CURRENT AND PLANNED RESEARCH ON AGRICULTURE FOR IMPROVED NUTRITION: A MAPPING AND A GAP ANALYSIS

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Executive Summary

- This report examines current and planned research projects on agriculture for improved nutrition and uses a mapping process to identify gaps in research coverage. A conceptual framework has been developed to define and characterize agricultural research for improved nutrition. Placing nutrition at the centre, the framework identifies pathways by which research may contribute directly and indirectly to nutrition and how evidence of impact may be gathered along these.

- The study found and characterized 151 research projects, most of which are part of broader research programmes. A significant majority of projects concern Sub-Saharan Africa, with a particular focus on nutritional impacts on women and children. Most projects are led by organisations in Europe and North America, with research partners typically located in low and middle income countries (LMICs).

- Over one-third of the research projects are associated with programmes of the Consultative Group on International Agricultural Research (CGIAR), with most of the rest being led by universities and a smaller proportion by NGOs. The private sector feature as partners in only a small number of projects.

- The research projects identified are funded by 46 organisations, but the funding landscape is dominated by five of these: the Bill and Melinda Gates Foundation, the United States Agency for International Development, the Canadian International Development Agency, the International Development Research Centre, Canada, and the Department for International Development, UK.

- Current research is of a range of types, including evaluations of agricultural development projects, research focused on specific agricultural interventions, and the creation and analysis of large datasets on agricultural and nutritional change. Most research projects are directed at improving the production of nutritious foods, including biofortification, other crop improvements, indigenous /traditional/local foods and agrobiodiversity. A second set of projects are characterised by their focus on value chains, which are also largely concerned with nutritious foods. A third group are concerned with agricultural growth and development with no specific focus on nutritious foods. The rest of the projects fall into much smaller categories, including the development of methodologies, collection of datasets, governance/capacity building and aflatoxins.

- A gap analysis was conducted to identify more poorly researched areas, relative to the possible links between agriculture and improved nutrition identified in the conceptual framework. This analysis identified eight clear research gaps:
    - the whole research chain – research that considers the full pathway of change from agricultural inputs, practices, value chains, food environment to nutrition outcomes; a significant number of projects do not consider the value chain
    - the indirect effect of changes in agriculture on nutrition, through income and economic growth and associated changes in health and investments in health and education services
    - the effects of agricultural policy on nutrition as mediated through the value chain
    - governance, policy processes and political economy as it relates to the development of agriculture-for-nutrition policies and programmes, the ability to implement them (and scale up) and for them to achieve their stated goals once implemented.
    - the way research on agriculture and nutrition is conducted, such as the development of methodologies and appropriate metrics
    - consumers as a broader target group, notably rural workers and non-rural populations
    - the rural and urban poor at risk from nutrition-related non-communicable diseases
    - cost-effectiveness

- Although information was collected on the metrics and methods used in the research where available, it did not appraise them in anyway, meaning that it was not possible to identify gaps arising from inadequate quality in existing and planned research projects.

1. Introduction and Objectives

Despite the clear potential for agricultural change to improve nutrition in low and middle income countries, the evidence base for this relationship is poor. Recent systematic reviews of studies which have evaluated agricultural interventions for improved nutrition reveal little strong evidence of impact and a need for more and better designed research (Masset et al, 2011, Girard et al, 2012). With growing concern about food security and its effect on persistent under-nutrition in LMICs, agricultural programmes for improved nutrition are being initiated in many countries, associated with research projects to evaluate their impact. There is little information on the pattern, design and direction of these research efforts that might help determine whether it is being directed with greatest effort towards identifying the best agricultural interventions for improved nutrition.

The UK Department for International Development commissioned this study of current and planned research on agriculture for improved nutrition in order to map the coverage of current projects and to identify gaps where more research may be useful. Full terms of reference can be found in Annex 1. Decisions about what programmes and projects were included in this study were based on a specifically developed conceptual framework, which describes the different ways by which nutritional status may be affected by agricultural inputs, practices and value chains and the impact and evidence pathways linking these. The mapping exercise is restricted to research projects that have, as a stated aim, the improvement of nutritional outcomes.

The report identifies some indicators of gaps in existing and planned research relative to its potential to contribute to improved nutritional outcomes. It does not seek to assess whether what is being done will actually achieve its potential (e.g. by examining the quality of the research projects nor the utility of specific metrics and methodologies they use), and thus can only be conclusive about the gaps arising from of a lack of research, rather than those arising from the poor quality of existing research. However, it does examine the kinds of metrics and methods currently being used in research projects, where these are stated.

More generally, this study is intended to assist the development of a more coherent framework for research in this area, which can be drawn upon by a range of development partners. By identifying a broad range of ongoing programmes, it is also hoped that the

study will assist in linking researchers and projects so that they may share methods and experience and improve the overall quality of research on agriculture for improved nutrition.

In this report we:

- Provide an overview of existing current and planned research
- Identify the clear gaps in current and planned research

In addition, we present:

- A conceptual framework for characterizing and categorizing research at the interface between agriculture, nutrition and health (Figure 1)
- A list of institutions contacted in the course of the analysis (Annex 3)
- The research template used (Annex 4)

The study was conducted by a core team of researchers and an expert panel from the Leverhulme Centre for Integrative Research on Agriculture and Health (LCIRAH) and from the Centre for Sustainable International Development at the University of Aberdeen, UK. The expert panel comprised an interdisciplinary team of academics, providing expertise in agricultural science for development, agricultural economics, international development, social sciences, nutrition and diet, maternal and child health and HIV AIDS. The work was also informed by an external advisory panel set up by DFID.

2. Methods

The analysis was conducted in seven overlapping stages. Stage 1 involved **the development of a conceptual framework linking agriculture, food, and nutrition**. The conceptual framework was developed to define the domain of research on agriculture for improved nutrition, to establish inclusion criteria for research to be considered, and to characterise that research in a comparative way, relative to the different impact pathways linking agricultural change and nutritional outcomes. The framework was developed by the expert panel making use of existing concepts for interactions between agriculture and health (CGIAR, 2010, Hawkes, 2006, Hawkesworth, 2010) tailored to the research context. The process involved reviewing existing frameworks (already largely known to the team) and both incorporating and simplifying the information. A detailed description of the conceptual framework (Figure 1) and its rationale can be found in the next section.

Stage 2 involved **developing a "template"** for listing the details of the research projects. The template was a direct translation of the conceptual framework onto an Excel spread sheet (Annex 4 and Annex 5). Each box in the framework was translated into one column in the template, and additional columns added to record basic information about each research project.

In Stage 3 a series of **inclusion and exclusion criteria** for the projects was developed. These criteria, which follow from the conceptual framework, are listed in Box 1. Projects that involved no research activity, and those that did not have the stated objective of contributing to improved nutritional outcomes, were not considered to fall into the category of "agriculture, food and nutrition research" and were not included. Research projects that did not consider explicit nutritional outcomes were included as long as improved nutrition was a stated project objective.

Box 1: Inclusion and exclusion criteria

Inclusion criteria

The research must:

- be focused on low and middle income countries
- have a stated objective of contributing to improved nutritional outcomes (even if food intake or nutritional status is not explicitly considered or measured)
- target a potential interaction between agriculture and nutrition, such as: agricultural interventions to improve nutrition and their evaluation; the influence of agricultural practices and food value chains on nutrition; governance and policy processes through which agriculture and nutrition are linked; and links between agricultural productivity and/or growth and nutrition at a macro scale etc.
- include an agricultural component even where the main focus is on the 'food value chain', e.g. be related back in some way to food production (local farms/ farmers), and not just the end of the supply chain such as retail, catering, food promotion or labelling
- include an assessment of the relationship between agriculture and a measure of food consumption and/or nutritional status, or, at the very least (and provided the project has a stated nutritional objective) with the "food environment" (see Section 3 for a definition)
- be current or planned (next 5 years), though the start date may be in the past.
- have a research/ evaluation component
- constitute a 'major research activity' (i.e. be of a reasonable size)

Exclusion criteria

- Research on foods with no agricultural component (e.g. fortification)
- Research on zoonotic or other agriculture-associated diseases (note: later in the project, work on aflatoxins was included).
- Basic science research at the interface of agriculture, nutrition and health such as plant and animal breeding (but including biofortification)

Stage 4 involved the preparation of a **list of relevant research projects and programmes**. This list was drawn up based on information already known to the research team and expert panel and their institutions, as well as information provided by DFID. Information about further programmes and projects was gathered from eight sources:

- the external advisory panel - consisting of representatives of the centres of the Consultative Group on International Agricultural Research (CGIAR), working through its CGIAR Research Programme, Agriculture for Nutrition and Health (A4NH), the United States Agency for International Development (USAID), and the Bill and Melinda Gates Foundation (BMGF)
- members of the European Initiative for Agricultural Research for Development (EIARD)

- other donors, including the Canadian International Development Agency (CIDA), the International Development Research Centre (IDRC), Canada and AusAid
- a "snowballing" process, involving organizations on the initial list, who were asked to provide contacts of other relevant groups or projects
- the LCIRAH-hosted University Network on Agricultural, Nutritional and Health Research
- the Agriculture and Nutrition Community of Practice hosted by the United Nations Standing Committee on Nutrition
- members of the maternal health research community
- a database search - six databases relevant to current and planned research were searched for information, but these yielded very little information relative to the contact-based search.

Contacts were asked if they were conducting agriculture-nutrition research and if so, the nature of the research (sample letter in Annex 2). Stage 5 then involved **populating the template** with information about the research programmes and projects (referred to here as "mapping"). Information for the template was obtained from the informants themselves and/or from project websites documentation. In some cases, where there were gaps or uncertainties about the information, the template was sent back to the contact for additional information and/or for checking for accuracy.

In Stage 6, **a series of categories was developed to classify the different projects**, based on information obtained and the needs of the gap analysis. The aim of the classification was to give a broad sense of the range and diversity of projects in the sample rather than as a strictly diagnostic/ scientific categorisation. It involved the development of two "typologies" to describe the basic features of the different research projects. The first was the type of research (evaluations of agricultural projects, agricultural research into inputs, practices or value chains, and the collection of new datasets, the analysis of existing datasets, or reviews of existing research). Second, was the theme of the research – the main agricultural focus of the projects, and then in some cases more specific themes within that category (Table 3). For the most part, identifying a single type or theme for each project was fairly straight forward. However, when a project did include a number of elements, a judgement was made as to which was the main focus.

Stage 7 was the **gap analysis**. The gap analysis followed a systematic process of identifying:

- *What research areas could be covered?* This is already represented in the conceptual framework and template, which sets out the effective research landscape for leveraging agriculture for improved nutrition and health outcomes.
- *What research areas are covered?* The conceptual framework was then cross referenced to what is being researched, as set out in the template.
- *What are the research gaps?* The gaps were then identified by assessing "what could be" minus the "what is". This involved an assessment of overall gaps and gaps within each research project ("the research chain"), but not the quality of existing current and planned research.

3. The Conceptual Framework

3.1 Developing the framework

The conceptual framework was developed to define the domain of "research on agriculture for improved nutrition" (Figure 1). It was developed based on the principles that: (1) the prime links of concern are between agriculture, food and nutrition, but with important indirect links through income and health at all scales; and (2) a framework should accommodate the linkages between agriculture, food and nutrition among all people in LMICs, farmers and non-farmers, rural and urban, inside and outside the food value chain. This contrasts with some existing conceptual frameworks for the interaction of agriculture and nutrition which focus on short food chains in rural communities. In these frameworks, the production of food by farmers has the potential to influence the nutrition of members of their households, either through direct consumption or by generating income which allows them to buy food locally.

3.2 Content of the framework

The framework in Figure 1 puts nutrition at the centre of the process, in yellow, emphasizing nutrition as an endpoint of an impact pathway associated with agricultural change. It presents a hierarchy of nutrition related outcomes, the top being change in **nutritional status**, which provides the strongest evidence of impact on nutritional outcomes. However, this does not imply that at the level of individual projects, each and every one can, or even should, seek to evaluate nutritional status. Less strong evidence is provided by measurement of **food consumption and intake** at the level of the household and individuals, in terms of household food expenditure, food consumption or dietary diversity, and individual food and nutrient intake or dietary diversity. Consumption among infants is also influenced by infant and young child feeding practices.

The third level of nutrition-related outcome is a change in the **food environment**. This refers to the foods that are available to consumers (including those who may be producers) in specific settings (e.g. at home, at work, in retail stores, in schools), the nutrient quality of that food, the prices of that food (affordability) and the information and promotion about those foods (acceptability). It does not refer to national levels of, for example, food availability, or world food prices, but the immediate environment in which consumers access foods and information about them.

The inclusion of the food environment as a nutrition-related outcome is based on the established role of access to food as a determinant of consumption. The food environment is conceptualised as a critical direct link between changes in agriculture and changes in consumption. These agricultural changes are shown in green in Figure 1. They may involve changes in **agricultural inputs**, such as new crop varieties, changes in **agricultural practices**, such as home gardening, or changes in the **food value chain** that delivers more nutritious agricultural products to consumers. The effect of a change at one level in input may be measured through subsequent levels – for instance if development of a more nutritious crop variety is to have a nutritional outcome, we would expect a change in practice (more of that crop produced), the food chain (more available in the food chain), the food environment (more of accessible to targeted consumers), and so on[1].

The food environment can also be influenced *indirectly* via changes in **economic outcomes** from agriculture which allows individuals and households greater access to nutritious foods[2]. We show indirect effects in orange in Figure 1. Agriculture also contributes to national economic growth, and can improve access to **health care and education**, either at the household or national level. That the link to **health/ education status and wellbeing** is conceptualised as important but indirect, reaffirms that the main focus on the framework is agriculture, food and nutrition.

There are a range of macro-factors and contexts which can influence agriculture and its nutritional outcomes, and these are depicted on the borders of the framework to indicate their cross cutting nature. Building them into the process depicted in the framework would complicate its visual simplicity, but this is not to underestimate the importance of research in these areas. They comprise:

- **Policy and governance.** Policy is a critically important target of research because of the role of agricultural and related policies in influencing nutritional and health outcomes at the macro-level, and the potentially large (and cost-effective) impact this could have. For example, policy (through a series of interventions on

[1] In the framework, a direct link is also shown between **agricultural practices** and **food consumption and intake**, to capture situations where practices can affect food intake such as when agricultural work affects infant and child feeding.

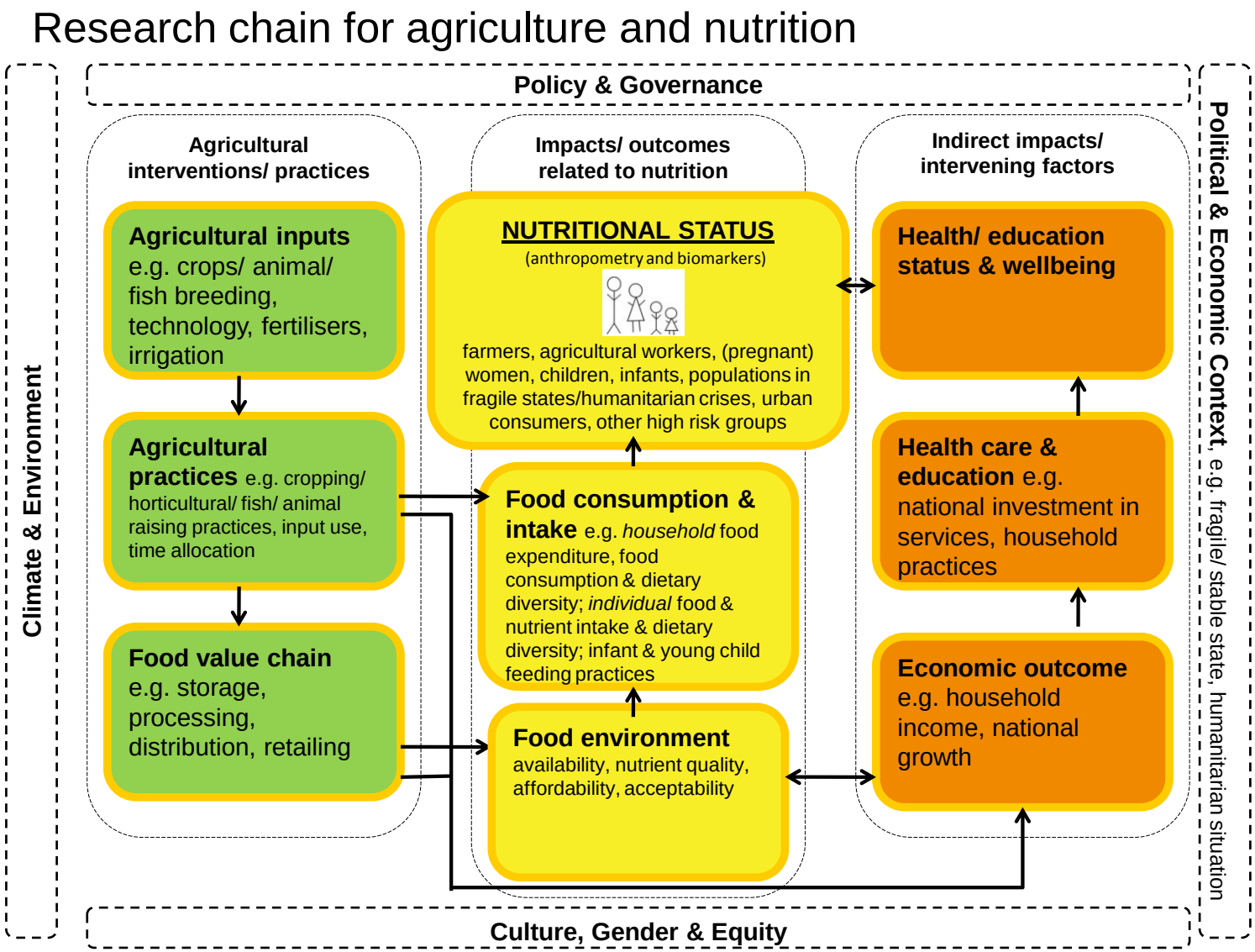
[2] Greater household income may increase access to nutritious foods, while less expensive foods leaves more income for other commodities such as education and health care, hence the two-way relationship.

infrastructure, tariffs etc) is likely to have a key bearing on the degree to which local food markets are integrated into national, regional or global food markets. Governance is also a critical macro-factor because of the known barriers to implementing cross-sectoral approaches to address nutrition through agriculture in institutions and policy processes – questions concerning why decision-makers make the decisions they do, what influences policy processes, and the ability of different sectors to work together (termed "political economy" by economists).

- **Culture, gender and equity**. Research demonstrates that gender is a critical dimension to all nutritional issues and outcomes. Inequity and culture have generally been inadequately addressed in poverty-focused research.
- **Climate and environment**. Food production and supply through value chains will be profoundly influenced by environmental change, including that associated with changing land use, water availability and climate change.
- **Political and economic context**. Fragile states or conflicts which create humanitarian situations will create particular contexts for the relationship between agriculture and nutrition, and challenges for research.

This framework does not include the important reciprocal effects of improving nutrition and health on increasing agricultural productivity. This was beyond the scope of the analysis, as was the consideration of interventions that improved nutrition and health by reducing the risk of food-borne and other diseases.

Figure 1: The Conceptual Framework



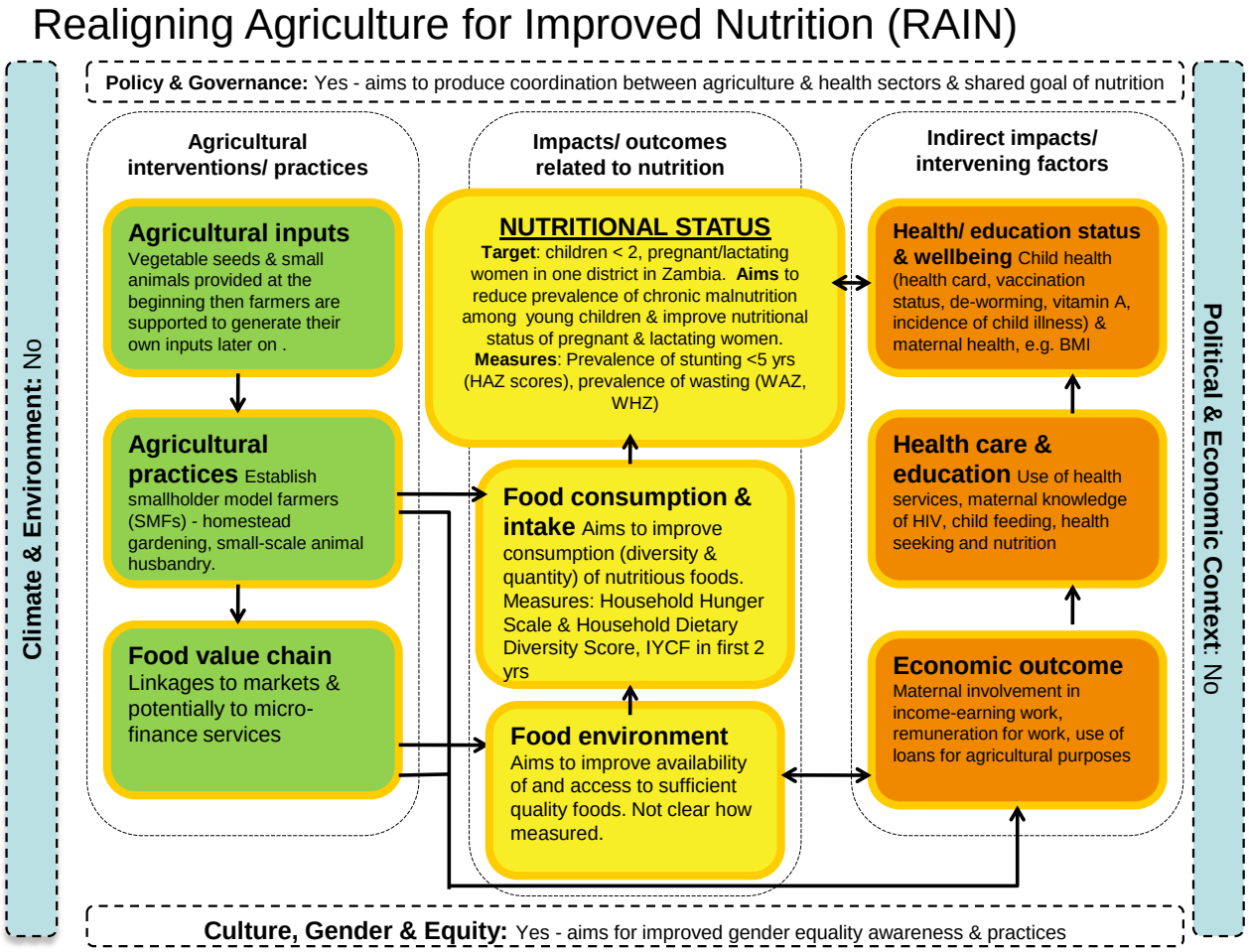
3.2 Using the framework

The framework is designed to be "run" for different groups of people, such as those illustrated in the "nutrition status" box, and not just for rural farmers as is the case for some existing frameworks. The potential pathways (boxes and links) leading in this framework from agricultural change to nutritional outcomes are likely to be different for, e.g., women farmers, urban householders or mothers and infants within the "1000 days".

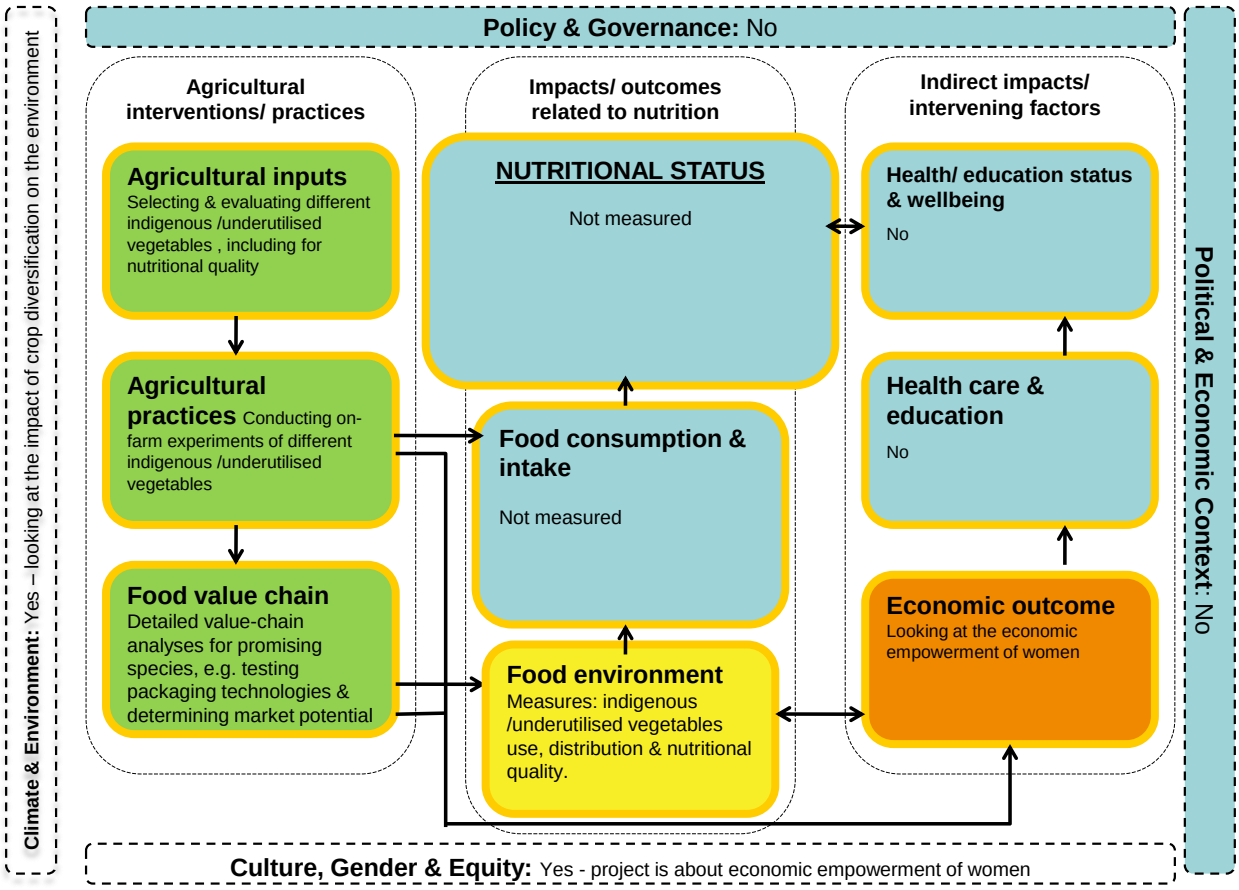
The framework can also be "run" for different projects to illustrate the extent to which a piece of research considers the different pathways and links between agriculture and nutrition. Two projects have been mapped in this way (Figure 2). Boxes shaded in blue indicate where elements of the pathway are not considered by the project. As can be seen, 'Realigning Agriculture to Improve Nutrition' (RAIN) includes research and measurement on almost all elements of the conceptual framework, whereas the project 'Sustainable Production of Underutilized Vegetables to Enhance Rural Food Security' (Ni-Can-Veg) focuses research and measurement on the agricultural components of the framework and the food environment.

The construction of the framework enables the identification of two kinds of potential research gaps. One gap may occur when the links in a "chain of evidence" or "research chain" linking an agricultural change and a nutritional outcome is not complete. For instance, we exclude from our study research on agricultural change that does not measure any outcomes in the yellow column. Another, perhaps more serious kind of gap, is where an entire pathway of impact from agricultural change to nutritional outcome is not explored at all.

Figure 2: Mapping two projects using the conceptual framework



Sustainable Production of Underutilized Vegetables to Enhance Rural Food Security



4. Results Overview

4.1 Number of research projects and programmes

In total, 136 institutions (research organisations, NGOs and donors) were included in our contacts list (Annex 3). All except four of these organisations were contacted directly via email[3]. In many cases, more than one individual in an organisation was contacted.

A total of 151 projects and programmes were identified that met the inclusion criteria. Of the 151 projects, detailed information was identified on 100, enabling their full inclusion of the gap analysis. The remaining 51 were included in the overview of research projects, as well as the aspects of the gap analysis not involving the research chain.[4]

In earlier stages, around 35 other projects were included on the list, but were eventually excluded when more information had been obtained about them, typically because they did not include (see Box 1):

- a research component e.g. the Secure Nutrition Platform, and the South Asia Food and Nutrition Security Initiative (SAFANSI), both based at the World Bank; the Caribbean Farmers Agriculture Nutrition initiative; and a range of agricultural projects which included a nutrition component but no research
- an explicit or implicit nutrition objective e.g. the PUREFOOD programme, which conducts research into Home Grown School Feeding programmes but with no assessment or consideration of their nutritional impact
- an agricultural component e.g. projects which measure the nutritional quality of indigenous crops but do not address the production of those crops in any way, such as: the project "Combating lifestyle diseases associated with over-nutrition through the use of indigenous South African foods" based at the University of Pretoria; and projects that deal with fortification with no agricultural component e.g. the fortification projects conducted by the project "Strengthening Partnerships, Results and Innovations in Nutrition" (SPRING).

The significant majority of the 151 projects are already underway, with around 25 still in the planning stages (e.g. final contracts with donor not yet signed, contracts signed but research not actually started, project started but only in the planning phase). Some of the projects still

[3] The organisations that were not contacted directly were Danida, ICRISAT, CIMMYT, IRRI since information about the research being conducted by these organisations was available via other sources or online.

[4] There were two reasons for not having more information about the 51 projects: lack of availability of information owing to lack of response from the research leaders; and lack of time to pursue obtaining more information during the time frame of the project.

being planned are relatively substantial, including the $50 million TACO-AN initiative at Cornell University, the DFID-funded consortium Leveraging Agriculture for Nutrition in South Asia (LANSA), the University of Stellenbosch Food Security Initiative, and several of the projects included under CRP4A4NH (e.g. value chain work).

The majority of the projects (n=133) are part of larger programmes or funding initiatives. In a small number of cases, these larger programmes are specifically about agriculture-nutrition/health research – such as the CGIAR's A4NH programme (which includes HarvestPlusII, SPRING and Agrosalud), LANSA, USAID's Nutrition Collaborative Research Programs (NCRSP), and projects conducted by LCIRAH. In others, agriculture-nutrition research projects form a significant proportion of larger programmes or funding initiatives – such as the Canadian International Food Security Research Fund (CIFSRF) an initiative of IDRC and CIDA. In others, agriculture-nutrition research forms a minor part of the entire programme, such as USAID's FANTA III and ENGINE, and the Home Grown School Feeding Initiative at the Partnership for Child Development, Imperial College London, UK.

4.2 Research funders and organisations

Projects reported a large number of different funders supporting their research projects – 46 in total for all 151 projects (although some were unknown) (Table 1). Almost all projects reported receiving funding from more than one donor. As shown by Table 1, in terms of numbers of projects five funders dominate: BMGF (n=43), CIDA (n=33), USAID (n=33), IDRC (n=30) and DFID (n=22). This is in part because of their support for the multiple projects included under the CGIAR research programme A4NH, such as HarvetsPlus II. Some funders are significant in other ways, such as the Sir Ratan and Sir Dorabhji Tata Trusts of India, who recently made a $50 million endowment to Cornell University, and the Leverhulme Trust, for its funding to LCIRAH.

Table 1: Organisations reported to be funding research on agriculture for improved nutrition

	Total no. research projects[5]	Includes…	
		A4NH Projects[6]	HarvestPlus Projects[7]
Bill & Melinda Gates Foundation	43	7	11
Canadian International Development Agency (CIDA)	33	6	11
United States Agency for International Development (USAID)	33	6	1
International Development Research Centre (IDRC), Canada	30	6	
Department for International Development (DFID), UK	23	6	11
Australian Centre for International Agricultural Research (ACIAR)	7	6	
European Union (e.g. FP7)	7		
Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), Germany	6		
McKnight Foundation, USA	3		
Concern Worldwide, UK	2		
International Fund for Agricultural Development (IFAD)	2		
Kraft Foods, USA	2		
Leverhulme Trust, UK	2		
Abbott	1		
Action against Hunger, UK	1		
British Red Cross, UK	1		
Canadian Foodgrains Bank, Canada	1		
CARE International, UK	1		
Center for International Governance Innovation, Canada	1		
DANIDA (Denmark's development coorporation)	1		
Finnish International Development Agency	1		
Fondation d'entreprise Hermes, France	1		
Global Alliance for Improved Nutrition (GAIN), Geneva	1		
Irish Aid, Ireland	1		
Kerry Group, Ireland	1		
MTT AgriFoods Finland	1		
Nestlé Foundation, Switzerland	1		
The OPEC Fund for International Development, Austria	1		
Oxfam GB, UK	1		
Save the Children, UK	1		
Sight for Life, USA	1		
Sir Ratan and Sir Dorabhji Tata Trusts of India	1		
Table for Two, Japan	1		
Tearfund, UK	1		
United Nations Environment Program Division of Global Environment Facility Coordination (UNEP/GEF)	1		
US National Institutes of Health (NIH), USA	1		
United States Department of Agriculture (USDA)	1		
World Food Programme (international)	1		
World Vision UK	1		
Presbyterian Church in Canada	1		

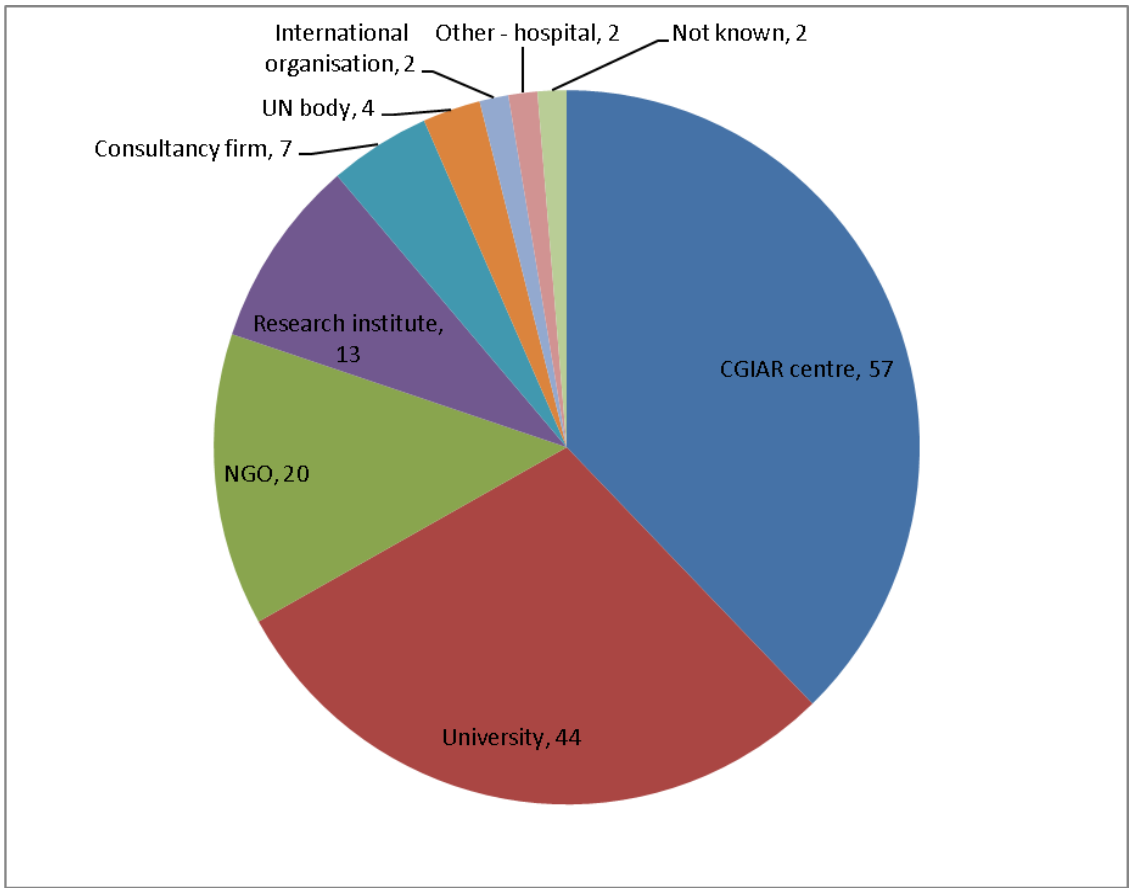
[5] Adds to more than 151 due to multiple funders for single projects.

[6] The first 6 funders listed all support the same 6 A4NH projects with BMGF funding one in addition to these. Another 3 A4NH projects were identified which are still awaiting the identification of specific funders.

[7] BMGF, CIDA and DFID all fund the same 11 HarvestPlus projects with USAID being an additional funder on one of them.

As shown in Figure 3, the largest proportion of the research projects are led by CGIAR centres (n=57). The second largest proportion are led by universities (n=44), followed by NGOs (n=20) and other types of research institute (n=13). Although a small number of projects are led by US-based consultancy firms, the private sector did not feature significantly as project leaders, nor in any significant way as partners.

Figure 3: Type of organisation leading the research projects (number)



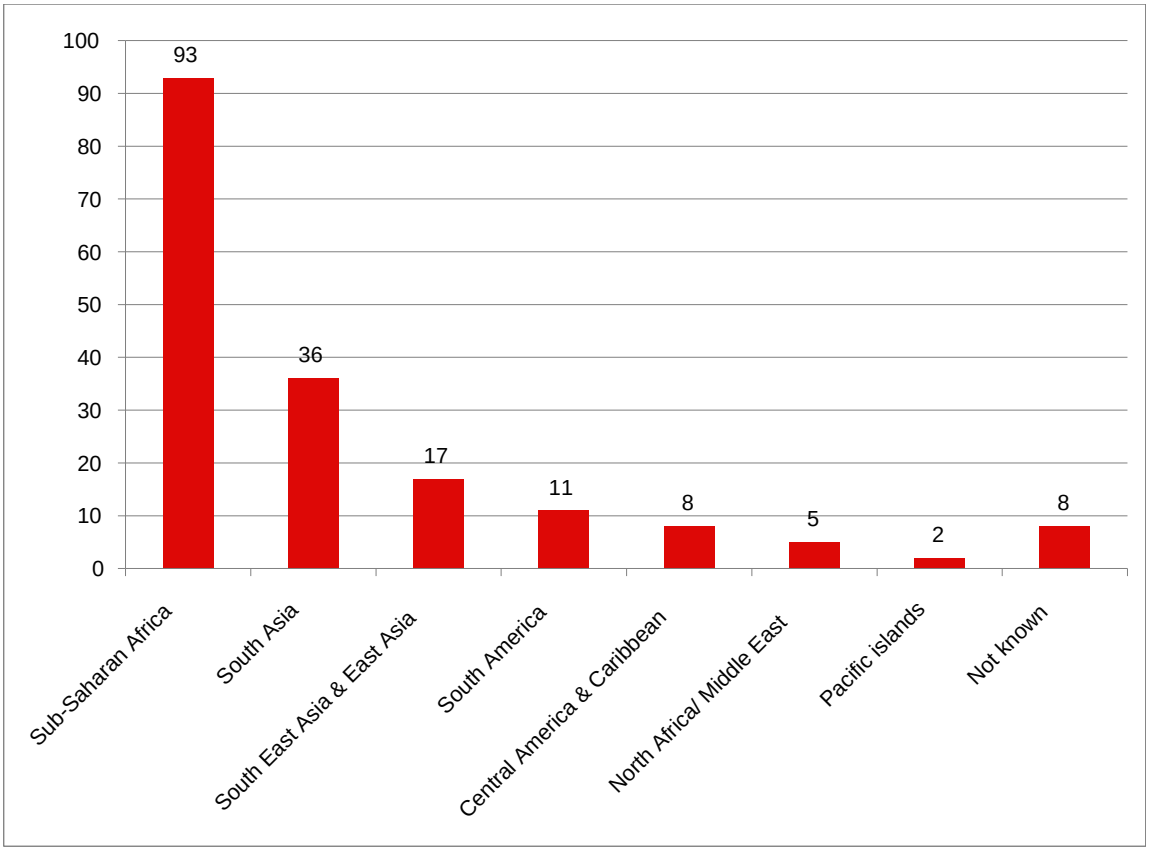
Over 50% of the lead organisations can be defined as international – including the members of the CGIAR Consortium and World Vegetable Center (n=82). Of the remaining research organisations, 42 are research centres in North America (Canada or United States), nine are based in Europe and one in Australia. A relatively small number of lead organisations are actually based in a developing country: one in North Africa/middle East (Lebanon), three in South Asia (all India), two in South America (Brazil, Peru) and nine in Sub-Saharan Africa (2 each in Malawi, South Africa and Kenya; 1 each in Botswana, Tanzania and Zimbabwe). None are based in South East Asia, though this may be due to lack of identification. Although a

very small number of projects are led by organisations based in a developing country, most included a local organisation as a partner.

4.4 Research location and targets

In terms of the location of the research, there is a strong emphasis on sub-Saharan Africa, followed by South Asia (Figure 4). No research was identified in China, and responses were not obtained from contacts there, so this remains an area for further investigation.

Figure 4: Location of research projects (number)



There is a significant emphasis in current and planned research projects on women and children. Table 2 shows the numbers of research projects targeting specific groups (in some cases projects targeted more than one group, for example, a number of projects target poor, rural women, and in others, there was no specified target, so the numbers do not equate to 151). Forty-six projects target children, with 18 specifically targeting children under 2 or the

"1000 days" period[8]. Forty-six projects target women, with 10 specifically targeting pregnant or breastfeeding women and 12 targeting women of reproductive age or mothers generally[9].

The other main target groups are rural households in general (n=16), farming and fishing households (n=24), rural poor households (n=6) and "very poor" households in general (n=14). There were many overlaps between these groups, for example projects targeted 'the rural poor' or 'extremely poor farmers'. Only three research projects targeted urban consumers and two specified men as a target group, although many projects were focused on the whole community and thereby included men.

Table 2: Groups specifically targeted by research

Specific target group	**Number**
1,000 day period and/or children under 2	18
Children over 2 / all children	32
All projects that focus on children	*46*
Pregnant or breastfeeding women	10
Mothers generally/ women of reproductive age	12
All women	24
All projects that focus on women	*46*
Rural generally	16
Farming/ fishing households	24
Rural poor	6
Poor/ extremely poor/ vulnerable in general	14
Urban	3
Men	2

4.4 Research types, themes and targets

Projects were classified according to the type of research (e.g. programme evaluation, systematic review etc.), their main agricultural theme (e.g. biofortification, home gardening, policy analysis etc.) and the food category target (e.g. fish, fruit and vegetables etc).

With respect to project type, over half (58%, n=88) involve research on some form of active intervention into agriculture. This includes both:

[8] Four projects specifically targeted children under 2 and older children.
[9] Three projects specifically targeted pregnant/ lactating women and mothers of slightly older children.

- evaluations of agricultural development projects (n=28), where an agricultural development project is being implemented and has a research component in the form of an evaluation[10];
- and field- or lab-based research on specific agricultural interventions (n=58), including improvement of inputs (e.g. crop breeding, provision of seeds), practices (e.g. training in agronomic practices, homestead food production), or value chains (e.g. post-harvest losses, product marketing).

The rest of the projects (n=63) involve research on existing datasets (including modelling), the collation of new datasets and analyses of existing research. This includes three systematic reviews:

- one mapping current (academic and applied) research activities on agriculture and nutrition in Africa (part of the SUNRAY project);
- another focused in India – a systematic review of the effectiveness and implementation of multi-sectoral, community-based interventions in rural India aimed at improving nutritional outcomes in vulnerable populations, including agricultural interventions, as part of the Tata-Cornell Initiative in Agriculture and Nutrition (TATA-AN) at Cornell University;
- and a newly-published systematic review conducted at Emory University, USA, on the effects of agricultural interventions to increase household food production on the nutrition and health outcomes of women and young children and provide recommendations for future research and programming.

With respect to main agricultural theme, the most frequent (n=66 or 44%) was to increase the production and availability of nutritious foods[11] as a means to improving nutritional outcomes (Table 3). These projects focus on interventions in agricultural inputs and practices that could improve the nutrient quality of food or make nutritious food more accessible (food environment in the conceptual framework). Although they focus on increasing production, all of the included projects do so with the explicit aim of improving nutrition outcomes, and include some form of measure of impact or other research activity on the food environment, food consumption or intake, and/or nutritional status. The largest proportion of this category of projects concern biofortification (crop breeding), followed by projects concerned with some other form of agricultural technology,

[10] Two evaluations were conducted of interventions implemented as part of research projects

[11] Nutritious, or nutrient-rich, foods are foods with a high nutrient content. They include animal-source foods (fish, meat, eggs, and dairy products), fruits and vegetables, and traditional local crops (including neglected and underutilized species and wild foods).

traditional/indigenous/local foods, agrobiodiversity, home-gardening/homestead food production and aquaculture.

A second set of projects can be characterised by their focus on the food value chains, which have a similar aim of making nutritious foods more available. Twelve of these projects are specific to biofortification (getting biofortified crops into the food environment with the aim of impacting nutritional status of specific groups), meaning that 18% of the entire project list (n=27) consists of biofortification projects.

A third group (n=21, 14%) are concerned with agricultural growth and development more generally with the aim of understanding how changing patterns of agricultural growth and technology has or can affect development, the food environment and nutrition. For example:

- TANDI aims 'to better understand and address the failure of sustained economic and agricultural growth to make significant inroads into levels of malnutrition in India';
- and the project 'Anthropological and economic studies of food security and nutrition in small farmer communities in South Africa' aims to understand how agricultural and non-agricultural livelihoods influence food purchase, preparation, exchange and consumption practices, how local institutional, agricultural and food systems interact to influence food consumption, and how household-level activities influence food consumption.

Another but relatively small group of projects (n=7) look at the impact of agriculture on nutrition alongside other policy areas such as health and the economy. These projects focus on nutrition and research on policy solutions for improving nutrition through agriculture as well as other sectors. Examples of these types of project include the two Nutrition CRSPs which 'aim to discover what, where and how interventions that include agriculture can best improve nutrition and health outcomes for women and children on a large scale' and the 'Community Nutrition Security Project' that seeks 'to understand the socio-economic conditions that contribute to persistent food and nutrition insecurity in rural and peri-urban communities and to design, implement and evaluate interventions that create conditions for sustainable community nutrition security'.

Fifteen projects examine 'Policy, research, data and methodology' around agriculture and nutrition. Some of these focus mainly on governance, capacity building and policy analysis and some on developing methodologies or collecting and analysing datasets.

A small but distinct group of projects (n=4) have the aim of understanding the impact of aflatoxin contamination on nutrition[12]. Fourteen projects did not fit into any of the categories above.

Table 3: Main agricultural theme of the research projects

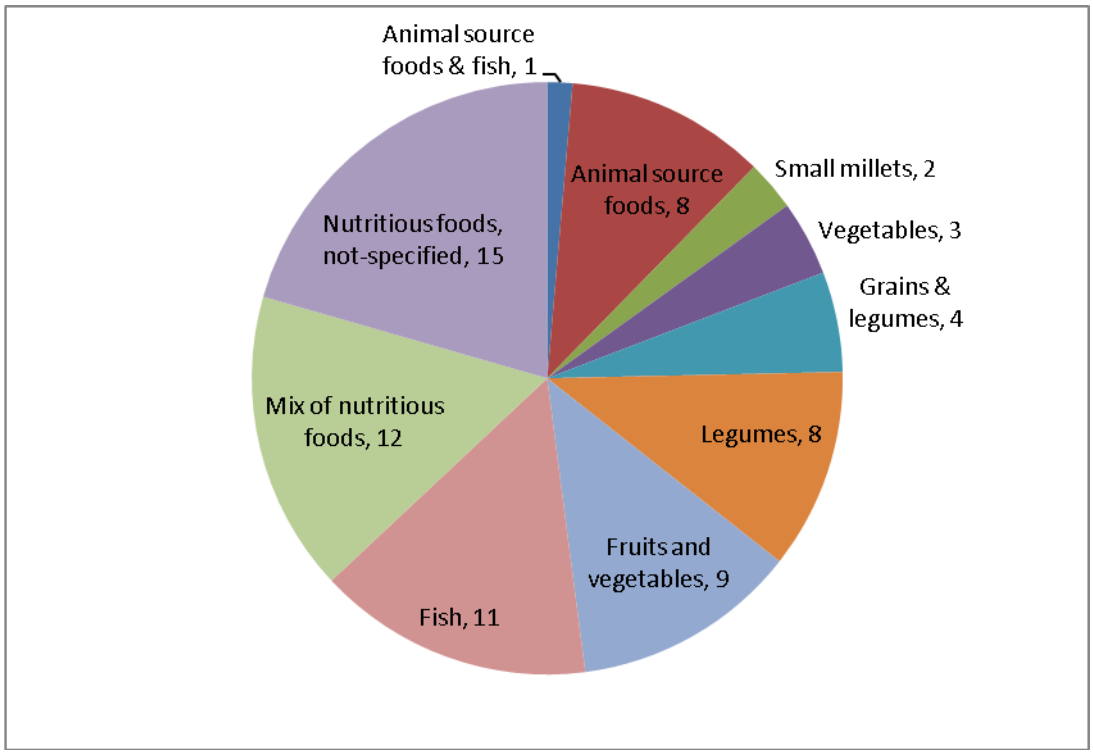
Category	Theme	Number of projects
Agricultural production of nutritious* foods	Biofortification (crop breeding)	17
	Agricultural development/technology	15
	Traditional/indigenous/local foods	11
	Home gardening/homestead production	11
	Aquacultural technology development	7
	Other	6
	Agrobiodiversity	5
	Total	***66***
Value chains	Of nutritious* foods	12
	Specific to biofortification	10
	Not specified	2
	Total	***24***
Agricultural growth/ development more broadly		***21***
Multi-sectoral nutrition projects that include agriculture		***7***
Reducing/ understanding impact of aflatoxin contamination		***4***
Policy, research, data and methodology	Governance/capacity building/policy analysis	6
	Development of methodology	4
	Collection/analysis of datasets	5
	Total	***15***
Other		***14***
Not known		***3***
Grand total		**151**

* Nutritious, or nutrient-rich, foods are foods with a high nutrient content. They include animal-source foods (fish, meat, eggs, and dairy products), fruits and vegetables, and traditional local crops (including neglected and underutilized species and wild foods).

[12]Research on aflatoxins was not specifically sought as part of the mapping exercise, but was included when the information was provided.

In terms of the agricultural target of the research, the majority, 73 of the 151 projects, were focused on improving production and consumption of nutritious foods of various kinds, mainly unspecified (n=15) or a mix of different crops (e.g. fruits and vegetables and livestock, (n=12)), while others were specific to particular commodities, as shown in Figure 5. In addition, 27 projects were concerned with biofortified foods[13], including sweet potatoes (n=5), maize (n=5), cassava (n=5[14]), rice (n=3), pearl millet (n=2), legumes (n=2) and beans (n=2)[15]. Another 48 projects were not particularly focused on nutritious foods, for example they were concerned with agriculture in general, and three looked at aflatoxins in food crops[16].

Figure 5: Agricultural targets of research into nutritious foods (excl. biofortification) (number)



[13] Note, for each agricultural target for HarvestPlus, e.g. cassava, there were two biofortification projects, one focused on crop breeding and the other on the value chain, i.e. piloting the delivery of the product.
[14] One of these projects looked at beans and cassava.
[15] The remaining projects looked bananas (n=1), wheat (n=1) and millet, sorphum, maize and cassava-based food (n=1).
[16] The fourth aflatoxin project looked specifically at peanuts.

5. Gap Analysis

5.1 General approach

This gap analysis is structured on the conceptual framework shown in Figure 1. We first consider gaps with respect to different impact pathways or "research chains" illustrated in the coloured boxes that link direct and indirect effects of agricultural interventions with nutrition-related outcomes. We then consider gaps in terms of the macro-factors indicated in the borders of this framework and, finally, gaps in coverage of the different target groups for improving nutrition.

With respect to research chains, our analysis identifies two kinds of gaps, as explained in Section 3. First, there are research gaps involving entire impact pathways and "research chains" from agricultural change to nutritional outcomes, where very little research has been done. Secondly for particular research chains, there are gaps where research is incomplete in measuring the nutritional effects of those interventions.

5.2 Gaps in research on different impact pathways

The majority of projects focus on impact pathways involving direct effects leading from agricultural change to nutrition. Very few projects focus on indirect effects feeding back from changes in economic outcomes arising from agriculture, back into nutrition through the food environment (purchase of more and healthier foods) or through improvements in health and educational status. This is perhaps not surprising, as indirect effects may face greater problems of measurement and attribution than direct effects.

About one-third of the fully mapped projects measure economic outcomes of agricultural change alongside measures of possible effects on nutrition. Fifteen projects reported measuring the income of farming/rural households. These include projects which have the dual aim of improving income as well as nutrition, for example:

- the Feed the Future-funded "Aquaculture for Income and Nutrition" being conducted by the WorldFish Centre in Bangladesh;
- evaluations of agricultural development projects, such as "Burkinabe Families Achieving Sustainable Outcomes" (FASO) being implemented by Catholic Relief Services;
- and projects primarily concerned with nutrition, such as the NCRSP.

The other main economic outcome indicator included is poverty, referred to in ten projects, with a smaller number of projects looking at other measures such as expenditure and market costs. However, these projects do not measure the effect of improved income and expenditure on nutrition, through changes in purchase or consumption of food.

Another indirect pathway is the broader relationship between agricultural-related growth and nutrition, operating at the national level. Just two projects focused on this relationship, both conducted by the International Food Policy Research Institute (IFPRI): The Agriculture and Nutrition Disconnect in India (TANDI) project, which, through literature reviews and analyses of existing data, aims to better understand and address the failure of sustained economic and agricultural growth to make significant inroads into levels of malnutrition in India (the first phase of this project, TANDI I, is now complete but is reported to be continuing under TANDI II); and a modelling project using secondary data examining the relationship between agricultural growth and nutrition in Malawi and the Yemen (like TANDI I, the main output has been published).

Finally, there are a set of projects that take a large scale, comparative approach to examining the relationship between agricultural interventions and nutrition. In this way, they may examine both direct and indirect effects, but may not be able to distinguish between them. These projects are characterised by their focus on collecting new datasets and analysing existing datasets rather than involving a specific intervention in the field. Four modelling projects were identified in this category, three of which are being conducted as part of the Standing Panel on Impact Assessment (SPIA), a sub-group of the CGIAR Independent Science and Partnership Council. The fourth is the BMGF-funded "Global Futures for Agriculture" study, which is using IFPRI's IMPACT model to assess the impact and appropriateness of emerging agricultural technologies on food availability. All, though, use relatively crude measures of malnutrition based directly on food-availability estimates, which has been found to be problematic (Hawkes et al, 2010).

Three projects were identified that involve the collection of new datasets on the impact of agricultural inputs or practices that have the potential to yield better quality estimates on the impact on nutrition. The SPIA project "Diffusion and Impact of Improved Varieties in Africa" (DIVA) aims to gain a more comprehensive understanding of the impact of crop improvement on poverty, nutrition, and food security in Africa. It is reported to be collecting

baseline diffusion information for 14 crops in 25 sub-Saharan African countries, and funding separate studies to assess the effects of new varieties on poverty, nutrition, and food security. In another example, a relatively new sub-component of the Agricultural Technology Adoption Initiative (ATAI) plans to assess the impact of agricultural technology adoption on nutritional outcomes based on detailed household surveys. Though not totally clear, the projects say they plan to collect information on nutritional status. The third project, Village Dynamics in South Asia (VDSA), part of the Village Level Studies programme, collects data on a whole range of agricultural practices conducted by households in South Asia alongside anthropometry measurements.

Another three projects are concerned with developing tools to enable improved measurement of the effects of agriculture on nutrition at a larger scale. Two of these are being undertaken in Africa by the Earth Institute at Columbia University under the auspices of the Millennium Villages Project and the African Agricultural Monitoring System project. The third is being conducted as part of the EC 7th Framework-funded "Aquaculture for Food Security, Poverty Alleviation and Nutrition" (AFSPAN), and aims to produce a comprehensive state-of-the-art methodology to be used by the project partners for assessing the contribution of aquaculture to alleviating poverty, improving food security. The project covers multiple low-income food-deficit countries (LIFDCs).

Overall, it would appear that there is a substantial gap in research on indirect effects, relative to direct effects. This is being mitigated to some extent by comparative analysis of country level data and modelling, but there remain a lack of studies which measure the local effects on households of agricultural interventions on nutrition acting through increased income and its effects on the food environment, education and improved health.

5.3 Gaps in research within impact pathways

The great majority of research projects are concerned with evaluating the direct effects of agricultural change on improved nutrition among participating households. Following our inclusion criteria, all projects examined had to include some assessment of potential or actual nutritional benefits, at the very least changes in the food environment, but ideally moving to measure impact on food consumption and nutritional status. Although no single project completes the research chain fully, some of the following types of projects come close:

- **Projects focused on the introduction of specific crop varieties.** Some of these projects examine uptake by farmers and value chain effects, and measure, or at least predicting from empirical studies, effects on the food environment, consumption or nutrition. This is notably the case for the biofortification projects – as has already been reported for the orange-fleshed sweet potato projects conducted as part of Harvest Plus (Low et al, 2007; Coote et al, 2011). Other biofortification projects appear to be taking a similar approach. For example, the Golden Rice Project conducts research into developing crop varieties (inputs), delivering the seed to farmers (practices), and marketing golden rice to consumers, including school feeding programmes (value chain). It also conducts clinical and community bio-efficacy trials to assess the impact of daily consumption on vitamin A deficiency status of women in Philippines. In the future it is planned to conduct an impact evaluation of introduction of golden rice under "real world conditions." Current HarvestPlusII projects (divided into breeding and delivery) also appear to extend from crop inputs through the value chain, measuring nutrient retention in typical storage conditions and processing and assessing impact on nutrition in community trials. These projects also measure cost-effectiveness (food environment), but few appear to measure infant and young child feeding practices (with the exception of BioCassava II, which measures breastfeeding).
- **Value chain projects**. Some of the value chain projects, for instance, the Pulse Collaborative Research Program (CRSP) study "Enhancing Nutritional Value and Marketability of Beans through Research and Strengthening Key Value-Chain Stakeholders in Uganda" conduct research at the input, practices, value chain and food environment (acceptability and quality) level, while also measuring impact on dietary diversity and income (albeit not infant and young child feeding practices or nutritional status).
- **Evaluations of agricultural development projects.** Some of these projects, specifically those that have been designed with careful consideration of the pathway of change, come close to completing the research chain. For example the USAID Feed the Future projects "Tajikistan Family Farming" and "Malawi Integrating Nutrition in Value Chains" both intervene in agriculture to improve nutrition with a clear impact pathway. Their evaluations are likewise relatively complete and involve examining the effects of improved seeds on smallholder agriculture, distribution and marketing through the value chain, and the effect on food prices, dietary diversity, child stunting and anaemia among women (but infant and young child feeding is not measured). Another example is "Strengthening and Evaluating Helen Keller International's homestead food production programmes" in Burkina Faso which is using measures of food availability, food consumption, nutritional status, infant and young child feeding that impact on nutrition, morbidity and income, with a special

emphasis on gender. The project led by the Food and Agricultural Organization of the United Nations (FAO) on "Improving the dietary intakes and nutritional status of infants and young children through improved food security and complementary feeding counselling" and "Realigning Agriculture for Improved Nutrition" (RAIN) project (see Figure 2), implemented by Concern Worldwide, are further examples of relatively complete projects.

- **Larger programmes concerned in an overarching way with agriculture for improved nutrition**. All such projects are still in the planning phase. The Nutrition Collaborative Support Program (NCRSP) in Uganda and Nepal, plans to examine all aspects of the research chain following from improved agricultural inputs and practices, including food prices, health status, economic outcomes, and cost-effectiveness as well as cross cutting areas, with the exception of "climate and environmental considerations." The same applies to LANSA and Transform Nutrition.

The main reasons for the gaps within the research chain are five-fold:

- **Lack of consideration of the value chain**. Forty-six of the 100 fully-mapped projects – almost half – do not incorporate the value chain into their work in any shape or form. While these projects do extend into the yellow boxes, their lack of consideration of value chains implies that the mechanisms through which the change in agricultural input or practice impacts on the food environment, food consumption and/or nutritional status are unlikely to be well-understood. This also shows, in general, a failure to consider the diversity of rural households, with some rural households being food deficit or surplus producing as a result of varying reliance on production, wage labour and self-employment. In some cases, though, consideration of value chain not to be necessary, if, for example, the project is part of a larger programme which does study value chains, such as the "Exploratory Assessment of the Relationship between Dairy Intensification, Gender and Child Nutrition among Smallholder Farmers in Buret and Kipkelion Districts, Kenya" which was conducted as part of the East African Dairy Development (EADD) programme. More projects do, however, appear to be incorporating market linkages directly into their work, such as the project "Linking Fisheries and Nutrition: Promoting Innovative Fish Production Technologies in Ponds and Wetlands with Nutrient-rich Small Fish Species in Bangladesh," which will examine market linkages, thus (in theory) enabling insights into how the relationship between increasing fish production and nutrition is mediated through the market.
- **Lack of consideration of food environment**. Few projects attempted to make explicit the link between changes in agriculture, value chain and the food environment and consumption indicators or nutritional status, such as specific changes in retail food prices, changes in market availability in specific settings, or food acceptability. As

such they fail to consider the impact of the project within wider market integration nationally, regionally and globally.

- **Lack of measurements to assess if and how the project influenced nutrition outcomes**. Fifty-seven of the 100 fully-mapped projects – over half – do not measure or consider nutritional status. However, of these, the majority (68%, n=39) measure some impact on household food consumption, individual intake, or dietary diversity. The remaining 18 projects relied on food environment indicators as an indicator of potential nutritional impact (n=11) or took no measure at all (n=7)[17]. Overall, just 14 of the 100 fully-mapped projects measure impact on infant and young child feeding that influence nutrition. Where nutritional effects are measured in projects, there are variations in methodology (Box 2) and metrics (Table 4).
- **Strong nutrition component but weak link to agriculture**. A smaller number of projects are heavily focused on diet and nutrition but with minimal agricultural components. For example, the WINFOOD programme has examined and measured the potential for local foods to improve complementary feeding, but is only just beginning to look at value chains and engaging with fish producers.

Finally, we noted a very low number of projects which estimated the cost effectiveness of the intervention – just 19 of the 100 fully mapped projects.

Box 2. Measuring nutrition – metrics and methodological patterns

Detailed information on the metrics and methods used in the nutritional component of each research project was not specifically sought in the mapping exercise; rather, the information was recorded where possible and ascertained from the information provided in the template. The degree of information and analysis did not allow an appraisal of the quality of existing research. However, to provide an indicator into the types of metrics and methodologies used for measuring the nutrition, a preliminary analysis was conducted into projects that involve ***evaluations of agricultural development projects*** (see Section 3).

Of the 28 projects identified for which the research component was limited to an evaluation, 23 had information about nutritional measurements. Of these 23, 70% (n=17) measure nutritional status, six of which also measure impact infant and young child feeding practices, and 12 of which also include measures of dietary diversity or household or individual level intake. Five of the projects measure

[17] For example the Ni-Can-Veg project (Sustainable Production of Underutilized Vegetables to Enhance Rural Food Security) is testing the production of underutilized vegetables, conducting value-chain analyses for promising species, testing packaging technologies and determining economic and market potential, but with no consideration of how this might affect nutrition (see Figure 2). Some of the projects which only extend to food environment indicators appear to do so because other parts of the same initiative do so – for example, Rwanda Superfoods, is testing consumer acceptability of the product as part of its value chain development work, but not testing for nutrition outcomes, which has been conducted by other orange-fleshed sweet potato projects.

only dietary diversity or household or individual intake (of fish and animal source foods) but not nutritional status, while one measures length of food insecure periods.

The study methodology used in the 17 projects that measured impact on nutritional status is not known for seven studies. For the remaining 10, four are confirmed randomized control trials (three of which use cluster methods)*, four have designs with control groups (one being quasi-experimental), one is a cohort study and one is a survey using longitudinal data.

In projects with broader research activity extending beyond evaluation, details of the specific research methods were typically not known. However, seven biofortification projects did report using randomized control trials to assess impact of consuming biofortified crops, as did one value chain-oriented project.

* These are "A Cluster Randomized Controlled Trial of an Agricultural Intervention Package to Improve Income, Empowerment and Health of HIV-affected Female Farmers and their Households in East Africa" being conducted by the Global Health Institute, University of California; and evaluations of Realigning Agriculture to Improve Nutrition in Zambia; of Helen Keller International's homestead food production programs; and of an existing aflatoxin management project in Kenya, the latter three all being by the International Food Policy Research Institute (IFPRI).

Table 4: Examples of metrics for measuring nutrition and food environment in agricultural research projects

Maternal health	Birth weight and prevalence of low birth weight (<2,500g)
Nutritional status (anthropometric)	Weight for height/length z-score (wasting) (children under 5y)
	Height/length for age z-score (stunting) (children under 5y)
	Mid-upper arm circumference (children under 5y)
	Body Mass Index (BMI) centile (children 5-16y)
	BMI (underweight, overweight, obesity) (adults)
Nutritional status (micronutrients)	Haemoglobin / serum ferritin (iron deficiency anaemia)
	Serum retinol / conjunctival impression cytology (vitamin A deficiency)
	Goitre / urinary iodine excretion (iodine deficiency)
	Plasma / toenail zinc (zinc deficiency)
Food consumption and intake	Individual diet by 24-hour recall(s), diet diaries or food frequency questionnaires
	Household food consumption by food inventory
	Intake (of individuals or household) of specific foods or food groups
	Dietary diversity
	Household hunger rating
	Consumption of fortified foods / supplements
Infant and young child feeding practices	Breastfeeding initiation, exclusivity, duration Use of formula milk Introduction of complementary foods (timing, type of foods, amount)
Food environment	Acceptability of novel foods or varieties
	Availability of nutrient dense foods, e.g. cassava, lowland rice, high-value vegetables
	Quality of food available, e.g. purity of processed sesame, cowpea
	Food prices (affordability) of nutrient-dense foods

5.4 Gaps in consideration of macro-factors

The framework also conceptualised macro-factors important for research on agriculture for improved nutrition, including the policies and governance, gender, environment etc. There were very significant research gaps in this regard, and we highlight two areas here: policy and governance.

One major "macro-factor" gap is the lack of policy research. Some projects do consider policy or governance in the context of generating policy-relevant results; 25 of the fully-mapped projects have the explicit aim of developing some form of guidance or governance structure for governments. For example, the "nutrition indicators of agricultural projects" project is being developed as a tool for policy- and other decision-makers and the "mainstreaming biodiversity conservation" project aims to develop cross-sectoral policy platforms. In a very small number of projects (three), research was being conducted in the context of government policy. For example, the Vision Garden Development Project in India was initiated in the context of government support in producing saplings at subsidized rate and for pest control, while the "market integration" project being planned by Bioversity International is set in the context of low political support for traditional crops.

However, just five projects were identified that actually conduct research into policies that influence the relationship between agriculture and nutrition at the broader scale: two value chain projects which consider policy as an explicit part of the value chain analysis; two modelling projects (the IFPRI IMPACT model and a SPIA project in Ethiopia) which examine the effect of differing policy scenarios; and just one project for which policy is the core component of the project – LANSA, which has the explicit research question "How can South Asian agriculture and related food policies and interventions be designed and implemented to increase their impacts on nutrition, especially the nutrition status of children and adolescent girls? There were no projects at all that looked at the methods and metrics that could be used to conduct this type of research.

There was likewise a macro-gap in governance research – research into policy processes, institutions ("political economy") that affect the ability to scale-up the lessons learned from more technical, smaller-scale research. There are five projects that do undertake this work, or at least plan to do so:

- "Transform Nutrition" aims to, among other things, answer the question "How can an enabling environment be promoted so as to use existing political and economic resources more effectively, and to generate new resources to improve nutrition?"
- the "prospective longitudinal case studies of scale up" component of SPRING (Strengthening Partnerships, Results and Innovations in Nutrition) aims to provide a better understanding of the processes surrounding scaling up multi-sectoral nutrition activities, how gaps can be overcome, and what synergies exist between sectors in the study countries;
- the Realigning Agriculture for Improved Nutrition (RAIN) project aims to produce a realignment of and coordination between Agriculture and Health sector systems and actors towards common goal of improved nutrition;
- the planned study in Ghana "Building capacity for sustainable livelihoods and health through public-private linkages in agriculture and health systems";
- the programme planned by the University of Stellenbosch on "Building Capacity for Sustainable Agriculture and Nutrition Security in Africa", which aims, among other things, to build nutrition into agricultural training in educational institutes in sub-Saharan Africa.

5.5 Target groups/health gaps

Apart from the general lack of an indirect link to health, two major nutrition-related health gaps emerged. The first is maternal nutrition. As noted in Table 2, 14 of the projects focus on pregnant and breastfeeding women or mothers, and 29 on women generally. However, in the 14 projects directed to pregnancy and breastfeeding it appeared that the core concern was for the child rather than the mother because only two of the projects specified measurement of maternal nutrition impact while the others focused on measures of child nutrition. This suggests that the maternal nutrition component was not well addressed along the continuum of care, despite it being a period of highest energy/nutrition requirements that affect both mother and developing foetus.

The second gap identified is "over-nutrition" and associated diet-related non-communicable diseases (NCDs). Only four projects identified were concerned with NCDs: a value chain project in Fiji conducted by a doctoral student at LCIRAH; an IDRC-funded study in Lebanon focused on local foods; a project on the anti-diabetic properties of bitter gourd as AVDRC; and the CIFSRF- supported project "Improving the Nutrition and Health of CARICOM Populations," which is exploring how to improve nutrition and health outcomes in Guyana, Trinidad, St. Lucia, and St. Kitts through market-oriented agricultural diversification and food

production combined with community nutrition interventions. There are examples of recently published research in this area (e.g. Lock et al 2012, Nugent et al 2011; Hawkes et al 2012) but all were one-off articles/reports. This is likely associated with the extremely small number of projects targeting urban consumers (n=3), but is also a reflection of the lack of consideration of the problem overall, since it is also an issue in rural areas and among poor people.

It should also be noted that only three projects specifically focussed on people living with HIV/AIDS. In addition, the gap analysis raises the question of whether the research is being directed to the poorest of the poor in the least developed countries, in humanitarian situations and in fragile states – which were not typically the location of research (though there are projects planned or being conducted in Afghanistan, Democratic Republic of the Congo, Haiti, Myanmar, Pakistan and Zimbabwe).

6. Conclusions

This mapping exercise of agriculture and nutrition research identified a considerable amount of current and planned research on agriculture and nutrition. However, it also identified some clear gaps, as well as some potential next steps. The clear gaps are as follows:

- A lack of research extending through the whole chain, including value chains (e.g. market linkages and incentives), the link with food environment indicators (e.g. food prices), through to measurements of individual food intake or dietary diversity, infant and young child feeding practices, and nutritional status. This gap prevents a more complete understanding of the full pathway of change.
- A lack of research on the indirect effect of changes in agriculture on nutrition, acting through agricultural effects on income and economic growth and associated changes in health and investments in health and education services. The great majority of projects consider direct effects of agricultural interventions on the food environment, consumption and nutrition on participating (usually producer) households, and thus fail to consider the impact of their interventions in the light of wider market dynamics, which may be affected by other local, national, regional or global trends.
- A lack of research on the effects of agricultural policy change on nutrition through the value chain. Given the potential of policy to have broad and extensive impacts at a population level, this is an extensive gap.
- A gap in research on governance, policy processes and political economy as it relates to the development of agriculture-for-nutrition policies and programmes, the ability to implement them (and scale up,) and for them to achieve their stated goals once implemented. Why do decision makers not make decisions that would favour greater leveraging of agriculture for nutrition? What explains success where collaborative policies have been developed? Why do implemented projects not have the impact they intend to have? Overall, what barriers need to be removed and processes put in place to enable the successful development and implementation of agricultural policies and programmes to improve nutrition?
- A lack of research seeking to improve the way research into agriculture and nutrition is conducted, such as through creation and analysis of large sets of agricultural and nutritional data, the development of methodologies (e.g. on tracing the effects of policy change), and more nutrition-sensitive value chain analysis.
- A gap in research on broader target groups, notably consumers more broadly such as rural wage workers and non-rural populations – a consequence of which is a profound gap in research on the potential for agriculture and food value chains to improve the diets of the rural and urban poor at risk from nutrition-related NCDs.

There is also relatively little research on people living in fragile states and post-conflict situations.

- There was very little work conducted on cost-effectiveness.

The mapping exercise identified some possible next steps for building upon and using the database developed here:

- **Clarification of the metrics for measuring the impact of agricultural on nutrition**. As already noted, this analysis did not examine in detail the quality of the research projects or the utility of specific metrics and methodologies they use, making it impossible to evaluate whether existing research will fulfil its potential. Though it identified a considerable number of research projects that include measurements of food consumption or intake, and/or nutritional status, it was not able to assess whether these measurements were adequate for the specific research project in question. A better understanding and analysis of the most appropriate methods and metrics is needed to be able to translate research into practice, and plan and design future research. Critical considerations may be, for example, when randomised control trials should be used (e.g. for evaluating specific interventions) and when other, broader research questions demand alternative methodologies, the appropriate measure of intake in different types of research (e.g. dietary diversity, individual intake, household consumption), the most effective way to measure the "food environment," useful and meaningful metrics for policy and governance research, and proxy indicators for when the ideal is not possible.
- **Research on a greater range of target groups**. A feature of the mapping exercise which we found novel and particularly productive was bringing together agriculture, nutrition and health experts. This not only helped us to "re-focus" the conceptual framework on people rather than agriculture, but identified a need to look more carefully at target groups (e.g. pregnant and lactating women and urban consumers), and the particular way in which changes in agricultural inputs, practices, and value chains could be used to enhance their nutrition. This is important given that changes in agriculture may impact on target groups in different ways. This study has made only a very preliminary examination of this aspect of research (Box 2 and Table 4), and more refined work is needed to look at which types of research projects affect which groups in order to identify if research is appropriately targeted (e.g. at pregnant and lactating women, 1000 days etc).
- **Broader involvement of relevant research organisations and partners**. The study identified very little research conducted by the private sector. Is this warranted, or a gap? Very little research was led by organisations in developing countries. Again, does this matter or is it acceptable given capacity constraints, provided these

organizations are involved as partners? The analysis also did not include an assessment of the discipline of the research organisations involved. Are a sufficiently broad enough set of research disciplines included? Likewise, is there sufficient collaboration between the research and practice communities? This type of analysis would be useful to increase the potential of the research to improve nutrition outcomes.

Finally, this study has identified a very large range of current and planned research projects on agriculture for improved nutrition, in sharp contrast to the poor record of past research captured in recent systematic reviews on this subject. Over a very short period, a substantial research community has developed on this subject. However, given the diversity of projects and sponsors, these researchers risk developing their research methods and projects in isolation. The outputs of this mapping study could be used to link researchers across projects and programmes, allowing them to share their methods and experiences, and to develop and spread improved research practices. A first step towards this outcome could be the establishment of an independent network of researchers, invited from the projects identified here, who would be interested in improving research methods for evaluation the effects of agriculture on improving nutrition.

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Annex 1: Terms of Reference

Integrated agriculture and nutrition research:
identifying gaps in current research initiatives

Background
Agriculture needs to expand and develop in order to meet the food requirements of a growing population in the face of natural resource constraints and climate change. The Foresight report on Global Food and Farming Futures identified that agricultural development can have positive (e.g. improved food and nutrition security) and negative (e.g. zoonotic diseases) impacts on population health and nutrition. There are multiple integrative research initiatives in agriculture and health being conducted globally by various stakeholders which aim to identify how best to maximise the positive impacts of agricultural development. To date there has been little over-arching review of these initiatives or analysis of gaps in research activities and evidence generation.

Purpose
Building on strong ministerial-level interest in nutrition, and considerable on-going activity in DFID on agriculture and health, the purpose of this work is to:

- undertake a gap analysis of research at the interface of agriculture, nutrition and health relevant to international development being undertaken over the next 5 years, based on a rapid but detailed mapping exercise of major research activities.

The analysis will inform the development of a coherent framework for international research investments in agriculture, nutrition and health which can be drawn on by a range of development partners. This will also enable DFID to identify where it can add value in relation to other research funders.

Scope
<u>Focus</u>
The mapping will focus on research with intended nutrition outcomes of interventions and policies relating to food production, marketing and value chains, access to food, food and nutrition security, price volatility and agro-ecosystems, relevant to international development. Interventions and policies aimed to reduce acute and chronic undernutrition (including those in humanitarian crises and conflict situations) and those tackling nutrition-related chronic diseases should be included.

The mapping will not include research relating to zoonotic or other agriculture-associated diseases, nor will it include basic science research at the interface of agriculture, nutrition and health such as plant and animal breeding.

<u>Geographical</u>
The mapping will focus on work of relevance to low- and middle-income countries. Of particular additional interest is research conducted by centres in Brazil, India, China and South Africa. A preliminary list of relevant research programmes and institutions activities is provided in Annex 1.

Timeframe of interest

The mapping will review current and planned research programmes over the next 5 years. The gap analysis will cover evidence needs for policy in the short term (ie up to 5 years) as well as in the medium (5-15 years) and long term. The medium- to long-term analysis will enable review of research requirements on long-term trajectories and drivers of nutritional outcomes, including the dietary transition, and the impact of climate change and resource scarcity.

Research stage

The mapping exercise will cover the research spectrum from the development of relevant tools and technologies (evidence generation), through the synthesis of existing evidence (literature and systematic reviews) to the research on the implementation and scale-up of proven interventions (research into use).

Approach

We propose to undertake this through a 2 pronged process:

1) Undertake a research mapping and gap analysis exercise.
2) Develop an external advisory group to validate the mapping and gap analysis, prioritise research actions, identify suitable research strategies and help determine DFID's added value in supporting relevant current and future research. The advisory group will reflect the broad geographic scope of stakeholders and research programmes, the multidisciplinary nature of the research, and include academic, operational and policy partners.

Product

The output should be a short, clear and succinct analytical report (no more than 15 pages excluding annex) which sets out:

- Mapping – a conceptual framework linking agriculture and nutrition/health with current and planned research being undertaken mapped against this framework (see for example Appendix 2).
- Gaps – an analysis of research challenges and questions that are not being adequately addressed in current and planned initiatives.
- Annex – setting out the research being undertaken and planned: primary research questions, methods used, outputs, sources and scale of funding, donors and research partners, geographical scope.

Management

The Senior Research Fellow in nutrition will provide overall technical support and oversight to the process, working closely with representatives from DFID's Nutrition Policy, Agriculture and Health research teams. The external advisory group will be engaged at project conception stage to provide guidance on relevant research initiatives, to validate the project findings and provide high-level input on the way forward.

Expertise required

DFID is looking for a small team of researchers (2-3 people) to undertake the first phase of this work, ie the mapping and gap analysis. We estimate it will take 90 days inputs, which should be delivered over a 6 week period. The team will need to have proven expertise at the interface of agriculture, health and nutrition and experience in related assignments.

Annex 2: Sample letter sent to contacts

Dear X,

We are writing to you from the Leverhulme Centre for Integrated Research on Agriculture and Health (www.lcirah.ac.uk) and the University of Aberdeen about a mapping project we are currently undertaking for the UK's Department for International Development.

The objective of the project is to map the growing research activity on agricultural interventions to improve nutrition in low-middle income countries and identify "gaps" in current and anticipated research.

We are aware of your interest in research into agriculture and nutrition at X. If you have any active programmes in this area, we would be grateful if you could send us some information about them. We would also be interested in a list of agriculture-nutrition research you are planning.

We are interested in a range of information about the research, so if you could send us documents, websites etc about the programmes we can then extract the information we are looking for.

If you know about any other agriculture-nutrition research that you think should be included in the mapping exercise or any networks (list serves, communities of practice etc), whom you think we should be in touch with, do please let us know.

We will be happy to share our project with you at a draft stage, to check that we have represented your work properly and to invite your inputs on our analysis generally.

If you have any questions about our request, please do not hesitate to ask. If you have questions about the project more broadly, please contact Corinna Hawkes, who has been contracted to lead the project, at corinnahawkes@o2.co.uk.

We are conducting this project on a tight timetable and would appreciate a reply before Friday 27th April if possible. If that is going to be impossible, please let us know a more realistic date.

Thank you very much and best regards,

Rachel

Rachel Turner
Honorary Research Fellow
Department of Nutrition and Public Health Intervention Research
London School of Hygiene and Tropical Medicine

On behalf of the project team

Annex 3: List of organisations in contacts list

Organisation/ institute	Acronym
Aberdeen University	
Abt Associates	
Agricultural Cooperative Development International/ Volunteers in Overseas Cooperative Assistance	ACDI/VOCA
Action Contre La Faim	ACF
Animal Production Research Centre	CVZV
Australian International Development, AUSAID	AUSAID
Austrian Development Cooperation	ADA
Belgium, Federal Public Service Foreign Affairs	
Bioversity International	Bioversity
BRAC	BRAC
Brazilian Agricultural Research Corporation	Embrapa
Canadian International Development Agency	CIDA
Caribbean Farmers' Network	CaFAN
Catholic Relief Services	CRF
Chicago Council on Global Affairs	
Chinese Academy of Agricultural Science, Institute of Nutritional Science, Shanghai, China Agricultural University	CAAS
Centre de coopération internationale en recherche agronomique pour le développement	CIRAD
City University, Centre for Food Policy	
Concern Worldwide	
Consultative Group on International Agriculture Research	CGIAR
Collaborative Research Support Programmes	CRSP
Cornell University, Centre for Sustainable Future	
Cornell University, Food and Nutrition Policy Programme	
Cronicas, Peru	
Cyrus, Agricultural Research Institute	
Development Alternatives Inc	DAI
Danish International Development Agency*	DANIDA
Department for Foreign Affairs and Aid, Ireland	
Deutsche Gesellschaft für Internationale Zusammenarbeit (Germany)	GIZ
UK Department for International Development	DFID
Emory University Department of East Africa Dairy Development	EADD
Enterprise EthioPEA, PepsiCo, USA	
Estonian Ministry of Agriculture	
European Commission (Directorate General Research)	EC
European Initiative for Agricultural Research for Development	EIARD

European Public Health and Agriculture Consortium	EPHAC
Farming First coalition	
Fintrac, United States of America	
Food and Agricultural Organization - “Food for the Cities” initiative	FAO
Food and Agricultural Organization - Evaluation Service	FAO
Food and Agricultural Organization - Nutrition	FAO
France Diplomatie	
Gates Foundation	Gates
Gender Informed Nutrition Agriculture (GINA)/ Food Basket Foundation International (FBFI)	GINA
Global Alliance for Improved Nutrition	GAIN
Harvard	
Harvest Plus	
Hatch	
Health Bridge	
Helen Keller International	HKI
Hungarian government	
Imperial College London	
INCAP Comprehensive Centre for the Prevention of Chronic Diseases	INCAP
INCLEN Trust	INCLEN
Indira Gandhi Institute of Development Research	IGIDR
INIA, Spain	INIA
Institute of Technology, Portugal	ITQB
Institute of Development Studies	IDS
Institute of Research for Development	IRD
International Center for Research in Agroforestry (ICRAF)/ World Agro-forestry Centre	ICRAF
International Centre for Tropical Agriculture	CIAT
International Crops Research Institute for the Semi-Arid Tropics*	ICRISAT
International Development Research Centre	IDRC
International Food Policy Research Institute (Bangladesh Policy Research and Strategy Support Program)	IFPRI
International Food Policy Research Institute (Development Strategy and Governance Division)	IFPRI
International Food Policy Research Institute (Food, Poverty and Health Division)	IFPRI
International Fund for Agricultural Development	IFAD
International Institute for Environment and Development	IIED
International Livestock Research Institute	ILRI
International Maize and Wheat Improvement Center*	CIMMYT
International Potato Centre	CIP
International Rice Research Institute*	IRRI

Iowa State University, Center for Sustainable Rural Livelihoods	
Istituto Agronomico per l'Oltremare i (Italy)	IAO
Johns Hopkins Bloomberg School of Public Health	
John Snow International	JSI
Kintampo Health Research Centre	KHRC
L V Prasad Eye Institute	LVPEI
Land O Lakes Inc	
League for Pastoral Peoples and Endogenous Livestock	
Leverhulme Centre for Integrative Research on Agriculture and Health	LCIRAH
London School of Hygiene and Tropical Medicine	LSHTM
Mbarara University of Science & Technology	MUST
McGill University, School of Dietetics & Human Nutrition	
McGill University, World Platform for Health & Economic Convergence	
Micronutrient Initiative, Senegal	
Millennium Villages Project	
Ministry of Agriculture & Forestry, Finland	
Ministry of Agriculture, Czech Republic	MZE
Ministry of Foreign Affairs, Denmark	UM
Ministry of Foreign Affairs, Luxemburg	MAE
Ministry of Foreign Affairs, the Netherlands	Minbuza
MS Swaminathan Research Foundation	MSSRF
Naandi Foundation	Naandi
National Institute of Nutrition (ICMR)	
National Agricultural Research Foundation , Greece	
New Partnership for Africa's Development	NEPAD
North Western University, South Africa	
Norwegian University of Life Sciences	UMB
Nova School of Business & Economics, Portugal	
Pan American Health Organization	PAHO
Programme for Appropriate Technology in Health	PATH
Reading University	
Scaling Up Nutrition	SUN
Soils, Food and Healthy Communities Project	SFHC
South Asia Food and Nutrition Security Initiative	SAFANSI
Southampton University (Institute of Human Nutrition)	IHN
Stellenbosch University Food Security Initiative	FSI
Supporting the Improvement of Household Food Security, Nutrition and Livelihoods in Afghanistan	
Sustainable Nutrition Research in Africa in the Years to come	SUNRAY
Swedish University of Agricultural Sciences	

Sweet potato Action for Security and Health in Africa, International Potato Center	SASHA
Swiss Agency for Development and Cooperation (SDC)	SDC
UNC Gillings School of Public Health	
Universidade Federal Rural do Rio de Janeiro	
Universidade Federal do Rio Grande do Sul, Brazil	
University of California Global Health Institute	UCGHI
University of Copenhagen	
University of East Anglia	UEA
University of Gottingen (GlobalFood)	GFC
University of Ottawa, Interdisciplinary School of Health Sciences, Faculty of Health Sciences,	
University of Pretoria, Institute for Food, Nutrition and Wellbeing, South Africa	
University of Saskatchewan	
University of Washington, Department of Global Health	
University of Western Ontario	
United States of America International Development (USAID	USAID
Wageningen University	
West African Health Organisation	WAHO
WHO, Department of Nutrition for Health & Development	WHO
World Bank, school feeding	
World Bank, SecureNutrition	SN
World Fish Centre	WFC
World Food Programme, P4P programme	WFP
World Food Programme, REACH Ending Child Hunger and Undernutrition Partnership	REACH
World Health Organisation, Geneva	WHO
World Vegetable Centre	AVRDC

* Not contacted directly

Annex 4: Blank Template

Programme/ Project basics	**Our Unique ID**
	Research project/ programme name
	Acronym
	Umbrella initiative
	Lead institution(s)
	Type(s) of lead institution(s) - research institute/university; government; NGO; private sector - & country
	Type of lead org (summary)
	Region of lead org
	Other institutions / partners involved
	Type(s) of other institution(s) - research institute/university; government; NGO; private sector - & country
	Start date
	End date
	Duration
	Location/ target area
	Funding organisations
	Funding amount
	Lead contact & email address
	Sources of information, e.g. website (including link)/ document (name)
	Funder code
Project overview	**Type of crop/ agriculture (specific)**
	Type of crop/ agriculture (final summary)
	Project involves intervening in an agricultural input, practice or value chain? (Yes/ No)
	Main project/programme theme re agriculture
	Nutritional analysis of crops/ food? (Yes/ No)
	Involves analysing existing data or collecting and analysing new data re nutrition (people)
	Type of research/ evidence re nutrition (people)
	Overall programme aim/ objective
	Research project/ programme aims concerned with nutrition
	Target group / population for improved nutritional status
	Number of beneficiaries/ recipients of the intervention (if relevant/known)
	Overview of research component(s)/ methods
	Notes/ other
Agricultural components	**Agricultural inputs** (e.g. crops, technology, fertilisers)
	Agricultural practices (e.g. crop selection, varieties, input use, time allocation)
	Food value chain (e.g. storage, processing, distribution, retailing)
	Other relevant agricultural interventions/ activities

	Measures of impact of agricultural activities on agriculture-related outcomes
Food and nutrition	**Food environment/ research activity** (e.g. food availability, price, quality, acceptability)
	Food environment: measurement of outcome
	Food consumption/ research activity
	Food consumption: measurement of outcome
	Nutritional status research activity
	Nutritional status: measurement of outcome
	Household practices which influence nutrition (non-food related, e.g. Breastfeeding)
	Household practices which influence nutrition: measurement of outcome
	Measures of cost-effectiveness
	Notes, e.g. Other nutrition and health interventions
Indirect impacts/ intervening factors	**Health & education status**
	Health care services and education services
	Economic outcomes/ research activity
	Economic outcomes/ measurement
	Research considerations - policy & governance
	Research considerations - culture, gender & equality
	Climate & environment - issues/ considerations
	Political & economic context - issues/ considerations
	Notes/ other information