

External evaluation of mobile phone technology-based nutrition and agriculture advisory services in Africa and South Asia

Mobile phones, nutrition, and agriculture in
Ghana: Cost-Effectiveness Baseline Report

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Executive summary

This is the baseline report for the cost-effectiveness analysis of the Vodafone Farmers Club, Ghana, a Value Added Service supported by a grant from GSMA as a part of the mNutrition programme. mNutrition is a global initiative supported by DFID, organised by GSMA, and implemented by in-country mobile network operators (MNOs) to use mobile technology to improve the health and nutritional status of children and adults in low-income countries around the world. This report forms part of the evaluation of the programme, which draws on a number of methods and interlinked components to gather evidence about the impact of the m-Nutrition intervention in Ghana.

This report is the baseline for research question 1 which states: “What are the impacts **and cost-effectiveness** of mobile phone-based nutrition and agriculture services on nutrition, health and livelihood outcomes, especially among women, children and the extreme poor?” (ToR, Annex A).

The report is one of four baseline deliverables for the “External evaluation of mobile phone technology based nutrition and agriculture advisory services in Africa and South Asia”. This report should be read in conjunction with the baseline Business Modelling report (Scott, Batchelor and Sharp, 2017). The deliverables Quantitative Baseline Report (Billings et al 2017) and Qualitative baseline report (Barnett et al 2017) give insight into the consumer environment that the service is targeted at.

Given that studies of ‘cost-effectiveness’ of agricultural programmes are not very common, the team undertook a literature review of both agricultural and nutritional interventions, and the way cost-effectiveness was handled. Two approaches were taken. In a more formal search, 38 studies meet key criteria, with 170 relevant cost-effectiveness data-points, or measures of cost-effectiveness analysis. This is because several studies included the comparative cost-effectiveness of several interventions. In a broader, less bounded approach, several different combinations of search terms were used. While this yielded various insights into how cost-effectiveness might be considered, it also drew out the key difference between cost-effectiveness and cost benefit analysis (a more common analysis for agricultural programmes).

Based on the literature the report creates a framework for future analysis. Acknowledging that the analysis cannot be undertaken until the quantitative component of the evaluation delivers its endline in 2019, this baseline report sought to define 3 analyses – including setup and ongoing costs for the specific intervention (Vodafone Farmers Club) (analysis A), wider mNutrition programmatic costs (analysis B), and a scenario that included societal costs including farmer costs and benefits (analysis C). One aspect of the Vodafone Farmers Club (VFC) is an intention to increase farmer’s net income. While this could be used for a cost benefit analysis, the impact measure most favoured in the nutritional and health literature would be DALYs averted. We have therefore proposed putting the increases in net income as mitigated costs in analysis C, and, given the aim of the cost-effectiveness component is to compare the intervention with other alternatives, we will seek to define the outcomes in terms of DALYs, calculated from diet diversity.

In the literature, many studies consider the benefits to farmer income, but fail to include changes in nutrition. By considering only financial benefits, they tend to use cost-benefit analysis. On the other hand, studies that do consider nutrition outcomes tend to use non-monetary measures of outcomes, such as dietary diversity and DALYs averted. This study will consider improved nutrition as the primary outcomes of the Vodafone Farmers Club project, so the cost-effectiveness analysis will be based on dietary diversity measures included in the design of the quantitative household

surveys. In order to facilitate comparison with studies from the nutrition literature, attempts will be made to assign ‘imputed’ saving in terms of DALYs.

Building on the framework the report defines what costs were known as at March 2017, the end of the data collection phase. It should be noted that there is ongoing evolution of the service with consequent changes in ongoing costs and that these will be documented between now and 2019 as much as possible. The baseline costs in this report are therefore indicative of current costs, not representative of final costs (Table 1).

Table 1 Summary of allocation of costs

	Year 1	Year 2
Analysis A: Direct Cost totals as at March 2017	£722,653	£1,017,833
Analysis B: A+ wider programme costs	£349,500	£349,500
Analysis C: A+B+ societal costs	Not yet known	Not yet known

Note, the totals combine known budgets/expenditure and a set of estimates

The report also considers the comparable interventions from the literature (Annex C). It acknowledges that no single intervention is comparable but that elements of the Vodafone Farmers Club are comparable to elements in other services.

Finally, the report concludes that ultimately, there are several decisions to be made with regard to the cost-effectiveness analysis of mAgri. These decisions are not always clear cut, for example the value of beneficiary labour, and contain within them implicit value judgements. The baseline proposes conducting three distinct analyses, taking account of different costs, to generate metrics that will be relevant to different stakeholders.

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List of abbreviations

AFRRI	Africa Farm Radio Research Initiative
AGRA	Alliance for a Green Revolution in Africa
ALC	Active Listening Community
ARPU	Average Revenue Per User
BMJ	British Medical Journal
BTL	Below the Line
CABI	Centre for Agriculture and Biosciences International
CARMMA	Campaign on Accelerated Reduction of Maternal Mortality in Africa
CB	Community Based
CBA	Cost Benefit Analysis
CDC	Centre for Disease Control
CE	Cost-effectiveness
CEA	Cost-effectiveness Analysis
CER	Cost-effectiveness Ratio
CGIAR	Consultative Group for International Agricultural Research
CSR	Corporate Social Responsibility
DALY	Disability Adjusted Life Year
DDS	Dietary Diversity Scores
DfID	Department for International Development
DSF	Demand Side Financing
EADD	East African Dairy Development
EMRI	Ethiopia Millennium Rural Initiative
F2FE	Farmer to Farmer Extension
FAO	Food and Agriculture Organisation
FCS	Food Consumption Score
FFS	Farmer Field Schools
FHI 360	Family Health International 360
GAIN	Global Alliance for Improved Nutrition
GCP	Global Content Partnership
GDP	Gross Domestic Product
GFRAS	Global Forum for Rural Advisory Services
GHS	Ghanaian Cedis
GSMA	GSM Association
HAZ	Height for Age Score
HDDS	Household Dietary Diversity Score
HNI	Human Network International
HSPR	Health Sector Priorities Review
ICER	Incremental Cost-Effectiveness Ratio
ICPD	International Conference on Population and Development
ICT	Information and Communication Technologies
IDS	Institute of Development Studies
IFPRI	International Food Policy Research Institute
ILRI	International Livestock Research Institute
IP	Intellectual Property
IRR	Internal Rate of Return
IVR	Interactive Voice Response
LCP	Local Content Partners
LMICs	Low and Middle-Income Countries
LYG	Life Years Gained

M&E	Monitoring and Evaluation
MDD-W	Minimum Dietary Diversity- Women
MDG	Millennium Development Goals
MNO	Mobile Network Operator
MOA	Ministry of Agriculture
NBS	National Bureau of Statistics
NCA	National Communication Authority
NGO	Non- Governmental Organisation
OBD	Outbound Dialling
OECD	Organisation for Economic Co-operation and Development
OFSP	Orange Fleshed Sweet Potato
OPM	Oxford Policy Management
PRC	Participatory Radio Campaign
PSI	Population Services International
QALY	Quality Adjusted Life Year
RAE	Retinol Activity Equivalents
R&D	Research and Development
RCHS	Reproductive and Child Health Section
RNI	Recommended Nutrient Intake
SBCC TWG	Social and Behaviour Change Communication Technical Working Group
SIM	Subscriber Identity Module
SMS	Short Messaging Service
SSA	Sub Saharan Africa
T&V	Training and Visiting
ToC	Theory of Change
UNICEF	United Nations Children’s Fund
USAID	United States Agency for International Development
USSD	Unstructured Supplementary Service Data
UX	User Experience
VFC	Vodafone Farmers Club
VfM	Value for Money
WAZ	Weight for Age Score
WHO-CHOICE	Choosing Interventions that are Cost-effective
WHO	World Health Organisation
WHZ	Weight for Height Score
WIAD	Women in Agricultural Development
YLD	Years Lived with Disability
YLL	Years of Life Lost

1 Introduction

The Vodafone Farmers Club (VFC) has been introduced in the context of a mature telecoms market, where growth in subscriber numbers is slowing down. The remaining, untapped market for voice and SMS will be made up mostly of low income consumers in rural areas. This is a market segment characterised by high dependency on agriculture, and relatively poor health outcomes. Vodafone Farmers Club has been designed to deliver value within this context.

Nutrition: Child stunting is 19 percent nationally in Ghana and higher in the Northern (33 percent), Central (22 percent), and UW (22 percent) regions (GSS and GHS, 2015). Varied and high-quality diets are key to addressing child and maternal undernutrition. The percentage of children 6-23 months who consume the minimum diet diversity of four food groups is 46.8 percent and, on average, women consume four out of nine food groups (Kothari and Nouredine 2010).

Mobile penetration in Ghana has risen dramatically in the past ten years, increasing from less than 20 subscriptions per 100 people in 2005 to 108 subscriptions per 100 people¹ in 2013². According to the Ghana Living and Standards Survey (GLSS Round 6), mobile phone penetration in 2013 was 80 percent in Ghana, with 70 percent of rural households reporting owning a phone and 88 percent of urban households reporting owning a phone (GLSS 2014). However, access to mobile phones in Ghana varies dramatically by region, socioeconomic status, and gender. In USAID's Feed the Future zone of influence (districts in Northern, UW, and Upper East regions), only 38 percent of males and 41 percent of females report having a mobile phone in the household (USAID 2012). Access to mobile phones in these regions is also lower among females, with only 14 percent saying they are the principal owner of their phones, while 57 percent of males say they are the owner.

Literacy in Ghana: According to the GLSS Round 6, adult literacy rates in rural areas are quite low, with only 41.7 percent of the adults knowing how to read or write in English or any Ghanaian language.³ Among rural women, rates are even lower, at 31.4 percent. These low rates have implications on the design of the Vodafone Farmers' Club product and its ability to reach an illiterate population.

Agriculture in Ghana: A little over half (51.5 percent) of households in Ghana own or operate a farm. Farming is predominantly rural, with 82.5 percent of rural households involved compared to 26.6 percent of urban households.⁴ The proportion of females involved in agriculture is 41.2 percent, and there is virtually no difference in urban and rural areas. The main crop harvested is maize, followed by cocoa and groundnut/peanut. The number of households harvesting crops and the types of crop grown vary extensively across ecological zones. Per the Ghana Socioeconomic Panel Survey baseline report (Aryeetey et al 2011), 51.7 percent of all households surveyed received agricultural advice from other households and the proportion of households receiving

¹ In Ghana off-net tariffs are high, which mean that people carry multiple phones using each one to minimise call costs.

² <http://databank.worldbank.org>

³ GLSS Round 6, August 2014.

⁴ *Ibid.*

agriculture extension advice through radio varies from 13.79 percent in the northern region to 0.26 percent in the Greater Accra region.

mNutrition within the mAgri program aims to promote behaviour change around key farming decisions and practices by delivering nutrition information to farmers.⁵ The objective of mNutrition and mAgri is to create and scale commercially sustainable mobile services that enable smallholder farmers to improve the nutritional status of their household and increase their productivity (see Figure 4 for GSMA's theory of change of mAgri). The stated GSMA targets are the following (GSMA M4D 2013):

- At least 20 percent of registered households that act on information and advice report consuming at least **four food groups** daily for at least nine months of the year because of more diverse agricultural output, increased income, and/or behaviour change in terms of nutrition.
- At least 50 percent of registered households that act on information and advice report a 25 percent increase in **agricultural productivity**.
- At least 50 percent of registered households that act on information and advice report increases in **agricultural income** of 20 percent.

1.1 Objectives

The mNutrition evaluation is intended to understand and measure the impact, cost-effectiveness and commercial viability of mNutrition services using a mixed methods evaluation design. The evaluation includes a quantitative component, a qualitative component and a business model analysis. The evaluations are being conducted by a consortium of researchers from Gamos, the Institute of Development Studies (IDS) and the International Food Policy Research Institute (IFPRI). The team draws on a number of methods and interlinked work streams to gather evidence about the impact of the mNutrition intervention in Ghana.

- A **quantitative impact evaluation**, employing a randomised encouragement design to determine the causal effect of the intervention. This component will conduct large-scale, statistically representative household surveys at the start of the programme implementation and roughly 18 months later.
- A **qualitative impact evaluation**, which consists of three qualitative data collection rounds (i.e. an initial qualitative exploratory baseline, in-depth case studies at midline, and rapid explanatory qualitative work after the quantitative endline survey data collection) and aims to provide understanding of the context, underlying mechanisms of change and the implementation process of mNutrition.
- A **business model and cost-effectiveness evaluation** employing stakeholder interviews, commercial and end user data, document analysis, and evidence from the quantitative and qualitative evaluation data to generate a business model framework and estimate the wider imputed benefits from the value-added service for the range of stakeholders involved.

⁵ For a detailed landscape analysis on the context for implementing mNutrition and mAgriculture programs see the report Barnett et al. 2016.

The business model and cost-effectiveness component of the evaluation is designed to contribute evidence to help answer the first of the broad research questions specified in the Terms of Reference (Terms of Reference, Annex A), and the last two:

- What are the impacts and cost-effectiveness of mobile phone-based nutrition services on nutrition, health and livelihood outcomes, especially among women, children and the extreme poor?
- How commercially viable are the different business models being employed at country level?
- What lessons can be learned about best practices in the design and implementation of mobile phone-based nutrition services to ensure (a) behaviour change and (b) continued private sector engagement in different countries?

The mNutrition intervention is being externally evaluated in two countries. In Ghana, the intervention is implemented via an mAgriculture programme in which nutrition information has been integrated with crop information as part of a package of agriculture support services. The target group is low income farmers in rural areas throughout the country. In Tanzania, the research consortium is evaluating mNutrition within a broader mHealth programme that promotes behaviour change around maternal and early childhood health and nutrition. The Terms of Reference refer to the impacts and effectiveness of mobile phone based services, so the scope of the evaluation is the mobile based service as deployed under the mNutrition programme, rather than the incremental impact of support provided through the mNutrition programme. We are therefore assessing the cost-effectiveness of Vodafone Farmer's Club delivered with the mNutrition Content.

The intended audience for the cost-effectiveness baseline report is DFID, along with other organisations involved in mNutrition and mAgriculture programmes globally (including local MNOs and NGOs implementing mNutrition services), national governments, international agencies, and donors.

1.2 The m-Nutrition intervention in Ghana

mNutrition is a global initiative supported by DFID, organised by GSMA, and implemented by in-country mobile network operators (MNOs) and third-party providers to use mobile technology to improve the health and nutritional status of children and adults in low-income countries around the world. mNutrition is implemented through 6 mAgri and 8 mHealth programmes in 12 countries throughout sub-Saharan Africa and South Asia. The nutrition content aims to promote behaviour change around key farming practices and around dietary and child feeding practices that are likely to result in improved nutritional health within a household.

The m-Nutrition intervention that is the focus of the evaluation in Ghana is the Vodafone Farmers' Club. The Vodafone Farmers' Club (VFC) service is a mobile agricultural extension service, offering agricultural and nutrition information via voice and SMS channels. The objective of Vodafone's mNutrition program is to create and scale commercially sustainable mobile services that enable smallholder farmers to improve the nutritional status of their household and increase their productivity. Vodafone began offering the Vodafone Farmers Club service in May 2015. Smallholder farmers with access to mobile telecommunications are the primary target for Vodafone Farmers Club enrolment. The service operates across 71 districts of Ghana, which were selected based on network access and crop cultivation patterns to ensure that farmers could receive messages and that content would be relevant to their location and crop choices. Promotion and active subscription of farmers via Vodafone Farmers Club agents varies between regions.

The value-added services components include:

- **Weather information:** Three SMS messages per week in English with local weather information.
- **Market price information:** One SMS message per week in English with local market price information for a selected crop and selected market.
- **Agri and nutrition tips:** One weekly recorded voice message in the selected local language with seasonal agricultural or nutrition tips (3 agri tips and 1 nutrition tip⁶ per month) for the selected crop.
- **Call centre:** Free access to a call centre with advice available from an agricultural expert.
- **Free calls and SMS** messaging to other Vodafone Farmers Club members.
- **Discounted SMS and calls** to non- Vodafone Farmers Club members.

In total, 20 messages per month are sent to the subscriber. The mode of content are SMS text messages for weather and price information and voice messages for agricultural tips and nutrition information. While SMS are in English, voice messages are available in ten local languages. Esoko Ghana, a mobile phone-based rural information service, develops and curates the message content and operates the platform to send tailored SMS and recorded voice messages to member farmers. Esoko also operates the Farmer Helpline call centre.

Nutrition message content was developed by GAIN. GAIN created a large library of nutrition-sensitive agriculture messages and nutrition-specific tips designed to complement the agriculture messages provided by Esoko. GAIN created 312 crop-specific messages (13 messages per crop for 24 Esoko-supported crops) with nutrition information on topics including food preparation, food hygiene, safety and storage, and processing. GAIN also developed many general nutrition-specific tips as well as messages for 13 crops that were not originally part of the Esoko profile. Agri tips developed by Esoko cover recommended planting time and information on best practices for cultivation and harvest.

The Vodafone Farmers Club service is available through a dedicated Farmers' Club SIM and is activated upon subscribing monthly to the service. The subscription fee for the mNutrition packages was initially GHS 2 (USD 0.45/ GBP 0.34) per month. At first members had to initiate monthly payments using airtime credit on their phone. As a result of very low rates of monthly membership activation, the program was modified to automatically deduct GHS 2 from a member's airtime credit each month. If a member's credit fell below GHS 2, their membership status would become inactive until they loaded sufficient credit on their phone to cover the monthly subscription fee, which would be automatically deducted when the credit was loaded. From October 2016 to June 2017, the monthly fee was dropped in order to increase subscriptions. In June 2017 the monthly service fee was reinstated at GHS 0.5 (GBP 0.09).

The Vodafone Farmers Club service is designed to offer customised information to farmers based on their selected preferences. Initially, each new member was profiled by a Vodafone agent at the time of registration, indicating their preference of location for weather and market price information, their preferred language for receiving recorded voice messages, and their preferred crop choice for agricultural tips and price information. It became apparent that much of the profiling data was not being collected by agents at the time of SIM registration. As a result, Esoko and Vodafone modified

⁶ Negotiations to increase the number of nutrition messages from 1 to 3 messages a month are currently underway as of August 2017.

their strategy so that all profiling would be done through a follow-up call to new members by the Farmers Club call centre after the SIM registration process was completed. However, when Vodafone suspended the monthly service fee and initiated a large push to increase the program member base, it became infeasible for Esoko to follow-up with each new VF Vodafone Farmers Club C member individually. Instead, new members were given default profile options based on their district of residence, receiving agri and nutrition tips on the crops most widely grown in that district. Farmers were given the option to contact the call centre themselves to request customised profile options.

Vodafone Farmers' Club is available to farmers and people in the farming ecosystem, such as market women and input dealers in 71 districts of Ghana, although promotion and active subscription of farmers via Vodafone Farmers Club agents varies between regions.

1.3 Purpose and scope of the cost-effectiveness baseline

This report is a milestone in the evaluation study; as a baseline report, it presents an outline of how the cost-effectiveness analysis will be conducted once the effect of the Vodafone Farmer's Club intervention has been estimated by the quantitative component of the evaluation (in 2019). This report seeks to:

- Proposition the relevant comparative literature, enabling the cost-effectiveness to be compared with programmes that have some similar elements to the Vodafone Farmer's Club.
- Create a framework for the analysis in 2019 (from the literature and baseline data)
- Collect and collate known costs at this point in time, with the specific view to gathering and monitoring missing costs in the coming period.

The research questions in the Terms of Reference were designed to cover all the projects supported through the wider mNutrition programme. Some of these projects deliver information to support livelihoods including the Vodafone Farmers Club. The quantitative component of the evaluation will estimate the effects on women and children, and has been designed to explore wider gender effects. The Vodafone Farmers Club strategy has included recruiting those who have registered SIM cards for their phones but who barely use them. The service is also targeted at households with minimal average revenue per user (ARPU), and therefore we expect there to be extreme poor among the users. The analysis will disaggregate findings by demographic variables, such as socio-economic status, which will enable the impacts on poorer groups to be assessed.

The report is one of four baseline deliverables on the Vodafone Farmer's Club project, each of which will be followed up by a final report at the end of the evaluation exercise in 2019. This report should be read in conjunction with the baseline Business Modelling Report (Batchelor, Scott and Sharp 2017). The Quantitative Baseline Report (Billings et al 2017) and Qualitative Baseline Report (Barnett et al 2017) give additional insights into the consumer environment that the service is targeted at. The findings from the cost-effectiveness baseline will be combined and triangulated with the quantitative, qualitative and business model baselines in a workshop planned for December 2017. The two-day workshop will examine the insights from the quantitative, qualitative cost-effectiveness and business modelling components of the evaluation and will be attended by those responsible for each of these components. It will inform the development of the integrated mixed method baseline report of the mNutrition impact evaluation in Ghana.

1.4 Organisation of the report

A literature study was undertaken that defined the general parameters of the cost-effective study; the key definitions are summarised in Section 2. Section 3 then seeks to create a framework by which to undertake the cost-effectiveness of the Vodafone Farmers Club service. In Section 4 the known costs of Vodafone Farmers Club are documented and baseline costs established. Section 5 refers back to the literature survey and introduces some of the comparable agricultural and nutritional interventions against which the final cost-effectiveness may be compared. Finally, the conclusions comment on how the cost-effectiveness will be handled once the endline is complete in 2019.

2 Methodology

2.1 Literature review

2.1.1 Study Selection

This baseline work included a literature review of the cost-effectiveness of various agricultural extension services and agricultural technologies, with some reference to health intervention literature, in order to benchmark the methods to be applied to the Vodafone Farmers Club cost-effectiveness. Two approaches were taken. In a more formal search, 38 studies met key criteria, with 170 relevant cost-effectiveness data-points, or measures of cost-effectiveness analysis. This is because several studies included the comparative cost-effectiveness of several interventions. Within this search, papers were included which focused on (1) any interventions aimed at improving nutrition; (2) any interventions aimed at improving agricultural outputs; and (3) any interventions aimed at using information and communication to change behaviour. Only articles which presented cost-effectiveness data, in the form of cost per unit outcome, were considered.

In a broader, less bounded approach, several different combinations of search terms were used in several different databases, including Pubmed, Google Scholar, Mendeley, JSTOR and Scopus. As the aim was to explore both methods of cost-effectiveness analysis, and cost-effectiveness metrics of different comparable agricultural extensions, several different combinations of search terms were used. These included 'cost-effectiveness analysis, cost-effectiveness, cost-effectiveness ratio, agricultural extension, and agricultural interventions. 'These were also accompanied by searches according to outcomes including, 'impact, nutrition, income, crop yields.' Each method of agricultural extension was searched with the above terms, including 'training and visiting, farmer field schools, farmer to farmer extension, mass media, mobile technologies, ICTs, radio, pamphlets, guide books, paper media, participatory extension.' Finally, the technologies were also searched, including 'biofortification, improved crops, home gardening, poultry, animal husbandry, livestock development, aquaculture, fisheries and marketing training.' The references of relevant papers were examined to produce a 'snowballing effect' of relevant papers. In addition, grey literature papers were searched, such as Opengrey, but little evidence from grey literature has been included. The studies are listed in a supporting document and there is an accompanying Excel database, along with a range of metadata and a list of all cost data identified in the sources for use in 2019.

The majority of interventions examined were based in Sub-Saharan Africa, although some studies from other geographical regions were included if no appropriate African examples could be found.

As stated by Ruel et al, 2013 (Hawkes et al 2012 in Self et al, 2015), there is surprisingly little information on either the costs or cost-effectiveness of agriculture policies, food-based strategies or integrated agriculture and health approaches to support recent initiatives and investments to scale up nutrition. This may be attributed to the general lack of well-designed studies for evaluating the impact of agriculture and health on nutrition outcomes (Webb-Girard et al 2012).

Due to the paucity of studies, the literature review cannot provide a comprehensive assessment of the cost-effectiveness of different agricultural interventions. It does, however, provide several options for measuring the cost-effectiveness of the mAgri project, dependent on the outcomes, and some tentative guidelines as to the relative costs and impacts of other agricultural interventions.

The findings of the literature review inform the following sections of this report, and are discussed in greater detail in Annex B.

2.1.2 Using the Literature to inform CEA methodology

This section seeks to briefly relate the literature to our chosen framework. Annex B summarises the literature insights, defining cost effectiveness in general terms, discussing approaches to defining health benefits, and what costs should be included. The literature points to the use of DALYs (Disability Adjusted Life Years) to ensure comparative measures of effectiveness. The literature differentiates between direct costs, programme development costs and societal costs (sometimes using different names for each). Dietary diversity can be expressed in terms of DALYs as a measure of health benefits, and our framework, which is given in Section 3 of the report, proposes three different cost analyses. The three are differentiated by which costs are included; Analysis A direct costs only, Analysis B which is A plus programme costs, and Analysis C adding in societal costs.

Outcomes and effectiveness

Few papers were found within the literature review that assessed the cost-effectiveness of multiple outcomes. It was difficult to find an example of cost-effectiveness analysis that included both health and livelihood impacts. Vodafone Farmers Club is a complex intervention, the messages are designed for a variety of outcomes and messages are intended to complement one another. The cost-effectiveness analysis will be based on data from a randomised encouragement design (conducted under the quantitative evaluation component), which will capture multiple agricultural and nutritional outcomes.

As can be seen in Annex B.4, there is no standard methodology for conducting cost effectiveness analysis with agricultural projects. Cost effectiveness may be quantified according to health and nutrition impacts (Self et al, 2015), livelihood impacts (Tsiboe et al, 2015) or even according to the cost per behaviour change (Mauceri et al, 2007). The relevant metric depends on the intended outcomes of the project.

Specifically, we are using Household Dietary Diversity Scores and Women's Dietary Diversity to quantify improvements in nutrition, as measured in the quantitative endline. However, the cost-effectiveness of an intervention that leads to multiple outcomes is sometimes distorted by including only one outcome in the analysis. Puett et al (2014), for example, measures the cost effectiveness of community gardens for people living with HIV and AIDS, quantifying cost effectiveness in the cost per household with an improved Food Consumption Score (FCS) and per household with Improved dietary diversity score(HDD-S). However, there were also other benefits such as improved income from vegetables grown. For analyses A and B (Sections 3.2 and 3.3), we have chosen to focus on the nutritional outcomes of the project, as this is the focus of DfID's contribution to the service. However, for analysis C, we have chosen to include both agricultural and nutritional outcomes in the analysis. Self et al (2015) was the only reference to use a cost-effectiveness metric that accounted for both livelihood and nutritional impacts. The paper uses a DALYs framework, but subtracts the total economic benefits to households from the total costs of the project. Self et al (2015) then uses that figure to divide by DALYs averted by nutritional impacts. Both the economic benefits to the families are accounted for, as well as the health impacts. This mirrors the idea of including societal costs where the cost effectiveness analysis takes into account a difference in use of health services. Learning from these and other similar papers (Larsen-Cooper et al 2016, Waters et al 2006, Fiedler et al 2014, Horton et al 1996), we will use the quantitative component of the impact evaluation to measure differences in multiple outcomes

between control and encouragement treatment groups. The cost-effectiveness analysis will be based on data from the randomised encouragement design (conducted under the quantitative evaluation component), which will capture multiple outcomes.

Regarding the use of DALYs averted, as stated above our cost-effectiveness analysis will be based on the results of a randomised encouragement design. As of March 2019, we will know the extent of health impacts and behaviour change following exposure to the intervention. It is this difference that will be used to estimate DALYs averted. We should therefore be able to assess the difference between no intervention, or access to standard agricultural support in Ghana, and the effect of the intervention. At that date we will have refined our intervention cost data (including societal costs). Our results will present a cost-effectiveness analysis, using the control group as a base case scenario (Baker et al 2006, Gonzales et al 2000, Nguyen et al 2012).

Ensuring the inclusion of relevant costs

Our costing methodologies were also derived from the literature. Our literature review evidenced that a range of costing methodologies were used (see Annex D), and even terminologies used to describe costing methodologies were not consistent (Neumann, 2009, Adam, 2003). Neumann (2009) found, for example, that studies claiming to be evaluating cost-effectiveness from the societal perspective often did not include all relevant societal costs. The wide variety of methodologies are sometimes presented as useful to the different audiences to which the cost effectiveness analyses may be relevant. Several papers for example (Harris et al, 2013, Norton et al, 2013) included only the costs of direct implementation of the intervention to the provider, excluding beneficiary costs or the costs of research and development necessary for the project to even begin. This may be relevant to those intending to 'replicate the programme. Meenakshi (2007) includes the research and development costs, such as those of researching biofortified crops. This is proposed as being more relevant to donors and funders who might want to replicate the programme in another setting, and need to consider reworking some of the research that tailored the programme to its location. Finally, some papers also include the costs to beneficiaries of behavioural change and achieving certain nutritional and health impacts such as Schrienemachers et al (2015) and Self et al (2015). The inclusion or dismissal of certain costs varies according to the intended audience for the analysis. For example, an intervention provider may not wish to include the costs of beneficiary transport as, providing that beneficiaries are able to pay this fee, it does not impact the feasibility of the project from their perspective. However, those wishing to understand the full scope of an intervention's impact would wish to include beneficiary costs. Seeing the potential relevance of several different costing methodologies, we have chosen to undertake three separate analyses, using different costing methodologies. These are explained in Section 3.

In terms of data collection; the literature also references several methodologies. Ideally, studies obtain the direct costs of a project using full financial data. Puett et al (2014), for example, collected data from budgets and project documents as well as informant interviews. However, the literature also specified that complete financial records were not always available (for example, Curry et al, 2013). In this case, estimates from the literature were used. Balthussen et al (2008) for example, uses estimates from WHO publications to determine the price of Iron supplementation.

We are aiming to evaluate the cost-effectiveness of the Vodafone Farmer's Club using as much accurate financial data as possible, a collection process which is still ongoing. However, where detailed financial records are lacking, we will make estimates based on published literature and cost data, as in Balthussen et al, 2008. To a certain extent, societal costs, for example the costs of agricultural inputs, will be captured by the quantitative component of the evaluation. However,

other costs may need to be estimated from the wider literature. All cost data will be tested in sensitivity analysis at the endline stage (see Annex B)

Regarding comparison of the intervention with those with similar outcomes, some studies compare interventions to other possible interventions, as seen in Fiedler and Afidra (2014) for example. We have chosen to conduct a cost-effectiveness analysis, as seen in Self et al (2015), comparing Vodafone Farmers Club users in the encouragement treatment group to the control group of the randomised encouragement design.

Regarding the time scale for assessing the effectiveness; Within the literature, timescales in cost-effectiveness analysis vary widely. Waters et al (2006), for example, collects only impacts within an 18-month time period, whereas Sabin et al (2012) projects averted DALYs over 10 years. Within agricultural literature, time scales can vary even more widely, for example Tsiboe et al (2015) projects benefits over the 25-year life span of a cocoa tree, but this is unlikely to be feasible for our purposes. As we will be working from the results of the quantitative study, the time scale of our evaluation is defined by this period: October 2016 to October 2018 (Gilligan et al, 2017). Agricultural impacts will also be quantified as those gained during this period. Cost data will be collected from the time of programme inception up until the time of endline data collection. However, appropriate timescales to be considered will be assessed at the endline. For example, if service is projected to continue, then R&D costs should be spread over more years, but if the service has stopped, reduced time scales may be considered. These factors will also affect whether the full capital cost is included or depreciation is taken into account.

Vodafone Farmer's Club had a high research and development cost compared to ongoing costs. Therefore, measuring only the DALYs averted or households with improved Dietary Diversity within the two years of the evaluation duration will likely give a relatively poor cost effectiveness ratio, and perhaps not do justice to the lower ongoing costs of the service, nor the full impact of early research investment. However, the feasibility of projecting nutritional or agricultural impacts into future years to take a broader time horizon depends on both the continuation of the Vodafone Farmer's Club programme (the intervention duration), its continued use of its current treatment (i.e. the content and delivery offering does not change significantly), and the residual impact of the intervention on farmers' knowledge. The ICT environment changes rapidly and the use of plain text SMS is likely to change significantly in the coming years. Certainly by 10 years (the time horizon used by Sabin et al, 2012) SMS will likely be overtaken by media rich content, which would effectively be a different treatment. The timescales to be considered should reflect any residual impact of the intervention, as knowledge based interventions can have long term intervention effects on benefits beyond the duration of the intervention (Ory et al 2010). We will wait until the endline data collection to determine whether using an extended time horizon in the analysis is appropriate. We will take into account the status of the Vodafone Farmer's Club service as evaluated in the endline business modelling component of the report, and any changes in service provision planned by the Vodafone Farmers Club team. Similarly, if the quantitative study suggests changed behaviours may endure after the service has ceased, this will need to be considered.

2.1.3 Limitations of Literature Review

Although every effort was made to pre-define search terms and use all relevant databases, the review is not intended to be a fully comprehensive study of all cost-effectiveness literature within agriculture, health and nutrition. There is a risk of neglecting some relevant literature. Furthermore, the paucity of literature available creates a risk of bias towards the ideas presented within included papers. Nonetheless, the search for relevant literature was extensive, and the authors believe it

accurately convey the current landscape of cost-effectiveness literature in agriculture, health and nutrition.

2.2 Ethical considerations and approval

As an overall guiding principle, the research team sought to conduct themselves in a professional and ethical manner throughout the baseline phase of work, with strict respect for principles of integrity, honesty, confidentiality, voluntary participation, impartiality and the avoidance of personal risk. These principles were informed by the OECD (2010) DAC Quality Standards for Development Evaluation and DFID's 'Ethics Principles for Research and Evaluation' which will be followed for the duration of the evaluation.

Overall, the baseline phase of this component has mainly drawn on the qualitative and quantitative data collected in the other two components of the evaluation. Both components have been through rigorous ethical clearance procedures. Other data sources are stakeholder interviews conducted with MNOs as well as secondary data collection (commercial and monitoring data) from MNOs and other relevant organisations.

Most research participants involved in the stakeholder interviews were already familiar with the mNutrition programme, and the principle of an independent evaluation. However, informed consent was sought from all participants via emails and briefing documents sent in advance, describing the research. In particular, information described the relationship between the evaluation consortium, DFID and GSMA, in order to avoid any possibility of deception, given the sensitivity of the business relationships and issues discussed during the interviews.

Whilst this evaluation component does not involve any primary data collection from human subjects at community / household level, ethical considerations are still considered important for all work carried out under this component. In particular, GSMA remain highly aware of the commercial sensitivities of its partner MNO's, so the issue of commercial confidentiality is very important for this area of work given that it relies on sharing of sensitive commercial data. Therefore, the Gamos team will pay specific attention to this issue as part of their ongoing work.

The Gamos team is currently operating under the Non-Disclosure Agreement (NDA) signed by GSMA and OPM during the inception phase of the project. Where relevant, stakeholder respondents are informed that an NDA with their trade association has been signed, and that the interview is bound by it. All the data being gathered falls within the scope of this agreement (e.g. development, business plans, marketing, operations, and finances), although there is a provision that such information should be designated as proprietary or confidential.

For the avoidance of doubt, all internal reports shared by Gamos are being marked as confidential and are not to be circulated outside of the evaluation team. Any outside reporting will not contain any detail that could be construed as proprietary or confidential information.

All external reports are being shared with key research participants in early draft form in order to establish principles of trust and reciprocity. This ensures that participants have an opportunity to confirm that their views have been reported accurately, and that publications do not breach their confidentiality requirements.

As this component draws on qualitative and quantitative data collected through the other two work streams, appropriate measures are being taken to ensure that the shared data is anonymised and there is no risk of confidentiality breach. For the quantitative data, a unique household ID has been

assigned to each household which allows for following up with respondents as necessary without providing access to any personal information on datasets that are made available for analysis. Similarly, all qualitative transcripts are anonymised, pseudonyms given, and any information that can lead to personal identification has been removed.

3 Cost-effectiveness Framework for Vodafone Farmers Club

3.1 Analysis Framework

The overall elements involved in the proposed cost-effectiveness analyses are summarised in Figure 1. Costs of the programme are considered, and these are set against the nutritional and agricultural impacts. Costs are collected from project budgets, expenditure reports and key stakeholder contacts from multiple organisations as available at March 2017. Impacts of the project will only be available after the completion and analysis of the quantitative endline survey data, and so this baseline seeks to define the outline of the analysis without seeking to undertake it as such. Other considerations necessary for the endline cost effectiveness analysis, such as sensitivity analysis, are outlined in Annex B.

It is proposed to conduct three separate analyses, each of which considers different cost components, reflecting the factors of interest to different stakeholders.

- Analysis A considers costs from the perspective of an organisation that would replicate a similar service, utilising the content created by CABI at no cost (Section 3.2).
- Analysis B considers cost-effectiveness from the perspective of a donor, including costs such as research and development. This analysis aims to show whether the impacts of the intervention represent Value for money for the funders (Section 3.3)
- Analysis C (Section 3.4) includes all the relevant costs in achieving the impact of the mNutrition programme. This includes those borne by public services, and households using the service. It will also include household gains, therefore including the economic and agricultural impact of the Vodafone Farmers Club. Generating data on costs will be challenging, given the complexity of the partnerships involved in delivering the Vodafone Farmers Club service, and the diversity of costs and impacts.

Data on impacts will be gathered from the quantitative baseline. Data on nutritional and agricultural impacts will be gathered by the quantitative teams. Where possible, data on nutritional impacts will be converted into DALY's using estimates calculated from the literature. For example, Zerfu et al (2016) states that women achieving minimum rates of dietary diversity have a 2-fold reduced risk of maternal anaemia, and a greatly lowered risk of pre-term birth and low birth weight. As the literature on dietary diversity is updated constantly, we will revise our method at the time of the quantitative endline. In this instance, the rates of increased WDD would be used to calculate the reduced rates of anaemia. The weighting for anaemia within the WHO's Global Burden of disease report would enable us to calculate the DALY's averted. We would aim to do this for all diseases influenced by WDD and included in the WHO's global burden of disease⁷. The analysis will consider potential double counting of final benefit (e.g. DALYs) from different intermediate outcomes (such as reduced incidence of anaemia and other outcomes such as reduced risk of infections) and ensure such double counting does not occur.

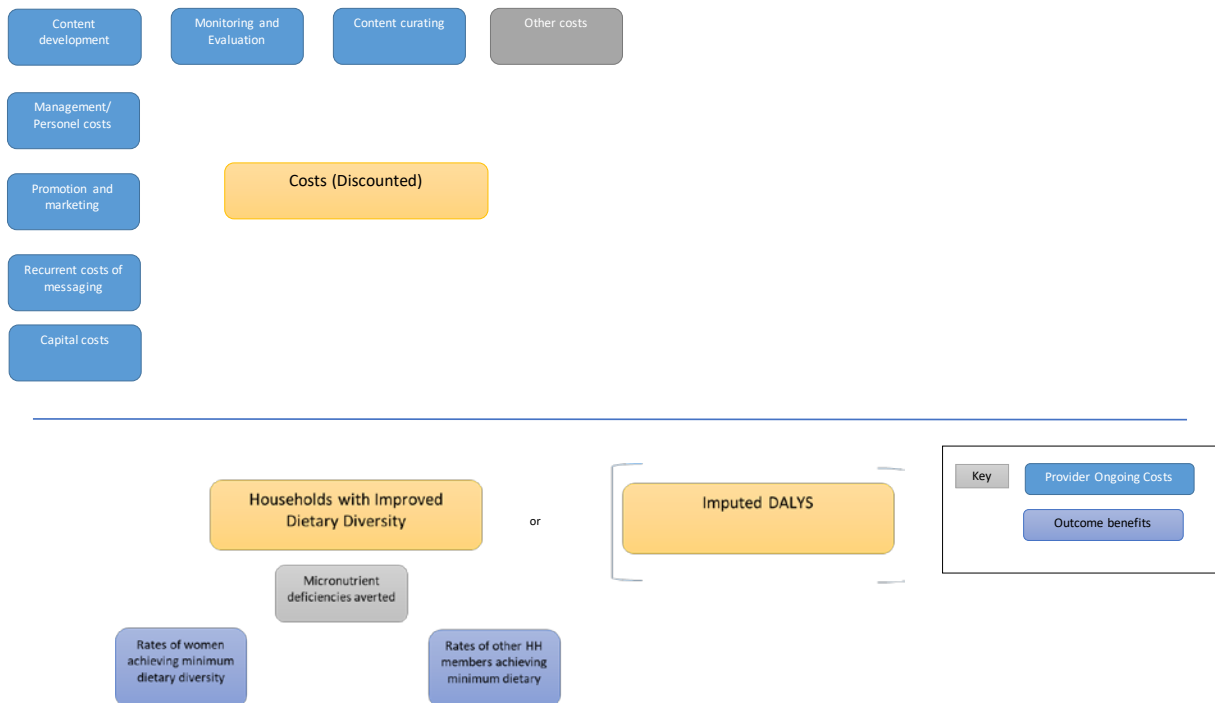
⁷ Arimond and Ruel (2004), for example, have also shown that Dietary diversity is directly associated with height-for-age Z-scores (HAZ) for children 6-23 months old. As the literature on dietary diversity is updated constantly, we will revise our method at the time of the quantitative endline.

Changes in agricultural practice that are as a result of the VFC messaging, and which result in improved yields or (net) income, will be documented by the quantitative survey with supporting detail from the qualitative work. While such changes may be dependent on the messaging, the study as a whole (qualitative and quantitative working together) is set up to capture relevant agricultural outcomes. Where such outcomes cannot be ‘translated’ into DALYs per se, analysis C will seek to include them in terms of micro cost benefit analyses above the line. Such mechanisms of change are discussed in section 3.5.

3.2 Analysis A (Ongoing Costs)

The simplest costs and effectiveness for assessing the cost-effectiveness of the Vodafone Farmers Club service is summarised in Figure 1. We call this Analysis A.

Figure 1 Costs associated with Analysis A



Authors own

Above the line in Figure 1, we include only the ongoing implementation costs and those directly associated with the setting up of the specific service (e.g. the localisation of the content development). It does not attempt to allocate a proportion of the wider mNutrition programme costs, nor take into account the sunk and investment costs associated with building the asset value of the agriculture and market information system that Esoko brought to the partnership, or the network infrastructure brought by Vodafone. Cost data, including the partners from Figure 5 involved in expenditure, collected as of March 2017 can be seen in Section 4.1, although the cost data collection process is still ongoing.

Below the line, the effectiveness will be the measured change in diet diversity. This will be measured within the quantitative component of the overall study. It will consist of two measures, diet diversity of women and diet diversity of the whole household. The two are closely correlated,

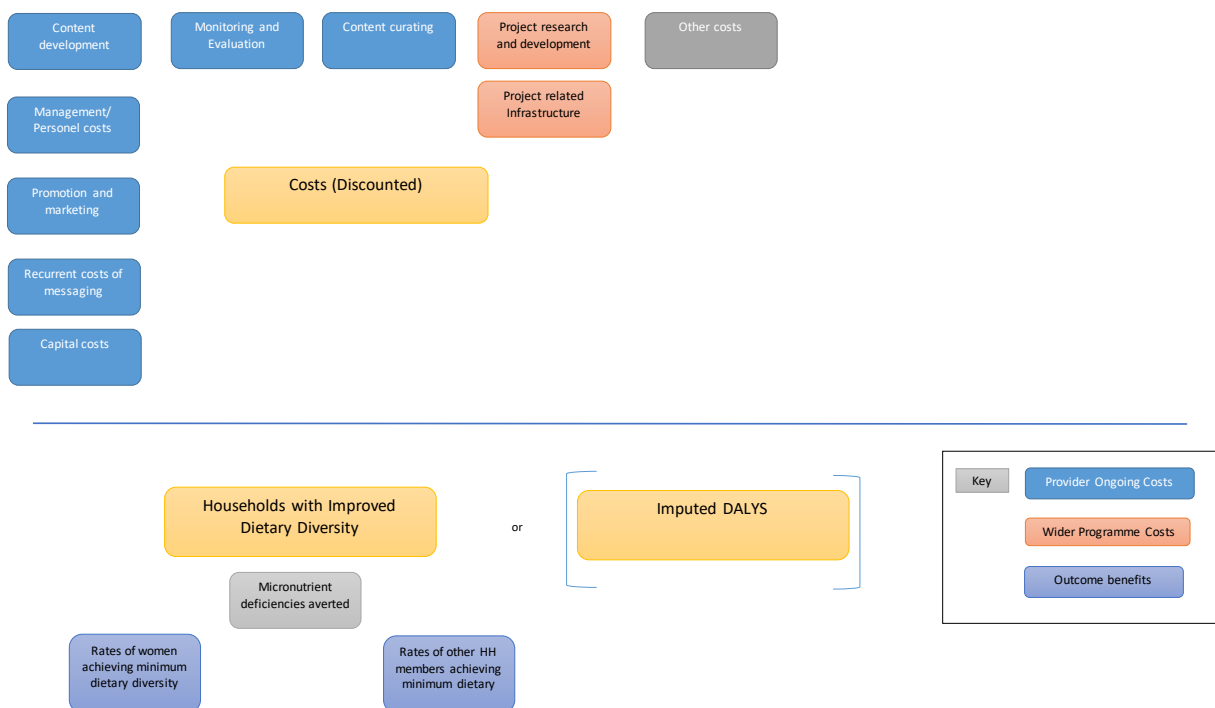
but for completeness a view will be taken on each and the methods revised once the quantitative endline data is received.

This analysis will be of primary use to stakeholders who may wish to replicate the service without further development costs and have a willing MNO in place who has similar coverage to Vodafone Ghana. It is based on the assumption that content, at least at the global level, will be available free of charge. This is indeed the case, given that all the factsheets and messages developed by the Global Content Partners to the mNutrition programme will be open access and made freely available through the CABI Knowledgebase. It also assumes that any future implementing agency will have access to the technical platform and capability needed to implement such a system, either as part of their own resources, or by sub-contracting the services of a company that does have such capability, such as Esoko.

3.3 Analysis B (Wider Programme Costs)

In addition to operating costs, Analysis B (illustrated by Figure 2) includes sunk costs or investments in the project development and the supporting infrastructure (orange boxes).

Figure 2 Costs associated with Analysis B



Authors own

The wider costs will be difficult to apportion. One could argue that a portion of the wider project research and development should be assigned to the Vodafone Farmers Club costs, since if donors were to invest in, for example, a next generation of mNutrition services, they would need an overarching programme of work similar to the mNutrition programme to stimulate MNOs to adopt new approaches, to coordinate learnings and effort, and to deliver wider programmatic benefits. The same argument applies to the global content developed as part of the overall mNutrition programme, and to the institutional infrastructure set up by GSMA (and others) in order to deliver the programme.

Below the line, we have argued in the introduction that a better measure of effectiveness is DALYs. This enables comparison of the Vodafone Farmers Club approach with other health and nutrition orientated approaches. In mHealth services, DALYs are the normal measure of effectiveness. Diet diversity can, through linkages to stunting, be assigned an 'imputed' saving in terms of DALYs. This is not the usual approach for agricultural projects, but seems appropriate for this evaluation – to at least make an attempt at such a calculation with considerable caveats and limitations.

Analysis B will be of most use to DFID and other funders or policy actors to assess whether the programme of mNutrition represented Value for Money (VfM). It would be of particular use if a similar programme was being planned for the future.

3.4 Analysis C (Inclusion of Societal Costs and Agricultural Gains)

The final possible analysis (Analysis C, see Figure 3) takes a comprehensive view of costs, taking into account not only operational costs (blue boxes) and wider programmatic costs (orange boxes), but also societal costs (green boxes).

For instance, there is an argument that the real cost of the text messaging service should include sunk investment in the platform, including intellectual property from previous, related projects. Esoko have a history of information provision and bring a wealth of learning on what works and what does not – the cost of that learning being sunk costs from previous projects (existing assets).

It also includes an element of the societal costs associated with any behaviours that farmers need to undertake in order to realise the benefits pursued by the project. For example, if the project aims to increase yields through the adoption of modern agricultural practices, such as the appropriate use of fertiliser, then success will require farmers to buy fertiliser. If the price of fertiliser is subsidised by the government, then an increase in the number of farmers using fertiliser will result in an increase in the government's subsidies budget (Public facilities). There is also an argument that previous investment in, say, the distribution network for fertiliser should be given some assigned cost – because if the programme were repeated in a country where there was no fertiliser distribution network the outcomes might be considerably less. In addition to price subsidies, therefore, in this example there will be costs associated with setting up and maintaining systems and infrastructure required to administer the system of subsidies, which should also be included in the 'existing assets' costs.

While we cannot take into account all elements of farming support, Analysis C at least considers these elements and assigns a monetary value where appropriate (and possible). These elements will be micro costed using cost data collected at the time of the endline.

3.4.1 Commercial sustainability

The system is intended to be a service that the farmer pays for. The original proposition of the mNutrition programme was that such services would be 'commercially sustainable'. In theory, if the service is commercially sustainable, then Vodafone as its implementer would expect the service to yield an attractive internal rate of return on their investment – which can be calculated using a cost benefit analysis. This cost benefit analysis would likely be of interest to other MNOs considering setting up similar systems. This might also be of interest to donors who might consider supporting future initiatives not with grants but with loans that are commensurable with the IRR of the service.

However, while the original mNutrition programme documents talked a lot about commercial sustainability based on direct revenue generation, the logical framework evolved to talk about imputed benefits to the MNO. The business modelling report discusses how changes in Average Revenue Per User (ARPU) and reductions in churn (users moving to other networks) can benefit the overall MNO bottom line without actually showing as a direct revenue from a service. Nevertheless, increased ARPU and reduced churn can indeed make the provision of the service 'commercially justifiable'.

At the launch of Vodafone Farmers Club, users were paying 2 cedis per month. According to the grant application made by Vodafone to GSMA, this level of income would result in between £1m and £4m profit over a two-year period (depending on subscriber numbers). Subscriber uptake was slower than expected, so in order to achieve the Key Performance Indicator of subscriber numbers, the target was halved, and the monthly subscription fee was dropped (for a 6-month period). As at March 2017, the direct monthly income was zero, so Vodafone was not making any direct profit.

However, this is likely to change over time, with new user charges being introduced in order to make the service commercially acceptable within Vodafone (even though the ARPU and churn imputed benefits do seem to be evidenced in recent data). Outside the scope of this document, Vodafone are preparing a sustainability plan for Vodafone Farmers Club to be submitted in late July to GSMA.

How then do we treat 'commercial sustainability' within a cost-effectiveness analysis? A cost benefit analysis for the commercial product would be of interest to Vodafone, and inform their commercial decisions. However, this would potentially neglect the public goods associated with improved health outcomes that were the central to the original intent of the mNutrition programme. The evaluation is being requested by DFID with a view to informing programme interventions in future. Continuing to pursue a cost-effectiveness approach would enable the analysis to include benefits associated with diet diversity and imputed DALYs.

We therefore consider adding a cost box above the line that represents the profit generated by the MNO. Up until this point, costs above the line are those paid for mainly by donor grants or previous investments. In theory, all of these costs could be recoverable if the user paid a monthly charge. In terms of cost-effectiveness, this would not change any of the costs in the equation, only who pays. At the moment the donor pays, but if these costs were covered by user subscription fees then, in theory, it would be the user who would have ultimately paid. The fact that the costs were met by a grant from donor to GSMA to Vodafone is irrelevant - they could equally well have been met by a loan, attracting an interest rate commensurate to the projected IRR. If the user subscription fees exceed the total costs, then (over time), they will also be paying a profit share to the MNO. If we add a user subscription box, we double count all the costs. If we are agnostic to who paid for the costs, then the only extra cost the user is paying is the profit component of their user subscription fees.

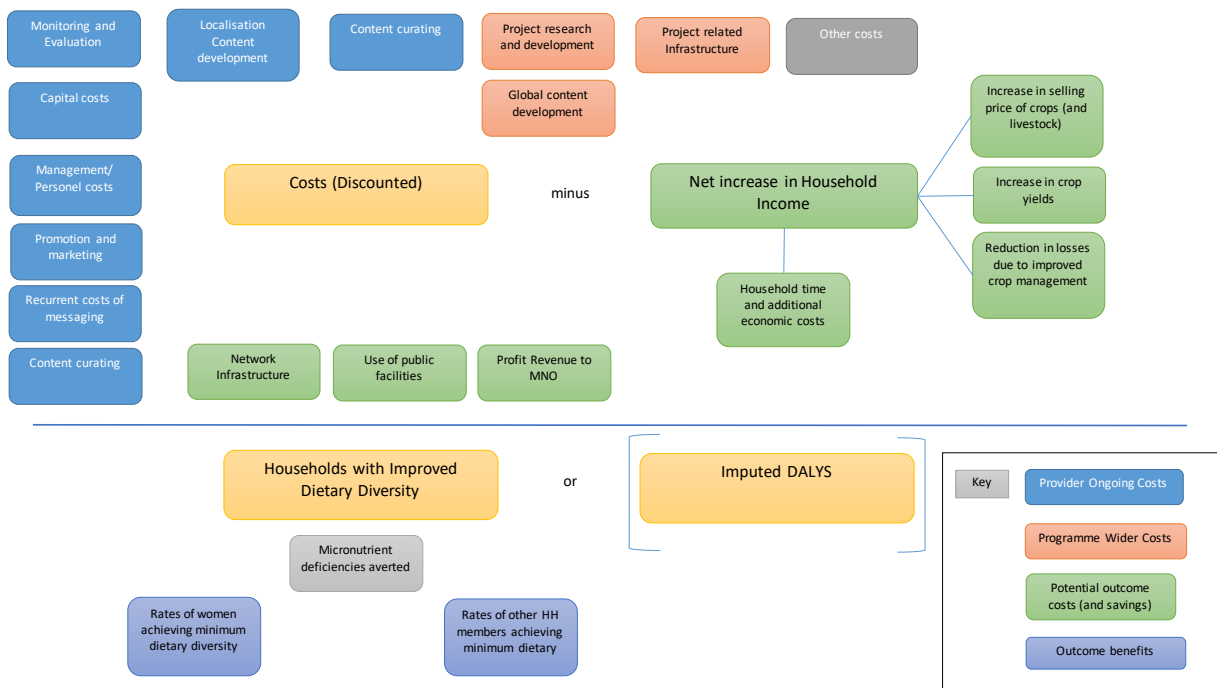
We emphasise that this is not a commentary on the profit motive or private sector – it is merely acknowledging that in order for the information service to be commercially viable, it may be necessary for users to pay some profit revenue to the MNO. As discussed above, based on March 2017 data, Vodafone was not making any profit, but this may change.

3.4.2 Farmer economic returns

We then trespass further into the cost benefit territory by asking whether there is a willingness to pay the subscription costs (if reintroduced). This mainly will depend on whether the farmer sees there is sufficient benefit in paying the subscriptions. They are unlikely to consider whether their diet has diversified and whether in the longer term they have averted any DALYs; rather they are likely to make a financial reckoning. Is the cost of user subscriptions plus the additional cost of action on the advice less than the increase in yields and/or increased income from sales and/or reduced losses? While the farmer may be undertaking a household level cost benefit analysis, in order to create a complete cost-effectiveness picture, we need to include the farmer level costs and financial benefits into the above line costs.

To clarify the additional action cost - the cost of taking action on advice given to them via the Vodafone Farmers Club, and thereby create the outcome of improved diet diversity, a farmer may have to spend more (e.g. on fertiliser). This expenditure can be considered a cost contributing to the effectiveness – if such a cost is not expended, improvements in diet diversity outcome may not occur. However, offset against this expenditure is the possibility that the farmer may gain more income (or reduce expenditure in other areas, e.g. crop losses post-harvest). These impacts will be collected by the quantitative team, or micro costed using data collected at the time of the endline. These costs and savings have been added above the line to differentiate them from the measurable nutritional outcome of dietary diversity (see Figure 3).

Figure 3 Costs associated with Analysis C



Authors own

Analysis C takes a much more comprehensive view of costs and is, therefore, designed to appeal to high level policy makers who will be interested in understanding the wider implications of mNutrition strategies. It is designed to include all types of costs considered in the literature, in a way that has not been identified in any of the key references. It represents an innovative methodology for handling projects implemented by private sector institutions by considering the

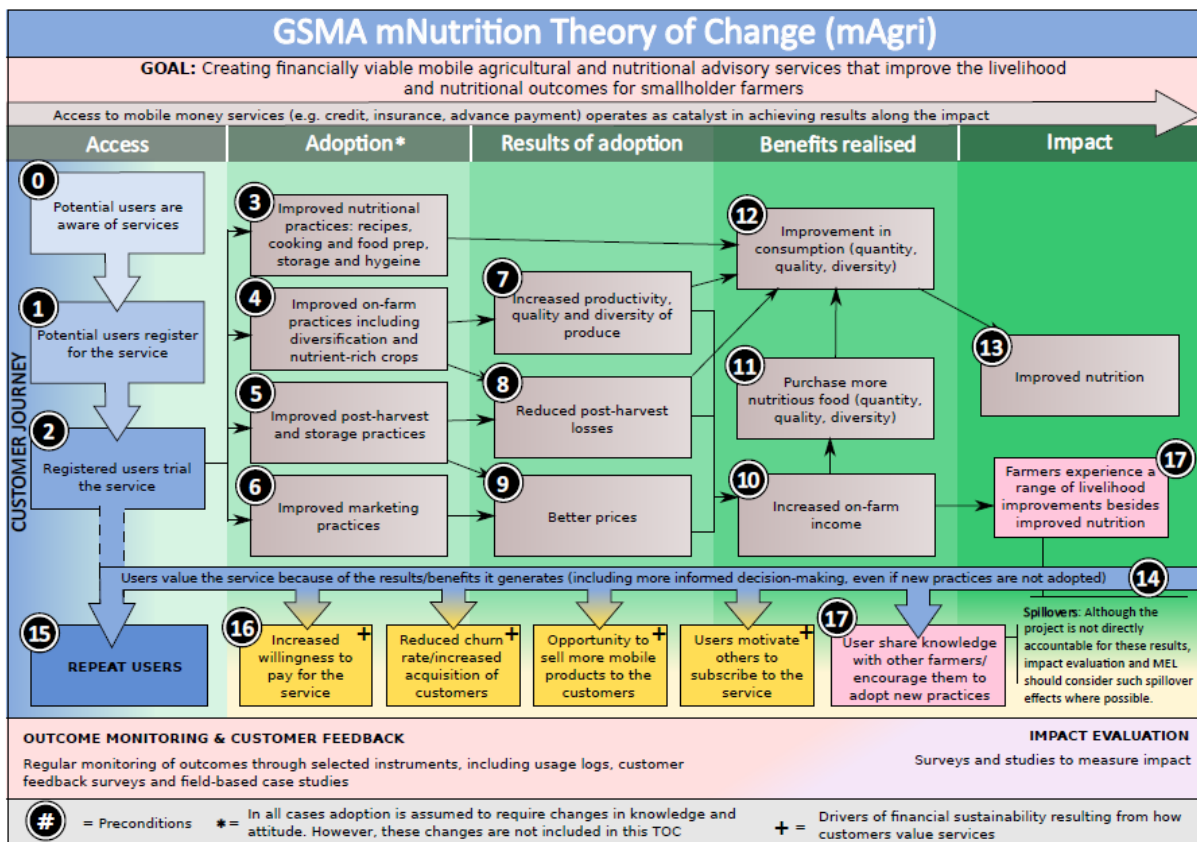
value of corporate assets deployed on projects, and by accounting for any profits made. Analysis C will be of most use to governments (and donors) considering replication in their country – do they have a similar landscape of societal investments that would make the programme work.

3.5 Effectiveness

Much of the discussion about effectiveness will be dependent on the results of the endline quantitative survey due to be completed in 2019. We have noted that within costs there may be extra expenditure from the users, and income to the users (offsetting costs). These figures can potentially be obtained from the quantitative endline survey and some indication of them may come from the qualitative surveys.

Similarly, in this baseline as discussed in the introduction, little can be said about the below the line items. As a predominantly agricultural intervention, Vodafone Farmers Club is hoping to have impacts on nutritional status, crop yields, net income of households and knowledge of farmers. Such livelihood outcomes will have an indirect impact on nutritional status of the household. As discussed briefly above, while the main measure of effectiveness captured in the surveys is the change in diet diversity, the nutritional gains could be explored by imputed changes. This is captured in the GSMA/Firetail theory of change for the mAgri programmes within the mNutrition programme (see Figure 4).

Figure 4 GSMA Theory of Change for mAgri programmes (GSMA 2016)



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The quantitative component has been designed to assess the primary outcomes of the study; a societal perspective, namely of household and women's dietary diversity, agriculture yields, and agriculture income. The dietary diversity outcomes will be measured using the following indices:

- Household Dietary Diversity Score (HDDS): based on food consumed in the household in the 24 hours prior to the survey. A Household Dietary Diversity Score (HDDS) will combine 21 food items from 12 groups; the score represents the number of food groups represented in the household diet.
- Minimum Dietary Diversity-Women (MDD-W): as with the HDDS, it is based on 21 different food items consumed by the primary female in the last 24 hours. However, they represent only 10 food groups, intended to reflect the micronutrient adequacy of the diet. It is a dichotomous indicator that reflects the greater likelihood of women consuming food from 5 or more food groups meeting their micronutrient needs than women consuming foods from fewer food groups (FAO and FHI 360, 2016).

Any changes in diet may possibly be fuelled by

- Differences in crop yields (disaggregated for different crops)
- Increases in prices gained per unit of crop
- Reductions in crop losses due to improved storage (can add to crop yields).
- Increases in net household incomes.

These measures will contribute to nuancing the cost-effectiveness analysis C with the changes in (comprehensive) above line costs.

These measures do not primarily capture extra expenditure by the farmer. Differentials in the use of key agricultural inputs will need to be extracted from the endline survey. The mNutrition programme has also been capturing changes in the ToC journey, particularly in terms of changes in knowledge, attitudes and behaviours. Some of these measures found in the GSMA/Firetail M&E reports could be used to determine extra expenditure:

- Increase in knowledge of agricultural practices (according to test scores on questionnaires)
- Increase in use of new agricultural inputs (manure, inorganic fertiliser, pesticides, herbicides and spraying services)
- Increase in use of hired/ exchange labour.
- Increase in use of alternative markets/ pre-arranged crop production contracts
- Increased use of credit for inputs.
- Increase in use of crop storage.
- Increase in knowledge of nutrition.

We acknowledge that in addition to the changes in knowledge, attitudes and behaviours above, GSMA/Firetail reports also seek to monitor changes in women's empowerment. This includes

- Increase in female decision-making power in a household (agricultural/ household purchasing)
- Increase in women in salaried employment
- Increase in discussion of nutrition/ agriculture in community groups
- Increase in women's physical mobility
- Increase in women's decision-making power regarding nutrition

Very few studies have been conducted on the cost-effectiveness of a project with relation to its impacts on knowledge and attitudes. This is likely because changes in knowledge and attitudes are rarely considered an end in themselves, but rather a precursor for material or physical gains. Improved knowledge about agriculture, for example, will ideally lead to material benefits from increased crop yields, and economic benefits at both the household scale, and wider. Knowledge and attitude change therefore, despite its value, is unlikely to be a sufficient measure of cost-effectiveness. It is therefore proposed to measure the cost-effectiveness of the Vodafone Farmers Club based on measures of nutritional improvement as described above. The focus will be on the difference (gain) in dietary diversity, with the context of that gain in terms of the other outcomes being taken into account as much as possible. This will also be used to prevent double counting of outcomes effects.

The discussion of cost-effectiveness metrics makes a distinction between economic methods, in which improvements in agricultural outcomes are quantified in monetary terms, and non-monetary methods. Non-monetary methods tend to be used in nutrition oriented projects, and typically employ dietary diversity metrics, and DALYs averted. Although the quantitative component of the impact study is not capturing anthropometric data, it is proposed to explore the idea of expressing benefits in terms of DALYs averted, which would make the results comparable with a wider body of nutrition literature. Whereas data on reduction in stunting can easily be used to estimate DALYs averted (using WHO published weightings), there will also be an opportunity to link Dietary Diversity Scores to DALYs through other work – for instance Arimond and Ruel (2004) who have shown consistently that increased dietary diversity is linked to increased Height for Age Scores (HAZ) in children, even when controlling for socioeconomic factors.

4 Vodafone Farmers Club Costs

Based on the analytical scenarios described above, this section presents the data available as at March 2017. More detailed historical cost and performance data has already been promised, and it may be possible (and we hope) that other historical costs might be quantified over the next two years as the work of the independent study team continues.

4.1 Analysis A

4.1.1 Setup and Ongoing costs (Analysis A)

If another MNO in another country were to consider setting up an agricultural information service, they would need to consider the costs associated with establishing a localised information database, along with the capital expenditure and operational expenditure required to get such a system up and running.

Where possible, the team has collected and collated costs for the Vodafone Farmers Club service. These costs, particularly ongoing ones, have and are likely to change as the service offering is adjusted. Initially starting with a 2 cedis per month charge, the charge was dropped for the months September 2016 to May 2017. As at the time of writing (July 2017) there are ongoing negotiations and assessments as to what the forward charging structure shall be (discussed in the Business Modelling report). In order not to be continually adjusting this report in the light of the dynamic changes of the service, all costs are taken as of March 30th, the end of the data collection phase. Further cost data will be collected from relevant stakeholders, provided in project budgets, expenditure reports and other relevant documents.

The service is being treated as a whole – the quantitative component of the evaluation will differentiate between the treatment group and the control. Therefore, any effect is the combination or synergy between livelihood messages and the nutritional messages. We have therefore at this stage taken the costs for the whole. At the endline report stage, when all cost data has been selected, we will perform sensitivity analysis, in order to account for any discrepancies in cost estimates or possible inaccuracies. At this stage we are not conducting any analysis, so sensitivity analyses cannot yet be addressed.

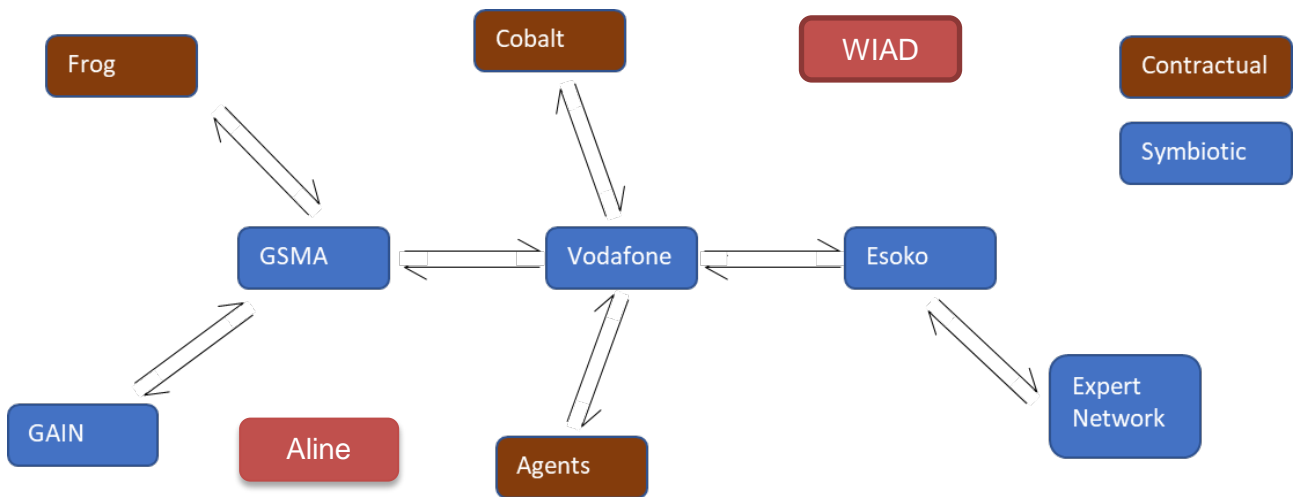
In the framework, the Setup and Ongoing costs (blue boxes in Figure 1) include:

-
- **Capital costs.** Cost of any infrastructure created to support Vodafone Farmers Club. In order to provide the service some extra equipment was required. For instance, while Vodafone did not have to make any particular purchases, Esoko servers needed to be upgraded and the grant provided finance for new computers. A service offering in a new country might also require some capital equipment.
- **Management/ Personnel costs.** The ongoing service requires expenditure on staff and management. MNO overheads could be incorporated here. In particular, Vodafone Farmers Club has a call centre associated with it – therefore this includes the training and employment of responding agents. Personnel costs need to include any engineers required to maintain the platform. In each case, the staff costs stated in the budget and reporting documents is attributed to the associated activity.

- **Promotion and marketing.** This includes the training of in country personnel, transport for trainers, hours of labour etc. Vodafone Farmers Club has already taken a number of different approaches to marketing. After considering an Ambassador model, the current marketing is through their network of agents and resellers. The initial service was targeted at new users, i.e. those with no phone, or those using a SIM card from another MNO. Vodafone Farmers Club was intended to attract users from other networks to Vodafone. Latterly, in order to achieve the numbers required for uptake, SMS blast messaging invited existing Vodafone SIM card holders to join the Vodafone Farmers Club tariff. The cost of acquisition is by definition higher for new users than migrating existing customers. These nuances need to be taken into account.
- **Recurrent costs of messaging.** On the face of it, one of the simplest costs is the price assigned to the text messaging. Each message has a cost associated with it. Message scheduling and despatch platforms will also incur ongoing maintenance costs. Who pays these costs is a more complex question. For the duration of the grant, costs were covered in part by donor financing. The service was, and will perhaps again become, a pay monthly model in which case costs are at least partly recovered from users. For the cost-effectiveness equation one could argue that revenue recovery is irrelevant – each message costs someone (donor, MNO or user) an amount to be sent and received. However, this revenue question will be revisited below in the more complex model C.
- **Localisation Content development.** mNutrition as a whole has been funded to develop and collate a global repository of nutrition information. In order for this to be applied to Vodafone Farmers Club Ghana there had to be a localisation process; taking the global fact sheets and making them relevant to the clientele of Vodafone Farmers Club. This involved a number of partnerships which will be discussed below.
- **Content curating.** There is an ongoing need for updating the content of the messages. Information can get out of date and while this is more likely to happen with medical information, there is nevertheless a need to ensure that the agricultural information remains relevant. In the case of Vodafone Farmers Club, there is real time messaging on market prices and weather, and to obtain this information incurs a cost.
- **User experience, Baseline, Monitoring and Evaluation** – Resources and personnel needed for User Experience surveys and feedback (called UX by the industry), baseline surveys, monitoring and evaluation. We include here the baseline surveys and User experience surveys required to design the specifics of the service, and the ongoing mechanisms of feedback to keep the service relevant to the farmers and to keep stakeholders apprised of the services effects (both financial returns and public good impact). It could be argued that the User Experience surveys are a part of the product research and development which we have modelled as a societal cost. However, if a similar service utilising the experience of Vodafone Farmers Club Ghana and the global content created by the mNutrition were to be set up in another country, there would need to be further User Experience surveys to inform the service shape and form, and to contribute to the localisation of the content.

The mNutrition programme is a collaboration between many partners, however, the Vodafone Farmers club service involves a relatively simple set of relationships. Our starting point has been the stakeholder map presented in Figure 5.

Figure 5 Relationships between stakeholders in the Vodafone Farmer's Club



Authors own

In terms of ongoing costs, Table 2 shows which partners might have incurred various cost items in our framework. It should be noted that Agents are private sector organisations that Vodafone pays to undertake marketing work. WIAD assumed responsibility for signing off on content – there may be very little cost associated with this action.

Table 2 Allocation of costs - Analysis A

Cost component	Partners involved in expenditure
Localisation Content development.	Esoko, Expert Network, GAIN, WIAD, GSMA
UX, Baseline, Monitoring and Evaluation	Frog, Cobalt, Aline, GSMA, Vodafone, Esoko
Capital costs.	GSMA, Vodafone, Esoko
Management/ Personnel costs.	GSMA, Vodafone, Agents, Esoko, (Expert network), WIAD
Promotion and marketing.	GSMA, Vodafone, Esoko, Agents
Recurrent costs of messaging.	Vodafone, Esoko
Content curating.	Esoko, (GSMA) WIAD

4.1.2 Analysis A, Baseline

Analysis A focuses on direct costs. Many of the costs in Analysis A are derived from either budgeted grant costs or actual reported costs; where these are not available interviews with key stakeholders have provided estimates. The split across the years was not always documented. Items such as capital expenditure occur in the first year, but the exact timing of items such as the Monitoring and Evaluation are not known, and an even split has been made on the assumption that they were carried out over the full period of time.

Table 3 Baseline costs for Vodafone Farmers Club Analysis A

	Partners involved in expenditure	Source of data	Detail	Year 1	Year 2	
Localisation Content development.	Esoko, Expert Network, GAIN, WIAD	Global content partnership (2017) (CABI, 2016, DFID 2016)	Staff Costs	£23,499	£6,107	
			Direct Costs	£ -	£8,526	
			LCP payments	£72,300	£13,266	
User experience, Baseline, Monitoring and Evaluation	Frog, Cobalt, Aline, GSMA, Vodafone, Esoko	Grant application (GSMA, 2014)	Vodafone / Esoko M&E 1500 per quarter	£ 6,000	£ 6,000	
			Stakeholder communication (GSMA, 2017)	Aline Firetail	£39,000	£39,000
			Stakeholder Communication (GSMA, 2017)	UX expert and design consultants	£ 74,300	£74,300
			Global content partnership (2017) Stakeholder Communication (GSMA, 2017), Authors estimates	Business Intelligence (GSMA)	£55,384	£55,384
Capital costs.	GSMA, Vodafone, Esoko	Grant application (GSMA, 2014)	Esoko farmer helpline	£ 22,000		
			VF software	£ 26,000		
			Integrations	£ 22,000		
Management/ Personnel costs.	Vodafone,	Estimates Based on Stakeholder communication (Vodafone, Gamos, 2017)	Project Management	£ 7,810	£ 7,810	
Promotion and marketing.	GSMA, Vodafone, Esoko, Agents	Grant application (GSMA, 2014)	Marketing 11000 per quarter	£ 44,000	£ 44,000	
			Acquisition events 16000 per quarter	£ 64,000	£ 64,000	
			BTL activities 5000 per quarter	£ 20,000	£ 20,000	

	Partners involved in expenditure	Source of data	Detail	Year 1	Year 2
			salesforce 15000 per quarter	£ 60,000	£ 60,000
Recurrent costs of messaging.	Vodafone, Esoko	Grant application (GSMA, 2014)	Esoko call centre maintenance 2000 per quarter	£ 8,000	£ 8,000
		Estimates Based on Stakeholder communication (Vodafone, Gamos, 2017)	Message scheduling (Esoko)	£ 61,200	£244,000
	Vodafone	Estimates Based on Stakeholder communication (Vodafone, Gamos, 2017), Vodafone website (2017)	cost of messages (SMS) ⁸	£83,160	£332,640
Content curating.	Esoko, (GSMA) WIAD	Esoko Sustainability Plan (GAIN, 2016)	Operational costs for content sustainability	£34, 000	£34,000
			Totals	£722,653	£1,017,833

Note, the totals combine known budgets/expenditure and a set of estimates

Table 3 shows the baseline costs considered for analysis A. Only the cost of message scheduling and the cost of sending the SMS messages themselves have been assumed to be variable costs. These costs have been based on estimated average numbers of users of 30,000 in Year 1, and 120,000 in Year 2 (assuming exponential growth from zero to 200,000 users at the end of year 2) (Vodafone user data 2017). We have taken the costs of all the messaging on the basis that the quantitative component is assessing the service as a whole, and that the synergy between nutritional messages and livelihood messages cannot be disaggregated.

As a sense check, the total of these costs (£1.74m) can be divided by the number of subscribers at the end of year 2 (200,000) to give a figure of £8.70 per farmer reached (this estimate assumes all farmers in Year 1 continue into Year 2). If it can be assumed that there is no material cost to Vodafone of sending the SMS messages, then this ratio drops to £6.6 per farmer reached. This suggests this intervention is considerably cheaper per farmer reached than farmer to farmer field schools (of order £20 - £30), but more expensive than community radio, which can reach farmers for less than £1 per adopter. Although interesting, these figures tell us nothing about value for money as they as yet take no account of impact achieved. .

⁸ These are in-kind contribution made by Vodafone (not included in the original application), and have been costed at the prevailing market rate for individual customers (0.055 GHS/SMS).

4.2 Analysis B

4.2.1 Wider programmatic costs (Analysis B)

As discussed briefly above, if a cost-effectiveness study is to be used not just to inform thinking on replicating an agricultural information service (forward thinking), but for a wider, retrospective assessment of what can be achieved for a given level of investment, then actors might need to understand the full cost of setting up Vodafone Farmers Club, inclusive of the wider programmatic costs. This is typically the kind of approach that would appeal to donors and policy actors interested in assessing whether the programme represents value for money. In order to include this wider perspective, the following costs need to be explored, in addition to those costs included in Analysis A:

- **R&D for the mNutrition programme as a whole.** The expanded nutritional messages sent out by Vodafone Farmers Club is only one particular output from the wider mNutrition programme. The mNutrition programme as a whole has spent time strategising, planning, co-creating global content, etc. leading to 14 specific in country services in 12 countries. While it is impossible to extract the specific costs of mNutrition related to the new nutritional content of VFC, it could be argued that 1/14 of the overall programme costs (minus specific grants) should be imputed to the mNutrition component of Vodafone Farmers Club. While this is open to question, for Analysis B we consider this cost. This should capture the research and development behind the mNutrition project after the project's inception (hours of labour devoted to the project by larger organisations, the amount paid to external researchers, costs of rent, vehicles and other transport costs associated with the project, costs of office supplies, electricity and other expenses necessary for research and development tasks).
- **Global Content Development.** The mNutrition programme paid for a global content generation process that was carried out by a consortium, comprising CABI, the Global Alliance for Improved Nutrition (GAIN), Oxfam, the International Livestock Research Institute (ILRI), and the British Medical Journal (BMJ). The Global Content Partnership was responsible for identifying relevant content, creating content structures, and specifying content validation and quality control processes. The content developed by the consortium was then made available to local content partners in each country to adapt for local consumption, and these costs are included as the localisation content development in Analysis A. A proportion of costs associated with the work of the global content consortium should be imputed to Vodafone Farmers Club in Analysis B.
- **Project related infrastructure.** In order to implement a complex programme across 14 projects in 12 countries and two continents, GSMA had to set up substantial infrastructure, at substantial cost. This includes institutional management structures, personnel, offices, IT networks etc. It is a proportion of these costs, paid for through the wider mNutrition programme, that are included in Analysis B.

There is the question of time horizons as discussed in Section 2.1.2. The proportion of allocated costs and their 'duration' will be revisited at the endline. The Global Content Development in particular may need to be allocated across a longer term than the two years of the project.

4.2.2 Analysis B, Baseline

Additional costs that could be considered in Analysis B which have been estimated from high level budgets. These figures will be updated if new cost data becomes available, and sensitivity analysis will be performed in the endline report, when all cost and impact data is available (Table 4).

Table 4 Baseline Costs for mNutrition

Cost	Partners involved in expenditure	Source of data	Detail	Year 1	Year 2
mNutrition programme as a whole (R&D, infrastructure).	GSMA (plus programme partners)	DFID 2013, DFID 2016, GSMA 2017 and CABI 2016	Proportion of programme overheads and global work.	£221,500	£221,500
Global content development.	CABI, GAIN	CABI 2016		£128,000	£128,000
Total				£349,500	£349,500

Note, the totals combine known budgets/expenditure and a set of estimates

Global content development

The CABI budget outlines costs associated with the local content generation process, which includes both payments to local content partners and consortium staff costs (these are included in Analysis A, Table 3). However, additional costs are allocated to the consortium partners for direct costs and staff costs, which amount to over £3.5m. A crude assumption can be made that these are spread evenly across all 14 projects, giving a total of £256,000 per country, or £128,000 per year if split over two years. The cost of content development for mNutrition was particularly high, as it was premised on building capacity within local institutions. It has been argued that it would be possible to develop content cheaper had the capacity building mandate not been in place.

mNutrition programme as a whole

GSMA have provided an estimate of the average total budget per project of £1,423,000 for those countries running mAgri projects as part of mNutrition. We have identified direct expenditure items which are included in analysis A (Localisation Content Development, and Product development (Monitoring and evaluation, User experience expert and design consultants, and Business Intelligence)), and the proportion of Global content development (Section 4.2.1). When these items are deducted from the average budget spend, the balance is £443,000. This has been split evenly over two years. This does not take into account whether GSMA has costed its overheads commercially. It is more than likely that some other parts of GSMA are subsidising the mDevelopment stream. This will be reconsidered in the light of endline cost data.

4.3 Analysis C

4.3.1 Including Household costs and savings (Analysis C)

As discussed above, for a more complete picture of the costs involved in the Vodafone Farmers Club service, one needs also to consider a number of additional costs, which can fall into two categories:

- Indirect, variable costs incurred as a consequence of users taking actions to implement new practices advocated by the Vodafone Farmers Club service.
- Sunk costs involved in building the assets that each partner brings to delivery of the VFC service.

The first category of costs considers expenditures and revenues at the household level. In order to achieve greater dietary diversity, they may need to spend money on seeds or fertiliser, or spend more time on labour intensive farming activities. The benefit or effectiveness of the Vodafone Farmers Club is, therefore, to some extent dependent on other costs met by the household. Offset against this, though, is the potential for the household to earn extra income and/or make savings on expenditure through their improved farm management. They may be expending more on fertiliser and achieving greater diet diversity, but are they also gaining extra income or reducing their irrigation costs?

An increase in selling price is of course a 'benefit'. However, in order to retain the comparability of the analyses with other programmes affecting nutritional based DALYs, the whole micro costing of the changes in farming practice have been brought 'above the line' as a cost. It may be (and we hope) that the farmer experiences a net benefit, which will be expressed as an offset to the costs of the programme reducing the cost per DALY saved. This retains the focus on dietary diversity and associate improvements as part of the GSMA/firetail model (section 3.5).

The following items should be considered:

- **Profit revenue for the MNO.** Based on the user subscription fee which the farmer pays, the farmer may be covering all or part of the costs tabled above, plus contributing directly to MNO profit line. In order not to double count the costs, we need only add the direct profit component (which is not the same as accounting for changes in ARPU and churn).
- **Household time and additional economic costs.** In addition to actual expenditure on more fertiliser or vaccines for livestock, the household may be required to spend more or less time in the fields, or accessing specific markets. The quantitative and qualitative components of the independent study should give insights into this possible extra expenditure.
- **Increase in selling price of crops (and livestock).** The quantitative component in particular should give insights into the increases in income due to sales of farm produce.
- **Increase in crop yields.** Yields may increase but not be sold. Nutritional advice about diet diversity may be accompanied by a preference for domestic consumption. This would need to be taken into account, and indeed the quantitative component explores crop harvests, as well as amounts sold and consumed.
- **Reduction in losses due to improved crop management.** Similarly, increased sales and yields may not reflect any reduction in losses. Post-harvest losses in small farm management are of the order of one third, and a reduction here might represent a saving in food related expenditure.

The second category of costs is associated with establishing intellectual and infrastructure assets that are employed in some way as part of achieving nutritional outcomes:

- **Project related infrastructure.** GSMA was able to implement the programme because it had previously invested in the infrastructure through which it operates. Here, we are using infrastructure in the widest possible sense, to include not just institutional management structures, offices, IT networks, but also the branding, relationships and reputation. This cost draws attention to the idea that another country wishing to implement a similar programme needs to ask itself if it has such project infrastructure in place – the GSMA has a unique role in the context of mobile telephony.
- **Global content repository.** Many of the partnerships draw on global content that has been built over many years of investment. While the localisation of this content is a key output of the project, nevertheless the project would have incurred considerable additional expenditure if GAIN and CABI had not had a collated ‘head start’ in terms of global content. This repository of content had to be collated, and the money paid to external content developers and hours of labour spent by other employees, and use of necessary resources could be taken into account. (N.B., it is important not to double count any payments made by mNutrition to content providers within the first item, the wider R&D of the programme.)
- **Existing Assets.** Vodafone and Esoko are both building on their existing network infrastructure. The Vodafone mobile network provides coverage of the majority of the country, and this makes the possibility of messaging large numbers of consumers a reality. Similarly, Esoko has been collecting market and weather data for a number of years and its network of informants brings value to the project, as does the technical platform they have developed. There are also intellectual property assets. The mNutrition programme builds on the learning and experience GSMA has gained through running previous mAgri programmes. It particularly builds on the learning and experience Vodafone has had in Turkey with a similar Vodafone Farmers Club product. The content provision and localisation builds on the experience of Esoko, which has been gained across the ten countries where they have a presence. One can argue that the cost of this learning is captured within the fee structure of the individual organisations. However, it can also be argued that Vodafone would not have been able to implement VFC so easily if Esoko had not had prior experience of running a market pricing and weather service.
- **Use of public facilities.** There are two ideas to capture here. The qualitative component of the study, and most of the literature on how farmers learn, emphasises that farmers learn from multiple sources. In addition to information received through Vodafone Farmers Club, farmers may also be learning improved farm management techniques from other sources, such as private or public-sector extension agents. While the experimental quantitative component of the independent study will disaggregate the added benefit from the Vodafone Farmers Club, the impact of the Vodafone Farmers Club advice may still have been supported by the extension services. If, for example a farmer had no other sources of advice (not even his or her neighbour), the outcomes attributed to the Vodafone Farmers Club service might be considerably reduced. In practice, farmers are exposed to a baseline level of complementary (and possibly conflicting) information and advice, so the experimental component will show the additional value resulting from use of the service. Therefore, in terms of cost-effectiveness we need some insight into the baseline of existing advice. The second idea captured here is that some advice can only be followed if some investment has been made in other facilities. For instance, farmers may be able to increase their yields through judicious and timely use of fertiliser. Has someone invested in a distribution network for fertiliser (private sector or public)

and/or does the government subsidise the fertiliser? One can imagine considerable gains made by the farmers resulting from increased use of subsidised fertiliser (or livestock vaccines or any agricultural input). However, the increased cost of any subsidies needs to be considered by the policy actor. The inputs revealed to be integral to the impacts of Vodafone Farmers Club will be micro costed and included at the time of the endline. We will seek to identify the difference in use between the treatment and control groups. In addition to this use of 'agricultural' public facilities, there may be some change in the use of health facilities. The nutritional messages could include advice that prompts a greater use of health facilities, or reduced use due to better health from better nutrition. While this likelihood is minimal within the Vodafone Farmers Club, it is more likely in the mHealth interventions within the wider mNutrition programme. We will liaise with the quantitative and qualitative components to see if changes in the use of health services may have occurred due to the Vodafone Farmers Club nutritional messages. If there is a difference (either way) between treatment and control groups we will undertake a micro costing of the differences in both health service use and out-of-pocket payments.

4.3.2 Analysis C, Baseline

Costs to be included in Analysis C mostly represent embedded value (or asset value) that each partner brings to the partnership. Quantifying this is a tricky and subjective exercise.

The other components relate to additional variable costs incurred as a result of increased uptake and use of health services. This can only be added after the endline Quantitative survey which will generate some data on uptake of services along with measures on increased yields, reduced losses, and increased income at the household level (Table 5).

Table 5 Baseline Costs for mNutrition

Cost	Partners involved in expenditure	Source of data	Detail	Year 1	Year 2
Global content repository	CABI, GAIN	CABI 2016	Proportion of global work.	To be determined	To be determined
Existing Assets	Vodafone	Annual reports	Proportion of Tanzania work.	To be determined	To be determined
Use of public facilities	Beneficiaries	Endline data	Micro costing based on endline	To be determined	To be determined

Global content repository.

CABI has been operating for more than 100 years, and GAIN was launched in 2002. Focusing on generating and accumulating agricultural and nutrition knowledge, the project obviously benefits from years of research. CABI has a turnover of about £36m per year and GAIN slightly more at around £45m per year, much of which generates knowledge and experience that was available for the project. CABI and GAIN are of course not the only sources of generated knowledge available

to the programme. The CGIAR network alone has a five-year budget of £8 Billion - generating knowledge that Vodafone Farmers Club would draw on. How then do we assign a cost proportion of this valuable content? As an estimate we have taken the GAIN project budget for developing content in Ghana, and apportioned an IP overhead of 50%, which gives a total of £124,000.

Existing Assets.

Vodafone Ghana is the branded name after Vodafone purchased a 70% stake in Ghana Telecom in 2008 for \$900m. Since then it had to undertake layoffs, so while the financials are not available, it seems that the value of the company (inclusive of infrastructure) is of the order £1,000m. Subscribers are 11m (NCA), therefore the asset value per customer is £90. However, this infrastructure needs to be discounted over its lifetime. If we assume straight line depreciation over 20 years, the annual value per customer is £4.5. The contribution to Vodafone Farmers Club can then be estimated by multiplying this value by the estimated average number of users per year. This is a crude calculation that makes no allowance for inflation or discounting. A similar approach could be taken to valuing the contribution to the project of Esoko assets, both intellectual and physical infrastructure. Efforts will be made over the next two years to gather data on historical costs invested in the development of Esoko.

Use of public facilities.

The 2017 Ghana Ministry of Agriculture Budget is £134m. This annual expenditure contributes to basic research that farmers rely on to improve their crops, gain advice (from posters, extension agents, their local offices), and for some regulation of farmgate markets. It is therefore important to understand national context – we reiterate; our premise is that the diet diversity gains from using Vodafone Farmers Club are only made when the Vodafone Farmers Club advice is combined with other advice. Repeating the service in countries where there is limited investment in agriculture would not necessarily produce the same change in diet diversity.

The quantitative study will reveal the extent of increased agricultural service and input use at the endline. The cost of this will be included in this analysis. Data on the cost of certain agricultural inputs and service units, such as extension worker visits will be calculated from available literature at the time of the endline. We will seek to micro cost those services impacted in the treatment group according to literature available at the time of the endline. Where available literature cannot accurately provide cost information for healthcare use, we will seek information from relevant stakeholders.

4.4 Cost Benefit analyses

In the discussion above we have noted the aspiration that the service be 'commercially sustainable'. This is discussed in more detail in the Business Modelling report. However, in the endline cost-effectiveness report, if the data is forthcoming, we could attempt a cost benefit analysis focusing purely on the financial returns. Vodafone will be submitting a sustainability report to GSMA. This will illustrate why they think the service will be sustainable over the coming two to three years. In 2019 we could use known subscription incomes to see what proportion of the wider costs have effectively been recovered, and to show a simple IRR for the wider cost picture.

This may be of use to donors considering funding similar programmes, particularly to assess whether any funding should be made as grants or loans, and to inform decisions on suitable interest rates.

There may also be a possibility to do an endline cost benefit analysis for 'typical' households. The quantitative survey will have gathered improvements in income, and possibly reduction in losses, as well as extra expenditure incurred on agricultural activities and Vodafone Farmers Club subscription costs to the user.

It is by no means certain that it will be possible to carry out these cost benefit analyses, as viability will depend entirely on the nature of the results arising from the endline survey data in 2019.

4.5 Limitations

Many of the stated costs are integral to a number of other programmes. The mNutrition programme as a whole has transaction costs that may or may not be imputed in part to the Vodafone Farmers Club Service. Vodafone Ghana as a whole has infrastructure which is being used for the delivery of the service, and one could argue that a proportion of 'overhead' costs needs to be assigned to the service. In the endline analysis we will construct a number of scenarios which cover both provider and societal costs. If the objective of the cost-effectiveness assessment is to add such a service to existing Mobile Network Operators, then provider costs may be enough. However, were DFID to consider the value for money of its intervention, and seek to repeat it in a new country with new partnerships, then societal scenarios may be more applicable.

5 Conclusion

Ultimately, there are several decisions to be made with regard to the cost-effectiveness analysis of mAgri. These decisions are not always clear cut, for example the value of beneficiary labour, and contain within them implicit value judgements. Decisions must be made as to the time when cost-effectiveness must be assessed, either at the stage of the endline survey, or the projected benefits decades into the future. The outcomes and benefits that are to be measured must be chosen, and a metric for assessing these must be chosen. Furthermore, criteria must be created for what is and is not considered a cost of the project.

At this stage, it is difficult to choose such a metric, as we are not aware of the potential impacts of the project. It is therefore important to begin to assess the costs of the project, but to keep an open mind as to the benefits that will be assessed at the projects endline.

The cost-effectiveness analysis is dependent on a measure of what the project has achieved, and this is to be determined by the results of the quantitative study currently being undertaken as part of the independent study by IFPRI. The endline survey is expected to be conducted late in 2018 and the results published thereafter – only once these results are available will it be possible to conduct the cost-effectiveness analysis. This baseline report presents a proposed methodology for the cost-effectiveness study, based on current practice in the literature. There is surprisingly little in the literature on costs or cost-effectiveness of comparable or related interventions, such as agriculture policies, agriculture strategies or integrated agriculture and health approaches.

While much of the literature focuses on the impact of innovative approaches, little attention is paid to costs. As such it is difficult for donors and governments to make informed decisions about priorities, to get the best value for money, to maximise impact for least cost. Key references that do attempt to address cost-effectiveness include a variety of different costs, illustrating that there is no standard approach or accepted methodology. Costs can generally be divided into three categories – project costs, research and development costs, and beneficiary costs, but none of the key studies takes a comprehensive view of costs by considering costs in all three categories.

We propose conducting three distinct analyses, taking account of different costs, to generate metrics that will be relevant to different stakeholders. The simplest analysis will include project related costs only, and is designed to reflect the interests of parties that might be interested in replicating the Vodafone Farmers Club service in some way, such as another MNO. This approach assumes that capital expenditure would be limited to modest costs associated with localising content, and to infrastructure items required to run the service, and that it would not be necessary to invest in the content generation and capacity building activities included in the mNutrition programme. A more comprehensive analysis will attempt to include all the mNutrition project costs, providing an assessment of value for money for the project as a whole. The third approach will take a much more comprehensive view of the costs associated with a wider range of factors required to achieve the improved outcomes, such as recognising the asset value that core partners bring to the project, expenditure by farmers, as well as how costs may be offset by financial benefits at the household level. Not only will this comprehensive approach inform policy makers of the wider implications of the project, but it provides an innovative methodology for handling projects implemented by the private sector.

The study presents preliminary costs data and estimates as available at March 2017. More detailed information on project costs has been promised, and the work of team over the next two years will continue to pursue cost data identified in these scenarios.

In the literature, many studies consider the benefits to farmer income, but fail to include changes in nutrition. By considering only financial benefits, they tend to use cost-benefit analysis. On the other hand, studies that do consider nutrition outcomes tend to use non-monetary measures of outcomes, such as dietary diversity and DALYs averted. This study will consider improved nutrition as the primary outcomes of the Vodafone Farmers Club project, so the cost-effectiveness analysis will be based on dietary diversity measures included in the design of the quantitative household surveys. In order to facilitate comparison with studies from the nutrition literature, attempts will be made to assign 'imputed' saving in terms of DALYs.

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Annex A **Terms of reference**

PO 6420: External evaluation of mobile phone technology based nutrition and agriculture advisory services in Africa and South Asia

Introduction

DFID (Research and Evidence Division) wishes to commission an external impact evaluation of mNutrition, a mobile phone technology based nutrition and agricultural advisory service for Africa and South Asia. mNutrition is a programme supported by DFID that, through business and science partnerships, aims to build sustainable business models for the delivery of mobile phone technology based advisory services that are effective in improving nutrition and agricultural outcomes.

mNutrition is primarily designed to use mobile phone based technologies to increase the access of rural communities to nutrition and agriculture related information. The initiative aims to improve knowledge among rural farming communities especially women and support beneficial behaviour change as well as increasing demand for nutrition and agriculture extension services. The mNutrition initiative launched in September 2013 will work in 10 countries in Africa (Cote d'Ivoire, Ghana, Malawi, Mozambique, Nigeria, Tanzania, Kenya, Rwanda, Uganda, Zambia) and four countries in South Asia (Bangladesh, India, Pakistan and Sri Lanka). The desired impact of mNutrition will be improved nutrition, food security and livelihoods of the poor.

Mobile phone based services have been endorsed by WHO as an effective strategy for behaviour change and for driving adherence to anti-retroviral treatment protocols (Horvath, Azman, Kennedy and Rutherford 2012). There is currently scant evidence on the impact and cost-effectiveness of mobile phone technology based services for nutrition and agriculture and on the sustainability of different business models for their provision. A rigorous evaluation of mobile phone technology based nutrition services would add significantly to the current evidence base. An external evaluation team managed by the Evaluator, independent of the programme delivery mechanism, will conduct an assessment of the impact, cost-effectiveness and sustainability of mobile phone technology based information and behaviour change messages for nutrition and agriculture.

Background to mNutrition

Introduction

Undernutrition is a major challenge to human and economic development globally. It is estimated that almost one billion people face hunger and are unable to get enough food to meet their dietary needs. Agriculture is a major source of livelihood in many poor countries and the sector has a potentially critical role in enhancing health, specifically maternal and child health and nutritional status. A well-developed agriculture sector will deliver increased and diversified farm outputs (crops, livestock, non-food products) and this may enhance food and nutrition security directly through increased access to and consumption of diverse food, or indirectly through greater profits to farmers and national wealth. Better nutrition and health of farmers fosters their agricultural and economic productivity. Current agricultural and health systems and policies are not meeting current and projected future global food, nutrition and health needs.

Despite major investment in agricultural and nutrition research and its uptake and application, there is significant social and geographic inequality in who benefits from these investments. Furthermore, in many developing countries, public extension systems for agriculture, health and nutrition are inefficient, have limited capacity and have a poor track record of delivery, especially in terms of supporting women and girls and the most marginalised populations (Alston, Wyatt, Pardey, Marra and Chan-Kang 2000; Anderson 2007; IFPRI 2010; Van den Berg and Jiggins 2007).

Several research and mobile network operators (MNOs) are testing a range of information and communication technology (ICT) solutions for improving access to a wide range of information and advisory services. Mobile phone based technologies are among the most promising ICT strategies, although current initiatives in nutrition are relatively small and fragmented.

What is mNutrition?

Enhancing access to the results of nutrition and agricultural research and development is potentially critical for improving the nutrition, health and livelihoods of smallholders and rural communities. mNutrition will harness the power of mobile phone based technologies and the private sector to improve access to information on nutrition, health and agricultural practices especially for women and farmers (both male and female). Specifically, mNutrition will initiate new partnerships with business and science to deliver a range of services including:

- An open-access database of nutrition and agriculture messages for use in mobile phone based communication (for example, information and behaviour change messages on practices and interventions that are known to have a direct impact on nutrition or an indirect impact via for example agriculture);
- A suite of mobile phone based nutrition and agriculture information, extension and registration services designed to: improve knowledge and generate beneficial behaviour change in nutrition and agriculture; increase demand for nutrition, health and agriculture goods and services; register and identify target populations for support; and, using real-time monitoring, support the conduct of nutrition risk assessments by community health workers.

The impacts of mNutrition are expected to include improved nutrition, food security and livelihoods of the poor, especially women in 10 countries in Africa (Cote d'Ivoire, Ghana, Kenya, Malawi, Mozambique, Nigeria, Rwanda, Tanzania, Uganda and Zambia) and 4 countries in South Asia (Bangladesh, India, Pakistan and Sri Lanka). This impact will result from the increased scale and sustainability of mobile phone based nutrition and agricultural-based information services, delivered through robust public private partnerships in each country.

mNutrition has two major outcomes. One outcome will be cost-effective, sustainable business models for mobile phone enabled nutrition and agriculture services to 3 million households in 10 countries in Africa and 4 countries in South Asia that can be replicated in other countries. Linked to this outcome, the second outcome will expect these services to result in new knowledge, behaviour change and adoption of new practices in the area of agriculture and nutrition practices among the users of these mobile phone based services.

These outcomes will be achieved through four outputs:

- Improved access to relevant mobile based health, nutrition and agricultural advisory services for 3 million poor people and community health workers across 10 SSA and 4 Asian countries;

- Launch and scaling of mobile phone based health, nutrition and agricultural advisory services targeted to poor people and community health workers;
- Generation and dissemination of high quality research and evidence on the impact, cost-effectiveness and sustainability of mobile phone based advisory services in nutrition and agriculture in South Asia and SSA; and
- Development of locally relevant content for mobile phone technology based agriculture and nutrition services meeting demands from users and community health workers.

In terms of promoting behaviour change and/or adoption of new practices, mNutrition will seek to achieve changes in one or more of the following areas:

- Adoption of new agricultural practices that are nutrition sensitive, improve agricultural productivity and utilise post-harvest technologies
- Changes in nutrition practices in either one or several knowledge domains including improved maternal nutrition practices during pregnancies; infant and young child feeding practice; and micro-nutrient supplementation to children at risk (i.e. Vitamin A, Zinc and Oral Rehydration Solution (ORS)).

mNutrition has started implementation from September 2013. For the 2 countries selected for the impact evaluation (Tanzania and Ghana), mobile network operators and content providers have been identified through a competitive process during the first half of 2014. The MNOs and content providers started developing and launching their services during the 4th quarter of 2014 and early 2015. The mobile phone based advisory services are expected to run at least till 3rd quarter of 2018.

mNutrition Project Coordination

DFID support to mNutrition will be channelled to GSMA, as well as directly to this associated independent external impact evaluation. GSMA is a global body that represents the interests of over 800 mobile operators. GSMA already works with the major mobile operators across Africa, (including Airtel, MTN, SafariCom/VodaCom) with a collective mobile footprint of more than 67% of total African connections. GSMA has a number of existing development initiatives, including mHealth and mFarmer, that are part of GSMA's Mobile for Development which brings together mobile operator members, the wider mobile industry and the development community to drive commercial mobile services for underserved people in emerging markets. GSMA will provide technical assistance to mobile phone operators, and support new partnerships with content providers to develop and scale up new nutrition and agriculture message services. GSMA will ensure sharing of best practices and promote wider replication and uptake of effective business models.

Objective and Main Questions

The objective of this work is to conduct an external evaluation of the impacts and cost-effectiveness of the nutrition and agriculture advisory services provided by mNutrition compared to alternative advisory services available in the two selected countries (Ghana and Tanzania), with particular attention paid to gender and poverty issues. The impact assessment is required to answer the following questions that relate to impact, cost-effectiveness and commercial viability:

- What are the impacts and cost-effectiveness of mobile phone based nutrition and agriculture services on nutrition, health and livelihood outcomes, especially among women, children and the extreme poor?

- How effective are mobile phone based services in reaching, increasing the knowledge, and changing the behaviour, of the specific target groups?
- Has the process of adapting globally agreed messages to local contexts led to content which is relevant to the needs of children, women and poor farmers in their specific context?
- What factors make mobile phone based services effective in promoting and achieving behaviour change (if observed) leading to improved nutrition and livelihood outcomes?
- How commercially viable are the different business models being employed at country level?
- What lessons can be learned about best practices in the design and implementation of mobile phone based nutrition services to ensure a) behaviour change and b) continued private sector engagement in different countries?

Further evaluation questions related to other aims of mNutrition will be addressed in at least 1 country (either Ghana and/or Tanzania):

- Are mobile phone based services a cost-effective way to register and identify at risk populations to target with nutrition support?
- Are mobile phone based services a cost-effective way for community health workers to improve the quality and timeliness of data surveillance (a core set of nutrition-related indicators)?

The content for the mobile phone based advisory services will be based on international best practices and widely endorsed protocols (i.e. by the World Health Organisation) and evidence-based nutrition-sensitive agricultural practices identified by international experts. Through an iterative multi-stakeholder process, international and country experts will localise and adapt the content to make it relevant to the specific target audience in the 14 countries. The adapted content and nature of messages is expected to vary across specific target audiences within and across countries. The main purpose of assessing the relevance of the content is not to evaluate the overall health and nutrition content but on how this content has been localised and adapted and to what extent the needs of the specific target groups within their particular context have been met.

In assessing the commercial viability, it is recognised that evaluating the sustainability/long-term financial viability of the mobile phone based advisory services will be difficult as mobile network operators may not be willing to provide this potentially commercially sensitive information. Therefore, GSMA will provide support through its access to aggregated confidential financial results of the mobile network operators providing the service. GSMA will provide a financial summary report on the commercial viability of the business models without compromising the commercial sensitivity of the data for the mobile network operators. The evaluator will assess and validate commercial sustainability through an analysis of the aggregated information provided by GSMA and additional qualitative business analysis approaches.

The Evaluator has the option of proposing refinements of the existing evaluation questions during the inception phase as part of developing the research protocol. These suggestions will be considered by the Steering Committee and an independent peer review during the review of the research protocol as part of the inception phase.

Output

The output of this work will be new and robust evidence on the impact, cost-effectiveness and commercial viability of mobile phone based advisory services focusing on nutrition and agriculture delivered by public and private partners, and including the development of robust methodological approaches to impact assessment of phone based advisory services.

Recipient

The primary recipient of this work will be DFID, with the beneficiaries being GSMA, governments, international agencies, foundations, MNOs and other private companies and civil society involved in policies and programmes in nutrition and agriculture that are aimed at improving nutritional, health and agricultural outcomes. The findings of this impact evaluation are intended as global public goods.

Scope and timeline

The scope of this work is to:

- Develop a research protocol for the external evaluation of mNutrition;
- Design and undertake an external evaluation of mNutrition in two countries: Ghana and Tanzania;
- Contribute to the communication of the learning agenda, evaluation strategy and evaluation results.

The evaluation will be in two of the 14 mNutrition target countries; Ghana and Tanzania. These countries have been selected based on the phased start-up of mNutrition programme activities. The focus and approach in the two respective countries will be different allowing for a comparison of the effectiveness of approaches applied. In Tanzania, mNutrition will focus on mobile phone technology based nutrition and health services and registration and identification of target population. In Ghana, the mobile phone technology will focus on nutrition and agriculture sensitive services.

In terms of coverage in number of people being targeted for these services, in total 3 million people will be reached through mNutrition; including 2 million for nutrition sensitive agriculture advisory messages in 4 Asian and at least 2 African countries and about 1 million beneficiaries for mobile phone based nutrition services in 10 countries in SSA.

The evaluation contract period will be September 2014 to 31st December 2019. The development of the research protocol must be completed by month 4 for review and approval by DFID. Full details on tasks and deliverables are provided in sections below.

Statement on the design of the mNutrition evaluation

The evaluation design is expected to measure the impact, cost-effectiveness and commercial viability of mNutrition, using a mixed methods evaluation design and drawing on evidence from two case study countries and the M&E system of the programme. Overall, the proposed design should ensure that the evidence from the two case study countries has high internal validity and addresses the priority evidence gaps identified in the Business Case. Being able to judge the generalisability/replicability of lessons learned from the programme is of equal importance and so a credible approach to generalisation and external validity will be an important component of the overall evaluation design. The final evaluation design and methodology to generate robust evidence will be discussed in detail with DFID and GSMA before implementation.

For assessing cost-effectiveness, the Evaluator will further fine-tune their proposed evaluation approach and outline their expectations in terms of data they will require from implementers. A theory based evaluation design, using mixed methods for evaluating the impact has been proposed. During the inception phase, the Evaluator will put forward a robust evaluation design for the quantitative work, either an experimental or a quasi-experimental method, with a clear outline of the strengths and limitations of the proposed method relative to alternatives. During the inception phase, the Evaluator is also expected to identify clearly what will be the implications of the design for implementers in terms of how the overall programme would be designed and implemented and for evidence to be collected in the programme's monitoring system. The Evaluator will also assess the

degree to which it is realistic to assess impacts by early 2019 for a programme where implementation started mid 2015 and, if there are challenges, how these would be managed.

The Evaluator, in its 6 monthly reports, will be required to provide information to feed into the DFID Annual Review and Project Completion Report of mNutrition.

Gender and inclusiveness

The impact evaluation will pay particular attention to gender and other forms of social differentiation and poverty issues. From current experiences, it is clear that access to and use of mobile services is differentiated along a range of factors, including gender, poverty, geographic marginalisation, education and illiteracy levels. Therefore, the impact evaluation will look at and analyse differentiated access to and potential utilisation of mobile phone based services for improved nutrition and agricultural production. Based on the findings, it will identify opportunities and challenges in having an impact on women in general and more specifically the poor and the marginalised.

Tasks

The Evaluator will perform the following tasks:

A. Finalise a coherent and robust evaluation approach and methodology based on their proposal (inception phase)

- Conduct landscape analysis of existing experiences in mobile phone based services for nutrition and agriculture based on available publications and grey project documents to identify additional critical lessons and priorities for evidence gathering and programme design and implementation;
- Ensure that gender issues and poverty issues are well integrated into the impact evaluation design;
- Develop robust sampling frameworks, core set of indicators and research protocols that allow the consistent measurement and comparison of impacts across study countries, taking into account differences in business models and programmes as needed;
- Work closely with mNutrition programme team in GSMA to familiarise them with impact assessment methodology, discuss evaluation approaches, identify and agree on data provided by programme monitoring system and possible modifications to design;
- Identify risks to the evaluation meeting its objectives and how these risks will be effectively managed;
- Review existing evaluation questions and if deemed relevant propose refinement of existing questions and/or add other questions;
- Prepare a research protocol, including an updated workplan, project milestones and budget. The research protocol will be subject to an independent peer review organised by DFID; and
- Develop a communication plan.

B. Implement and analyse evaluations of impact, cost-effectiveness and commercial viability in accordance with established best practices

- Based upon the agreed evaluation framework, develop and test appropriate evaluation instruments which are likely to include data collection forms for households, community health workers, service providers including health and agricultural services, content providers and private sector stakeholders including mobile network operators. Instruments will involve both quantitative and qualitative methods;

- Register studies on appropriate open access study registries and publish protocols of studies where appropriate;
- Conduct baselines and end-lines, qualitative assessments and business model assessments in both of the two impact evaluation countries;
- Conduct and analyse the evaluations and present findings in two well-structured reports addressing the evaluation questions. The reports should follow standard reporting guidelines as defined by, for example, the Equator Network. Primary findings should be clearly presented along with a detailed analysis of the underlying reasons why the desired outcomes were/were not achieved;
- The Evaluating Organisation or Consortium may subcontract the administration of surveys and data entry, but not the supervision of those tasks, study design, or data analysis; and
- The country-specific mixed methods evaluation reports, cost-effectiveness and business models studies and final evaluation report will be subject to an independent peer review organised by DFID.

C. Contribute to the communication of the learning agenda, impact evaluation strategy, and evaluation results.

- Develop a communication plan outlining the main outputs and key audiences;
- Conduct lessons learnt workshops in each of the 2 impact evaluation countries and key dissemination events; and
- Assist in communicating the results of the evaluation and contribute to the development and communication of lessons learnt about mobile phone based extension approaches in nutrition and agriculture.

Deliverables

The Evaluator will deliver the following outputs⁹:

During the design and study inception phase of maximum 4 months:

- A publishable landscape analysis report highlighting lessons learnt from existing initiatives on mobile phone based advisory services related to nutrition and agriculture by month 4;
- A updated work plan with project milestones and budget by end of month 1 (possibly adjusted based on the approved research protocol by month 4);
- A communication plan outlining the key outputs, audience and timeline for review and approval by month 4; and
- A full research protocol by month 4 for review and approval. The research protocol should be registered with appropriate open access study registries;

Interim reports:

- 4 biannual progress reports for the External Evaluation as a whole, and for each country evaluation, against milestones set out in the workplan;

⁹ Exact timeframe of deliverables will be agreed on during the design phase as appropriate.

- Two desk reviews submitted by June 2016
- Two Baseline quantitative reports submitted by April 2017
- Two Baseline qualitative reports submitted by February 2017
- Two Cost-effectiveness reports 1 submitted by March 2017
- Two Business Model reports 1 submitted by March 2017
- Two Mixed Methods Baseline reports completed by September 2017
- Two Midline qualitative reports submitted by March 2018
- All survey data collected during the evaluation provided in a suitable format to DFID for public release.

At project's end:

- Two Endline quantitative reports submitted by June 2019
- Two Endline qualitative reports submitted by August 2019
- Two Cost-effectiveness report 2 submitted by July 2019
- Two Business Model report 2 submitted by July 2019
- Two Evaluation reports submitted by October 2019
- At least 1 article, based on the findings from the country evaluation reports, published in a research journal;
- A shared lesson learnt paper published and at least one presentation highlighting key lessons for similar initiatives of promoting mobile based technologies for providing extension services and the promotion of uptake of technologies by December 2019.

Research protocol and all final reports will be independently peer reviewed. This will be organised by DFID. Outputs are expected to be of sufficiently quality so that a synthesis of findings can be published in a leading peer-reviewed journal.

Coordination and reporting requirements

A mNutrition Advisory Group (AG) will be established for the programme which will a) provide technical oversight and b) maximise the effectiveness of the programme. The Advisory Group will meet on a bi-annual basis and comprises of representatives of DFID, NORAD and GSMA representatives and independent technical experts. The Evaluator will be managed by DFID on behalf of the mNutrition Advisory Group. The Evaluator will work closely with the mNutrition programme team in GSMA and its specific country implementing partners. The Evaluator will:

- Ensure coherence and lesson learning across all pilot impact assessments on the key evaluation questions and indicators identified.
- Incorporate a clear code of ethics; incorporate plans for open access publications and public access to data sets.

The Evaluator will work closely with the mNutrition project management team, in particular in the design of the overall evaluation framework and the evaluation plan for the specific project components and the countries selected for the evaluation. Collaboration and regular communication between Evaluator and mNutrition project management team and implementing partners in selected case study countries is crucial as the evaluation design may have implications for project implementation and vice versa. The mNutrition project management team will lend support in

communication as requested by the Evaluator or the Advisory Group. The Evaluator will report directly to DFID who will manage the evaluation on behalf of the mNutrition Advisory Group. The main point of contact for technical matters is Louise Horner, Livelihoods Adviser and Hugh McGhie, Deputy Programme Manager for all other project related issues. The mNutrition Advisory Group will be the arbiter of any disputes between the evaluation function and the overall programme implementation.

At the end of each 6 months, the Evaluator will submit a brief report outlining key achievements against the agreed deliverables. Pre-agreed funding will then be released provided that deliverables have been achieved.

In addition to the 6 monthly reports outlined above, the Evaluator will provide information to feed into the DFID Annual Review of mNutrition. The 6 monthly reports will be a key source of information used to undertake the Annual Review and Project Completion Report for the programme. These reviews will be led by the Livelihoods Adviser and Deputy Programme Manager, in consultation with the mNutrition AG. All reviews will be made available publicly in line with HMG Transparency and Accountability Requirements.

Mandatory financial reports include an annual forecast of expenditure (the budget) disaggregated monthly in accordance with DFID's financial year April to March. This should be updated at least every quarter and any significant deviations from the forecast notified to DFID immediately. In addition the Evaluator will be required to provide annual audited statements for the duration of the contract.

Contractual Arrangements

The contract starts in September 2014 and will run till end of December 2019 subject to satisfactory performance as determined through DFID's Annual Review process. Progression is subject to the outcome of this review, strong performance and agreement to any revised work plans or budgets (if revisions are deemed appropriate).

A formal break clause in the contract is included at the end of the inception period. Progression to the implementation phase will be dependent on strong performance by the Evaluator during the inception period and delivery of all inception outputs, including a revised proposal for implementation period. Costs for implementation are expected to remain in line with what has been agreed upon for this contract, with costs such as fee rates fixed for contract duration. DFID reserves the right to terminate the contract after the inception phase if it cannot reach agreement on the activities, staffing, budget and timelines for the implementation phase.

DFID reserves the right to scale back or discontinue this assignment at any point (in line with our Terms and Conditions) if it is not achieving the results anticipated. The Evaluator will be remunerated on a milestone payment basis. DFID has agreed an output based payment plan for this contract, where payment will be explicitly linked to the Evaluator's performance and effective delivery of programme outputs as set out in the ToR and approved workplan. The payment plan for the implementation phase will be finalised during the inception period.

Open Access

The Evaluator will comply with DFID's Enhanced and [Open Access Policy](#). Where appropriate the costs of complying with our open access policy should be clearly identified within your commercial proposal.

Branding

The public has an expectation and right to know what is funded with public money. It is expected that all research outputs will acknowledge DFID support in a way that is clear, explicit and which fully complies with DFID Branding Guidance. This will include ensuring that all publications acknowledge DFID's support. If press releases on work which arises wholly or mainly from the project are planned this should be in collaboration with DFID's Communications Department.

Duty of Care

The Evaluator is responsible for the safety and well-being of their Personnel (as defined in Section 2 of the Contract) and Third Parties affected by their activities under this contract, including appropriate security arrangements. The Evaluator is responsible for the provision of suitable security arrangements for their domestic and business property. DFID will share available information with the Evaluator on security status and developments in-country where appropriate.

The Evaluator is responsible for ensuring appropriate safety and security briefings for all of their Personnel working under this contract and ensuring that their Personnel register and receive briefing as outlined above. Travel advice is also available on the FCO website and the Evaluator must ensure they (and their Personnel) are up to date with the latest position.

The Evaluator has confirmed that:

- The Evaluator fully accepts responsibility for Security and Duty of Care.
- The Evaluator understands the potential risks and have the knowledge and experience to develop an effective risk plan.
- The Evaluator has the capability to manage their Duty of Care responsibilities throughout the life of the contract.

Annex B Insights into the analysis from the literature

B.1 Definitions and process of analysis

Cost-effectiveness

Cost-effectiveness has been taken as a measure of an intervention's value for money. The aim is to analyse which interventions can provide the best possible outcomes at the least cost., thereby saving valuable and finite resources. It is differentiated from Cost-Benefit analysis, as the gains of the project are non- monetary and therefore the measurement will be given as the number of dollars that yield a certain increase in crop yields, a certain decrease in malnutrition, or any other measures of non-monetary impacts of the intervention.

Measuring Benefits

Cost-effectiveness is reported in several different ways. Often the phrase 'cost-effectiveness' is used as a proxy for cost-benefit analysis in the literature. Waddington and White (2014), for example, use a cost-benefit ratio to determine cost-effectiveness, examining the time after the intervention for the costs to be regained in benefits. Other studies, such as Tsiboe (2015), examine the benefit to cost ratio as the monetary benefits gained over the 25-year life cycle of the project; '\$13 to \$22 for every dollar spent on human capital development.'

True cost-effectiveness analysis, however, is most commonly used in health interventions. The WHO (2003) created guidelines for a generalised cost-effectiveness analysis that allows health interventions to be compared against one another, based on their ability to diminish the global burden of disease at the least cost. The benefits of health interventions are measured in Disability Adjusted Life Years (DALYs) averted, which allows for the Years of Life Lost (YLL) to a specific disease to be combined with the Years Lived with Disability (YLD), weighted for the severity of the disability caused. Wasting and Stunting, for example, are calculated as 0.053 and 0.002 of YLL respectively (WHO, 2004). DALY's caused by inadequate diet would therefore be the YLL plus the YLD caused by wasting and stunting, as well as other disabilities caused by malnutrition including iodine deficiency, vitamin A deficiency and iron deficiency anaemia, each multiplied by their respective weighting.

To calculate the cost-effectiveness of a health intervention, the total costs are divided by the number of DALY's averted. 'The World Health Organisation (WHO) Commission for Macroeconomics and Health (WHO 2001) has provided the following guideline for thresholds of cost-effectiveness:

- 'An intervention is considered very cost-effective, if the monetary amount spent on the intervention per disability-adjusted life year (DALY) saved is less than the per capita gross domestic product (GDP) for the nation in which the intervention is applied.
- An intervention is considered (moderately) cost-effective, if the monetary amount spent on the intervention per DALY saved is less than three times the per capita GDP.
- An intervention is not cost-effective if, per DALY saved, its cost is greater than three times the per capita GDP.'

A health intervention in Ghana, for example, would be considered very cost-effective if one DALY is saved for US\$1860 (World Bank, 2013) and cost-effective if one DALY could be saved for US\$5570. This allows different outcomes of a myriad of health projects to be compared to one another.

The WHO guidelines, although very useful, do not directly enable decision makers to choose the most cost-effective option, as several interventions may be considered within the cost-effective threshold. It is therefore desirable to directly compare interventions with other similar options. A cost-effectiveness ratio compares the intervention to the 'base-case scenario (World Bank, n.d.) We will therefore conduct a cost-effectiveness analysis, seeking to enumerate our results in cost per DALY averted. This can then be compared to other interventions as seen in (Neumann, 2016) with an acknowledgement of variation in methods.

Outside of health, it is more difficult to compare the cost-effectiveness of different outcomes of interventions. 'Most social interventions pursue multiple objectives. It is possible that an intervention is the most cost-effective option for increasing one outcome, but not another' (McEwan, 2012). It is only really possible to compare projects when the outcomes are measured in the same units. Education projects, for example, can be compared by their impact on test scores within one country. For example, McEwan (2012) conducted an 'experimental impact evaluation of a programme that provided merit scholarships for adolescent girls who scored well on examinations. The average treatment effect was 0.12 standard deviations (a common metric for expressing test score gains). The incremental cost per pupil was \$1.69, implying an Incremental Cost-effectiveness Ratio (ICER) of \$1.41 per 0.1 standard deviations. The author calculated ICERs for other interventions, using other Kenyan experimental evaluations, including a teacher incentive programme, textbooks and flipchart provision, and school-based deworming. The effect of some interventions could not be statistically distinguished from zero in the impact evaluation, implying an infinite ICER, and removing them from consideration. The ICERs suggest that scholarships and teacher incentives are similarly cost-effective (\$1.41 and \$1.36 per 0.1 standard deviations, respectively), and much more so than textbook provision (\$5.61 per 0.1 standard deviations).' Here, however, a cost-effectiveness ratio cannot be considered a complete measure of an interventions value, as projects may have other effects outside if the measured outcome. School based deworming, for example, may have health benefits even if it does not impact test scores.

Some authors further attempt to conduct a full Cost Benefit Analysis by estimating and aggregating the monetary benefits of two or more measures of outcomes, often using additional analysis of secondary data and assumptions, for example, converting the value of DALY's averted into economic gains. It is possible to extrapolate data from achievement of one outcome and convert it into another. Poverty Action Lab (2012), for example, '*compares the cost-effectiveness of multiple interventions in reducing the incidence of child diarrhoea, a final outcome. Two experiments only report effects on an intermediate outcome: change in water chlorination rates. The CEA used descriptive data to inform its assumptions about the relationship between chlorination rates and eventual incidence of diarrhoea*' (in McEwan, 2012). Drummond et al (2005), Gold (1996) and Musgrove and Fox-Rushby (2006) all provide examples of the use of regression modelling to convert short term impact evaluations into measurements of an interventions long term impact on health. Such information, however, being based on assumptions is less reliable, and it is therefore far more common to simply compare interventions using similar measurements of impact (McEwan, 2012).

Some agricultural benefits are measured as impacts on nutrition (Wu, 2010) whilst some are measured as an increase in crop yield or net income (Norton et al, 2013). These benefits are often disaggregated by gender or level of poverty. Impacts such as adoption of new techniques, or accumulation of new knowledge are often measured, but rarely alongside an analysis of costs. Few cost-effectiveness studies of agricultural interventions incorporate benefits such as empowerment or community cohesiveness, although these have been reported qualitatively (Waddington and White, 2014, Puett et al, 2014).

Given the aim of the cost-effectiveness component is to compare the intervention with other alternatives, we will seek to define the outcomes in terms of DALYs, calculated from diet diversity.

Measuring Costs

Equally as important as the measurements of benefits, are the costs of the intervention considered. Including the costs to beneficiaries, for example, can have massive impacts on any cost-effectiveness analysis (CEA). If an increase in crop yield is of equal or less value than the increased labour required achieving such a yield, then the intervention is not cost-effective. In order for a cost-effectiveness analysis to be rigorous, it must include all aspects of cost.

Cost-effectiveness results may depend on the choice of comparative intervention, the costs included, and assumptions made in estimating total health benefits. For example, home-based care is often more expensive than care at an outreach clinic or at the health facility when the costs included are estimated from a health services perspective, and any direct or indirect costs incurred by families are ignored. Similarly, the cost-effectiveness of life-saving interventions may substantially under-estimate the resources required to reduce maternal and neonatal mortality if the cost of demand- and supply-side strategies are not considered. As one study demonstrated, there was an eightfold increase in the cost per facility-birth when the full cost of the health promotion activities were included in the cost-effectiveness calculations (Mangham-Jefferies, 2014).

Costing techniques within the literature generally fall into two categories; the societal or the provider perspective. The societal perspective accounts for costs regardless of whom the costs fall upon, whether inside or outside the official budget of the intervention. A programme or provider perspective includes only the costs borne by the intervention provider. Within the literature, there was also variation within these two categories of costing technique. This means, for example, that the labour cost of volunteer health workers would be included in costs from a societal perspective, but not from a provider perspective. In interventions that rely heavily on volunteer support, a provider perspective is unlikely to be appropriate, as any measure of cost-effectiveness would be misleading and discounting the considerable labour of unpaid workers. Although this perspective may still be useful for healthcare providers, a societal perspective would provide a broader consideration of the costs of the intervention.

The WHO (2003) recommends the ingredients approach to costing; in this method (1) all program resources (or "ingredients") are identified, (2) each ingredient is assigned a value (including its opportunity cost), (3) the values are then adjusted for inflation, time-value (since costs incurred in the future are worth less to society than those incurred in the present), and currency, and (4) the values are aggregated (McEwan, 2012 in Evans and Popova, 2015). The ingredients method can be approached from either the societal or the provider perspective, certain ingredients are simply not included if only calculating from the provider perspective.

The WHO recommends counting the costs for an intervention from the moment of its inception. This includes research and development costs and start-up costs, defined as; 'the period between deciding to implement an intervention and starting to deliver it to the first beneficiary.' Capital investments, such as building and vehicles, must be added together with the start-up costs and annualised over the period of the intervention. Other start-up costs may include staff training and content development. The extent to which these resources are utilised must also be considered, for example a van or personnel may operate outside of the intervention, as well as inside, and therefore incorporating an entire salary, or the cost of the whole van would be an overestimation of cost.

Once start-up costs are considered, the recurrent costs of establishing, evaluating and running an intervention must be considered. These include costs to the implementer of the intervention, and costs to the beneficiaries. Costs to beneficiaries may include the cost of transport to reach an intervention, the costs of time and labour spent on an intervention, or the cost of new inputs or practices necessary to take part fully in the intervention. Many evaluations of cost-effectiveness use solely the accounting data from the managing organisation, and exclude the considerable costs to beneficiaries from labour intensive agriculture techniques (Dorman, 2007). Finally, costs that may need to be included are the potential costs of scaling up an intervention, rolling it out to more remote areas, or costs of adding or removing individual services from bundled interventions. Care should be taken in any analysis to consider the implications of any benefits assessed. For example, Norton et al (2013) evidence that the success of a widely implemented Cocoa Livelihoods project would lead to an increased yield, but possibly not a net increase in income as the price of cocoa would drop due to the demand remaining stable as the supply of cocoa increases.

Evans and Popova (2015) also assert that researchers must be aware of 'pilot bias' when conducting a cost-effectiveness analysis. The cost per beneficiary of a pilot are usually considerably higher than a scaled-up programme, and impacts can vary considerably when the programme is implemented on a wider scale. Possible variations in cost according to the scale of the project must be considered.

Another potential challenge is 'recall bias.' Costs estimated using qualitative methods following the event are often estimated as lower than in actuality.

In the baseline below, we have sought to document all programme and societal costs. While documenting the existing costs, we anticipate that new costs will arise, and the CE analysis, once the outcomes are defined from the quantitative component, will need to include updated costs. The costs included so far were derived from available project budgets, and expenditure reports and from contact with key stakeholders and members of partner organisations. As is seen in Figure 5, Vodafone Farmers Club comprises a complex set of partnerships, and we therefore do not yet have a full understanding of investments and costs. Further cost data will be collected from key informants throughout the evaluation period.

B.2 Factors to be considered in analysis

Discount Rates

The majority of interventions will not see benefits for some time. The costs incurred in each year cannot simply be summed without any adjustment. 'Individuals and society prefer to pay costs in the future rather than now, so from today's perspective, a cost of \$100 payable after 10 years is not seen to be as high as a cost of \$100 payable today. The present value of \$100 payable in 10 years is, therefore, less than \$100. Discounting is the process of converting future costs to their present value, to reflect the fact that, in general, individuals and society have a positive rate of time preference for consumption now over consumption in the future. For comparability across studies, it seems important that analysis is performed using a common discount rate. For that purpose, WHO-CHOICE uses a discount rate of 3% for the base case, as suggested in a number of guidelines. A discount rate of 6% is also explored using sensitivity analysis. If country analysts wish to use country-specific rate of return of long-term government bonds as the social discount rate for costs, they may do this using sensitivity analysis' (WHO, 2003). The majority of studies on

agricultural intervention cost-effectiveness use a 3% discount rate (Wu, 2010, Meenakshi, 2007) but adjust for sensitivity analysis.

Some studies used the WHO recommended rate of 3% (Meenakshi, 2007) but even more did not use a discount rate at all (Harvest plus, 2010, Ricker- Gilbert et al, 2008, Harris et al, 2013). The argument for a constant or zero rate of discounting is that interventions are not aimed at making a profit, but improving standards of living and the concept of longitudinal equity states that society should make allocation decisions in such a way that present and future cohorts are treated equally, regardless of when they come into existence (Datz and Welch, 1993). Therefore, curing an illness in the future has the same value as curing one now.

However, for those projects measuring economic outcomes, a comprehensive discount rate was necessary. Tsiboe et al, estimated the discount rate according to the average annual deposit rate of each country. Theory suggests the discount rate should be the opportunity cost of the project relative to other potential investments.

Adjusting for Inflation

Again, if the benefits of an intervention are only seen after several years, the value of a currency may be less at the time of measuring benefits than at the time of the initial costs. This is particularly true of developing countries, where inflation rates are often high. The WHO (2003) recommend using the GDP Price deflator to measure and adjust costs and benefits to a common year. Similarly, costs accrued in different currencies must be converted to one currency, in one year.

Complex interventions

Most of the interventions studied in the literature will have multiple outcomes. For example, Wellard et al (2013) studied a farmer to farmer extension project promoting staples, and measured changes in maize, millet, and cassava yields, but they did not measure improvements in livelihoods and nutritional status that would be expected to result from improved agricultural outcomes, nor improved empowerment of farmers arising from increased awareness and knowledge as a result of the intervention. This study, as an example, used cost benefit analysis, which would not be compatible with benefits that could not be enumerated in financial terms, such as nutritional and livelihoods outcomes. While the mNutrition projects are expected to yield multiple outcomes, as described in the theory of change (see Figure 5), this study proposes that nutrition be considered as the primary outcome, in which case the benefits will be enumerated in terms of nutritional indicators.

Some of the projects studied in the literature also use multiple intervention methods. For example, Harvestplus (2010) studied a multimedia campaign promoting biofortification; the campaign included training, community drama, radio broadcasts and other marketing activities. Norton (2013) studied a combined package comprising Farmer Field School, Farmer Business School, and input credit package. No attempt has been made to disaggregate the effects of the individual components of these packages – all activities included in the project design have been treated as a discrete intervention. It might seem a bit frustrating to adopt this approach for the Vodafone Farmers Club because the individual components of the bundle are quite distinct – free voice calls can be used for different purposes than weather forecasts. However, there are a couple of reasons why Vodafone Farmers Club is best considered as a holistic product:

- There is no sound methodology for disaggregating the effect of linked, composite activities;

- There is synergy (or reinforcing effect) between components designed to work together whereby the impact of the bundle exceeds the sum of the impacts that each component might yield in isolation.

Sensitivity Analysis

Sensitivity analysis is necessary as, evidently, there are many plausible combinations of the numbers used to conduct the analysis. As stated earlier, the discount rate is a subject of debate, and therefore must be varied in order to understand the full scope of possibility of the CEA. Definitions of cost may also vary widely. There may be several plausible ways to value the cost of beneficiary labour, for example, or arguments for different costs to be included or excluded from analysis. Therefore, sensitivity analysis must be conducted using different measurements of cost. Measurements of both costs and benefits will be subject to uncertainty, so sensitivity analysis can be conducted using the upper and lower confidence bounds of component metrics. Finally, different methods of calculating benefits must be considered in sensitivity analysis. This may include taking into account new benefits, such as knowledge gained. Sensitivity analysis will allow for an optimistic and pessimistic measure of cost-effectiveness for any intervention.

B.3 Assessing Costs

Budgets

Several projects (Waddington and White, 2014, Mauceri et al, 2007, Harris et al, 2013, Tsiboe et al, 2015) used the project budget to account for costs and divided per household. Budgets and expense reports are able to account for several more concrete measures of costs, such as agricultural inputs bought, equipment and staff salaries.

These published budgets, however, rarely account for the full cost of a project. Projects often use resources outside of their budget, such as public services and beneficiary labour, which must be accounted for in order to understand the full cost. Furthermore, at the times when budgets are created, there are usually considerable expenses sunk into the project; into the design, budgeting and research stages. Nonetheless, budgetary information can inform one 'ingredient' of the total costs of the project.

Research and Development Costs

Of all the studies, only one (Meenaksi et al, 2007) explicitly included the costs of a project's research and development. Harvestplus budgets for biofortification crops research and development were used, and a proportion of this cost was added to the total costs of any singular project. The problem with research costs is that every project utilises past research and knowledge, as does every individual involved in the project. Research is often not carried out with any specific project in mind, for example systematic reviews may inform a project, and had considerable costs, but these costs cannot be directly linked to the project. To attempt to account for all of these costs would be impossible, but the research behind an agricultural intervention is by no means free and therefore some decision as to what aspects of research costs may be considered must be made. Usually, this extends only so far as research carried out with the explicit aim of informing the intervention in question.

Estimations using Qualitative Data

The problem of research costs brings up another key issue; that of shared costs between institutions and interventions. In the case where professionals may be working on multiple projects,

for example, it may not be clear how much of a professional's time is taken up by a particular project. In this case, qualitative interviews are required to clarify the cost of labour used by a project. Puett et al 2014, Schreinemachers et al 2015, and Self et al 2015 all used key informant interviews to estimate the percentage of working time staff spent on a particular project in order to ascertain staff labour costs. This was also used to estimate the proportion of rent or vehicle costs used on a particular intervention by a particular organisation. Qualitative interviews may also be necessary to determine public services used during the project.

Beneficiary Costs

Costs to beneficiaries will rarely be found in project budgets and reports, but are integral to any measure of cost-effectiveness. Labour costs were quantified in a number of ways in the literature. Mauceri et al (2007), for example, chose to exclude labour costs as they were considered to be roughly equal to the gains from reduced fertiliser expenditure. The new adoptions were considered cost neutral to beneficiaries. Several studies counted only the time of workers to attend the trainings, for example hours at a farmer field school, but did not account for the time taken to apply the new practice and gain the improved yields (Panurak, 2010, Self et al, 2015). Other studies chose to estimate labour time spent on a new practice. In addition, studies chose to quantify the time of workers differently. Some chose to cost all workers at an average daily wage for the area, but Harris et al (2013) chose to cost women at only half the average daily wage as, in that region of Bangladesh, women were not likely to ever hold a waged job. Nonetheless, women's labour, either paid or unpaid (for example, childcare) was necessary for the project. In sensitivity analysis, Harris et al used a full daily wage for women's labour, and this change in measurements moved the intervention from the category of cost-effective, according to the WHO criteria, to not cost-effective. This evidences the importance of well-considered cost inclusion and exclusion criteria in cost-effectiveness analysis.

Costs used in the literature

The cost factors used in key references are presented in Annex D. These studies have been selected on the basis that they explore the cost-effectiveness of interventions linked to agricultural extension, foods and the burden of disease, food security, or nutrition. The range of costs included in different studies illustrate how there is no standard approach or accepted methodology. Costs considered have been divided into the categories described above – project costs, research and development costs, and beneficiary costs. One of the striking features of the table in Annex B is that no study has been identified that takes a comprehensive view of costs, considering all three categories of costs.

In this study, we go on to consider a further category of costs, covering those costs incurred in achieving the outcomes, but which are met by parties external to the project. The literature includes beneficiary costs, which include any expenditures (in cash or time) that beneficiaries need to make in order to realise improved outcomes, but often the actions that farmers need to adopt incur additional costs on third parties. This category of costs is recognised in the literature on health and nutrition, where encouraging women to give birth in health facilities, for example, has cost implications for government funded hospitals. These costs are included in the cost-effectiveness framework presented in Section 3.

B.4 Cost-effectiveness Metrics used in the Literature

Economic and non-monetary Methods

Where we consider the features of the Vodafone Farmers Club service and comparable approaches that might yield a similar outcome and impact, the cost-effectiveness of agricultural extension in all its forms seems an under studied arena. Many studies consider the benefits to farmer income, but fail to include changes in nutrition. And where some evaluative exercise has been undertaken on a particular approach, the published data rarely includes clear commentary on cost data. In this light, there are relatively few studies that can serve as benchmarks to guide this study.

In this section we outline a few of the analyses to build a basis for our own analysis. The first three metrics described are economic methods, in which the benefits are expressed in monetary terms. The remaining metrics represent benefits in non-monetary terms, such as the number of farmers reached, or disability adjusted life years (DALYs), as is common health literature.

Net Benefit per Farmer

This measure (used by Ricker- Gilbert et al, 2008) is an estimated figure of farmers' increased income based on data reporting the number of farmers adopting new practices. The study uses secondary data to estimate the benefits of adopting new practices (for example the average increased crop yield from sweeping pests from crops with hand nets). The total costs of the project are divided between the total number of farmers involved in the intervention (including those who did not adopt new practices) to create a cost per farmer reached. The total estimated benefits of the farmers who claimed adopting a new practice is also averaged over the farmers reached. The per farmer cost of each intervention approach is then subtracted from the per farmer benefit to gain an average net benefit per farmer.

This method does not account for changes in nutrition, and is also based on assumptions that all practices are adopted correctly and efficiently in order to achieve the required benefit.

Net benefit per Dollar spent on training/ Economic Surplus per Dollar invested

In this measure, (also used by Ricker- Gilbert et al, 2008 and Harris et al, 2013), the total estimated benefits from the adoption of new practices are divided by the costs of the project. Notably, Harris et al (2013) also uses projected rather than real adoption rates from data recording number of farmers reached. This figure can also be expressed as a cost- benefit ratio.

Benefit Cost Ratio

These methods again estimate the total economic gains of the project and divide by the total costs. Tsiboe et al (2016) projected the discounted benefits of an extension programme over the course of 25 years and divided this by the costs, whereas Norton (2013) examined the discounted benefits over 50 years. Understandably, this produced very different ratios.

Both the costs and the benefits are often divided among the number of households to gain a benefit cost ratio per household. Again, benefit cost ratios do not express the non-monetary gains of an agricultural intervention. If, for example, a significant proportion of an increased crop yield were consumed in the home rather than sold for increased income, then the benefit cost ratio may be low, despite the project having considerable impact. Equally, estimating project benefits over a long period of time relies on assumptions regarding the market and other variables.

Cost per farmer adopting a new practice

Mauceri (2007) et al, measures the cost per change in behaviour of farmers. This is unusual, as most interventions see behavioural change as an intermediate goal, with increased economic or

health outcomes as the ultimate aim. Mauceri divides the total cost of the project by the total number of farmers reporting the adoption of a new practice.

This metric could be used, as has been done in Harris et al (2013) and Ricker- Gilbert et al (2008) to project ultimate gains from adoption. It could also, however, be used as a measure of intermediate success, reflecting the effectiveness of the project to change behaviour, and a later study could be completed to examine the impact of such behaviour change.

Cost per person with improved food security/ household dietary diversity

Puett et al (2014) measured the cost for each household that improved both food security and household dietary diversity to an acceptable level (moderate). The total costs of the project were divided by the marginal increase in households categorised as moderately food secure or with moderately diverse diets. This created two measures of cost-effectiveness, one for the cost of a household increasing food security, and the other for households increasing dietary diversity. As each figure accounted for the whole of the costs, but only one measure of impact, the cost-effectiveness ratio does not fully account for the benefits of the intervention, which is perhaps why the cost per household appears so high.

DALYs Framework

The most commonly used non- monetary measure of cost-effectiveness is also that recommended by the WHO. Within agriculture, the DALY's framework is largely used for three types of intervention; to assess cost-effectiveness of DALYs reduced by strategies to improve nutrition, DALYs averted by reduced pesticide use, or DALYs averted by aflatoxin reduction strategies in crops to decrease rates of cancer (Wu, 2010).

Harvestplus (2010) measured the impact of consuming orange flesh sweet potato on vitamin A intake. The baseline amount of DALY's caused by vitamin A deficiency in the project area was estimated. This is the years of life lost by vitamin A deficiency added to the years lived with disability caused by vitamin A deficiency multiplied by the disability weighting of Vitamin A deficiency (0.277 for corneal scarring (WHO, 2004)). The marginal difference in vitamin A intake after the project was then used to recalculate the number of DALYs caused by vitamin A deficiency. The difference between the two figures represents the number of DALYs averted by the intervention. The total costs of the project are divided by the number of DALY's averted to produce a cost per DALY averted.

This figure can be divided by the GDP of the country of the intervention to produce a cost-effectiveness ratio. If this ratio is below 3 the intervention is considered cost-effective, and if below 1, very cost-effective. This measure was also used by Meenakshi (2007), Schreinemachers et al (2015) and Self et al (2015).

This measure does not include livelihood outcomes, but is beneficial as, since there is an agreed metric for calculating DALYs, multiple nutrition outcomes can be evaluated at the same time. For example, the cost per DALY can account for DALYs averted from improved vitamin A intake, iron intake, stunting and wasting and iodine deficiency.

Combined Economic and Non-Monetary Methods

Self et al (2014) used the only measure of cost-effectiveness that accounts for both livelihood and nutritional impacts. She uses a DALYs framework, but subtracts the total economic benefits to households from the total costs of the project. Self et al (2015) then uses that figure to divide by

DALYs averted by nutritional impacts. Both the economic benefits to the families are accounted for, as well as the health impacts. This is arguably the most complete measure of cost-effectiveness. However, as WHO guidelines are explicitly designed to account only for health impacts, it does not make the project comparable to other health interventions.

Annex C Comparable Agriculture and Nutrition Interventions

As discussed in Annex B most of the interventions studied in the literature will have multiple outcomes, even if the study only measures a single outcome of interest. It is therefore difficult to directly compare the mNutrition Vodafone Farmers Club service with any other form of agricultural or nutritional interventions. However, some elements of the Vodafone Farmers Club service correspond with some elements of other interventions. The following annex outlines some of the commonality between the interventions and comments on the possibility of comparing the final cost-effectiveness analysis with other interventions.

Most components of the Vodafone Farmers Club bundle correspond to approaches found in other agricultural extension processes. Table 6 explores this view.

Table 6 Comparing Vodafone Farmers Club bundle to agricultural extension approaches

VFC bundle	Potential Agricultural outcome
Discounted SMS and Calls;	
Free calls and SMS to other Farmers' Club users;	Peer to peer discussion and validation of decisions (i.e. when to plant)
Market price information: One SMS message in English with local market price information per week for a selected crop and selected market	Information leading to improved negotiation for farmgate sales
Weather information: Three SMS messages in English with local weather information per week	Data Information leading to improved farm management
Agri and nutrition tips: One weekly recorded voice message in the selected local language with seasonal agricultural or nutrition tips (3 agri tips and 1 nutrition tip per month) for the selected crop(s).	Advisory bite sized Information leading to improved farm management and nutrition
Call centre: Free access to a call centre with advice available from an agricultural expert.	Advisory discussion with experts
Vodafone Farmers Club bundle	Potential Agricultural output
Discounted SMS and Voice SMS;	
Free calls to other Farmers' Club users;	Peer to peer discussion and validation of decisions (i.e. when to plant)
Weekly price information: wholesale and retail prices per market, prices available weekly on 35 markets and daily on 10 most important regional capital markets; 56 commodities available.	Information leading to improved negotiation for farmgate sales
Daily weather information: daily SMS weather predictions including rainfall.	Data Information leading to improved farm management

Weekly farm tips/extension information: disease awareness and prevention, best agricultural practices (livestock and crop).	Advisory bite sized Information leading to improved farm management
Healthy living advice: mainly nutrition sensitive information tailored around farmers' food crop cultivation.	Advisory bite sized Information leading to improved nutrition
Access to Farmer Helpline and Vodafone Customer care.	Advisory discussion with experts

We have drawn out the difference between data information (factual such as market prices and weather), and advisory information. Within advisory information we note a difference between 'bite sized' information and discussion. Within discussion we note a difference between that with agricultural experts, and with peer farmers and neighbours.

As we shall see below the history of agricultural extension has moved from delivery of 'advice', through demonstration of that advice, to a more discursive enablement of farmers. Farmer to farmer extension seeks to gather farmers together and stimulate discussion. In theory, free farmer voice calls within the Vodafone Farmers Club could lead to such an effect; it could simply facilitate "chat", or it may be that farmers use free calls to seek validation for agriculture related decision they are about to make (e.g. "I am thinking of planting this week, what do you think?").

The Vodafone Farmers Club bundle has elements of a number of agricultural extension methods. No one method can capture and replicate all the features of another. We therefore propose a method of cost-effectiveness analysis within limited boundaries of change.

The broader literature review describes cost-effectiveness analyses of other agricultural extension programmes. This gives a view on what constitutes value for money in agricultural intervention, and insight into how value for money is usually measured. Annex D summarises its findings. Agricultural extension is premised on the assumption that technologies and agricultural methods exist to improve agricultural productivity in developing countries, but are not being used. Agricultural extension therefore aims to enable farmers to take up innovations, improve production, and protect the environment through the diffusion of information. As alluded to above, comparing the cost-effectiveness of different interventions is difficult for several reasons. Firstly, agricultural extension has a long history, and is used in the majority of developing countries, often run as a public service. This means that several agricultural extension approaches may be used at the same time, making it difficult to assign benefits to one specific approach. Secondly, it is rare in the literature to find a discussion of costs, and even rarer for such costs to include a breakdown of what is included and excluded from analysis. Finally, agricultural interventions, like any development project, are vulnerable to differences in effectiveness based on the temporal and spatial variations in which projects were implemented. These include management, external political climates, physical climates and cultural differences among many others (Birner et al, 2009). This section aims to produce some comment on the different costs and effects of several agricultural extension methods, but cannot provide an accurate, direct comparison.

There is limited research underway on the development of new methodologies and metrics to measure effects along the different impact pathways, or to evaluate cost-effectiveness of interventions (Waage et al, 2015).

C.1 Comparable Agricultural Extension Alternatives

Training and Visiting

Training and Visiting (T&V) was first implanted in the Satara, Solapur and Jalgaon Districts in April 1981 in Maharashtra, India. The idea was to eliminate perceived inefficiencies in existing public extension services by regularly upgrading the technical skills of field workers and providing more regular contact with farmers (Howell, 1988). The programme has since been implemented in 70 countries (Umali and Schwartz, 1994 in Anderson and Feder, 2004). For T&V, cost-effectiveness is widely considered to be poor, although there is little recent data regarding its actual costs. Aside from their high costs, there were issues of willingness by public institutions to pay for the services. This may have been due to the inconsistencies between the ideal model of extension agent, and the reality.

Farmer Field Schools

Farmer Field Schools (FFS) were introduced in Indonesia in the 1980's and have since been used to train 12 million farmers in 90 countries across Asia, Africa and Latin America (Waddington and White, 2014). 'FFS are adult education interventions, which use intensive discovery-based learning to promote skills' (Waddington and White, 2014). FFS are often heralded as more effective than more top-down approaches to agricultural extension, as they are more participatory, and adaptable to local contexts and needs (Davis et al, 2012).

Waddington and White's (2014) systematic review of FFS outcomes found that although many FFS had positive impacts on crop yields and net income, these often decreased as projects were scaled up from the pilot stage. There is insufficient evidence regarding FFS impact on health and empowerment. Furthermore, FFS have generally high costs per capita (Quizon et al, 2001). Waddington and White estimate that the cost per farmer trained is \$20-40 for most FFS schools, although the average cost is \$56 due to the very high per capita costs of some interventions (Van Der Berg and Jiggings, 2007 in Waddington and White, 2014). It is however difficult to generalise regarding the cost-effectiveness of FFS, as it is dependent on several factors. Davis et al (2012), for example, found that FFS increased crop productivity by 80% in Kenya and by 23% in Tanzania, whilst yielding no positive results in Uganda.

Farmer to Farmer Extension

As a community-based approach, Farmer to Farmer Extension (F2FE) systems encourage community participation and represent a farmer-centred extension approach. F2FE can be defined as the provision of extension services by farmers (called lead farmer, farmer-trainer, etc.) to other farmers (GFRAS, 2015). F2FE systems do not aim to substitute other extension systems (e.g. public extension services), but rather to complement extension provision to women and men farmers, particularly in rural and remote areas.

F2FE programs have grown tremendously in Africa in recent years and are now quite common. For example, in a survey of 39 of the largest organisations providing extension services in Malawi by Masangano and Mthinda (2012) found that 78% used the approach. Tsafack et al. (2014) found that 47 of 151 organisations (31%) providing extension services across seven provinces of Cameroon used the F2FE approach.

'We were unable to find any formal impact evaluations that used a randomised controlled trial (RCT) to assess the impact of F2FE' (Davis et al, 2016). Little information regarding the costs of F2FE programmes exists. Kiptot, Franzel, and Kirui (2012) reported that the main costs of the East

Africa Dairy Development (EADD) project's F2FE program were the initial training, follow-up training, and incentives to motivate farmer-trainers, such as contests, T-shirts, and bags. In the EADD farmer-trainer program in Kenya, these costs amount to about (US\$)160 per farmer-trainer per year (Kiptot, Franzel, and Kirui 2012). Wellard et al. (2013) calculated discounted benefit-cost ratios for four F2FE programs run by the NGO Self Help Africa in Ghana, Uganda, and Malawi. They compared the costs and returns associated with a farmer-trainer program with a nearby area not benefitting from farmer-trainers. Costs and benefits were extrapolated over the project period and discounted. Four years was taken as the minimum project period and a discount rate of 15% was used. The resultant estimated costs per CB extension worker are around £510- £3,160 whilst benefits range from around £3,600 in Ghana to £13,760 in Malawi's MZADD programme for the four-year period.

Mass Media (Older ICTs)

'Mass media are those channels of communication which can expose large numbers of people to the same information at the same time. They include media which convey information by sound (radio, audio cassettes); moving pictures (television, film, video); and print (posters, newspapers, leaflets). The attraction of mass media to extension services is the high speed and low cost with which information can be communicated to people over a wide area. Although the cost of producing and transmitting a radio programme may seem high, when that cost is divided between the millions of people who may hear the programme, it is in fact a very cheap way of providing information. The cost of an hour's radio broadcast per farmer who listens can be less than one-hundredth of the cost of an hour's contact with an extension agent. However, mass media cannot do all the jobs of an extension agent. They cannot offer personal advice and support, teach practical skills, or answer questions immediately' (FAO, 2017).

Harris et al's (2013) research in Bangladesh found that technology transfer programs may increase their impact by reallocating funding from intensive but costly interpersonal communication methods (i.e., farmer field schools) to less intensive methods (i.e., mass media and field days) that reach broader audiences.

The impact of radio, the most common mass media extension approach, on crop yields and income is not clear. This is partly because mass media is usually combined with other forms of extension, including agent visits, field days or demonstrations, as well as TV or newspapers (Aker, 2010). Furthermore, radio programmes vary in the quality of the information they supply. Chapman (2003) found that some radio programmes do little research regarding farmers preferences for message delivery (for example through drama or lecture style) or even regarding which agricultural methods are most likely to be adopted. Those radio shows that do carry out such research are likely to have greater costs, but a far greater impact.

Another example is Farm Radio International's Participatory radio campaigns, funded by the Bill and Melinda Gates foundation. The project involved farmers in the design and development of radio programmes. They found that Farmers engaged in the design and development of farm radio programming were almost 50 per cent more likely to take up agricultural practices deemed to improve their food security than passive listeners. Those in what African Farm Radio Research Initiative (AFRRI) deemed "active listening communities" (ALCs) were 10 times more likely to adopt the practice than those farmers who had no access to the farm radio programs (AFRRI, 2011). Adopting practices does not necessarily lead to higher yields or nutrition, but is considered the first step towards such progress. Although participatory radio programmes have a higher cost than non-participatory programmes, the AFRRI claim that the initiatives were introduced at a 'very low cost per farmer' (2011; 84) – 'The cost of a Participatory radio campaign is pennies per farmer reached, and less than a dollar per adopter'. However, there is little evidence of their impact, as separated

from other interventions, and therefore their cost-effectiveness remains uncertain. Furthermore, many believe that radio must only be used in tandem with other approaches.

New ICTs

It is increasingly recognised that ICT is necessary for accessing required information and knowledge (Anandajayasekaram et al. 2008; Mcnamara 2009; Aker 2010). ICT kiosks, ICT-equipped intermediary organisations and mobile phones are expected to play an important role in strengthening the more complex and time-urgent pathways of information and knowledge-sharing on which agricultural innovations depend. Indeed, this is a premise of the Vodafone Farmers Club.

Like older forms of mass media, however, it is difficult to assess the cost-effectiveness of newer ICTs, as they are often combined with other forms of agricultural extension. One World Bank Study (Qiang et al, 2012) however, does analyse the gains of receiving ICT, specifically mobile app based information in Kenya, as seen below (Figure 6).

Figure 6 Benefits of Various Mobile Applications (Qiang et al, 2012)

Table 3.2. Benefits of Various Mobile Applications

Application	Country	Increased income through better access to information and services	Higher-yield production	Improved efficiency in supply chain	Better access to finance
Virtual City AgriManagr	Kenya	<ul style="list-style-type: none"> Typically, small farmers see their incomes increase 9% due to better measuring and recording of produce weights 		<ul style="list-style-type: none"> Transaction time reduced from 3 minutes to 22 seconds Cost of delivery reduced by 75% Fraud minimized through use of electronic data entry 	
KACE	Kenya	<ul style="list-style-type: none"> 75% of farmers and 60% of commodity traders report higher incomes 		<ul style="list-style-type: none"> Market integration (linkage efficiency) improved for two commodities—maize and beans 	
Kilimo Salama	Kenya	<ul style="list-style-type: none"> \$150 average increase in income per small farmer 	<ul style="list-style-type: none"> 50% increase in production due to insurance on higher-yield inputs 	<ul style="list-style-type: none"> More efficient value chain leads to lower retail costs 	<ul style="list-style-type: none"> Farmers in first year insured 10-20% of their inputs and increased insurance to 50% of inputs the next year
DrumNet	Kenya	<ul style="list-style-type: none"> Farmer incomes rose by an average of 32% 		<ul style="list-style-type: none"> Improved access to agricultural inputs Input suppliers achieve economies of scale 	<ul style="list-style-type: none"> Bank creditworthiness increased due to secure produce supply contracts Reduced transaction costs for financial institutions

Notable recent studies include that of Subervie (2011) evaluating the impact of SMS-based alerts for farmers via Esoko where econometric modelling of spatial arbitrage conditions found a significant effect on prices with a 10 percent increase amongst the treatment group of 500 farmers to whom mobile phones were distributed in the northern region of Ghana.

The cost of mobile based agriculture is estimated to be around the same as radio (Aker, 2010). The question, therefore, is whether farmers are more likely to adapt practices based on radio messaging or mobile phone technologies, or require some form of face to face interaction.

Complementary Methods

There are arguments that combinations of agricultural extension approaches may increase their cost-effectiveness. For example, a combination of ICTs with a limited number of extension agent visits has lower costs than repeated agent visits, but mobilises farmers to act on information more than purely ICT driven extension. The FAO (2017) argues that although many nutrition communication programmes rely heavily on creative strategies using mass media advertising, media strategies alone do not always lead to sustained behavioural changes.

C.2 Agricultural Technologies

Biofortification

‘Bio-fortification is the use of traditional crop breeding practices or modern biotechnology to produce micronutrient-dense staple crops to reduce micronutrient deficiencies (Micronutrient Initiative 2009). Given that Vodafone Farmers Club is about increasing diet diversity and nutritional gains, how does the programme compare with a biofortification programme?’

Stewart et al’s systematic review (2016) found a large positive effect of programmes introducing orange flesh sweet potatoes on farmers’ food security. ‘A meta-analysis of five studies in Africa; South Africa (Faber et al. 2002), Mozambique (Low et al. 2007; Hotz et al. 2012b), Kenya (Hagenimana et al. 2009) and Uganda (Hotz et al. 2012a) found an effect size of 0.86, translated into an increase of 39.8 percent in vitamin A levels among participating farmers. The meta-analysis of the three studies that assessed impacts on small holder farmer’s income (South Africa (Hofs et al. 2006), Tanzania (Bulte et al. 2014) and Uganda (Matsumoto 2013)) yielded an effect size of 0.26. This represents a 12.4 percent change in the levels of income among smallholders receiving the input innovation. Unfortunately, consideration of costs was not present for all studies, yet in ‘2004 OFSP was the cheapest source of vitamin A on the market, costing 1 cent for 700 RAE¹⁰’ (Low et al, 2007 in Stewart et al, 2016).

In Kenya, Self et al (2014, 2015) evaluated the Mama-SASHA project, which aims to improve the health and nutrition of pregnant/lactating women and children <2 years through an integrated orange-fleshed sweet potato (OFSP) and health service strategy in Western Kenya. Effectiveness data from a quasi-experimental study were used to estimate DALYs associated with changes in vitamin A deficiency, stunting, wasting, anaemia, diarrhoea, and mortality for children <2 years and their mothers. The authors used ingredients based micro-costing to estimate economic costs of agriculture, health and community interventions, including opportunity costs of labour for health workers, community volunteers and participants. Net economic cost over three years was US \$445,000. DALYs averted per year were mostly attributable to improvements in stunting and anaemia. The Incremental Cost-effectiveness Ratio (ICER) was US \$1,919 per DALY averted, which is two times Kenya’s GDP per capita (\$994 per person) and meets cost-effectiveness criteria set by WHO.

Home Gardening

‘Generally, home gardening refers to the cultivation of a small portion of land which may be around the household or within walking distance from the family home. Home gardens can be described as a mixed cropping system that encompasses vegetables, fruits, plantation crops, spices, herbs, ornamental and medicinal plants as well as livestock that can serve as a supplementary source of food and income’ (Galhena et al, 2013). While some similarities exist across the board, each home garden is unique in structure, functionality, composition, and appearance as they depend on the natural ecology of the location, available family resources such as labour, and the skills, preferences, and enthusiasm of family members.

The cultural acceptance of home gardening is also an important constraint’ (in Galhena et al, 2013). The cost-effectiveness is therefore highly dependent on the intervention method. ‘A recent review of evidence for home gardening by the UK Department of International Development found 15 papers in English in peer-reviewed journals that had done an impact evaluation in low- or

¹⁰ Retinol Activity Equivalents

middle-income countries (DFID 2014, in Schreinemachers, 2016). Only seven reported a link between home gardening and micronutrient status, while 10 showed a link between home gardening and increased production and consumption of micronutrient-rich foods. The review mentioned that no cost-effectiveness study has been performed on home garden interventions' (in Schreinemachers, 2016).

Since the Dfid review, Schreinemachers et al (2016) quantified the impact and cost-effectiveness of training poor rural women in Bangladesh in home gardening and nutrition. Households that had received the intervention harvested an average quantity of 108.7 kg of vegetables and fruit from their home garden. The difference-in-difference estimator suggested a 31.0 kg increase ($p < 0.01$) as a result of the intervention. This additional amount translates into a daily per capita quantity of vegetables of 16.5 g. 'Costs from October 2011 to September 2014 were calculated from project financial reports, project work plans, and information obtained from key persons involved in the project. To estimate DALYs saved, the micronutrient intake gap before and after the intervention was first calculated. The intake gap before the intervention is the ratio of current micronutrient intake and recommended nutrient intake, both based on secondary data published in Nahar et al. (2013). Based on the estimated reduction in the nutrient intake gaps for iron (4.5 per cent), vitamin A (100 per cent) and zinc (8.0 per cent), we assumed a reduction in DALYs by the same percentages. This would mean a total of 122,610 DALYs saved if the intervention could reach all households affected by iron, vitamin A and zinc deficiencies (16.5 million households). Reaching these many households with a home garden intervention, assuming no economies of scale, would cost US\$375.1 million (US\$23.2 × 16.5 million) per year. This implies a cost of US\$3,059 per DALY saved' (Schreinemachers et al, 2016).

Animal Husbandry

Agricultural diversification may also incorporate the rearing of domestic livestock. Within extension services, livestock usually take second place to crop production. Livestock production information in extension services would provide a benefit to farmers. However, the additional training required of extension agents, or the development of extra content for mass media approaches would create extra costs.

Leroy and Frongillo (2007) reviewed the evidence on the nutritional impact of interventions promoting animal production (including aquaculture, dairy development and poultry). A total of 14 studies were identified and analysed across seven indicators: production; income and expenditure; caregiver income; caregiver time and workload; zoonosis; dietary intake and nutritional status (measured by any indicator, including anthropometric measurements, iron deficiency, serum retinol concentration and haemoglobin levels). The authors found a clear positive impact on production and income but not on other indicators. Only four of the studies reviewed reported nutritional outcomes, and the results were not always positive. The authors concluded that the evidence is insufficient to answer whether the promotion of animal production is an effective means to alleviate undernutrition' (in Masset, 2011).

Poultry Development

Similar to animal husbandry, Poultry development has been found to increase household income. Nielsen et al. (2003), found that in Bangladesh, income is 15% higher among households in a poultry promotion programme (in Masset, 2011). Again, there was little information regarding the costs of poultry development. A project in Ethiopia used mass media, veterinary services and extension agents, and so costs are likely to be high, but without cost information, or information regarding final nutritional or income outcomes, cost-effectiveness of poultry extension is not certain.

Aquaculture



One agricultural technology promoted by mAgri and other interventions, is domestic fish farming. For many people who are food insecure, fish represents a rich source of protein, micronutrients and essential fatty acids (Beveridge et al, 2013). Despite low rates of fish consumption in SSA, fish consumption in Ghana has always been relatively high; much higher than the global average of 17 kg/capita/year, with current annual estimates at 25-30 kg/capita or 60% of the dietary animal protein consumed (Frimpong, 2014). The cost-effectiveness of Tilapia, therefore, is highly dependent on the methods used by farmers. Access to information regarding aquaculture is therefore vital to its success.





Each has some relevance to the Vodafone Farmers Club messaging (for instance one nutritional message regarding Tilapia is “Do you eat Tilapia? If not then start, because it keeps your heart rhythm steady and healthy”).

Annex D Inclusion of Costs

As stated in the main text, there are varied methods of calculating the costs of a project. To inform our own analysis, Table 7 below shows the different cost factors included in the literature.

Table 7 Inclusion of costs within literature

Authors	Year	Country of Intervention	Type of Intervention	Outcomes measured	Costs included	Project Costs	R&D Costs	Beneficiary Costs
Harris et al	2013	Bangladesh	Electronic media	Per household reached * estimated number of IPM strategies disseminated by method * projected adoption rates * estimated yield increase from knowledge gained (eggplant)	Department of Agricultural Extension budget allocation in 2009 and 2010			
Harris et al	2013	Bangladesh	Print Media	Per household reached * estimated number of IPM strategies disseminated by method * projected adoption rates * estimated yield increase from knowledge gained (eggplant)	Department of Agricultural Extension budget allocation in 2009 and 2010			



Harris et al	2013	Bangladesh	Field Day	Per household reached * estimated number of IPM strategies disseminated by method * projected adoption rates * estimated yield increase from knowledge gained (eggplant)	Department of Agricultural Extension budget allocation in 2009 and 2010			
Harris et al	2013	Bangladesh	Extension Agent	Per household reached * estimated number of IPM strategies disseminated by method * projected adoption rates * estimated yield increase from knowledge gained (eggplant)	Department of Agricultural Extension budget allocation in 2009 and 2010			
Harris et al	2013	Bangladesh	Farmer Field School	Per household reached * estimated number of IPM strategies disseminated by method * projected adoption rates * estimated yield increase from knowledge gained (eggplant)	Department of Agricultural Extension budget allocation in 2009 and 2010			
Harvest plus	2010	Uganda	Biofortification promotion (training, community drama, radio broadcasts and other marketing activities)	Intake of Vitamin A	Not specified			

Harvest plus	2010	Uganda	Biofortification promotion (community drama, radio broadcasts and other marketing activities)	Intake of Vitamin A	Not specified			
Mauceri et al	2005	Ecuador	Farmer Field Schools	Number of farmers adopting improved practices	Budgets and cost data (unclear)			
Mauceri et al	2005	Ecuador	Field Days	Number of farmers adopting improved practices	Budgets and cost data (unclear)			
Mauceri et al	2005	Ecuador	Pamphlets	Number of farmers adopting improved practices	Budgets and cost data (unclear)			
Meenakshi	2007	DR Congo	Biofortification (cassava)	Estimated impact of micronutrient foods on burden of disease	research and development, adaptive breeding, maintenance breeding, and dissemination +recurring costs			

Meenakshi	2007	Brazil	Biofortification (cassava)	Estimated impact of micronutrient foods on burden of disease	research and development, adaptive breeding, maintenance breeding, and dissemination +recurring costs			
Meenakshi	2007	Nigeria	Biofortification (cassava)	Estimated impact of micronutrient foods on burden of disease	research and development, adaptive breeding, maintenance breeding, and dissemination +recurring costs			
Meenakshi	2007	Ethiopia	Biofortification (Maize)	Estimated impact of micronutrient foods on burden of disease	research and development, adaptive breeding, maintenance breeding, and dissemination +recurring costs			
Meenakshi	2007	Kenya	Biofortification (Maize)	Estimated impact of micronutrient foods on burden of disease	research and development, adaptive breeding, maintenance breeding, and dissemination +recurring costs			
Meenakshi	2007	DR Congo	Biofortification (cassava)	Estimated impact of micronutrient foods on burden of disease	research and development, adaptive breeding, maintenance breeding, and			

					dissemination +recurring costs			
Meenakshi	2007	Brazil	Biofortification (cassava)	Estimated impact of micronutrient foods on burden of disease	research and development, adaptive breeding, maintenance breeding, and dissemination +recurring costs			
Meenakshi	2007	Nigeria	Biofortification (cassava)	Estimated impact of micronutrient foods on burden of disease	research and development, adaptive breeding, maintenance breeding, and dissemination +recurring costs			
Meenakshi	2007	Ethiopia	Biofortification (Maize)	Estimated impact of micronutrient foods on burden of disease	research and development, adaptive breeding, maintenance breeding, and dissemination +recurring costs			
Meenakshi	2007	Kenya	Biofortification (Maize)	Estimated impact of micronutrient foods on burden of disease	research and development, adaptive breeding, maintenance breeding, and dissemination +recurring costs			


Norton et al	2013	Ghana	Farmer Field School, Farmer Business School and Input credit package (combined)	Cocoa yield increase estimated over 50 years based on one year yield increase	Costs of training + costs of input promoter training			
Pananurak	2010	China	Farmer Field Schools	Savings from reduced pesticide use, increase in cotton yield	operational project costs + opportunity costs of participating farmers (equal to the daily hired wage)			
Pananurak	2010	India	Farmer Field Schools	Savings from reduced pesticide use, increase in cotton yield	operational project costs + opportunity costs of participating farmers (equal to the daily hired wage)			
Pananurak	2010	India	Farmer Field Schools	Savings from reduced pesticide use, increase in cotton yield	operational project costs + opportunity costs of participating farmers (equal to the daily hired wage)			
Puett et al	2014	Zimbabwe	Home Gardening	number of households with improved food security and dietary diversity	Project implementation costs + percentage of capital costs (eg rent, cars) estimated from informant interviews + cost of beneficiary labour - income increase for beneficiaries			

Ricker Gilbert et al	2008	Bangladesh	Farmer Field Schools	Number of farmers with knowledge of IPM methods, Number of farmers adopting new IPM methods, Estimated benefits for farmers adopting new IPM methods.	Total recurring budget + opportunity costs to trainers +opportunity costs to farmers for attending the programme			
Ricker Gilbert et al	2008	Bangladesh	Farmer Field Schools	Number of farmers with knowledge of IPM methods, Number of farmers adopting new IPM methods, Estimated benefits for farmers adopting new IPM methods.	Total recurring budget + opportunity costs to trainers +opportunity costs to farmers for attending the programme			
Ricker Gilbert et al	2008	Bangladesh	Field Day	Number of farmers with knowledge of IPM methods, Number of farmers adopting new IPM methods, Estimated benefits for farmers adopting new IPM methods.	Total recurring budget + opportunity costs to trainers +opportunity costs to farmers for attending the programme			
Ricker Gilbert et al	2008	Bangladesh	Field Day	Number of farmers with knowledge of IPM methods, Number of farmers adopting new IPM methods, Estimated benefits for farmers adopting new IPM methods.	(Total recurring budget/ goal no of farmers reached) + opportunity costs to trainers +opportunity costs to farmers for attending the programme			

Ricker Gilbert et al	2008	Bangladesh	Agent Visit	Number of farmers with knowledge of IPM methods, Number of farmers adopting new IPM methods, Estimated benefits for farmers adopting new IPM methods.	Total recurring budget+ opportunity costs to trainers +opportunity costs to farmers for attending the programme			
Ricker Gilbert et al	2008	Bangladesh	Agent Visit	Number of farmers with knowledge of IPM methods, Number of farmers adopting new IPM methods, Estimated benefits for farmers adopting new IPM methods.	(Total recurring budget + opportunity costs to trainers +opportunity costs to farmers for attending the programme			
Schreinemachers et al	2015	Bangladesh	Home Gardening (classroom training + hands on demo)	Impact of Home gardens on intake of iron, vitamin A and Zinc	Project implementation costs + percentage of capital costs (eg rent, cars) estimated from informant interviews + cost of women's labour			
Self et al	2015	Kenya	Biofortification (OFSP)	Effectiveness data from a quasi-experimental study were used to estimate DALYs associated with changes in vitamin A deficiency, stunting, wasting, anaemia, diarrhoea, and mortality for children <2 years and their mothers	Estimated costs from monitoring data and expense reports + opportunity costs of health workers and participants + distribution of OFSP vouchers, enhanced nutrition counselling at antenatal			


					care visits and pregnant women's clubs			
Tsiboe et al	2016	Ghana	Farmer Field School, Farmer Business School and Input credit package (combined)	Cocoa yield increase estimated over 25 years based on one year yield increase	Cost of project operations + cost of increased inputs + cost of increased labour			
Tsiboe et al	2016	Cote D'Ivoire	Farmer Field School, Farmer Business School and Input credit package (combined)	Cocoa yield increase estimated over 25 years based on one year yield increase	Cost of project operations + cost of increased inputs + cost of increased labour			
Tsiboe et al	2016	Nigeria	Farmer Field School, Farmer Business School and Input credit package (combined)	Cocoa yield increase estimated over 25 years based on one year yield increase	Cost of project operations + cost of increased inputs + cost of increased labour			

Tsiboe et al	2016	Cameroon	Farmer Field School, Farmer Business School and Input credit package (combined)	Cocoa yield increase estimated over 25 years based on one year yield increase	Cost of project operations + cost of increased inputs + cost of increased labour			
Wellard et al	2013	Uganda	Farmer to Farmer extension	Net change in Maize, Millet and Cassava Production compared to non-members	Training of extension workers, equipment for CB extension workers, supervision by project or Ministry staff and other back-stopping costs (planning, coordination and reporting by district, country, regional offices).			
Wellard et al	2013	Ghana	Farmer to Farmer extension	Net change in Maize, Millet and Cassava Production compared to non-members	Training of extension workers, equipment for CB extension workers, supervision by project or Ministry staff and other back-stopping costs (planning, coordination and reporting by district, country, regional offices).			

Wellard et al	2013	Malawi	Farmer to Farmer extension	Net change in Maize, Millet and Cassava Production compared to non-members	Training of extension workers, equipment for CB extension workers supervision by project or Ministry staff and other back-stopping costs (planning, coordination and reporting by district, country, regional offices) +fertiliser costs			
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Key:

 some costs considered

 most costs considered

