

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

Ghana Mixed Methods Baseline Report

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Executive summary

This report constitutes the mixed methods baseline report of the evaluation of the mNutrition intervention in Ghana. The report summarises the key findings from the quantitative baseline, the initial exploratory qualitative study and the first cost-effectiveness/business model analysis.

Vodafone Farmers' Club (VFC) in Ghana

mNutrition is a five-year global initiative that has been supported by the Department for International Development (DFID) since 2013, organised by Groupe Spéciale Mobile Association (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. The nutrition content of the programmes aims to promote behaviour change around key dietary and child feeding practices that are likely to result in improved nutritional health within a household.

In Ghana, mNutrition is implemented through an mAgri platform called Vodafone Farmers' Club (VFC). This service is a 'bundled solution', offering agriculture and nutrition information through SMS and voice message (provided by Esoko), as well as free calls to others with Vodafone Farmers' Club SIM cards. The nutrition content aims to promote behaviour change around key farming decisions and practices and around maternal and other household practices that are likely to result in improved nutritional health within a household.

Evaluation design

The aim of the impact evaluation is to assess the impact, cost effectiveness and commercial viability of mNutrition. The evaluation is 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 uses a mixed methods approach with three interlinked components to gather evidence about the impact of the mNutrition intervention in Tanzania, including:

- A **quantitative impact evaluation**, employing a randomised encouragement design to determine the causal effect of VFC on accessibility of information available with regard to dietary diversity, agricultural income, and productivity. Households in study communities that were randomly assigned to the treatment arm received extra encouragement to become a VFC member in the form of a price discount and door-to-door promotion; households in communities that were randomly assigned to the control arm did not receive any additional encouragement but still had access to the VFC service.
- A **qualitative impact evaluation**, which consists of three qualitative data collection rounds (i.e. an initial qualitative exploratory study, 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 to generate a business model framework and estimate the wider imputed benefits from the value-added service for the range of stakeholders involved.

This report

This report summarises and integrates the key findings from the initial data collection round of each evaluation component carried out between October 2016 and January 2017. This report takes a theory-based approach and makes explicit use of the mNutrition theory of change (ToC) to structure the findings, assess the underlying assumptions about causal links between outcomes and draw conclusions about whether and how mNutrition may lead to the desired impact in the context of Ghana.

Key baseline findings

The analysis of underlying assumptions found that most assumptions that can be assessed based on baseline data fully or largely hold true. However, there are a few assumptions that only partially hold true and that may pose considerable risks to the effectiveness of VFC. Some of these assumptions can be addressed by the interventions while others clearly lie outside of the intervention's influence.

One assumption that only partially holds true and that may significantly reduce the likelihood of success for VFC is related to the strength and stability of Vodafone network coverage. Due to the limitations in network coverage, Vodafone is not the preferred network for many farmers, especially in Central Region (CR), which may result in low or no usage of VFC SIM cards. Consequently, the VFC voice messages may be missed. This is a considerable risk that lies outside the control of the intervention.

Another assumption that only partially holds true relates to farmers' unfamiliarity with voice messages, which may hinder farmers from taking up the messages. In addition, farmers may be reluctant to pick up voice messages as they may fear being charged (a common concern voiced by farmers and the main reason for the widespread distrust of MNOs). To mitigate these risks, farmers need to be familiarised with voice messages and how to access them. Farmers also need to be assured that voice messages from VFC are free of charge.

One of the underlying motivations for VFC and mNutrition is the assumption that farmers lack access to credible information on agricultural and nutrition practices and that mobile phone-based services can help to address these existing gaps. While there are certainly knowledge gaps both with regards to agriculture and nutrition among farmers, no acute lack of access to credible information could be identified. In fact, most farmers had (at least some) access to credible information (e.g. health worker, agriculture extension worker, radio, TV). For VFC and mNutrition voice messages to be perceived as valuable (above and beyond existing information sources) they need to extend existing information, be more tailored to specific needs and/or be more convenient to access. Careful profiling of farmers during the initial sign up to VFC is also vital to ensure that the content is highly relevant to the specific needs of each farmer.

The baseline analysis of indicators that are expected to change as a result of the intervention indicated that there is considerable scope for improvements in agricultural productivity and income as well as dietary diversity in both regions. VFC may trigger and support improvements with carefully tailored and targeted messages. However, the analysis also identified several contextual factors that may hinder the desired improvements; some of these factors may be addressed by careful intervention design, whereas other factors are outside the influence of the intervention. An increase in agricultural productivity and income may be hampered by a restrictive land tenure system in CR; the unwillingness of poor farmers to take risks and change established practices; restrictive intra-household decision-making processes; and a lack of profitable local markets and safe crop storage. All of these factors are outside the influence of the intervention. The main barrier to improvements in dietary diversity was poverty, which may restrict households from purchasing

varied foods (and in particular animal-sourced foods). The intervention may potentially address this limitation by increasing household available income for food purchases. Moreover, nutrition advice should promote the consumption of locally available and inexpensive food items only.

Based on the business model analysis, VFC appears to be a Business to Business to Consumer (B2B2C) model, whereby Esoko provides services to Vodafone, which then delivers services to consumers. However, VFC does not really fit this model because of the way both core partners share the delivery of services (and interaction with consumers). VFC is built upon the complementary capability of each of the partners. Vodafone may have the technical capability to develop and deliver the service, but it is Esoko that has the technical capability to develop locally relevant content and to register farmers, and has the platform to schedule messages appropriately. It appears, therefore, that VFC is built upon a partnership model that is distinct from either of the B2B2C models described above. The synergy between the two core partners is one of the key features of VFC. Esoko gets to deploy its system and Vodafone creates a new mass marketing segment. However, even at this stage it appears that both parties are looking to the future, implying that the existing arrangement may only be a stepping stone towards creating a product of even greater value.

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Abbreviations and acronyms

ARPU	average revenue per user
CR	Central Region
DFID	Department for International Development
FGD	focus group discussion
GAIN	Global Alliance for Improved Nutrition
GDP	gross domestic product
GHC	Ghanaian cedi
GSMA	GSM Association
IDI	in-depth interview
IDS	Institute of Development Studies
IFPRI	International Food Policy Research Institute
MNO	mobile network operator
SMS	Short Messaging Service
ToC	theory of change
UWR	Upper West Region
VAS	Value Added Service
VFC	Vodafone Farmers' Club

1 Introduction to mNutrition evaluation

1.1 Objectives of the report

This report constitutes the mixed methods baseline report of the evaluation of the mNutrition intervention in Ghana. mNutrition is a five-year global initiative that has been supported by the Department for International Development (DFID) since 2013, organised by the GSM Association (GSMA), and implemented by in-country mobile network operators (MNOs). mNutrition's goal is 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 existing mAgri and mHealth programmes in 12 countries throughout sub-Saharan Africa and South Asia.

In Ghana, mNutrition is implemented through an mAgri platform called Vodafone Farmers' Club (VFC). This service is a 'bundled solution', offering agriculture and nutrition information through SMS and voice message, as well as free calls to others with Vodafone Farmers' Club SIM cards. The nutrition content aims to promote behaviour change around key farming decisions and practices and around maternal and other household practices that are likely to result in improved nutritional health within a household.

The main objective of the evaluation is to measure the impact, cost effectiveness and commercial viability of the mNutrition service in Ghana using a mixed methods evaluation design. The evaluation includes a quantitative component, a qualitative component and a business model/cost-effectiveness analysis.

The evaluation will address the following research questions, as stated in the DFID terms of reference (TOR):

1. What are the impacts and cost effectiveness of mobile phone-based nutrition services on nutrition and health outcomes, especially among women, children and the extreme poor?
2. How effective are mobile phone-based services in reaching, increasing the knowledge and changing the behaviour of the specific target groups?
3. Has the process of adapting globally agreed messages to local contexts led to content that is relevant to the needs of children and pregnant women and mothers in their specific context?
4. What factors make mobile phone-based services effective in promoting and achieving behaviour change (if observed), leading to improved nutrition and livelihood outcomes?
5. How commercially viable are the different business models being employed at country level?
6. 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?

This report summarises and brings together key findings from the quantitative baseline, the initial exploratory qualitative study and the first business model/cost-effectiveness assessments of the evaluation [1-4]. The report describes the baseline situation for impact indicators that are expected to change as a result of the intervention. The report also explores key factors that may affect the

uptake and success of the intervention in changing behaviours, improving dietary diversity, increasing agricultural income and productivity, and providing a commercially viable service.

The report is structured as follows:

- **Section 2** describes the programme in more detail, including its theory of change (ToC) and the assumptions that underpin it.
- **Section 3** briefly discusses the overall design of the evaluation and the potential limitations.
- **Section 4** describes the economic, agriculture and nutrition context of Ghana within which VFC and the evaluation are situated.
- **Section 5** uses data from the baselines to analyse the assumptions underlying the programme's ToC.
- **Section 6** presents the key baseline findings for the primary outcome indicators (agriculture productivity and income; dietary diversity) that are expected to change as a result of the programme.
- **Section 7** presents our conclusions and summarises the implications.

1.2 Intended audience of the report

This report summarises the combined key findings of the quantitative, qualitative and cost-effectiveness/business baselines. This report deliberately presents results in a way that is accessible to non-technical audiences. In-depth technical and methodological details and discussions have therefore been excluded but are included in the detailed method-specific baseline reports [1-4].

The primary audience for the evaluation results is DFID's agriculture and evaluation departments, along with other key stakeholders including GSMA and its national members (including local MNOs which are implementing mNutrition services), national governments (in particular the Ministry of Health and Agriculture), international agencies and donors, as well as community-level health/nutrition and agriculture extension workers.

The findings of this report were presented and discussed with key stakeholders from GSMA, the government of Ghana, various non-governmental organisations and donors, and academics during a one-day workshop in Accra on 7 March 2018.

2 The mNutrition service in Ghana: Vodafone Farmers' Club

2.1 Description of the intervention

The Vodafone Farmers' Club (VFC) service is a mobile agricultural extension service, offering agricultural and nutrition information via voice and SMS. Vodafone's goal for the mNutrition programme 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 VFC service in May 2015. Smallholder farmers with access to mobile telecommunications and potential new Vodafone customers are the primary targets for VFC enrolment. The service operates across 71 districts of Ghana, selected on the basis of 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 VFC agents varies between regions.

The value-added services of VFC 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:** Recorded voice message in the selected local language with a seasonal agricultural or nutrition tip for the selected crop. Initially three agri tips and one nutrition tip were sent per month; the number of nutrition tips increased to three per month in July 2017
- **Call centre:** Free access to a call centre with advice available from an agricultural expert and/or a nutrition expert
- **Free calls and SMS messaging** to other VFC members
- **Discounted SMS and calls** to non-VFC members.

In total, approximately 20 messages per month are sent to subscribers via SMS for weather and price information, and by voice messages for agricultural tips and nutrition information. While SMS messages are sent 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 (Global Alliance for Improved Nutrition). 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 food 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 times and information on best practices for cultivation and harvest.

The VFC 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 Ghanaian cedi (GHC) 2 (US\$0.45) per month. Initially, members had to initiate monthly payments using airtime credit on their phone. But due to very low rates of monthly membership activation, the

programme was modified to automatically deduct GHC 2 from a member's airtime credit each month. If a member's credit fell below GHC 2, their membership status would become inactive until they loaded sufficient credit onto 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 GHC 0.5, but farmers who were enrolled in the quantitative study continued to receive the service free.

The VFC service is designed to offer customized 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.

Vodafone research showed 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 their strategy so that all profiling would be done through a follow-up call from the VFC call centre to new members after the SIM registration process was completed. However, when Vodafone suspended the monthly service fee and initiated a large push to increase the programme member base, it became unfeasible for Esoko to follow up each new VFC 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 free of charge to request customized profile options.

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

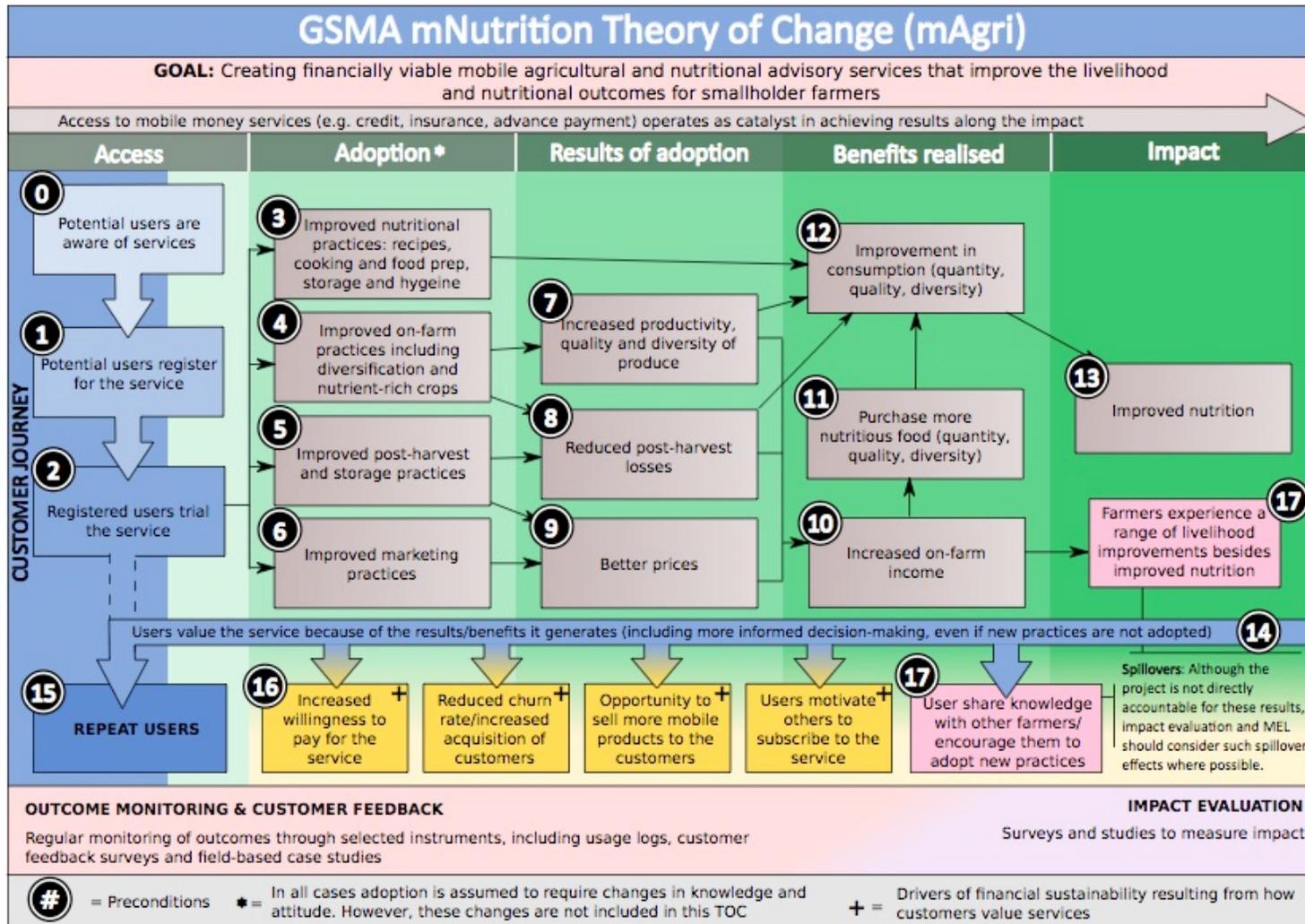
2.2 Programme theory of change

Figure 1 shows the generic theory of change (ToC) developed by GSMA for mNutrition programmes implemented through existing mAgri platforms. The programme's overarching ToC is that mAgri services offer access to mobile-based nutrition and agricultural services while generating direct revenues and indirect commercial value. The *mobile-based nutrition services* will increase farmers and other service users' knowledge of nutritional practices that support good nutrition. Acting on this knowledge will lead to improved nutritional practices among users, which may result in improved consumption (with regard to quantity, quality and diversity of food) and thereby contribute to improved nutrition for users.

This model assumes that *mobile-based agricultural services* will increase farmers and other service users' knowledge of agricultural practices (in particular related to on-farm practices, and to post-harvest, storage and marketing practices). Acting on this knowledge will lead to improved agricultural productivity and income for users, which may result in improved consumption (with regard to quantity, quality and diversity of food) and thereby contribute to improved nutrition for users.

Figure 1 is a graphical depiction of the generic ToC; below we describe the intended pathways to impact.

Figure 1 GSMA mAgri VAS theory of change



Source: [5]

2.2.1 mNutrition customer journey

The first component is the **mNutrition customer journey** (depicted in blue), which consists of the following sequential stages [5]:

- Awareness of the mNutrition service
- Registration and trial of the service
- Use and repeat use, which leads to impact.

GSMA hypothesises that repeat users are more commercially valuable to mAgri service providers. They will generate more direct revenue for mAgri services than low-level users (i.e. those who try the service only a few times or infrequently) because they access more information, they spend more time and money on the service and the Vodafone SIM. Repeat users will be more likely to generate direct and indirect commercial value for operators for the following reasons:

- They stay with the operator providing access to this service
- They like it (known as ‘reduced churn’¹)
- They spend money on other products and services with that operator, known as ‘incremental upsell’ – such as making more calls and sending SMS to friends and relatives.

Other indirect benefits include:

- Increased brand awareness and brand affinity, leading to improved customer perception
- Increased customer lifetime (i.e. length of time spent with an operator and increase in spend as a result). The longer a user stays with a particular MNO the greater the likelihood of increasing spend on other services [5].

GSMA hypothesises that there is a correlation between the extent to which customers use mAgri services and the likelihood that they will demonstrate improved nutritional and agricultural information and improved practices – leading down the pathway to nutrition in the ToC [5].

2.2.2 Pathway to impact

The second component of the ToC is the **pathway to impact** (depicted in green). Once mNutrition users have access to the nutrition and agricultural information, they are expected to gain new information about practices that could help them to improve their nutrition, agricultural productivity and income. The improved knowledge is expected to trigger a change in attitude towards these practices (see preconditions). As a result of these changes, users are expected to change their current nutrition and agriculture practices and adopt new improved practices. The intended result of the adoption (see ToC) is an increase in agriculture productivity and agricultural income, which is assumed will have a positive impact on household food consumption (including a more diverse diet), leading to improved nutrition. The primary outcomes which are the focus of this evaluation are improved agriculture productivity and income and improved dietary diversity.

¹ There are four main and several smaller mobile network operators in Ghana, and customers are typically not very loyal to one or the other, so reducing churn is a high priority.

2.2.3 Sustainable commercialisation pathway

The third component of GSMA's ToC is the **sustainable commercialisation pathway (not explicitly presented in the generic ToC)**. mNutrition is a commercially viable service when direct revenues of the service to MNOs (meaning revenues generated through paid elements of the service) and indirect commercial value (meaning revenues generated through new customers who were attracted by the mNutrition service or who purchased other services offered by the operator) are greater than the running costs of the service) [5].

2.2.4 Assumptions that underpin the ToC

GSMA stated the assumptions that lie behind the ToC in their monitoring and evaluation (M&E) framework and the mNutrition log frame [24, 25]. The evaluation team drew on these assumptions, the desk review [7], the landscaping exercise [8] (conducted as part of the impact evaluation) and the evaluation team's experiences from previous impact evaluations to develop a list of implementation, strategic and purpose-level assumptions about the causal links between outcomes [6].

Table 1 presents the assumptions that lie behind the ToC. Assumptions are subdivided into assumptions related to the customer journey and the pathway to nutrition service impact.

Assumptions that can be explored at baseline stage (before the roll-out of the VFC services) are depicted in blue; assumptions that can partly be assessed with data from the baselines are depicted in yellow; and assumptions that can only be assessed based on midline and endline data (after the roll-out of VFC) are depicted in green. It should also be noted that the list of assumptions will be further developed throughout the evaluation, as new assumptions may emerge.

As part of the analysis presented in this report we will test the assumptions behind the ToC to assess the strengths and weaknesses of the programme design and the likely effectiveness of the programme. For each assumption we will draw on baseline findings to determine whether the assumption 'fully holds true', 'largely holds true', 'only partially holds true' or 'does not hold true'.

Table 1 Assumptions behind the mNutrition theory of change (ToC)

Customer Journey	Nutrition Service Impact pathway			
Awareness, registration and use	Uptake of new information	Adoption of new practices and results	Results of adoption/benefits realised/impact	Commercial viability
Farmers can access mobile phones to subscribe and use service	Farmers have information gaps related to agricultural and nutrition practices	Farmers have the resources (e.g. economic, time, labour,) to act on the advice	Farmers have access to more and better foods and agricultural equipment	VFC targets viable customer segments
Farmers can get sufficient Vodafone signal coverage and strengths to subscribe and use service	Farmers lack access to credible information on agricultural and nutrition practices	Farmers have the power to make decisions based on advice received	Farmers have access to functioning markets and can sell agricultural products at the best price	The value proposition of the service satisfies the identified customer segments
Farmers are comfortable with receiving voice messages and SMS	Farmers perceive the information as credible and trust the information provided	Other contextual factors support a change in agricultural and nutritional practices	Contextual factors that may interact with agricultural productivity and income and nutritional outcomes are not a barrier	Channels for reaching the customer remain in place and customer relationships are able to reach and maintain the desired customer segments
Farmers have enough money to use the service	Farmers perceive the information as actionable and context relevant	Farmers implement the agriculture and nutrition advice correctly	There are no national-level crises or humanitarian emergencies such as conflict, war, droughts, etc.	Revenue streams, both direct and indirect, fulfil the key performance indicators required by the supply partners
Farmers have access to electricity to charge their mobile phones regularly	Farmers use the different components (e.g. voice messages, call centre, SMS) and perceive them as useful	Farmers act on the new information and change their agricultural and nutrition practices		Seeing the performance of the product, resources are made available from key supply partners
There are no social norms or attitudes that may hinder farmers from engaging with mobile	Farmers understand the information provided (both language and content)			Key partnerships in the supply chain are valued by each partner and maintained

phone-based information services				
Farmers find the service useful and use it repeatedly	The information provided is accurate and correct			A balance of cost, expenditure, investment and income, both direct and indirect, make for sustainable commercialisation of the product
The subscription to VFC and the profiling of farmers is user friendly				Alternative approaches found in-country do not supersede the value proposition of the product
Service is successfully delivered to farmers' mobile phones				

Key

Blue: assessed at baseline stage
Green: assessed only at endline stage
Yellow: partly assessed at baseline stage

3 Methods and evaluation design

3.1 Overall evaluation design

The overall evaluation uses a mixed-method design consisting of three interrelated work streams:

A quantitative impact evaluation, employing a randomised encouragement design to determine the causal effect of VFC on accessibility of information available with regard to dietary diversity, agricultural income, and productivity. Households in study communities that were randomly assigned to the treatment arm received extra encouragement to become a VFC member in the form of a price discount and door-to-door promotion; households in communities that were randomly assigned to the control arm did not receive any additional encouragement but still had access to the VFC service. The quantitative evaluation includes two regions of Ghana: Central Region (CR) and Upper West Region (UWR). A baseline survey was conducted prior to implementation of the encouragement treatment. Sampled households will be revisited for the endline survey 1.5 years after the encouragement intervention was initiated.

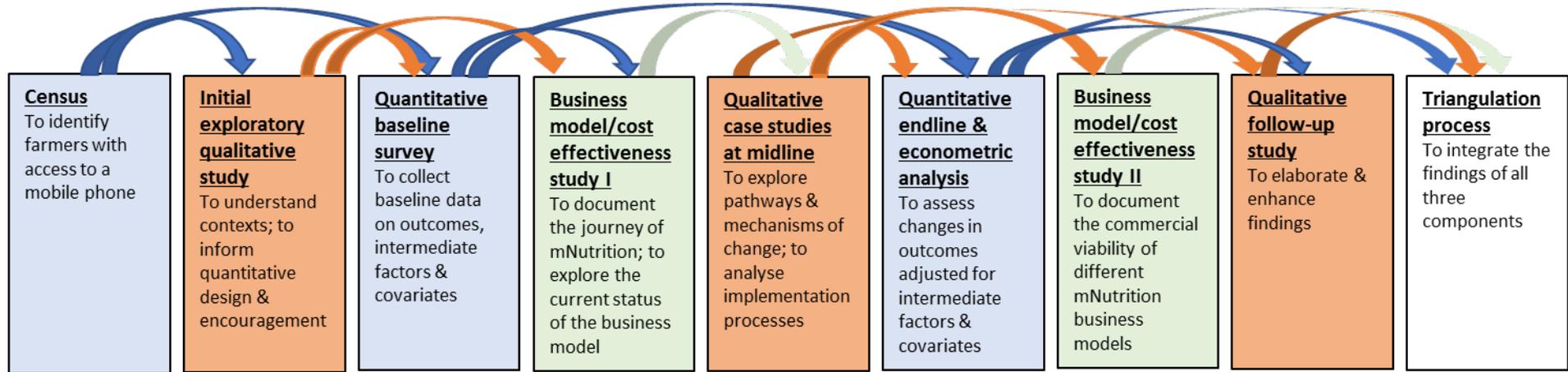
A qualitative impact evaluation comprising three qualitative data collection rounds: an initial exploratory qualitative study (which is part of this report); in-depth case studies at midline; and a rapid explanatory qualitative study after the quantitative endline survey data collection. The qualitative evaluation stream aims to provide understanding of the context within which mNutrition is embedded, and which might facilitate or hinder uptake of the intervention. The qualitative impact evaluation also explores the underlying mechanism of change in response to the intervention and traces implementation processes via process tracing. Qualitative data collection is being conducted in a sub-sample of the quantitative communities in both CR and UWR. Qualitative data collection will only be conducted in treatment communities, in order to provide in-depth information on the effects of the intervention.

A business model and cost-effectiveness evaluation employing stakeholder interviews (from Vodafone and Esoko), commercial and end-user data, and document analysis and evidence from the quantitative and qualitative evaluation data. This will generate a business model framework and estimate the wider imputed benefits from the value-added service for the range of stakeholders involved. It will relate the model to the GSMA ToC (see above) and consider the effectiveness of the customer journey, with a particular focus on commercial viability and sustainability of the service. This component will rely on ongoing mixed-method data collection, with two intensive phases of in-country data collection with key stakeholders in early 2017 (which are part of this report) and 2019.

The three evaluation components are closely linked and integrated with each other at all stages of the evaluation to inform, enhance and explain the design, the development of data collection tools and the analysis of each individual component. The different approaches are thereby used in a sequential manner² (see Figure 2). More details on the evaluation design can be found in Annex A and in the baseline reports [1-4].

² See Creswell, J.W., et al., Advanced mixed methods research designs, in *Handbook of mixed methods in social and behavioral research*. 2003, Sage Publications: London. p. 240

Figure 2 Sequential mixed-method design to assess the impact of VFC



Source: Authors' own

3.2 Evaluation activity timeline

Table 2 summarises the impact evaluation activities in Ghana during the implementation phase, running from October 2014 to October 2019. Data collection began with the initial exploratory qualitative study in October 2016, followed by the business data collection in January 2017. The quantitative baseline survey was undertaken in March-April 2017. Active encouragement and initial sign-up to VFC took place at the time of the quantitative baseline and again in July 2017. The qualitative midline will be undertaken in March-April 2018, followed by the quantitative endline survey in November 2018. Finally, a short qualitative endline and final business model data collection is planned for March-April 2019.

Table 2 Timeline of evaluation activities during the implementation phase

Date	Activities	Status
September 2016	Desk review	Completed
October 2016	Initial exploratory qualitative study data collection	Completed
January 2017	Business model data collection	Completed
March-April 2017	Quantitative baseline survey	Completed
March-April 2018	Qualitative midline	In progress
November-December 2018	Quantitative endline survey	In preparation
March-April 2019	Qualitative endline data collection	Planned
April 2019	Business model data collection	Planned

3.3 Limitations of the evaluation

This section outlines the limitations of the entire evaluation.

1. **Changes in VFC service:** Since the start of the impact evaluation there have been several changes in the VFC service. These include changes in pricing, the number of nutrition messages sent to users, and the approach to promotion and profiling of farmers. These changes have had consequences for the impact evaluation design, requiring the evaluation team to respond and adapt.
2. **Seasonality:** Qualitative and quantitative data collection were carried out before the onset of the rainy season in Ghana. Seasonality is a significant factor that can affect the nature of responses from farmers (e.g. in terms of foods they consume, issues around food security, access to markets and services, and how their information needs might vary according to the cropping season). This limitation is recognised and the midline and qualitative follow-up study (planned after the quantitative endline survey) will be designed to take into account seasonal differences. Moreover, as the quantitative survey was undertaken after the exploratory qualitative study, some changes will be captured and cross-checked through that data for future data collection rounds.
3. **Data access challenges:** Accessing business and, in particular, user data has been a persistent challenge for the impact evaluation team. Although stakeholders have expressed a positive intent to share data, this has not happened. GSMA have emphasised the

sensitivities surrounding data and are currently negotiating with stakeholders to access data.

4. **Small qualitative sample:** The aim of the initial exploratory qualitative study was to gain insights into contextual factors that could affect the uptake of the mNutrition intervention. The amounts of time and budget allocated to this initial qualitative data collection were relatively small. This made it necessary for the team to restrict the number of communities that could be visited and also influenced the approach chosen to select participants (e.g. with the help of focal persons in the community). Naturally, this limits the conclusions that can be drawn. However, the qualitative sample is not intended to be representative or allow for generalisable conclusions but instead aims to provide insights into multiple contextual factors.

4 Context: Ghana

This section discusses the mNutrition operating context in Ghana and highlights agricultural and nutritional factors that might affect the programme's implementation in either a positive or a negative way, as well as other factors that might influence its intended outcomes or impact.

The section examines the operating context at a national level. Information on the regional context is provided in Annex B.

4.1 Smallholder agriculture in Ghana

The west African country of Ghana is a lower-middle income country with a population of 28.8 million (as at 2017); 46 percent of the population live in rural areas and 54 percent in urban areas [12]. Ghana's economy is primarily agrarian, with agriculture contributing 23 percent to gross domestic product (GDP) in 2012 and employing about 53.6 percent of the labour force in 2013. Cocoa is the most important agricultural export (in terms of value), accounting for 30 percent of export revenues. Other agricultural exports are cashew, refined sugar and rubber [13].

Approximately 59 percent of Ghana's total land area is classified as agricultural, of which 56 percent is currently under cultivation. Most agriculture is rain fed, with only 0.4 percent of the total agricultural land under irrigation (based on data from 2012) [12]. Agriculture in Ghana is predominantly subsistence based. There is limited use of high-yielding seed and 80 percent of total agricultural output is produced using rudimentary technology – for example, hoe and cutlass are the main farming tools [13].

Ghana's agricultural production has grown at an average annual rate of 5.1 percent since 1983, placing the country among the top five performers in the world. However, most agricultural growth has been due to land expansion and cultivation of land previously not used for agriculture.

Agricultural productivity has remained low. Ghana has one of the lowest agricultural yields per hectare in the world [14]. Even cocoa yields per hectare are far lower than in neighbouring cocoa-producing countries such as Côte d'Ivoire [13]. Productivity is particularly poor in the northern parts of the country due to limited access to agricultural inputs and new technologies and to low coverage of extension services to improve practices. Low productivity in the north has been described as one of the main causes for persistently high levels of poverty [13].

According to the 6th Ghana Living Standards Survey (GLSS), farmers (and in particular self-employed smallholder farmers) are the poorest population group [15]. Other key development indicators of Ghana are outlined shown in Table 3.

Table 3 Key development indicators for Ghana in 2015

Indicators	
Life expectancy at birth m/f (years)	61/64
Adult literacy rate (%)	71.5
Infant mortality rate (per 1,000 births)	32

Under-5 mortality rate (per 1,000 births)	72
HIV prevalence (% 15-49 years)	1.3
Population living below national poverty line (%)	28.6
GDP (\$, billion)	37.86

Sources: [12]

4.2 Nutritional context in Ghana

Child undernutrition remains a persistent challenge in Ghana. In 2014, 19 percent of children aged under 5 years were stunted (low height-for-age) and 5 percent were wasted (low weight-for-height) [16]. Undernutrition in adult women is common in rural areas (7.4 percent of women aged between 15-49 years) [15]. Children in rural areas were more likely to be stunted than their urban counterparts (22 percent versus 15 percent). There were also considerable regional differences in child undernutrition, with children in northern Ghana being most likely to be stunted (33 percent of all children). 'Hidden hunger' due to micronutrient deficiencies was also significantly more common in the rural northern areas [15].

5 Key findings on assumptions behind the mNutrition theory of change

This section analyses the assumptions behind the theory of change (ToC) drawing on baseline data from all three evaluation streams. For each assumption we assess whether the assumption ‘fully holds true’, ‘largely holds true’, ‘only partially holds true’ or ‘does not hold true’. Assumptions regarding external or contextual factors, the implementation and causal links between the mNutrition services, and the expected impact, are all explored. As households did not receive encouragement to sign up for mNutrition service at the baseline stage, it is too early to discuss assumptions related to service design, content of the messages and actual changes in behaviour.

5.1 Assumptions that underpin the customer journey

5.1.1 Farmers can access mobile phones to subscribe and use service

This assumption **largely holds true**, with high levels of mobile ownership by men, although access is considerably lower among women.

Mobile phone ownership was moderately high across the evaluation sites, with 47 percent of women and 80 percent of men reporting that they owned a mobile phone (based on the quantitative baseline data). There were some regional differences, with men and women in CR being more likely to own a mobile phone compared to their counterparts in UWR (for men, 86 versus 74 percent; for women 57 versus 37 percent). While less than half of all women owned a mobile phone, 82 percent said they can access one. However, the qualitative data suggests that while most women may have access to a mobile, access was often strictly controlled and monitored by the owner (usually their spouse). The practice of mobile phone sharing was uncommon due to trust issues between spouses or to practicalities (e.g. the husband took the mobile phone to work).

Tightly controlled access to a mobile phone may prevent some women farmers from accessing VFC regularly or at all.

5.1.2 Farmers can get sufficient Vodafone signal coverage and strength to subscribe and use service

This assumption **only partially holds true** as poor network connectivity and unstable network coverage was a common problem across the two evaluation regions.

For most farmers, network strength and coverage were the main determining factors when choosing a network operator. To access the best network coverage for each location (e.g. across different villages but often also within the same village) many farmers owned SIM cards from different service providers and manually exchanged cards depending on location. Nevertheless, most farmers said that one SIM card was usually their ‘main’ card and that they mainly used the telephone number associated with it.

Vodafone network coverage was available in all study communities,³ but the qualitative data found that network strength and stability varied. Therefore, it is not surprising that only 31 percent of women and 35 percent of men reported Vodafone to be the service provider for their main telephone number. Both the qualitative and quantitative data also suggest large regional differences regarding use of and preference for Vodafone. While Vodafone was the network of choice for a small majority in Upper West Region (55 percent of men and 53 of women), far fewer people chose Vodafone in Central Region (14 percent and 13 percent).

Insufficient strengths or stability of the Vodafone network may act as a barrier to regular access to and use of VFC especially in CR.

5.1.3 Farmers are comfortable with receiving voice and SMS messages

This assumption **only partially holds true** because voice messages and SMS are communication modalities that are not familiar to all farmers.

As the mNutrition behaviour change messages are delivered by voice messages and the price and weather information by SMS, farmers need to be comfortable about using both of these delivery channels.

The majority of men (96 percent) and women (87 percent) said they had used a mobile phone to receive a call in the previous 14 days. This finding echoes the qualitative work, which found that almost all participants were comfortable receiving and making calls. However, very few respondents reported ever receiving a recorded voice message. Many farmers were also unsure whether they could repeatedly listen to recorded voice messages.

Less than a quarter of women (23 percent) and nearly half of all men (47 percent) reported having received an SMS in the previous 14 days. The qualitative findings suggest that the reason for low engagement with SMS was farmers' lack of familiarity with the text message function of their phones and the high level of illiteracy. In fact, the quantitative survey found that only 17 percent of the interviewed women and 31 percent of the household heads (mainly men) could read a phrase in English.

Farmers' limited familiarity with voice messages and SMS may pose a barrier to the uptake and use of VFC.

5.1.4 Farmers have enough money to use the service

This assumption **largely holds true since** the small monthly subscription fee of 0.50 cedis does not seem to be a major barrier to access to VFC, although some very poor households and women farmers might not be able to pay it.

The pricing structure of VFC has been changed repeatedly since the start of the evaluation, as described above. For several months the service was free of charge. However, in June 2017 a monthly subscription fee of 0.5 cedis (£0.09) per month was reintroduced.

The quantitative data found that women in CR spend on average 13 cedis per months on air time, whereas women in UWR spend only 5 cedis. Similarly, men in CR spend 32 cedis and in UWR 14 cedis. This suggests that paying a subscription fee of 0.5 cedis may pose more of a challenge for

³ Which is unsurprising given that one of the selection criteria for the evaluation sites was access to Vodafone network.

farmers in UWR than in CR. However, it needs to be highlighted that VFC also includes free calls to other VFC members and may thus help farmers to reduce their overall spend on airtime.

When we elicited farmers' willingness to pay for the VFC service, 85 percent said they would pay 1 cedi a month, 50 percent said 2 cedis and 19 percent 3 cedis. Men were willing to pay significantly more for the service than women. This suggests that a fee of 0.5 cedis would be acceptable for most farmers, but at prices higher than 1 cedi you lose a substantial portion of farmers, especially women.

While farmers may be willing to pay for the service, the qualitative data suggest that households frequently face economic constraints when paying for air time. Farmers explained that they used various strategies to ensure they had mobile phone credit (e.g. borrowing money, saving money on other household expenses including food). In particular, women farmers reported that they were often not in control of household money and had to ask their husbands to pay for their air time.

5.1.5 Farmers have access to electricity to charge their mobile phones regularly

This assumption **largely holds true**, although it is possible that limited access to electricity may pose a barrier to regular use of VFC. Although access to, and costs (both direct and indirect) of, electricity have been shown to be barriers to uptake of mobile phone-based health interventions in resource-poor settings [18], the quantitative data showed that nearly three-quarters (73 percent) of farmers were able to charge their mobile phone at home (with farmers in UWR slightly less likely to charge at home compared to CR). The qualitative data suggests that the remaining farmers charged their phones in neighbouring villages, often at the local mobile phone kiosk and usually for a charging fee. To save time and money for travelling, farmers often had to leave their phone in the neighbouring village to charge until their next planned trip there. During this time, they could not be reached via the phone and thus could miss VFC voice messages or SMS

5.1.6 There are no social norms or attitudes that might hinder farmers from engaging with mobile phone-based information services

This assumption **only partially holds true** since the data showed that, while farmers might engage with mobile phone-based services, distrust about MNOs might pose a considerable barrier to uptake of VFC.

Context-specific social norms and attitudes towards mobile phone-based information services have been shown to pose barriers to engagement with the service in previous studies [19].

Both qualitative and quantitative data suggest that the majority of farmers (78 percent) would be receptive to and would trust a mobile phone-based information service on nutrition and/or agriculture. In the qualitative interviews, farmers explained that they were more likely to subscribe to such a service if the benefits were clear. Farmers were mainly interested in services that helped them to boost agricultural productivity and income.

Qualitative findings also suggest that farmers had some strong doubts about the trustworthiness of MNOs. There was a widespread perception that MNOs were mainly interested in generating profits and not in helping 'poor farmers'. Farmers were particularly worried that their MNO would reduce their credit when they engaged with mobile phone-based services. This attitude might have an influence on whether or not farmers decide to sign up for and use a mobile phone-based information service such as the Farmers' Club provided by Vodafone.

5.2 Assumptions that underpin the nutrition impact pathway

5.2.1 Farmers have information gaps related to agricultural and nutrition practices

Farmers have information gaps related to agricultural practices

This **assumption fully holds true**.

The quantitative baseline survey used 12 questions to assess farmers' current agricultural knowledge levels and to identify potential information gaps. The questions were created from the repository of agricultural messages developed for VFC and focused mainly on the cultivation of food crops (rather cash crops).⁴ The assessment suggests medium agricultural knowledge levels among both male and female farmers, with male farmers on average correctly answering 58 percent of the questions and female farmers 54 percent. A small difference was noted between farmers (both male and female) in the two regions: UWR farmers had slightly better information compared to their counterparts in CR (for men: 62 percent versus 54 percent; for women: 58 percent versus 50 percent). Knowledge gaps existed in particular with regard to planting, weeding and harvesting specific food crops such as peppers, onions and cassava.

The quantitative findings are corroborated by qualitative findings, which highlight farmers' information gaps on food crop production. Especially in CR, farmers complained that agriculture extension workers provided information only on cash crop cultivation (mainly cocoa and rubber) and no information on food crops. This might also help to explain the lower percentage of correct answers among farmers in CR.

When farmers were asked in the qualitative interviews what specific information they lacked, the majority said that they were lacking information on: (1) how and where to gain access to funding (e.g. loans and credits) for agricultural inputs; and (2) farming practices to increase crop yield. Farmers were also interested in specific information that would help them address day-to-day farming challenges, depending on their level of experience (e.g. crops cultivated, agricultural problems).

While VFC may help to address some of farmers' information gaps (in particular around the cultivation of food crops and how to increase agricultural yields), others (e.g. related to information on access to funding) may not or may only partly be addressed. However, the uptake of new information could be hampered if information provided is not relevant to the farmer.

Farmers have information gaps related to nutrition practices

This **assumption fully holds true**.

The quantitative baseline survey assessed nutrition information using 16 questions created from the repository of nutrition messages developed for VFC. Nutrition knowledge levels were medium, with men answering 55 percent of the questions correctly and women 59 percent. As with agricultural knowledge, there were differences between the two regions, with men and women in UWR being slightly better informed (for men: 58 versus 52 percent; for women: 64 versus 55 percent). There were knowledge gaps in particular with regard to the nutritional value of different foods.

When farmers were asked in the qualitative interviews whether they lacked information on nutrition, most explained that learning about nutrition or diet had never been a priority. They were more

⁴ The aim of VFC mNutrition messages is to promote cultivation of food crops for household consumption.

concerned to have information that would support their day-to-day survival and their livelihoods. In particular, men were not concerned with nutrition or the nutritional value of foods. Women were slightly more interested and said that information on how to cook a nutritious meal on a very tight budget and with limited access to fresh foods would be useful to them.

Farmers have gaps in their nutritional knowledge that VFC could address if farmers were appropriately profiled or nutrition messages were general enough to be relevant for most farmers. However, the uptake of new information could be hampered by farmers' not perceiving any such need, information not being relevant to them, and their limited interest in nutrition.

5.2.2 Farmers lack access to credible information on agricultural and nutrition practices

Farmers lack access to agricultural information

This assumption **only partially holds true**. While access to agricultural extension workers was a challenge, both radio and TV are currently delivering agriculture information considered trustworthy by farmers.

Both qualitative and quantitative data suggest that farmers perceived agriculture extension workers as the most trusted formal source of agriculture information; 92 percent agreed that they would trust agricultural information from an agriculture extension worker. However, only 23 percent of farmers said that agriculture extension workers were the most important source of agriculture information (with some regional difference: CR 19 percent; UWR 28 percent). Potential explanations for this may be that farmers face multiple challenges when trying to access formal agriculture extension services. These include severe staff shortages, poor infrastructure and lack of transportation to and from rural communities. Women farmers often faced additional barriers when attempting to access agriculture extension services. For example, most agriculture extension workers were men who were mainly accustomed to providing services to male farmers but less familiar with the specific needs of female farmers. Women farmers also had limited mobility and lacked the time and resources to travel to the local agriculture extension office.

Apart from agriculture extension workers, various media outlets (e.g. newspaper, TV, radio) were identified as highly trusted sources for formal agriculture information. Given that 64 percent of all rural households owned a radio [15] and 37 percent of households in our sample own a TV (50 percent in CR; 23 percent in UWR), a considerable proportion of farmers might receive at least some credible agriculture information via the media. While farmers valued information received via the radio or TV, most stressed that they preferred to receive information through face-to-face communication, which enabled them to ask for clarification and further information.

VFC may help to improve access to credible information on agricultural practices, especially for female farmers. However, mobile phone-based information may compete with information delivered through other (well established and trusted) media outlets (e.g. TV, radio).

Farmers lack access to nutrition information

This assumption **only partially holds true** as most women receive access to (at least some) credible nutrition information during antenatal care. Male farmers have less access to nutrition information, although many men also said they do not perceive a need for such information.

Community health workers were identified as the most trusted source for credible information on nutrition in both the qualitative and the quantitative data. Many women farmers described being given nutrition advice as part of antenatal care they had received when pregnant and also during

monthly child growth-monitoring sessions in Baby Well Clinics. Given that antenatal coverage and child growth monitoring is almost universal in both CR and UWR [15], most women should have had some access to formal nutrition information.

However, most of the advice women received was focused narrowly on infant and young child feeding; no, or very limited, information had been provided on household diets. While community health workers could provide (at least in theory) more general nutrition advice, farmers usually lacked time and interest in using and/or demanding this service.

Newspapers, TV and radio were other widely used sources of trusted information on nutrition.

VFC may help to improve access to credible information on nutrition. However, mobile phone-based information may compete with information delivered through other (well established) channels including from health workers and media outlets (e.g. TV, radio).

5.3 Assumptions underpinning the sustainable commercialisation pathway

5.3.1 VFC targets viable customer segments

This assumption **only partially holds** true as, despite the large number of smallholder farmers, the intervention is specifically aimed at an ‘underserved’ rural population, which includes many people who do not have mobile phones and women farmers with lower access to mobile phones.

The intended customers for the service are 5 million smallholder farmers in Ghana, who account for 77 percent of the entire agricultural base in the country. More specifically, these intended customers are:

- Female farmers – estimated at 2.8 million (56 percent of the agricultural labour force)
- Semi-literate and illiterate smallholder farmers – estimated at 3.3 million (30 percent of the entire agricultural base is estimated to be illiterate)
- Rural residents without access to mobile phones – estimated at 3.2 million.

These segments are not mutually exclusive. A further segment comprises rural residents who do have a mobile phone but who subscribe to a competing network. Encouraging this group to switch to Vodafone is considered part of the indirect benefits of VFC.

These are still very broad segments. During discussions with Vodafone, the impression was given that VFC is somehow different to normal commercial products. For example, the specifically stated objective of the product is to meet the needs of the ‘underserved’ in rural areas. Based on the quantitative and qualitative baseline data, access to a mobile phone was particularly challenging for female farmers, which might make it difficult for VFC to reach women farmers. Another challenge might be the limited Vodafone signal coverage and strength in some areas of Ghana, which made Vodafone one of the least favoured networks (especially in CR). Consequently, farmers may be reluctant to switch to a Vodafone to receive VFC.

5.3.2 The value proposition satisfies the identified customer segments

This assumption **largely holds true** as several of the components of VFC are attractive and desirable features for farmers, including discounted voice minutes, free community calls to other VFC users and the farmer helpline. Other features may be less attractive, especially as farmers may perceive less of a need for these features, including market price and weather information, agricultural and nutritional advice.

The key to assessing the value proposition is to consider how it meets the needs of customers. VFC offers customers the following:

- **Discounted voice minutes:** VFC offers ‘competitive call rates’ and in discussions Vodafone explained that they have raised the discounted voice call tariffs for VFC from 5/9 Gp/min (on/off net) to 9/11 Gp/min. This is still a good offer, as most MNOs offer 12/13 Gp/min for off net calls, and Vodafone’s normal tariff is 11/13 Gp/min. The qualitative data suggests that the costs for voice calls influence people’s network choice. Furthermore, farmers use their mobile phones mainly to make and receive calls. Therefore, discounted voice minutes may be a good selling point for VFC.
- **Free community calling (closed user group):** Free calls between all VFC users are one of the features of VFC. This may potentially be an attractive selling point as farmers use their mobile phones mainly to make and receive voice calls.
- **Agricultural advisory content:** VFC offers agricultural information via regular voice messages. The qualitative findings suggest that there is a need for agriculture information tailored to the individual farmer. However, there are other trusted information sources, including agriculture extension workers and different media channels. VFC will only be valued if information adds to/complements/extends existing information.
- **Weather:** VFC offers regular weather information. Farmers did not mention weather forecasts as one of their information needs relating to agriculture during the qualitative research. One of the reasons for this was that farmers (especially in UWR) often did not have a choice regarding the timing of agricultural activities. When activities were carried out depended on the availability of the communal tractor or labour force.
- **Market prices information:** VFC provides regular market price information. Findings from the qualitative research suggest that the value of market price information depends on geographical location (e.g. access to markets) and agricultural products (e.g. market prices for cocoa are fixed).
- **Nutrition advisory content:** VFC provides regular nutrition information. The qualitative research found that information on nutrition was not perceived as a priority by farmers, and that men were generally less concerned than women about nutrition and food choices. This suggests that nutrition information is unlikely to be a strong selling point for VFC.
- **Farmer helpline:** VFC users can use a free helpline to ask further questions related to agriculture and nutrition. The qualitative data found that farmers prefer and value interactive sources of information. The helpline may be valued by farmers (if they use it and also depending on their experience when using it). Channels for reaching the customer remain in place and customer relationships are able to reach and maintain the desired customer segments.

This assumption **only partially holds true** because of repeated changes in the approaches used to reach potential customers (some more and others less targeted) and a general lack of trust in MNOs.

There has been some evolution of responsibilities and locations of action within Vodafone. Initially the product was targeted at those not currently on the Vodafone network. The idea was that the new product would attract farmers from other MNOs and be the instrument by which they switched their allegiance. Due to the slow pace of take-up and the need to reach key performance indicators (KPIs) on customer acquisition,) the product was subsequently offered to existing Vodafone customers. Vodafone sent out blast SMS messages to low ARPU (average revenue per user) customers in rural areas inviting them to transfer to the VFC service.

There were originally three channels through which Vodafone acquired VFC members. This was through the use of:

- Agents of VFC (only)
- Freelancers – Vodafone employs around 3,000 people to go out into communities and promote Vodafone products in general, rather than only VFC
- ‘Retailers’ – these are stationary (e.g. they have a table at a market).

VFC has long struggled with devising an effective payment mechanism. The biggest problem is finding a way to get farmers to pay which is consistent with their patterns of behaviour. However, problems with payment have temporarily disappeared because, although subscriber numbers were growing steadily, a step change in acquisitions was needed in order to meet KPIs, so two changes were made:

- Membership was opened up to existing Vodafone customers
- All subscription charges were temporarily dropped, from October 2016, but were re-introduced in June 2017.

For commercial sustainability within Vodafone, the product will need to be aligned not only with the VFC team’s targets but with wider corporate strategies.

Another challenge emerged in the qualitative baseline data, which found that many farmer distrusted MNOs, especially with regard to accuracy in charging.

5.3.3 Revenue streams, both direct and indirect, fulfil key performance indicators required by supply partners

This assumption **largely holds true** as the re-introduction of the subscription charge (as long as the charge is low) may not pose a huge barrier to re-subscription.

The original business model was built on a hybrid approach, generating revenue from both usage fees (discounted airtime tariffs), which is the traditional telecommunications model based on selling airtime, and from subscription fees. However, the way airtime fees are charged is not straightforward. Calls to numbers on the Vodafone network and to numbers on other networks (off network) are charged by the minute but calls within the closed user group (to other VFC members) are nominally free. During the life of VFC, revenue streams have changed. In October 2016, the subscription fee was dropped in the interests of attracting more subscribers in order to meet targets. While this was successful, it was feared that this was not a sustainable approach in the longer term, and the subscription charge was re-introduced in June 2017, albeit at a much lower

rate. It is hoped that such a low rate will not present a barrier to re-subscription, given that both the quantitative and qualitative baselines found that most farmers would be willing to pay a small subscription fee for the service.

5.3.4 Seeing the performance of the product, resources are made available from key supply partners, and key partnerships in the supply chain are valued by each partner and maintained

This assumption **largely holds true** as long as the synergy of the two core partners (Vodafone and Esoko) is perceived as beneficial by both.

The synergy between the two core partners (Vodafone and Esoko) is one of the key features of the emerging business model. For Esoko, the VFC partnership offers the possibility of achieving the scale and impact on smallholder farmers that they have aspired to since their inception. For Vodafone, VFC creates a new mass marketing segment. However, even at this stage it appears that both parties are looking to the future, implying that the existing arrangement may only be a stepping stone towards creating a product of even greater value. Both parties noted the attraction of making the Tulaa platform⁵ more widely available to farmers, and this appears to match the most pressing need among farmers identified by qualitative research, so the idea would appear to have enormous potential.

Esoko has a long track record of working with agricultural Value-Added Service (VAS),⁶ having set up Tradenet in Ghana over ten years ago. During this time, they have developed a database of locally relevant agricultural content that they bring to the partnership, but which remains their intellectual property. Moreover, they have agriculturalists on their staff who have worked on developing content, and who have been able to fulfil the role of the local content partner in the mNutrition project. GAIN developed content for an additional 13 crops, and Esoko adapted them to be locally appropriate. They also had quality control and data validation processes in place, which were of value in developing the VFC product. However, GAIN introduced a new set of quality control procedures that involved converting information into a different format, e.g. factsheets. Esoko then restructured their data into this new format at their own expense. Esoko continued to rely on their Expert Network as part of the revised quality control procedures, and maintain that this is a particularly valuable resource, which they have fostered over time.

5.3.5 A balance of cost, expenditure, investment and income, both direct and indirect, make for sustainable commercialisation

This assumption **only partially holds true**. While the costs and economies of scale of messaging are predictable, VFC would need to attract (and retain) 33,000 new customers to cover annual costs.

The primary cost components comprise setup and ongoing costs, wider programme costs, and societal costs, such as the cost to farmers of adopting new practices. We anticipate that these

⁵ Tulaa is a mobile commerce platform for rural consumers and producers in Africa. Incubated inside of Esoko and launched in Ghana in 2016, the solution uses mobile technology and mobile money to enable farmers to save and borrow to purchase inputs, receive tailored agronomic advice, and market their crops at harvest time.

⁶ Value Added Service: Non-core services are all services beyond standard voice calls available at little or no cost to promote the uptake of a specific MNO.

costs will change over the lifetime of the intervention as new approaches to marketing and service provision (and customer charges) are explored.

Only the cost of message scheduling and the cost of sending the SMS and voice messages themselves have been assumed to be variable costs. This means that costs are predictable, and potential economies of scale are high. 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). 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.

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 £6.60 per farmer reached. There is some value in documenting costs in this way, especially in being able to calculate the unit cost of a key output, that being reaching a farmer with the service. This is a measure of efficiency. Although interesting, these figures tell us nothing about value for money, as they take no account of impact achieved.

With the caveat that the figures are based largely on assumptions and estimates, a number of points arise from the relative magnitudes of categories of costs:

- The value of SMS messages delivered accounts for one-third of operational costs⁷ and is the largest single cost component. The overall cost of messaging (SMS plus message scheduling by Esoko) accounts for 42 percent of all estimated costs over the 2-year period.
- Support provided by the GSMA mNutrition programme for product development, including design and business intelligence, accounts for 20 percent of costs over the 2-year period. Further research is required to determine the value and how much the partnership might be willing to continue to invest after the end of the mNutrition project.

If we assume that ARPU is roughly £2.50/month,⁸ then VFC would need to attract (and retain) 33,000 new customers to cover these annual costs, which is well below the numbers currently on the system. Although this calculation is unrealistically crude, it does imply that the proposition could be viable.

As the cost-effectiveness report states, the above costs are only those directly associated with the VFC offering. In addition, there has been investment from DFID and GSMA in the wider programme costs that stimulated and supported this action. There has also been matching investment from Vodafone. For instance, when Vodafone temporarily dropped the monthly charge for VFC, they effectively invested an amount equivalent to the lost revenue from that period into the development of the product. In August 2016, Esoko received grant support (US\$867,788) from the Alliance for a Green Revolution in Africa (AGRA) for the deployment of Fasiba/Tulaa to help 80,000 smallholder farmers in Ghana overcome challenges associated with access to affordable and quality inputs to increase productivity and incomes. The Tulaa platform may be a key component of the end of grant negotiations and may play a strong role in the sustainability plan.

⁷ These are based on a 'market' value of 0.055 GHS/SMS
<http://support.vodafone.com.gh/customer/portal/articles/1823814-sms->

⁸ MTN, for example, published 2016 ARPU data for Ghana at around 12.5 GHS/month (www.mtn.com)

5.3.6 Alternative approaches found in-country do not supersede the value proposition of the product

This assumption only partially **holds true**. Ghana was identified by GSMA as one of the largest potential Value-Added Service (VAS) markets; they estimated that the market would be worth US\$5 million by 2020. Data published by the National Communications Authority (NCA) indicates there are over 100 VAS providers in the country (as of September 2016⁹), but even this may not be comprehensive.

Despite there being a number of possible VAS services that could 'overtake' VFC, none are currently showing a dominance in the market, or reaching meaningful scale, and none threaten VFC at the moment. However, with regards to information services there are several well-established and highly trusted information sources in place, including health workers and agriculture extension workers, television and radio.

5.3.7 Implications of the assessment

Table 4 presents the findings of the baseline assessment of the assumptions underpinning the ToC of mNutrition implemented through VFC. In the last columns we reflect on the potential risks of the findings of the assessment for the successful uptake and use of mNutrition (as described in the three components of the ToC) and suggest potential mitigation strategies.

9 <https://nca.org.gh/media-and-news/news/list-of-authorized-value-added-services/>

Table 4 Summary table of assumptions underlying the ToC

Assumptions	Fully holds	Largely holds	Only partially holds	Does not hold	Risks for the success of VFC	Suggested mitigation strategy
	Customer Journey					
Farmers can access mobile phones to subscribe and use service		X			Reaching (female) farmers with the VFC intervention could be challenging, including reaching them through their spouses' mobile phones	To reach as many women as possible, promotion campaigns should target not only women but also men, who often control women's access to mobile phones
Farmers can get sufficient Vodafone signal coverage and strength to subscribe and use service			X		In areas in which Vodafone does not provide a strong and stable network, farmers might be reluctant to activate VFC/only rarely use the VFC SIM card	No mitigation strategy identified
Farmers are comfortable with receiving voice and SMS messages			X		Farmers lack of technical confidence and knowledge may prevent them from receiving and repeatedly listening to mNutrition voice messages	Consider the provision of basic training on voice-based messages (e.g. what exactly is it; how to listen repeatedly; no costs for farmer)
Farmers have enough money to use the service		X			No specific risk could be detected	No mitigation strategy needed
Farmers have access to electricity to charge their mobile phones regularly		X			VFC voice messages may be missed if the mobile phone runs out of battery and cannot be recharged	Promotion strategies could potentially highlight the importance of ensuring that the mobile phone is charged
There are no social norms or attitudes that might hinder farmers from engaging with mobile phone-based information services			X		Distrust of MNOs and fears of being charged may prevent farmers from taking up VFC services	Reassure farmers that VFC is free of charge and that there are no hidden costs.
	Impact Pathway					

Assumptions	Fully holds	Largely holds	Only partially holds	Does not hold	Risks for the success of VFC	Suggested mitigation strategy
Farmers have information gaps related to agriculture practices	X				No specific risk could be detected	No mitigation strategy needed
Farmers have information gaps related to nutrition practices	X				Lack of interest in and demand for nutrition information may act as a barrier to uptake	Raise demand for nutrition information; provide nutrition information that is relevant to farmers' specific needs
Farmers lack access to credible information on agricultural practices			X		Risk that the content of the VFC messages does not add new information and is therefore perceived as useless	Ensure that the VFC messages are based on context-specific analysis of information needs to address the specific information needs highlighted and information gaps identified
Farmers lack access to credible information on nutrition practices			X		Perceived lack of need for nutrition information, as nutrition has never been a priority for farmers	Ensure that the VFC messages are based on context-specific analysis of information needs to address the specific information needs highlighted and information gaps identified
Sustainable Commercialisation Pathway						
VFC targets viable customer segments			X		There is a risk that some important customer segments are excluded (e.g. female farmers)	Explore different targeting mechanisms to ensure that all customer segments are covered
The value proposition satisfies the identified customer segments		X			Users may be only interested in one or two services that are part of VFC (e.g. the free calls) and not engage with/be aware of the other services	Ensure that all services which are part of VFC are promoted
Channels for reaching the customer remain in place and customer relationships are able to reach and			X		Distrust of MNOs and high competition between MNOs may affect access to VFC	Try to increase trust in Vodafone

Assumptions	Fully holds	Largely holds	Only partially holds	Does not hold	Risks for the success of VFC	Suggested mitigation strategy
maintain the desired customer segments						
Revenue streams, both direct and indirect, fulfil key performance indicators required by supply partners		X			Direct revenue from VFC has been changed repeatedly as user fees are changed/dropped. Limited direct revenues may affect the sustainability of VFC. However, small subscription fees are not perceived as a barrier by farmers	Ensure that subscription fees remain low to ensure good uptake.
Seeing the performance of the product, resources are made available from key supply partners and key partnership in the supply chain are valued by each partner and maintained		X			Synergy between core partners (Vodafone and Esoko) is essential for maintained performance. Changes in the partnership may affect the delivery of VFC	No mitigation strategy identified
A balance of cost, expenditure, investment and income, both direct and indirect, make for sustainable commercialisation			X		Most of the initial development of mNutrition was funded by grants. The sustainability of the intervention without grants may be a risk factor	No mitigation strategy identified
Alternative approaches found in-country do not supersede the value proposition of the product			X		Farmers may not value VFC advisory service as there are other trusted information sources in place (e.g. health workers and agriculture extension services, TV and radio)	Mobile phone-based advisor services need to be better tailored and more convenient to be able to compete with other (well-established information sources)

VFC risks **being less effective** if it:

- Fails to increase farmers' comfort and familiarity with using voice messages and SMS
- Does not tailor agriculture information to the needs of the individual farmer
- Does not generate demand for nutrition information.

Other contextual factors that are outside the direct control of the intervention could **limit the effectiveness** of VFC if not addressed or considered in the programme design/marketing include:

- Limited access to mobile phones, especially for female farmers
- Insufficient Vodafone network strengths and farmers' preference for more reliable networks
- Limited access to electricity and the associated risk of being offline for some time
- Distrust of MNOs and its potential impact on the uptake of VFC
- Competition from other (potentially better) established delivery platforms for agriculture and nutrition information (i.e. radio and TV).

Among the most relevant programme components that could **contribute to the success** of VFC are those that focus on:

- Addressing farmers' need for agricultural information (especially if the provided information responds to information needs identified by farmers themselves)
- Ensuring that the subscription fee remains at a level that farmers feel comfortable with.

6 Key findings on baseline characteristics of the impact indicators

This section presents key findings on the baseline characteristics of the impact indicators that are expected to change as a result of the programme. The indicators are presented in the order they appear in the ToC, starting with agricultural productivity and income, and dietary diversity (as one element of improved consumption).

6.1 Agricultural productivity and income

Different quantitative indicators can be used to measure agricultural productivity and agriculture income.¹⁰ The quantitative survey employed a detailed agriculture module to construct accurate measures of productivity and income using data on crop diversity, crop yields per area, value of crop production, agriculture input costs and profits. All indicators were based on data from the previous season.

On average, households in both CR and UWR cultivated three crops (see Table 5). Overall profits generated through the production of crops varied across regions, with households in UWR earning considerably less than households in CR. The main reason for the huge regional difference was that households in CR were able to generate large profits from cocoa (on average 2,000 GHC per household), Ghana's most important cash crop [7]. The qualitative data found that market prices for cocoa were fixed by the government and that farmers usually sold their cocoa to traders from the same Licensed Buying Companies at village level. When asked whether they saw any scope for increasing their income from cocoa, most of the interviewed farmers felt that this was outside their power, given that cocoa prices were fixed and that they had no money to buy additional agricultural inputs (e.g. fertilisers) to increase productivity. Cocoa production was usually very labour intensive, conducted on leased land by male (migrant) farmers and heavily reliant on traditional methods (e.g. cutlass). In this context, it should also be noted that cocoa productivity per acre in Ghana is considerably lower than in other cocoa-producing nations (such as the neighbouring Côte d'Ivoire) [21]. This suggests that there is potential to improve profits for cocoa production further (although the scope is limited, given that cocoa prices are fixed and access to agricultural inputs limited).

Groundnut was only produced in UWR and generated slightly more than one-third of the overall profits from crop production for households. Input costs for groundnut production were relatively high and thus reduced overall profit from groundnuts. Maize was grown in both regions, with households in UWR being slightly more likely to grow maize (75 percent versus 68 percent). Maize yields were very similar across the two regions. However, the profits¹¹ households were able to generate from maize were generally small (compared to the other crops they produced). There was also a huge regional difference, with households in UWR earning on average GHC 15 and households in CR GHC 360 from maize in the previous season. The reason for this difference is that input costs¹² for maize production differed considerably across regions.

The qualitative data offer some explanations for the high input costs for crop production in UWR. Land preparation in UWR was frequently very labour intensive. Most farmers attempted to hire a tractor for the work but given the high demand and the lack of available tractors this was often

¹⁰ For a review of different indicators and a discussion of strengths and limitations of each indicator, see [20].

¹¹ Profits were calculated by subtracting the input cost of each crop from the value of production of that crop.

¹² Input costs are total incurred costs on fertilisers, pesticides, herbicides, spraying services, tractor hire and labour costs.

impossible. Others (in particular female farmers) tried to hire external labour to help with land preparation and weeding. However, high levels of rural-urban migration in recent years have resulted in a dramatic loss of rural labour. As a consequence, it has become increasingly expensive to hire labour. Access to other agricultural inputs (e.g. fertilisers) is also expensive, in part due to transport costs.

Potential barriers that need to be considered by VFC when attempting to increase agriculture productivity and income are:

- The existing complex land tenure systems in CR that might prevent farmers from changing practices (e.g. because tenancy agreements require farmers to cultivate specific crops or employ specific farming techniques)
- Intra-household decision-making processes related to crop production and (in particular) female farmers' inability to request change
- Unwillingness of poor farmers to experiment and adopt new practices due to fear of failure (poor farmers have previously been shown to be more risk averse than wealthier farmers [22])
- Unavailability of profitable markets to sell agricultural products (including governmental price fixing for some products)
- Unavailability of safe storage for crops to capture the best price possible at local markets.

It is clear that these are very significant contextual challenges that could be addressed with other types of products or service interventions but are well outside the control of an intervention like VFC.

Table 5 Agriculture productivity and income, by region

Agriculture products/income	N	All	CR	UWR
Number of crops cultivated (number)	3,846	2.970	2.963	2.976
Farmer grows maize (%)	3,839	71.1	67.5	74.6
Farmer grows cocoa (%)	3,839	27.1	53.9	0
Farmer grows cassava (%)	3,839	43.0	85.3	0.4
Farmer grows groundnut (%)	3,839	36.9	0.4	73.6
Yield of maize (kg/acre)	2,675	344.9	341.9	347.6
Yield of cocoa (kg/acre)	1,028	65.3	65.3	0
Yield of cassava (kg/acre)	1,626	1,063.414	1,063.414	0
Yield of groundnut (kg/acre)	1,380	339.7	0	339.7
Total value of production (GhC)	3,811	3,526.251	4,353.121	2,691.971
Total value of maize produced (GhC)	2,697	684.565	595.549	765.095

Agriculture products/income	N	All	CR	UWR
Total value of cocoa produced (GhC)	1,029	3,012.345	3,012.345	0
Total value of cassava produced (GhC)	1,627	768.637	768.637	0
Total value of groundnut produced (GhC)	1,384	844.607	0	844.607
Total input costs (GhC)	3,817	1,167.417	1,057.168	1,278.770
Input cost of maize (GhC)	2,708	500.278	230.806	747.612
Input cost of cocoa (GhC)	1,035	949.308	949.308	0
Input cost of cassava (GhC)	1,628	177.681	177.681	0
Input cost of groundnut (GhC)	1,391	365.115	0	365.115
Total profit (GhC)	3,783	2,323.356	3,262.412	1,374.820
Profit from maize (GhC)	2,680	182.765	366.998	15.329
Profit from cocoa (GhC)	1,020	2,009.409	2,009.409	0
Profit from cassava (GhC)	1,614	597.432	597.432	0
Profit from groundnut (GhC)	1,369	474.266		474.266

6.2 Household and women's dietary diversity

When asked about their perceptions of a 'good and healthy' diet, most farmers described varied diets with plenty of meat, eggs, dairy and vegetables. However, farmers reported that they seldom could afford such a diverse range of foods themselves but rather had to rely on cereal-based, relatively monotonous and simple diets. The quantitative survey corroborated these findings.¹³ Quantitative baseline data show that households had consumed on average between five and six food groups (out of 12) in the previous 24 hours (see Table 6 for details). There was a small regional difference, with households in CR consuming a slightly greater variety of foods than households in UWR (six versus five food groups).¹⁴ Nutrient-rich animal-sourced foods (e.g. meat, egg, dairy) were the least commonly consumed foods in both regions, followed by legumes, pulses, nuts and seeds, which were eaten by only one-quarter of all households. Vegetables were

¹³ Dietary diversity at household level was assessed based on information collected on 21 food items that the household/woman consumed in the 24 hours prior to the survey. The data were used to construct a Household Dietary Diversity Score (HDDS), which combines responses to the 21 food items consumed into 12 food group indicators. Women's dietary diversity was based on the same information collected on 21 food items. The data was used to construct the Minimum Dietary Diversity-Women (MDD-W), a dichotomous indicator that reflects the greater likelihood of women meeting their micronutrient needs than women consuming foods from fewer food groups.

¹⁴ There are no established cut-off points in terms of number of food groups to indicate adequate or inadequate dietary diversity for the HDDS.

consumed by only slightly more than half of all households (63 percent), whereas cereals, roots and tubers (in CR only), fruits and condiments were widely consumed.

The primary female of the household consumed on average 4.5 food groups out of ten, with very little differences between CR and UWR (Table 7). This means that only slightly more than half of all women (52 percent) met the minimum dietary diversity for women. Women in CR are slightly more likely than women in UWR to meet the minimum dietary diversity requirements (54 percent versus 50 percent). These findings suggest that there is a need for interventions aimed at improving dietary diversity in both CR and UWR.

Table 6 Household dietary diversity by region

Food groups	N	All	CR	UWR
Household Dietary Diversity Score (1-12)	3,721	5.8	6.3	5.4
Household consumed cereals (%)	3,807	90.7	87.7	93.7
Household consumed roots and tubers (%)	3,809	47.0	87.0	7.0
Household consumed vegetables (%)	3,811	62.9	55.0	70.8
Household consumed fruit (%)	3,809	82.1	84.3	79.9
Household consumed meat and organ meat (%)	3,805	19.5	19.9	19.1
Household consumed eggs (%)	3,787	8.6	14.4	2.8
Household consumed seafood (%)	3,810	81.6	93.1	70.2
Household consumed legumes, pulses, nuts, and seeds (%)	3,804	25.4	24.8	26.0
Household consumed dairy (%)	3,815	13.9	17.3	10.6
Household consumed oils and fats (%)	3,797	41.2	20.9	61.6
Household consumed sweets (%)	3,760	20.0	28.0	11.9
Household consumed condiments (%)	3,808	91.3	96.8	85.8

Table 7 Women's dietary diversity by region

	N	All	CR	UW
Women's Dietary Diversity Score (1-10)	3,770	4.48	4.55	4.41
Met Minimum Dietary Diversity for Women (MDD-W)	3,770	0.52	0.54	0.50
Primary female consumed grains, white roots, tubers	3,821	0.96	0.99	0.93
Primary female consumed pulses	3,816	0.14	0.10	0.18
Primary female consumed dairy	3,824	0.10	0.11	0.09
Primary female consumed meat, fish, poultry	3,821	0.84	0.95	0.73
Primary female consumed eggs	3,797	0.07	0.11	0.03
Primary female consumed green leafy vegetables	3,817	0.60	0.52	0.68
Primary female consumed vitamin A rich fruits and vegetables	3,821	0.37	0.11	0.63
Primary female consumed other vegetables	3,818	0.64	0.78	0.50
Primary female consumed other fruits	3,818	0.64	0.78	0.50
Primary female consumed nuts and seeds	3,804	0.10	0.10	0.10

The qualitative data identified several barriers that need to be considered by VFC when aiming to improve the dietary diversity of households and women in CR and UWR:

- a) Poverty was highlighted as the main barrier to farmers consuming a more diverse range of foods. Farmers usually consumed crops they had produced themselves and supplemented their diets with small amounts of purchased food.
- b) The availability of fresh foods (e.g. meat, vegetables) at local markets was often very limited and seasonal, and difficult to access (due to distance, poor infrastructure and lack of money).
- c) Heavy workloads and time burdens of farm work often prevented female farmers from spending time on food preparation and the purchase of fresh foods.
- d) In many households (especially in UWR) women participated only marginally in decision making regarding food choices.
- e) The lack of much diversity in agriculture production limited the range of foods available for household consumption.

6.3 Implications of the key findings

The findings from the baselines on agriculture productivity and income and on dietary diversity suggest there is some scope for improvement.

Agriculture profits were already considerably higher in CR compared to UWR, mainly thanks to the cultivation of cocoa. However, comparison with other cocoa-producing countries suggests that cocoa productivity and profits might be increased further with more effective farming techniques and methods. VFC could support this improvement.

Surprisingly, agriculture productivity of maize was very similar in CR and UWR. However, input costs varied considerably, and were in UWR almost three times those of CR. VFC could help to

increase agriculture productivity and income in UWR by supporting a reduction in input costs, for example through assisting farmers with improved farming techniques and cost-effective use of inputs.

There are various contextual barriers to improvements in agriculture productivity and income. These include: restrictive land tenure systems in CR; the unwillingness of poor farmers to take risks and change established practices; restrictive intra-household decision-making processes; and a lack of profitable local markets and safe crop storage. These issues are well outside of the control of the intervention but should be taken into consideration in future alterations of the programme.

Slightly more than half of all women were meeting the minimum dietary diversity requirements, and households consumed, on average, 5.8 of 12 food items. Across both regions, only a small proportion of women consumed dairy, nuts/seeds and eggs, thus these food groups have the greatest potential for improvements. Awareness of the health benefits of a varied diet was also high among farmers. But there are several contextual factors that prevent farmers from consuming a diverse diet or otherwise improving nutrition outcomes – with poverty being the main limiting factor. VFC could be successful in improving dietary diversity through sending behaviour change messages addressing the economic constraints to a diverse diet (e.g. by suggesting inexpensive food choices or promoting more diversity in agriculture production for household consumption). VFC also provides information on which foods are nutrient dense and how to preserve nutrients in food preparation and storage. The information may help farmers to improve the quality of their diets. Furthermore, additional income earned from agricultural improvements may be used to support investments to improve nutrition.

7 Discussion and conclusion

This section summarises the key findings of our analysis of the assumptions underpinning the ToC as well as the baseline situation of key outcomes expected from the programme. The implications of the findings are also discussed. The outcomes are presented in the order in which they appear in the ToC.

The analysis of underlying assumptions found that most assumptions that can be assessed based on baseline data fully or largely hold true. However, there are a few assumptions that only partially hold true and that may pose considerable risks to the effectiveness of VFC. Some of these assumptions can be addressed by the interventions while others clearly lie outside of the intervention's influence.

One assumption that only partially holds true and that may significantly reduce the likelihood of success for VFC is related to the strength and stability of Vodafone network coverage. Due to the limitations in network coverage, Vodafone is not the preferred network for many farmers (especially in CR) which may result in low or no usage of VFC SIM cards. Consequently, the VFC voice messages may be missed. This is a considerable risk that lies outside the control of the intervention.

Another assumption that only partially holds true relates to farmers' unfamiliarity with voice messages, which may hinder them from taking up the messages. In addition, farmers may be reluctant to pick up voice messages as they may fear being charged (a common concern voiced by farmers and the main reason for the widespread distrust of MNOs). To mitigate these risks, farmers need to be familiarised with voice messages and how to access them. Farmers also need to be assured that voice messages from VFC are free of charge.

One of the underlying motivations for VFC and mNutrition is the assumption that farmers lack access to credible information on agricultural and nutrition practices and that mobile phone-based services can help to address these existing gaps. While there are certainly knowledge gaps both with regards to agriculture and nutrition among farmers, no acute lack of access to credible information could be identified. In fact, most farmers had (at least some) access to credible information (e.g. health worker, agriculture extension worker, radio, TV). For VFC and mNutrition voice messages to be perceived as valuable (above and beyond existing information sources) they need to extend existing information, be more tailored to specific needs and/or be more convenient to access. Careful profiling of farmers during the initial sign up to VFC is also vital to ensure that the content is highly relevant to the specific needs of each farmer.

The baseline analysis of indicators that are expected to change as a result of the intervention indicated that there is considerable scope for improvements in agricultural productivity and income as well as dietary diversity in both regions. VFC may trigger and support improvements with carefully tailored and targeted messages. However, the analysis also identified several contextual factors that may hinder the desired improvements; some of these factors may be addressed by careful intervention design, whereas other factors are outside of the influence of the intervention. An increase in agricultural productivity and income may be hampered by a restrictive land tenure system in CR; the unwillingness of poor farmers to take risks and change established practices; restrictive intra-household decision-making processes; and a lack of profitable local markets and safe crop storage. All of these factors are outside the influence of the intervention. The main barrier to improvements in dietary diversity was poverty, which may restrict households from purchasing varied foods (and in particular animal-sourced foods). The intervention may potentially address this limitation by increasing household available income for food purchases. Moreover, nutrition advice should promote the consumption of locally available and inexpensive food items only.

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Annex A Further details on the evaluation design

1. Quantitative evaluation design

This section provides a brief outline of the design and methodology of the quantitative evaluation. For a more detailed description of the quantitative methodology please refer to the quantitative baseline report [9].

The quantitative evaluation aims to study the impact of the VFC on: agricultural productivity; agricultural income; and dietary diversity.

1.1. Randomised encouragement design and intervention

A randomised encouragement design is used to estimate the causal impact of VFC. A randomised encouragement design is one example of an experimental impact evaluation design, which makes it possible to interpret differences in outcomes between the encouragement treatment group and the control group as causal, as being a result of the interventions being implemented. Impact estimates have a causal interpretation in randomised field experiments because access to the programme cannot be correlated with local conditions or household behaviour, except by chance, in the way that is typical of targeted interventions and those in which household self-selection is a major determinant of participation.

The encouragement design does not restrict access to the VFC, but randomly assigns some communities to receive additional marketing and promotion of the service (treatment communities), whereas other communities do not receive additional encouragement, but can still access VFC at the market rate (comparison communities). Because access to the additional promotion in the encouragement design is completely random, any differences in average outcomes between the encouragement treatment and control communities must be due to the effects of the additional promotion to use VFC. The evaluation uses the random variation in exposure to the VFC through the encouragement promotion to estimate the causal impact of taking up VFC on agriculture and nutrition outcomes.

The encouragement intervention was implemented at the time of the baseline data collection. Study households in treatment communities were offered the opportunity to become VFC members when they completed the household survey. A randomly targeted male or female household member was informed about the VFC service through either an agriculture script or an agriculture plus nutrition script. At the end of the script the targeted individual was asked to play a short game to determine their willingness to pay for the service, and at the end of the game, the service was offered for free.

If the targeted household member chose to join VFC, the enumerator attempted to complete the new member SIM registration and record information for profiling the new member to the service before leaving the household. Farmers were profiled to receive the appropriate weather and market price information for their district, and crop information for their chosen crop in their chosen language. This information was sent to Esoko to complete the profiling. If the targeted individual already had an existing Vodafone SIM, they could opt to migrate their existing number to the VFC service rather than receive a new SIM. In these cases, the migration requests were sent to Esoko in batches to complete the migration for existing Vodafone subscribers who wished to become VFC members.

1.2 Quantitative sampling strategy

In consultation with Vodafone, five districts in the Upper West Region (UWR) and five districts in the Central Region (CR) of Ghana were selected for the evaluation. All sites had to have good Vodafone network connectivity and low levels of marketing activities for VFC.

From each selected district, 20-21 enumeration areas were randomly selected from a list of enumeration areas within a 10-mile radius of a cell phone tower.¹⁵ A total of 207 enumeration areas (104 in the encouragement arm and 103 in the comparison arm) were selected (see Table 8). In each enumeration area, 19 farmer households were randomly sampled, for a total sample of 3,933 households at baseline and 3,736 at endline (assuming a 5 percent attrition rate across rounds).

The inclusion criteria into the household sample were that households must: be a farming household; own a mobile phone; not be a current member of the VFC; and have at least one female member aged 15-60 years old.

Table 8 Quantitative sample selection

Enumeration areas	207
Encouragement arm	104
Comparison arm	103
Households per enumeration area	19
Total sample (households)	
Baseline	3,933
Endline	3,736

1.3 Quantitative data collection

Baseline household questionnaires were designed by the IFPRI team based on the initial exploratory qualitative study [1], the landscaping review [8], and past experiences conducting quantitative evaluations of agriculture and nutrition interventions in sub-Saharan Africa.

The household survey is the principal source of information for the primary and secondary outcomes. In addition, the questionnaire collects data on indicators expected to be strongly correlated with the primary and secondary outcomes – which can be used to help improve the statistical precision of the treatment effect estimates – as well as on measures that are important for testing the different causal mechanisms that could generate differences in the final outcomes of interest. When paired with the endline data collection in the context of the randomised evaluation design, the baseline instrument will enable us to carefully test for causal effects of the mNutrition programme at different levels of the causal chain. Data collected during the baseline survey – GPS coordinates and all mobile phone numbers for each household – will also be used to help locate the households surveyed at baseline for endline fieldwork.

The baseline household questionnaire collected information on:

- Primary outcomes (i.e. agriculture productivity and income and dietary diversity)
- Secondary outcomes (i.e. knowledge and current practices)
- Basic demographics
- Indicators likely to be predictive of primary and secondary outcomes
- Intermediate outcomes relevant for testing different causal mechanisms.

¹⁵ Urban areas made up of more than one enumeration area were clustered together for randomisation.

The full baseline questionnaire can be found in the baseline report [9].

1.3.1 Baseline characteristics and balance test

Analysis of baseline data provided key statistics on the study population, across regions, with respect to demographics, mobile phone access and use, dietary diversity, agriculture production, nutrition knowledge and behaviour, farming knowledge, and sources of information and trust. Balance tests were conducted to test for baseline differences between the encouragement treatment group and the comparison group, as well as within the encouragement groups.¹⁶ The balance tests found that, overall, randomisation was successful, as the samples were well balanced with regard to all key outcomes of interest (for further details see [2]).

As this report is aimed at non-technical readers, the presentation of quantitative data is kept to a minimum and percentages are rounded to whole percentage values if possible.

2. Qualitative evaluation design

The qualitative component of the evaluation aims to: (1) provide an in-depth understanding of the context within which mNutrition is embedded, and which is likely to affect take-up and outcomes; and (2) explore processes of change and their underlying mechanisms to explain how and why (and why not) mobile phone-based services lead to change in nutrition behaviours. The qualitative component consists of three qualitative data collection events:

- An initial exploratory qualitative study
- In-depth case studies at midline
- Qualitative follow-up mini case studies following the quantitative endline.

This report draws only on findings from the initial exploratory study. The following provides a brief overview of this initial study. For further details, see the initial qualitative report [1].

2.1 Initial exploratory qualitative study

In the initial exploratory qualitative study, a comprehensive contextual analysis of social, institutional, political and environmental factors was carried out. The analysis focused specifically on:

- The acceptability, familiarity and use of mobile phone technology
- Factors that may affect the operation of and/or access to a mobile phone and mobile phone-based behaviour change messages by the target group
- Current information-seeking behaviours related to nutrition and agriculture
- Social, economic and environmental factors that might influence the uptake of behaviour change messages provided by mNutrition.

2.2 Qualitative sampling

A purposive sample of six communities was chosen. The selected sites were a sub-sample of the quantitative sites and aimed to provide insights into different geographic contexts. Within each site,

¹⁶ To do this, we first calculated average values for all key characteristics for each treatment arm and the comparison group. We then tested whether groups differed in a statistically significant way.

participants were selected to illustrate characteristics of different sub-groups (e.g. male and female farmers).

Table 9 Data collection tools for initial exploratory qualitative study by region and community

Tools	Central Region District 1			Upper West Region District 2			National	TOTAL
	Asara	Dolira	Soloba	Foli	Nzoro	Tangoro		
Individual interviews								
In-depth interviews (IDIs) with farmers	2	2	2	2	2	2	NA	12
Key informant interviews (local)	3	3	3	2	2	2	NA	15
Key informant interviews (national)	NA	NA	NA	NA	NA	NA	2	2
Expert interviews (national)	NA	NA	NA	NA	NA	NA	3	3
Total IDIs	5	5	5	4	4	4	5	32
Focus group discussions (FGDs)								
Farmers with phone	1 (male)	1 (female)	1 (male)	1 (male)	1 (male)	1 (female)	NA	6
Community members with phone	1 (female)	1 (female)	1 (female)	1 (female)	1 (female)	1 (male)	NA	6
Total FGDs	2	2	2	2	2	2	0	12

2.3 Qualitative data collection

Data collection consisted of audio-recorded in-depth interviews (IDIs) with farmers who had access to a mobile phone and with local key stakeholders including health workers, community leaders and agriculture extension workers (see Table 9). This was accompanied by detailed field-note observations and focus group discussions (FGDs) with farmers and other relevant community members (e.g. elderly people, men). Three IDIs with national experts in agriculture were also conducted to triangulate the qualitative findings. All IDIs and FGDs were guided by semi-structured topic guides organised around the main aims of the initial exploratory qualitative study.

2.4 Qualitative tools

Multiple data collection tools were used to obtain qualitative data from different sources and perspectives. This enabled us to conduct a nuanced analysis of the context but also helped to triangulate the data. The main data collection tools were semi-structured IDIs with farmers, key informant interviews, national-level expert interviews, and community member interviews and FGDs. In total, 32 in-depth interviews and 12 FGDs were conducted across six communities (three in each district) (see Table 9).

2.5 Qualitative data analysis

The qualitative data were analysed using a directed content analysis approach focused on the main qualitative evaluation questions [10]. Data analysis started with open coding of several interviews using the qualitative data analysis software (NVivo) and the development of an initial coding scheme that guided the coding of the remaining data. To improve the rigour of the data analysis, coding was done by two researchers independently and coding schemes were then discussed and modified into a joint scheme. While the coding scheme guided the coding, it was flexible enough to allow for unforeseen topics that emerged to be added at any point. After preliminary coding, transcripts were recoded – for additional information and emerging themes. Initial analysis results, as well as the final report, were shared with the field team and lead researcher in Ghana to ensure that the Institute of Development Studies (IDS) team interpreted the findings correctly and to provide additional details that were considered necessary.

3. Business model and cost effectiveness evaluation

The business model component aims to describe the value proposition of mNutrition and how services are provided, and how these change over the duration of the programme. The cost-effectiveness analysis will compare the costs and outcomes associated with mNutrition programmes with more conventional or traditional communication channels such as radio and extension agents.

3.1 Methods

Business models traditionally describe how a business is going to make a profit from a product or service and identify the direct relationship between the two. It considers who its customers are, why they will buy the product or service (the value proposition), and how the company is going to provide the product or service. On the financial side, it considers both revenues (and pricing) and costs. The role of Value Added Service (VAS) within mobile network operators (MNOs) is not always straightforward. There are imputed benefits, and these are recognised as important within the DFID log frame for the whole GSMA programme. The challenge here then is to identify the broad business model including the non-monetary benefits of the service to each stakeholder.

This component consists of ongoing mixed data collection drawing on:

- Qualitative interviews with stakeholders and MNOs
- Commercial data provided by stakeholders and MNOs
- Findings from qualitative research by IDS and quantitative research by IFPRI
- Monitoring data
- Cost and impact performance data available in published literature, analysis from government stakeholders and alternative service providers as a source of additional, unpublished information on costs and impact.

3.2 Data management and analyses

Given the complexity of the partnerships involved in the mNutrition projects, Osterwalder and Pigneur's [11] business model canvas was used as a framework for the research (see [3] for further details). Initial data analysis for the quantitative data was conducted by IFPRI; the qualitative transcription, data cleansing, and analysis was collected by IDS in close collaboration with in-country data collection partners (PDA for qualitative study and ISSER for quantitative study).

The qualitative and quantitative data were then used to populate the Osterwalder and Pigneur canvas and complemented with other data sources (e.g. user experience testing, case studies, Rapid Feedback surveys, etc), as well as grey literature.

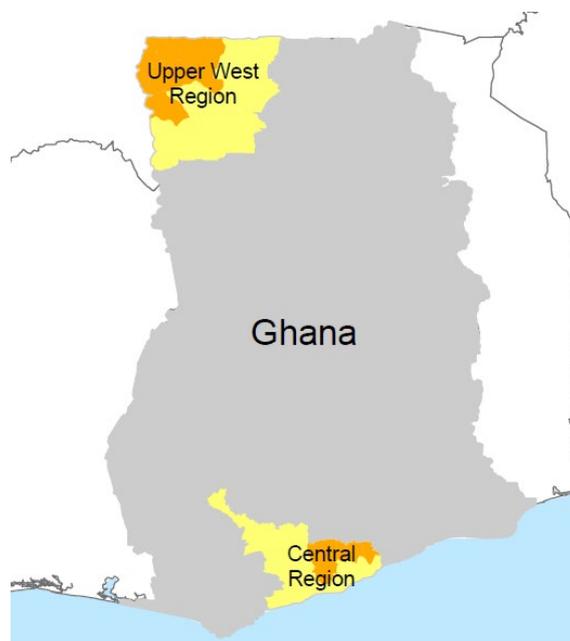
4. Ethical approval

The ethical implications of the study were reviewed by three independent committees. National-level ethics approval for the impact evaluation was obtained by the University of Ghana Ethics Committee for the Humanities. In addition, ethics approval for the quantitative component was obtained from IFPRI's Institutional Review Board and IDS Ethics Board provided approval for all components of the evaluation.

Annex B Regional profiles

This section examines the profile of the two regions where the VFC is being evaluated. It highlights the social and geographical context of these regions (see Figure 3).

Figure 3 Regional map of Ghana



Source: Authors' own

Central Region

The Central Region (CR) lies between the dry equatorial zone and the moist semi-equatorial zone, with annual rainfall ranging from 1,000mm to 2,000mm. The prominent months of rainfall are May to June and September to October.

Literacy: The literacy rate is 78.2 percent across CR, with the rate being higher in urban areas (82 percent) compared to rural areas (74 percent) [12].

Agriculture: A little over half of all households (51.4 percent) practise agriculture; women account for slightly more than half (51.6 percent) of those engaged in agriculture. The main food crops of the region include: tubers such as yam, cassava and cocoyam; grains such as maize, rice and millet; and tree crops including cocoa, oil palm and citrus fruits. About 58 percent of farms in the region produce food crops. Farming is evenly split among the three main types of cropping: mixed cropping (34.6 percent), mono cropping (33.5 percent) and inter-cropping (31.9 percent).

Mobile phone: Of those aged 12 years or over, 44.9 percent own a mobile phone. Ownership is skewed in favour of men (51.5 percent) compared to women (39.2 percent) [12].

Health and nutrition: CR has an under-5 mortality rate of 69 per 1,000 births, while the infant mortality rate is 48 per 1,000, live births [15]. The institutional maternal mortality rate is 102 per 100,000 live births. Of women aged between 15 and 49 years, 98 percent received antenatal care

(for the most recent births) from a skilled provider [15]. Some of the basic indicators for nutrition are shown in Table 10.

Table 10 Nutrition indicators in Central Region

Indicator	%
Severe stunting	8.6
Moderate stunting	22
Severe wasting	0.6
Children ever breastfed	99.4
Children breastfed one hour after birth	60.9

Source: [15]

Upper West Region

The Upper West Region (UWR) is in the north-western corner of Ghana and is bordered by the Upper East region to the east, the Northern region to the south, and Burkina Faso to the west and north. The UWR has a single rainy season from April to September, with average annual rainfall of about 115cm. This is followed by *harmattan*, a prolonged dry season characterised by cold and hazy weather from early November to March, followed by an intense hot weather season, which ends with the onset of early rainfall in April. UWR can be sub-divided into two agro-ecological zones: Guinea savannah in the south and Sudan savannah in the north and north-east.

Literacy: More than half of the population (59.5 percent) in the region are illiterate. This is twice as high as the national average of 25.9 percent [17]

Agriculture: The majority of people of the UWR practise farming, which is primarily rain fed and carried out on a subsistence as well as commercial basis. The major crops cultivated are maize, rice, sorghum, millet, yam, cowpea, groundnut and soya bean. Minor crops include sweet potato, beans and cassava [12]. While maize, guinea corn and groundnuts are cultivated for domestic consumption, cotton and cowpea are produced as cash crops [17]. Vegetables such as okra, pepper, tomatoes and leafy vegetables are also cultivated in the region, especially in the dry season. Cash crops include cashew, mango, cotton and shea. Cattle rearing is another important agricultural activity in the region.

Mobile phones: Only 21.7 percent of the population (12 years or over) owns a mobile phone [12].

Health and nutrition: In 2014, the infant mortality rate in the region was 64 per 1,000 births and the under-5 mortality rate was 92 per 1,000 births [15]. Some of the basic indicators on nutrition are shown in Table 11.

Table 11 Nutrition indicators in Upper West Region, children under age 5 years

Indicator	%
Severe stunting	5.7
Any stunting	27.9
Severe wasting	1.4
Children ever breastfed	100
Breastfed one hour after birth	40.6
Anaemia among women	35.6

Source: [15]