and multi-stakeholder dialogues in target countries;
2. By improving the performance of multiple nutrient-rich agri-food value chains and identifying options to upscale effective food system innovations to large segments of target populations; and
3. By supporting agri-food system CGIAR Research Programs (AFS-CRPs) through communities of practice (CoP) that can guide researchers in using food-system pathways and strategies for strengthening and leveraging agri-food systems for healthier diets in CGIAR research.

This knowledge will support scaling up through targeted capacity building, knowledge dissemination, and policy engagement. Through an agri-food value chains pathway and a policies pathway, the FP directly addresses the second system level outcome (SLO2) on *improved food and nutrition security for health*, through the sub-intermediate development outcome (IDO) on *improved diets for poor and vulnerable people.* It also has important links with the SLO on *reduced poverty*, through the contributions to the sub-IDO on *diversified enterprise opportunities,* and to SLO3 on *improved natural resource systems and ecosystem services*, through the contribution to the sub-IDO on *enhanced adaptive capacity to climate risks*. Given the wide-ranging implications of food system changes, it also contributes to three of the cross-cutting issues (see **Figure 2.1.2** and Performance Indicator Matrix – Table C).

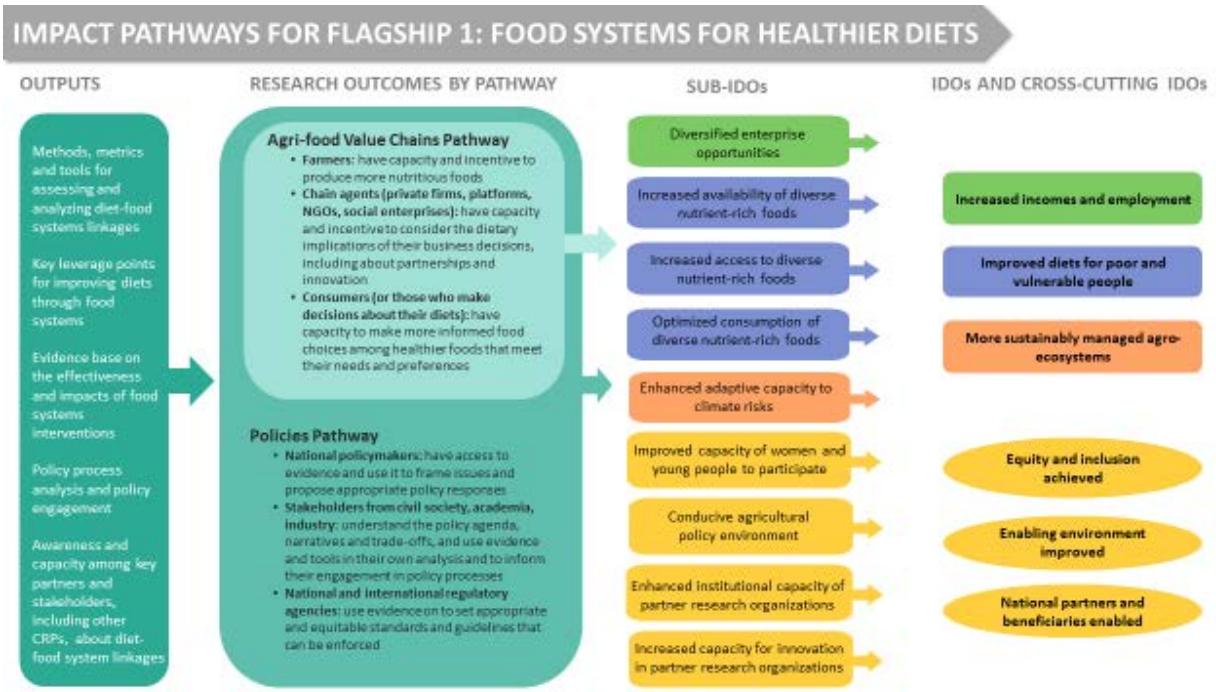
By 2022, this FP expects its research to contribute to three main outcomes, as described in Performance Indicator Matrix – Table B):

- Partners and other CRPs incorporate nutrition, health, and gender in agri-food value chains and food systems programs;
- Partners, including value chain actors, use evidence from impact evaluations when making operational and investment decisions; and
- Public-private partnerships formed to promote implementation of A4NH strategies for agri-food value chain/food system innovations and interventions at scale.

By 2022, the following outcomes will be achieved in all four target countries (see geographies below):

- Evidence on diet quality and food systems linkages and key leverage points for improving diets through food systems used by at least 4 stakeholders across the 4 focus countries in policy and programming
- 12 partners, including value chain actors, use evaluation findings to inform operational and investment decisions
- 4 public-private partnership networks are formed across the 4 focus countries

Figure 2.1.2. Impact pathways for FP1: Food Systems for Healthier Diets



Target Geographies

FP1 will focus on two regions: Africa south of the Sahara, and South and Southeast Asia. In addition, complementary studies may be conducted in Latin America on specific experiences with food system innovations and dietary change. In the focal regions, we will examine trends and variability in healthier diets within and across countries and population segments, linking them to changes in food system dynamics. To provide a deeper understanding of diets and food system interactions at national and

subnational levels, we will conduct more detailed analysis of diets and food systems in four target countries: Bangladesh, Ethiopia, Nigeria, and Vietnam. These countries provide a range of diet and (sub)-national food system contexts at various stages of food system transformation and urbanization, and they are all CGIAR Site Integration ++ countries. In other countries, specific interventions may be piloted and scaled up, but not research on the national and sub-national food-systems.

2.1.1.3 Impact pathway and theory of change (for each individual FP)

FP1 contributes to development outcomes through two primary impact pathways: Agri-food Value Chains Pathway and Policies Pathway. Both pathways are linked and synergies and trade-offs are recognized. While the first pathway provides the necessary evidence to make policy decisions, in turn, policy decisions may also influence the pathway. Both are strongly context specific; and the diagnosis/foresight work and testing of identified food system innovations are important for adjusting the Theories of Change (ToCs) to national level.

In the first pathway, diet quality is improved and human well-being increased through changes in multiple nutrition-relevant agri-food value chains. For target populations with low dietary diversity, we will explore how to support more rapid development of (in)formal agri-food value chains for nutritious foods—whether single foods (e.g. fruits, vegetables, ASF, grain legumes, and biofortified staples) or combinations of foods (e.g. processed foods)—to enhance diet quality among women and children. The ToC in Figure 2.1.3 has both supply (left) and demand (right) components. In the focus countries, this FP will identify the best leverage points for entry into food system dynamics from a dietary perspective. On the demand side, changes in diets can occur in response to changes in cultural or social norms, preferences, education, and access to information, relative prices of foods, income, or through behavior change. Changing behavior requires five steps: making new behaviors understood, easy, desirable, rewarding, and habitualized (Weed 2012). On the supply side, entry points include the types of products and their key characteristics, such as affordability and accessibility. To attain the IDOs, it is important to identify the agri-food value chains and partners most relevant for healthier diets. The goal of CoA 2: food system innovations, is to test the effectiveness of such interventions (see below).

The supply side offers several key testable assumptions. For example, do producers or agri-food value chains actors have the resources and perceive benefits from opportunities for new, healthier products? We will measure available endowments and attitudes among key groups for specific, identified opportunities and then test whether producers/actors are willing to take the risk embedded in these new opportunities by investing in new crops or products. On the supply side, it is particularly important to pay attention to the role of gender; when specific crops are produced, processed, and/or sold by either men or women, gender relationships along the food production side of the chain can influence welfare, bargaining, and, ultimately, nutritional outcomes. Finally, FP1 will assess how beneficial, detrimental, or vulnerable a specific innovation is to the environment and integrate those insights into decision-making processes.

On the demand side, this FP will test whether or not information about healthier diets reaches targeted beneficiaries or those who purchase food for them (especially mothers), as well as whether those knowledge changes are leading to behavior changes. This FP will also measure the relative cost of more nutritious foods to understand whether these foods fit income constraints and whether decisionmakers have the agency, information, resources, and desire to purchase and consume more nutritious foods. If these assumptions can be met, improved accessibility of nutritious foods could lead to improved diet

quality among (young) women, children, and vulnerable populations. Being the future workforce, leaders and bearers of the next generation, needs and aspirations of the adolescent girls and young women are important to consider as in this period of life youth is receptive to new ideas and make lifestyle (including diet) choices determining their future health. If they cannot be met, it is important to trace where assumptions break down so that projects can adapt.

In the second impact pathway, this FP will contribute to development outcomes through policy processes, initially in target countries and later in other countries. National and sub-national governments, and other local and regional actors, can influence policy and regulatory frameworks to promote healthier foods and reduce unhealthy components and to make food systems more environmentally sustainable and resilient to climate-change. To inform policy discussions and regulatory options, this FP will conduct policy analysis and provide evidence on diet and food system changes and their links to national and sub-national policy processes, in relation to direct domains (e.g. food safety, health, agriculture subsidies) and indirect domains (e.g. urbanization, infrastructure planning, environment or climate change). Key decisionmakers and stakeholders (i.e. from private sector and consumer organizations) will be identified and engaged early in target countries. Results of the diagnostic work can help frame policy debates. Later, evidence on specific policy interventions can help shape the policies themselves or how they are implemented (e.g. through public-private investments).

The ToC of this policy pathway is described in Figure 2.1.4. We will work closely with FP4: SPEAR, which works on public good program pathways and looks at country SDG indicators for nutrition and health, while this FP concentrates on food policy, regulations, and investments linked to the agri-food value chains pathway. While in both pathways, diet quality for (young) women and children is the main outcome, we will also work closely with the CRPs on Climate Change, Agriculture, and Food Security (CCAFS) and Policies, Institutions, and Markets (PIM) to ensure that we consider synergies and tradeoffs between impacts of food system innovations on diets with other outcomes, such as equity, empowerment, economic performance, and sustainability.

2.1.1.4 Science quality

This FP builds upon lessons learned from the Phase I flagship on Value Chains for Enhanced Nutrition (VCN), whose main goals were to build a framework to assess single-product value chains from a nutrition perspective, to pilot innovations for improving value chains, and to test local opportunities to improve consumption of nutrient-dense foods. The framework analyzes value chains from the consumer, rather than producer perspective, and provides an understanding of how to fill dietary gaps with nutrient-dense foods, such as ASF, fruits, vegetables, and pulses (Gelli et al. 2015). It suggests both nutrition and agricultural performance indicators to understand whether agri-food value chains are functioning properly to deliver nutritious foods. It also develops tools for better understanding the role of gender in terms of food choices and bargaining at different points in the chain.

Using this framework, the research team has made considerable progress analyzing value-chain improvements from a nutrition perspective, and experimenting with incentives to increase demand for nutritious foods. Value-chain assessments show how markets can be relevant for filling gaps in the diets of poor consumers, based on the analysis of value chains for indigenous fruits in Kenya and Peru, animal-source foods in the slums of Nairobi, and beans and amaranth in East Africa (Kehlenbeck, Asaah, and Jamnadass 2013; Penny et al. 2015). Projects with World Food Programme (WFP) focus on food system metrics, taking a multi-chain approach for structured demand (e.g. schools and hospitals).

Figure 2.1.3. Theory of Change of the Agri-Food Value Chains Pathway

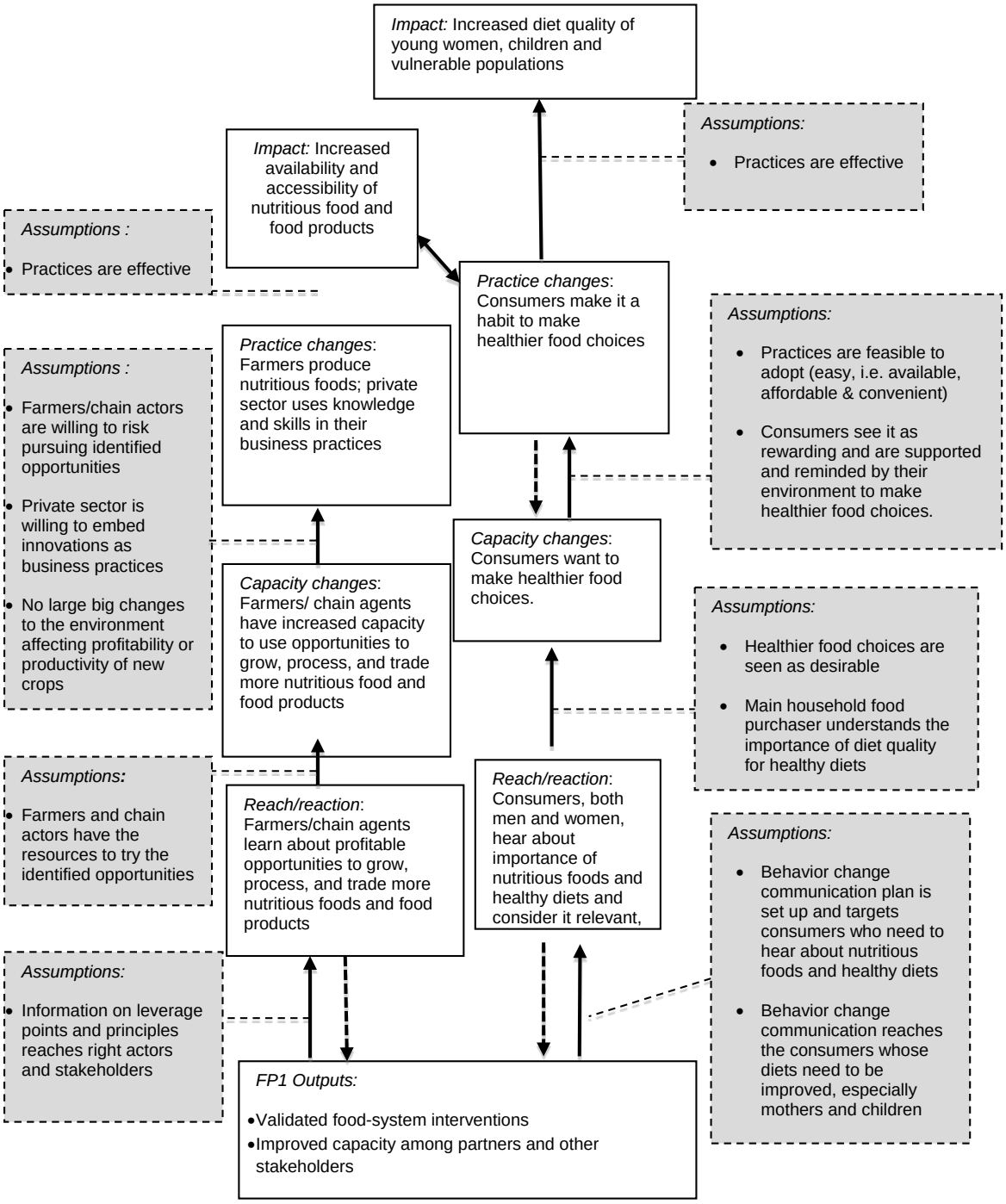
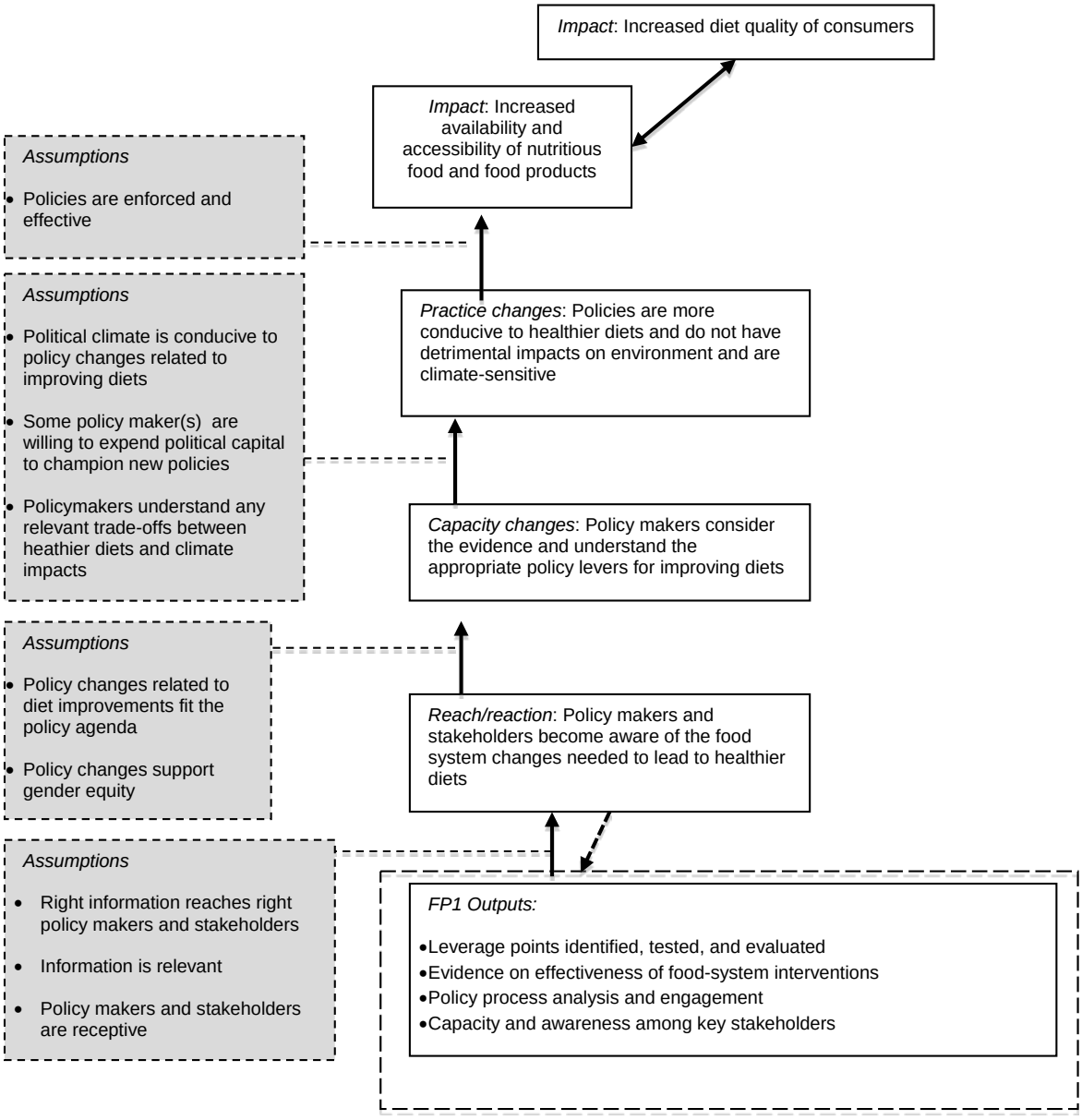


Figure 2.1.4. Theory of Change of the policies impact pathway



Other ongoing work for food systems and nutrition analysis at national and subnational levels is funded by the International Fund for Agricultural Development (IFAD), the Bill & Melinda Gates Foundation (BMGF), and the European Union (EU). The CRP on Agriculture for Nutrition and Health (A4NH) partners are collaborating with AFS-CRPs to assess national and local food systems, including linkages and trade-offs between nutritional, environmental, and socioeconomic performance, in Ethiopia, Kenya, Vietnam, and Zambia. The work on nutrition sensitive landscapes led to a conceptual framework and methods and tools for assessing potential synergies and trade-offs between agricultural production, the environment, and food and nutrition security in selected landscapes (Groot et al., in press; Kennedy et al., in press).

Recently, the framework extended to consider agri-food value chains from both a nutrition and sustainability lens (Allen, de Brauw, and Gelli 2016). A4NH began to experiment with methods of stimulating demand for nutritious foods. In Bangladesh, studies focused on specific value chains, placing nutrition messages on seed packets given to randomized groups, and trying to understand factors stimulating demand for yogurt. In another project, women were organized into cooking contests that required the use of more nutrient-dense foods, as an effort to stimulate the use of more nutritious ingredients in selected communities. Also in Bangladesh, a project planned for 2016 will measure the change in people's willingness to pay for specific pulse products when nutrition information is displayed on the packaging. In India, A4NH is testing an intervention for getting unsold vegetables into the hands of relatively poor consumers. In Colombia, Honduras, and Nicaragua, research co-financed by the Ford Foundation, focusses on how to stimulate demand for heathier diets by poor consumers.

In Phase I, research focused on assessing value chains and their contributions to improved nutrition. In Phase II, this will expand to include the wider food system. Taking a diet quality perspective, the scope must broaden from analysis of single commodity value chains, to innovations at the whole food system level. This widens the scope of research to consider, while continuing to focus on linkages between food consumption and agricultural production. Specifically, decisionmaking on business practices in the private sector that could affect the food system at different levels (household, municipality, region, country) must be considered, and the policy scope must include food system, environment, and other scaling policies.

This FP will therefore pursue a novel line of research by studying food systems comprehensively, within the broader socio-economic, political economy, and environmental systems in which they are embedded (McDermott et al. 2015; Ingram, Erickson, and Leverman 2010). This FP will develop generic frameworks and integrated metrics to assess food-system performance and drivers for diet change at individual, household, (sub)regional levels in different national contexts. Institutional and regulatory frameworks, and power relations—in particular those formed along gender or similar lines—are considered crucial in determining how food systems are performing. We cannot rely on unidirectional flows of knowledge from scientists to decision-makers, but need reciprocal flows between science, policy, and practice, building transdisciplinary science (Foran et al. 2014; Hammond and Dubé 2012). Understanding feedbacks between food system actors (as complex adaptive systems) and nonlinear interactions (through multi-agency simulation) offers opportunities for a new generation of food and nutrition foresight models for pursuing healthier and sustainable diets.

CGIAR has considerable capacity in many elements of food systems research including primary agricultural production, agro-food value chains, natural resources and environmental sustainability, and policies and institutions. In 2012, CGIAR added improved nutrition and health as a high-level goal (or

System Level Outcome). A4NH has developed a strong basis for this proposed research: it has validated dietary diversity indicators (Fiedler et al. 2012; Martin-Prével et al. 2015), developed a framework for nutrition-sensitive value-chain interventions (Gelli et al. 2015), analyzed agriculture-nutrition pathways (Gillespie, Harris, and Kadiyala 2012), developed gender-nutrition tools and methods (Johnston et al. 2015), and assessed diet transitions (Headey et al. 2015; Arimond et al. 2010). However, the nutrition transition requires diet quality indicators beyond simple dietary diversity scores to evaluate diet composition (both healthy and unhealthy components), and dietary patterns, and to develop and validate new assessment tools (Ocke 2013; Imamura et al. 2015; Marshall, Burrows, and Collins 2014; Waijers, Feskens, and Ocké 2007).

Beyond A4NH's experience developing research on value chains for enhanced nutrition, Wageningen University and Research Centre (Wageningen UR) brings experience and leadership in international projects related to food systems, and a strong capacity component of training young researchers from lower- and middle-income countries (LMICs). The EU-funded Sustainable Food and Nutrition Security (SUSFANS) project provides a conceptual framework and analytical tools for underpinning food policies and their impact on consumer diet, implications for nutrition and public health, the environment, and the competitiveness of the agri-food sectors. The FOODSECURE project provides a set of analytical instruments to experiment, analyze, and coordinate the effects of short and long term policies to achieve food security, and can be operationalized into the EU-Africa Research & Innovation Partnership, with a focus on food and nutrition security and sustainable agriculture. Multi-stakeholder partnerships between food system actors (business, research organizations, government and civil society) are essential to identify and test innovations at a scale. Experiences in public private partnership platforms (e.g. the Amsterdam Initiative against Malnutrition) suggest key action areas to establish effective upscaling networks and pathways for institutional anchoring (Reid, Hayes, and Stibbe 2014). This also broadens the scope for innovations on incentives (nudging) to motivate individual consumers and the private sector towards healthier food choices.

2.1.1.5 Lessons learnt and unintended consequences

As discussed above, FP1 builds and expands upon lessons learned from the Phase I VCN flagship. This flagship will also continue the consumer perspective, in this case studying the food system from the perspective of the diet, in alignment with CGIAR's Strategy and Results Framework (SRF). The primary emphasis on food systems will be at the national level, since national governments play an important role in determining policies and investments to help meet their agricultural potential, and such investments have important implications for what farmers grow and what people eat within a national context. Next, one can consider subnational agro-ecological zones, and how the food systems of each fits together. One can build up national food systems to consider regional food systems, which may be particularly important in countries with a great deal of agricultural trade.

Phase I research focused primarily on individual value chains for more nutritious foods (ASF, fruits and vegetables, and pulses). By broadening the focus to food systems, this FP can incorporate multiple value chains that come together within the context of food systems, spanning multiple crops and food products that are the focus of AFS- CRPs and other potential partners. The goal in Phase II is to better complement the supply side emphasis of value chain research conducted by AFS-CRPs, and to enhance the tools for value chain analysis that have been developed in FP3 of PIM, from a healthy diets perspective.

In order to make diets healthier through food systems, a deep engagement with the private sector in focus countries is necessary; in Phase I, private sector engagement was limited to interactions mediated through business schools. To ensure dietary improvements are anchored in the food system, research programming must address how private actors in the economy account for dietary quality in their decisionmaking, and understand how dietary quality trades off against profits and sustainability considerations. Through its strong partnership with the Global Alliance for Improved Nutrition (GAIN), this FP will engage in action research projects with the private sector to build an understanding of these tradeoffs in focus countries.

It is first important to understand the diet from a more holistic perspective, understanding the drivers that lead to both undernutrition and overnutrition, from a systems perspective. As those drivers are understood, this FP can then consider and pilot test interventions to improve the diet from a health perspective, while considering economic and environmental tradeoffs. Alternatively, this FP can suggest policy changes that could lead to healthier diets based on modeling. As successful interventions and policies are identified, they can be considered for scale up at a national level.

Wageningen UR will lead this FP, using its experience in bringing together multiple disciplines in previous food systems projects (e.g the SUSFANS project) and its strong track record of research on human health and diet quality in relation to food systems. It has also brought together multiple disciplines in previous food systems projects and has strong linkages with the private sector. Additionally, GAIN and its Amsterdam Initiative against Malnutrition will be an important partner in this FP, strengthening partnerships with the private sector. To limit the otherwise broad focus of food systems, this FP will focus its work in four countries, developing partnerships and relationships with important actors in the food systems of those countries.

2.1.1.6 Clusters of activity (CoA)

FP1 strengthens the analytical capacity on food systems for healthier diets in CGIAR and beyond by revisiting and advancing concepts, recasting and testing evidence, conducting rigorous analysis, and engaging stakeholders. The FP is organized in three CoAs: in **CoA 1: diagnosis and foresight,** the initial focus is to fill crucial knowledge gaps on the dynamics of interactions between food systems and diet quality at national and subnational levels. The knowledge will be used to identify actions needed to address diet gaps through food systems, while accounting for possible environmental and economic trade-offs. Concrete opportunities to improve diet quality and policies/regulatory frameworks will be identified and tested in **CoA 2: food system innovations**, by identifying and testing interventions that work through food systems to provide a diversity of healthier foods. Through the compilation of results generated from the first two CoAs, **CoA 3: scaling and anchoring,** will identify lessons for scaling up within focus countries.

CoA 1: Diagnosis and foresight: Linking dietary and food systems transformations
Despite food systems' critical role in people's diets, limited information about both food system transformations and diet changes exists and the theoretical and empirical understanding of the ***interactions*** between food systems and diets is incomplete. A thorough understanding of the current status and dynamic interaction between food systems, diets and their drivers (e.g. urbanization, demographic transition, climate change, new food retail and prepared food outlets) is required to guide transformations of food systems toward healthier diets for poor populations and to address future

environmental, social and economic trade-offs. This CoA will be structured around five main research questions (see **Box 2.1.2**).

Box 2.1.2. Main research questions in CoA1: Diagnosis and Foresight

1. What are the crucial gaps (including deficiencies, excesses, imbalances) in diet quality in the focus countries (and subregions), and how are those gaps linked to the present state of their food systems?
2. How are diet quality changes influenced by food system transformations and vice versa, and how does this interaction play out for the different target groups (women and children)?
3. Which constraints and enablers within national and subnational food systems hinder or support key actors (including consumers, public and private food actors, and producers) in making diets healthier?
4. What are environmental, social, and economic trade-offs and synergies of improving food systems and diets to ensure sustainability of sufficient diet quality for human well-being?
5. What are the key leverage points to support food systems in focus countries in ways that lead to improved diets?

The research will have three interlinked sets of activities. The first set involves **concept development, metrics, and tools**. The research will focus on reviewing and refining existing conceptual frameworks, including relationships and interactions between consumers, value chain actors (retailers, wholesalers, food processors), and primary producers, from a nutrition lens. The resulting framework will be used to develop testable hypotheses on how a range of food system activities contribute—positively or negatively—to diet quality and how they are influenced by environmental, economic, social, cultural, and policy processes. Relevant qualitative and quantitative metrics, data collection, and analytical tools will be developed to assess diet quality and characterize food systems using primary and existing secondary data. This work will be supported by analytical tools and foresight techniques used to analyze drivers shaping the linkages between food systems and diet quality, and the role of policies in influencing food system–diet relations locally and nationally.

The second set of activities focuses on **characterization and assessment.** Metrics, methods, and tools identified in the first set of activities will be used in focus countries (and subnational regions/landscapes) to characterize diets, determine crucial diet quality gaps, and link findings to current food systems. We will assess drivers of existing diets and food systems and their interlinkages, specifically investigating how demand- and supply-side drivers influence diet trends for nutritious foods, such as fruits, vegetables, and ASF, and how diet transitions influence local food systems. Special attention will be paid to trade-offs and synergies, in terms of nutritional, environmental (land and water use, biodiversity), and equity outcomes. This work will also examine the influence of policies (international, national and subnational) and the political economy of policy changes, especially the implications for different socioeconomic and gender groups.

Based on results of the first two areas of work and priorities arising from the other two CoAs (see below), the third set of activities will be structured around **foresight and scenario analysis**. Modeling and scenario techniques will be used at three main scales to support foresight on food system development from a diet perspective, while considering sustainability and climate change constraints. First, dynamic micro-level models will be used to operationalize healthy diets and to understand their feasibility, affordability, convenience, and desirability. Farm household modeling will be used to understand the environmental, climatic, and economic trade-offs of focusing the food supply on optimized diets. At the meso-level, country/landscape-level modeling will build understanding of the drivers and interlinkages between diets, food systems, and agro-ecosystem conditions. This area of work will build on economy-wide models developed under FP2 in PIM and by LEI-Wageningen UR (Magnet)

with the objective of assessing how key drivers, such as urbanization and income growth, interact with domestic farming systems, natural resources, and climate, leading to changing relative food prices and production patterns, particularly for more nutritious foods. Finally, macro-level modeling will aim at improving current global models being applied to trade, agricultural policy, biofuel policy, and climate change issues. The three levels of modeling will be implemented in close cooperation with PIM and CCAFS to reinforce the coherence with the other CRPs' portfolios. Major outputs and outcome ones are described in **Box 2.1.3**.

Box 2.1.3. Major outputs and outcomes of CoA1 (see Perf. Indicator Matrix – Table D for more)

2018	• Validated metrics and tools for assessing diet quality and characterizing food systems applied by 10 research organizations (partner and external organizations) across the 4 focus countries
2019	• Leverage points identified for improving diet quality and food system linkages and dynamics are used by 4 country teams in CoA2 to identify interventions across the 4 focus countries
2021	• Full framework conceptualizing the interactions between diet quality and food systems and their environmental, economic, social, cultural and policy drivers used by at least 1 other AFS-CRP
2022	• Evidence on diet quality and food systems linkages and key leverage points for improving diets through food systems used by at least 4 stakeholders across the 4 focus countries in policy and programming

CoA 2: Food System Innovations

This CoA will identify concrete opportunities to improve diet quality and develop solutions in partnership with food systems stakeholders, referred to as “co-development,” and then analyze these innovations to study their dietary impacts. Innovations may occur in the public or private sector, and can involve specific nutritious agri-food value chains or broader elements of the food system. Such innovations need a proof of concept to validate their technical, organizational, socioeconomic, and environmental feasibility, and to assess food-system actors’ incentives to implement them. Research in this CoA will be guided by the results generated in CoA 1: diagnosis and foresight, for the focus countries and augmented by targeted opportunities in additional countries. Activities will be structured around three main research questions (see **Box 2.1.4**).

Box 2.1.4. Main research questions in CoA 2: Food System Innovations

1. Which demand-side innovations stimulate consumers to choose foods that make them healthier (across all food groups or for specific nutritious food groups)?
2. What supply-side innovations will promote the affordability, availability and sustainability of nutritious foods (across all food groups or for specific nutritious food groups)?
3. How do these innovations influence the diet; e.g., what are the net nutritional impacts of specific innovations, and are there gender-related, income and/or environmental trade-offs?

These research questions will be answered through three sets of activities. The first focuses on identifying and assessing **demand-side innovations.** Without proper incentives, consumers will not necessarily purchase healthier foods, and even if they do, targeted individuals (women, children, youth, and the poor) may not consume them. Building on studies conducted or begun in Phase I, we will study ways to stimulate demand among food purchasers in households and among individuals within households. At a micro level, different methods of advertising, packaging, store placement, pricing, or behavior change communication (including public policy campaigns) can all potentially improve demand for readily available healthier foods. Methodologies used include lab-in-the-field experiments and

randomized control trials designed in collaboration with implementing partners. This research will generate knowledge about how to stimulate demand for healthier foods.
The second set focuses on identifying and assessing **supply-side innovations**. Value chains—for one product or multiple products—are a major channel for interventions to improve diets. For example, we can safely assume that fruit and vegetable consumption is lower than optimal, and increasing seasonal and overall availability, affordability, convenience, and desirability of fruits and vegetables would improve diets (Siegel et al. 2014). We will address the relative lack of production of nutritious foods with implementing partners from the private and public sectors. Innovations may relate to inputs (seed or seedling quality, fertilizer use, credit), postharvest handling and management (storage, transport), or market outlet frameworks (daily delivery, contracts, preferred suppliers). In value chains combining several foods, innovations can help make nutritious foods more available and affordable relative to less nutritious foods. Such innovations may include improving fresh markets for food safety and availability, establishing nutritional profiling systems as a basis for regulatory and fiscal food system policies, or guiding food processors on maintaining nutrients during processing and/or limiting levels of fat, sugar and salt in processed foods. Such interventions will be assessed using tools developed by PIM's FP on Inclusive and Efficient Value Chains, and during A4NH's first phase.

The third set relates to evaluating the **influence of these innovations on the diet.** Outcomes of studied innovations will be assessed through base- and end-line dietary assessments, and analyzed in terms of their effectiveness, cost, and practical feasibility for addressing dietary gaps in targeted groups. Evaluations will be designed to learn about gendered and environmental impacts (biodiversity, water quality, soil fertility, land degradation, climate change), so innovations that would negatively affect either gender balance or the environment if scaled up would not be recommended. Assessment tools developed during Phase I of the CRPs on CCAFS, Water, Land, Soils, and Ecosystems (WLE), and A4NH and by CoA 3: scaling and anchoring, will be used to assess interventions.

The process ownership will be shared by food system stakeholders and researchers, so that all are involved in the development and evaluation of innovations. Early and full stakeholder engagement increases the likelihood that innovations are implemented and adopted by consumers. We will focus on working through public-private platforms (PPPs) in focus countries, to identify incentives that encourage positive shifts by the private sector. The goal is to build up contextual evidence to use in CoA 3: scaling and anchoring. For each of the research questions, research generated by individual activities will be synthesized into reports and policy briefs that discuss any generalizable lessons. Datasets generated as part of the research on specific innovations, will be made publically available. CoA 3: scaling and anchoring, offers a major area of joint research with AFS-CRPs. Major outputs and outcome ones are described in **Box 2.1.5**.

Box 2.1.5. Major outputs and outcomes of CoA2 (see Perf. Indicator Matrix – Table D for more)

2017	• At least 2 partners, including value chain actors, participate in the identification and design of at least 2 gender-sensitive interventions aligned with findings from CoA1 to improve diets in Ethiopia and Vietnam
2019	• At least 4 partners across the 4 focus countries, including value chain actors, improve understanding of linkages between diets and value chain interventions in food system context
2021	• Value chain partners implement at least 4 gender-sensitive interventions aligned with findings from CoA1 in all focus countries • 8 partners, including value chain actors, build capacity to use evaluation findings to inform operational and investment decisions
2022	

- 12 partners, including value chain actors, use evaluation findings to inform operational and investment decisions

CoA 3: Upscaling and Anchoring Food System Transformation

This cluster aims to identify and better understand drivers and innovations enabling food system transformation for healthier diets at scale, building on knowledge gains from system analysis in CoA1, and small-scale innovations studied in CoA2. Research will focus on influencing food systems' performances at two levels. First, actors in agri-food value chains will be supported in scaling up innovations for healthier foods and improving the nutritional quality and safety of already distributed foods. Second, research will focus on how public policy and investment decisions enable food system transformations for healthier diets at scale, building on the first CoA. This research will use PPPs to anchor innovations in the food system, where anchoring is a process of making multiple connections to increase the chance that sustainable change is realized (Elzen, van Mierlo, and Leeuwis 2012; Leeuwis et al., n.d.; Linn 2012).

Research into options for scaling up and anchoring food system transformation for healthier diets is based on the premise that policy processes vary by country and can be influenced by several national strategies, enabling conditions for private sector innovation. The research will (a) systematically assess country experiences in food system transformation strategies at different points in time and (b) draw on relevant examples from countries (like Brazil), which made significant progress in reducing hunger and undernutrition with a combination of agricultural productivity growth, social protection, and new dietary guidelines. Policies and strategies that will be explored include:

- Major agri-food system policies (such as smallholder or larger farm-based growth, value addition of food products, and spatial focus on growth corridors, rural towns, and remote areas) (Hartmann et al. 2013).
- How food chain policies (pricing/taxation, labeling, and reducing transaction costs) account for economic, health, and environmental trade-offs, including their implications for equity; and
- Mainstreaming healthier food in food systems, through dietary guidelines, nutrient profiling, food grades and standards, and regulation and taxation of unhealthy foods (Tara Garnett et al. 2015).

Particular attention is paid to the dynamic role of agri-food business networks (small and medium-sized enterprises (SMEs) enterprises, business incubators) and connections to scaling agents (supermarkets, agri-food processors, finance and banking, and trading/logistics firms). Within this broader food system analysis, four key research questions relevant for scaling and anchoring are formulated (see **Box 2.1.6**).

Box 2.1.6. Main research questions in CoA 3: Scaling and Anchoring

1. In specific national contexts, what specific policies can enable food systems to sustainably shift toward healthier diets at scale?
2. What innovations at scale are successful at supporting food systems for healthier diets for specific target populations?
3. Can engaging consumers and civil society/advocacy groups effectively influence demand for healthier and more sustainable diets, and more sustainable food systems?
4. Will agri-food businesses include sustainability and health considerations in their decisions, and does this influence the accessibility and consumption of healthier food?

The research will have three linked sets of activities. The first set focuses on **comparative learning,** systematically assessing different scaling and anchoring options for food system transformation linked

to changing dietary patterns within and across countries. The goal is to compare different pathways toward healthier and more sustainable diets in relation to varying market and institutional conditions. The second set involves **participatory scenario analyses**. Here we will analyze different scenarios of possible food system changes (generated in CoA 1: diagnosis and foresight) together with key societal partners, to identify effective informative arrangements and appropriate policy incentives for upscaling. This activity will collaborate with CCAFS CoA 1.2 to generate combined climate, food and nutrition scenarios at national and subnational levels, linked to global scenarios. Attention will be paid to both horizontal (cooperative) networks and vertical (supply) chains for innovations that enhance food quality (Ruben et al. 2007), improve reliable logistic conditions, and support PPPs for anchoring food system change (Hartwich et al. 2008). Third, identified options will be tested through **concerted actions**. The emphasis will be on aligning healthier food chain innovations with consumer choice, which requires an understanding of the role of diet information, sector-wide standards, commodity labels, and certification in food system transformation.

Main research approaches will include comparative case studies, participatory scenario analysis, robust impact assessment and interactive adaptive system methods. Consumer response surveys, non-experimental approaches, and experiment-based methods may be used to assess broader feasibility of food system innovations (Kiesel, McCluskey, and Villas-Boas 2011). Major outputs and outcome are described in **Box 2.1.7**.

Box 2.1.7. Major outputs and outcomes of CoA3 (see Perf. Indicator Matrix-Table D for more)

2018	• 8 stakeholders in relevant policy processes across the 4 focus countries are made aware of A4NH evidence on dietary trends
2019	• 12 stakeholders across the 4 focus countries use results of systematic assessment of different scaling and anchoring options for food systems
2020	• 20 stakeholders engage in participatory scenario analysis in Bangladesh and Nigeria Active policy engagement in the focus countries
2021	• At least 4 policymakers (e.g., ministries, divisions) across all 4 focus countries have knowledge and capacity to design concerted actions to support healthier food systems
2022	• 4 public-private partnership networks are formed across the 4 focus countries

2.1.1.7 Partnerships

To address the challenges of convening and integrating diverse partners in a food systems and diet transition research program, A4NH will launch a partnership with **Wageningen UR** as leader of this FP. Wageningen UR currently partners with most CGIAR Centers and AFS-CRPs and has a portfolio of food system projects (total contracted value of 15M€). It provides broad expertise across all food system analysis elements and longstanding experience in linking technical, behavioral and policy analysis beyond what currently exists within CGIAR. It also adds considerable experience with (inter)national PPPs. **Research** will be carried out with a wide range of research institutes, including:

- Within A4NH, FP4: SPEAR, related to CoA3, to develop methods for cross-country and multi-level analysis of drivers of food system changes. Similar collaborations are planned for FP2: Biofortification and FP3: Food Safety.
- Other AFS-CRPs and CGIAR Centers (e.g. WorldFish, World Agroforestry Centre (ICRAF), International Maize and Wheat Improvement Center (CIMMYT), International Potato Center (CIP), International

Crops Research Institute for the Semi-Arid Tropics (ICRISAT)) to jointly identify key leverage points in specific agri-food value chains, and to compliment ongoing AFS-CRP research.
- Other ICRPs: for economic, environmental, and policy perspectives with PIM's FP on Inclusive and Efficient Value Chains (e.g. trade and subsidies; value chain hubs). For natural resource and climate change research with the sustainability and resilience of food systems under WLE's FP on Rural-Urban Linkages, and with CCAFS.
- Universities and (public health) research institutes to align research on, for example, dietary assessments (e.g., Tufts University INDEXX project with IFPRI and FAO) and on the health consequences of dietary change (e.g. Tufts, Harvard).

As **agri-food chains actors**, especially private companies, play a large role in food systems, operational research on the types of PPPs that can best lead to healthier diets will occur through existing PPPs (e.g. Amsterdam Initiative for Malnutrition (AIM), the GAIN Marketplace for Nutritious Foods, COLEACP, The Sustainability Consortium (TSC), the Pulse Innovation Partnership led by McGill University) and through collaboration with private companies, such as Nutreco, Unilever, DSM and FrieslandCampina. Collaboration will be sought with SMEs in the key countries in developing healthier food products and portfolios. Opportunities for consumer labels will be worked out with, for example, Choices International Foundation, Fair Trade, and Eco.

Co-development and testing of food system interventions and innovations will be done with **national partners**, especially in the focus countries (see initial consultation in Ethiopia). Examples of local partners are the Ethiopian Public Health Institute, University of Ibadan (Nigeria), ICDDR,B and BIDS (Bangladesh), and National Institute of Nutrition and Can Tho University (Vietnam). In focus countries, we will work closely with local agriculture, public health, and policy agents to identify appropriate incentives and regulatory responses. We will cooperate with the Scaling Up Nutrition (SUN) national multi-stakeholder platforms to support national leadership for pursuing nutrition-specific interventions and promoting good nutritional practices and enhancing nutrition-supportive policies and regulations. For increased uptake at the **global level**, we will engage with the United Nations system (e.g., WFP), IFAD, the global SUN Movement, the Milano Urban Food Policy Pact, and the EAT initiative and will complement FP4: SPEAR working with SUN on monitoring and evaluation of public programs and country performance for the SDGs/WHA targets. This FP will cooperate more with the GAIN coordinated SUN Business Alliance.

2.1.1.8 Climate change

Climate change is an important factor in research proposed in this FP. Concerning CoA1, climate change is a key potential driver of food systems transformations and will affect productivity, quality, availability, stability, and affordability of food for many agricultural products. This will influence how value chain and other food system actors will respond and interact. Climate change will also affect priorities related to agricultural investments and therefore directly to the food system through the 'policy' impact pathway. Diagnostic tools and forecasting models for food system dynamics and their trade-offs will be developed in close collaboration with the CCAFS FP on Priorities and policies for climate-smart agriculture, to assess likely scenarios for climate change that apply to different settings, ensuring proper integration of climate change into our diet and food systems analyses, as well as ensuring diet and food system scenarios are included in climate change analysis (see Annex 3.6).

In CoA2, climate change is key when selecting pilot food system innovations to test. Some nutrient

dense foods are resource intensive, so resource use must be considered in planning interventions that may lead to increased consumption of such foods. Specifically, ASF are both land- and water-intensive, and fruits and vegetables are typically water-intensive. Our proposed innovations to promote production and consumption of these foods will consider climate-smart varieties and animal breeds, and nutrient dense crops that may be more adapted to heat, drought tolerance, and other climate effects. We will work with agri-food value chains actors to develop and test innovations for post-harvest handling and storage, for example on cold chain technology. CoA3, will scale up interventions deemed successful in the second CoA, to ensure tradeoffs related to climate change are well understood.

2.1.1.9 Gender

Gender issues are of critical importance throughout this FP. Access to nutrition, food choices and dietary outcomes (CoA 1: diagnosis and foresight) are strongly influenced by gender bargaining power at intra-household and community level. We will register gender-associated trends in nutrients and energy intake for gender dietary profiles to enable gender-specific analysis of food choices. Similarly, gender engagement into commercialization (CoA 2: food system innovations) is frequently accompanied by exclusionary practices, and benefits from agri-food value chains innovations do not automatically accrue to women and children. Consequently, gender equity requires a precise tracing of revenue streams and targeting of welfare effects throughout the agri-food value chains. Due attention is also given to implications for gender-based differences in labor use associated with particular food system innovations. Fostering women's participation in food systems co-innovation partnerships will require gender-specific strategies to ensure gendered control over assets, including technology and women's employment. This also holds for the upscaling strategies (CoA 3: scaling and anchoring) that are based on steering consumer choice towards healthier diets and tend to rely strongly on gender-based food selection decision-making frameworks. Similarly, preferences and response reactions will reflect gender-related differences that should be acknowledged to enable gender equity at scale. Priority will be given to ensure both women and men benefit from healthy food systems, especially as consumers and food chain actors, while avoiding unintended negative consequences, such as harm to women's time in child care, food processing, storage, and to work burden, control over income and resources, and health status. Where appropriate, we will suggest ways gender roles can be modified to improve food systems outcomes.

2.1.1.10 Capacity development

For the design and implementation of the capacity strengthening activities (e.g. for producers, chain agents, consumers, and policymakers), the elements identified by the CGIAR CoP on capacity strengthening will be used (CRP Section 1.0.10 and Annex 3.2). Key to our strategy is co-learning across CGIAR, Wageningen UR, and national partners, encompassing two interrelated components: joint learning and formal training. Joint learning will occur through co-development and testing of food system innovations with national partners and in collaborative and cross-country research with AFS-CRPs and GI-CRPs. Specific gaps at national partner level will be assessed in collaboration with the CGIAR CapDev CoP and then addressed with individual, formal learning through short-term training courses (e.g. at Centre for Development Innovation at Wageningen UR (CDI), and long-term PhD programs at Wageningen UR and/or other universities). This dual strategy will help develop individual and institutional food system champions, building capacity of partners in the analysis of diet and food systems change data, and building capacities amongst public and private agents to design, implement,

and assess interventions and approaches. The Wageningen UR sandwich PhD program suits this process well, as it allows joint supervision between Wageningen UR and CGIAR staff, and includes a 2.5 year research period at the partner institute, ensuring joint learning and embedding in the partner countries. Joint learning activities will also build capacity among policymakers and actors in the policy process to support the willingness and ability to use evidence in policymaking and implementation, including commitment to collecting and analyzing diet-related data to inform policy decisions and monitor progress towards outcomes. The free public access to learning materials by the partner institutions increases the multiplier effects in capacity development.

2.1.1.11 Intellectual asset and open access management

Intellectual assets will be designed based on CGIAR open access and open data principles. In Phase II, researchers from this FP will contribute a number of intellectual assets, such as decisionmaking tools, new databases, evidence of cost effectiveness, and impact evaluation analysis. CGIAR researchers associated with this FP will make their data available to other researchers through their Center-specified platform, such as the IFPRI Dataverse platform. Publications related to evidence and analysis will also be made open access in following the CGIAR open access policy. Wageningen UR in all its activities will obey the Netherlands Code of Conduct for Academic Practice governing the correct exercise of duties for staff members at institutions that fulfil a societal role, developed by the Association of Universities in the Netherlands. Data are deposited into the Data Archiving and Network Services (DANS) of the Netherlands Organisation for Scientific Research (NWO). More details on the A4NH management of both open access and open data and intellectual assets can be found in Annexes 3.8 and 3.9, respectively.

2.1.1.12 FP management

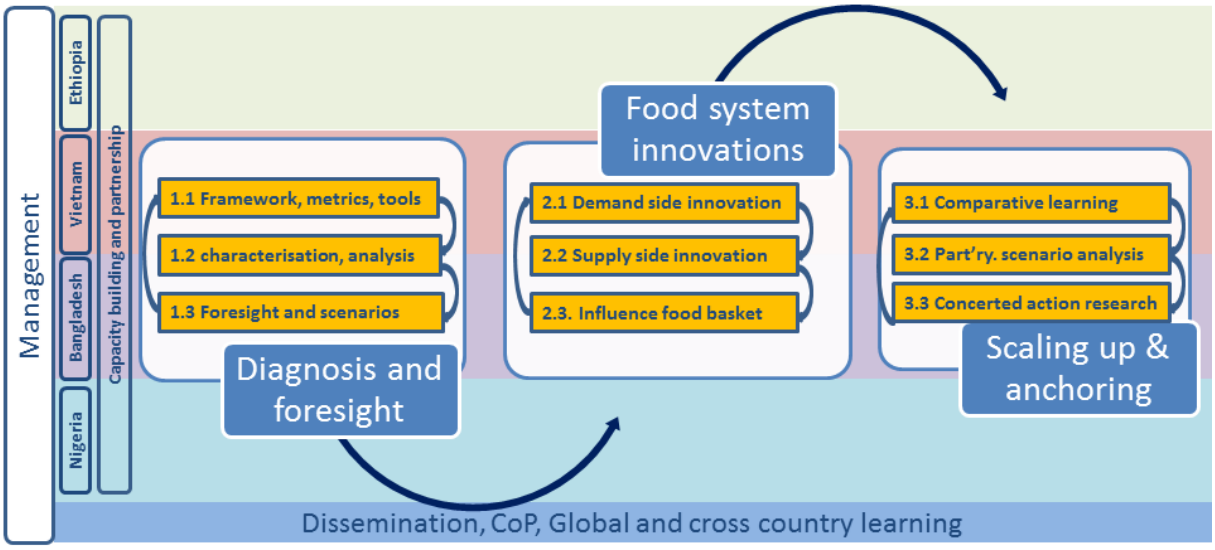
Project management will be based on activity-based budgeting like EU programs (see Figure 2.1.5) and programmatic management identified at three levels: FP, CoA, and focus country. Wageningen UR will be the **overall FP leader** and will employ an experienced FP leader responsible for scientific leadership, coordination, and management (to be recruited, see ToR for the position in Annex 3.7). Together with **finance/admin support** provided by **LEI-DLO**, the FP leader will constitute the **Daily Management Team (DMT)**. The FPMT will cooperate with the Amsterdam Initiative against Malnutrition (AIM/GAIN) for involving private sector partners in food system co-innovations.

For each **CoA**, joint leadership will be established with representatives of two institutes, for example CoA 1: diagnosis and foresight (Wageningen UR/Bioversity International), CoA 2: food system innovations (IFPRI/AIM (GAIN)), and CoA 3: scaling and anchoring (Wageningen UR/International Center for Tropical Agriculture (CIAT)), guaranteeing research coherence, policy relevance, and cross country learning.

For each focus country, one partner is assigned as the responsible **Country Team Leader,** for example Ethiopia (Bioversity International/ILRI); Nigeria (International Institute for Tropical Agriculture (IITA)); Bangladesh (IFPRI); Vietnam (CIAT), responsible for embedding the research in respective countries. Chaired by the FP leader, **the FP management team (FPMT)** is comprised of one representative of each CoA and Country Team, and of key institutions involved (CGIAR Centers, Wageningen UR, GAIN/AIM, other business partners) and will meet at least once annually to review overall progress. The FPMT will

be responsible for major strategic decisions and for determining long term FP strategy and direction (steering). This FP will convene regular food systems events within the framework of the Agriculture, Nutrition and Health Academy linked to the CoP.

Figure 2.1.5. Organization of clusters and set of activities



2.1.2 Flagship Budget Narrative

2.1.2.1 General Information

CRP Name	CGIAR Research Program on Agriculture for Nutrition and Health
CRP Lead Center	International Food Policy Research Institute (IFPRI)
Flagship Name	FP1: Food Systems for Healthier Diets
Center location of Flagship Leader	Wageningen University and Research Center, the Netherlands

2.1.2.2 Summary

Total Flagship budget summary by sources of funding (USD)

Funding Needed	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Total
W1+W2	4,000,000	4,200,000	4,460,000	4,730,000	5,000,000	5,295,000	27,685,000
W3							0
Bilateral	9,251,008	10,731,726	11,258,761	10,824,574	11,516,942	12,015,977	65,598,990
Other Sources							0
	13,251,008	14,931,726	15,718,761	15,554,574	16,516,942	17,310,977	93,283,988

Funding Secured	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Total
W1+W2 (Assumed Secured)	4,000,000	4,200,000	4,460,000	4,730,000	5,000,000	5,295,000	27,685,000
W3							0
Bilateral	3,674,373	2,221,102	700,000	200,000			6,795,475
Other Sources							0
	7,674,373	6,421,102	5,160,000	4,930,000	5,000,000	5,295,000	34,480,475

Funding Gap	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Total
W1+W2 (Required from SO)	0	0	0	0	0	0	0
W3 (Required from FC Members)	0	0	0	0	0	0	0
Bilateral (Fundraising)	-5,576,635	-8,510,624	-10,558,761	-10,624,574	-11,516,942	-12,015,977	-58,803,516
Other Sources (Fundraising)	0	0	0	0	0	0	0
	-5,576,635	-8,510,625	-10,558,761	-10,624,575	-11,516,943	-12,015,977	-58,803,516

Total Flagship budget by Natural Classifications (USD)

	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Total
Personnel	4,284,783	4,903,399	5,496,006	5,745,920	6,134,834	6,390,260	32,955,205
Travel	691,654	728,885	576,885	541,427	556,030	568,530	3,663,415
Capital Equipment	0	0	0	0	0	0	0
Other Supplies and Services	3,653,549	4,466,205	4,638,063	4,703,067	4,737,030	4,862,027	27,059,944
CGIAR collaborations	0	0	0	0	0	0	0
Non CGIAR Collaborations	2,832,171	2,824,773	2,884,002	2,441,187	2,853,187	3,143,187	16,978,510
Indirect Cost	1,788,848	2,008,463	2,123,802	2,122,971	2,235,859	2,346,970	12,626,915
	13,251,005	14,931,725	15,718,758	15,554,572	16,516,940	17,310,974	93,283,974

Total Flagship budget by participating partners (signed PPAs) (USD)

	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Total
Wageningen University and Research Center (WUR)	4,310,865	5,450,006	6,314,387	6,694,104	7,331,825	7,715,732	37,816,921
IFPRI	2,292,180	2,490,901	2,707,515	2,942,267	3,199,990	3,477,153	17,110,008
Bioversity International	4,033,696	3,511,829	2,916,990	2,228,106	2,259,494	2,291,821	17,241,938
CIAT	1,802,629	2,457,897	2,592,656	2,647,750	2,710,183	2,776,676	14,987,794
IITA	811,636	1,021,091	1,187,210	1,042,344	1,015,452	1,049,593	6,127,328
	13,251,006	14,931,724	15,718,758	15,554,571	16,516,940	17,310,975	93,283,974

Explanations of these costs in relation to the planned 2022 outcomes:
70% of the budget is from bilateral grants with $27.6M (27%) from W1/W2. Approximately 20% of the bilateral grants are secured for the first three years. Given this is a new FP, there are major gaps in secured W3/bilateral grants for all Cluster of Activities (CoAs). An important part of co-funding is secured from knowledge-basis funding under the Food & Nutrition Security program of Wageningen University & Research.

Personnel costs are the main cost drivers. Which is critical in building this new research partnership and its grant portfolio. In 2016, we expect to accelerate the formation of an interim management group, with particular emphasis on developing a grant portfolio. Partnerships with private sectors partners (coordinated with GAIN) and business schools will be critical. A number of PhDs are also included in in other services and supplies for a sandwich PhDs program, with focus countries that jointly develop a coordinated research portfolio. Additional partners, both CGIAR Centers and non-CGIAR research institutes such as AVRDC and icipe will be included in the Non-CGIAR cost category details to be developed later, this represents 21% of the FP budget.

Risks
The major risks relative to outcome delivery in 2022, is how quickly we can develop a strong FP team and partnership effort. WUR has great experience in leading and coordinating partners in research consortia and managing through work packages and activity-based budgeting. In this task, WUR is taking on its role as other CGIAR managing partners that lead FPs as well as contribute to the overall FP PMC. Achieving a rapid increase in grant funding will also be challenging, but WUR and IFPRI have strong comparative advantage. The partnership with private sector facilitated by GAIN should also be very attractive to donors.

As with other FPs, changes in security situations in different fields sites can be important and we will work closely with partners on the ground and adjust our programs accordingly.

2.1.2.3 Additional explanations for certain accounting categories

Benefits: WUR's benefits are compulsory in the Dutch government system and are embedded in the overall personnel costs.

IFPRI's Fringe benefits includes primarily leave, health, and pension costs.

Bioversity provides fringe benefits only to International recruited staff for pension, insurance.

CIAT - NRS: Fringe benefits for national staff (costs for all benefits are added to the base salary to provide the total cost of the position) are comprised of legal benefits (local mandatory) and extralegal benefits (CIAT mandatory) and the provisions to cover local legal requirements such as: Pension - social security, training and development, occupational health, transportation costs and subsidies, work clothes and personnel protection requirement, and food subsidy.

IRS: Fringe benefits for international staff (costs for all benefits are added to the base salary to provide the total cost of the position) are comprised of housing allowance, education allowance, car allowance, Cost Of Living Allowance (COLA), hardship, home leave tickets, insurance, retirement contribution, occupational health, training and development, repatriation and relocation provisions.

IITA uses a paygrade (PG) system for Internationally Recruited staff (IRS) and Nationally Recruited Staff (NRS). For IRS, there are 6 PG levels, and standard costs (pension, health and other insurance, housing/transport/security/leave allowances). Actuals can vary (for example by duty station or family size). For NRS the PG rates (level 1-15) depend on country laws on wages and salaries and internal set scales. NRS staff costs are split into salaries, fringe benefits and allowances, also dependent on country laws. Allowances (housing, transport, subsistence, utility, entertainment, and leave) can used to provide competitive salaries in different local markets.

Other supplies and services: WUR supplies and services include housing and corporate contribution, fellow costs for PHD students, contribution to infrastructure and other facilities, and other general supplies and services.

IFPRI's service center charge is included under supplies and services; this is a necessary cost to support research activity. The cost of the services is allocated to benefiting projects based on utilization of these services measured by the number of direct labor hours incurred for each project. IFPRI's service centers are comprised of computer, facility, library, and research support.

2.1.2.4 Other Sources of Funding for this Project

The greatest risk for project funding is in CoA2. This research is led by ILRI and much of the research is done together with value chain research in Livestock and Fish (as in phase 1) and with WLE (phase 2). The opportunities for joint project funding proposals with other these other CRPs will be pursued as well as with other partners identified in the FP3 proposal.

2.1.2.5 Budgeted Costs for certain Key Activities

	Estimate annual average cost (USD)	**Please describe main key activities for the applicable categories below, as described in the guidance for full proposal**
Gender	800,000	Research to understand how gender influences consumption, production and value chain decisions; assess potential for unintended consequences of interventions and policies; coordination with GEE unit on learning platform
Youth (only for those who have relevant set of activities in this area)	300,000	Engagement with youth in food system interventions and innovations, particularly small-scale agro-enterprises
Capacity development	1,500,000	Co-learning with national partner leaders; building capacity in key areas and support to key institutions identified through focus country planning
Impact assessment	150,000	Short-term assessments of initial interventions; planning a mix of ex-ante and ex-post IA with national partners
Intellectual asset management	0	
Open access and data management	150,000	Ensure high quality and prompt availability of diet quality data from consumption studies; Rapid availability of research products to national partners; support to national institutions on data use and open access and data management issues
Communication	150,000	Activities include engaging in policy dialogue; communicating research results and prompting learning and collaboration across the FP team and partners

2.1.2.6 Other

FP1 responds to much greater demands from donors and governments for research on food system and diet transformation. The FP team under WUR leadership brings a strong research group together experience in public-private partnership for food, which provides much greater comparative advantage than we had in value chains for nutrition in phase 1.

Use of W1/W2
FP1 is the FP in which we link most actively with other CRPs and with national partners in 4 focus countries. W1/W2 funds are invested in the FP leader for strategic planning and also in an FP manager for coordination with other CRPs.and national partners. W1/W2 funds are also invested in joint research

on: diet quality diagnostics, foresight into cross-country analysis of food system and diet transformation, and synthesis of food system innovation and cross-country analyses of scaling out and anchoring.

Priorities for uplift funding
Partners and other CRPs incorporate nutrition, health and gender in agri-food value chains and food systems programs (more focus countries included in the deep-dive analysis in CoA1 and CoA3)
Stakeholders (investors, civil society, policy makers) consider healthier diets in processes related to food systems (more stakeholders in more countries are involved large scale trials
Partners implement A4NH strategies for agri-food value chain/food system innovations at scale (more focus countries and partners from these countries involved)

2.1.3 Flagship Uplift Budget

Outcome Description	Amount Needed	W1 + W2 (%)	W3 (%)	Bilateral (%)	Other(%)
Partners and other CRPs - in additional countries beyond the four focus countries - incorporate nutrition, health and gender in agri-food value chains and food systems programs	15,000,000	40	0	60	0
Stakeholders (investors, civil society, policy makers) - in additional countries beyond the four focus countries - consider healthier diets in processes related to food systems	20,000,000	40	0	60	0
Partners - in additional countries beyond the four focus countries - implement A4NH strategies for agri-food value chain/food system innovations at scale	13,000,000	40	0	60	0

2.2. Flagship Program (FP2) on Biofortification

2.2.1 Flagship Program Narrative

2.2.1.1 Rationale, scope

Micronutrient deficiency affects approximately 2 billion people globally. Children who are micronutrient deficient in early childhood are at a much higher risk of infections, and less able to recover than healthy children. It is estimated that 150 million years of healthy life were lost to poor nutrition in 2004—five times that lost to malaria (Department for International Development 2009).

A major cause of micronutrient deficiencies is poor-quality diets resulting in low intakes of key micronutrients. Vitamin A deficiency, which increases susceptibility to infection and can cause irreversible blindness, remains a significant public health challenge across Africa and Asia and in parts of South America. An estimated 33% of preschool-aged children (190 million) and 15% of pregnant women (19 million) do not have enough vitamin A in their daily diet (World Health Organization 2009). Iron deficiency, which causes anemia, lethargy, and reduced cognitive performance, affects about 25% of the world's population, most of them women and preschool-aged children. The proportion of developing-country populations at risk of inadequate zinc intake is estimated to be 25–33%. Zinc deficiency is associated with poor growth and impaired response to infection.

Biofortification uses plant breeding to improve the nutritional content of food crops. It addresses Sustainable Development Goal (SDG) 2, to end hunger, achieve food security and improved nutrition, and promote sustainable agriculture. By focusing on staple foods that poor people already eat, biofortification provides a comparatively inexpensive, cost-effective, sustainable, long-term means of delivering more micronutrients to the poor. Breeding staple crops for higher levels of vitamin A, zinc, and iron is technically feasible with conventional breeding. All biofortified crop varieties that have been released to date are competitive with or better than the best varieties farmers currently grow, in terms of productivity and other traits that farmers and consumers value.

The long-run solution to micronutrient deficiency is to improve the quality and diversity of diets. Improving dietary diversity is a complex and long-term undertaking that involves reshaping food systems. In the CGIAR Research Program (CRP) on Agriculture for Nutrition and Health (A4NH), FP2: Biofortification is undertaking this work. In the meantime, increasing the micronutrient content of staple commodities that the poor consume can reduce inadequate intakes and reducing micronutrient deficiency. Conventional approaches to tackling vitamin and nutrient deficiencies, like supplementation and fortification, require continual financial outlays, and there are challenges ensuring coverage, particularly in areas where services and markets are weak. Biofortification complements these approaches and is available to rural populations, and nutritionally vulnerable urban ones, who are difficult to reach through other nutrition interventions.

Even as evidence to biofortification grows, more research is needed to support scaling out and learning about delivery of biofortified crops through a systematic approach, especially to assess effectiveness and delivery at scale through markets, and to mainstream biofortification into crop improvement research, nutrition and agriculture policy, and partner activities.

Using a Theory of Change (ToC) for each country-crop combination, we identified evidence gaps and research questions relevant to delivery. In Phase II, strategic research will include impact assessments of delivery channels; efforts to better understand intrahousehold dynamics around adoption and consumption; and studies to identify mechanisms to maximize adoption and consumption of biofortified crops. As countries demand more biofortified crops, we need to better understand the nutritional impact and potential synergies of the biofortified "food basket" in which people consume a combination of biofortified crops. Partners are increasingly taking up and distributing biofortified crops, and it is important to assess the impact of these delivery efforts.

Determining the full impact at scale of biofortification can currently be estimated using ex ante models to simulate the impact of the intervention, and these suggest that biofortification is a cost-effective intervention, per World Bank standards. Effectiveness studies are planned for Phase II, to better understand the impact of biofortification and changes in the nutritional status of populations in real-world conditions.

HarvestPlus, which leads FP2, will strengthen its emphasis on mainstreaming biofortification into partners' crop development work and shift its long-term focus to scale up biofortification, retaining a focus on evidence, knowledge production and sharing, monitoring and evaluation, and technical assistance to assure impact at scale.

This FP builds on a strong history of strategic CGIAR crop breeding for important traits combined with nutrition evaluation to develop biofortified food crops, and is a logical extension of engagement with national implementing and enabling partners to extend these crops at scale. The clusters of activity (CoA) in this FP will build on previous research to mainstream biofortified traits into crop development research, while also focusing on learning about delivery in a contextually rich world of markets, farmer behaviors, and dietary practices. In Phase II, filling key evidence gaps and capturing lessons learned is critical, and will involve intensifying the work of promoting production and consumption in target countries as a "proof of concept" of the approach, analyzing the effectiveness of delivery mechanisms, and developing lessons for scaling up. This evidence will contribute to promoting an enabling environment for biofortification and developing tools to facilitate delivery by others.

2.2.1.2 Objectives and targets

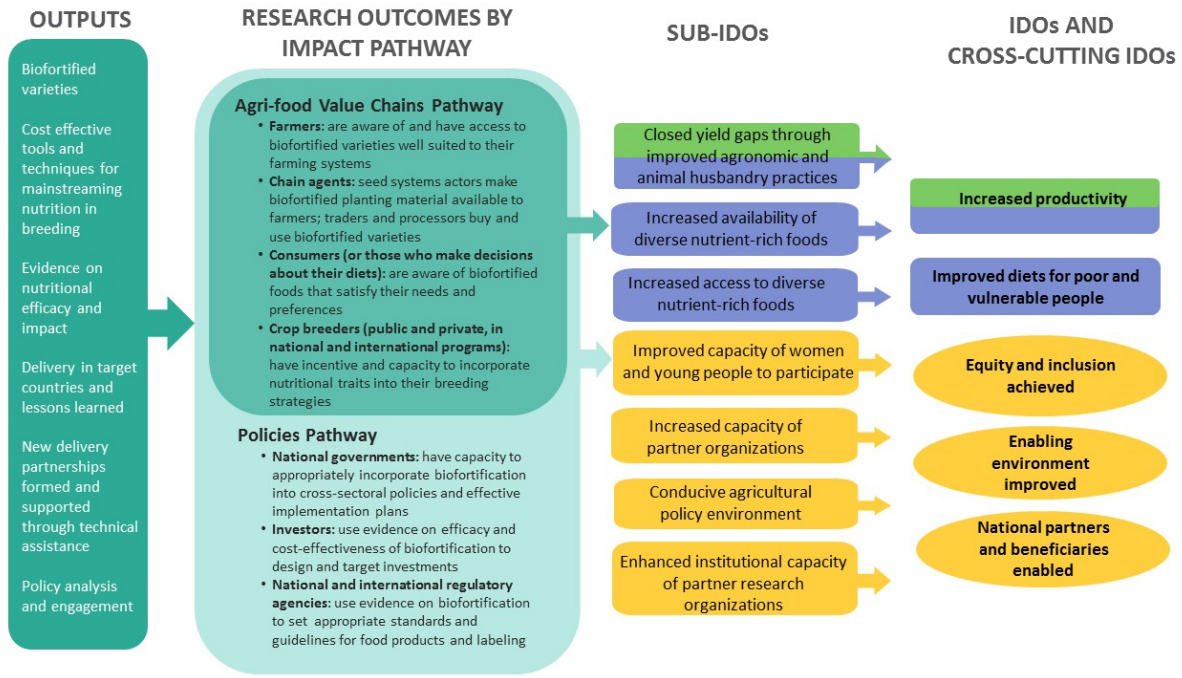
FP2 addresses the problem of micronutrient deficiency due to inadequate dietary intake of micronutrients, contributing to the second system-level outcome (SLO2) on *improved food and nutrition security for health* through the intermediate development outcomes (IDOs) of *improved diets for poor and vulnerable people*, *increased productivity* (**Figure 2.2.1** and Performance Indicator Matrix-Table C) and all three cross-cutting IDOs. Improvements in productivity will also contribute to the SLO on *reduced poverty*.

During Phase II, this FP aims to:

1. Assess the viability, cost-effectiveness, and impact of scaling up in the nine priority countries (Bangladesh, Democratic Republic of Congo (DRC), Ethiopia, India, Nigeria, Pakistan, Rwanda, Uganda, and Zambia) where HarvestPlus and national partners are taking the lead, in addition to those reached by partners working in other countries;

2. Develop and submit for national release biofortified varieties in target and expansion countries, while mainstreaming biofortification into CGIAR and national agricultural research system (NARS) breeding efforts; and
3. Provide evidence and analysis, and strengthen capacity and leadership to integrate biofortification into policy, program development, and implementation, to support the scaling up of biofortification.

FIGURE 1.2.1. IMPACT PATHWAYS FOR FP2: BIOFORTIFICATION



By 2022, FP2 expects to have achieved the following (see Performance Indicator Matrix – Tables B and D for more):

- **20 million HHs** growing and consuming biofortified crops (15 M in target, 5 M in partner countries);
- All **8 target countries** release full target varieties and partnership countries have tier 1 crops in release pipelines;
- **2.5% annual increase** in mainstreaming as a percentage of total CGIAR Center efforts for target crop/agroecology ;
- **2 decisionmaking tools** incorporate evidence from efficacy studies of multiple biofortified crops in culturally acceptable combinations for women of child bearing age and for children 6-24 months of age;
- Biofortification included in **5 national/regional policies** and **3 country grants/loans** from IFIs;
- Biofortification included in **10 additional national/regional policies** and **5 additional country grants/loans from IFI**s ;
- **Codex Alimentarius** will adopt criteria for use of biofortification terms on food labels; and

More specifically, FP2 will make contributions to two 2022 CGIAR targets: 20 million more farm households that have adopted biofortified varieties and 43.1 million more people, of which 50% are women, without deficiencies of one or more of the following essential micronutrients: iron, zinc, iodine, vitamin A, folate, and vitamin B12 (Performance Indicator Matrix – Table A).

Target Geographies
HarvestPlus's delivery science work focuses on the nine target countries (Bangladesh, DRC, Ethiopia, India, Nigeria, Pakistan, Rwanda, Uganda, and Zambia) where HarvestPlus and national partners are taking the lead. Target countries represent a variety of market environments for biofortified crops, from a primarily commercial private sector approach (India, Zambia), to various mixed public-private delivery systems (Bangladesh, Nigeria, Rwanda, Uganda), to primarily public or social marketing systems (DRC). HarvestPlus also works closely with government-sponsored biofortification programs in Brazil, China, and India. Through the HarvestPlus Latin American and Caribbean (LAC) program, led by EMBRAPA, HarvestPlus provides technical assistance and support to government-driven biofortification programs in Bolivia, Colombia, Guatemala, Haiti, Nicaragua, and Panama and is exploring efforts in several additional countries. Increasingly, HarvestPlus is seeking partners to take the lead in scaling up biofortification in partnership countries, a growing list that includes Ghana, Kenya, Malawi, Tanzania, and Zimbabwe, and is expected to include several additional countries, such as Cambodia, Indonesia, Myanmar, Nepal, Sri Lanka, and Vietnam by the end of Phase II.

By 2030, HarvestPlus's aspirational goal is for 1 billion people to be regular consumers of biofortified staple foods. The roadmap to reaching 1 billion is still under development, and continues to be informed by lessons learned in target countries, detailed value chain analyses, and capacity assessment and strengthening of key actors, all of which will be a focus in the first years of Phase II. Key considerations for sustainability and scaling up are discussed in the next section.

2.2.1.3 Impact pathway and theory of change (for each individual FP)

Available evidence and experience suggests that the goal of reaching 1 billion people by 2030 is audacious, but not impossible. To date, HarvestPlus has facilitated the release of biofortified varieties of six staple crops (vitamin A orange sweet potato, iron beans, vitamin A cassava, vitamin A maize, zinc rice, and zinc wheat), and several secondary staples (vitamin A banana/plantain[15], iron cowpea, zinc and iron lentils, iron and zinc potato, and iron and zinc sorghum). Biofortified varieties have now been released in 30 countries and are in multi-location testing in 42 countries. In 2015, biofortified planting materials reached more than 2 million farmers in HarvestPlus priority countries.

The pathway from research—through seed dissemination, adoption, and consumption—to improved diet and micronutrient status is long, complex, and context-specific. This FP has a good understanding of the pathway, specifically in contexts where delivery is taking place. In Phase I, we developed a series of country-by-crop-combination ToCs to identify key outcomes, underlying assumptions and risks for each, and availability of evidence to test them (Johnson, Guedenet, and Saltzman 2015). ToCs identify key areas for research in Phase II, guide country-level delivery and monitoring, and provide a framework for country-level and cross-country learning. ToCs inform scaling approaches in market environments, from the commercially oriented delivery of vitamin A maize in Zambia, to mixed public-private delivery models used in Nigeria and Rwanda. They help identify key areas for further research, like the role of youth in biofortification activities; gender-based differences in preferences and adoption; and unintended consequences of introducing biofortified crops.

[15] Provitamin A-rich banana varieties are naturally high in pVACs. They are being introduced from their center of origin in the Pacific to Eastern Africa.

Scaling and sustaining impact in target countries during delivery will require: (1) mainstreaming biofortification in agricultural research, together with crop CRPs; (2) learning from existing delivery efforts and developing operational partnerships in new countries; and (3) establishing a policy environment conducive to biofortified crops, in cooperation with the CRP on Policies, Institutions, and Markets (PIM). Based on lessons learned in the first years of delivery and potential risks identified by the ToCs, these activities are critical to attaining the 2022 and 2030 goals. They align with the three critical elements involved in scaling up biofortification: *supply* (agricultural research entities recognize high mineral and vitamin content as core plant breeding objectives), *demand* (consumers see the value of, and demand, high mineral and vitamin content in their staple foods), and *policy* (a wide range of public officials recognize the impact of biofortification to improve public health, and the high economic return to investments and commercial feasibility of biofortification). Scale in Phase II can be achieved only by working with other organizations and institutions to pilot, expand, and manage biofortification initiatives.

Investments in this FP have launched breeding pipelines in CGIAR Centers and NARS with biofortified varieties that are agronomically competitive, disease resistant, have preferred end-use qualities, and have full target levels of micronutrients. To sustain this investment, CGIAR Centers and NARS partners must mainstream biofortification, using micronutrient-dense materials throughout their breeding programs. In 2014, Director Generals (DGs) of CGIAR Centers made a commitment to mainstream biofortification, but this commitment requires concrete planning.

To support adoption in target countries and beyond, Phase II will focus on expanding knowledge in key areas, such as farmer and consumer acceptance, youth involvement, nutritional efficacy for a wider range of age and gender groups, and cost-effectiveness assessments (discussed further below). This evidence of lessons learned will be valuable, both to adjust delivery strategies for efficiency, and to help stakeholders decide whether and where to invest in biofortification. We will develop operational partnerships with development organizations interested in mainstreaming biofortified crops. In new partnership countries, we will facilitate multi-location testing by NARS and provide technical assistance and training for NARS. Once a crop is released, partners will take the lead in introducing and using the biofortified varieties.

Significant progress has already been made in mainstreaming biofortification into regional and national policies. At the Second International Conference on Nutrition (ICN2) in 2014, representatives from Bangladesh, Malawi, Nigeria, Pakistan, and Uganda highlighted the role of biofortification in their national strategies to end malnutrition by 2025. Panama and Colombia were among the first countries to include biofortification in their national food security plans. Since the 2nd Global Conference on Biofortification in 2014, biofortification has been included in national nutrition strategies in Nigeria, Rwanda, and Zambia. HarvestPlus is engaged with regional and global processes, like the African Union's Comprehensive Africa Agriculture Development Programme (CAADP) and the Scaling Up Nutrition (SUN) Movement, to ensure an enabling environment for biofortification. Efforts are underway to include biofortification in global standards and guidelines for food products and labeling, such as the Codex Alimentarius, the food standards-setting agency administered jointly by the World Health Organization (WHO) and the Food and Agriculture Organization of the United Nations (FAO) and recognized by the Sanitary and Phytosanitary Agreement (SPS) of the WTO as its reference organization. This work will be linked to work in A4NH's FP4: Supporting Policies, Programs and Enabling Action through Research (SPEAR).

2.2.1.4 Science quality

In Phase I of A4NH, our research agenda focused on testing hypotheses to provide proof of concept that biofortification is feasible without affecting yield and other positive crop characteristics; that farmers would be willing to adopt, and consumers to consume, biofortified crops; and that consumption would lead to an improvement in the nutritional status of target populations. That evidence is now available for many crop, country, and nutrient combinations. Evidence of the effects of nutrition-sensitive agriculture on nutritional outcomes in real world conditions, however, is limited. The effectiveness of biofortified vitamin A–rich orange sweet potato for increasing maternal and child vitamin A intake and status has been demonstrated, but evidence of effectiveness is not yet available for other micronutrient and crop combinations.

Phase II of A4NH offers a unique opportunity not only to develop effectiveness evidence for iron and zinc crops, but also to develop vital lessons on cost-effective delivery channels, public-private partnerships (PPPs), gendered effects of adoption and consumption decisions, and synergies of delivering and consuming multiple biofortified crops. Developing an understanding of the effects of nutrition-sensitive agriculture on livelihood and nutritional outcomes—across several countries, crops, and types of commercial and social marketing arrangements—will vastly deepen the body of knowledge on agriculture-nutrition linkages. In parallel with efforts to mainstream breeding for vitamin and mineral traits and provide evidence to support incorporation of biofortification into agriculture and nutrition policies and investments, the Phase II research will lay the foundation for global scaling of biofortified crops.

FP2 is committed to science quality and has a strong track record in developing a robust evidence base to support the biofortification concept (Bouis et al. 2013; Saltzman et al. 2013; Johnson, Guedenet, and Saltzman 2015). The success of the discovery phase of HarvestPlus (2003–2008) and the development phase (2009–2013) demonstrated that the team has the technical and institutional capacity to bring people together across institutions, countries, and disciplines to forge partnerships and deliver high-quality technical outputs and immediate development outcomes.

Crop development research has not only produced new varieties of biofortified crops, but also contributed greatly to the field of knowledge, with findings about vitamin and mineral heritability in different crops, adaptation of rapid-throughput technologies to use in screening, and identification of new markers to use in marker-assisted selection. Vitamin and mineral traits can be effectively combined with other desirable agronomic traits, and all biofortified crop varieties that have been released to date are competitive with or better than the best varieties farmers currently grow. Effectiveness evidence is available for orange sweet potato (Hotz, Loechl, de Brauw, et al. 2012; Hotz, Loechl, Lubowa, et al. 2012). Nutritional efficacy has been demonstrated for vitamin A crops (maize (Gannon et al. 2014), cassava (Talsma et al. 2016)) and iron crops (bean (J. Haas et al., n.d.), pearl millet (Finkelstein et al. 2015), rice(J. D. Haas et al. 2005)), with zinc efficacy results expected in 2016. Research publications for 2014 provide insight into the depth and breadth of the HarvestPlus research program, which supports and informs delivery activities.

In addition to the ex post cost-effectiveness data that are available for vitamin A orange sweet potato, ex ante cost-effectiveness analyses (CEAs) have been carried out for other biofortified crops. These CEAs have long time horizons (about 30 years), as it takes time for the suitable biofortified varieties to

become available and to be adopted and consumed on a large scale, and then for health benefits to materialize within the consuming population. The CEAs show that for all crop-country combinations, biofortification can be rated as very cost-effective. Moreover, biofortification is found to be more cost-effective than fortification for all crop-country-micronutrient combinations and more cost-effective than supplementation for all cases except one (Birol et al. 2014; Lividini and Fiedler 2015). The cost advantage of biofortification comes from the economies of scale (once a new crop has been developed, its benefits can be spread relatively cheaply over time and space) and its ability to reach a high number of rural farming households that produce and consume large amounts of staple food crops and whose members suffer from micronutrient deficiencies. A combination of biofortification, supplementation, and fortification may be best for achieving the desired objective—large-scale or targeted impact—in a cost-effective way.

In Phase II, research will build on Phase I evidence and focus on developing new evidence on speeding and scaling delivery, as well as unintended consequences that may result. A robust Monitoring, Learning, and Action (MLA) system is now in place in the HarvestPlus target countries, and analysis of the data collected through that system is expected to provide a great deal of insight into audiences reached through various delivery channels, including through informal diffusion and the seed market. Results will be used to inform and speed scaling strategies, particularly through a range of private-sector partnerships. Monitoring surveys will also provide information about the consumption of biofortified crops, particularly among the women and children for whom FP2 seeks to reduce micronutrient deficiency. To support scaling up of biofortification, the nutrition unit will place greater emphasis on knowledge translation for evidence sharing

Impact research will also generate new evidence, including results from effectiveness trials in at least two additional countries (zinc wheat in Pakistan and iron beans in Guatemala). Strategic research will provide insight into how gender influences decisions within households about producing and consuming biofortified crops, and into how the market can best support sustainable investment in developing biofortified seeds as well as promote awareness, access, and consumption of biofortified foods by target populations. Aiming to generate useful information for planning in this FP, as well as for external stakeholders, impact research will build on previous research to estimate the long-run impact and cost-effectiveness of biofortification across country-crop-micronutrient combinations, and compare the cost-effectiveness of biofortification to and in combination with other interventions in these countries.

2.2.1.5 Lessons learnt and unintended consequences

In Phase I, the research team built in mechanisms for ongoing learning, systemically gathering lessons through annual reporting and business planning cycles, which HarvestPlus reports through research publications and an annually updated set of progress briefs. External evaluations, such as a 2012 evaluation by Abt Associates (Abt Associates Inc. 2012) and a Strategic Gender Assessment (SGA), completed in 2013-2014, have also provided strategic feedback that was used to improve FP performance during Phase I.

Lessons learned in Phase I help inform the Phase II research agenda. For example, lessons from countries with rapid expansion of biofortification, like Nigeria and Rwanda, can be applied to delivery strategies in later countries. As this FP achieved its projected outcomes in Phase I, it learned more about risks and gaps that can affect the impact of biofortification. Country- and crop-specific ToCs (Johnson, Guedenet, and Saltzman 2015) consolidated evidence that biofortification can work and helped identify

gaps and potential unintended consequences to be addressed in Phase II. Remaining issues include managing identity preservation of biofortified seed and grain in the market, combating consumer perception that biofortified crops are genetically modified organisms (GMOs), and improving understanding of farmer and consumer behavior.

HarvestPlus also developed lessons on engagement with the private sector. For example, in Zambia, a memorandum of understanding (MOU) between the Zambia Agriculture Research Institute (ZARI) and private seed companies licensed three released hybrids and allocated those hybrids to the seed companies; HarvestPlus was involved as ''interested party,'' but faced a challenge when initial seed production was lower than expected, setting back projected delivery targets. To address this issue, HarvestPlus recruited a Maize Seed System Specialist position for Africa south of the Sahara to assist with technical production issues and strengthened its contracts for seed production with seed companies. HarvestPlus also adjusted its growth projections based on feedback from seed companies. With a better understanding of how the private sector assesses and responds to market conditions, HarvestPlus is exploring different models of private sector engagement, as well as various incentive and risk mitigation tactics.

Partnerships are increasingly central to scaling up biofortified crops. Partnership activities in Phase I will inform efforts in Phase II, including addressing key capacity gaps. Identifying key allies and advocates in partnership organizations to help build trust with program staff was found to be essential to obtaining organization-wide buy in. Even as enthusiastic allies take up biofortification, challenges remain in standardizing systems for monitoring and reporting, which will continue to be a focus in Phase II. Recognizing that a lack of expertise in gender-sensitive delivery strategies could result in unintended consequences for farmers adopting biofortified crops, HarvestPlus commissioned an external SGA to review and assess current programs, identify gaps in gender knowledge and implementation, and identify successful efforts that can be built upon or scaled up. Based on the SGA recommendations, HarvestPlus leadership endorsed an approach to promote the integration of gender-responsive programming into HarvestPlus's current work.

HarvestPlus undertook changes to organizational structure and staffing as the FP grew. For example, the Program Management Committee structure, which had grown to include more than 25 people, including all country managers and unit heads, was replaced by an Executive Committee, which includes the Director, Deputy Directors for Operations and Programs, and head of Strategic Alliances. Both the Deputy Director for Programs and head of Strategic Alliances positions were new in Phase I, developed on the recommendation of the 2012 external evaluation.

2.2.1.6 Clusters of activity (CoA)

FP2 is structured around three interacting CoAs, described below. Earlier phases of HarvestPlus focused on breeding and nutritional evaluation, bringing together scientific research evidence with an impact orientation. Through 2020, HarvestPlus is building on previous research to mainstream crop development (CoA1: Crop development mainstreaming and capacity building) while also focusing on delivery in a contextually rich world of markets, farmer behaviors, and dietary practices (CoA2: Delivery science and developing lessons learned). Filling key evidence gaps and capturing lessons learned is of great strategic importance in this phase. This will involve intensifying work to promote production and consumption of crops in target countries as a "proof of concept" of the approach, analyzing the effectiveness of different delivery mechanisms, and developing lessons for scaling up. This evidence will

contribute greatly to promoting an enabling environment for biofortification and developing tools to facilitate delivery by others (CoA3: Promoting an enabling environment).

The delivery phase offers an opportunity to learn about what works, what does not, and how delivery strategies can be refined to enhance impact. The biofortification research agenda builds on previous work with partners throughout CGIAR, including Centers that carry out crop development work and other A4NH FPs. In Phase II, in addition to collaborating with FP4: SPEAR around policy and the enabling environment at the national and international scales, we will collaborate with FP1: Food Systems for Healthier Diets and FP3: Food Safety to address research questions on production (e.g. aflatoxins), opportunities and risks associated with value addition (e.g. processing, storage), and reaching target consumers in specific crops and countries.

CoA1: Crop development mainstreaming and capacity building
Mainstreaming nutrition into breeding requires a two-pronged approach: (1) annually increasing the percentage of biofortified germplasm in Centers' breeding programs, which are then distributed to NARS for further adaptation and eventual release, and (2) developing methods to reduce costs of breeding for biofortified varieties (through marker-assisted selection and low-cost, high-throughput methods of measuring vitamin and mineral content). This FP also continues to lead training and capacity development with NARS for the development and eventual release of biofortified varieties.

Mainstreaming biofortified traits into breeding parental lines is a strategy to ensure that as new climate-adaptive varieties are developed, they will also contain higher levels of micronutrients. During Phase II, we will work with CGIAR to realize its 2014 commitment to develop and implement a plan for mainstreaming.

The specific research questions that this CoA will address during Phase II include the following:

- Can HarvestPlus and its partners breed target levels of nutrients into staple crops adapted for an increasingly wide range of climatic conditions, without compromising other farmer-preferred traits and crop characteristics?
- What methods can reduce the cost and/or improve the efficiency of breeding for biofortified varieties?
- How can biofortified crops be mainstreamed in international and national breeding programs?

To accomplish this, researchers working on the crop development cluster will focus on the following primary activities:

1. Develop second and third waves of high-yielding, biofortified germplasm with higher nutrient content. These new lines will be distributed globally to NARS for further crossing, testing, and eventual release. Crop development activities will focus on Tier 1 biofortified staple crops (wheat, rice, maize, bean, cassava, and pearl millet), with some investment in secondary staples (banana/plantain, cowpea, lentil, potato, and sorghum).
2. Develop (i) cost-saving breeding methods, such as marker-assisted selection (identifying specific genes associated with high mineral and vitamin content); and (ii) improved low-cost, high-throughput methods for measuring the mineral and vitamin content in seeds (in collaboration with universities in Australia, Europe, and North America).

3. Negotiate with CGIAR Centers and national breeding programs the eventual inclusion of biofortified traits within regular breeding programs, independent of specific FP funding.

Outputs:
- Biofortified varieties; cost-effective tools and techniques for mainstreaming nutrition in breeding
- By 2017: Second-wave releases in all target countries; recommendations of molecular marker external review implemented
- By 2019: Third-wave releases in all target countries; multi-location testing of biofortified crops in 75 countries; application of molecular markers for rice, wheat, maize, and cassava
- By 2022: 2.5% annual increase in crop development efforts for target crop/ecologies that mainstream biofortified traits

Outcomes: Farmers will have access to biofortified varieties well suited to their farming systems; crop breeders will have the incentive and capacity to incorporate nutritional traits into their breeding strategies.

CoA2: Delivery science and developing lessons learned
In this CoA, operational partnerships are developed for countries where biofortified crops are released, and a wide variety of partners are sought, including private seed companies, international NGOs, multilateral institutions, food processing companies, and national governments. Important research questions remain about which approaches work best to reach target beneficiaries (within farm households), how gender influences consumption and production decisions within households, and how the market can best support, not only sustainable investment in developing biofortified seeds, but also awareness, access, and consumption of biofortified foods by target beneficiaries. The nine target countries offer a rich source of information about how to effectively deliver biofortified crops, and allow for comparisons between countries to understand how delivery modalities can vary across market environments.

Where full-target varieties are available, rigorous impact evaluations will measure impacts on outcome variables, such as micronutrient intake and nutritional status of target beneficiaries. These efforts will be complemented by targeted research in key areas, such as gender, markets, and technology adoption specifically designed to answer important questions about the FP2 ToC, and about potential for scaling up biofortification and other agricultural interventions.

The specific research questions that this CoA will address during Phase II include:

- What drives uptake of biofortified crops in target countries? What is the role of research tools, evidence, and ex ante cost analysis in increasing investment and scaling? What are the determinants of farmer and consumer acceptance of biofortified varieties?
- Will biofortified crops improve nutritional status for infants, prior to conception through infancy, and how do multiple biofortified crops improve nutritional status?
- Which delivery models are most cost-effective, including for reaching women, in different market environments?
- What is the impact of biofortification on key outcome variables (adoption, diffusion, micronutrient intake, and deficiency status, all disaggregated by sex) under non-controlled conditions?
- What guidelines for approaches and processes can be replicated by stakeholders who are interested in scaling up biofortification in other countries or environments?

To accomplish this, researchers working on the delivery science cluster will focus on the following primary activities:

1. Assess scalability of biofortification through direct intervention in target countries, developing lessons learned about delivery modalities, consumer acceptance, and private sector engagement. Identify the factors that drive farmer and consumer acceptance and behavior change, including differences by age, gender, and other relevant social variables.
2. Conduct nutritional efficacy trials for a wider range of age groups (including infants); for a longer time frame (for example, prior to conception through infancy); and combining multiple biofortified crops with different nutrients (for example, high-iron and high-zinc pearl millet combined with orange sweet potato).
3. Implement ex ante and ex post cost-effectiveness assessments, and expand ex ante cost-effectiveness analysis to include food-basket approaches.
4. Conduct impact assessment studies in target countries, and implement at least two effectiveness studies (iron beans, Guatemala; zinc wheat, Pakistan).
5. Combine short-term monitoring with medium-term progress indicators to track adoption by farmers, as well as to estimate consumption and public health impacts.

Outputs:

- Evidence on nutritional efficacy and impact; delivery in target countries and lessons learned
- By 2017: Bioavailability and efficacy evidence published for zinc rice; zinc wheat effectiveness trial initiated in Pakistan; ex ante analysis for more countries and food-basket approach; impact assessment surveys completed in at least three countries (Nigeria – cassava, Rwanda – beans, Zambia – maize); monitoring and forecasting models validated for country-crop combinations
- By 2019: Efficacy evidence published for multiple biofortified crops in a single study; effectiveness trial for Guatemala completed
- By 2022: Assessment of the efficacy of multiple biofortified crops in culturally accepted combinations for women of child-bearing age and for children 6–24 months of age; zinc wheat and iron bean effectiveness study results published

Outcomes: Farmers will be aware of and have access to biofortified varieties well suited to their farming systems; agents will incorporate biofortified planting materials and crops into their value chains; consumers will be aware of biofortified varieties that satisfy their needs; evidence on cost-effectiveness, nutritional efficacy, and consumer acceptance will be used by implementers in the design and implementation of investments in biofortification.

CoA3: Promoting an enabling environment

In Phase II, this FP will undertake a broad agenda of developing regulatory standards, partnerships, and policy analysis and tools to support a policy environment conducive to a broad range of nutrition interventions, including scaling up biofortified crops. This engagement, and the translation of efficacy and effectiveness evidence to be understood as relevant by policymakers and regulators, must continue in order to sustain the momentum for biofortification. Recently, HarvestPlus has increased its efforts to convene other actors around biofortification, including at the 2nd Global Conference on Biofortification in 2014. The Global Panel on Agriculture and Food Systems for Nutrition released a policy brief in early

2015 reviewing the evidence on biofortification and recommending that policymakers take steps to scale up biofortified crops.

HarvestPlus will continue to develop tools, like the Biofortification Prioritization Index (BPI), to help partners identify high-potential country-crop combinations for expansion, as well as implementing and evaluating biofortification projects (Asare-Marfo et al. 2013). Policy research will help identify the best mix of nutrition interventions for specific country contexts, considering the contributions of complementary interventions to addressing micronutrient deficient populations, and disseminate evidence through decision support systems like ReSAKSS. HarvestPlus LAC is demonstrating the importance of linking government-supported biofortification programs together across countries, and with CIAT and other CGIAR Centers working in LAC, producing lessons that can be applied elsewhere as biofortification scales up. Many activities in this area will have significant synergies with FP4: SPEAR.

A primary international standards vehicle is the Codex Alimentarius, the food standards-setting agency administered jointly by the WHO and FAO and recognized by the SPS of the WTO as its reference organization. Recognition and standardization of biofortification requires consensus from the 184 member governments of the Codex Alimentarius. In close cooperation with IFPRI, which has been accorded observer status within Codex, HarvestPlus is working with the Codex Committee on Nutrition and Foods of Special Dietary Use (CCNFSDU) to develop an internationally accepted definition of biofortification. Without an internationally accepted definition, national governments are unable to include biofortification in national legislation and cannot set regulations and related policies specific to biofortified foods. This is an impediment to harmonization and international trade.

The specific research questions that this CoA will address during Phase II include the following:

- What are the barriers and constraints to creating cross-sectoral policy and institutional environments that better support the inclusion of biofortified crops in agriculture, nutrition, and development policies and programs?
- What standards, guidelines, and recommendations for biofortified foods and regulations are internationally accepted, supported by evidence, and can be taken up by Codex Alimentarius and national governments?
- What can be learned from countries that are successfully incorporating biofortification into their policies and programs (including Brazil and others in LAC)?

To accomplish this, researchers working on the enabling environment cluster will focus on the following primary activities:

1. Seek inclusion of biofortification in strategies, policies, and programs on global, regional, and national levels through multilateral and regional organizations. This will include the CAADP and SUN policies, as well as other collaborative bodies, in coordination with CoA3: Capacity, Collaboration, Convening (3C) in A4NH FP4: SPEAR
2. Engage in developing biofortification standards and regulations through formal global normative, regulatory, and donor agencies and global technical, scientific, and implementing agencies, including: (i) develop a definition and standards for biofortification within the Codex Alimentarius and (ii) establish links to national nutrition policies to share standards, guidelines, and recommendations developed by international bodies
3. Evaluate and synthesize knowledge and lessons learned in HarvestPlus LAC countries

4. Identify and develop tools to help partners implement and evaluate biofortification projects, including biofortification priority indices at the subnational level

Outputs:

- By 2017: 3rd Global Conference on Biofortification, including dissemination of evidence and lessons learned
- By 2019: Tools to assess the cost-effectiveness of different portfolios of complementary interventions to address micronutrient deficiency, including biofortification; national and international standards and guidelines on biofortification
- By 2022: Synthesis of lessons learned from countries incorporating biofortification into their policies and programs; Building country capacity to develop and monitor national standards on biofortification

Outcomes: National governments will have the capacity to incorporate biofortification into cross-sectoral policies and implementation plans; national and international regulatory agencies will use the evidence on biofortification to set appropriate standards and guidelines for food products and labeling. Standards for biofortified foods are developed and approved by Codex Alimentarius and biofortification is included in WHO guidelines on micronutrient deficiencies.

2.2.1.7 Partnerships

As HarvestPlus seeks to mainstream and scale up biofortification, its types of partnerships will expand from predominantly academic institutions, CGIAR Centers, and NARS, to new types of partners throughout to achieve SLOs 1 and 2. This FP will develop a wide range of international public goods at each step of the impact pathway, from discovery to development to delivery. Lessons learned on partnerships in different countries will inform partnership strategies for scaling in Phase II. Learning from PPPs, in particular, may offer new approaches that can be used throughout CGIAR.

Scaling will require building new and expanding existing partnerships, maintaining engagement, and increasing partner capacity. Earlier phases of HarvestPlus focused on building an evidence base for biofortified crops, working with research partners to initiate studies on agronomic characteristics, nutritional efficacy, and consumer acceptance, investing specifically in upgrading equipment and training technical staff in 22 labs.

As HarvestPlus shifted into delivery, it launched delivery partnerships with private seed companies, local and international NGOs, government extension programs, and school feeding programs. In Phase I, this F2 developed capacity in more 100 delivery partners, trained thousands of extension staff on agronomic practices and nutrition messages for biofortification, and developed technical packages for partners to use in delivery programming. Through these experiences, the FP learned to effectively engage different types of partners, find mutually beneficial areas for collaboration, and maintain momentum in partnerships. We also learned about the challenges of coordinating, influencing, and gathering data from partners with different priorities and systems,

In Phase II, this FP will add new and diverse partners, including private food companies and retailers, UN agencies, regional organizations, and innovative financing mechanisms and development banks. A focus in Phase II is building capacity for evidence sharing and policymaking at national and regional levels,

including through the SUN platform and CAADP nutrition initiatives. Upstream partners include private sector seed and food companies, from small start-up companies to large multinationals. Involving private sector seed companies to develop and test biofortified varieties shortens the time to market and lays the groundwork for the proof-of-concept stage. Food companies test biofortified crops for use in processed foods, evaluating mineral and vitamin retention for different types of processing.

Many different types of partners are involved in proof of concept work, including private seed companies, international NGOs, and multilateral agencies. In countries with robust private seed systems that reach smallholder farmers, private seed companies are a natural partner, which is particularly advantageous in crops where hybrid seeds predominate (e.g. Seed Co. in Zambia (hybrid maize) and Nirmal Seeds in India (hybrid pearl millet) and where seed companies operate regionally). An MOU was developed with World Vision to introduce biofortified crops into its agricultural programs, which are then linked to its health and nutrition programs. The World Food Programme's (WFP) Purchase for Progress program is very interested in local purchasing of biofortified crops, and partnerships are being developed in several countries. In Rwanda, local bean production is purchased and stored in WFP warehouses for later emergencies.

As this FP scales up biofortification, it will expand its delivery partnerships and pursue different ways of working with a wide variety of partners, including FAO, WHO, World Bank, the International Fund for Agriculture Development (IFAD), WFP, Africa Union, CAADP, and the SUN Movement.

2.2.1.8 Climate change

Biofortified crops can contribute to improve the resilience of farmers and rural communities to climatic changes and weather extremes by improving the quality of diets (at no extra cost to the consumer), and thus their nutritional status. Other things being equal, projections indicate that food price levels will rise and that prices will be more variable, due to climate change. Biofortified staples ensure that farmers and their families can access essential micronutrients, even if rising food prices reduce their access to more micronutrient-dense non-staples.

Climate change may have an impact on the nutritional quality of the crop itself. While rising carbon dioxide (CO_2) levels may accelerate plant growth initially, some studies suggest that the nutrient content of crops is likely to decline, especially as plants adapt to higher atmospheric CO_2 levels. One review found a decline in micronutrient content. Overall, the evidence on effects of climate change on nutritional quality is mixed; other climate-related factors may influence nutrient density in the opposite direction. Further research is needed, as there is variability in how plants will respond to the different effects of climate change. Biofortification could offer a solution in those instances where crop nutritional quality will decline.

Breeding for nutrient traits is and must be strongly linked to breeding for adaptation to climate change. Increasingly, FP2 must consider other programmatic adaptations that might be required due to changing climatic conditions. Less predictable weather patterns may affect farmers' varietal preference in ways that are not yet known. Inconsistent weather can affect seed production, and as this FP scales up its partnership in seed production, it will consider measures to mitigate the risks posed by climate change.

2.2.1.9 Gender

FP2 will specifically promote gender equality by identifying how biofortification can be effective in targeting the nutritional status of women and children, by targeting interventions and gathering evidence on the impact of different approaches to scaling up biofortified crops.

The independent SGA will help ensure this FP reaches its goal to improve micronutrient intakes for 20 million households by 2020. As delivery scales up, FP2 will be more systematic in understanding how gender dynamics can affect the adoption and consumption of biofortified crops. It is clear that men and women engage differently with new crop varieties and the path from adoption to consumption is not always direct. We are beginning to understand the full implications of how specific activities may affect men and women differently, and the best pathways through which to achieve equitable access to biofortified crops and foods.

The SGA highlighted the importance of deepening understanding of gender dynamics for delivery issues, including household decisionmaking processes. FP2 will identify practical examples where unintended gender consequences may negatively affect program impact. A version of the Women's Empowerment in Agriculture Index (WEAI) is included in impact assessment and effectiveness studies to investigate the role of gender in adoption of biofortified varieties and the impact of varietal adoption on various women's outcomes (e.g. iron intake, time allocation, and income).

We are working to understand the gendered dynamics of delivering biofortified crops through research. Country teams are thinking critically about how to better reach target consumers: micronutrient-deficient women and children. We are asking whether men and women access biofortified planting materials differently and what the implications of any difference may be. A gender advisor to coordinate gender activities and conduct gender analysis for specific situations will be recruited in Phase II.

2.2.1.10 Capacity development

Phase II will continue to emphasize and invest in capacity building in NARS and national research partners and in training at existing labs, in addition to expanding lab support to the LAC region. The ToCs for target countries (Johnson, Guedenet, and Saltzman 2015) identify capacity gaps in the seed value chain as a potential bottleneck for biofortification. This FP supports increasing public and private sector capacity to deliver biofortified seeds. The FP assesses the seed and grain value chains for each crop-country context and develops a delivery strategy. Our approach is determined by the normal operation channels for a particular crop in a given country or subregion; private sector partners are preferred when a developed market exists, but in less-developed markets, value chain activities may be supported by government, NARS, or civil society partners. In some countries, we provide technical assistance to NARS to increase seed production. In others, like Uganda, we support strong PPPs for maintaining production and supply of clean planting materials so they are easily accessible to farmers. In selected countries, coordination with IFPRI country programs will be used to identify opportunities to increase the capacity for the priority setting process in the NARS and develop seed policy capacity to speed up the process of seed multiplication.

In contrast to earlier phases of HarvestPlus, which focused on building capacity to support the research agenda, development of expertise is now shifting to support the mainstreaming and scaling up objectives. Staff in target countries and regional teams support capacity development in seed systems,

marketing, nutrition, monitoring and evaluation, and policy in country offices and with national delivery partners. New and strengthened partnerships, both public and private, will be critical to achieving capacity at national and global levels to scale biofortification.

2.2.1.11 Intellectual asset and open access management

In Phase II, researchers from FP: Biofortification will contribute a number of intellectual assets, such as genetic characterization of staple crops and underutilized plant genetic resources; improved biofortified varieties suitable to a broad range of target environments; decisionmaking tools; and evidence, including cost-effective analysis and impact evaluations. Intellectual assets will be designed with CGIAR open access (OA) and open data principles in mind. For example, researchers will make their raw data available to other researchers through their Center-specified platform in a timely manner. For IFPRI, from which all nutrition and impact data in this FP is generated, this platform is Dataverse. Tools to support improved decisionmaking developed by this FP will follow OA and open data principles, minimizing the hurdles to scaling out. More details are on both open access and intellectual assets are included in Annexes 3.8 and 3.9, respectively.

2.2.1.12 FP management

The current HarvestPlus director, Howdy Bouis, will soon be retiring, and recruitment is underway for his replacement, who will begin by the 3rd quarter of 2016. FP2 links with crop breeding programs of the agri-food system CRPs (AFS-CRPs)/Centers through a coordinated and well-managed program unit. Day-to-day management decisions are determined through a consultative process within the Executive Committee, composed of the Director, Deputy Director of Operations (Wolfgang Pfeiffer), Deputy Director of Programs (Ina Schonberg), and Head of Strategic Alliances (Thom Sprenger). CVs are in Annex 3.7.

Management tasks include six broad mandates:

A. Provide strategic planning and managerial direction to program initiatives, in consultation with IFPRI and CIAT management and the Program Advisory Committee.
B. Provide appropriate leadership, oversight, and support to country programs and supporting technical and administrative functions/units.
C. Mobilize sufficient resources to meet project and organizational objectives.
D. Plan, track, and manage financial resources effectively.
E. Perform administrative and coordination functions in a timely and effective fashion.
F. Facilitate knowledge sharing within the project, through intranet and other information technologies.

These activities have important synergies. For example, documenting progress in target countries will assist in partnership activities. Success in breeding varieties is also required for rapid scale-up. Monitoring, evaluation, and learning will inform planning and implementation inside and outside of HarvestPlus. Close coordination across organizational functions is critical to achieve the ambitious outcomes of FP2 and A4NH. Using lessons from the first half of Phase II, we may seek alternative arrangements for working with partners, who will increasingly scale biofortified crops independent of HarvestPlus. Discussions of the types of institutional arrangements needed to support this work are already underway.

2.2.2 Flagship Budget Narrative

2.2.2.1 General Information

CRP Name	CGIAR Research Program on Agriculture for Nutrition and Health
CRP Lead Center	International Food Policy Research Institute (IFPRI)
Flagship Name	FP2: Biofortification
Center location of Flagship Leader	International Food Policy Research Institute (IFPRI), Washington, DC

2.2.2.2 Summary

Total Flagship budget summary by sources of funding (USD)

Funding Needed	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Total
W1+W2	3,500,000	3,570,000	3,640,000	3,710,000	3,790,000	3,860,000	22,070,000
W3							0
Bilateral	33,199,398	33,446,445	34,178,589	34,927,143	35,638,036	36,597,629	207,987,241
Other Sources							0
	36,699,398	37,016,445	37,818,588	38,637,143	39,428,035	40,457,628	230,057,237

Funding Secured	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Total
W1+W2 (Assumed Secured)	3,500,000	3,570,000	3,640,000	3,710,000	3,790,000	3,860,000	22,070,000
W3	0						0
Bilateral	22,276,005	20,130,164	12,430,400				54,836,569
Other Sources							0
	25,776,005	23,700,164	16,070,400	3,710,000	3,790,000	3,860,000	76,906,569

Funding Gap	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Total
W1+W2 (Required from SO)	0	0	0	0	0	0	0
W3 (Required from FC Members)	0	0	0	0	0	0	0
Bilateral (Fundraising)	-10,923,393	-13,316,281	-21,748,189	-34,927,143	-35,638,036	-36,597,629	-153,150,672
Other Sources (Fundraising)	0	0	0	0	0	0	0
	-10,923,393	-13,316,281	-21,748,189	-34,927,143	-35,638,036	-36,597,629	-153,150,672

Total Flagship budget by Natural Classifications (USD)

	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Total
Personnel	4,274,507	4,445,487	4,679,880	4,867,075	4,939,379	5,136,954	28,343,284
Travel	487,500	487,500	487,500	487,500	487,500	487,500	2,925,000
Capital Equipment	0	0	0	0	0	0	0
Other Supplies and Services	1,885,000	1,885,000	1,885,000	1,885,000	1,885,000	1,885,000	11,310,000
CGIAR collaborations	18,350,000	18,370,000	18,690,600	19,081,812	19,563,648	20,043,594	114,099,654
Non CGIAR Collaborations	6,370,000	6,450,000	6,580,600	6,701,812	6,823,648	7,026,121	39,952,181
Indirect Cost	5,332,391	5,378,457	5,495,008	5,613,943	5,728,859	5,878,458	33,427,120
	36,699,398	37,016,444	37,818,588	38,637,142	39,428,034	40,457,627	230,057,233

Total Flagship budget by participating partners (signed PPAs) (USD)

	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Total
IFPRI	36,699,398	37,016,445	37,818,588	38,637,143	39,428,036	40,457,628	230,057,240
	36,699,398	37,016,445	37,818,588	38,637,143	39,428,035	40,457,628	230,057,237

Explanations of these costs in relation to the planned 2022 outcomes:
The majority of the budget is from grants with only $22M (10%) from W1/W2. FP2 has been effective in obtaining program as well as project grants and continuing this is an important assumption. Outcomes to 2022 require continuing research on varietal development and monitoring, evaluation and impact assessment as well as more investment in research supporting nutritional effectiveness and lessons on scaling delivery, both of which have important gender research dimensions, as well as mainstreaming biofortification in breeding programs.

Partnership contracts are an important cost-driver (78% of direct costs) for varietal development and scaling up in target countries. Given the complexity of this successful multi-institutional partnership, maintaining key research and management personnel is critical to success. The outcomes, especially for reaching millions of farmers and consumers, are ambitious and require a transition from varietal development, nutrition efficacy and socio-economic research to greater action research and evaluation on enabling delivery at scale.

Some of the risks in this change have been anticipated. One risk to meeting targets is to establish cost-effective delivery strategies through public and private partnerships. This is being mitigated by monitoring, evaluation and learning on context-specific delivery strategies and on factors that enable and inhibit partnership performance. Lessons learned inform the development of future partnerships, leading to co-investment for biofortification. A second risk is to ensure high quality research from partners in new areas of research on delivery science, nutritional effectiveness in populations and on mainstreaming biofortification through more cost-effective varietal selection. New forms of competition and results-based management for research contracts are planned to expand the research partners and maintain and improve research quality as well as documentation and dissemination.

2.2.2.3 Additional explanations for certain accounting categories

Benefits: IFPRI's Fringe benefits - primarily includes leave, health, and pension costs.

Other Supplies and Services: Provide a brief description and rationale for other Supplies and Services required, including cost assumptions used to develop the budget for these costs.

2.2.2.4 Other Sources of Funding for this Project

FP2 has had strong donor support and has met high donor expectations. Thus, we are optimistic about the level of donor support available for Phase II and have already secured 71% of the funding in the first three years. Efforts are underway to identify additional donors and the HarvestPlus Strategic Alliances unit has embarked on a vigorous fundraising and partnership campaign. Public and private sector partners are increasingly providing in-kind and financial support for biofortification projects. If revenues fall short of the projection, the priority will be to protect funds for mainstreaming and learning activities and for research on effectiveness and impact assessment studies that measure cost-effectiveness.

2.2.2.5 Budgeted Costs for certain Key Activities

	Estimate annual average cost (USD)	**Please describe main key activities for the applicable categories below, as described in the guidance for full proposal**
Gender	766,857	Research to understand how gender influences consumption and production decisions, gender adviser to improve gender sensitivity of delivery strategies and identify potential unintended consequences of interventions
Youth (only for those who have relevant set of activities in this area)	383,333	Engagement with you in biofortification activities, particularly small-scale agro-enterprises
Capacity development	2,300,000	Training with NARS for the development and assessment of biofortified varieties; training and technical assistance for partners and other actors who will scale up biofortification
Impact assessment	2,979,241	Strategic research to assess the effectiveness of various delivery channels and identify bottlenecks and opportunities along the food and seed value chains, cost effectiveness research
Intellectual asset management	383,333	Prompt dissemination of research results and maximazitation of their global accessibility
Open access and data management	1,150,000	The monitoring, learning and action team plans, coordinates, and implements open access and data management issues
Communication	766,857	Activities include engaging in policy dialogue to scale up results on the ground engagement with actors to scale up biofortification, communicating research results and prompting learning and collaboration across the organization

2.2.2.6 Other

As noted, the budget for partnerships is unusually high, reflecting the requirements for partnerships in mainstreaming bio fortification in breeding programs and in engaging key national partners, public and private, in delivery in the 9 target countries.
The HarvestPlus team has been successful in establishing the confidence of donors in their planning, implementation and evaluation. This has allowed them to attract programmatic funding as well as project funding and thus to streamline planning, monitoring and reporting.

The priorities for expanded support under uplift would be more broad and rigorous nutritional efficacy and effectiveness studies, as well as to expand and accelerate activities under the base budget for greater outcomes.

W1/W2 funding
In FP2, W1/W2 funding is targeted to research related to delivery. The two main research areas funded by W1/W2 are evaluation and learning of scaling up activities in target countries and on nutritional effectiveness studies of the consumption of biofortified crops on improving micronutrient status of target populations. If there is additional W1/W2 funding for uplift, this could support the on-going task of varietal improvement. All delivery activities are funded by other grants.

2.2.3 Flagship Uplift Budget

Outcome Description	Amount Needed	W1 + W2 (%)	W3 (%)	Bilateral (%)	Other(%)
High-yielding micronutrient enhanced varieties developed and released - at a quicker rate due to increased breeding efficiency and multi-locational testing in a larger number of locations/environments - in target and expansion countries	25,000,000	50	0	50	0
High-yielding micronutrient enhanced varieties delivered at scale in target and expansion countries - at a faster rate, particularly in expansion countries where small investments in seed production and technical assistance capacity can vastly incentivize partners	25,000,000	50	0	50	0
More extensive evidence on nutritional efficacy and impact - from a larger number of countries and market environments, covering a broader range of ages, more combinations of biofortified foods, and reach/efficiency of different delivery channels - informs value chain actors, as well as national and international investors	12,000,000	50	0	50	0

2.3. Flagship Program (FP3) on Food Safety

2.3.1 Flagship Program Narrative

2.3.1.1 Rationale, scope

The enormous burden of foodborne disease in developing countries
The first global assessment of foodborne disease (FBD) found a human health burden comparable to that of malaria, HIV/AIDS, or tuberculosis (Havelaar et al. 2015) with an estimated 410,000 deaths per year. Most of the global burden of FBD (98%) is borne by developing countries: 35% in South Asia, 35% in Africa, and 9% in Southeast Asia (Havelaar et al. 2015). Most FBD is the result of microbes (79%), though macro-parasites also contribute to the burden (18%) as do chemicals and plant toxins (3%). Most FBD is caused by fresh foods sold in informal markets of Africa and Asia (Grace 2015b).

FBD may worsen as value chains rapidly develop
The last decades have seen dramatic declines in most infectious diseases, but FBD is a troubling exception (Grace 2015b). Countries with good health records in the Americas and Europe have seen no decline in FBD. Although records in developing countries do not allow trend monitoring, several factors are increasing risks: (1) consumption of animal source foods (ASF) and vegetables, the most risky foods, is accelerating ((Tschirley et al. 2015); (2) value chains are growing longer and branching out, allowing greater spread of hazards; and (3) price volatility and low margins are putting pressure on actors to sacrifice food safety (Grace and McDermott 2015). Higher average temperatures and extreme weather events due to climate change may favor fungal and other biological contaminants (Tirado et al. 2010).

Unsafe foods threaten opportunities for the poor and for women
Beyond health impacts, unsafe food also brings economic, trade, and equity impacts. Poor farmers and countries are already excluded from some export markets partly because of inability to assure food safety. They may also be excluded from high-value domestic markets (Unnevehr and Ronchi 2014). Countries and farmers lose out on local food aid purchase programs for maize or groundnuts when farmers fail to meet aflatoxin standards. Through women may dominate in traditional food processing, they tend to drop out of more complex value chains that demand greater food safety assurances, missing opportunities from more profitable value chains (Roesel and Grace 2014). Supporting informal markets to provide safer food and supporting women to engage in emerging formal markets can achieve multiple outcomes of improved health, livelihoods, nutrition, and equity.

Rising concern over FBD
Consumers and policymakers are paying more attention to food safety in developing countries. Cross-country studies find that safety is often among consumers' most important food concerns (Jabbar et al. 2010). Experimental evidence from developing countries suggests consumers are willing to pay significantly more (at least for a short time) for food that is certified as safe (Birol et al. 2015), though consumers often do not trust certification, with good reason. Policymakers are concerned about FBD but have limited understanding of how to attain food safety and manage trade-offs with other development objectives. They may react to food scares by proposing draconian regulations (Grace and McDermott 2015), which can threaten the livelihoods of poor value chain actors and increase the cost of nutritious foods for consumers. Attempts to create markets for safe food may lead to a concentration of unsafe food in poor populations (Moser and Hoffmann 2015).

"Safe food, fair food"
Despite the growing severity of food safety problems and increasing attention from policymakers, there are still painfully few standards and approaches to address challenges in informal markets, where most of the world's poor buy and sell food, where the risks are pervasive, costs of compliance are high, and enforcement capacity is currently weak (Unnevehr and Grace 2013).

This flagship program (FP) proposes bold changes that include: (1) risk based, pro-poor approaches that can shift governance away from doomed attempts to enforce regulation and toward enabling actors to meet important food safety demands; (2) market-based approaches that provide value chain actors with immediate incentives for behavior change; and (3) technologies that dramatically reduce the costs of ensuring food safety.

Previous initiatives to improve food safety in domestic markets have focused on Good Agricultural Practices (GAP), farmer field schools, installation of milk plants and abattoirs, and upgrading markets. These approaches have been constrained by high delivery costs, an inability to develop markets that reward quality, and extremely low scalability and sustainability (Grace 2015b). Thus, the CGIAR Research Program on Agriculture for Nutrition and Health (A4NH) plans to rigorously test our theory on how food safety research will lead to development impact, assuming that sustainable impact is possible (Grace, Mahuku, et al. 2015; Baker and Omore, 2011), while acknowledging the researchable constraints and committing to serious research on overcoming constraints.

The logic for engaging agricultural research to improve food safety is that FBD is responsible for an enormous health burden and negative livelihood, nutritional, and economic impacts. One consideration in determining the strategic importance of our research areas is the size of health and other burdens; another is the role of agriculture in creating and addressing the problem.

In Phase II, FP3: Food Safety will have two main areas of focus: Evidence that Counts, and Solutions that Scale. There will be three clusters of activity (CoA). CoA1: Evidence that Counts will generate evidence on questions at the interface of agriculture and FBD and will build capacity to assess and manage FBD. Solutions that Scale focuses on two approaches that have shown promise for reaching millions of consumers: market-based solutions to improving safe food (CoA2: Safe Fresh Foods) and aflatoxin mitigation through biocontrol and GAP (CoA3: Aflatoxin Mitigation).

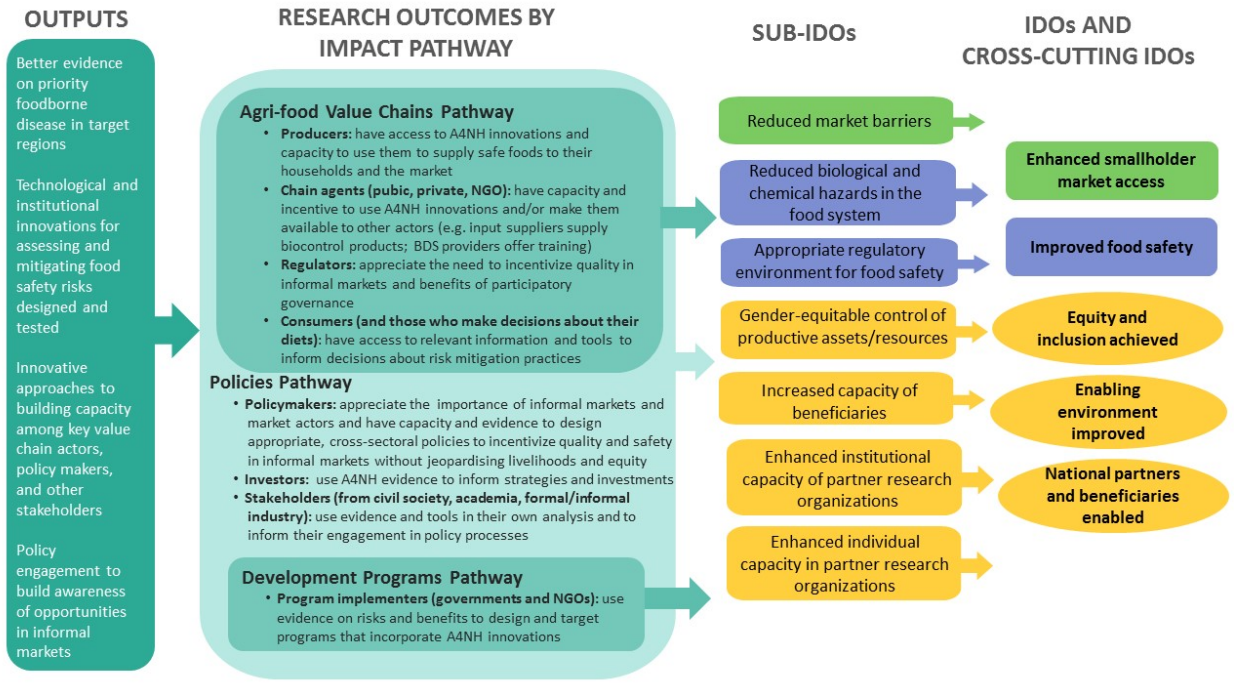
2.3.1.2 Objectives and targets

This FP addresses the problem of poor health due to the production and consumption of contaminated foods, contributing to the second system-level outcome (SLO) on *Improved food and nutrition security and health* through the intermediate development outcomes (IDOs) on *Improved food safety*[16], *Enhanced smallholder market access*, and to three cross-cutting IDOs (*Equity and inclusion achieved*, *Enabling environment improved*, and *National partners and beneficiaries enabled*) (**Figure 2.3.1**). The bulk of activities in this FP are oriented toward improving the performance of value chains and their supporting policy environments, while smaller research activities explore the potential of programs to

[16] FP3: Food Safety will contribute to improved water quality (sub-IDO2.3.1) however their contributions are captured in the sub-IDO on reduced biological and chemical hazards in the food system (sub-IDO 2.2.1).

improve food safety. In doing so, it targets the first three Sustainable Development Goals (SDGs) to "end poverty in all its forms everywhere," "end hunger, achieve food security and improved nutrition and promote sustainable agriculture" and "ensure healthy lives and promote well-being for all at all ages."

Figure 2.3.1. Impact pathways for FP3: Food Safety



FP3: Food Safety will work primarily through two impact pathways:

- Agri-food Value Chains Pathway (primarily through CoAs 2 and 3): This pathway has a target population of the moderately poor earning between $1.25 and $10 per day, a population which makes up a majority of the global poor, shows high levels of undernutrition and stunting (The World Bank 2015), and has an increasing intake of risky, fresh foods purchased in informal markets. The focus of this pathway is market-based solutions driven by consumer demand, public health concern, and direct, near-term incentives for value chain actors. The main outcome sought is reduced exposure of consumers to hazards, which requires an appropriate regulatory environment and improved capacities of all partners. Underpinning the approach is a focus on safeguarding or improving access to markets and thus supporting the livelihoods of women, who dominate most informal markets but are often excluded from formal markets, and providing opportunities for youth. The latter is especially critical in Africa, where the population is predicted to double by 2050, yet many are pessimistic on the prospects of the formal sector or agriculture to provide the hundreds of millions of acceptable jobs that need to be created. This FP will work closely with FP1: Food Systems for Healthier Diets to ensure that its value chain development work is done within a food systems perspective, and also to ensure that food safety is appropriately considered in food systems work.
- Policies Pathway (primarily through CoA1): This pathway targets investors and decisionmakers. Food safety is a relatively new focus for international agriculture research, and the informal food sector

has been long neglected. Hence, it is important to generate information on food safety burden and management, to build capacity to access and understand this information, and to encourage investors and policymakers to support appropriate food safety–specific and food safety–sensitive policies and interventions.

By 2022, this FP expects its research to contribute to three main outcomes, as described in the Performance Indicator Matrix – Table B:

- Key food safety evidence users (donors, academics, INGOs, national policymakers, regulators, civil society, and industry) are aware of and use evidence in the support, formulation and/or implementation of pro-poor and risk-based food safety approaches
- Market-based food safety innovations delivered at scale in key countries, along with understanding of their impact and appropriate use
- Biocontrol and GAP delivered at scale in key countries, along with understanding of their impact and appropriate use

This FP's contribution to the 2022 CGIAR target is approximately 469,000 more farm households that have adopted biocontrol, GAP, or improved varieties that reduce aflatoxin contamination (Performance Indicator Matrix – Table A). In addition, we expect up to 12,000 traders and 3 million on-farm consumers and 23 million other consumers in Kenya, Uganda, Tanzania, and Vietnam will benefit from improved food safety practices in target value chains by 2022.

Target Geographies
Research in CoA1: Evidence that Counts will look at global, regional, and foresight issues, focusing in countries where A4NH has a track record and good partnerships, but flexible in identifying new and important issues.

CoA2: Safe Fresh Foods will focus on value chains in partnership with the CGIAR Research Programs (CRPs) on Fish and on Livestock, emphasizing dairy in Tanzania and pork in Uganda and Vietnam. Future collaborations with CRP Livestock will be explored in Kenya, Ethiopia, Burkina Faso, and India and with CRP Fish's work in Bangladesh. In Uganda and Vietnam, we will link with the CRP on Water, Land, and Ecosystems (WLE) on issues related to water and livestock waste. We will prioritize the young, old, pregnant women, malnourished, and immune-suppressed who are most at risk of infectious FBD.

CoA3: Aflatoxin Mitigation will focus on Africa, which has the highest levels of exposure and an increasing aflatoxin-associated health burden. This cluster will benefit from strong existing alliances, notably with the Partnership for Aflatoxin Control in Africa (PACA). Currently, this FP has large projects in three countries: Kenya, Nigeria, and Senegal, and project activities with partners in nine other countries in Africa where the aflatoxin burden is greatest (Burundi, Ghana, Malawi, Mali, Mozambique, Niger, Rwanda, Tanzania, and Zambia). We will explore opportunities to collaborate in India during Phase II.

2.3.1.3 Impact pathway and theory of change (for each individual FP)

Impact will occur through two main pathways: (1) generating evidence to influence key decisionmakers and policy processes (mainly CoA1) and (2) taking food safety solutions from successfully tested pilots to scale (mainly CoAs 2 and 3). The theory of change (ToC) identifies critical assumptions that underlie the

outcomes along the pathways. A ToC for CoA1 will be developed with FP4: Supporting Policies Programs and Enabling Action through Research (SPEAR) in 2016-17. ToCs for the other CoAs have already been developed, peer reviewed, and published. While ToCs are living documents that are regularly updated based on new evidence and experience, it is important to make them publically available to build understanding of how agricultural research contributes to nutrition and health outcomes in practice.

The ToC for CoA2: Safe Fresh Foods is largely based on behavioral change rather than changes in technology, infrastructure, or market structure. It looks at how an institutional innovation – training and certification (T&C) – can improve the quality and safety of fresh foods (Johnson et al. 2015). The relatively small number of fresh meat and produce sellers (thousands as opposed to millions of consumers and farmers) means market agents are leverage points where low-cost interventions can have profound up- and downstream impacts. Moreover, informal markets have low barriers to entry and are important sources of employment for women and youth, added justifications for investments.

Initial evidence from a relatively small number of A4NH projects supports the assumption that informal sector market agents change their practices as a result of participating in the program and experience social and economic benefits, even if they do not receive a higher price from consumers (**Table 2.3.1**). Some pilots have also shown that food safety and quality improved for substantial numbers of customers, however there have not yet been studies on their health outcomes. Likewise, though food sold was initially safer, no studies assess longer-term safety or sustainability. There are significant challenges in attaining political acceptability for initiatives in informal markets. Attaining real, rather than token, compliance with standards at scale and over long periods of time has not been demonstrated. Although there are several examples of food currently being certified as safe in niche developing country markets, there are no examples of credible food safety assurance in mass domestic markets in developing countries.

Table 2.3.1. Theory of change for CoA2: Safe Fresh Foods *(adapted from Johnson et al. 2015)*

Outcomes	**Assumptions**	**Evidence***
Exposure decreases if perishable food is safer	Currently fresh foods are mostly unsafe Most fresh foods are bought in wet markets	Fair to strong Strong
Food is safer if traders change practices	Practices are effective	Fair short-term, weak long-term
Practices can be changed	Practices are feasible and generate benefits Traders and consumers are motivated	Fair Weak
Traders buy in to scheme	Traders can access training Materials and approaches are effective, relevant	Fair Fair
Traders are reached by scheme	Most traders can be reached Policy environment can be made enabling	Weak to fair Fair

Addressing research constraints will require multi-disciplinary teams. We will build on existing partnerships in CRP Livestock and CRP Fish value chains, with public health researchers in FP5: Improving Human Health (on health risks and benefits), and with academic partners such as the International Institute on Environment and Development (IIED) who recognized expertise in informal markets in developing counties. Partnerships with government regulators will be crucial for scaling up, and even for piloting innovations, in places where the informal sector is currently banned. New partnerships may be needed to implement market-based innovations at scale, for example, by the

government (e.g. dairy in Kenya) or by an NGO or private firm (e.g. supplier of business development services).

The ToC on CoA3 (Aflatoxin Mitigation) looks at how use of farm level mitigation technologies and practices (GAP, resistant varieties, and/or biocontrol (aflasafe™) could reduce exposure among consumers ((Johnson, Atherstone, and Grace 2015). Where economic incentives are sufficient, farmers readily adopt technologies, however evidence to date suggests there are significant challenges to ensuring incentives and reaching target consumers (**Table 2.3.2**). Unlike the case for perishables, aflatoxin contamination often originates on farms, so reaching farm households and changing post-harvest practices on farms and in markets will be important. Improving the ability of consumers to recognize and demand safe food risks increasing exposure through concentration of contaminated grain in markets used by the poor.

Table 2.3.2. Theory of change for CoA3: Aflatoxin Mitigation *(Johnson, Atherstone, and Grace 2015)*

Outcomes	**Assumptions**	**Evidence**
Exposure to aflatoxins significantly decreases if staples are safer	Currently staples are often contaminated Staples most important source of aflatoxins	Strong Strong
Consumers eat aflatoxin-safe products	Aflatoxin-safe foods are available Consumers can identify safe foods	Weak to fair Weak
Consumers are aware and convinced of risks	Information gets to consumers Information is appropriate and useful	Fair Fair
Traders buy from farmers with adopted practices	Staples produced meet market needs Staples below standards find other use	Weak to fair Very weak
Farmers adopt technologies and practices	Technologies and practices are accessible/affordable Technologies and practices deliver visible and desired benefits	Weak to fair Very weak
Farmers are aware and convinced of benefits of aflatoxin mitigation	Information reaches farmers Information is appropriate and useful	Weak to fair Weak to fair

Although there is a strong case that aflasafe™ and GAP may reach millions of farmers in the next five years, it may not be sustainable or affordable. A4NH will actively research how the formal private sector can overcome this challenge. Agronomic benefits of GAP, and bundling of yield-enhancing inputs with aflasafe™ will help motivate farmer adoption. The intensive livestock sector is a promising market for aflatoxin-safe grain that may require less regulatory oversight than markets for human food due to the deleterious impact of aflatoxins on animal health. More research is needed on the costs and benefits of aflasafe™ compared to other, less expensive means of aflatoxin mitigation. Aflatoxins are responsible for a relatively small proportion of the overall known health burden in developing countries (although the likely health impacts are much greater), but more research is needed on the full public health benefits of aflatoxin mitigation, and the relative advantage of agriculture-based interventions in delivering these.

Key research partnerships will be with CRPs on Dryland Cereals and Legumes Agri-Food Systems (DCL), Livestock and MAIZE on technology adoption, with A4NH FP1: Food Systems on consumer demand for low-aflatoxin products, and with other A4NH flagships (4 and 5) on nutrition and health impacts. Partnerships with governments will ensure that the technologies are available, for example in the case of aflasafe,™ whose commercial production requires regulatory approval, and to support production of

low-aflatoxin grain in target areas The private sector and NGOs will be crucial for scaling out to smallholders, and filling the research gaps related to farmer and consumer awareness and acceptance will be important to defining their roles.

2.3.1.4 Science quality

Novelty and soundness of proposed research
Agricultural and food systems are intimately connected to health outcomes, but health policy and programs often stop at the clinic door while agriculture rarely includes "maintaining or enhancing health" as an articulated objective. The disconnect between agriculture, health, and nutrition is at least partly responsible for the disease burden associated with food and farming. FP3 : Food Safety draws on the following areas of research that promise to reconnect human, animal, and environmental health:

- One Health and Ecohealth are related approaches that grew out of the huge concerns raised by waves of emerging disease starting in the 1990s (such as bird flu, SARS, and Ebola) on the one hand, and by the increasing burden of disease associated with degraded ecosystems on the other hand. Both approaches are multidisciplinary and emphasize the importance of agriculture- and ecosystem-based interventions in order to attain health goals. They have been central to successes in improving control of neglected and emerging zoonoses (Grace 2014). This type of approach underlies both FP3: Food Safety and FP5: Improving Human Health.
- The risk-based approach to food safety focuses on the severity and likelihood of human health impacts. People (including policymakers) are notoriously poor judges of risk, and research is critical to better evidence. Optimal solutions are often counterintuitive (e.g. differences between hazards and risks are frequently misunderstood), and uninformed actions can make things much worse, especially for the poor. Risk analysis emerged in the 1990s as the internationally accepted approach for assessing food safety and trade issues (Vose 1998). Rather than focusing on the presence or absence of a hazard in the food system, risk analysis looks at whether the hazard poses a risk to human health. All hazards do not pose significant risks, and removing or reducing a hazard may not reduce risk. Risk analysis offers a systematic, science-based process for organizing and integrating quantitative and qualitative information about risks. The International Livestock Research Institute (ILRI) has been developing methodologies for applying risk assessment to the data and resource-scarce informal value chains in developing countries, conducting more than 30 risk assessment and risk management studies (Grace, Baker, and Randolph 2010).
- Randomized controlled trials (RCTs) are considered the gold standard method for generating scientific evidence. RCTs will be utilized to test new approaches to reducing food safety risk, and to evaluate the impact of solutions at scale.

Most FBD research and development has focused on formal markets and exports, neglecting the informal value chains that supply most of the fresh foods eaten by poor people and provide markets for most poor livestock keepers and market gardeners. Drawing on the two strands of research described, this FP will help fill this knowledge gap in a novel way. At the same time, it is a natural extension of past CGIAR research. Although food safety was not an initial focus of CGIAR research, by the first official mention in 2000, CGIAR Centers had already started small-scale research focusing on pest-resistant crops, biocontrol for aflatoxin, reducing cyanide in cassava, and milk quality and safety (Kassam and Barat 2003). In the last 15 years, strong research agendas have developed around aflatoxins and hazards in ASF. An independent CRP-Commissioned External Evaluation (CCEE) of A4NH food safety research found that Phase I research was highly relevant, had generated important evidence and had generally

met expectations; however, there were still challenges to be overcome in going to scale and opportunities to improve communication and build private sector links (Sridharan, Tschirley, and Stark 2015).

Track record of research team
Science quality in Phase I has been reflected in a high number of peer-reviewed articles in well-respected journals (n=126); graduate and post-graduate theses (n=125); the first book on food safety in informal markets (Roesel and Grace 2014); participation of researchers in high-level processes such as PACA, the Foodborne Disease Epidemiology Reference Group (FERG) of the World Health Organisation (WHO), WHO's International Agency for Cancer Research (IARC) Working Group on aflatoxin control measures, and the UN Committee of Food Security High Level Panel of Experts writing groups; requests for evidence syntheses (Grace 2015a; Grace, Roesel, et al. 2015), commentaries (Fèvre 2015) contributions (Grace and McDermott 2015) and presentations to donor groups; and integration of food safety into high-impact health and agriculture research for development papers (*PNAS*, *Lancet*, *Animal, PLOS*).

For the external evaluation of food safety, the panel reviewed multiple published papers on food safety research conducted as part of A4NH. Some of the research is of very high quality, but not all. The A4NH external evaluation found a lack of consistency in systems to assure quality across the CRP, largely due to the fact that sequence quality is managed at Center, not CRP level. We will address this in Phase II by providing stronger support to junior scientists, developing CRP guidelines, and actively engaging CRP management with core partners on science.

This FP builds on the work and expertise of four CGIAR Centers. The International Institute of Tropical Agriculture (IITA) emphasized biocontrol research for aflatoxins in early 2000 and has developed an effective product, aflasafe™ (Bandyopadhyay and Cotty 2013), and a systematic approach to large-scale production, ensuring conducive policies and supporting dissemination for scale-up (Grace, Mahuku, et al. 2015). Another major focus of IITA has been to breed aflatoxin-resistant maize (Menkir, Ajala, and Badu-Apraku 2015). The use of on-farm, low-cost aflatoxin mitigation methods has been documented by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) in West and in Southern Africa (Waliyar et al. 2006; Waliyar et al. 2013; Waliyar et al. 2007). In Phase I, ICRISAT made remarkable progress in identifying groundnut genotypes that are resistant to pre-harvest *Aspergillus* infection and aflatoxin contamination. The International Food Policy Research Institute's (IFPRI) work on aflatoxins has included randomized evaluations of the impact of aflatoxin exposure on child growth (Hoffmann, Jones, and Leroy 2015), farmers' adoption of technologies to reduce contamination, and consumer response to third-party aflatoxin labeling (Hoffmann, Moser, and Herrman 2015), as well as policy analysis of aflatoxin control strategies (Florkowski and Kolavalli 2013). ILRI's work on aflatoxins has focused on assessments in ASF, impacts on livestock health and production, and policy and management related to aflatoxins in feed and ASF.

2.3.1.5 Lessons learnt and unintended consequences

Since the inception of Phase I, there have been major developments in food safety. A key event was the long-awaited publication of WHO's global assessment of FBD in 2015 (Havelaar et al. 2015). Key findings and estimates, acknowledged to be conservative, include the following:

- The burden of FBD is similar in magnitude to malaria, tuberculosis, or HIV/AIDS.

- Overall, 98% of the burden is borne by developing countries, with highest burden in Asia and highest incidence in Africa.
- Children under 5 years of age bear 40% of the burden, even though they make up just 9% of the population.
- Most of the known burden (97%) is due to microbial hazards and parasites.

In Phase I, the A4NH flagship on Agriculture-Associated Diseases generated evidence on FBD in developing countries, finding that most FBD was due to biological hazards in fresh foods sold in informal markets, noting that, although we do not yet have solutions proven to be scalable and sustainable, some approaches to food safety are clearly unsatisfactory whereas others are promising. During Phase I, considerable advances were also made in biological control of aflatoxins along the delivery pathway.

There is good evidence that CGIAR food safety research has influenced donors, decisionmakers, and national policies, though the 2015 CCEE of food safety identified A4NH branding and recognition as an area for improvement (Sridharan, Tschirley, and Stark 2015). There is less evidence that CGIAR has developed food safety solutions that are sustainable and scalable. However, impact assessments and evaluations suggest the potential impact is high. A4NH is identifying research questions based on specific assumptions identified in the ToC. These research questions include the following:

- Projects for biological control of aflatoxins are being taken to scale by the private sector with funding from donors. In Nigeria 260,000 tons of low-aflatoxin maize will be produced by 2018, equivalent to around 3% of current maize production. Another aflasafe™ plant is under construction in Kenya, where the government has allocated $10.7 million for implementing aflatoxin mitigation plans. **However, health impacts have not been assessed and to determine whether large-scale introduction and adoption can be stimulated and replicated across the continent, ongoing research is needed on the multiple benefits of biocontrol, institutional innovations, funding mechanisms, and incentives for uptake.**
- GAP can improve yield, productivity, worker safety, product quality, and food safety. **Although pilot and boutique projects often show impacts (Omore and Baker 2011) and initiatives have enabled small farmers to comply with GAP for export, there is little evidence of success at scale in domestic markets** (Schreinemachers et al. 2012; Viet Nam News 2013; Waddington and White 2014). We will research the constraints to adoption; incentives that can improve uptake of tested, effective GAP; and innovations for easier, cheaper, and more attractive GAP.
- In Kenya and the Indian state of Assam, initiatives to train milk traders and provide an enabling environment were effective, economically attractive, scalable and sustainable, and highlighted in CGIAR impact assessments (CGIAR Standing Panel on Impact Assessment 2008). Currently, an estimated 6.5 million consumers are benefiting from safer milk sold by trained and certified traders in the two countries, as described previously. **However, the health impacts of these solutions were never assessed, and in the absence of sustained follow-up, it appears some of the proven benefits of the Kenyan smallholder dairy initiative may erode**. We will increase research into the costs, benefits, sustainability, and potential application of these initiatives.

2.3.1.6 Clusters of activity (CoA)

FP3 focuses on two parallel streams of research: generating evidence that counts, and delivering impact at scale. Food safety has not been a major focus area in agricultural research. While the first WHO global

assessment shows that the health impacts are enormous, many unanswered questions remain about the assessment of the FBD burden, the priorities in different food systems, approaches and technologies for improving food safety, and their relative costs, benefits, and feasibility.

CoA1: **Evidence that Counts**

This CoA will focus on generating evidence to increase investments in food safety and shifting investments in a pro-poor direction. It is well known that decisionmakers and the general public are poor judges of foodborne risk. Lay people generally have a greater fear of novel technologies used in value chains than most experts consider warranted by the actual health risk. For example, 88% of scientists in the USA agree that genetically modified organisms (GMOs) are safe to eat, but this position is shared by only 37% of the general public (Pew Research Center 2015); likewise consumers fear chemicals more than biological hazards, yet 97% of the known health burden from food is due to biological hazards and only 3% due to chemicals (Havelaar et al. 2015). Risk perception is complex and driven only partly by factual evidence. Food technologies often involve "fear factors" or emotional characteristics that make them seem more worrisome than other, willingly accepted, risks, (Slovic 2010). These factors include distrust of large companies, dislike of "unnatural" processes, and uncertainty over unfamiliar dangers. The tension between consumer and expert perceptions and between food access, food quality, and desired production methods is a challenge to sustainable agriculture. We can reduce this tension by generating evidence on actual, rather than perceived, risk, by building capacity to understand and assess risk, and by improving decisionmaking in contexts of multiple and competing objectives.

Traditionally, food safety has focused on reducing hazards without considering the health risks caused by these hazards, the feasibility of implementing hazard control, or the possibility that implementation will lead to undesired effects on food safety or other outcomes, like gender equity, livelihoods, or nutrition. Researchers in this FP will continue to provide evidence and build decisionmakers' capacity to help them better understand the importance of distinguishing risk from hazard and of considering trade-offs among development objectives.

Specific research questions: We will answer demands for better evidence around food safety and agriculture issues and explore emerging issues where there is great concern but little or ambiguous evidence (e.g. chemicals in food), thus influencing the behavior of donors and decisionmakers. Foresight activities will include studying cross-country trends with major implications for food safety such as increasing demand for risky foods (e.g., ASF, vegetables), the spread of food safety standards, "supermarketization," and sustainable intensification. Research questions will focus on the following:

- **Health and other burdens:** What are the full health, economic, and social burdens of FBD?
- **Technology discovery and development**: What existing or emerging technologies have potential for reducing FBD? These include genetic resistance, biocontrol, vaccines, hygiene technologies, food processing, decontamination, toxin binders, and others.
- **Food safety and other IDOs:** How does attaining food safety synergize and address trade-offs with nutrition, livelihood, market access and equity outcomes?
- **Regulations and standards:** How can regulations to improve the safety of food for all consumers be effectively designed and implemented in markets characterized by large numbers of small, informal firms and weak capacity to detect hazards? What are the most appropriate standards for markets where currently a large proportion of foods sold do not meet standards?

- **Emerging FBD:** While most human infectious diseases are declining, FBD appear to be increasingly driven by changes in food systems. What are the drivers and how can they be mitigated?

Major outputs and outcomes are described in Box **2.3.1**.

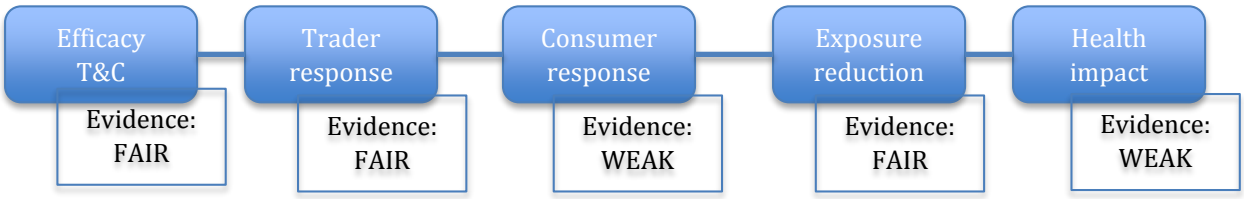
Box 2.3.1. Major outputs and outcomes of CoA1 (see Perf. Indicator Matrix-Table D for more)

2017	• **Livestock policy platforms** established in 4 countries and use A4NH evidence on food safety in informal markets • **National partners in at least 2 countries** agree to engage in a gender-sensitive policy/regulatory review process on food safety in informal markets;
2018	• East African Community (EAC) countries adopt standardized and harmonized policies and regulations for aflatoxins following policy support process
2019	• **National partners in 2 countries** build capacity and use tools from A4NH to implement gender-sensitive risk-based approaches in managing food safety
2020	• At least **3 intergovernmental agencies (WHO, FAO, OIE)** adapt evidence on policy and regulatory advice for food safety in informal markets to member states • Regulators in **at least 4 countries** approve registration of 6 Aflasafe products based on evidence of efficacy and safety of the products.
2022	• **2 countries in EAC** implement monitoring systems that take into account equity and risks when setting policies and regulations

CoA2: Safe Fresh Foods

In this cluster, the key interventions to be tested are based on T&C of informal traders or other value chain actors. Implementation will be with bilateral funding and partners from the private or public sectors. In countries A4NH has studied, thousands to tens of thousands of traders supply millions of urban consumers, who constitute the largest market for fresh foods. Following the logic of the ToC, A4NH funding will be directed toward generating evidence that is currently lacking or weak (**Figure 2.3.2**).

Figure 2.3.2. Standard of evidence for links in chain from market-based intervention to improved health



The scientific approach is participatory risk analysis for hazard detection and socio-economic studies for assessing costs of food hazards and incentives for risk management options. Small controlled experiments will explore biological and behavioral constraints and solutions (**Box 2.3.2**). Given the importance of women in the informal sector, research into gender-based barriers to technology adoption, and unanticipated effects on women will be important.

Box 2.3.2. Food Safety Trials

A Food Safety Trial laboratory will conduct short, field-based, low-cost experiments on biological and behavioral aspects of food safety. Through "lab-in-the-field" experiments, value chains actors will be faced with real

choices that mirror the food safety decisions they make on a day-to-day basis, but where key parameters can be experimentally varied and consequences can be monitored.

In addition to filling evidence gaps through evaluation of interventions, CoA2 will synthesize findings to address the following:

- **Enabling environment:** Which policies are currently constraining or facilitating the provision of safe food in target markets? How can policy be influenced to better facilitate this in the informal sector, especially in contexts where the formal sector is poorly governed?
- **Market-based approaches to food safety:** What is the potential of differentiated markets, where premiums exist for quality, to deliver safe foods? What is the size and value of these markets? How can the potential risks that such markets direct contaminated food to the poor be mitigated? What are the ethical and economic risks of market-based approaches to food safety?

A4NH funding will also be used to support ancillary research into products and processes needed to support continued investment by donors and delivery at scale. Specific research questions are:

- Which populations can best be served through market-based approaches? How can food safety be improved for populations not well served by market-based approaches? How can institutions, gendered approaches and technologies best support behavior change in informal markets?

A4NH funding will also support upstream research into technologies to improve food safety, specifically diagnostics needed to support quality assurance and risk mitigating processing technologies.

CoA2 will work closely with other CRPs (Fish, Livestock, WLE) and with A4NH FP1: Food Systems. Specifically, we will work with CRP Livestock on pork value chains in Uganda and Vietnam and dairy in Tanzania. Activities will align with their flagships on “Livelihoods and Agri-food Systems” and “Animal Health.” We will explore collaboration with CRP Livestock in Kenya, Ethiopia, Burkina Faso, and India and with CRP Fish in Bangladesh.

With WLE, we will work on water and livestock waste, specifically to: (1) assess risks and risk-mitigation options for water- and foodborne disease associated with peri-urban vegetable farming in Vietnam and elsewhere; and (2) optimize resource recovery in urban abattoirs in Kampala for application in other locations. There are also links with the CRP on Policies, Institutions, and Markets (PIM) through its FP3: Inclusion and Efficient Value Chains. Agricultural growth is increasingly concentrated in high-value commodities and markets, which are likely to increasingly demand food safety as a prerequisite for participation. Building the capacity of smallholders to comply with food safety standards enables them to take advantage of opportunities for income growth and avoids their exclusion from modernizing value chains. Major outputs and outcomes are described in Box **2.3.3**.

Box 2.3.3. Major outputs and outcomes of CoA2 (see Perf. Indicator Matrix-Table D for more)

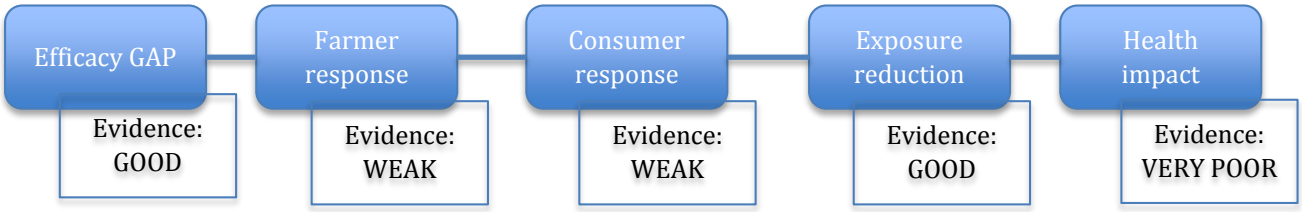
2017	• 1-2 CRP value chains for animal-source foods and/or produce identified for scaling up and out using incentive and market based approaches, coordinated with CRP Livestock, CRP Fish and others
2019	• Novel food safety technologies and/or diagnostics deployed at scale in 1 or more value chains • **Traders and policy/regulators** in at least two types of VCs (dairy, fish, produce) in at least 4 target countries are made aware of gender-sensitive guidelines based on evidence from A4NH Phase I and II
2020	• **3 more CRP value chains** identified for piloting and testing a T&C scheme coordinated with CRP Livestock and CRP Fish
2021	• **Actors in two target VCs/countries** adapt and use ex-post gender-sensitive impact assessments of sustainability and compliance in the T&C schemes in their food safety systems
2022	• **VC/food safety actors implement and track performance**, benefitting up to 12,000 traders and 3 million on-farm consumers and 23 million other consumers in Kenya, Tanzania, Uganda and Vietnam

CoA3: Aflatoxin Mitigation

In this CoA, implementation of aflatoxin mitigation at scale will be delivered through action research with partners in focus countries. Mitigation approaches will be both farm-based and market-based. Currently, a large research-for-development initiative is scaling out biocontrol and GAP in several countries. This provides an opportunity to direct A4NH funding toward generating evidence that is needed to link agricultural research to health and development outcomes (**Figure 2.3.3**). Key research questions include the following:

- **Health impacts:** To what extent does aflatoxin contribute to stunting and immunosuppression in children? Do human health impacts justify subsidies and if so how can they be designed to be effective and financially supported? To what extent can on-farm technologies reduce human exposure, and what will be the effect on health? This research will be undertaken in collaboration with nutrition and health researchers.
- **Farmer/producer awareness:** How can farmers be made aware and convinced of the benefits of risk-mitigating technologies and practices? To what extent can other benefits of hazard control (higher yields, profits, reduced waste) drive adoption? How can various mitigation strategies be integrated? Is the existing premium offered by firms demanding aflatoxin-safe inputs sufficient to cover farmers' costs of inputs to reduce contamination?
- **Scaling out of technologies**: What can we learn from the new scaling out efforts and how can these lessons inform other scaling out efforts? What are appropriate models for engaging public and private sector in tech transfer and commercialization?
- **Formal sector linkages:** Phase I found formal sector millers in Kenya had strong demand for improving aflatoxin detection; can this be leveraged to reliably improve the safety of formal sector maize without concentrating contaminated maize in informal markets? Likewise, can the strong demand for aflasafe™-treated maize by the poultry sector in Nigeria be leveraged to increase uptake of biocontrol and amounts of aflasafe™-treated maize consumed by people? Can small farmers be directly linked to the formal sector? Can differentiated markets deliver aflatoxin safe food without leading to concentration of unsafe food in the food consumed by the poorest?

Figure 2.3.3. Standard of evidence for links in chain from aflatoxin mitigation on-farm to improved health



A4NH funding will also be used to support ancillary research into products and processes needed to support continued investment in aflatoxin mitigation by donors and delivery at scale. Specific research questions are the following:

- **Diagnostics:** Given that aflatoxins are expensive and difficult to reliably measure, how can basic and applied research improve diagnosis?
- **Alternate use of aflatoxin contaminated crops:** Given that a proportion of crops will continue to be contaminated, how can these be safely used?

While biocontrol combined with GAP is currently the approach closest to achieving impact at scale, there is also a need to discover and develop new, additional options for aflatoxin control, pilot in different food systems, and understand the changing dynamics of aflatoxin under land use and climate change. Some questions are the following:

- **Genetic resistance and biocontrol:** How can we discover and develop novel strategies? What are the impacts of deploying current strategies?
- **Integrated control:** How effective are various integrated aflatoxin management techniques (agronomic practices, resistant/tolerant varieties, market solutions)?
- **Climate change:** What are the effects of climate change on contamination and management?

Several CGIAR Centers have research programs related to CoA3**,** the largest being IITA. As in Phase I, A4NH funding will be used to help coordinate efforts across centers (IITA, ICRISAT, IFPRI, ILRI) and link to bigger food system efforts in MAIZE, DCL, and CCAFS. Specifically, we will work with DCL on on-farm aflatoxin mitigation in its FP6: Integrated land, water, and crop management technologies. There will also be links to its FP1: Priority setting and impact acceleration and FP5: Improved rural livelihood system. With CRP Maize we will explore collaboration with the flagship on value addition, looking in particular at gender issues and postharvest losses. Like CoA2, CoA3 will also work with PIM on value chains. CoA3 will work with A4NH FP2: Biofortification where relevant (e.g. orange maize in Zambia). Major outputs and outcomes are described in Box **2.3.4**.

Box 2.3.4. Major outputs and outcomes of CoA3 (see Perf. Indicator Matrix-Table D for more)

2017	• 39,000 farmers adopt biocontrol across 8 countries in Sub Saharan Africa;
2018	• Regulatory authorities in Kenya adopt guidelines for use of binders in animal feed
	• **At least 40 farm-based organizations** obtain 5% premium or more from sale of Aflasafe maize and groundnut due to market linkages created by innovation platforms
2019	• **At least 3 large-scale maize millers** in up to 3 countries participate in aflatoxin proficiency and/or verification testing
2020	• **156,000 farmers** adopt biocontrol across 8 countries in Sub Saharan Africa, producing 548,000 tons of low-aflatoxin maize and groundnut (with 159,000 tons for consumption)
2021	• At least **100 public sector agencies and agri-businesses** adopt gender-sensitive aflatoxin mitigation technologies (aflasafe, post-harvest practices and aflatoxin testing) for reducing aflatoxin in crop value chains
2022	• **461,000 farmers** have adopted Good Agricultural Practices and/or biocontrol to mitigate aflatoxin contamination

2.3.1.7 Partnerships

We will have a small number of key partners with whom we work closely in relations of high trust, and a broader range of partners where we work on areas of mutual interest. There will be a strong emphasis on ensuring science quality and building the capacity of partners. Different partners will make different contributions along our impact pathways.

Generating evidence. We will work with key research partners to generate high quality, relevant evidence to influence global and national enablers and their future investments.

- We conduct joint research with other A4NH flagships (especially 1, 4 and 5) and CRPs (Livestock, Fish, DCL, WLE, CCAFS), national universities in our target countries (for example University of Nairobi and Sokoine University of Agriculture) and elsewhere (e.g., Royal Veterinary College and the Leverhulme Centre for Integrative Research on Agriculture and Health), plus national research institutes such as the Public Health Foundation India, the Hanoi School of Public Health, and the Centre Suisse de Recherches Scientifiques in Cote d'Ivoire.
- Global partners set the overarching agenda, recognize the importance of food safety, endorse CGIAR solutions for food safety, and make use of evidence provided by CGIAR to change approaches to food safety in ways that make them more effective and equitable. Ongoing partnerships around food safety with WHO, OIE, FAO, IARC and the World Bank will continue. We are raising awareness and sharing evidence on the aflatoxin agenda through regional and continental level policy institutions such as African Union Commission (AUC), Common Market for Eastern and Southern Africa (COMESA), East African Community (EAC), and Economic Community of West African States (ECOWAS) through PACA.
- Donors are important enablers who fund pilots and jumpstart out-scaling of the most promising approaches, and reduce investments in approaches that are not helpful. Key donor partners are BMGF, USAID, USDA, GIZ, DFID, and ACIAR. We are actively seeking to broaden this group.
- In addition to working through regional organizations, we are also working directly with governments in key counties such as Kenya, Nigeria, and Senegal.

Partners play an important role in making sure that evidence reaches and is understood by target audiences. Key partners for other communication and outreach include CTA, PACA, and public services and NGOs to engage with media in countries we work.

Piloting and delivery at scale: Research partners generate evidence on the importance of the problem and ways to mitigate it. We partner with the researcher partners mentioned above to pilot solutions for improving food safety. Successfully piloted solutions require implementation and scale-out through funders and partners: these partnerships build on existing relations, maintaining engagement through generation of evidence on impacts and costs. We will work with other CRPs, in particular, to pilot solutions, and will work with specific partners identified by them.

- National, regional, and continental public sector partners provide an enabling policy environment and invest in out-scaling.
- Development partners are involved in implementing pilots and supporting out-scaling.
- Private sector (large- and small-scale) partners respond to policies and incentives by changing structure and behavior and support development efforts through corporate social responsibility.

2.3.1.8 Climate change

Climate change can increase FBD by bringing novel vectors and pathogens into temperate regions or by contributing to temperature-associated changes in contamination levels. Many animal pathogens either live in soils and waters, are spread by insect vectors or rodents, or pass from one animal to another when humidity is high. As the world gets warmer and wetter, conditions become better for diseases to flourish and spread. Extreme events, like floods and droughts, allow sporadic diseases to become common. A recent extensive literature review concluded that several important FBDs were likely to increase due to increasing air and water temperature, annual precipitation, and precipitation events (Tirado et al. 2010).

The impact of climate change on aflatoxins is not well known, though unpredictable rainfall patterns associated with climate change may favor fungal growth, as droughts cause plant stress during cultivation and excessive rainfall leads to unfavorable conditions for drying after harvest. Hotter, drier conditions favor some toxigenic strains, which can expand. Long-term climate changes may also create zones suitable for fungal growth, making aflatoxins a problem in larger parts of the world. Any negative impacts of climate change on food availability are likely to increase exposure to mycotoxins and the impact of aflatoxins (Tirado et al. 2010)

Likewise, non-poor tropical areas, like Singapore and northern Australia, tend to have disease levels comparable to non-tropical rich countries. Improved living standards, health care, public awareness, and infrastructure can build resilience to diseases. Our approach to the interface of FBD and climate change will focus on better understanding of the epidemiology and distribution of FBD due to climate change and to develop adaptation strategies to improve resilience under climate change, like disease forecasting, all done in collaboration with CCAFS and WLE.

2.3.1.9 Gender

Women's participation in value chains is high, but activity and resource-use by women and men varies between cultures, systems, and stage in a value chain. A review of 21 informal value chains in Africa and India (Grace, Roesel, et al. 2015) found that men caught fish, shot game, slaughtered large animals, and predominated in meat sales, while women predominated in traditional processing, slaughter of

chickens, and sale of fish and street food. Food systems are rapidly evolving in developing countries and new structures may exclude women unless additional efforts are made to retain or include them. Across the value chains studied, both women and men consumed ASF, but consumption patterns varied by gender. There are many taboos around consumption of food (especially nutritious food) that tend to disadvantage women. Worldwide, meat is the main target of taboos for pregnant women (Fessler 2002). In some countries, men have more access to ASF because they predominate in bars that serve meat and alcohol and are at higher risk than woman for FBD (Roesel and Grace 2014; Han et al. 2013).

Women and men also have different knowledge, awareness, and responsibilities when it comes to consumption-related decisions, which may affect the risks they are exposed to. In general, women are the key risk managers for FBD in the house and important risk managers along value chains and on farms. Understanding gender roles in pre- and post-harvest management on farms is especially important for mitigating exposure to aflatoxins since contamination originates on farms and affects production for home consumption and markets.

In order to achieve gendered outcomes (**Table 2.3.3**), we will seek to understand gendered health risks and benefits of participation in food value chains, test targeted interventions to reduce vulnerability of women and men to FBD, and ensure that market-based food safety interventions do not exclude women from emerging value chains.

Table 2.3.3. Gender and equity outcomes from clusters' theories of change

Outcomes	**Assumptions**	**Status of Evidence**
Better women's and men's health	Women and men are have different risks from FBD Gendered interventions can improve health more effectively than gender-blind interventions	Strong Very weak
Better child nutrition and health outcomes	Women target more resources they control to children Participation of women in informal food value chains improves child outcomes	Fair Very weak
Greater equity	As value chains develop, women and the poor tend to be excluded Gendered interventions can improve inclusion Greater inclusion provides significant benefits to women and the poor	Fair Weak Fair
Greater health resilience to illness	Sickness is a major cause of falling into and remaining in poverty FBD is an important cause of poverty-inducing illness Interventions targeting FBD will build resilience to illness	Strong Weak Very weak

2.3.1.10 Capacity development

In Phase I, this FP developed capacity in more than 100 high-level regulators, graduated dozens of PhD and MSc students, trained technical staff on biocontrol research, and helped upgrade university curricula. A4NH supports a national food safety policy task force in Vietnam and is establishing food safety in commodity policy platforms in four countries. The BecA-ILRI Hub, a shared agricultural research

and bioscience platform, is increasing access to world-class research facilities to build capacity in African scientists.

The CGIAR Capacity Development CoP has identified ten core elements of capacity building. This FP will focus on the following elements with partners whose involvement is key to the impact of evidence generation and delivery (see Annex 3.2).

- Developing skills and tools to improve decisionmaking and inform investment in FBD management, specifically through learning materials and short training courses for the public sector.
- Collaborating with development partners to build capacity in understanding, implementing, and evaluating measures for FBD management.
- Raising awareness on the importance of food safety issues within CGIAR, advanced research institutes, and local universities, and developing future research leaders through direct outreach to undergraduates.
- Participating in A4NH-supported communities of practices and/or learning platforms on food systems (through FP1: Food Systems), agriculture and health (through FP5: Improving Human Health), nutrition (through FP4: SPEAR), gender, and other initiatives like the Agriculture, Nutrition and Health Academy, to share food safety methods and metrics.
- Developing or evaluating materials designed to increase capacity in value chain actors (e.g. prototype curricula for T&C of traders) with partners, and generating evidence to encourage development partners or private sector to invest in training value chain actors.

2.3.1.11 Intellectual asset and open access management

The FP's open access (OA), open data, and research data management (RDM) are guided at CGIAR-level by CGIAR's Open Access and Data Management Policy and CGIAR's Open Access and Data Management Implementation Guidelines. OA and open data actions and platforms are key mechanisms to implement CGIAR intellectual assets principles. Robust intellectual assets management and OA data management help in promoting uptake and achieving outcomes, while also contributing to the FP's effectiveness, learning, and accountability. Most Phase I outputs are already accessible through CGSpace and other online portals (e.g. http://data.ilri.org/tools/ for ILRI and Dataverse for IFPRI).

In Phase II, researchers from this FP will contribute a number of intellectual assets, such as improved varieties, novel and improved diagnostics, improved production technologies, decisionmaking tools, cost-effectiveness and cost-benefit analyses, impact evaluations, data or databases, online platforms, learning and capacity-building materials, and scientific publications—all of which will be designed with CGIAR OA and open data principles in mind. For example, peer-reviewed papers will be published in an OA format. Researchers will make raw data available to other researchers through their Center-specified platform in a timely manner. Tools to support improved decisionmaking developed by this FP will follow OA and open data principles, minimizing hurdles to scaling out. Further upstream, genome sequencing generates large amounts of data that will be put into an open database. For more information, see Annex 3.9.

In the long term, bilateral projects in this FP will budget for making information and data OA and to have a dedicated communications budget. In the short term, we will reserve a small budget ($15,000) to support making information accessible and communicating research.

2.3.1.12 FP management

In Phase I, food safety was combined with neglected zoonoses and emerging infectious disease into a single flagship on Agriculture-Associated Diseases, led by ILRI. In Phase II, food safety is proposed as a separate FP, justified by its great importance to value chain performance and the high burden of FBD.

In Phase I, A4NH funding was used to coordinate four meetings to help build an aligned research agenda around aflatoxins. The development of ToCs was also an opportunity to build researcher capacity in understanding impact pathways, to identify research areas where A4NH could add the most value, and to identify comparative advantages and appropriate roles for different partners. Whereas Phase I started with four centers that had widely separated research agendas and reported separately to the A4NH Program Management Unit (PMU), going into Phase II, we envisage a more joined-up FP that can deliver an integrated food safety research agenda.

ILRI will serve as the lead Center and will identify a FP leader responsible for coordinating planning and reporting across the FP. He/she will be supported by a part-time program management officer based at ILRI and will draw on communication and gender expertise in the PMU. The three CoAs will likewise have cluster leaders: the first two based in ILRI and the third in IITA, all of whom will meet monthly with the FP leader, either face-to-face or virtually.

Different partners will play different and critical roles in FP management. Some A4NH resources will be used to support integrated activities and internal learning within and across clusters. Partners will also agree upon and report against key objectives (for example, under gender impact, OA, or integration).

2.3.2 Flagship Budget Narrative

2.3.2.1 General Information

CRP Name	CGIAR Research Program on Agriculture for Nutrition and Health
CRP Lead Center	International Food Policy Research Institute (IFPRI)
Flagship Name	FP3: Food Safety
Center location of Flagship Leader	ILRI, Kenya

2.3.2.2 Summary

Total Flagship budget summary by sources of funding (USD)

Funding Needed	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Total
W1+W2	3,500,000	3,680,000	3,860,000	4,050,000	4,250,000	4,470,000	23,810,000
W3	300,000	250,000	250,000	200,000			1,000,000
Bilateral	6,878,892	9,141,133	9,610,142	10,477,795	9,274,523	9,019,202	54,401,690
Other Sources							0
	10,678,892	13,071,133	13,720,142	14,727,795	13,524,523	13,489,202	79,211,687

Funding Secured	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Total
W1+W2 (Assumed Secured)	3,500,000	3,680,000	3,860,000	4,050,000	4,250,000	4,470,000	23,810,000
W3							0
Bilateral	4,935,895	5,264,296	4,148,271	3,216,744	0	0	17,565,206
Other Sources					0		0
	8,435,895	8,944,296	8,008,271	7,266,744	4,250,000	4,470,000	41,375,206

Funding Gap	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Total
W1+W2 (Required from SO)	0	0	0	0	0	0	0
W3 (Required from FC Members)	-300,000	-250,000	-250,000	-200,000	0	0	-1,000,000
Bilateral (Fundraising)	-1,942,997	-3,876,838	-5,461,871	-7,261,052	-9,274,524	-9,019,203	-36,836,485
Other Sources (Fundraising)	0	0	0	0	0	0	0
	-2,242,997	-4,126,838	-5,711,871	-7,461,052	-9,274,524	-9,019,203	-37,836,485

Total Flagship budget by Natural Classifications (USD)

	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Total
Personnel	4,014,967	5,447,807	5,752,136	6,367,252	7,062,250	7,097,775	35,742,190
Travel	666,459	749,269	707,322	735,652	295,450	287,950	3,442,103
Capital Equipment	66,000	156,000	102,000	132,000	36,000	36,000	528,000
Other Supplies and Services	1,685,947	1,974,192	2,361,636	2,401,565	2,048,426	1,834,965	12,306,733
CGIAR collaborations	0	0	0	0	0	0	0
Non CGIAR Collaborations	2,815,410	2,993,050	2,946,202	3,119,437	2,186,916	2,346,361	16,407,377
Indirect Cost	1,430,107	1,750,814	1,850,844	1,971,888	1,895,480	1,886,150	10,785,285
	10,678,890	13,071,132	13,720,140	14,727,794	13,524,522	13,489,201	79,211,679

Total Flagship budget by participating partners (signed PPAs) (USD)

	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Total
International Livestock Research Institute (ILRI)	3,059,124	4,669,035	5,469,152	6,669,396	6,966,423	7,001,052	33,834,184
IFPRI	1,593,869	1,654,016	1,788,831	1,947,674	1,977,199	2,158,407	11,119,999
IITA	6,025,898	6,748,081	6,462,157	6,110,724	4,580,902	4,329,742	34,257,506
	10,678,891	13,071,132	13,720,140	14,727,794	13,524,522	13,489,201	79,211,680

Explanations of these costs in relation to the planned 2022 outcomes:

70% of the budget is from bilateral grants with $23.8M (30%) from W1/W2. About 40% of the grants are secured for the first three years. The biggest gap is for CoA2 (Safe Fresh Food), with a much higher proportion (75%) secured for CoA3 (Aflatoxin Mitigation).

Personnel costs are the main cost drivers and critical in building the grant portfolio. In phase I, we invested in new and younger staff, which with experienced research leaders are an important asset. The initial budget estimate for non-CGIAR partnerships is 24%, which may increase as new bilateral grants are secured. This is highest for scaling out for aflatoxin control with partner countries in Africa.

FP3 does make use of the laboratory infrastructure at IITA and at the ILRI-BecA hub shared facility in Nairobi. Major capital costs have not been budgeted but supplies and services will be provided at standard IITA and ILRI charges.

As noted in the ISPC donor survey for phase II priorities, food safety has a very narrow donor interest at present. On the other hand, it is only this team that works on food safety and there is extremely high demand for the team's food safety research in Africa and Asia. We will work closely with all stakeholders to build the consensus and agenda for food safety research, particularly in informal markets, in which the poor buy and sell food.

As with other pilot or scaling out research, implementation challenges for aflatoxin control are great, which will plan to mitigate by closely working with partners to co-learn and adjust our programs accordingly. We will also continue to work closely with policy makers and national stakeholders in dialogue on appropriate regulations and their implications for implementation as well equity and gender empowerment.

As with other FPs, changes in security situations in different field sites can be important and we will work closely with partners on the ground and adjust our programs accordingly.

2.3.2.3 Additional explanations for certain accounting categories

Benefits: IFPRI's fringe benefits - primarily includes leave, health, and pension costs
ILRI's Actual computations on average for fringe benefits and employment costs in relation to base salary would translate to an average multiplier of 97% and 68% for International and National staff respectively. The reason for the high multiplier for international staff is because of the housing and security allowance and education allowance that are not provided to nationally recruited staff. Fringe benefits include pension, housing allowances, education allowance, security, health insurance, other insurances, catastrophe fund, annual leave and severance pay. Other employment related costs include staff training and development; transportation, recruitment, appointment and repatriation allowances and payroll administration fees.

IITA uses a paygrade (PG) system for Internationally Recruited staff (IRS) and Nationally Recruited Staff (NRS). For IRS, there are 6 PG levels, and standard costs (pension, health and other insurance, housing/transport/security/leave allowances). Actuals can vary (for example by duty station or family size). For NRS the PG rates (level 1-15) depend on country laws on wages and salaries and internal set scales. NRS staff costs are split into salaries, fringe benefits and allowances, also dependent on country laws. Allowances (housing, transport, subsistence, utility, entertainment, and leave) can used to provide competitive salaries in different local markets.

Other supplies and services: IFPRI's other supplies and services cost include Service centers charges which is a necessary services to support research activity. The cost of the services is allocated to benefiting projects based on utilization of these services measured by the number of direct labor hours incurred for each project. IFPRI's service centers are comprised of computer, facility, library, and research support.

For ILRI, supplies and services includes information and communication technology, office space, research coordination, inception workshop, mid review, outcome mapping and monitoring workshop, peer review publication costs, epidemiologist training, field visits, data analysis costs, lab analysis and diagnostics lab costs., cost of MSc students for capacity development, and an internet for six months.

For IITA, supplies and services includes research support services, cost of vehicles, cost of sample analysis IT services, survey costs, capacity develop of NARS, and various microbiology, chemical and molecular supplies for lab work.

2.3.2.4 Other Sources of Funding for this Project

The greatest risk for project funding is in CoA2. This research is led by ILRI and much of the research is done together with value chain research in Livestock and Fish (as in phase 1) and with WLE (phase 2). The opportunities for joint project funding proposals with other these other CRPs will be pursued as well as with other partners identified in the FP3 proposal.

2.3.2.5 Budgeted Costs for certain Key Activities

	Estimate annual average cost (USD)	**Please describe main key activities for the applicable categories below, as described in the guidance for full proposal**
Gender	132,019	Research to understand how gender influences consumption, production and value chain decisions; assess potential for unintended consequences of interventions and policies; coordination with GEE unit on joint projects with other CRPs
Youth (only for those who have relevant set of activities in this area)	132,019	Engagement with youth in food system interventions and innovations, particularly small-scale agro-enterprises
Capacity development	1,980,292	Co-learning with national partner leaders including civil society and traders; building capacity in key areas and support to trader associations identified through discussions with value chain actors
Impact assessment	264,039	Impact assessment of previous food safety interventions (dairy in Kenya in particular); short-term assessments of new interventions; planning a mix of ex-ante and ex-post IA with national partners
Intellectual asset management	10,000	Prompt dissemination of research results and maximization of their global accessibility
Open access and data management	20,000	Ensure high quality and prompt availability of diet quality data from consumption studies; Rapid availability of resaerch products to national partners; support to national institutions on data use and open access and data management issues
Communication	132,019	Activities include engaging in policy dialogue; communicating research results and prompting learning and collaboration across the FP team and partners

2.3.2.6 Other

FP3 responds to much greater demands from consumers and countries for better food safety, particularly for fresh foods from informal markets, identified by WHO as much higher health burdens than previously thought. Through an CRP-commissioned external evaluation in 2015, we looked at prospects for expanding this research and advice is reflected in the FP proposal and base and uplift budgets presented. One outstanding issue is better evidence on whether stunting can be reduced through aflatoxin control. The IITA Aflasafe technology provides a unique opportunity to test this effectively. Priorities for additional W1/2 (uplift) funding

- Randomized controlled trials linked to Aflasafe
- Large scale trials of market-based solution to fresh food in CRP Livestock urban value chain
- Assessment of burden and attribution of FBD in 3 CG site integration countries

W1/W2 funding

There are 3 main uses of W1/W2 funding for research: 1) to support data collection and analysis for prioritizing food safety risks in low and middle income countries; 2) evaluation and impact assessments of methods to improve food safety of fresh foods in informal markets through market-agents and 3) coordination and synthesis (risk analysis and economic incentives) across a range of aflatoxin control efforts from breeding and agronomy through to use of aflasafe, better storage and improved market information. W1/W2 uplift could be used for rigorous trials to evaluate the nutrition and health outcomes of aflatoxin control.

2.3.3 Flagship Uplift Budget

Outcome Description	Amount Needed	W1 + W2 (%)	W3 (%)	Bilateral (%)	Other(%)
Key food safety evidence users (donors, academics, INGOs, national policymakers, civil society, and industry) are aware of and use evidence to in the support, formulation and/or implementation of pro-poor and risk-based food safety approaches	11,000,000	41	0	59	0
Market-based food safety innovations delivered at scale in key countries along with understanding of their impact and appropriate use	28,000,000	41	0	59	0
Biocontrol and GAP delivered at scale in key countries along with understanding of their public health impact, particularly on stunting, and appropriate use	12,000,000	41	0	59	0

2.4. Flagship Program (FP4) on Supporting Policies, Programs, and Enabling Action through Research (SPEAR)

2.4.1 Flagship Program Narrative

2.4.1.1 Rationale, scope

Agricultural development has enormous potential to make significant contributions to reducing malnutrition and associated ill health. With its close links to the direct causes of undernutrition (diets, feeding practices, and health) and its underlying determinants (e.g. income, food security, education, access to water, sanitation, hygiene [WASH] and health services, and gender equity), the agriculture sector can play a much stronger role than in the past in improving nutrition outcomes (Kadiyala et al. 2014; Pinstrup-Andersen 2012). In spite of recent positive trends in commitments and investments in increasing the nutrition-sensitivity of agriculture (e.g. USAID Feed the Future; the Bill & Melinda Gates Foundation/DfID annual grant opportunity for agriculture-nutrition impact studies), examples of success in improving maternal and child nutrition documented through standardized rigorous methods has only started to emerge (Hotz, Loechl, de Brauw, et al. 2012; Hotz, Loechl, Lubowa, et al. 2012; Deanna K Olney et al. 2015; D. K. Olney et al. 2016; Gillespie et al. 2016). To date, there is still limited evidence that agricultural interventions are benefiting nutrition (Ruel and Alderman 2013) or that agricultural growth consistently leads to nutritional improvements (Webb and Block 2012). In many low- and middle-income countries (LMICs), where a high dependence on agriculture-based livelihoods coexists with a high burden of undernutrition, large changes in agricultural policy and practice have generated relatively small changes in nutrition (Headey, Chiu, and Kadiyala 2012; Ecker, Breisinger, and Pauw 2011). In short, there remains a disconnect between agriculture and nutrition (**Box 2.4.1**).

Box 2.4.1. Definitions for concepts in FP4: SPEAR

The **agriculture-nutrition disconnect** describes the paradox of persistent undernutrition in a rapidly growing economy. From 2010–2012, members of the FP4 team were engaged in the Tackling the Agriculture-Nutrition Disconnect in India (TANDI) project that, among other activities, investigated the causes of this disconnect and the possible responses. The conceptual framework developed by TANDI (Gillespie, Harris, and Kadiyala 2012; Kadiyala et al. 2014) has since become very widely used and adapted for a USAID/SPRING brief.

Nutrition-sensitive agricultural programs are agriculture programs that have specific nutrition goals and integrate nutrition interventions (e.g. behavior change communications, distribution of micronutrient-fortified products, etc.) to achieve them (Ruel and Alderman 2013). They may or may not also integrate other types of interventions from other sectors such as water, sanitation and hygiene (WASH) or health (e.g. immunization, promotion of use of health services, etc.).

This disconnect represents a challenge—but also an opportunity. The many links between agriculture and nutrition suggest that agricultural policies, interventions, and practices can be better designed to enhance nutrition and health benefits. In FP4: Supporting Policies, Programs, and Enabling Action through Research (SPEAR), we seek to understand why the disconnect persists, and more importantly, how we can turn agriculture into a powerful lever for raising people's health and nutritional status, while at the same time contributing to other outcomes, such as food security, income, equity, and sustainability. Leveraging agriculture for nutrition implies: (a) making agricultural programs more nutrition-sensitive and therefore more effective in improving nutrition and health, (b) creating and strengthening policy environments that enable agriculture to support nutrition and health goals, and (c)

developing capacity and leadership to use evidence-informed decisionmaking to enhance the impact of agriculture on nutrition and health. We have more to learn in all of these areas, and FP4 is designed to address such knowledge gaps.

Nutrition and health are complex challenges, driven by factors and processes that require inputs and contributions from many sectors and at many levels, including both direct (nutrition-specific) interventions usually delivered by the health sector and indirect (nutrition-sensitive) programs implemented by a variety of sectors, underpinned by enabling policy environments (Black et al. 2013). Even if the recommended package of nutrition-specific interventions put forward by the *Lancet* Nutrition Series was scaled up to 90% population coverage in the 34 countries with the highest burden of undernutrition, child stunting would fall by only 20% (Bhutta et al. 2013). This means that efforts to scale up nutrition-specific interventions need to be paired with investments in nutrition-sensitive development programs and policies that address the underlying drivers of malnutrition.
Given the multi-sectoral nature of nutrition, agriculture needs to work in harmony with other sectors to maximize its impacts on nutrition. For example, social protection can protect the nutrition and health of poor smallholder households as they grapple with seasonality and climate shocks and stresses. Improved WASH can increase the nutritional benefits of agricultural programs and policies aimed at improving diets by reducing disease and enhancing nutrient absorption. And linkages between local agricultural production and school feeding may generate win-win benefits: income for small producers and their families, and nutrition and cognitive gains (and likely future income) for school-age children.

FP4 seeks to fill major gaps in our understanding of the agriculture-nutrition disconnect, and to identify and evaluate global and local actions to successfully connect the two sectors.[17] In doing so, it directly targets the second Sustainable Development Goal (SDG2) to *"end hunger, achieve food security and improved nutrition, and promote sustainable agriculture."* We will build on current involvement of the CGIAR Research Program (CRP) on Agriculture for Nutrition and Health (A4NH) staff and partners with global and regional initiatives in Africa and Asia to support countries in addressing these gaps and tackling these goals.

To address the previously mentioned challenges, this FP is structured in three interacting and mutually reinforcing Clusters of Activity (CoAs):

1. *CoA1: Nutrition-Sensitive Agricultural Programs (NSAP)* focuses on understanding, documenting and enhancing the contribution of nutrition-sensitive agricultural programs to improvements in maternal and child nutrition.
2. *CoA2: Supporting Countries through Research on Enabling Environments (SCORE)* focuses on understanding how enabling environments (policies, institutions, governance) for nutrition and health are created and sustained, and testing approaches for cultivating such environments.
3. *CoA3: Capacity, Collaboration, Convening (3C)* focuses on strengthening capacity to demand, use and act upon relevant evidence, as well as providing a crucial bridge to other FPs, CRPs, and relevant

[17] Challenges relating to the agriculture-nutrition disconnect have been discussed in the 2013 *Lancet* Nutrition Series, the 2014 and 2015 *Global Nutrition Reports*, and high-level fora such as the Nutrition for Growth (N4G) event (June 2013), Global Gatherings of the Scaling Up Nutrition (SUN) Movement (2013-15), the CGIAR's Science Forum in Bonn (September 2013), the International Conference on Nutrition (ICN2) in Rome (November 2014), and within the African Union's Comprehensive African Agriculture Development Programme (CAADP) investment planning process.

national, regional, and global processes and opportunities to maximize the impact of CGIAR work to improve nutrition and health.

2.4.1.2 Objectives and targets

The main objective of FP4 is to understand and enhance agriculture's contribution to improving nutrition at scale, aiming to:

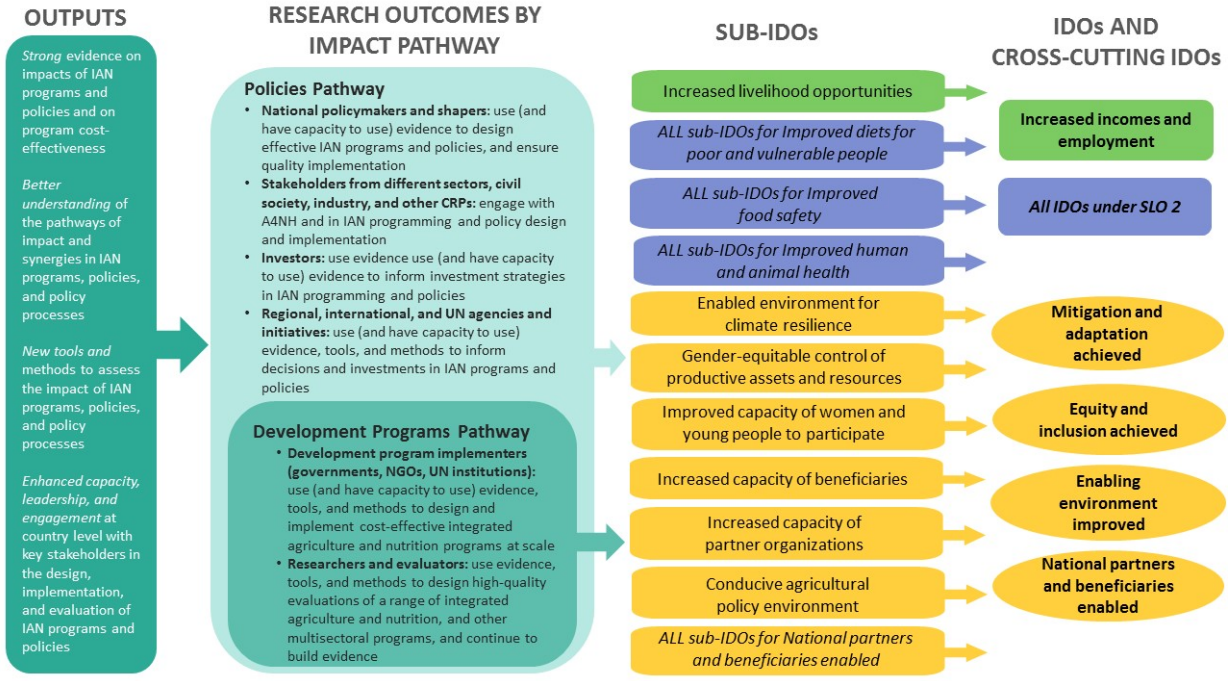
1. Understand, document, and enhance the impact of **nutrition-sensitive agricultural programs** on dietary quality and health- and nutrition-related outcomes in children, adolescent girls, and women of reproductive age;
2. Understand and document the barriers and opportunities, and test approaches for strengthening **enabling environments** for agriculture to support nutrition and health goals; and
3. Strengthen **capacity and leadership to promote evidence-informed decisionmaking** along the policy, program development, and implementation continuum, to enhance the impact of agriculture on nutrition- and health-relevant policy and programming.

This FP will impact the second system-level outcome (SLO2) on *improved food and nutrition security for health* (**Figure 2.4.1**), with the potential to contribute to SLO1 on *reduced poverty*. We will focus primarily on undernutrition, and also consider the growing challenge of overweight and obesity. The three CoAs will contribute indirectly to all three intermediate development outcomes (IDOs) under SLO2. We envision short term impact through the IDO on *increased incomes and employment* and long term impact by building human capital.[18]

Impact will be achieved through four cross-cutting IDOs, with direct relevance for the IDO on *enabling environment improved*, defined as, "the wider political and policy processes which build and sustain momentum for the effective implementation of actions that reduce undernutrition" (see blog post and (Gillespie et al. 2013). Since sustainability is a key element of an enabling environment for nutrition and health, this FP, in collaboration with the CRP on Climate Change, Agriculture, and Food Safety (CCAFS) and other Integrating CRPs (ICRPs), will also contribute to the sub-IDO on *mitigation and adaptation achieved* by re-viewing policies, programs, and interventions through a climate lens. Our focus on gender equity and empowerment of men and women, and on youth (school-age children and adolescent girls in particular) will contribute to the cross-cutting IDO on *equity and inclusion achieved* (see Section 2.4.1.9). We will contribute directly to the fourth cross-cutting IDO on *national partners and beneficiaries enabled.* Our contributions to the IDOs are summarized in Performance Indicator Matrix – Table C.

[18] Improving nutrition in utero and the first few years of life can improve cognitive development, educational achievement, employment and wages, and health and nutrition at adulthood and in future generations (Prendergast and Humphrey 2014; Addo et al.; Hoddinott et al. 2013).

Figure 2.4.1. Impact pathways for FP4: SPEAR[19]



By 2022, this FP will contribute to five main outcomes (Performance Indicator Matrix – Table B):

- Development program implementers and investors (governments, non-governmental organizations [NGOs], United Nations [UN] institutions) use evidence, tools and methods to design and implement cost-effective nutrition-sensitive agricultural programs at scale;
- Researchers and evaluators, in CGIAR and other CRPs, use evidence, tools, and methods to design high-quality evaluations of nutrition-sensitive agricultural and other multisectoral programs, and continue to build evidence;
- Regional, international, and UN agencies and initiatives, and investors use evidence, tools, and methods to inform decisions and investment strategies to guide nutrition-sensitive agriculture programming and nutrition-sensitive policies;
- National policymakers and shapers, and stakeholders from different sectors, civil society and industry use evidence to design effective nutrition-sensitive policies and ensure quality implementation; and
- Stakeholders from different sectors, civil society, and industry, in CGIAR and other CRPs, have improved capacity to generate and use evidence to improve nutrition-sensitive agriculture programming, nutrition-sensitive policymaking, and implementation.

These outcomes will contribute to the 2022 CGIAR target of 73 million people being without deficiencies in key micronutrients in 10 focal countries (Performance Indicator Matrix – Table A).

[19] In this figure, NSA is shorthand for "nutrition-sensitive agriculture".

Target countries. The primary geographic focus of this FP is on countries where poverty and high burdens of malnutrition and ill health coexist; we will therefore focus on Africa south of the Sahara and South/Southeast Asia. Our central focus is on enabling and sustaining *country-level* impact, thus aligning with the Busan declaration for aid effectiveness that fosters country ownership and a focus on results, transparency, and accountability. Within countries, we will "zoom in" to optimize the impact of nutrition-sensitive agricultural programs and to understand the policy-implementation nexus at a *subnational* level. In selecting target areas for subnational analysis and engagement, we will emphasize the role of gender relations in influencing agriculture and nutrition outcomes, and on climate vulnerability, liaising with the CCAFS. Given rapid urbanization, we will expand in Phase II to look at programs and policy issues as they apply to urban-rural linkages and urban/peri-urban/urbanizing environments, including their potential impacts on overweight, obesity, and the double burden of under- and overnutrition, where relevant. We will also focus on populations affected or displaced by ongoing agrarian change and agricultural intensification.

Geographically, our focus will initially[20] be on 10 countries in Africa (Burkina Faso, Ethiopia, Malawi, Mali, Tanzania, and Zambia) and Asia (Bangladesh, India, Nepal, and Vietnam) that are home to nearly 1 billion people within landholding households (and more from agriculture-dependent but landless households). An estimated 82 million stunted young children (over 50% of the global total) reside in these 10 countries, all of which are among the 20 priority countries for CGIAR, and four of which are among the six highest-priority (++) countries.

2.4.1.3 Impact pathway and theory of change (for each individual FP)

FP4: SPEAR seeks to achieve impact via outcomes generated through the *Policies Pathway* and the *Development Programs Pathway* (**Figure 2.4.1**). More elaborate theories of change (ToCs) will be developed in which the roles of, and synergies between, the three CoAs will clarified, building on ToCs that originated in Phase I. A set of ToCs will be developed, contextualized, and validated in a participatory manner with stakeholders.

Policies Pathway. Scaling and sustaining research impact requires creating and supporting an enabling environment for nutrition- and health-sensitive agricultural development and policy. This requires policy dialogue and adaptation to different national and sub-national contexts, informed by evidence, guided by stakeholder analysis, and implemented through partnerships. Promoting the development of nutrition-sensitive agricultural policies will support adequate implementation strategies and resource commitments. We will build on recent work on scaling up impact on nutrition (Gillespie, Menon, and Kennedy 2015) and the fourth paper of the *Lancet* Maternal and Child Nutrition Series (Gillespie et al. 2013) to apply lessons learned from past attempts to create and sustain large-scale enabling environments. We will deepen our ongoing engagement, via CoA3: 3C, with regional and global platforms, such as Comprehensive Africa Agriculture Development Program (CAADP) and the Scaling Up Nutrition Movement (SUN), as well as directly engaging with other CRPs, the other A4NH FPs, and partners, including governments, in our focal countries.

[20] If and when funds become available and opportunities arise, we will explore options for working in additional CGIAR/A4NH priority countries.[21] With 120 citations in just over two years, this paper is rated in the top 3 percent of all *Lancet* articles of its age and remains the second most influential paper by IFPRI, as per Altmetric.

Through CoA3: 3C, this FP will represent CGIAR as a convener in nutrition and health policy and program processes, bringing information about what CGIAR has to offer to national and global processes, and feeding back information and guidance to CRPs about where and how their work can contribute. This will allow sharing of lessons learned in agriculture and nutrition, which will optimize the collective impact of CGIAR on improving diet quality and nutrition in focus countries and regionally. In sum, this will help enhance the impact of investments in CGIAR and individual CRPs on nutrition and health outcomes. By bringing agriculture and nutrition and health stakeholders together, FP4 will help stimulate an enabling environment for partnerships and joint program and policy-making in the area of agriculture and nutrition.

Development Programs Pathway. CoA1: NSAP seeks to facilitate improved design, targeting, implementation, and scale-up of nutrition-sensitive agricultural programs, by development implementers. Building on Phase I work, it will continue to translate evidence on what program design and implementation modalities work, into actionable recommendations, and disseminate them to a broad range of implementers (including governments) nationally and internationally, to ensure that lessons learned are used to inform decisionmaking about program choice, targeting, design, and scale-up. This type of decisionmaking is often influenced by investors, with whom we work closely to ensure that evidence supports and informs strategies and investment choices. Examples include the U.S. Government's Feed the Future initiative, which promotes the improvement of nutrition through multi-sectoral approaches linking agriculture, health and nutrition in 19 target countries, and the Bill & Melinda Gates Foundation's newly launched nutrition strategy, which includes a strong focus on leveraging agriculture and food systems to improve nutrition.

Uptake also requires that program implementers can operationalize findings and adapt them to their own contexts. To facilitate uptake of our research outputs by programs, this FP will work closely with program implementers to formulate research questions, define program impact pathways, and discuss findings from process and impact evaluations. Through CoA3: 3C, it will work with *knowledge brokers*, defined here as communication experts or other specialized staff who work closely with researchers on evidence synthesis, knowledge translation, and knowledge mobilization. They will work with program implementers, policymakers, and investors to stimulate demand for information and feed contextual knowledge back to research teams. They will create and moderate a dialogue between researchers and policy and program actors and decisionmakers.

In Phase I, researchers in this FP worked closely on dissemination and capacity-strengthening activities with external institutions (e.g. the FANTA and SPRING projects and select NGO and UN institutions). In Phase II, we will work more closely with a mix of in-house and external knowledge brokers and engage with in-country staff and institutions who can support A4NH's work and that of other relevant CRPs. Knowledge mobilization activities will include connecting different stakeholders to tailored and relevant nutrition information, data, knowledge, and tools; targeted policy and media engagement; and the translation of knowledge and evidence into lessons learned, guidance, and actionable recommendations. We will draw from successful work connecting stakeholders with nutrition knowledge in India through our Partnerships and Opportunities for Strengthening and Harmonizing Actions on Nutrition in India (POSHAN).

In Phase II, we will continue to collaborate with researchers and mentor students from academic institutions and across CGIAR to further the reach and use of our outputs, continue to build a multi-disciplinary research culture, and to benefit from the methods, tools, and evidence generated by a

broad range of researchers working in the agriculture, nutrition, and health development continuum. In Phase II, researchers from this FP will continue to play an important role supporting the A4NH gender-nutrition community of practice (CoP) and other A4NH-supported CoPs or learning platforms.

2.4.1.4 Science quality

This FP builds and expands on more than a decade of CGIAR work focused on understanding, evaluating, and strengthening nutrition-sensitive agricultural programs and policies, on analyzing the political economy of leveraging agriculture for nutrition and health, on policy process research, and on cultivating and sustaining enabling environments for nutrition in South/Southeast Asia and Africa.

Tackling the agriculture-nutrition disconnect requires innovation on *outcomes* and to the *systems and processes* through which innovations are generated and delivered to their target audience (World Bank 2012).

A key innovation of this FP's work on nutrition-sensitive agricultural programs (CoA1: NSAP) is the use of rigorous impact evaluation methods, such as experimental designs complemented by process evaluations and cost-effectiveness assessments. In the past, researchers have shied away from experimental approaches, which led to a deplorable lack of solid evidence of their impact on nutrition or other development outcomes (e.g. income, food security, diets, women's empowerment), (Ruel and Alderman 2013). As pressure mounts for agriculture to deliver on nutrition, stakeholders (including investors, governments, and program implementers) increasingly demand evidence, successful models, lessons learned, and guidance for designing, implementing, and scaling up agricultural programs that drive improvements in nutrition. CoA1: NSAP started to fill this knowledge gap in Phase I, by using state-of-the art methods and developing tools and indicators to generate a rich body of evidence on what works in leveraging agriculture for nutrition. Research in Phase II will focus on extensive synthesis work to compile lessons from Phase I, contextualized with findings of other relevant research in recent years. It will investigate new program modalities and agriculture platforms (e.g. self-help groups in India, national agricultural extension services in Bangladesh), and will document impacts on a broader range of indicators along the program impact pathways to nutrition, with a strong focus on women's empowerment (e.g. Project-level Women's Empowerment in Agriculture Index [pro-WEAI]). In collaboration with CoA3: 3C, the team will intensify its efforts in knowledge translation, dissemination, mobilization, and capacity strengthening.

CoA1: NSAP's multi-disciplinary team first developed its strong reputation for impact evaluations by assessing the impact of large-scale social protection programs (e.g. Mexico's path-breaking conditional cash transfer [CCT] program) on a variety of outcomes, such as poverty, food security, diet quality, women's empowerment, and child nutrition (Skoufias 2005). Since this high-profile impact evaluation, the team has evaluated the nutritional impact of a variety of complex nutrition-sensitive programs in agriculture and other sectors, such as health and social protection, in a number of developing countries (Hidrobo et al. 2014; Ruel et al. 2008; Quisumbing et al. 2015; D. K. Olney et al. 2015; D. Olney et al. 2015; D. K. Olney et al. 2013; De Brauw et al. 2014). The team's strong multi-disciplinary focus, combined with more than a decade of experience using experimental designs to evaluate complex development programs around the world, puts CoA1: NSAP in a unique position to generate a rich body of evidence on successful programming in agriculture and nutrition and documenting impacts on a wide range of indicators on households and individuals at all stages of the life cycle. Through the CoA2: SCORE

and CoA3: 3C, this evidence will be fed into country, regional, and international program and policy design processes.

CoA2: SCORE's innovations in Phase I included the development of a framework to characterize enabling environments for nutrition (Gillespie et al. 2013) [21]. Subsequently applied successfully in Africa and South Asia, the framework highlights two stages (building momentum for nutrition, and translating it into implementation and ultimately impact) and three cross-cutting domains (knowledge and evidence, politics and governance, and capacity and resources). Other innovations to be built on in Phase II include the adaptation of tools for monitoring nutrition-relevant commitment and accountability, such as through the use of the Hunger and Nutrition Commitment Index (HANCI), co-developed by Transform Nutrition, which has attracted much media and government attention, and at the global level, through the *Global Nutrition Report*. Phase II will also build on the use of the innovative Stories of Change methodology to understand the drivers and pathways of change in our focal countries, and at state-level in India.

With regard to nutrition-relevant policy analysis, CoA2: SCORE's leadership role is evidenced by the Copenhagen Consensus, *The Lancet Maternal and Child Nutrition Series*, the *Global Nutrition Report*, the Regional Strategic Analysis and Knowledge Support System (ReSAKSS), and multi-partner consortia such as Transform Nutrition, Leveraging Agriculture for Nutrition in South Asia (LANSA), and POSHAN. The Gillespie et al (2013) framework was used in the Phase I work of the LANSA and Leveraging Agriculture for Nutrition in East Africa (LANEA) initiatives (Gillespie et al. 2015)(Gillespie et al. 2015) and was adopted by the *Global Nutrition Report* (2015). This report, which originated in Phase I, is now widely regarded as the most comprehensive, up-to-date compendium of data, evidence, and insight on international nutrition. Other work on policy included papers in *World Development* and *Food Policy* on innovative research on the role of governance among other cross-country predictors of nutrition outcomes and on the role of leadership and capacity in country constraints and success. The team has developed with the CRP on Policies, Institutions and Markets (PIM) a toolkit and bibliography on understanding, engaging, and evaluating policy processes in agriculture, nutrition and health.

During Phase I, Transform Nutrition achieved specific impacts, including revisions to the Productive Safety Net Programme in Ethiopia on the basis of research on the program's limited nutritional impact. Members have been invited to join nutrition policy development working groups in Bangladesh, Ethiopia, and India (at the national level and in Maharashtra state). The Government of India used Transform Nutrition's situation analysis documents on nutrition-sensitive policies, and the December 2015 launch of the first India Health Report (with a focus on nutrition) generated a raft of media coverage, after a joint launch by two ministers.

Phase II will include a new CoA on "capacity, collaboration, and convening." Although capacity development is critical to the success of current initiatives, such as SUN and CAADP, it is often undertaken without adequate documentation for meaningful lesson sharing and development of guidelines. CoA3: 3C will use a participatory qualitative research approach to ensure systematic documentation of capacity strengthening processes, and thus will contribute to global public goods for nutrition action within the SUN and CAADP frameworks. It will also test mechanisms and strategies to

[21] With 120 citations in just over two years, this paper is rated in the top 3 percent of all *Lancet* articles of its age and remains the second most influential paper by IFPRI, as per Altmetric.

increase the capacity and leadership needed for effective evidence-informed decisionmaking along the policy, program development, and implementation continuum.

2.4.1.5 Lessons learnt and unintended consequences

This FP will build on progress on understanding nutrition-sensitive agricultural programs and policies and creating an enabling environment for nutrition. We cite here a few examples of how learning from Phase I shaped new areas of research for Phase II.

Targeting and measuring impacts on different age groups (including adolescent girls): Phase I showed that a nutrition-sensitive homestead food production program (HFPP) in Burkina Faso improved mothers' and children's diets and nutritional status (D. Olney et al. 2015; D. K. Olney et al. 2015). New evidence emphasizes the need to focus on *adolescent girls* to accelerate nutrition progress because they are nutritionally vulnerable (e.g. high iron requirements due to menses; early pregnancy) and need to be better prepared for pregnancy, childbirth, and lactation (Bhutta et al. 2013). In Phase II, the team will explore the use of agriculture platforms to reach and support the nutrition of adolescent girls, in addition to mothers and children. Based on Phase I research showing that linear growth faltering continues beyond the first 1,000 days (Leroy, Ruel, and Habicht 2014), we will also include preschool children (2–5 years old) in our research where appropriate.

Assessing long-term impacts and intergenerational effects: Preliminary results from Phase I suggest that the Burkina Faso HFPP had sustained impacts on mothers' nutritional status two years after the program ended and benefited their new babies (Bliznashka et al., unpublished data). In Phase II, we will explore opportunities to assess the sustainability of impact and test whether improvements in outcomes, such as maternal empowerment and nutrition and health knowledge, confer long-term benefits for themselves and their future children.

New platforms and approaches to empowering women in agriculture: In Phase I, most of our research focused on filling knowledge gaps regarding the potential of HFPP to empower women and improve nutrition. In Phase II, our larger agriculture portfolio will explore a variety of new platforms, including self-help group networks focused on agriculture, livelihoods, and financial services (India) and women-focused agricultural credit programs and government agricultural extension services (Bangladesh). We will also test and evaluate new approaches to sensitize men/communities on gender equity.

Preventing overweight and obesity: In Phase II, as we expand our geographic focus to new countries, including some that are undergoing rapid economic growth and related nutrition transition (characterized by rapid changes in diets and physical activity, and rise in overweight/obesity and non-communicable diseases), we will explore new ways to tackle the double burden of malnutrition (co-existence of undernutrition and problems of overweight/obesity) through nutrition-sensitive agriculture programs and policies (including value chains with FP1: Food Systems). We will work with program implementers, policymakers, knowledge brokers, and other stakeholders to design and evaluate approaches (e.g. promoting production and consumption diversity and incorporating behavior change communication) to ensure that income gains from agriculture translate into more nutritious diets and better maternal and child nutrition, and also help prevent overweight and obesity. In its work on enabling environments, CoA2: SCORE will investigate options for countering emerging "obesogenic" environments.

Capacity, collaboration, convening: Phase I learning indicated a need for dedicated activities on capacity and leadership, collaboration, and convening. The recent independent evaluation of the SUN Movement and the 2015 Global Nutrition Report both highlighted these areas as critical in the next phase of SUN implementation to support progress. In addition, there is recognized need for greater coherence among CGIAR centers and CRPs to enhance the nutrition sensitivity and impact of the system's overall work. In Africa, new requirements to mainstream nutrition within CAADP monitoring processes via ReSAKSS have also created a unique opportunity to promote research uptake for greater impact of agriculture on nutrition. CoA3: 3C will also aim to help countries demand and use evidence, and to strengthen the capacity for enhanced nutrition sensitivity of CGIAR as a whole.

2.4.1.6 Clusters of activity (CoA)

FP4 is structured around three interacting CoAs. They are not silos, but rather, interdependent and synergistic entities – in a sense, a three-legged stool that supports this FP. Put simply, the benefits of knowledge generated on programs and policies by CoA1: NSAP and CoA2: SCORE will be maximized through the interactions with CoA3: 3C. Links between the first two CoAs relate to national ownership, scale, and sustainability. Program innovations can influence policy, and policy (and enabling environments in general) can incentivize and enable the implementation and scaling of successful programs and interventions. Dialogues between program designers, policymakers, and stakeholders—and their resulting actions and outcomes—can be improved over time through the convening of learning events and through strengthening capacity and leadership, which is the focus of CoA3: 3C. Each CoA is thus linked, and the three clusters, working in harmony, are all essential for maximizing FP4's impact.

CoA1: Nutrition-Sensitive Agricultural Programs (NSAP)
Nutrition-sensitive agricultural programs underpinned by nutrition-sensitive agricultural policy are now considered key elements of comprehensive strategies to support achievement of the ambitious global nutrition targets. As a result, there is strong demand from governments, investors, and program implementers for evidence on (1) the impact of agricultural programs on nutrition outcomes and the role of women in supporting achievement of nutrition goals, (2) how the design and implementation of agricultural programs can be strengthened so that they empower women and deliver on nutrition targets (addressing malnutrition in all its forms), and (3) the cost and cost-effectiveness of nutrition-sensitive agricultural programs (Ruel and Alderman 2013). CoA1 is designed to fill these gaps by generating and synthesizing evidence on what works, where, how and at what cost to improve the impact of agriculture on nutrition and health. This CoA focuses on the most nutritionally vulnerable population groups: adolescent girls, pregnant and lactating women, and young children, all of whom have high nutrient requirements, are particularly susceptible to infections, undernutrition, and increasingly, overweight and obesity. In addition, we seek to build capacity in this area among investors and implementers by generating guidance documents, and among researchers within and outside of CGIAR, by providing methods and tools for the rigorous evaluation of nutrition-sensitive agricultural programs.

The specific **research questions** that CoA1 will address in Phase II are:

1. How can nutrition-sensitive agricultural programs be optimized to improve diet quality and health and nutrition outcomes—including prevention of both undernutrition and obesity (where relevant)—especially in children, adolescent girls, and women of reproductive age?

2. How can nutrition-sensitive agricultural programs be optimized to empower women in agriculture and ensure that this empowerment translates into better nutrition and health outcomes for women, children, and other household members?
3. How can new nutrition-sensitive agriculture delivery platforms be leveraged to improve diets, health, nutrition and women's empowerment (e.g. experimenting with value chains; self-help groups focused on agriculture, livelihoods or financial services; government agricultural extension services)?
4. What are the key pathways of impact of nutrition-sensitive agricultural programs that are particularly important and should be leveraged to optimize impacts on health and nutrition outcomes (e.g. agricultural production and household food availability, access to nutrient-rich foods, hygiene, health and nutrition related-knowledge and/or practices, income and/or women's/men's empowerment, culture)?

To accomplish this, we will undertake the following **activities** in the associated **timeline:**

1. Synthesize results and draw lessons from Phase I's portfolio of evaluations and other recent literature on nutrition-sensitive agricultural and other multi-sectoral programs including from other relevant sectors (e.g., social protection, health, gender), (2017-18).
2. Broaden the scope and depth of Phase I's work to include measuring impacts over longer time horizons to examine longer-term, spillover, and/or intergenerational effects; a greater focus on children beyond the first 1,000 days and on adolescent girls; additional outcomes and impact indicators (e.g. early child development outcomes; overweight, obesity, non-communicable diseases (where relevant), new indicators of women's empowerment (pro-WEAI); and new information on cost-effectiveness (2017-21).
3. Test a variety of new nutrition-sensitive agricultural program models and platforms for delivery (e.g. link with FP1: Food Systems' CoA2: Food System Innovations); explore incorporating nutrition into national agricultural extension systems; test new program models in urban/peri-urban areas); expand our range of implementing partners (e.g. PRADAN in India, a strong agriculture NGO working on women's self-help groups); and incorporate hygiene, optimal management of human and animal feces interventions (especially in the context of agriculture projects involving animals), aflatoxin (with the International Livestock Research Institute [ILRI]), and linkages with the health sector to ensure that appropriate malaria prevention and treatment is available for populations included in agricultural programs to maximize potential impacts on nutrition through reductions in disease burdens (in partnership with FP1: Food Systems, FP3: Food Safety, and FP5: Improving Human Health), (2017-21).
4. Conduct synthesis work on the whole portfolio and relevant additional literature; generate, publish and disseminate a rich body of evidence on what works, where, how, and at what cost with nutrition-sensitive agricultural programs (2022).

CoA2: Supporting Country Outcomes through Research on Enabling Environments (SCORE)

Better evidence will not lead to better outcomes if evidence-informed policy changes are not adopted and implemented. Evidence on existing policy, other available options, and the likely impacts on key target groups needs to be framed and communicated effectively so that it is accessible and useful to decisionmakers. But new evidence must also be accompanied by an understanding of the political economy of agriculture and agri-food systems and of the politics of policy processes, including the prevailing incentives, disincentives, opportunities, constraints, trade-offs, and potential synergies (Gillespie et al. 2015). This CoA is fundamentally about rigorously researching and supporting enabling

environments and policy change in order to enhance the nutrition sensitivity of agriculture. It is essential for understanding where further political or policy leverage might be applied to the technical leverage gained from our work. As an example , to get an insight into policies and the policy processes in case-study countries, and to identify areas for further action, the LANSA and LANEA (Leveraging Agriculture for Nutrition in East Africa) projects conducted reviews of evidence on agriculture-nutrition pathways and of agriculture, nutrition and integrated agriculture-nutrition polices, along with mapping exercises and in-depth interviews with stakeholders (government, INGOs, NGOs, private sector, donor agencies, researchers). Some examples of policies or institutions that were highlighted include the Productive Safety Net Program (PSNP) in Ethiopia, National Rural Livelihood Mission in India and the Country Investment Plan on Agriculture, Food Security, and Nutrition in Bangladesh. Drawing on Phase I activities like these, we will continue to use different policy change models to structure our work and bring political and wider social science perspectives to our examination of agriculture-nutrition-health linkages in different contexts.[22] We will structure such work to enable investigation of policy drivers of overweight/obesity as well as undernutrition.

The overarching **research questions** that CoA2 seeks to address are as follows:

1. *Policy coherence:* Why are agricultural policies and programs not aligned with nutrition and health goals, and what needs to be done to achieve alignment?
2. *Policy processes:* What are the barriers and constraints to (and the opportunities for) creating cross-sectoral policy and institutional environments that better support nutrition and health goals for the poor and vulnerable?
3. *Policy learning:* What are the wider lessons from examples where political momentum for nutrition has been successfully linked to effective, large-scale implementation of relevant agricultural and other programs?

We will address these questions through core **activities** that fall into three overlapping stages, in the associated **timeline**:

1. *Understanding:* Undertake/update stakeholder mapping and policy landscaping in focal countries, using participatory approaches (e.g. NetMap). Linking with CoA3: 3C's focus on capacity assessment, such in-country participatory mapping will involve a prioritization of policies for more in-depth policy research. Apply the Phase I conceptual framework (for characterizing enabling environments) and select policy change models in different contexts to investigate policy and implementation-related challenges, constraints, incentives, trade-offs, opportunities/windows using mixed qualitative and quantitative Stories of Change and other approaches. The Stories of Change methodology is a means to document changes in the relationship between agriculture and nutrition—and to inspire and inform action by stakeholders at national and regional levels (Gillespie and van den Bold 2015). A series of state-level Stories of Change will be developed in India. This will include formative research into "mental models" or mindsets of key decisionmakers regarding agriculture and nutrition, building on earlier work in Africa and South Asia (Gillespie et al. 2015)

[22] For example, Sumner and colleagues from IDS disaggregate policy change into changes in framing, agenda-setting, content, resource allocation and, crucially, implementation, while Resnick and colleagues working in Policies, Institutions and Markets CRP (PIM) have developed the "kaleidoscope model" of policy change in agriculture, nutrition, and health (Sumner et al. 2011; Resnick et al. 2015).

Policy analysis will also draw on CoA1: NSAP's analysis of hitherto unexplored but high potential impact pathways linking agriculture and nutrition (2017-18).

2. *Operationalizing:* Work with stakeholders (in liaison with CoA3: 3C) to develop and apply diagnostic and priority-setting tools. Document real-time policy and program engagement processes, including CAADP and SUN processes, in focal countries. Investigate approaches for ensuring horizontal (cross-sectoral) as well as vertical (intra-sectoral) coherence in nutrition-sensitive agri-food systems and policy processes. Conduct policy research to identify and resolve emerging context-specific challenges and trade-offs, and to understand the relative roles and benefits of different tactics in catalyzing change.[23] (2018-20)
3. *Evaluating:* Continue to document and evaluate real-time policy influence and engagement processes, and synthesize outputs and lessons learned. CoA2 will become a repository of global and local knowledge on policy processes to be accessible to all CRPs with a country presence (2019-22)

CoA3: Capacity, Collaboration, Convening (3C)

This CoA has three core functions, captured in its title – namely, capacity and leadership, collaboration and engagement, and convening and knowledge translation. CoA3 aims firstly to strengthen capacity and leadership for promoting evidence-informed decisionmaking along the policy, program development, and implementation continuum in order to enhance the impact of agriculture on nutrition-relevant policy and programming. In doing this, it will promote the effective use of research outputs from the first two CoAs. Second, it will foster collaboration with different stakeholders in the generation and use of evidence to influence decisions on policy, programming and implementation. And third, it will translate, frame and present knowledge and evidence generated by the first two CoAs in ways that are useful to policy and decisionmakers. This CoA will thus support CoA1: NSAP and CoA2: SCORE, as well as being responsive to other core constituencies (including other A4NH FPs, CRPs, focal countries and regional initiatives).

CoA3 is largely intended to *support* and maximize impact of research, but it will also address the following **research questions**:

1. What individual, organizational and systemic capacity[24] and leadership gaps limit collaborative engagement, evidence generation and use across the policy, program development, and implementation continuum in focal countries and regionally?
2. What are effective mechanisms and innovative strategies to increase the capacity and leadership needed for effective evidence-informed decisionmaking?
3. What can be learnt from this FP's approach (internal process documentation) to change?

The following planned **activities** for focus countries and regions will be responsive to the work done by CoA1: NSAP and CoA2: SCORE (years of milestone achievement in brackets).

1. Document and evaluate *capacity and leadership gaps* in evidence-informed decisionmaking by (i) retrospectively auditing Phase I at CGIAR and FP level, (ii) interviewing stakeholders, (iii) systematically reviewing the literature (2017). After a prioritization exercise (with stakeholders) an

[23] For example, as undertaken in recent work by te Lintelo and Lakshman in IDS (te Lintelo and Lakshman 2015).

[24] We will apply the Potter and Brough (2004) framework with its differentiation of capacity into individual, organizational and systemic levels, building on its adaptation by Gillespie and Margetts (2013)to nutrition-sensitive agricultural settings.

initial capacity strengthening plan will be developed. On an ongoing basis, we will develop, document, and conduct activities to strengthen and sustain capacity and leadership, liaising with the first two CoAs for selected country programs. Training materials and related guidelines will be developed and shared through knowledge brokers, country and regional level platforms.

2. Support multisectoral, multistakeholder *collaboration* (2017 onwards). In liaison with CoA2: SCORE, work with country knowledge institutions, SUN and CAADP knowledge networks, and explore factors and processes that influence evidence demand, generation, and use for decisionmakers. Promote collaborative networks and institutional arrangements to support evidence generation and use cycles. Convene regional learning events (2019 and 2022) in focal countries.
3. Leverage A4NH's *convening role*, and explore ways this FP could help other CRPs address knowledge, capacity and leadership gaps along agriculture-to-nutrition impact pathways. Synthesize lessons and develop guidelines for CGIAR (2019 and revised in 2022). Disseminate knowledge generated through CGIAR–convened learning events for CRPs (2019 and 2022) to help enhance the nutrition-sensitivity of research programs.
4. Consolidate and synthesize evidence on key learnings on what works at country, regional, and CRP levels to increase demand, use and uptake of evidence through a systematic process documentation of 3C. The process documentation will use an innovative participatory qualitative research approach – the content of group discussions before and during learning events being analyzed for emerging themes and subsequently used to inform capacity development activities. This is an adaptation of an approach successfully used by the Africa Nutrition Leadership Programme (ANLP). The co-lead of CoA3, the EVIDENT network (Evidence-informed Decision-making in Health and Nutrition), uses a similar approach responding to expressed needs of decisionmakers. In addition to this approach, Skype or WebEx recordings will be used to collect data. The documented process will serve as a learning guide to increase the impact of nutrition-sensitive agriculture programs and policies 2022).

2.4.1.7 Partnerships

The International Food Policy Research Institute (IFPRI) will lead FP4, with two of the three CoAs being co-led by strategic partners. The Institute of Development Studies (IDS) will co-lead CoA2. The EVIDENT network, coordinated by the Institute of Tropical Medicine (ITM) in Antwerp will co-lead CoA3. Bioversity will be actively involved in two CoAs as convener with Rome-based agencies (Food and Agriculture Organization of the UN [FAO], International Fund for Agriculture Development [IFAD], World Food Programme [WFP], UN Standing Committee on Nutrition [UNSCN], REACH).

FP4 has extensive experience working with three of A4NH's four broad categories of partners. We rely heavily on strong partnerships with high-quality development **implementers,** such as international NGOs (INGOs) and NGOs, governments, and UN institutions. Examples include long-lasting partnerships with Helen Keller International (HKI) in several countries and with BRAC in Bangladesh. In some countries we interact with the national and community health systems through partner NGOs. In others, we work directly with governments to generate country-specific evidence for decisionmaking. We will expand partnerships with NGOs, such as PRADAN in India, which works through self-help groups.

We work closely with **enablers,** such as governments and investors, who decide which programs are implemented or scaled up. Examples include the Zambian National Food and Nutrition Commission and IFAD. We will continue our collaboration with IFAD to strengthen joint research on nutrition-sensitive agriculture. Enablers share evidence with international agencies, governments, and investors. The team

has been effective in building an evaluation culture and increasing demand for rigorous evidence within networks of program implementers and investors.

FP4 already has strong links with a range of **national research partners**, including in the four CGIAR high-priority countries where we will work: Addis Ababa University and the Ethiopian Public Health Research Institute, International Centre for Diarrhoeal Disease Research, Bangladesh (ICDDR,B) and BRAC University (Bangladesh), National Institute of Nutrition (Vietnam), and Sokoine University (Tanzania).

In Phase II, we will build on partnerships with **other A4NH FPs**. We will collaborate with FP2: Biofortification on testing and documenting different crop dissemination approaches, and studying how countries translate evidence into national policy and results on the ground. We will collaborate with FP1: Food Systems, exploring synergies in countries where obesity is an increasing concern, and collaborating on characteristics of enabling environments for nutrition-sensitive agriculture in different food system contexts, at both national and subnational levels in common focal countries. We will continue work with FP1 on understanding which policy environments support homegrown school feeding programs, plus expand work to other value chains. FP3: Food Safety has already applied the CoA2 conceptual framework to its analysis of national food safety regulations and will build on this in Phase II around aflatoxins and informal markets for meat, milk, and fish.

With regard to **other CRPs**, we will collaborate with PIM in its CoA 2.3 (Political Economy and Policy Processes) within its FP2 (Economy-wide Factors affecting Agricultural Growth and Rural Transformation in Low- and Low-Middle-Income Countries); and with its CoA 4.1 (Social Protection Delivery and Outcomes) of FP4 (Social Protection Strategies and Programs) on integrating social protection with complementary agricultural interventions and nutrition to enhance poverty and nutrition impacts. We will also engage with CCAFS as discussed later. This FP will play a convening role for CGIAR, retaining the flexibility to engage with CRPs, based on expressed demand and comparative advantage. Where relevant and feasible, CoA3 will address capacity gaps identified by other FPs and CRPs.

2.4.1.8 Climate change

Both A4NH and CCAFS are concerned with issues of vulnerability and of sustainability, and it will be important to harmonize our work as far as possible, especially in countries in which both are active. A climate lens will be applied to our work in all three clusters. We will explore options for adopting the conceptual work recently undertaken by the Global Panel on Agriculture, Food Systems, and Nutrition, in structuring this work, in addition to our team's Phase I work on developing a sectoral brief on climate, food, and nutrition security as part of a collaboration with FAO.

Building on discussions with CCAFS in the FP4 proposal development workshop, we will seek to address the following questions: Is nutrition-sensitive agriculture always climate-smart? Can the joint pursuit of climate-smart and nutrition-relevant objectives for agriculture open up potential synergies, and highlight areas for productive partnership, and possibly joint research? Can partnerships of key actors focusing on climate and nutrition respectively generate win-win gains? Are there situations where these two objectives do not align—where, for example, the pursuit of climate-smart agriculture may be at odds with the nutrition-sensitivity objective? Why does this happen, where does it happen, and how can such a dilemma be resolved? What trade-offs are revealed? A three-way link between us, CCAFS, and A4NH FP1: Food Systems, may help explore the meaning and viability of a "sustainable diet" in different contexts. Our engagement with CCAFS will be via CoA 1.3 (Enabling Policy Environments for CSA) within

its FP1 (Priorities and Policies for Climate-Smart Agriculture). In CoA2: SCORE and CoA3: 3C clusters we will also explore the option of undertaking joint policy/governance work with CCAFS—for example, developing case studies for synthesizing lessons on good practice (engagement, implementation) in select countries.

2.4.1.9 Gender

Phase I research highlighted the key role of women in fostering impacts of agriculture on nutrition (Gillespie, Harris, and Kadiyala 2012; Herforth and Harris 2014). We identified women's health, nutrition, empowerment, and time use as key factors to ensure agriculture leads to improved diets and optimal use of income to protect the health and nutrition of vulnerable household members. In Nepal, we saw that low production diversity was associated with poorer maternal and child diets and poorer child nutritional status, while women's empowerment mitigated these negative effects (Malapit et al. 2015). Results from our study in Burkina Faso with HKI showed that a nutrition- and gender-sensitive agricultural program improved women's nutritional status and empowerment (D. Olney et al. 2015), including control and ownership of assets, and reduced the male-female asset gap (van den Bold, Quisumbing, and Gillespie 2013; Quisumbing et al. 2015). Preliminary evidence shows that increases in women's empowerment mediated impact on reducing the prevalence of wasting among young children (Heckert, Olney, and Ruel 2015). We will continue work, with the A4NH Gender, Equity, and Empowerment (GEE) unit, and using the Women's Empowerment in Agriculture Index (WEAI) and pro-WEAI, in the context of impact evaluations, and program design aimed at empowering women and reducing gender gaps in agriculture.

Our Phase II will be consistent with the A4NH Gender Strategy, taking into account women's position as disadvantaged economic agents in many contexts. This approach is embedded within current agri-nutrition conceptual frameworks (Gillespie, Harris, and Kadiyala 2012) that highlight the balance between women's wider livelihoods, unpaid care, optimal infant feeding practices, and women's nutritional and health status. We will identify new ways to empower women and sensitize men and communities about the importance of supporting women in their multiple roles and in reducing gender bias.

2.4.1.10 Capacity development

Capacity is front and center to our proposed work. It is the essential rationale and basis for CoA3: 3C that seeks to ensure country-level contextualization of our work—and providing a conduit for engagement with other FPs, CRPs, and platforms. The other CoAs will generate evidence on what is needed for more effective policy, planning, and implementation processes relating to agriculture, nutrition and health, and their links to other sectors. This will identify capacity and leadership gaps that limit uptake of research outputs towards impact for sustained progress. 3C will build on the conceptual work by Gillespie and Margetts (2013) in terms of system, institutional and individual capacity strengthening, and practical work undertaken by the EVIDENT team on nutrition-relevant capacity in Africa, to develop, test, and document approaches for strengthening capacity and leadership of key actors and organizations. It will also build on the capacity assessments undertaken in selected African countries under the ReSAKKS program.

The CGIAR Capacity Development CoP has identified several core elements. Through the work of 3C, and through the process of undertaking research in the other CoAs with different partners, we will focus on all these elements. For example, Transform Nutrition has a strong record of capacity strengthening, having designed and implemented a series of Transform Nutrition short courses for policymakers and decisionmakers held in the UK and India; the Transform Nutrition alumni network for these courses now stands at nearly 200 members. The annual global and regional events this FP describes in 3C are designed to strength institutional capacity to look at both innovation and on development outcome demands between agriculture research and nutrition and health policy and advocacy communities with European Union- UN Children's Fund (EU-UNICEF), SUN Civil Society, and other networks. Specific activities are described more detail in Annex 3.2.

2.4.1.11 Intellectual asset and open access management

FP4 will contribute intellectual assets, such as evidence on impacts of nutrition-sensitive agriculture programs, cost-effectiveness; methods and tools for rigorous impact evaluations; datasets; decisionmaking, diagnostic and priority setting tools; policy process analysis; success stories; training materials and guidelines; and capacity needs assessments made available in peer-reviewed articles, books, reports, briefs and other print outputs; audio-visual and multimedia outputs; web and social media; and in-person seminars, presentations and workshops. Details are in Annexes 3.8 and 3.9.

These outputs will be fed into networks of stakeholders through existing knowledge platforms including IFPRI e-library and Institute of Development Studies OpenDocs repositories; Transform Nutrition, LANSA, Eldis, POSHAN and Africa Nutrition Leadership Programme, the Global Nutrition Leadership Platform, the Agriculture, Nutrition, and Health Academy, the EVIDENT network, the SUN Communities of Practice on functional capacity for nutrition, and on social mobilization and communication, the SUN Civil Society Network, CAADP via ReSAKKS, and Dataverse for datasets. Transform Nutrition and LANSA have developed particularly strong policy engagement in their focal countries. India and Ethiopia have recently hosted major conferences.

Knowledge mobilization activities will be led by knowledge brokers, drawing on the expertise of our partners, supplemented by specialist inputs and in-house knowledge translators. We will monitor the success of this global dissemination using online tools, like Altmetrics and Google scholar citations, recognizing that these measures of global availability and access will not capture all types of use. We will work directly with government partners to generate and disseminate country-specific evidence for decisionmaking and through the tailoring of knowledge and evidence generated by FP4 to support our capacity and leadership strengthening activities.

2.4.1.12 FP management

FP4 will adopt a distributed leadership approach in which clusters will have the following co-leaders (CVs are included in Annex 3.7):

CoA1: NSAP: Marie Ruel, Jef Leroy, Deanna Olney (IFPRI);
CoA2: SCORE: Stuart Gillespie (IFPRI), Nicholas Nisbett (IDS)
CoA3: 3C: Namukolo Covic (IFPRI), Roos Verstraeten (EVIDENT/ITM)

Two of the three CoAs are institutionally co-led: CoA2: SCORE will build on collaborations between IDS and IFPRI (e.g. Transform Nutrition, LANSA, *Global Nutrition Report*). IDS is a leading global institution for development research at the University of Sussex in the UK. IDS was ranked no. 1 for Development Studies in the QS World University Rankings in 2015. Through its leadership of the Future Agricultures Consortium and the STEPS Centre, IDS brings considerable interdisciplinary expertise and experience in the analysis of policy processes and the political economy of agricultural policy, as well as in nutrition and health policy through its leading researchers in political science, anthropology and geography.

CoA3: 3C will be co-led by IFPRI and EVIDENT, which brings its considerable experience in connecting African researchers and decision-makers. Strong links will be forged with the Africa Nutrition Leadership Programme (ANLP, linked to the Global Nutrition Leadership Platform) and the Agriculture, Nutrition, and Health Academy, which aims to foster a global community of interdisciplinary researchers working on agriculture and food systems for improved nutrition and health.

The FP leader, Stuart Gillespie, will ensure CoA collaboration via monthly calls and periodic meetings. We will adopt an adaptive, results-based management approach in which we periodically review FP governance in the context of our ToC and workplan. We will be adaptive to seize new opportunities for national and regional impact, as and when they arise—as well as being responsive to other flagships and other CRPs.

2.4.2 Flagship Budget Narrative

2.4.2.1 General Information

CRP Name	CGIAR Research Program on Agriculture for Nutrition and Health (A4NH)
CRP Lead Center	International Food Policy Research Institute (IFPRI)
Flagship Name	FP4: Supporting Policies, Programs and Enabling Action through Research (SPEAR)
Center location of Flagship Leader	International Food Policy Research Institute (IFPRI), Washington DC, USA

2.4.2.2 Summary

Total Flagship budget summary by sources of funding (USD)

Funding Needed	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Total
W1+W2	4,006,251	4,142,721	4,308,884	4,457,666	4,651,839	4,814,897	26,382,258
W3							0
Bilateral	17,825,178	18,238,119	18,718,563	19,343,218	19,646,968	20,265,218	114,037,265
Other Sources							0
	21,831,429	22,380,840	23,027,447	23,800,884	24,298,808	25,080,115	140,419,523

Funding Secured	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Total
W1+W2 (Assumed Secured)	4,006,251	4,142,721	4,308,884	4,457,666	4,651,839	4,814,897	26,382,258
W3							0
Bilateral	14,124,166	2,431,028	2,405,599	2,475,439			21,436,232
Other Sources							0
	18,130,417	6,573,749	6,714,483	6,933,105	4,651,839	4,814,897	47,818,490

Funding Gap	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Total
W1+W2 (Required from SO)	0	0	0	0	0	0	0
W3 (Required from FC Members)	0	0	0	0	0	0	0
Bilateral (Fundraising)	-3,701,012	-15,807,091	-16,312,964	-16,867,779	-19,646,969	-20,265,218	-92,601,033
Other Sources (Fundraising)	0	0	0	0	0	0	0
	-3,701,012	-15,807,091	-16,312,963	-16,867,779	-19,646,968	-20,265,217	-92,601,030

Total Flagship budget by Natural Classifications (USD)

	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Total
Personnel	6,475,656	6,742,561	7,204,886	7,662,922	7,994,475	8,310,719	44,391,222
Travel	751,903	843,303	943,389	970,071	987,763	1,001,559	5,497,991
Capital Equipment	0	0	0	0	0	0	0
Other Supplies and Services	9,656,154	9,657,446	9,703,154	9,848,778	9,893,417	10,141,273	58,900,224
CGIAR collaborations	0	0	0	0	0	0	0
Non CGIAR Collaborations	1,955,517	2,079,737	2,024,390	2,053,576	2,083,362	2,179,181	12,375,766
Indirect Cost	2,992,197	3,057,791	3,151,625	3,265,535	3,339,787	3,447,379	19,254,318
	21,831,427	22,380,838	23,027,444	23,800,882	24,298,804	25,080,111	140,419,506

Total Flagship budget by participating partners (signed PPAs) (USD)

	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Total
IFPRI	18,148,331	18,624,551	19,177,816	19,850,783	20,240,498	20,905,190	116,947,172
Institute of Development Studies	340,663	346,958	353,504	360,312	367,393	374,757	2,143,590
Evident Network	2,317,234	2,324,493	2,332,042	2,339,893	2,348,058	2,356,549	14,018,270
Bioversity International	1,025,198	1,084,836	1,164,083	1,249,894	1,342,858	1,443,617	7,310,489
	21,831,426	22,380,838	23,027,445	23,800,882	24,298,806	25,080,113	140,419,510

Explanations of these costs in relation to the planned 2022 outcomes:
FP4 will contribute to all 3 IDOs under SLO2, to SLO1 on reduced poverty and the 4 crosscutting IDOs. Outcomes to 2022 will build on the current high-quality IFPRI portfolio and bring in Bioversity, and IDS and EVIDENT network/ITM as non-CGIAR strategic partners. FP4 will contribute to evidence for nutrition action in 10 countries in the SUN and CAADP frameworks and convene engagement in policy processes to enhance the impact of CRP investments on nutrition and health outcomes.

Cost drivers:
Personnel costs (salary and benefits): 37% of base budget. Each cluster of activities a core team, including leaders (50% LOE) with responsibility for keeping the program on track, researchers across the range of experience and skills, and essential research and program support (W1/2 funded).
18% of budget is dedicated to strategic partners. Travel is at economy fares.

Bilateral funding will be sought for the high costs of data collection. W1/2 funds provide additional expertise and co-funding to projects that develop international public goods through new knowledge, synthesis across research projects and clusters, translation and uptake of knowledge, convening across the CGIAR and wider networks to strengthen capacity and collaboration.

Assumed growth rate of 5% per year for W1/W2.

Risk mitigations:
- Working with partners in country, we will adjust to changes in security situations.
- Working closely with implementers in evaluation work and building their capacity will minimize implementation failures.
- The FP4 team has a strong track record in fundraising. 77% of bilateral funds for 2017 are secured, nearly 10% for the next 3 years. Our target is based on actual funding to date. There is flexibility to expand/reduce objectives with <10% changes in funding. We must maintain a critical mass of researchers and range of projects for external validity for international (not just national) public goods and to achieve our outcomes.

The FP4 team has an established track record of delivery.

2.4.2.3 Additional explanations for certain accounting categories

Benefits: IFPRI, IDS, and ITM's fringe benefits primarily includes leave, health, and pension costs. ITM's fringe benefit is mostly built into the salary and University's of Bioversity provides fringe benefits only to internationally recruited staff for pension and insurance.
Other supplies and services: The broad categories of other costs are given below.

Outreach/publications – This includes costs for hosting seminars and engagement events, printing and publication costs (including open access fees), website and multimedia output costs, and at least one larger event or conference for each cluster towards the end of the period. An average dissemination workshop cost is estimated at $15,000 and APC fees at an average of $3,500.

Programme costs include fieldwork costs for survey work including training, other activities specific to the cluster of work such as support to network building in the 3C Cluster, and operating costs associated with activities. These have been estimated as lump sums based on previous experience.

IFPRI's Service center charge includes services to support research activity. The cost of the services is allocated to benefiting projects based on utilization of these services measured by the number of direct labor hours incurred for each project. IFPRI's service centers are comprised of computer, facility, library, and research support.

2.4.2.4 Other Sources of Funding for this Project

The SPEAR team is highly successful in attracting bilateral funding. Our budget anticipates the continuation of this as equivalent levels to 2015 and we are confident of being able to achieve this. Bilateral funding is raised in relation to specific projects, so it would be possible to scale our ambitions to achieve our objectives for an expanded or reduced budget, if we can maintain critical mass and sufficient scope for international public good relevance. Reductions in W1+W2 funding would be a more serious constraint in terms of production international public goods through synthesis and convening activities proposed.

2.4.2.5 Budgeted Costs for certain Key Activities

	Estimate annual average cost (USD)	Please describe main key activities for the applicable categories below, as described in the guidance for full proposal
Gender	7,242,008	Research to understand how gender influences nutrition and health outcomes; assess potential for unintended consequences of interventions and policies; linkages with GEE unit on joint research and translation to other CRPs and partners is embedded throughout this FPs research
Youth (only for those who have relevant set of activities in this area)	1,097,274	Largely through interventions with adolescent girls
Capacity development	3,072,367	Co-learning with national partner leaders including civil society; building capacity in key institutions for program interventions and policy making- 3C cluster will be coordinating hub for our capacity development activities, but many activities in other clusters will contribute to this objective
Impact assessment	1,097,274	Impact assessment of past interventions and short-term assessments of impacts and unintended consequences of policy decisions with national partners, embedded in cluster and FP leadership
Intellectual asset management	0	Outputs are knowledge products covered by open access/open data activities
Open access and data management	1,097,274	Ensure high quality and prompt availability of diet quality data from consumption studies; Rapid availability of research products to national partners; support to national institutions on data use and open access and data management issues
Communication	2,633,457	Activities include engaging in policy dialogue; communicating research results and prompting learning and collaboration across the FP team and partners

2.4.2.6 Other

FP4 will work in an increasingly integrated and mutually reinforcing way across the 3 clusters and link with other Flagships within A4NH and other CRPs. There are therefore many overlaps and cross-connections in the activities set out in the budget.

The large, long-term grant portfolio in this FP is critical to meet knowledge and evidence demands by countries and the international development community. It also requires a large investment in proposal writing, communications and outreach. FP4 offers ambitious outcomes from a modest investment of W1/2 funding, by leveraging bilateral grants for evaluation and policy engagement research linked to

large-scale agriculture-nutrition intervention projects. This has been a successful approach; active partnership with development implementers, investors and national governments maximizes impact. The FP4 agenda attests that existing work adds value by ensuring that Phase II is focused on key challenges, draws on a broad range of existing data, allows for analysis over longer timeframes, benefits from established partnerships and working relationships, and has credibility to back the evidence. Preliminary findings from Phase I have informed selection of new areas of emphasis and expansion for Phase II, with some continuation of ongoing work. Each cluster will begin Phase II synthesizing, drawing lessons from and applying the frameworks and approaches developed in Phase I.
Priorities for additional W1/2 (uplift) funding:

- Expand work with external partners particularly on tools and guidelines
- Leverage research and convening with the nutrition and health communities to engage other CRPs in new joint projects.
- Further develop the translational and knowledge sharing work with specialist knowledge translators, partners and other CRPs
- Expand country engagement to more countries
- Develop new research in consultation with countries and in convening with other CRPs and international nutrition and health partners.

W1/W2 funding
In FP4, W1/W2 funding is used strategically for synthesis and funding key research gaps in the context of a portfolio of large W3/bilateral projects assessing evidence of nutrition and health outcomes from agricultural interventions. W1/W2 funding will also be used for coordination and strategic planning with national partners and with research synthesis, communication, and convening of ANH partners from national to international levels.

2.4.3 Flagship Uplift Budget

Outcome Description	Amount Needed	W1 + W2 (%)	W3 (%)	Bilateral (%)	Other (%)
Development program implementers and investors (governments, NGOs, UN institutions) use evidence, tools and methods to design and implement cost-effective nutrition-sensitive agricultural programs at scale with increased impact through greater engagement with partners	12,000,000	49	0	51	0
Researchers and evaluators, including in CGIAR and other CRPs, use evidence, tools and methods to design high-quality evaluations of a range of nutrition-sensitive agricultural and other multisectoral programs, and continue to build evidence through expanded joint projects with other CRPs	4,000,000	49	0	51	0
Regional, international and UN agencies and initiatives and investors use evidence, tools and methods to inform decisions and investment strategies in nutrition-sensitive agricultural programs and nutrition-sensitive policies	4,000,000	49	0	51	0
National policymakers and shapers, and stakeholders from different sectors, civil society and industry use evidence to design effective nutrition-sensitive agricultural programs and nutrition-sensitive policies, and ensure quality implementation, informed by a greater exploration of locally-relevant policy research questions in more countries	12,000,000	49	0	51	0
Stakeholders from different sectors, civil society and industry listed in the other four outcomes, including CGIAR and other CRPs, have improved capacity to generate and use evidence to improve nutrition-sensitive agricultural programming, nutrition-sensitive policymaking and implementation. Working with more partners will generate a greater critical mass of engagement that increases impacts	9,000,000	49	0	51	0

2.5. Flagship Program (FP5) on Improving Human Health

2.5.1 Flagship Program Narrative

2.5.1.1 Rationale, scope

Agriculture enhances access to food and livelihoods, but may also have less desirable outcomes, such as increased risks of disease transmission. Over the past decades, CGIAR research has explored health interactions related to irrigation and vector-borne diseases, use of wastewater in agriculture, integrated pest management (IPM), and emerging and neglected zoonotic diseases (Grace et al. 2012; Boelee, Konradsen, and Hoek 2002; WHO/FAO/UNEP/UNCHS Panel of Experts on Environmental Management for Vector Control 1996). Past CGIAR initiatives, like the Agriculture and Health Research Platform (2008-2012) facilitated cooperation between research, policymakers, and practitioners working in agriculture and health. Research that bridges disciplinary divisions and enhances links between agriculture and health provides a largely untapped opportunity to improve the health and livelihoods of poor people, especially in rural areas where ill health may be the most critical pathway for staying or becoming poor, and undermines the benefits of agricultural development.

To meet the challenge of effectively linking agriculture and health research, FP5: Improving Human Health, will launch a joint research partnership between leading public health research institutes, convened by the London School of Hygiene and Tropical Medicine (LSHTM) and CGIAR, led by the International Livestock Research Institute (ILRI). Together, we offer the best methods, procedures, and tools from the agriculture and health sectors in disciplines such as biology, ecology, epidemiology, economics, risk assessment, and operational research. Public health research partners engaged through this FP will be encouraged to contribute to other public health-related issues across other FPs, and provide CGIAR with a platform for cross-sector agenda-setting and research to support health-related intermediate development outcomes (IDOs). Research outcomes from this FP will also contribute to addressing the third Sustainable Development Goal (SDG) to “ensure healthy lives and promote well-being for all at all ages” and the sixth to “ensure availability and sustainable management of water and sanitation for all.”

The development of this FP was informed by a series of three regional consultations and one global consultation convened by A4NH in 2015 to obtain advice from agriculture and public health research communities on research content and process. Focused on Africa and Asia, we identified strong regional networks working on challenges that this FP can support and build upon. Across the large portfolio of potential agriculture and health research that A4NH can enhance, we have prioritized three broad challenges critical to these regions.

The first challenge is to **identify and manage important health risks and optimize important health benefits for rural communities associated with agricultural change and intensification.** In agricultural landscapes, rural and peri-urban, farming practices affect health and its social and environmental determinants, but their impact is poorly understood. For instance, introducing irrigation often increases the abundance of vectors of diseases, like malaria, schistosomiasis, and Japanese encephalitis, while also improving livelihoods and capacity of households to prevent or manage infection. Wastewater use in agriculture poses potential infectious disease threats to farmers and consumers, but may be critical to urban food supply. How do we develop and deploy irrigation and other farming interventions with farming communities to minimize health risks while maximizing agricultural outcomes?

The second challenge is to **anticipate, prevent and manage emerging and neglected zoonotic diseases**. Three quarters of new human infectious diseases have originated in animals and, in this century, seven out of the eight major and costly human pandemic threats have arisen from livestock (Jones et al. 2013; Cleaveland, Laurenson, and Taylor 2001; Grace 2014; World Bank 2012). Cysticercosis, for example, is responsible for 2.7 million Disability-Adjusted Life Years (DALYs) lost in humans (Havelaar et al. 2015) and is ranked by the Food and Agriculture Organization of the United Nations (FAO) as the most important foodborne parasitic disease globally (FAO/WHO 2014). It has a high disease burden in poor pig-keeping communities, but can be effectively controlled through on-farm interventions like improved sanitation, pig-keeping practices, and vaccination of pigs. For such neglected zoonotic diseases, how can we devise integrated interventions between the agriculture and health sectors to prevent the substantial health burden posed by these diseases, while maximizing the benefits to livelihoods and nutrition of animal production?

The third challenge is to **identify solutions to common problems arising for agriculture and health in a development context**. About 10 million human deaths per year may be attributable to antimicrobial resistance (AMR), (Grace 2015) and this risk is rising. As much as two thirds of global antibiotics are used in livestock and fish production (Van Boeckel et al. 2015) and yet we have a very poor understanding of the significance of agricultural use to human health, particularly in low- and middle-income countries (LMICs). The development of insecticide resistance in mosquitoes threatens global goals to reduce the burden of malaria (Reid and McKenzie 2016; World Health Organization 2012). While this resistance has historical origins in pesticides used in agriculture, we know very little about the influence of agricultural use on vector resistance today. How can we manage these common interventions in health and agriculture so as to maximize beneficial outcomes for both?

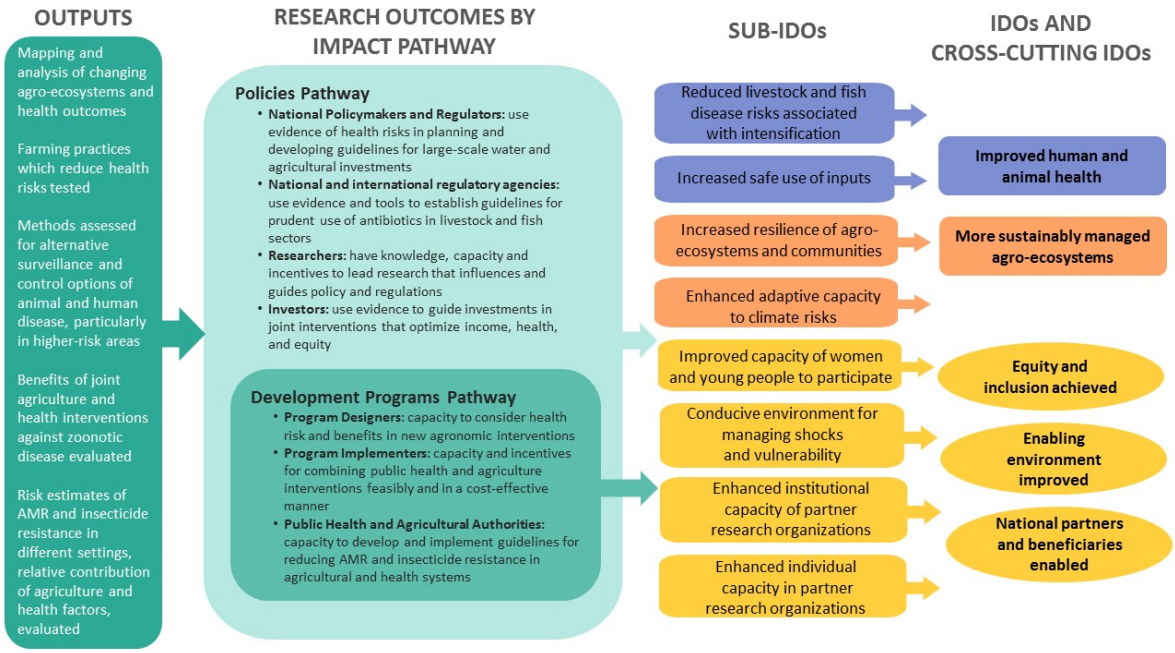
In response, FP5 will address these three challenges through three clusters of activity (CoA): CoA1: Diseases in Agricultural Landscapes, CoA2: Emerging and Neglected Zoonotic Diseases; and CoA3: Global Challenges on Agriculture and Health.

2.5.1.2 Objectives and targets

This FP is designed to directly contribute to the system level outcome (SLO) on *improved food and nutrition security for health* and the IDO on *improved human and animal health through better agriculture practices* (and its sub-IDOs), (**Figure 2.5.1**). It will also contribute to SLO3 on *improved natural resource systems and ecosystem services.* Importantly, this is a cross-disciplinary activity between sectors (agriculture/animal health and public health), with added value benefits achieved by joint actions. **CoA1**: Diseases in Agricultural Landscapes will address the IDO on *improved human and animal health through better agricultural practices* and the IDO on *more sustainably managed agro-ecosystems*. **CoA2**: Emerging and Neglected Zoonotic Diseases directly and jointly addresses the IDO on *improved human and animal health through better agricultural practices* and its sub-IDOs by focusing on human health benefits achieved by targeting transmission from livestock. A major emphasis is on sustainable control of cysticercosis in poor communities in Africa and South Asia, a defined World Health Organization (WHO) priority, and it will also make major contributions to the cross-cutting IDOs on *equity and inclusion achieved*, *enabling environment improved*, and *national partners and beneficiaries enabled* (see **Figure 2.5.1** for main sub-IDOs under these cross-cutting IDOs). **CoA3**: Global Challenges on Agriculture and Health will work mainly on AMR and will focus on human health benefits of better-managed antibiotic use in animals (livestock and fish) and align with the CRP on Livestock that will focus

on animal health benefits and risks of better managed antibiotic uses. Work on insecticide resistance will also generate human health benefits in terms of resistance events averted. Both will contribute to the IDOs on *more sustainably managed agro-ecosystems*, at national and community levels. Contributions are summarized in Performance Indicator Matrix – Table C.

FIGURE 2.5.1. IMPACT PATHWAYS FOR FP5: IMPROVING HUMAN HEALTH



This FP aims to:

1. Understand and manage the gendered human health impacts (both risks and benefits) arising from intensification and changes in land-use;
2. Deliver gender-sensitive interventions targeted at livestock systems that improve health outcomes for zoonotic diseases with livestock reservoirs (with CRP on Livestock); and
3. Understand and manage interacting health and agriculture interventions, including AMR and insecticide resistance.

By 2022, this FP expects to contribute to three main outcomes, as described in the Performance Indicator Matrix – Table B:

- Agricultural research initiatives, including farming communities, measure health risks and benefits;
- Agricultural and public health policymakers and implementers are delivering coordinated and effective solutions to cysticercosis and other zoonotic threats; and
- Public and private sector policymakers are implementing measures to reduce health risks from AMR in hotspot livestock systems.

Key milestones to be achieved include:

- At least 1 key national agricultural research authority issues recommendations that promote agricultural production methods that reduce vector risk
- 15 decision makers in national, regional, or global contexts use A4NH evidence in processes to inform policy and implementation for zoonoses prevention and control in livestock communities
- In collaboration with WHO, at least five national policy guidelines for cysticercosis control (China, India, Kenya, Uganda, and Vietnam), developed within the framework of NTD and agricultural development programs
- Cross-sectoral partnerships increase capacity to participate in efforts to manage pesticide use in agriculture and disease control in 4 countries

Target Geographies
For diseases in agricultural landscapes, particularly expansion of irrigation, we will build on current projects in Benin and Kenya and may expand later to other countries in West Africa (Cameroon, Côte d'Ivoire, Mali, and Nigeria) and East Africa (Tanzania and Uganda). Uganda will likely be one of the initial countries for work on insecticide resistance. Additional target geographies, aligned with irrigation expansion projects, will be determined in consultation with colleagues from the CRPs on RICE (AfricaRice) and Water, Land, and Ecosystems (WLE) (through the International Water Management Institute [IWMI]). For our initial target zoonotic disease – cysticercosis – our geographic targets are based on WHO targets and livestock opportunities (World Health Organization 2011), and include Kenya/Uganda, India, and Vietnam. For work on AMR in humans and animals, initial biological work (collecting bacterial isolates from humans and livestock and using state of the art molecular tools to characterize population level diversity) will build on established sites in Tanzania and Kenya (an existing aligned, bilateral project). Further work will be based on work already started on assumptions and geographies in China, India, Kenya, Thailand, and Vietnam. Three of the countries where this FP will work are among the highest priority countries for CGIAR Site Integration (++) and five more are among the list of high priority countries (+). This FP will also deliver research outputs at global and regional levels for Africa and Asia (South, Southeast, East).

2.5.1.3 Impact pathway and theory of change (for each individual FP)

For FP5: Improving Human Health, the two primary impact pathways are through programs and policies (**Figure 2.5.1**). Evidence generated by this FP will influence agriculture and health program implementers in designing and implementing more cost-effective programs, while also helping enablers, like policymakers, decisionmakers, and donors, to make sound policy and investment decisions to improve human health. This research will build on theories of change (ToCs) already developed in A4NH, such as how research influences program implementers and how to create an enabling cross-sectoral policy environment.

For CoA2: Emerging and Neglected Zoonotic Diseases, there is complementarity with FP3: Food Safety, which focuses on interventions through the agri-food value chains impact pathway and this FP, which works through agriculture or public health program interventions. The partners for enabling policies and regulations include FAO, World Organization for Animal Health (OIE), WHO, and with food, public health, and veterinary agencies in countries. ILRI has an important role in these policy and regulatory

convenings through its participation in the Livestock Global Alliance. Policy relevant research will link to policy analysis and process research in FP4: SPEAR.

One key assumption underlying both the program and policy ToCs is that agriculture and health researchers must work productively together. The usefulness of outputs and outcomes from interdisciplinary research in this FP will largely depend first on researchers, then on governments' willingness to break down sectoral silos and establish effective institutional arrangements between sectors, as envisaged in the SDGs. To date, the greatest agriculture-health cross-sectoral successes have come through the application of a One Health approach, which describes the integrated effort of multiple disciplines working together to attain optimal health for people, animals, and the environment. One Health has been successfully implemented at scale, for example, in the control of *rhodesiensis* sleeping sickness (a zoonosis) in Uganda, brucellosis in Mongolia, and for avian influenza in a number of countries. Researchers in this FP have developed frameworks to consider the cross-sectoral benefits of managing brucellosis using One Health (McDermott, Grace, and Zinsstag 2013) and more broadly, WHO (2011) has highlighted the added benefits from the One Health approach, which goes well beyond researchers cooperating effectively and into the adoption of an integrated approach by policymakers. For example, our work in Kenya contributed to two kinds of achievements: *structural*, in the establishment of a Kenyan One Health office, which is jointly funded by health and agriculture government ministries, and *functional*, in that the collaboration resulted in the design of a joint integrated response to Rift Valley fever (RVF) outbreaks (Mbabu et al. 2014). Methods of joint work between sectors will be a key secondary output of this FP, linked closely with policy work planned in FP4: SPEAR.

We have already explored the potential for cross-sectoral ToC development in a series of regional consultations with agriculture and health researchers held in 2015, where A4NH's overall approach to impact pathways and ToCs (Mayne and Johnson 2015) was enthusiastically endorsed. Initial ToCs were developed for cysticercosis and AMR, for further development and integration into the research process, summarized in the consultation report. Beyond direct health benefits, outcomes across all proposed research will likely integrate equity, gender, youth and vulnerability issues. For example, emerging zoonoses often cause panic and lead to market disruption, reduced access to inputs, and diversion of funding to emergency responses, that can be much more harmful to poor producers and consumers than direct losses from the disease (McDermott and Grace 2011). Key assumptions in the ToCs include the acceptability and accessibility of solutions for intended beneficiaries and the degree to which program implementers and enablers can jointly design and adapt interventions that are feasible, scalable and sustainable.

In newer areas of research, this FP will generate research outputs through evidence gap mapping and systematic reviews supported by epidemiological studies, analysis of geospatial data on changing patterns of agriculture and health, formally assessed intervention trials in multiple countries, and bacterial genetics studies on AMR to assess and quantify risks. We will also undertake innovative economic assessments of health costs of agricultural practices, intersectoral cost-benefits of different interventions, and how the benefits and costs are distributed by gender, age and other social categories. This will provide guidance, and an economic justification, for implementing proposed outcomes. New research approaches will be developed, including innovative ways to combine existing agriculture and health data and synthesize evidence across sectors and contexts.

2.5.1.4 Science quality

The major gap this FP fills is the lack of coordinated agriculture and health research expertise on human health challenges associated with agriculture. By linking CGIAR experts in agricultural systems in LMICs with health experts in the same regions and at the international level, we will create and apply interdisciplinary tools and methods to identify research priorities and design coordinated interventions that can mitigate the negative effects of agricultural activities on human health and/or maximize opportunities for agriculture to benefit human health. Our work will involve integrating datasets collected and maintained by different sectors in addition to developing new tools and metrics. As a result, there will be several important practical applications:

- Economists will collaborate with epidemiologists to create innovative ways to measure **combined agriculture and health benefits and costs** of interventions in target populations;
- Agro-ecosystem experts will work with epidemiologists and social scientists to understand and **manage agricultural processes for positive health benefits**;
- Animal health and human health epidemiologists and evaluation specialists will work together to **model and measure cross-sectoral risks** (e.g. for zoonotic disease or AMR and ACR); and
- Molecular biologists will develop and apply genomic methods to measure the movement of pathogens and **pathogen resistance between livestock and humans**.

Work on improving human health draws on many years of CGIAR research and existing close partnership with public health institutions. In East Africa, ILRI research has focused on emerging infectious diseases and neglected zoonoses and researchers have worked closely with civil society and government partners. To date, some of the generated evidence that is influencing policymakers includes: (1) Vector-borne and zoonotic diseases are important, under-reported causes of illness and often misdiagnosed; (2) Degraded landscapes have more disease, but the relation between biodiversity and disease is not straightforward; (3) Gender is an important determinant of human exposure to mosquito-borne infections in irrigated and non-irrigated regions; (4) Domestic pigs are important reservoirs for a number of emerging disease issues, and increases in pig production increases the risk of transmission to humans; and (5) Middle East Respiratory Syndrome (MERS)-Coronavirus has been circulating in camels for decades undetected in Kenya. Researchers in this FP have been working closely with government partners in several countries to improve surveillance and response to zoonotic disease issues, including through providing evidence and tools for decisionmakers – like risk maps, decision support tools, and modeling of vaccination strategies – that increases their capacity to compare different control options.

In Asia, ILRI partnered with the Hanoi School of Public Health, Chiang Mai University, and the Public Health Foundation of India (PHFI) and others to conduct capacity building and research in EcoHealth. Like One Health, but newer, EcoHealth describes a field of study researching how changes in the earth's ecosystems affect human health. It also encourages disciplines to work together to create joint solutions. To date, key EcoHealth achievements by our researchers and their partners include the establishment of two EcoHealth Research Centers at universities in Thailand and Indonesia, engagement with provincial-level decisionmakers leading to the scale out of community-based rabies management in villages across Bali in Indonesia, and the introduction of systematic prioritization for zoonoses in Vietnam. In India, our collaboration with the (Phase I) CRP on Livestock and Fish supported the assessment of bovine reproductive diseases (including zoonoses) in Bihar, India.

Although the link with the public health research community, led through LSHTM, is new and now formalized, it builds on previous work. LSHTM is a key partner in the Leverhulme Centre for Innovative Research on Agriculture and Health (LCIRAH). Established in 2010, LCIRAH is a unique inter-institutional, interdisciplinary, and inter-sectoral collaboration for research and capacity building in agri-health. During Phase I, LCIRAH and A4NH worked closely together on several initiatives, including the development of the Agriculture, Nutrition and Health Academy (ANH Academy), to accelerate innovative research on methods and metrics for designing and evaluating agricultural interventions, which A4NH and LCIRAH officially launched in June 2014. Over the past five years, LCIRAH has built a unique interdisciplinary academic research consortium with research and capacity building initiatives linking human health and agriculture, including work on human-animal interfaces, through projects with the Royal Veterinary College (RVC), LSHTM, and ILRI. This proposal expands this LCIRAH-A4NH involvement, and draws in a range of other public health research sector partners, to bring in new areas of public health research, including malaria and other infectious diseases, AMR, vector management, epidemiological modelling, health policy, medical anthropology, and gender and public health. LSHTM and the other partners have an outstanding track record in these subject areas and extensive links with other globally recognized leaders, including institutions in Africa, Asia, and Latin America.

Our role as evidence providers is increasingly recognized. The United Kingdom's Department for International Development (DFID) commissioned researchers from this FP to undertake the first systematic mapping of poverty and zoonoses, and evidence summaries on AMR and MERS. The OIE-commissioned us to develop estimates of the impacts of livestock diseases (including zoonoses and diseases of most importance to women and poor livestock keepers). The CRP on Climate Change, Agriculture, and Food Security (CCAFS) requested that we develop a paper on climate-sensitive livestock pests, which was presented to the United Nations Framework Convention on Climate Change (UNFCC); and, currently, some researchers are contributing to a *Lancet* commission on climates change and health (Grace et al. 2012; Jones et al. 2013; Grace 2015; Watts et al. 2015; Jores 2015; Grace et al. 2015). LSHTM has emerged in recent years as a center for research on interactions between health, agriculture, and environment, contributing to novel evaluations of health and environmental co-benefits from agricultural change, including the Rockefeller Foundation-Lancet Commission on Planetary Health, co-chaired by LSTHM/LCIRAH member Sir Andy Haines. LSHTM currently holds four of the ten international research grants awarded by the Wellcome Trust in its new program, Our Planet Our Health, which seeks to link environmental change, including agricultural change, with health outcomes.

During Phase I, the A4NH flagship on Agriculture-Associated Diseases had a high ratio of peer-reviewed publications in Institute for Scientific Information (ISI) journals compared to the overall research budget. Most partners also have processes in place for internal reviews for research outputs not sent for peer-review (though we emphasize that most of our evidence outputs will be peer reviewed, Open Access [OA] publications). ILRI has an institute committees on ethics, animal welfare and biosafety which ensure projects meet best practices. LSHTM is one of the leading public health champions in promoting ethical evaluation of lab- and field-based research. IFPRI has an institutional review board, and as Lead Center of A4NH, has agreed to share its subscription in the online Collaborative Institutional Training Initiative (CITI Program) with A4NH affiliated researchers outside of IFPRI to complete online training courses on the historical development of protections of human subjects involved in research and current information on regulatory and ethical issues.

2.5.1.5 Lessons learnt and unintended consequences

Moving into Phase II, we plan to continue working on areas, such as zoonoses, using One Health and Ecohealth approaches in Africa and Asia. At the same time, we will develop a research agenda with new public health partners, facilitated by LSHTM, to bring strong health research expertise into ongoing activities in particular vector-borne diseases, AMR in humans, and socio-economic health systems and policy research, which are relevant to research challenges addressed by CoAs in this FP.

In developing FP5: Improving Human Health, we sought advice from our external evaluators on the past history of agriculture and health research and opportunities for the future and we conducted a series of consultations with agriculture and health researchers. From this, it emerged that cross-sectoral collaboration requires a strong appreciation of the benefits and a respect for the valuable knowledge held by each sector. The public health researchers consulted welcomed agricultural research collaboration on health issues associated with ecosystem change and global challenges, such as AMR and chemical resistance to help the health community move beyond response and into mitigation and prevention. To succeed, this cross-sectoral convergence approach must be agreed upon and supported by implementers from government agencies, for example, as well as enablers, like donors and policymakers.

Much of the success of previous work on the human side of public health, and the basis for planned outputs and outcomes in the first three years of Phase II, is the result of long-standing collaborations with national champions, both inside and outside CGIAR. This resource, especially strong in East Africa, Southeast Asia, and West Africa is key to obtaining credibility and impact in the Phase II. See, for example, participation lists from our regional consultations.

We will rely on lessons learned from past collaborations between CGIAR Centers and public health research, for example, between WHO and IWMI, AfricaRice, International Service for National Agricultural Research (ISNAR) and IFPRI, and system-wide initiatives on malaria, IPM, and wastewater in agriculture. LSHTM, through its five-year experience in LCIRAH, brings to Phase II important experience on building effective research programs across these sectors. Lessons learned include:

- It takes time to establish interdisciplinary relationships, mutual understanding, and effective ways of collaboration;
- Evidence generated must be validated by both the agricultural and health research perspectives, and communicated in both communities through their respective journals and institutions; and
- Research should be policy relevant to both sectors and to the concept of intersectoral action.

We will apply these lessons to develop and strengthen links between public health research and agricultural research within the new CGIAR research portfolio. Given the importance of cross-CRP collaboration, and the position of A4NH as an integrating CRP (ICRP), we will work closely with the AFS-CRPs, such as Fish; Forest, Trees, and Agroforestry (FTA); and Livestock on topics like zoonoses and AMR. We will also collaborate with the ICRPs, CCAFS and WLE, and with the AFS-CRP on Rice, on issues related to agricultural intensification and health risks in communities, for example, of irrigation expansion in Africa, and of the impact of climate change on disease distribution. Partnerships already exist with colleagues researching livestock value chains in Asia and Africa, fish value chains in Africa, and vegetable value chains in Asia, which we will build upon through joint fundraising and shared use of epidemiological and laboratory facilities.

2.5.1.6 Clusters of activity (CoA)

CoA 1: Diseases in Agricultural Landscapes
Agriculture is a primary driver of landscape change in rural settings, which have important consequences for infectious disease. This CoA will examine the disease-related effects of agriculture, both as ecological/biological processes, and as social/cultural/economic processes. The overall aim of this CoA, which is supposed by previous IFPRI research (Wielgosz et al. 2012), is to identify modes of agricultural practice that may enable farming communities to enjoy the benefits of intensification, while avoiding or minimizing unintended negative consequences.

We will consider a range of diseases, vectors, and settings, but will initially focus on irrigated cropland, given its expansion in Africa, and its major source of vector breeding sites. Focus settings will be:

- Mosquito vectors of malaria and RVF in African rice fields;
- Malaria vectors in market gardening in urban and semi-arid parts of Africa; and
- Mosquito vectors of Japanese Encephalitis virus (JEV) in Asian rice fields.

Changes in agriculture can affect disease transmission by (1) creating vector breeding sites, (2) altering adult vectors' access to humans, and (3) affecting the ability of humans to defend themselves from vectors and pathogens. In each setting, the work will have two strands: community and ecology. On the community side, the social factors affecting use of nets and other forms of personal protection is already a major focus of health research, but we know nothing about farmers' attitudes toward their role in growing mosquitoes. To develop the foundation for participatory development of agronomic practices to reduce disease transmission, we will study farmers' understanding of:

- Mosquito breeding and attitudes to it,
- Methods of protection including nets,
- House design and the keeping of livestock,
- Household decision making and the role of women, and
- Externalities and inequities

The ecology side has two aspects. One is understanding how we can maximize crop productivity, but minimize mosquito productivity. There is preliminary evidence that methods of field preparation, water management, transplanting methods, weeding, and application of fertilizers and pesticides can all impact mosquitoes. We will identify rice research settings where we can add indicators of mosquito productivity to existing sampling routines to measure productivity. If promising culture methods are identified in this way, experimental field trials will begin to confirm their potential. CRP RICE (through Africa Rice) has agreed to collaborate in this effort, which will take place in East and West Africa. The other ecological element concerns other vector characteristics – such as host choice and longevity – that can affect transmission intensity even more than vector numbers. These can have a major effect. For example, in Kenya, more livestock was reported in villages with irrigation, which reduced malaria. Conversely, other reports have speculated that higher levels of humidity may increase vector longevity, and thus could promote transmission. We will use classical and new tools for measuring longevity to understand how changing agricultural landscapes can influence transmission, in order to learn whether there are farming practices that can prevent an increase in transmission despite an increase in mosquito numbers.

We will also ask a more open and large-scale question about the links between agriculture and vector borne disease. Crops and malaria both vary with climate and season, but we do not know whether there is any significant association between agro-ecosystem change and the change in malaria and other vector borne diseases in a given area. We will work with HarvestChoice at IFPRI, which has an exceptionally detailed dataset on crops, and the Malaria Atlas Project (MAP) of Oxford University, which has extensive geospatial data on malaria, to address this question using hypothesis-driven analysis. A national-scale CGIAR study in Uganda (Wielgosz, Kato, and Ringler 2014) suggests that this analysis may produce interesting hypotheses to merit further investigation.

Major outputs and outcomes of this CoA will be: potential interactions between health and agriculture identified through linked geospatial analysis of irrigated crop production systems in West and East Africa (2017), and field trials of methods to reduce disease risks in irrigated crop production systems, based on intial assessments of KAPs of household farming communities in relation to vectors and vector-borne disease problems, completed in sites in West and East Africa (2022). More detail can be found in Performance Indicator Matrix – Table D.

CoA2: Emerging and Neglected Zoonotic Diseases

ILRI research to date (Gilbert et al. 2015) has helped to identify priority zoonotic and emerging diseases and countries where they are particularly problematic. Our focus will be to integrate agricultural and health data to analyze the effects of livestock systems change on zoonotic and emerging disease burden, and to test agricultural actions that can mitigate these disease risks. We will maintain a strong emphasis on existing Phase I research that have or will soon generate successful outcomes (Ng'ang'a, Bukachi, and Bett 2016; Gray et al. 2015; Munyua et al. 2016)(Deem et al. 2015), and broader One Health and Ecohealth approaches to control. Focus countries will be Kenya, Uganda, Vietnam and India (Prasad et al. 2008), and our initial target zoonoses will be the neglected tropical disease, cysticercosis, caused by infection with the helminth tapeworm *Taenia solium*. It has been prioritized internationally at the highest level by FAO/OIE and WHO (Havelaar et al. 2015; FAO/WHO 2014; Maurice 2014). Its control is primarily focused in the pig reservoir, with human health benefits, thus making it ideal for One Health research. Successful control will rely on joint public health programs and pig value chain interventions and thus fits well in this FP although there is a clear interface with FP3: Food Safety. Our work will contribute to pig keeping systems which are growing rapidly in many countries in Africa and Asia. Our applied research, in collaboration with partners, will develop community-wide cysticercosis control at scale. WHO, partnered with CGIAR, has spearheaded efforts at international coordination (Maurice 2014), and highlighted the following new tools of note: a pig vaccine (Assana et al. 2010) to prevent infection with cysts in the pig host; the licensing of oxfendazole (Gonzalez et al. 2001), an anti-helminthic drug used to kill cysts in the pig; novel point-of-care diagnostic assays for cysticercosis diagnosis in the field; and improved understanding of the infection's epidemiology and public health burden (Wardrop et al. 2015; Thomas et al. 2015).

Proposed activities will include:

1. ***Development of diagnostic assay:*** Building on existing CGIAR work to optimize a pen-side assay system, we will test it widely with farmers and field vets. This validation will include implementing a field study to quantify diagnostic parameters in field conditions in Kenya, Uganda, and Vietnam.
2. ***Policy formulation for cysticercosis:*** In both Asia and Africa, we will work closely with stakeholders, under a WHO umbrella, to develop national policy guidelines for cysticercosis control. The priority is

to integrate the required activities within the framework of countries' neglected tropical disease and agricultural development programs. Our target countries will be China, India, Kenya, Uganda, and Vietnam.

3. ***Intervention trials including vaccine delivery:*** A number of intervention options are available to fit with country specific priorities (Thomas 2015), including use of the new vaccine together with oxfendazole treatment, value chain interventions, treatment of human carriers and improved sanitation in rural communities. The choice of control tools will depend on the local disease, social and policy landscape. We will trial combinations of control tools in an Asian and African site (e.g. Uganda/Kenya and Vietnam/China), with expansion when successful. We will work closely with partners to produce a proof-of-concept of control on a large scale, which will then provide the evidence base to attract significant development funding for implementing control.

Major outputs and outcomes of this CoA will be: quantitative gold standard data on diagnostic assay performance (2017); a validated and semi-commercialized diagnostic assay in use by stakeholders (2018); and tested intervention strategies backed by region-specific policy advice (2022).

CoA3: Global Challenges on Agriculture and Health

Rapid changes in both agricultural development and efforts to address disease burdens in LMICs are bound to interact. New challenges which arise for each may be more effectively addressed if actions are coordinated, particularly where there may be an interaction between specific interventions. In recent years, two such challenges have arisen: the rapid development of AMR in human and animal health, and the development of insecticide resistance in crop pests and disease vectors. From a health sector perspective, both problems are of enormous significance.

Our research will address the question, **"what is the relationship between the development and spread of AMR in animal and human health systems in LMICs, and what measures will best minimize health risk?"** This CoA will focus on the role that a changing livestock sector in LMICs may play as an incubator for development of AMR in both livestock and humans. Ensuring effective antimicrobials for humans is just one dimension of protecting health and livelihoods. Livestock are a critical resource in many poor households, and AMR can therefore undermine both livelihoods and health. Our research will generate an understanding of these complex relations, as well as the implication for health and livelihoods of AMR management interventions in both sectors. This CoA will have three components:

1. We will significantly improve estimates of levels and trends in antimicrobial consumption in livestock production in LMICs. Relatively few estimates of antimicrobial use in livestock currently exist outside OECD countries and information on use in LMICs is very poor. We will build on existing mapping work at ILRI (Van Boeckel et al. 2015), working with organizations like OIE to extend collection of data, reconcile existing estimates across a range of spatial scales, and bridge the gap between the bottom-up approaches based on treatment guidelines (e.g. in China) and top-down approaches based on sales data.
2. We will explore the biology, ecology and epidemiology of AMR in order to understand and quantify the contribution of antimicrobial use in agriculture to the development of AMR in medically important pathogens. We will develop experimental sites where we will evaluate antimicrobial sales, product quality and usage in the human and animal health sectors, and link these to biological studies on appropriate pathogens and resistance genes, using molecular techniques to map AMR distribution across hospitals, clinics, animal production facilities, households, livestock and connecting environmental pathways. We will use whole genome sequencing to reveal and begin to

quantify the two-way traffic of AMR bacteria between the farm and the clinic and will identify key drivers of AMR exposure and evolution in low income settings. We have identified several potential sites for initial work in Kenya and Tanzania where platforms are established for linked veterinary and medical research; we will extend work later to Asia.

3. We will research potential interventions for reducing AMR risks through managing antimicrobial use in the livestock sector in LMICs. This work will begin with an exercise involving biologists, epidemiologists, social scientists, economists and policy specialists to identify potential animal-human AMR hotspots where interventions could have the greatest impact on human and animal health and be most amendable to policy interventions in one or both sectors. Once identified, we will draw on existing experience in both human and animal systems to design experiments on the effects of regulatory and behavior change interventions. These might include 'lab-in-the-field' experiments, where farmers and value chain actors will be faced with real choices that mirror the drug use decisions they make day-to-day, but where key parameters can be experimentally varied and consequences can be monitored.

Major outputs and outcomes of this CoA will be detailed information to policymakers and multi-stakeholder platforms including: current and projected consumption of antimicrobials in livestock under different growth scenarios (2017); a framework and monitoring system for antimicrobial use in livestock, disaggregated by production system, purpose of use, dosage and antimicrobial type (2018); phylogenetic analysis of bacterial and genes isolates indicating the evidence for and pathways of resistance flow between animals, food systems, environment and humans (2019); and the benefits and costs (including trade-offs) of different interventions to reduce the use of antimicrobials and to interrupt transmission pathways in developing country agriculture (2022),

Insecticide resistance in agricultural and health systems

In recent years, resistance to pyrethroid insecticides used in malaria control has been evolving rapidly; in some parts of Africa it has reached very high levels (1000-fold) (Hemingway 2014). In its Global Plan for Insecticide Resistance Management in Malaria Vectors, the WHO estimates that this resistance problem could eventually lead to an additional 259,000 child deaths every year in Africa, and calls for inter-sectoral action involving local agricultural authorities (World Health Organization 2012).

Historically, agricultural insecticide use in Africa has contributed to the generation of insecticide resistance in mosquitoes in several cases (World Health Organization 2012; Reid and McKenzie 2016), but there are other cases where anti-malaria spraying was instead the main selective force (Lines 1988). Understanding the crop systems and conditions under which agricultural insecticide use contributes to vector resistance is needed, particularly in light of major new donor investment in the development of novel insecticides for use against insect disease vectors. Working initially in East Africa with researchers studying insect vector resistance, we will evaluate the role of agriculture in its origin and maintenance. This will involve studies on **the cross-resistance spectra of the main resistance genes in adults and larvae, and the associations between resistance gene frequency and the timing and location of insecticide use.** Our research will inform and catalyze cooperation between initiatives on IPM and integrated vector management (IVM). The main outputs will be an understanding of whether and how agricultural insecticide use contributes to vector resistance (2018) and how best to integrate agricultural and medical use so as to minimize resistance, particularly for new products now in development (2020).

2.5.1.7 Partnerships

Our research partners include both advanced and developing country research institutes and academic institutions at the national and international level. In each focal region, we have identified a group of agriculture and health research champions, many already engaged in One Health research through programs. These regional actors will help facilitate joint research, networking, and mutual learning. In addition, LSHTM will convene a cross-sectoral learning platform between agricultural and public health researcher communities, with the following aims:

- Convening - establishing through A4NH an international learning platform and interactions space for agriculture and health research communities working in international development, including the funder of that research;
- Capacity – developing understanding and appreciation of research approaches and methods across sectors, and ideas for inter-sectoral research approaches; and
- Collaboration - jointly identifying research problems where collaborative research will improve outcomes and impacts of interventions in either or both sectors.

Through theme-based symposia involving natural and social scientists from both sectors, we will identify and develop joint research areas. LSHTM and other public health partners (PHFI, the Swiss Tropical and Public Health Institute, and the Institute of Infection and Global Health at the University of Liverpool) will coordinate symposia. We will engage non-academic health bodies, including WHO, Wellcome Trust, the Bill & Melinda Gates Foundation, Global Fund, and the *Lancet*. ILRI, IFPRI, International Institute of Tropical Agriculture (IITA), IWMI, and other CGIAR Centers/CRPs will represent the agricultural research community. Short studies commissioned from inter-sectoral teams will guide development of new methods and research programs. We will build consensus around action in both sectors to generate added value through joint research. We will prepare joint funding calls to targeted bilateral donors, including the Wellcome Trust, the Swiss Science Foundation, the UK Research Councils, National Institutes of Health/ National Science Foundation (NIH/NSF), and DFID. LSHTM has unique experience in successful research collaborations with the agricultural sector through its membership in LCIRAH, with RVC, and the School of Oriental and African Studies in London.

We rely heavily on partnerships with program implementers, including government departments and ministries, the United Nations, and other global initiatives, non-governmental organizations (NGOs), civil society organizations, and farmers' groups, that all play critical roles in development programming. A4NH helps development implementers increase the effectiveness of their joint agriculture-health programming. For example, we have worked closely with the Kenya Government Zoonotic Disease Unit, supporting their evidence generation to directly inform policy (Obonyo et al. 2016; Wardrop et al. 2015; Thomas et al. 2015), WHO work on food-borne parasites (Torgerson et al. 2015), and DFID work on AMR (Grace 2015). Many of our national partners have developed relationships with important civil society and community groups, which enhances the likelihood research outputs can contribute to achieving outcomes.

There is a unique role for engaging the private sector in FP5. The pharmaceutical industry and pesticide companies (including those based in target countries) have an important role in improving antibiotic and pesticide use, and in producing and distributing diagnostic assays.

This flagship will build on its experience working with enablers, such as policymakers and decisionmakers, and investors involved in creating enabling environments for agriculture and health at national, regional, and global levels, including Phase I linkages with global enablers, such as DFID, Organization for Economic Co-operation and Development (OECD), OIE, FAO and WHO.

2.5.1.8 Climate change

Climate change mediates a strong interaction between agriculture and human health outcomes in several ways. Firstly, it will influence health outcomes through its effects on agriculture, e.g. through changes in patterns of irrigation and livestock production and consequent impacts on vector borne disease. Secondly, climate change will impact directly on the ecology and epidemiology of disease, affecting the distribution and dynamics of vectors and pathogens, for instance the evidence, which has been challenged, that climate contributes to altitudinal distribution of vectors and malaria. Finally, climate effects will have separate but concurrent effects on both agriculture and health, the interactions of which are uncertain, e.g. the demonstrated effects of El Nino periods on both crop production and malaria. We will investigate in particular the potential of climate change to drive a great expansion of irrigation-water reservoirs and on-farm dams and its effects on water-related disease like schistosomiasis and malaria. Livestock production and intensification will also be linked to climate change and through zoonotic disease to health outcomes. RVF, a subject of study by ILRI in Phase I of A4NH, is a clear example of how changing rainfall patterns influence disease dynamics and reservoirs in livestock, with implications for human health. We plan to explore linkages with the CRP on Livestock and with CCAFS on this topic during Phase II.

2.5.1.9 Gender

Past research has shown gender differences in disease risk and outcomes (Rathgeber and Vlassoff 1993; Wang et al. 2006). An important research topic in this flagship will be to see how women's empowerment and gender-based differences in roles and responsibilities influence differential risk, prevention of disease, and management of health. In CoA1: Diseases in Agricultural Landscapes, for example, we want to explore in detail how more specific routine tasks such as providing water for drinking and cleaning and exposure to vector-borne disease during farming and other activities in agricultural landscapes impact health outcomes.

Key research questions of to help understand the unintended consequences of agriculture on health outcomes and gender-based differences are:

1. How do the health risks and benefits of agriculture vary by gender (unintended consequences; gender-based differences)?
2. How does gender influence decisionmaking about agricultural intensification, and how can women be more involved in decisions about how to improve management of agricultural intensification to improve health outcomes? (gender-based differences),
3. How can integrated agricultural and health development interventions engage women and girls while avoiding harm to women's time and health (unintended consequences)?
4. How can they engage men to play a greater role in supporting better health?

Some examples of the gendered outcomes that we hope to influence are:

- Water development and irrigation planning and practice for agriculture take into account evidence of gender and disease risks in prioritizing actions (CoA1: Diseases in Agricultural Landscapes).
- National and/or regional emerging disease response plans take into account evidence on the gender and equity impacts of past emerging disease outbreaks like avian influenza (CoA2: Emerging and Neglected Zoonotic Diseases and CoA3: Global Challenges on Agriculture and Health)

2.5.1.10 Capacity development

Strengthening capacity of agricultural researchers to understand the potential impact—positive and negative—of their research on health outcomes, is a key activity and responsibility of this FP. We will contribute to four of the nine elements of CGIAR capacity development. We will develop **CRP and Center capacity to partner** (Element #3) with public health research through the Platform for Public Health and Agriculture Research Collaboration, and through specific project collaborations. Through the ANH Academy, we will **design and deliver innovative learning materials and approaches** (Element #2) and **develop future research leaders through fellowships** (Element #4) which provide inter-sectoral supervision and mentoring. In Phase I, the flagship on Agriculture-Associated Diseases had an excellent track record of engaging in country postgraduates (50%+ female) in our research activities.

This FP partners with strong intersectoral capacity development institutions and networks in Africa and Asia. In India, PHFI integrates both research and public health capacity development with a focus on Ecohealth. In Southeast Asia, effective regional networks and platforms, such as the One Health/Ecohealth Resource Center and Veterinary Public Health Center for Asia Pacific (VPHCAP) at Chiang Mai University (Thailand) and the Hanoi School of Public Health, will be active partners. Past investments by Wellcome Trust have established two agriculture-health networks, Southern African Centre for Infectious Disease Surveillance (SACIDS) and Afrique One, in Eastern and Southern, and West and Central Africa, respectively. We will link these with research through the IITA-convened Agro-Ecohealth Platform, ILRI-coordinated zoonoses research efforts in East Africa, and LCIRAH's One Health program between the Royal Veterinary College and. These partners provide this FP with expertise and models for **institutional strengthening** (Element #6) in agricultural research for improving human health.

2.5.1.11 Intellectual asset and open access management

In Phase II, researchers in this FP will contribute a number of intellectual assets, such as spatial maps of livestock and fish systems, antibiotic use in livestock and data on microbes; evidence for policy and regulation to engage governments and inter-governmental organizations; microbial isolates frozen in curated OA biobank (ILRI-BecA Azizi); genome sequence data in GenBank; DNA and serum samples and parasite/microbe isolates as part of ILRI-BecA Azizi OA BioBank; and databases merging human and agricultural data on agricultural intensification, pathogen risks, morbidity and mortality, disaggregated by sex, linked to socio-economic data.

These intellectual assets will be designed with CGIAR OA and open data principles in mind, for example: peer-reviewed papers will be published in an open-access format; researchers will make their raw data

available to other researchers through their Center/Institute-specified platform in a timely manner; and tools to support improved decision making developed by FP5 will follow OA and open data principles. All of these actions minimize the hurdles to scaling out. More details on both A4NH management of open access and open data and on intellectual assets are found in Annexes 3.8 and 3.9, respectively.

2.5.1.12 FP management

FP5 will be co-led by two A4NH managing partners: ILRI and LSHTM. LSHTM is based in London with global projects on health issues and is a global convener of the international public health community. ILRI in Nairobi works with a network of livestock and health related projects across the tropics, with in house expertise on zoonoses (partly due to co-location of University of Liverpool scientists on the campus in Nairobi).

The co-leaders have jointly recruited a leader for this FP, Eric Fèvre, a Joint Appointee of the University of Liverpool and ILRI for the past seven years based at ILRI in Nairobi. ILRI and LSHTM will support him in convening a FP management team of senior researchers from different institutes to work together to plan, implement, and evaluation the research.

LSHTM will lead CoA1: Diseases in Agricultural Landscapes (Jo Lines) and the networking of public health and agricultural research, ILRI (Eric Fevre) will lead CoA2: Emerging and Neglected Zoonotic Diseases and LSHTM and ILRI will jointly lead CoA3: Global Challenges on Agriculture and Health (Tim Robinson and Jo Lines). For each CoA, a large number of academic and development partners already exist, and these ongoing collaborations will be further built upon. IITA in West Africa and ILRI in East Africa will play a critical role in facilitating regional partnerships. From CGIAR, researchers in A4NH (mainly from ILRI and IITA) have produced key priority-setting and systematic evidence reviews to inform proposed Phase II research. CVs can be found in Annex 3.7

A Program Manager working for ILRI will be responsible for coordinating the co-lead partners and having the primary interface with A4NH. The FP management team will meet physically at least twice per year, and will convene monthly virtually to ensure activities are on track. The administrative support at ILRI will maintain a formal Risk Register, and will regularly report on progress against a detailed program of agreed timelines.

2.5.2 Flagship Budget Narrative

2.5.2.1 General Information

CRP Name	CGIAR Research Program on Agriculture for Nutrition and Health
CRP Lead Center	International Food Policy Research Institute (IFPRI)
Flagship Name	FP5: Improving Human Health
Center location of Flagship Leader	International Livestock Research Institute (ILRI)

2.5.2.2 Summary

Total Flagship budget summary by sources of funding (USD)

Funding Needed	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Total
W1+W2	2,000,000	2,100,000	2,210,000	2,320,000	2,430,000	2,550,000	13,610,000
W3							0
Bilateral	3,905,670	5,734,163	6,825,365	7,441,005	8,252,666	8,956,551	41,115,423
Other Sources							0
	5,905,670	7,834,163	9,035,365	9,761,005	10,682,666	11,506,551	54,725,420

Funding Secured	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Total
W1+W2 (Assumed Secured)	2,000,000	2,100,000	2,210,000	2,320,000	2,430,000	2,550,000	13,610,000
W3							0
Bilateral	473,998	208,502					682,500
Other Sources							0
	2,473,998	2,308,502	2,210,000	2,320,000	2,430,000	2,550,000	14,292,500

Funding Gap	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Total
W1+W2 (Required from SO)	0	0	0	0	0	0	0
W3 (Required from FC Members)	0	0	0	0	0	0	0
Bilateral (Fundraising)	-3,431,673	-5,525,661	-6,825,365	-7,441,006	-8,252,666	-8,956,552	-40,432,923
Other Sources (Fundraising)	0	0	0	0	0	0	0
	-3,431,673	-5,525,661	-6,825,365	-7,441,006	-8,252,666	-8,956,552	-40,432,923

Total Flagship budget by Natural Classifications (USD)

	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Total
Personnel	2,475,813	3,903,736	4,652,023	5,241,392	5,964,898	6,539,579	28,777,443
Travel	123,734	154,968	309,203	335,968	310,734	335,734	1,570,343
Capital Equipment	72,646	85,292	85,292	85,292	72,646	72,646	473,818
Other Supplies and Services	1,378,964	1,580,125	1,650,706	1,652,851	1,752,533	1,810,365	9,825,546
CGIAR collaborations	0	0	0	0	0	0	0
Non CGIAR Collaborations	1,000,103	1,000,103	1,060,750	1,060,750	1,060,750	1,110,750	6,293,207
Indirect Cost	854,409	1,109,935	1,277,389	1,384,750	1,521,103	1,637,475	7,785,063
	5,905,669	7,834,159	9,035,363	9,761,003	10,682,664	11,506,549	54,725,407

Total Flagship budget by participating partners (signed PPAs) (USD)

	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Total
International Livestock Research Institute	2,426,288	4,225,031	5,093,906	5,473,436	5,950,387	6,296,477	29,465,527
LSHTM	2,595,991	2,652,350	2,855,022	3,218,766	3,665,886	4,136,661	19,124,678
IITA	883,391	956,780	1,086,436	1,068,802	1,066,394	1,073,412	6,135,216
	5,905,670	7,834,161	9,035,364	9,761,004	10,682,665	11,506,550	54,725,414

Explanations of these costs in relation to the planned 2022 outcomes:

FP5 is a newer research program in A4NH, most research will be at an early stage, personnel costs is the key cost driver. Personnel include a mix of senior research staff, younger researchers and technical/managerial staff. Some key staff are already in place and some new hires will be required as the FP expands. CoA2 (cysticercosis control in the field) and CoA3 (AMR) are expected to expand most. Also, as in other multi-sectoral research, partnership contracts will also be critical costs. The work in CoA1 and CoA3 is newer and thus outcomes will come later. Budget risks for outcome targets are greatest for CoA2, particularly for plans for scaling control and elimination of cysticercosis.

The FP, Professor Eric Fèvre, is a Joint Appointee (with the University of Liverpool's Institute of Infection and Global Health) at ILRI, based at ILRI. Eric will provide 30% of his time to flagship leadership at University of Liverpool costs. Eric will be supported by one identified senior personnel from LSHTM and ILRI. ILRI will be responsible for monitoring, reporting and all other management and administrative support to the partners through a full-time Program Manager. As this is a relatively small FP, CoA leadership and management responsibilities are financed by specific allocations of time for senior researchers in the CoA. Each CoA will be led by a senior researcher from the main partners, with a minimum of one-third of their time dedicated to their CoA leadership and scientific activities (CoA1: Dr Jo Lines (LSHTM); CoA2: Prof Eric Fèvre (University of Liverpool/ILRI); CoA3: Dr Tim Robinson (ILRI) and Dr Jo Lines (LSHTM)). Dr Jo Lines and Prof. Jeff Waage of LSHTM will provide leadership in the convening of public health research partners and their engagement with ILRI, IITA and other CRPs/Centers.
FP5 will have important biomedical research and can rely on the labs of the partners and in particular the ILRI-BecA hub in Nairobi for CoA2. Given the FP5 is a relatively small user of these facilities, capital costs are not included but shares of supplies and services will be provided at standard ILRI charges. There are efficiencies and a critical mass of support services and the laboratory facilities are shared by the Animal Health and Animal Genetics FPs in Livestock as well as a number of research activities with partners coordinated by BecA.

2.5.2.3 Additional explanations for certain accounting categories

Benefits: ILRI's personnel costs are defined as the total remuneration costs of an individual: base salary, fringe benefits and other

Employment costs. Actual computations on average for fringe benefits and employment costs in relation to base salary would translate

To an average multiplier of 97% and 68% for International and National staff respectively. The reason for the high multiplier for international staff is because of the housing and security allowance and education allowance that are not provided to nationally recruited staff. Fringe benefits include pension, housing allowances, education allowance, security, health insurance, other insurances, catastrophe fund, annual

leave and severance pay. Other employment related costs include staff training and development; transportation, recruitment, appointment and repatriation allowances and payroll administration fees. IITA uses a paygrade (PG) system for Internationally Recruited staff (IRS) and Nationally Recruited Staff (NRS). For IRS, there are 6 PG levels, and standard costs (pension, health and other insurance, housing/transport/security/leave allowances). Actuals can vary (for example by duty station or family size). For NRS the PG rates (level 1-15) depend on country laws on wages and salaries and internal set scales. NRS staff costs are split into salaries, fringe benefits and allowances, also dependent on country laws. Allowances (housing, transport, subsistence, utility, entertainment, and leave) can used to provide competitive salaries in different local markets.

LSHTM has compulsory UK fringe benefits (approximately 27% of salary costs) that include national health insurance, pension and social security payments).

Other supplies and services: For ILRI, supplies and services includes information and communication technology, office space, research coordination, inception workshop, mid review, outcome mapping and monitoring workshop, peer review publication costs, epidemiologist training, field visits, data analysis costs, lab analysis and diagnostics lab costs., cost of MSc students for capacity development, and an internet for six months.

For IITA, supplies and services includes research support services, cost of vehicles, cost of sample analysis IT services, survey costs, capacity develop of NARS, and various microbiology, chemical and molecular supplies for lab work.

For LSHTM, supplies and services include facilities, library, information and computer services as well as convening meetings of agriculture and public health communities.

2.5.2.4 Other Sources of Funding for this Project

The W3/bilateral growth expectations are challenging but the partnership with LSHTM and other public health research institutes provides additional comparative advantage and the team will be working in some high-priority new research areas such as anti-microbial resistance. Thus, while most of the W3/bilateral funding is unsecured for 2017, the total amounts expected are relatively modest in the first couple of years and funding possibilities reasonable. The FP lead institutions and A4NH PMU will monitor this closely and actively support the growth of this FP.

2.5.2.5 Budgeted Costs for certain Key Activities

	Estimate annual average cost (USD)	Please describe main key activities for the applicable categories below, as described in the guidance for full proposal
Gender	456,045	Research to understand how gender influences health outcomes in different programs; assessing potential for unintended consequences of program interventions and policies; coordination with GEE unit on joint projects with other CRPs
Youth (only for those who have relevant set of activities in this area)	0	
Capacity development	1,368,136	Co-learning with national partner leaders including research, government and civil society; building capacity in key areas and institutions
Impact assessment	91,209	Reviews and meta-analyses of impacts of past interventions in key research areas; short-term assessments of new interventions; planning a mix of ex-ante and ex-post IA with national partners
Intellectual asset management	10,000	Prompt dissemination of research results and maximization of their global accessibility
Open access and data management	20,000	Ensure high quality and prompt availability of data; Rapid availability of resaerch products to national partners; support to national institutions on data use and open access and data management issues
Communication	91,209	Activities include engaging in policy dialogue; communicating research results and prompting learning and collaboration across the FP team and partners

2.5.2.6 Other

FP5 is a promising joint venture and is addressing high priority research across the agriculture and public health sectors. The new partnership arrangement put in place should add to the comparative advantage of the team in new priority areas such as AMR.

Priorities for additional W1/2 (uplift) funding
New initiatives on integrated vector management collaborating with integrated pest management to effectively manage risks of vector resistance at household level.
Large scale trials for elimination of cysticercosis on priority countries listed
Data collection on antibiotic use in animals and behaviors and links to antrimicrobial resistance in humans. Intervention experiments in key locations based on initial research.

W1/W2 funding
FP5 is a new and relatively small FP. W1/W2 funding is used for: (1) administrative support and part-time salary support to FP and CoA leaders; (2) synthesis and meta-analysis of existing evidence; (2)

prioritizing research in new areas (such as AMR), including strategic primary data collection; and (3) convening and joint research planning with international, regional and national agriculture-public health researchers.

2.5.3 Flagship Uplift Budget

Outcome Description	Amount Needed	W1 + W2 (%)	W3 (%)	Bilateral (%)	Other(%)
New agricultural research initiatives with new partners working on integrated pest management measure health risks and benefits of household-level vector resistance management	15,000,000	43	0	57	0
Agricultural and public health policymakers and implementers deliver coordinated and effective solutions to cysticercosis and other zoonotic threats, at faster and larger scale	23,000,000	43	0	57	0
Public and private sector policymakers implement measures to reduce health risks from antimicrobial resistance in more hotspot livestock systems	23,000,000	43	0	57	0