



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

Final Ghana mixed methods evaluation report

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Executive summary

Vodafone Farmers Club in Ghana

mNutrition was a five-year global initiative supported by the UK Foreign, Commonwealth and Development Office (FCDO), organised by Groupe Spéciale Mobile Association (GSMA), and implemented by in-country mobile network operators (MNOs), which sought 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 programme aimed to promote behaviour change around key dietary and child feeding practices that was likely to result in improved nutritional health within a household.

In Ghana, mNutrition was implemented through an mAgri platform called Vodafone Farmers Club (VFC). This service was a 'bundled solution', offering agriculture and nutrition information through SMS messages, voice messages, and an expert call centre (provided by Esoko), as well as offering free calls to others with VFC SIM cards. The content aimed to promote behaviour change around key farming decisions and practices, as well as around other household practices (e.g. safe food storage and preservation, the nutrient content of food, etc.), that is likely to result in improved nutritional health within a household.

Evaluation objectives and methodology

A consortium of researchers from Gamos, the Institute of Development Studies (IDS), and the International Food Policy Research Institute (IFPRI) was contracted by FCDO to undertake an impact evaluation of VFC in Ghana. The objectives of the evaluation were to assess the impact, cost effectiveness, and commercial viability of VFC. The field data collection for this evaluation covered the period from October 2016 until April 2019. The evaluation used a theory-based mixed methods approach with three interlinked components, as follows:

- A **quantitative component**, which used a randomised encouragement design to determine the causal effect of VFC on dietary diversity, agricultural income, and productivity. The encouragement design did not restrict access to VFC, but instead worked by randomly assigning some communities to receive additional marketing and promotion from the evaluation team, to encourage uptake of VFC. Because the encouragement was randomly assigned, the systematic variation in take-up of VFC could be used to measure the causal impact of the programme as the difference in outcomes between encouraged and comparison communities at endline. Quantitative data collection took place in Central Region (CR) and Upper West Region (UWR) in Ghana.
- A **qualitative impact evaluation**, which consisted of three qualitative data collection rounds and which took place in a purposefully selected sub-sample of quantitative villages in CR and UWR, where the encouragement intervention had taken place (i.e. the treatment villages). It aimed to provide in-depth understanding of the context, assumptions, underlying mechanisms of change, and the implementation process of VFC.
- A **business model and cost-effectiveness evaluation**, which employed stakeholder interviews, commercial and end user data analysis, document analysis, and evidence from the quantitative and qualitative evaluations. These data were used to generate a business model framework and to estimate the wider imputed benefits from the value-added service (VAS) for the range of stakeholders involved.

The evaluation report presents the findings structured around the evaluation questions (see Section 4.1). It draws on evidence from each component to address each question as comprehensively as possible. This report deliberately presents the results in a way that is accessible to, and actionable for, non-technical audiences, including policymakers. In-depth technical and methodological details and discussions have therefore been excluded, but these are included in the detailed method-specific reports

Main findings and recommendations

Effectiveness of VFC in reaching smallholder farmers

The evaluation found that the overall reach of VFC was low. In particular, female farmers and poor farmers were often excluded, as they had limited or no access to a mobile phone. The limited reach of VFC can be explained by shortcomings in the available supportive infrastructure, the capacity of the intended VFC recipients, and limitations in the implementation and design of VFC:

- The availability of supportive infrastructure is an important requirement to enable a mobile phone-based information service to effectively reach the intended target group in a chosen context. This includes adequate signal coverage and strength of the network that provides the service (here Vodafone), sufficient autonomy of the target group in relation to access to a mobile phone (i.e. access is not controlled and restricted by the owner), or ownership of a mobile phone (especially among female farmers), and easy access to electricity to charge the mobile phone (without long down times due to lack of electricity). If these requirements are not met for a large proportion of the intended target group, alternative modes of content delivery (e.g. via radio or community outreach) or blended approaches (e.g. radio and community workers) may have a wider reach and be more inclusive.
- Introducing a mobile phone-based service with a new SIM card can pose a barrier to the effective reach of the service as farmers who own a mobile phone usually already own at least one (preferred) SIM card that they regularly use. Consequently, there is no perceived need or demand for an additional SIM card and no incentive to use it regularly.
- Offering a mobile phone-based service through a network that is not the preferred network in a location (e.g. Vodafone in CR) is likely to lead to only low take-up of and sustained engagement with the service.
- The delivery modalities of mobile phone-based information services need to be chosen based on the capacity of the target audience (e.g. in areas with high levels of illiteracy, voice-based services only).
- Illiteracy and the inability to understand English were major barriers to the uptake of the VFC SMS messages on price and weather. We recommend offering the content of SMS messages as recorded voice messages (in local languages). However, as weather and price information are highly time-sensitive and context-specific, and voice messages are more expensive to deliver and produce, providing this information as recorded voice messages may increase the implementation costs of VFC considerably (thus making the service less likely to be commercially viable).
- Farmers missed a large proportion of the recorded voice messages as they had no voicemail set up, or were unaware of how to access their voicemail to capture missed voice calls. This implementation challenge at the end user level is easy to address and is likely to have a significant impact on the reach of recorded voice messages.
- The sharing of agriculture and nutrition advice provided by VFC between farmers could increase the reach of the service considerably, including to farmers who are currently excluded

(e.g. because they cannot afford a mobile phone). However, the evaluation suggests that sharing does not frequently happen. VFC should consider experimenting with approaches to actively encourage message sharing (e.g. by sending reminders to share and highlighting the benefits of sharing, such as better well-being of the entire community).

- The customer journey is key for the successful reach of a mobile phone-based information service. Provision must be made to help customers understand the service, to register easily, and to subscribe transparently and painlessly. It is important that field agents are trained and incentivised to sell the product appropriately. Alternatively, the service needs to be simple enough for customers to manage themselves.
- Adding human support features to mobile phone-based services is likely to increase reach and long-term engagement. This could include interpersonal contact with promoters during registration, profiling, and implementation, as well as a well-functioning call centre. Also important is that farmers are made fully aware of available human support features and the conditions of their use (e.g. the call centre can be contacted free of charge).

Impacts of VFC on nutrition and livelihood outcomes

Based on the quantitative impact evaluation findings, being offered the VFC service or having used it at least once had no impact on households' and women's dietary diversity, agriculture production and income, or nutrition or agriculture knowledge or practices. The lack of impact of VFC can in part be explained by the low reach of, and very limited sustained engagement by farmers with, VFC.

Nevertheless, the subset of farmers who engaged with VFC for at least several months made at least some changes in their agriculture-related behaviours and practices (and to a lesser extent their nutrition-related behaviours and practices). The types of changes farmers made varied greatly and depended on their financial circumstances, capacities, and contexts.

The evaluation findings also suggest that offering VFC free of charge can positively affect farmers' attitudes towards, and use of, Vodafone as their network provider. However, reintroducing user fees for the service may negatively affect attitudes towards Vodafone.

Process of content development for VFC

The evaluation found high levels of overall acceptance of the content of VFC for the subset of farmers that used the service. Farmers perceived the agriculture tips as easy to understand, useful, and relevant. In particular, female farmers valued the agricultural and nutrition content. Trust in the credibility of the content of the service was generally high. Nevertheless, not all content was perceived as relevant to farmers' specific needs and the evaluation also suggests some potential areas for improvement, as follows:

- Nutrition tips were mainly valued by female farmers. However, there was a lack of focus in the nutrition tips on the main nutrition-related behaviour that VFC aimed to improve (i.e. dietary diversity). The reason for this is that the nutrition tips in VFC covered a large range of topic areas, including food preparation, food storage, and food and environmental hygiene, and only very few messages related to approaches to improve dietary quality or diversity. Furthermore, the frequency of nutrition tips (one to three per month) is likely to have been too low to trigger any quantifiable changes in behaviours. We recommend increasing both the frequency and the focus of the nutrition tips to promote a change in dietary practices more effectively.

- Poor farmers were very receptive to tips on practical, low/no-cost agricultural practices, especially as this information was often missing from other sources. Future interventions should focus on providing practical, low-cost agriculture and nutrition advice that is actionable and achievable within resource-poor contexts.
- The information needs of farmers change dynamically and farmers frequently looked for information that would help them to tackle individual, pressing agricultural or nutritional problems. Introducing and strengthening existing two-way communication channels (e.g. the VFC call centre or interactive dialogues) could enable farmers to actively seek the information they need at the time they need it.
- Poor tailoring of the content could result in disengagement with the service. Careful and individualised profiling during the initial registration process is vital to build trust and to ensure well-tailored content. However, this is also time-consuming, laborious, and difficult to conduct at scale. Experimenting with new approaches to profiling might help to achieve effective optimal tailoring without increasing the costs significantly.

Mobile phone-based services for behaviour change

Several features give mobile phones an advantage over 'traditional' channels for behaviour change communication:

- Mobile phones can help to address area and time-sensitive information needs (e.g. time-sensitive agriculture advice) more effectively and with less effort than most other information sources, even in remote, inaccessible settings (as long as there is sufficient network coverage).
- Mobile phone-based services are more convenient as information can be accessed at a time that is convenient for the farmer (assuming they have voicemail set up). This can help to address information asymmetries and saves time and resources as regards information-seeking.
- In particular, female farmers, who often struggled with multiple demands on their time and/or had mobility constraints, valued receiving mobile phone-based information on an ongoing basis.
- In a context of declining access to agricultural extension workers, mobile phone-based services potentially offer a low-cost mechanism for reaching farmers, and one that is more inclusive of low-income and female farmers.

However, there were several shortcomings of VFC that would need to be addressed to increase its effectiveness for behaviour change:

- The transmission of information (i.e. SMS and recorded voice messages) to passive audiences without an element of interactive engagement is likely to have limited the effectiveness of VFC in changing behaviours. Farmers require peer, social, or emotional support when attempting to adopt the advice from VFC. Strengthening the field presence and the call centre, and introducing other interactive components into mobile phone-based services, is likely to increase their effectiveness in changing behaviours.
- Radios are preferred over mobile phones for the delivery of information by many as this method of communication is more inclusive, not dependent on network coverage, and less distracting during farm work. The blending of mobile phone-based information and radio might make use of the advantage of both technologies and be more inclusive.

Other findings regarding the effectiveness of mobile phone-based services to change behaviours include the following:

- To increase the effectiveness of mobile phone-based behaviour change interventions, they could be joined up with other ongoing interventions (e.g. livelihood improvement programmes or social protection programmes), or with mobile money services that provide farmers with the financial resources needed to act upon VFC advice.
- Mobile phone-based advisory services such as VFC are unlikely to be effective as a stand-alone channel for behaviour change; they may perform best when integrated with traditional media and channels as part of a multi-level strategy. Mobile phone-based information could therefore be one part of a broad and many-pronged policy, and not the only component aiming to change behaviours and practices.
- Effective engagement with selected well-tailored mobile phone-based messages might be sufficient to trigger change. Thus, rather than focusing on increasing levels of ongoing engagement with mobile phone-based interventions, it should be acknowledged that farmers' engagement with the intervention is likely to vary over time.

Commercial viability of business models for VFC

- VFC was offered under both subscription and freemium business models. Financial modelling shows that, under certain circumstances, it would be possible for both of these approaches to be financially viable. Key assumptions relate to subscriber numbers, the cost of SMS messages, and average revenue per user (ARPU). Each of these assumptions has implications for the sustainability of the business model applied. In order to achieve the necessary subscriber numbers (in the order of 200,000), onboarding processes need to be addressed. Creating a simple product and a well-informed salesforce is key. Third-party service providers need to pay the real costs of bulk SMS messages, whereas an MNO may not allocate real costs to messages sent, making an MNO-hosted service more attractive. Targeting particularly low-income segments of mass market customers results in low ARPU.
- SMS costs are the largest single component of cost of sales. Including an MNO partner that can cover these costs can help to make mobile phone-based information services more commercially viable. It may therefore be easier to make a financial case for an agricultural advisory service hosted by an MNO rather than a third-party content provider, given that it is not clear that MNOs allocate real costs to SMS messages sent, whereas a content provider will buy bulk SMS messages at the market cost.
- Subscriber numbers for a mobile phone-based information service are crucial for commercial viability, but they have to be the right customers in order to maintain high retention rates. In a country the size of Ghana, the number required (around 200,000) represents a large proportion of the potential rural market. Extensive marketing would be required to reach all of the potential market. More importantly, barriers to adoption of the service would need to be overcome, especially in relation to registration and profiling, and there would need to be effective marketing by field agents who are trained and incentivised to sell the product and its features appropriately.
- Contracting in VAS (e.g. as Vodafone did with Esoko) enables an MNO to set up a service quickly and with minimal up-front costs. The drawback is that the MNO might then lack market understanding and expertise, making the product vulnerable to the partnership relationship. Contractual relationships, for example, provide little incentive to innovate. Future programmes should take the time needed to understand the nature of the partnerships involved.
- Mobile phone-based information services depend on multiple partnerships (including content and platform providers, and the MNO). Effective partnerships depend on personalities. Partnerships must be agile in order to respond to changing markets. Support initiatives should include some form of future-proofing to help mitigate changes that will occur over the duration of a programme.

- Mobile-based agricultural advisory services offer the promise of improving agricultural practices among low-income farmers at low cost. However, the study highlights a number of challenges faced by scaled-up SMS-based systems when trying to engage with their target group:
 - Each information delivery channel (e.g. SMS, outboard dialling (OBD), and interactive voice response (IVR)) has advantages and disadvantages in terms of cost, literacy, timing, permanent record, and so on. Hybrid approaches would be ideal, but financial sustainability is highly sensitive to the price of messages, making it difficult to take advantage of expensive, voice-based technologies.
 - Farmers lack the financial resources to implement changes to their agricultural practices.
 - Low-income farmers are risk averse, making them reluctant to implement new practices and making it more difficult to convince them to subscribe.
 - The process of onboarding is crucial, and it needs to be simple and immediate. Providing a local presence to assist (e.g. through well-informed agents) is expensive.
 - VFC offered a complex bundle of services that customers struggled to understand, especially when agents had a poor understanding of the product, tending to sell it as a SIM rather than as a VAS package.
 - Financial sustainability is most challenging when serving customers with the lowest ARPU.
- Emerging digital agritech services may well provide more comprehensive packages of support for farmers, which may result in significant improvements. However, the barrier to adoption of these data-driven services is higher (in terms of digital literacy), so they risk widening digital divides and leaving the poorest behind.
- This report argues that an agricultural advisory service such as VFC could be financially sustainable under certain circumstances. This raises questions about the ethics of spending public money on services that result in financial benefits for the private sector. There would therefore be value in the donor community engaging in discussion on how commercial returns can be used to reimburse expenditure from public funds (while still generating sufficient revenues for the MNOs involved).

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List of abbreviations

ARPU	Average revenue per user
CR	Central Region
FAO	United Nations Food and Agriculture Organization
FCDO	Foreign, Commonwealth & Development Office
FGD	Focus group discussion
GAIN	Global Alliance for Improved Nutrition
GHS	Ghanaian cedi
GSMA	Groupe Spéciale Mobile Association
IDI	In-depth interview
IDS	Institute of Development Studies
IFPRI	International Food Policy Research Institute
IRR	Internal rate of return
ITT	Intent-to-treat
IVR	Interactive voice response
LATE	Local average treatment effects
MNO	Mobile network operator
MTN	Mobile Telephone Networks
OBD	Outboard dialling
OPM	Oxford Policy Management
PPI	Poverty Probability Index
SMS	Short messaging service
ToC	Theory of change
UWR	Upper West Region
VAS	Value-added service
VFC	Vodafone Farmers Club
WHO	World Health Organization
WTP	Willingness to pay

1 Introduction to the mNutrition evaluation

1.1 Objectives of evaluation

This report constitutes the final mixed methods report on the evaluation of the mNutrition intervention in Ghana. mNutrition was a five-year global initiative supported by FCDO, organised by GSMA, and implemented by in-country mobile network operators (MNOs). mNutrition's goal was to use mobile technology to improve the health and nutritional status of children and adults in low-income countries around the world. mNutrition was implemented through existing mAgri and mHealth programmes in 12 countries throughout sub-Saharan Africa and South Asia.

In Ghana, mNutrition was implemented through an mAgri platform called Vodafone Farmers Club (VFC). This service was a 'bundled solution', offering agriculture and nutrition information through SMS and voice messages, an expert call centre, and free calls to others with VFC SIM cards. The message content aimed to promote behaviour change around key farming decisions and practices, as well as around other household practices (e.g. safe food storage and preservation, nutrient content of foods, etc.), that were likely to result in improved nutritional health within a household.

A consortium of researchers from Gamos, IDS, and IFPRI was contracted by FCDO to undertake an impact evaluation of VFC in Ghana. **The objectives of the evaluation were to assess the impact, cost effectiveness, and commercial viability of VFC.** The evaluation used a mixed methods theory-based approach with three interlinked components: an experimental quantitative encouragement design; an in-depth qualitative study with multiple rounds; and a business modelling and cost-effectiveness assessment. Data collection for the evaluation covered the period from October 2016 until March 2019.

1.2 Aim of the report and intended audience

The aim of this mixed methods report is to combine the findings of the three components of the evaluation in order to build a deeper understanding of, and gather lessons learned about, best practices in the design and implementation of mobile phone-based information services to ensure (a) behaviour change and (b) continued private sector engagement in different countries.

This report deliberately presents the results in a way that is accessible to, and actionable for, non-technical audiences, including policymakers. In-depth technical and methodological details and discussions have therefore been excluded but these are included in the detailed method-specific reports that can all be found [here](#).¹

The primary audience for the evaluation results are FCDO staff working on agriculture, nutrition, and digital interventions, along with other key stakeholders, including GSMA and its national members (including local MNOs implementing mNutrition services), national governments (in particular, ministries of health and agriculture), international agencies and donors, as well as community-level health/nutrition and agriculture extension workers.

¹ www.ids.ac.uk/projects/external-evaluation-of-mobile-phone-technology-based-nutrition-and-agriculture-advisory-services-in-africa-and-south-asia-mnutrition-2/

The evaluation's communications strategy, developed during the inception phase of the project, laid out a set of goals, objectives, communication channels, and activities which have informed the basis of all communication activities undertaken to date.

The findings of this report were presented and discussed with key Ghana-based programme partners as well as wider stakeholders working in or interested in this area during an interactive webinar in April 2020. Earlier findings from the evaluation (and in particular the qualitative midline study) fed into the design of the subsequent FCDO-supported GSMA programme and it is anticipated that the evaluation's findings will be used to inform ongoing implementation, as well as the design of future digital information services and programmes.

1.3 Organisation of the report

Following the description of the VFC service and the theory of change (ToC) for VFC in Section 2, a brief description of the evaluation context is given in Section 3. Section 4 provides a brief overview of the evaluation methodology.² Section 5 presents the findings of the evaluation, structured around the evaluation questions laid out in FCDO's terms of reference. For each question, key findings resulting from the integration of the results from all three evaluation components are provided, and lessons learned and recommendations for policy and practice are presented. Section 6 briefly revisits the ToC for VFC and considers the extent to which it (and in particular its underlying assumptions) has been validated by the evaluation. Section 7 discusses the findings of the evaluation, drawing on the wider global literature on mobile phone-based interventions to change nutrition and agriculture behaviours. In this section we also draw parallels with the evaluation of mNutrition in Tanzania (Barnett *et al.*, 2020). The report ends with the conclusions in Section 8.

² The reader is referred to the technical evaluation reports for more details, if they require these.

2 The mNutrition service in Ghana: Vodafone Farmers Club

2.1 Description of the intervention

VFC was a mobile phone-based service offering agricultural and nutrition information via a bundled ‘solution’ (see Table 1 for details of the services offered in the bundle). VFC was launched in 2015 and the service was paused in January 2019, when Vodafone’s contract with Esoko expired. VFC failed to achieve the number of subscribers expected and a new service was then designed as part of a strategy to consolidate a number of offerings targeting farmers.

Table 1: Services included in the VFC bundle

Services included	Delivery mode	Frequency	Language
Local weather information	SMS messages	Three messages per week	English
Local market price information (for selected crops)	SMS messages	One message per week	English
Agricultural tips for selected crops	Recorded voice messages	Three per month	Local language
Nutrition tips (for selected crops and in general)	Recorded voice messages	Three per month ¹	Local language
Call centre (with agriculture and nutrition experts to answer farmers’ questions)	Calls	At any time	Local
Free calls and SMS messages to other VFC members	Calls/SMS messages	At any time	N/A
Discounted SMS messages and calls to non-VFC members	Calls/SMS messages	At any time	N/A

¹ Initially, VFC only provided one nutrition message per month.

Source: Authors’ own

The content for the agricultural tips was developed by Esoko Ghana, a mobile phone-based rural information service. Esoko also operated the call centre.

The content for the nutrition tips in VFC was developed by the Global Alliance for Improved Nutrition (GAIN). GAIN created a library of 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. To further strengthen the nutrition content these messages were later supplemented by messages developed by Grameen, with 26 messages focusing on animal-sourced food (e.g. eggs and dairy).

VFC was designed to offer customised information to farmers based on their selected preferences: their location (for weather information and crop market price information), preferred language for receiving recorded voice messages, and preferred crop choice for agricultural tips and price information.

The VFC service was available through a dedicated VFC SIM card and was activated upon obtaining a monthly subscription to the service. Initially, there was a subscription fee of Ghanaian Cedi (GHS) 2 (US\$ 0.45) per month, paid through airtime credit, initiated by the member on their phone. However, due to very low rates of membership activation the programme was modified to automatically deduct GHS 2 per month. If a member's credit fell below GHS 2, membership would become inactive until credit sufficiently increased. Between October 2016 and June 2017, the monthly fee was dropped altogether in order to increase subscriptions. From June 2017 until December 2018, when the service was suspended, the fee was reinstated at a lower level of GHS 0.5 per month.³

2.2 How was VFC expected to improve nutrition and agricultural outcomes among farmers, and to be commercially viable?

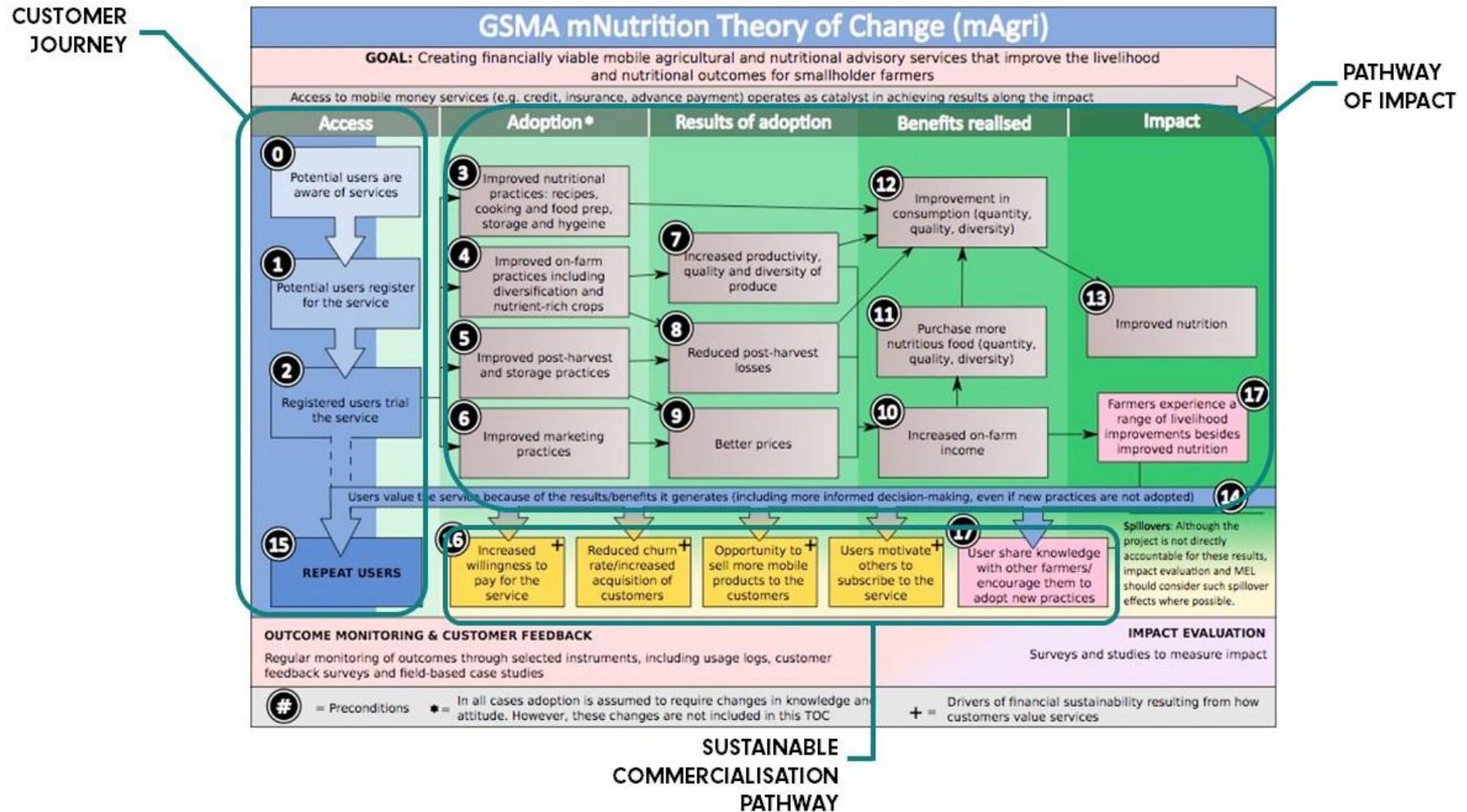
GSMA has developed a visual presentation of how mAgri services (including VFC⁴) were expected to improve agricultural and nutritional outcomes while generating direct revenues and indirect commercial value for the MNOs (here: Vodafone) (see Figure 1). In order to facilitate comprehension, we have conceptualised the ToC into three components:⁵ the customer journey, the pathway of impact, and the sustainable commercialisation pathway. These components are briefly described below.

³ Farmers who were enrolled in the treatment group of the quantitative impact evaluation received VFC free of charge throughout the entire intervention period (until 31 March 2019). The evaluation team contracted Esoko directly to continue the VFC service from January through to March 2019 when VFC had officially ended.

⁴ It should be noted that the ToC presented in Figure 1 is a generic version.

⁵ This conceptualisation was inspired by the ToC used for the mHealth plus mNutrition framework, which suggests three distinct components (see Barnett *et al.*, 2017).

Figure 1: GSMA mNutrition Theory of Change for mAgri



Source: GSMA 2016, reproduced with permission

2.2.1 Component 1: Customer journey

The first component is the **customer journey** (depicted in blue in Figure 1), which consists of the following sequential stages (GSMA and Altai, 2017):

- awareness of VFC;
- registration and trial of VFC; and
- use and repeated use, which ultimately leads to impact.

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

- they stay with the operator providing access to this service (known as reduced churn⁶);
- they like it (the service adds to the brand); and
- they spend money on other products and services from that operator, known as ‘incremental upsell’ – such as making more calls and sending SMS messages to friends and relatives.

GSMA hypothesised 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 impacts in the ToC (GSMA and Altai, 2017).

2.2.2 Component 2: Pathway to impact

The second component of the ToC is the **pathway to impact** (depicted in green). It was assumed that once farmers had access to the nutrition and agricultural information, they would gain new information about practices that could help them to improve their nutrition, agricultural productivity, and income. The improved knowledge was expected to trigger a change in attitudes towards these practices (see assumptions in Section 2.2.4). As a result of these changes, farmers were expected to change their current nutrition and agriculture practices and adopt new improved practices. The intended result of the adoption (see Figure 1) was a direct improvement in household consumption and an increase in agriculture productivity and agricultural income, which was assumed to have a positive impact on household food consumption (including a more diverse diet), leading to improved nutrition. The primary outcomes that were the focus of this evaluation were improved agriculture productivity and income, and improved dietary diversity.

2.2.3 Component 3: Sustainable commercialisation pathway

The third component of GSMA’s ToC is the **sustainable commercialisation pathway** (depicted to some extent in yellow). It was assumed that VFC would be a commercially viable service if Vodafone’s direct revenues from the service (meaning revenues generated through paid elements of the service) and indirect commercial value (meaning reduced churn, increased ARPU, and revenues generated through new customers who were attracted by VFC) became greater than the

⁶ There are four main and several smaller MNOs in Ghana, and customers are typically not very loyal to one or the other, so reducing churn is a high priority.

running costs of the service, and provided an acceptable return on any capital investment made in setting up the service.

2.2.4 Assumptions that underpin VFC

Table 2 presents the key assumptions that lay behind each component of the ToC of VFC. The list of assumptions was developed by the evaluation team and was based on GSMA's own monitoring and evaluation framework, the mNutrition logframe (GSMA, 2015a; GSMA, 2015b), the desk review (Barnett and Srivastava, 2017), and the evaluation team's experiences from previous impact evaluations of digital and behaviour change interventions.

Table 2: Assumptions behind the ToC of VFC

Customer journey	Pathway to impact			Sustainable commercialisation pathway
	Uptake of new information	Adoption of new practices and results	Results of adoption/benefits realised/impact	
Farmers can access mobile phones to subscribe to and use the 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 strength to subscribe to and use the 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 and SMS messages	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 make it possible 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 messages) and	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

	perceive them as useful			
There are no social norms or attitudes that may hinder farmers from engaging with mobile phone-based information services	Farmers understand the information provided (both language and content)			Key partnerships in the supply chain are valued by each partner and maintained
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
The service is successfully delivered to farmers' mobile phones				

Source: Authors' own

As part of this impact evaluation, the underlying assumptions were explored and tested. See Section 6 for the key findings of this assessment.

3 Evaluation context: Ghana

3.1 Characteristics of Central Region and Upper West Region

The impact evaluation was conducted in two regions of Ghana: CR and UWR. The two regions were purposefully selected as they are different in terms of socio-demographic characteristics, seasons, agriculture, and nutrition outcomes (see Table 3).

Table 3: Regional and national characteristics in Ghana

	CR	UWR	National
Population (2010)*	2.2 million	702,110	24.7 million
Poverty head count** (2010) (%)	19.2	69.4	30.2
Urban population (2010)* (%)	47.1	16.3	50.9
Literacy level (2010)* (%)	78.2	46.2	74
Agriculture indicators			
Percentage of urban and rural population in agriculture workforce (2010)*	51.4	83.7	45.8
Agricultural seasons	Major April – July Minor Sept – Nov+	May – Nov**	N/A
Crop farming (% of farmers) (2010)*	94.1	95.7	95.1
Tree growing (2010)*	1.7	1.9	1.1
Livestock rearing (2010)*	34.9	63.7	40.5
Nutrition indicators			
Child underweight+ (weight-for-age) (2014) (%)	13.9	13.5	11
Maternal undernutrition (%) (2003)^	5	9	9
Dietary diversity (%) (4+ food groups among children 6–23 months) (2014)^	44.3	20.4	28.1

Notes:

*2010 Population and Housing Census National Analytical Report, www.statsghana.gov.gh/gsspublications.php?category=OTc2NDgyNTUzLjkzMDU=/webstats/p9r0796n5o

**2015 Ghana Poverty Mapping Report – Ghana Statistical Service

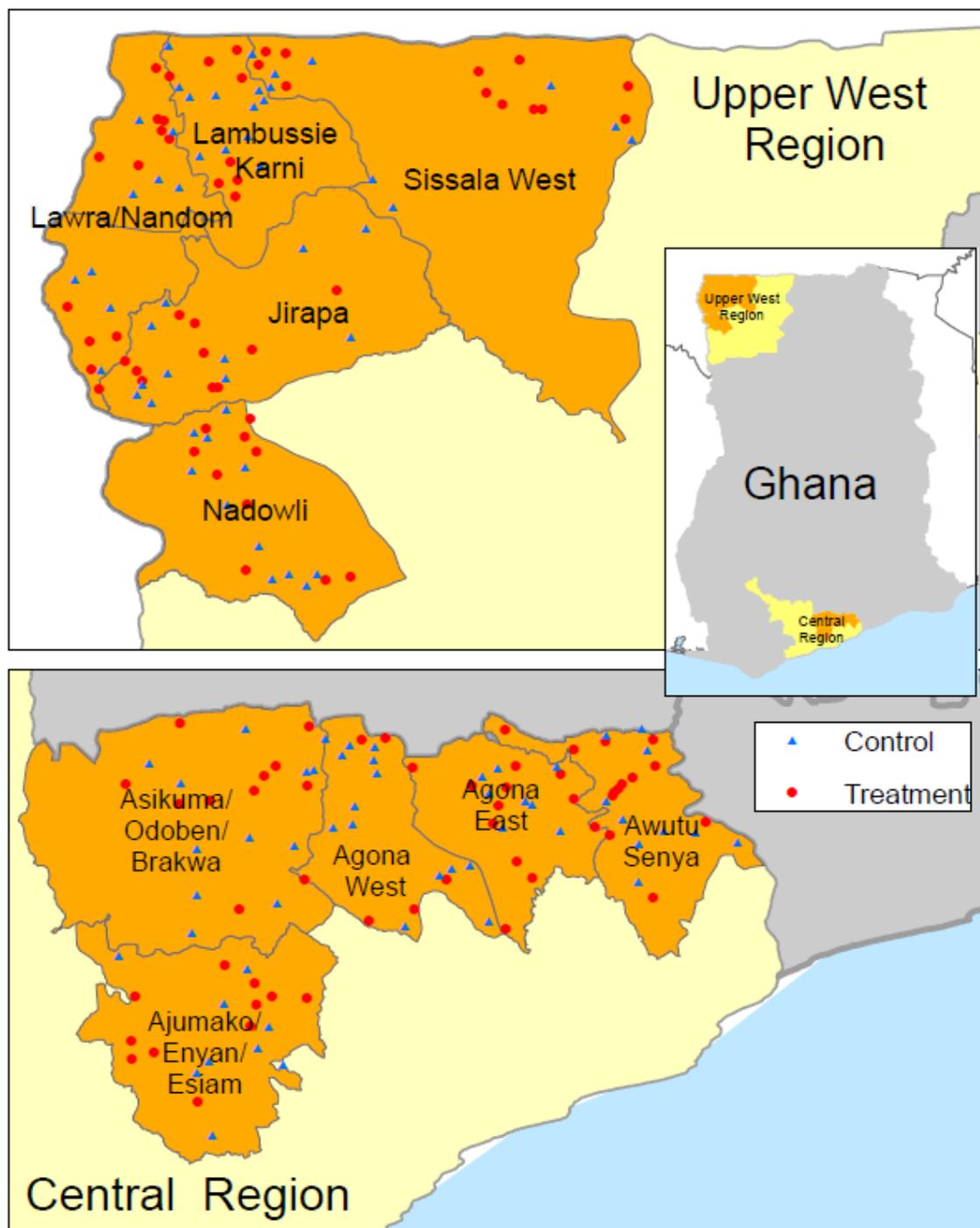
++ Bampuori (2007).

^ Stats for 2003: Nutrition of Young Children and Mothers – Ghana 2003 – Africa Nutrition Chartbooks.

^^2014 GDHS, <https://microdata.worldbank.org/index.php/catalog/2373/related-materials>

Source: Authors' own

In both regions data were collected in five districts each (10 districts in total) (see Figure 2). The districts were purposefully selected, based on: 1) availability of Esoko market price information for crops; and 2) low VFC subscription rates at baseline.

Figure 2: Map of research sites in Ghana

Source: Billings *et al.*, forthcoming

3.2 Smallholder agriculture in Ghana

Approximately 59% of Ghana's total land area is classified as agricultural, of which 56% is currently under cultivation. Most agriculture is rain-fed, with only 0.4% of the total agricultural land under irrigation (Ghana Statistical Service, 2018). Agriculture in Ghana is predominantly subsistence based. There is limited use of high-yielding seed and 80% of the total agricultural output is produced using rudimentary technology – for example, the hoe and cutlass are the main farming tools (United Nations Food and Agriculture Organization (FAO), 2015).

Ghana's agricultural production has grown at an average annual rate of 5.1% 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 (Asmah, 2011). Even cocoa yields per hectare are far lower than in neighbouring cocoa-producing countries such as Cote d'Ivoire (FAO, 2015). 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 of persistently high levels of poverty. According to the 7th Ghana Living Standards Survey, farmers (and in particular self-employed smallholder farmers) are the poorest population group (Ghana Statistical Service, 2018).

Agriculture extension agents are the main source of reliable agricultural information for the majority of smallholder farmers in Ghana. However, service delivery is weak, with a very low extension worker-to-farmer ratio (1:2,700) (Aidoo and Freeman, 2016). As a consequence, access to agriculture information is generally poor and can hamper agricultural development (Danso-Abbeam *et al.*, 2018).

4 Evaluation methodology

4.1 Evaluation questions

The main objectives of this evaluation were to assess the impact, cost effectiveness, and commercial viability of VFC. In line with these objectives, the evaluation has addressed the following evaluation questions⁷:

1. How effective is VFC in reaching smallholder farmers in Ghana?
2. What are the impacts of VFC on nutrition and livelihood outcomes (including knowledge and behaviours), especially among female farmers and extremely poor farmers?
3. Has the process of adapting globally agreed messages to local contexts led to content that is relevant to the needs of poor farmers and their families?
4. What factors make the mobile phone-based VFC service 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 for a mobile phone-based platform such as VFC? And how cost effective is VFC?

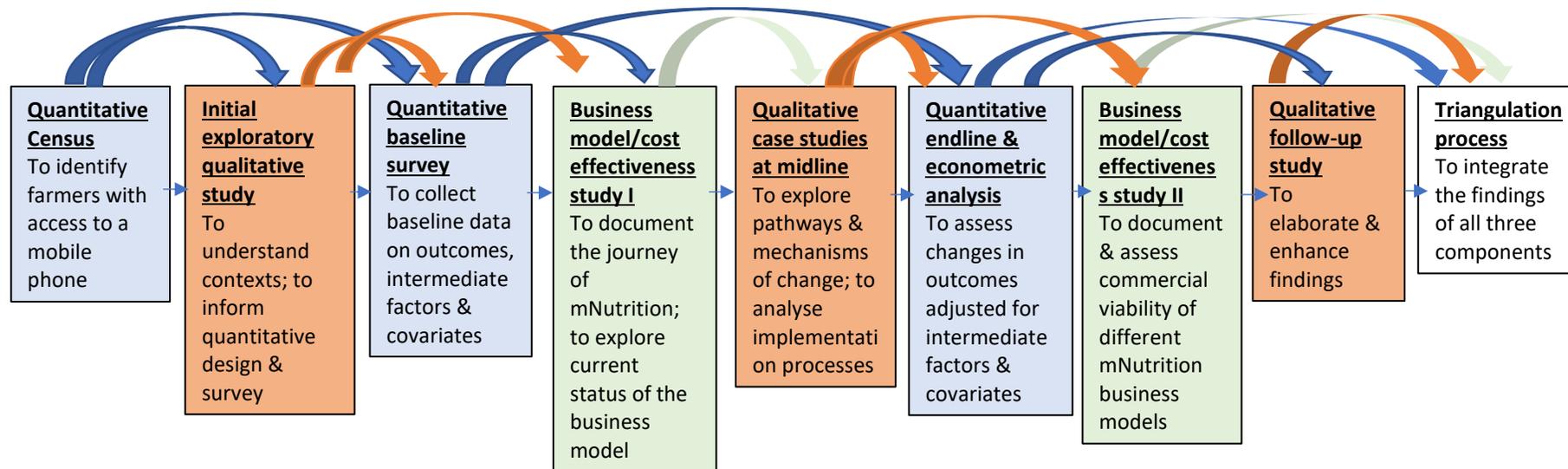
As an overarching aim the evaluation also set out to build a deeper understanding of, and to gather lessons learned about, best practices in the design and implementation of mobile phone-based information services to ensure (a) behaviour change and (b) continued private sector engagement in different countries.

4.2 Evaluation approach

The evaluation has used a theory-based sequential mixed methods approach (Ivankova *et al.*, 2006; Creswell *et al.*, 2003), including a quantitative, a qualitative, and a business model and cost effectiveness component. The three evaluation components were closely linked and integrated with each other at all stages of the evaluation to inform, enhance, and explain the design, development of data collection tools for, and analysis of each individual component (see Figure 3).

⁷ These evaluation questions are in line with the original FCDO terms of reference. However, the questions have been slightly modified to reduce repetition, and have been reorganised and specified to VFC (rather than applying to mNutrition in general).

Figure 3: Visual depiction of the sequential mixed methods design used for the evaluation



Source: Authors' own, based on Barnett, I. *et al* (February 2019)

In the following sections, each evaluation component will be briefly described. The detailed methodology for each component, including sampling strategies and data collection tools used, as well as details of how the components were integrated for each data collection and analysis activity, can be found in the technical reports.⁸ The evaluation consortium was led by three institutions, with each one leading on a different component, in partnership with local data collection partners in Ghana. IFPRI led the quantitative component, IDS led the qualitative component, and Gamos led the business model and cost effectiveness component. ISSER carried out the quantitative baseline and endline surveys and Participatory Development Associates conducted the three rounds of qualitative data collection. Gamos conducted its own data collection. The teams from each lead institution collaborated throughout the evaluation, with regular team calls, meetings, and workshops to share and discuss draft data collection tools, triangulate emerging findings, and to decide jointly about any adaptations to the design required to ensure a coherent and triangulated mixed methods approach.

IDS took the overall leadership of the management and implementation of the evaluation. FCDO, GSMA, the local programme implementing partners Vodafone Ghana and Esoko, and other key stakeholders, were consulted and involved at key points during the evaluation design and implementation, and the evaluation team shared all draft reports with them for comment.

All consortium partners followed rigorous international and country-level ethical approval processes and procedures to ensure data collection was conducted in a professional and ethical manner with respect for confidentiality, voluntary participation, impartiality, and avoidance of personal risk.⁹

4.2.1 Quantitative component: randomised encouragement design

Randomised encouragement design

To rigorously assess the causal impact of VFC on nutrition and agricultural outcomes the quantitative evaluation employed an experimental evaluation design. Given the nationwide roll-out of VFC in Ghana it was impossible to find a pure control group to generate a counterfactual that measured what would have happened to farmers in the absence of the intervention. The quantitative evaluation therefore employed a variation of the classic randomised control trial model: a randomised encouragement design (West *et al.*, 2008). The encouragement design did not restrict access to VFC, but instead worked by randomly assigning some communities to receive additional marketing and promotion for VFC.

The additional marketing and promotion to encourage take-up and continued use was a combination of offering the service for free and door-to-door marketing to farmers in selected communities throughout the evaluation period. The free offer of the service through door-to-door marketing included a short advertisement script on the value added by the service that was randomly targeted to either a male or female from each household.

Because the encouragement was randomly assigned, we used the systematic variation in take-up of VFC to measure the causal impact of the intervention. The estimation methodology compared differences in outcomes of interest across the comparison and encouraged groups, and within the different encouraged groups, using data collected in baseline and endline surveys.

⁸ www.ids.ac.uk/projects/external-evaluation-of-mobile-phone-technology-based-nutrition-and-agriculture-advisory-services-in-africa-and-south-asia-mnutrition-2/

⁹ These principles were guided by the OECD (2010) DAC Quality Standards for Development Evaluation and FCDO's (2011) Ethics Principles for Research and Evaluation.

Primary and secondary quantitative outcomes

The primary outcomes of interest for the quantitative evaluation were:

1. households' and women's dietary diversity;
2. agricultural productivity; and
3. agricultural income.

Secondary outcomes included a large set of variables to measure: (1) intermediate outcomes, such as nutrition knowledge and behaviour, and knowledge and practices relating to farming techniques; and (2) factors that affect take-up and use of the product. Data on nutrition knowledge and behaviour and farming knowledge and behaviour were collected separately for males and females within the same household to analyse differences across gender. We also collected information at baseline on an individual's willingness to pay (WTP) for the VFC service, using the Becker-DeGroot-Marschak method¹⁰ (Berry *et al.*, 2015).

Data collection and sampling strategy

Quantitative data collection took place in five districts in UWR and five in CR, across 207 enumeration areas (104 in the encouragement arm and 103 in the comparison arm). In each enumeration area, 19 farmer households were randomly sampled, for a total sample of 3,933 households at baseline. The criteria for inclusion in the sample were that households must: 1) be a farming household; 2) own a mobile phone; 3) not be a current VFC member; and 4) have at least one female member aged 15–60 years old. The last criterion ensured that we could measure woman's dietary diversity (a primary outcome) in all our sample households.

In order to know which households met our sampling criteria, a census in our selected enumeration areas was conducted. The census also allowed us to calculate current take-up rates for VFC in each enumeration area before the start of the encouragement. The baseline report (Table 5.2) shows the number of households that were not an existing VFC member, out of the total number of households.

The baseline survey was conducted in March–April 2017, before the extra encouragement was implemented, and the endline survey took place between November 2018 and February 2019.

Data analysis

To estimate the impacts of the VFC service on primary and secondary outcomes, we rely on the randomised encouragement design and estimate two distinct measures of impacts. The first are intent-to-treat (ITT) impacts that compare outcomes across households in communities that were randomly assigned to receive the door-to-door offer of the VFC service – i.e. the encouraged group – and households that were randomly assigned to not receive that offer, i.e. the comparison group. The ITT impact estimates measure the average impact of VFC on households in communities randomly assigned to receive the encouragement campaign, regardless of whether the household signed up for VFC and continued to use it. The second impact measures are local average treatment effects (LATE). These, under additional assumptions, estimate the impact of receiving the mNutrition messages on outcomes for households that were induced to register and use the VFC service by the random door-to-door offer ('compliers'). The LATE estimates represent the causal effect of exposure to VFC messaging on these compliers. However, the average causal

¹⁰ This is a common method for eliciting WTP. Under this mechanism, an individual reports a bid for an item; the item's price is then randomly drawn. If the bid is above the price, the individual receives the good and pays the drawn price.

effect on compliers that is estimated is not necessarily the average causal effect on the sample population.

4.2.2 Qualitative component: multiple rounds with a qualitative case study approach

The qualitative component was closely integrated with the quantitative component and the business model/cost-effectiveness component at all stages, to inform, enhance, and triangulate the design, data collection, and analysis. The selection of sites and participants for qualitative data collection was purposive and was a sub-sample of the quantitative treatment sites (no qualitative data collection was conducted in comparison communities). Three qualitative data collection events took place: an initial exploratory study, midline case studies, and rapid follow-up studies.

Initial exploratory qualitative study

A comprehensive contextual analysis of the social, institutional, political, and environmental factors was carried out prior to the quantitative baseline. The analysis focused 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 farmers (and in particular female and poor farmers);
- current information-seeking behaviours related to nutrition and agriculture; and
- social, economic, and environmental factors that may influence the uptake of behaviour change messages provided by VFC.

Two districts (Asikuma Odoben in CR and Nadowli in UWR), and three communities within each district, were purposively selected to offer insights into a variety of different contexts and geographical settings (dry savannah versus rainforest, cocoa farming versus food crop subsistence farming).

Data collection consisted of audio-recorded in-depth interviews (IDIs) with farmers who had access to a mobile phone and local key stakeholders, including community leaders and agriculture extension workers. This was accompanied by detailed field observations and focus group discussions (FGDs) with farmers and other relevant community members (e.g. elderly people, men). To triangulate the qualitative findings, three IDIs with national-level experts on agriculture were also conducted. All IDIs and FGDs were guided by semi-structured topic guides organised around the main aims of the initial qualitative study, and constructed by the qualitative research lead, with input from the quantitative and business model teams, as well as in-country partners.

In-depth case studies at midline

The midline case studies explored the underlying mechanisms and processes that influenced whether advice provided by VFC was translated into actual behaviour change, and for whom and under what circumstances this happened. The midline also included a process evaluation of the implementation processes of VFC as experienced by users.

The initial plan¹¹ had been to purposefully select three treatment communities in which to conduct in-depth qualitative case study research with engaged VFC users and users who had successfully registered with and activated VFC but had discontinued engagement after some time. However, given the very low take-up of, and sustained engagement with, VFC (see Section 5.1) it was very

¹¹ As set out in the inception report for this evaluation; see IDS, IFPRI, and Gamos (2016).

difficult to identify sufficient numbers of farmers who, firstly, had successfully activated the service, and, secondly, still actively engaged with VFC. As a consequence, we had to adapt our approach and increase our sample frame significantly to achieve our aim of interviewing around 100 VFC users (within our proposed budget).¹² In total, 46 VFC users in CR and 51 VFC users in UWR were included in the qualitative midline case study data collection.

Data collection consisted of audio-recorded IDIs of engaged VFC users, complemented by FGDs that included participatory matrix ranking to explore the different components of VFC services in more depth. To identify potential spill-over within the communities, FGDs with various community members and IDIs with key informants were also conducted. To investigate implementation processes, IDIs with project implementation staff and other key informants in the community were carried out. All IDIs and FGDs were guided by semi-structured topic guides organised around the main aims of the midline case studies.

Rapid qualitative follow-up studies

The aims of the qualitative follow-up study were: (1) to identify underlying reasons for sustained or continuous engagement with VFC in a context within which most farmers had disengaged from the service; and (2) to explore the pathways by which VFC services promoted a change in agricultural and/or dietary practices among farmers.

Overall, we interviewed 24 farmers who still actively engaged with VFC in UWR, and 29 farmers who did so in CR. The very limited number of still engaged users of VFC per community (and the geographical distance between communities as determined by GPS mapping) also made it logistically difficult to recruit sufficient numbers of farmers to conduct FGDs, which we had originally planned to do. We therefore decided not to carry out any FGDs but only to carry out IDIs with farmers who still actively engaged with VFC.

As in previous rounds, data collection consisted of audio-recorded IDIs with VFC users who were still engaged, guided by semi-structured topic guides organised around the evaluation questions.

Data analysis

The qualitative data were analysed using a directed content analysis approach that focused on the main qualitative evaluation questions (Patton, 2008). Data analysis started with open coding of several interviews and the development of an initial coding scheme that guided the coding of the remaining data. To increase the rigour of the data analysis, coding was done by two UK-based researchers independently and coding schemes were then discussed and merged into a joint scheme. While the coding scheme guided the coding, it was flexible enough to allow for topics that emerged to be added at any point.

4.2.3 Business model and cost-effectiveness component

In contrast to the quantitative and qualitative components, which primarily focused on farmers' experiences with VFC, this component explored the organisations involved in the delivery of services, with a particular focus on the commercial sustainability.

¹² This meant clustering several treatment communities together to have enough VFC farmers (around 35 per cluster) who still engaged with the service. A total of 16 communities (11 in CR, five in UWR) were sampled, from four districts across the two regions. Within the selected communities all VFC users who had successfully registered were identified based on VFC user data (provided by Esoko) and invited to participate in the interviews.

This component of the evaluation sought to track the process through which stakeholders evolved the sustainable commercial approaches. It documented how private sector institutions formed and shaped alliances, how donors interacted with the private sector, and which elements were responsible for key outcomes.

Framework for the business model

Given the complexity of the partnerships involved in VFC, we used Osterwalder and Pigneur's (2010) canvas as the basis for analysis. The product is at the centre of the canvas, which is then divided into two: one half is customer-facing (customer segments, channels, customer relationships, and revenue), while the other considers internal factors (partners, activities, resources, and investments).

Data collection and analysis

This component consisted of ongoing mixed data collection, drawing on:

- qualitative interviews with stakeholders and MNOs;
- commercial data provided by stakeholders, MNOs, and GSMA;
- findings from the qualitative research by IDS and the quantitative research by IFPRI;
- monitoring data gathered by Aline;
- cost and impact performance data available in published literature; and
- government stakeholders and alternative service providers as a source of additional, unpublished information on costs and impact.

The process of enquiry and data collection had to be flexible and responsive to events on the ground, given that the service offerings were constantly evolving. The team from Gamos sought opportunities to meet key individuals, taking advantage of, for example, conferences and meetings, or following the publication of the key case study outputs.

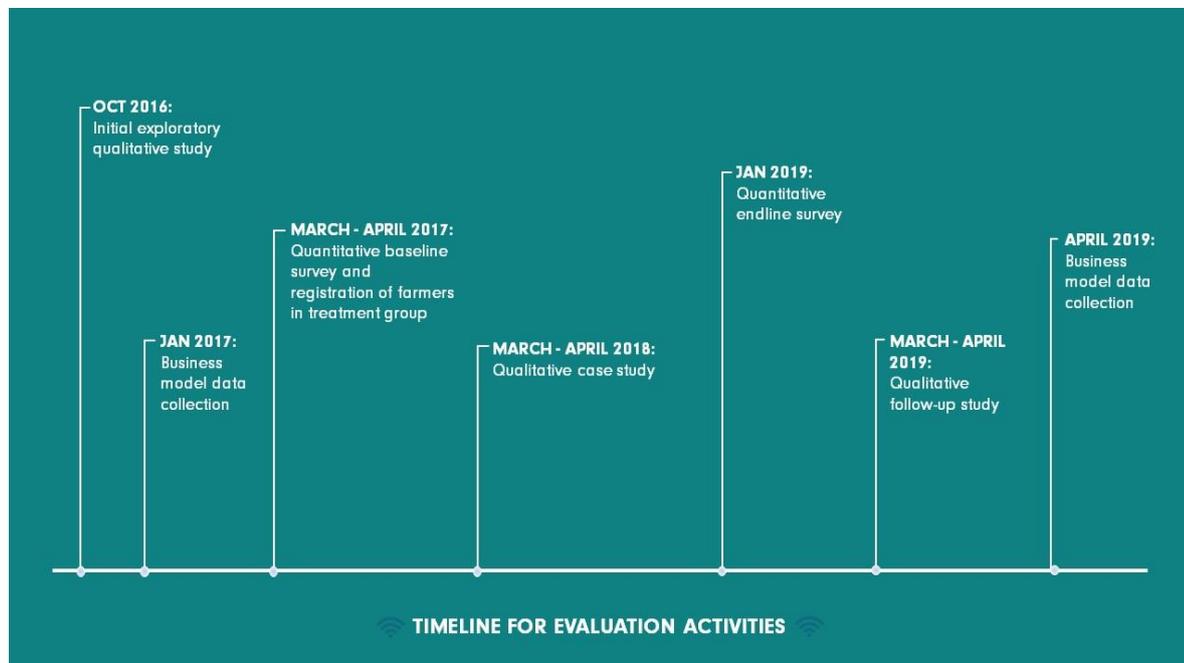
In order to collect the required information, the following activities were carried out:

- At baseline, the modified Osterwalder and Pigneur canvas was provisionally populated with information from reports previously published under mNutrition programmes (e.g. user experience testing, case studies, rapid feedback surveys, etc.), as well as grey literature.
- Contribution to the design of both qualitative and quantitative instruments (both baseline and endline) to incorporate indicators relating to customers' non-financial attitudes towards services, and to MNOs in particular, such as customer satisfaction and brand loyalty. These instruments also explored attitudes towards alternative services offered by other providers, e.g. different media and face-to-face extension.
- Field visits to establish relationships with key stakeholders. Interviews to gather additional data to populate the Osterwalder and Pigneur canvas. Ongoing communication and field visits to monitor developments in services and to track the commercial justification for changes.
- Interviews with alternative service providers to explore alternative business models (among alternative mobile services). Gathering data on the cost effectiveness of more traditional behaviour change communication approaches, and how they compare with the mNutrition services.

4.3 Evaluation timeline

Figure 4 summarises the data collection activities that were conducted for the impact evaluation in Ghana. A list of all the outputs from this impact evaluation can be found in Annex A.

Figure 4: Timeline for data collection activities for the evaluation



Source: Authors' own

4.4 Limitations of the evaluation

This section outlines the limitations of the entire evaluation:

1. **Changes in the VFC service and very low take-up of VFC:** After the start of the impact evaluation there were several changes in the VFC service (as was to be expected in the very dynamic digital landscape). These included changes in pricing, the number of nutrition messages sent to users, and the approach to promotion and the profiling of farmers. Furthermore, take-up of VFC and sustained engagement with VFC was unexpectedly low (see also Section 5.1 on the reach of VFC). Both of these factors had consequences for the impact evaluation design, requiring the evaluation team to respond and adapt repeatedly (e.g. to adapt the qualitative sampling strategy and to carry out additional quantitative fieldwork to encourage registration with VFC; moving the timing of the quantitative endline to earlier).
2. **Data access challenges:** Accessing business, and in particular VFC user data was a persistent challenge for the impact evaluation team. Although the programme's implementing stakeholders expressed a positive intent to share data, this did not always happen. To mitigate this, GSMA staff emphasised the sensitivities surrounding data and did their best to negotiate data access with stakeholders.
3. **External validity:** While the randomised design ensures the internal validity of the quantitative study (i.e. that our impact estimates are not biased within our study sample), the external validity (i.e. that the study findings are representative of impacts on the overall

rural population in Ghana) may be compromised. Firstly, it should be highlighted that the independent mixed methods evaluation focused only on two mNutrition projects (VFC in Ghana and Wazazi Nipendeni in Tanzania) and the findings may not reflect the performance of the overall mNutrition initiative. Secondly, the quantitative experimental design actively encouraged farmers in the treatment sites to take up VFC, and also facilitated the registration process if necessary. Furthermore, VFC was made available free of charge for the treatment farmers throughout the entire intervention period (even after Vodafone had reintroduced a fee for the other subscribers). Consequently, our treatment farmers were not 'typical' VFC users but included a wider variety of farmers (including many who might not have signed up for the product in a real-world context, such as female farmers or poor farmers who could not afford the fee for the service). However, we believe that this approach helped us to increase the learning and transferability of the evaluation findings as it allowed us to assess the effectiveness of the mobile phone-based services in relation to a broader and more diverse audience. We also complemented the experimental quantitative trial with multiple qualitative data collection rounds to gain in-depth insights into the impact of 'context' on the implementation and outcomes of VFC. A thorough understanding of how the context interacted with and/or facilitated and hindered the reach, uptake, and effectiveness of VFC is particularly relevant to the transferability of the results and the lessons learned to other mNutrition projects.

5 Evaluation findings

5.1 Effectiveness of VFC in reaching smallholder farmers

This section answers the evaluation question – How effective is VFC in reaching smallholder farmers in Ghana?

Recap of the intended target group of VFC:

Mobile phone-based information services may offer an innovative approach to providing much needed information to hard-to reach populations, including poor farmers who live in remote rural areas and female farmers, who are frequently excluded from agriculture extensions services (Beevi *et al.*, 2018). The primary target for VFC was 5 million smallholder farmers in Ghana, who account for 77% of the entire agricultural base in the country (GSMA, 2014).

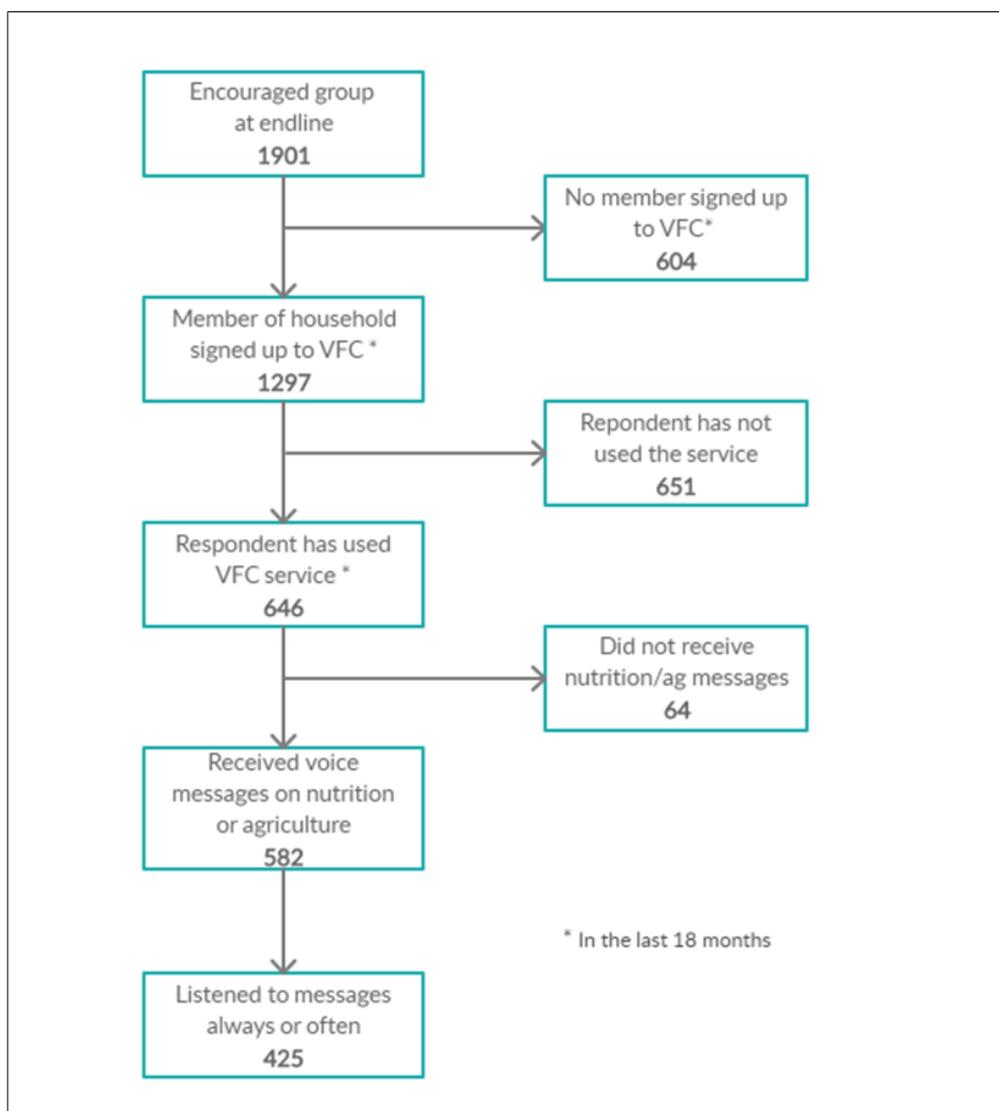
5.1.1 Limited success of VFC in reaching smallholder farmers in Ghana

The reach of a programme usually refers to whether and how the intended target groups took up, engaged with, and used an intervention or programme (Glasgow and Linnan, 2008). The concept of reach is particularly salient for VFC, as impact, cost effectiveness, and commercial sustainability are highly dependent on the total number of farmers who used the mobile phone-based service (McNamee *et al.* 2016).

Reach of VFC in the encouragement sample

Figure 5 presents the reach of VFC among farmers in the encouragement sample. As can be seen, use and sustained engagement with VFC were low; while 68% (n=1297) of encouragement households reported signing up to the VFC service, only 34% (n=646) reported having actually used VFC in the last 18 months. At the time of the quantitative endline, only 27% of households (n=509) had someone still signed up to VFC – which indicates high drop-out rates over time.

Figure 5: Flow-chart of take-up and sustained engagement with VFC service among treatment farmers



Source: Billings *et al*, forthcoming

Both quantitative and qualitative data revealed considerable **gendered differences in the reach of VFC**, with female farmers being less likely to have used the service in the last 18 months compared with male farmers (43% vs 63%). There were also some differences in take-up of VFC by location, with 63% of households in CR reporting having a household member who was or had been signed up to VFC, compared to 74% in UWR. However, with regards to use of VFC services, no significant regional differences could be found.

The quantitative data revealed no differences in rates of signing up or using the service in the last 18 months based on poverty status, although poorer households were less likely to use the different components frequently. Based on the qualitative data, very poor farmers were less likely to continuously use VFC compared with less poor farmers. Moreover, it needs to be highlighted that VFC was offered free of charge to the treatment group (i.e. subscription costs were not a barrier to reach) and one of the selection criteria for inclusion in the quantitative sample was ownership of a mobile phone. Consequently, about 26% of households¹³ who could not afford a

¹³ In the census, 16,010 households were interviewed across the 207 enumeration areas. Of these households, 11,826 (or 74%) had a mobile phone.

mobile phone were excluded from the service from the start. The desk review conducted as part of the evaluation and the initial qualitative study suggests that only approximately 70% of households in the rural communities owned a mobile phone (Barnett and Srivastava, 2017). This means that around 30% of households were potentially excluded from VFC services altogether.

Reach of VFC in the comparison group

The take-up of VFC in the encouragement group was considerably higher than in the comparison group, i.e. in a 'real-world' context, which is not surprising given the extensive door-to-door promotion and support provided by the evaluation team. Without the additional encouragement, VFC was not very effective in reaching farmers – only around 15% of households in the comparison group had ever heard of VFC, compared to 85.7% in the encouraged group. In addition, 68% of households in the encouraged group had signed up for the programme, compared to only 1.2% of the comparison group, which translates into a take-up gap of approximately 67%.

The evaluation has identified several barriers, discussed in detail below, that can help to explain the limited reach of VFC: (1) availability of supportive infrastructure; (2) capacity and behaviours of the target group; and (3) factors related to the implementation and design of VFC. These are discussed in turn in the following sections.

5.1.2 Limited reach due to shortcomings in the available supportive infrastructure

The recently published World Health Organization (WHO) recommendations on digital interventions for health highlight the importance of reliable supportive infrastructure for the effective reach of digital health interventions, especially in resource-poor settings (WHO, 2019). The evaluation found evidence of several shortcomings in the supportive infrastructure in Ghana that reduced the reach of VFC considerably.

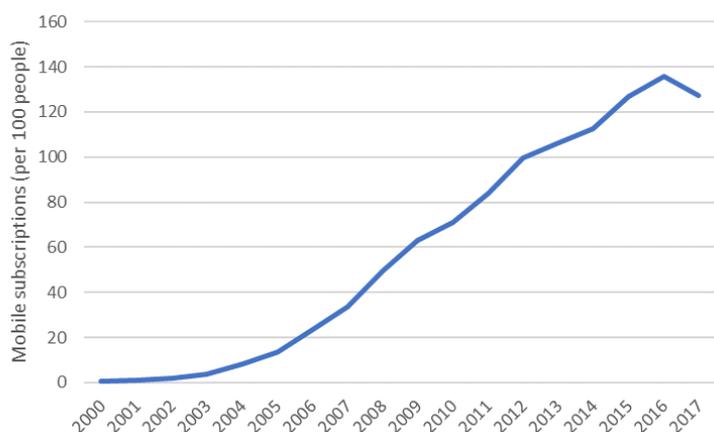
Access to and ownership of a mobile phone was a barrier, especially for female and poor farmers

Based on the quantitative baseline data, 45% of female farmers and 80% of male farmers in the encouragement sample owned a mobile phone, and the majority of the remaining farmers said that they had access to a mobile phone (overall, 91% of male farmers and 82% of female farmers). However, data from all three qualitative rounds suggest that self-reported access to a mobile phone did not ensure that VFC services effectively reached farmers. In particular, female farmers who did not own a mobile phone but used the mobile phone of a family member said that they usually had limited control over their access to the phone. In many cases, access was irregular, closely monitored by the phone's owner, and restricted to occasional calls in the case of emergencies. Regular mobile phone sharing between spouses was very uncommon. Inserting, activating, and regularly using the VFC SIM card in somebody else's phone was usually impossible.

In many households, the owner of the mobile phone (usually a male household member) worked away from home all day or travelled for work for long periods at a time (e.g. to pursue paid employment in nearby towns). During these times other household members had no access to the mobile phone and thus to VFC services. The quantitative endline survey further strengthened these qualitative findings and reported that 32% of female farmers in the encouragement group did not use VFC services because they could not access a mobile phone (compared to only 12% of male farmers).

As highlighted above, approximately 26% of all households in the rural communities that were included in the evaluation did not own a mobile phone and thus were excluded from access to VFC service through the study. The main reason for not owning a mobile, as found in the qualitative exploratory study, was not being able to afford one (and not been able to afford to buy air time to use the phone). Based on the business model evaluation, it is clear that a proportion of rural residents is likely to remain excluded from mobile phone services in the future. This is because targeting rural residents without access to mobile phones assumes that there remains a potential customer base that still aspires to mobile ownership. However, published subscription rates (see Figure 6) suggest that the market in Ghana may be saturated (although, on the other hand, a one-year dip does not necessarily reflect a long-term trend).

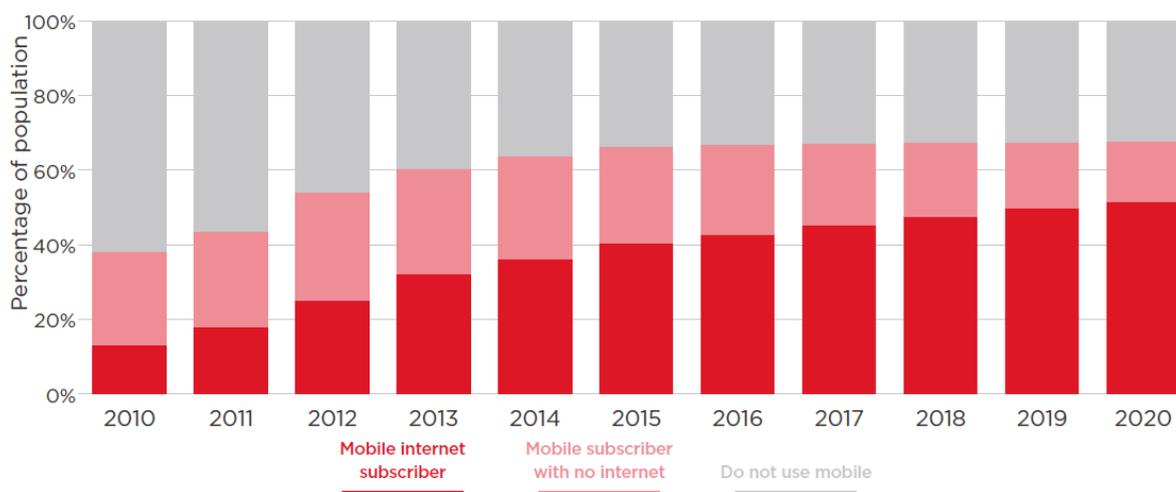
Figure 6: Mobile subscription rates per 100 people (Ghana)



Source: Scott and Batchelor, 2020.

GSMA’s own research suggests that the proportion of the Ghanaian population that will not sign up for a mobile subscription will bottom out at around one-third of the population after around 2017 (see Figure 7). In this scenario, it is not viable to invest in extending coverage to serve the ‘laggards’ or the lowest ARPU¹⁴ customer segment.

Figure 7: Saturation of mobile phone market in Ghana



Source: Hatt *et al.*, 2017

¹⁴ Note here that ARPU is defined as the total revenue generated divided by the number of subscribers.

In conclusion, female farmers who do not own a mobile phone and poor farming households that cannot afford a phone are likely to be excluded (and potentially to stay excluded) from mobile phone-based information services such as VFC. Given that these farmers may gain most from the advice (as they are often excluded from traditional extension services), alternative delivery channels for agricultural and nutrition information (e.g. low-tech or a merged technology approach that incorporates mobile phone and other approaches such as radios) are likely to be more effective.

Limited Vodafone network coverage

VFC can only be accessed in geographical locations with Vodafone network coverage. To ensure sufficient network coverage we only included communities located within a 10 km radius of Vodafone's cell towers in the evaluation sample. Nevertheless, poor Vodafone network connectivity was reported as a reason for not using VFC services, especially in CR (9% of farmers in the encouragement group, versus 4% in UWR).

The qualitative data corroborated these findings and elaborated further that poor Vodafone network signal strength was also a common reason for farmers not to activate their VFC SIM cards after registration,¹⁵ as well as for not regularly using the service. In particular, recorded voice messages were often missed by farmers who spent most of their days in areas with poor Vodafone coverage (e.g. in their fields). Farmers also explained that they preferred to keep using their SIM cards from other MNOs that had better network connectivity (e.g. MTN).

The business modelling analysis further speculates that a proportion of the rural population in Ghana (mostly the poorest) are likely to continue to live in locations with no Vodafone network coverage, given that Ghana's mobile market is maturing and thus incentives to improve the network signal in remote rural areas are shrinking. Consequently, the potential for Vodafone to increase its rural customer base is diminishing quickly (see Figure 7).

To sum up, poor Vodafone network connectivity posed an important barrier to take-up and use of VFC, in particular in CR.

Access to electricity to charge the mobile phone

Access to, and costs (both direct and indirect) of, electricity was a barrier for some farmers. The quantitative baseline data showed that slightly more than one-quarter (27%) of farmers could not charge their mobile phones at home (with farmers in UWR slightly less likely to charge at home compared to those from CR). Based on qualitative data, most of these farmers had to charge their phones in neighbouring villages, often at the local mobile phone kiosk and usually for a charging fee. To save time and money that would otherwise be spent on travel, 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 missed recorded voice messages and SMS messages.

Multi-SIM card use with preference for a non-VFC SIM card

If financially possible, farmers owned and used SIM cards from different MNOs in parallel, which allowed them to switch between networks flexibly, depending on the best network coverage and tariff. While around 53% of farmers in UWR already used a Vodafone SIM card as their main SIM

¹⁵ After the VFC SIM was successfully registered, households were required to activate their new SIM cards by using the phone to check the balance or send a text message to start receiving VFC messages.

card at baseline, only 13% of farmers did so in CR (which can be explained by the poorer Vodafone network coverage in CR).

Most farmers owned one-slot mobile phones¹⁶ and had to manually exchange SIM cards depending on their needs. Especially if Vodafone was not the preferred network, farmers often did not place a high value on the VFC SIM card that they had received free of charge from the survey team. Consequently, these farmers only infrequently or never inserted the VFC card into their mobiles. Based on qualitative interviews, farmers (especially female farmers) who did not own a mobile phone and had signed up to VFC with the mobile number of a family member or friend often had few or no opportunities to insert the SIM card into the owner's phone. The qualitative data also suggest that some farmers were worried about using another SIM card as they had saved all their contacts on their preferred SIM card and friends and family members only knew the telephone number linked to that SIM card. Unsurprisingly, many farmers (nearly 50% of those that signed up with the VFC service based on the quantitative survey) reported having lost or never having used the VFC SIM card. It should be highlighted that farmers with existing Vodafone SIM cards could upgrade the card to include VFC. However, only 20% of treatment farmers used existing Vodafone SIM cards to receive VFC.

5.1.3 Capacity and behaviours of the target group

Illiteracy and limited digital literacy were major barriers to the reach of VFC

Table 4 summarises the reach of the different delivery modalities of information services included in the VFC bundle in the encouragement group. Note that this is only among farmers who reported having used the service in the last 18 months (n=646).

The majority of farmers (around 90%) said that they had received SMS messages with weather and market price information and recorded voice messages at least once in the last 18 months. However, only around 55% of these farmers reported having always or often read the messages. Illiteracy and an inability to understand English prevented many farmers from reading SMS messages, especially female farmers (who were more likely to be illiterate¹⁷). This finding was also strongly echoed by the qualitative data.

Recorded voice messages in local languages seemed to be a better delivery channel than SMS messages in areas with high illiteracy. This is supported by the quantitative endline data, which found that 73% of treatment farmers said that they always or often listened to the messages. However, it could be that farmers did not know how often they should have received messages, and thus they claimed to always listen to the ones they were aware of. Moreover, the qualitative data and user data from Esoko challenge the finding from the quantitative survey and suggest that regular engagement with recorded voice messages may have been considerably lower. For example, based on Esoko's user statistics from December 2017, 81% of the calls with recorded voice messages were declined without answering ('hung-up calls') and another 7% were disconnected calls ('dropped calls'). Only 4% of calls were successfully answered and another 2% left a voicemail.¹⁸ The qualitative data also revealed that many farmers missed a large proportion of the voice messages as they were unaware of how to set up and access their voicemail to capture missed voice calls and/or did not pick up, or they dropped voice calls as they feared that they would be charged for listening to them.

¹⁶ As opposed to dual-slot phones that allowed farmers to manage and switch between different active SIM cards easily and without missing communication sent through any of the cards.

¹⁷ Only 31% of women in rural Ghana are able to read (Ghana Statistical Service, 2014).

¹⁸ In each month Esoko made between nine and 16 attempts to reach each farmer with VFC recorded voice messages.

Both SMS and recorded voice messages were a ‘push’ service, and the timing of when farmers would receive messages was determined not only by the scheduling of the sending agency but also by the capacity of the technology (e.g. Esoko messages were often sent several hours after scheduling because of congestion). This could have negatively affected the reach of recorded voice messages (less so for SMS messages as these could be read at any time once delivered). The qualitative data suggest that farmers did not pick up voice messages if they were delivered at an inconvenient time (e.g. during the day, when farmers are in the field, or late at night).

With regards to commercial viability it also needs to be considered that recorded voice messages are substantially more expensive to administer than SMS messages (20 times the cost).¹⁹ Financial modelling has shown that financial performance is highly sensitive to the price allocated by an MNO to messages. If an MNO can justify discounting the price allocated to recorded voice messages, the commercial viability of the service might be greater.

It should be highlighted that only a few farmers mentioned a lack of interest in the agricultural information as a reason for not reading/listening to messages. However, a lack of interest in nutrition tips was reported by male farmers as a reason for not listening to recorded voice messages.

Table 4: Reach of different delivery modalities in VFC and reasons for low reach

	SMS weather	SMS market price	Recorded voice messages (agri/nutrition)
Received service in last 18 months (n=646) (%)	92	89	90
Received service a few times a week ^a (n=646) (%)	43	36	35
Always/often reads or listens to message (n=646) (%)	55	54	73
Reasons for not reading/listening	<ul style="list-style-type: none"> - Illiteracy - Inability to understand English 	<ul style="list-style-type: none"> - Illiteracy - Inability to understand English - No demand for price information as a subsistence farmer 	<ul style="list-style-type: none"> - No voicemail set up - Misconception that VFC would reduce mobile credit when listening - No demand for nutrition tips (males)

^a Consistent with weekly delivery schedule by Esoko.

Source: Authors’ own based on Billings *et al.* (forthcoming, 2020)

Limited reach of VFC beyond subscribers as sharing was uncommon

Even households without access to a mobile phone could benefit from the VFC if farmers who received the recorded voice messages/SMS messages shared the content. GSMA monitoring and evaluation data suggest that farmers may have shared messages’ content with up to 10 people (personal communication). The qualitative and quantitative evaluation data did not corroborate this, however. The evaluation findings do indicate that some content sharing took place between spouses and within the household, but the majority of farmers said that they were reluctant to share VFC content with outsiders. Common reasons for not sharing included: perceiving the

¹⁹ MNOs charge roughly GHS 1 per minute for voice messages, compared with GHS 0.05 per SMS. There are also additional costs for recording voice messages in multiple languages.

content as irrelevant, fearing that others would not believe them or would see them as arrogant, the perception that information is private, feeling protective over their VFC membership and the information they received from VFC, and simply forgetting to share.

5.1.4 Barriers to reach related to the design and implementation of VFC

The evaluation also identified several barriers to the reach of VFC that were related to the design and implementation of the service. It should be highlighted that some of these barriers may strongly depend on the Ghanaian context and may not pose a barrier to reach for mobile phone-based agriculture services in other countries (e.g. mNutrition in Pakistan or Sri Lanka, as highlighted by the business modelling evaluation).

Difficulties in onboarding for VFC

For farmers to access VFC services they needed to be able to register successfully and the registration process needed to be as easy as possible. Findings from all three evaluation components suggest that the initial registration process for VFC (also called onboarding) was complex, often time-consuming, and could have posed a barrier to the reach of the service, as shown below.

Onboarding to VFC in ‘real life’

The registration comprised three steps. First, farmers had to register for VFC, which required either migrating their existing Vodafone phone number to VFC or receiving a dedicated VFC SIM card. Second, farmers had to be profiled in order for the Esoko system to send them information tailored to their needs. This included providing their preferred language, location, markets, and a priority crop.

Profiling was time-consuming and had to be done by hand by Vodafone field agents at the same time as they signed farmers up to VFC. Agents were incentivised by the number of farmers they signed up, and because the profiling process was complex and time consuming it was often skipped. As a result, VFC struggled with the profiling of farmers. Consequently, VFC adopted an automated profiling process, whereby farmers were allocated a ‘typical’ profile based on the crops most commonly grown in their geographical location. However, typical profiles were usually less engaging and relevant for farmers, who valued VFC for the tailored content (see also Sections 5.3 and 5.4).

Farmers who were allocated a typical profile could call the Esoko call centre to tailor their content to their individual needs. However, GSMA’s own research indicated that most farmers were not aware of this option (GSMA, 2017). The qualitative evaluation data also suggest that there were various misconceptions and fears that prevented rural farmers from using the call centre, including feeling intimidated or too uneducated to call and that they would be judged by educated call centre agents, based in the capital. Another option for profiling was for Esoko to call the farmer after registration. However, the restricted capacity of agents within Esoko made this impossible.

The third and final step to register for VFC was for farmers to activate their VFC SIM card by checking their balance, sending a text message, or making a call. The whole process of onboarding took time and there was the potential for error/delays and a risk of losing farmers at every step. GSMA’s own research also recommends that keeping the pathway from registration to receiving information as short as possible is important in order to keep customers engaged.

Onboarding to VFC in the evaluation, and lessons learned

To ensure successful registration, profiling of farmers, and activation of the VFC SIM among treatment farmers, the quantitative team facilitated the onboarding process. The team promoted VFC in all treatment households as part of the quantitative baseline data collection. Almost 92% of treatment households gave consent to be registered with VFC. Based on qualitative data, many farmers decided to join VFC because they enjoyed the face-to-face interactions with the quantitative team, felt honoured to be visited by researchers from Accra, and perceived the team to be very credible and professional.

The quantitative team completed the first step of the registration of treatment farmers directly in their homes if possible (i.e. if there was sufficient network coverage) and also collected all the information necessary to profile the farmers, which was sent to Esoko. The team also supported Esoko in the profiling process, although there were still initial delays from the time a farmer was registered to the time they were profiled.²⁰

Despite this additional support, more than 20% of treatment households did not finalise the initial registration process or had not activated their VFC SIM cards several weeks after the baseline survey (according to user data from Esoko). Qualitative data suggested several reasons for this, including no demand for a SIM card from Vodafone in an area with poor Vodafone connectivity, and therefore no incentive to activate the card, no access to a mobile phone (even if access was reported in the initial quantitative census), and uncertainty over how to activate or complete registration. To increase the likelihood that treatment households would register and activate their VFC SIM cards, the quantitative team went back to all treatment households and facilitated activation (once per household) between July and August 2017.

The findings from the facilitated onboarding process suggest that face-to-face interaction and support would be likely to increase successful registration and activation of VFC services. However, while human interaction is highly valued by farmers, helps to build trust in the service, and is effective for onboarding, it could also – according to the business model evaluation – be prohibitively expensive and complicated to organise on a large scale. In fact, VFC considered at one point engaging with local champions or ambassadors, i.e. influential local people who are well respected within their communities. The idea was for them to promote VFC among target groups of farmers and rural communities. However, incentives schemes failed and the concept was not pursued.

Lack of interpersonal contact and human support as a barrier to continuous engagement with VFC

VFC was predominately a one-way mobile phone-based intervention that pushed agriculture and nutrition information in various formats (i.e. recorded voice messages and SMS messages) to farmers. The lack of interpersonal contact was perceived by many farmers as a major limitation of VFC (not just during registration but throughout implementation). Farmers missed personal rapport, dialogue, and support from human beings. Over time, the lack of interpersonal contact could also have negatively affected farmers' trust in the credibility of the information.

The availability of human support through the VFC call centre was an important motivator for continued engagement with the service among the small sub-sample of farmers who used the service throughout the intervention period (based on the qualitative follow-up study). However, take-up of the call centre in general was very low, with only 36% of farmers (in the sub-group of treatment farmers) reporting ever having used this service. Simply being unaware of this service,

²⁰ Two interns from the quantitative evaluation team were based in the Esoko office in Accra to assist with the manual profiling of treatment farmers.

the misconception that one would be charged when contacting the call centre, and fear of Accra-based call centre agents judging them were common barriers to its usage (based on both the quantitative and qualitative data). The qualitative data also suggest that there were some inequalities with regards to the use of the call centre, with female farmers and poorly educated farmers being less likely to contact the VFC call centre due to fears of being judged.

Introducing occasional interpersonal interactions (e.g. community-based VFC meetings), strengthening the call centre capacity, and addressing fears and misconceptions around the call centre could have helped to address this shortcoming and increased both reach and sustained engagement. Section 5.4 provides some further discussion on the importance of adding human support to mobile phone-based interventions.

5.1.5 Lessons learned and recommendations: how to optimise the reach of VFC

VFC could only be effective in providing information and changing farmers' agriculture and nutrition practices when farmers were effectively reached by the service. The evaluation found that, despite VFC being free of charge, its reach was low. In particular, female farmers, who often had limited access to mobile phones and were more likely to be illiterate (and thus could not read SMS messages), were excluded. Mobile phone-based services can also generate new inequalities as poor farmers who cannot afford a phone are excluded from the service (and are likely to stay excluded). The limited reach of VFC among smallholder farmers in rural Ghana can be explained by shortcomings in the available supportive infrastructure (i.e. poor network connectivity, limited access to mobile phones, difficult electricity access, and multi-SIM card behaviour), capacity (i.e. high levels of illiteracy and a lack of digital skills), and behaviours (i.e. no sharing of messages with other farmers), as well as shortcomings in the implementation and design of VFC (i.e. overly complicated and time-consuming onboarding and lack of human support). Based on the evaluation findings, to optimise the reach of a mobile phone-based advisory service such as VFC the following recommendations should be considered:

- The availability of supportive infrastructure is an important requirement to enable a mobile phone-based information service to effectively reach the intended target group in a chosen context. This includes adequate signal coverage and strength of the network that provides the service (here Vodafone), sufficient autonomy of the target group over the access to a mobile phone (i.e. access is not controlled and restricted by the phone's owner) or ownership of a mobile phone (especially among female farmers), and easy access to electricity to charge the mobile phone (without long down times due to lack of electricity). If these requirements are not met or are not met for a large proportion of the intended target group, alternative modes of content delivery (e.g. via radio or community outreach) or blended approaches (e.g. radio and community workers) may have a wider reach and be more inclusive.
- Introducing a mobile phone-based service with a new SIM card can pose a barrier to the effective reach of the service, as farmers who own a mobile phone usually already own at least one (preferred) SIM card that they regularly use. Consequently, there is no perceived need or demand for an additional SIM card and no incentive to use it regularly.
- Offering a mobile phone-based service through a network that is not the preferred network in a location (e.g. Vodafone in CR) is likely to lead to only low take-up and sustained engagement with the service.
- Illiteracy and an inability to understand English were major barriers to the uptake of VFC SMS messages on price and weather. We recommend offering the content of SMS messages as recorded voice messages (in local languages). However, as weather and price information are highly time-sensitive and context-specific, and voice messages are more expensive to deliver and produce, providing this information as recorded voice messages would have increased the

implementation costs of VFC considerably (thus making the service less likely to be commercially viable).

- Recorded voice messages seem to be the best delivery channel in contexts with high levels of illiteracy (although, as noted above, they are considerably more expensive to administer than SMS messages). However, farmers missed a large proportion of the VFC recorded voice messages as they had no voicemail set up or were unaware of how to access their voicemail to capture missed voice calls. This implementation challenge at the end user level is easy to address and is likely to have a significant impact on the reach of recorded voice messages. For example, subscribers could have received a small tutorial on the use of voice messages, either in person (e.g. if sign-up happened through an agent) or during the initial profiling call conducted by Esoko.
- The sharing of agriculture and nutrition advice provided by VFC could increase the reach of the service considerably, including to farmers who are currently excluded (e.g. because they cannot afford a mobile phone). However, the evaluation suggests that sharing did not frequently happen. VFC could experiment with approaches to actively encourage message sharing (e.g. by sending reminders to share and highlighting the benefits of sharing, such as better well-being of the entire community).
- To reach poor farmers at scale, a mobile phone-based service needs to be simple not only to use but also to take up. The onboarding process for VFC was complex and time-consuming and negatively affected the reach of the service. Interpersonal contact with VFC promoters was perceived as important for building trust and convincing farmers to sign up. Interpersonal support was also important in facilitating the correct activation of the VFC SIM cards and ensuring that farmers took up recorded voice messages effectively (e.g. by setting up voicemail to capture missed calls). This suggests that an interpersonal component during the promotion, and as ongoing support, may increase both take-up and sustained use. However, this will also increase the costs for the service significantly, and could negatively affect the commercial viability of the service.
- Adding human support features to mobile phone-based services is likely to increase reach and long-term engagement. This could include interpersonal contact with promoters during registration and implementation of a well-functioning call centre. Also important is that farmers are made fully aware of available human support features, and the conditions of their use (e.g. the call centre can be contacted free of charge).

5.2 Impacts of VFC on nutrition and livelihood outcomes

This section answers the evaluation question – What are the impacts of VFC on nutrition and livelihood outcomes (including knowledge and behaviours), especially among female farmers and extremely poor farmers?

Recap of the primary and secondary outcomes of interest:

According to the pathway of impact in the ToC (see Section 2.2), the primary outcomes of interest for the quantitative evaluation of VFC were:

1. households' and women's dietary diversity;
2. agricultural productivity; and
3. agricultural income.

Secondary outcomes of interest focused on intermediate outcomes along the pathway and included: (1) nutrition and farming knowledge; and (2) market practices.

5.2.1 No impact of VFC on primary and secondary outcomes

Given the low reach and engagement with VFC, it is not surprising that the quantitative evaluation could not find any impact of VFC on the primary outcomes (i.e. dietary diversity for either households or women, and agriculture production and income), and only limited impacts on secondary outcomes (i.e. nutrition and farming knowledge and market practices) (see Table 5 and Table 6). Together, these results suggest that providing access to the VFC service was not sufficient to lead to changes in the primary or secondary outcomes of interest.

Table 5: No significant impact of VFC on dietary diversity, agricultural production, and agricultural income

	Comparison mean	ITT impacts ¹	LATE ²	N
1. Dietary diversity				
Household dietary diversity (1–12 food groups consumed in last 24 hours)	5.9	0.05 (0.09)	0.15 (0.27)	3,706
Women's dietary diversity score (1–10 food groups consumed in last 24 hours)	4.3	-0.05 (0.08)	-0.16 (0.25)	3,553
Met minimum dietary diversity for women	0.5	-0.02 (0.03)	-0.06 (0.08)	3,553
2. Agricultural production				
Number of crops cultivated	2.8	0.06 (0.08)	0.17 (0.23)	3,737
Total area cultivated (acres) (log)	1.7	-0.02 (0.04)	-0.07 (0.11)	3,622
3. Agricultural income				
Total value of production (GHS)	7.5	-0.10 (0.12)	-0.28 (0.33)	3,591
Total input costs (GHS)	6.6	0.02 (0.09)	0.07 (0.28)	3,593
Total profit (GHS)	3.4	-0.10 (0.33)	-0.29 (0.95)	3,562

Notes: Estimates from the mNutrition Ghana endline survey sample. ITT impacts measure the average impact of VFC on households in communities randomly assigned to the encouragement sample, regardless of whether the household signed up for VFC and continued to use it. LATE estimates the impact of receiving VFC messages on outcomes for households that were induced to register and use the VFC service. Standard errors are in parentheses and clustered at the enumeration area level.

Source: Authors' own, based on Billings *et al.* (forthcoming, 2020)

Table 6: No significant impact of VFC on nutrition and agriculture knowledge

	Female				Male			
	Comparison mean	ITT	LATE	N	Comparison mean	ITT	LATE	N
1. Knowledge								
Nutrition knowledge: percentage of correct answers	65.5	-0.94 (1.12)	-2.92 (3.39)	3572	67.23	-0.21 (1.06)	-0.78 (2.88)	2945
Farming knowledge: percentage of correct answers	68.7	-0.05 (0.62)	-0.24 (1.87)	3572	71.64	0.66 (0.65)	1.86 (1.78)	2945
2. Market practices								
Had sales revenue in the 2018 major season	0.5	-0.04 (0.03)	-0.12 (0.07)	3572	0.61	-0.03 (0.03)	-0.07 (0.07)	2945
Lowest price per kg received for maize	1.4	0.18* (0.10)	0.56* (0.29)	314	1.34	-0.06 (0.09)	-0.17 (0.25)	324
Highest price per kg received for maize	1.6	0.32*** (0.12)	0.96*** (0.36)	312	1.59	0.11 (0.18)	0.30 (0.49)	325
Lowest price per kg received for cocoa	53.3	6.75 (15.46)	17.10 (38.89)	660	56.65	11.08 (16.41)	27.97 (41.46)	677
Highest price per kg received for cocoa	58.1	5.57 (17.13)	14.12 (43.04)	660	60.89	4.12 (16.03)	10.44 (40.18)	677
Lowest price per kg received for groundnut	1.8	-0.13 (0.12)	-0.34 (0.32)	242	1.70	-0.13 (0.11)	-0.33 (0.29)	289
Highest price per kg received for groundnut	2.0	-0.10 (0.15)	-0.26 (0.39)	241	2.19	-0.01 (0.44)	-0.021 (1.141)	290
Knows more than one buyer who would have been willing to buy their crop	0.7	0.02 (0.03)	0.04 (0.08)	1612	0.71	0.01 (0.03)	0.024 (0.085)	1611

Notes: Estimates from the mNutrition Ghana endline survey sample. ITT impacts measure the average impact of VFC on households in communities randomly assigned to the encouragement sample, regardless of whether the household signed up for VFC and continued to use it. LATE estimates the impact of receiving VFC messages on outcomes for households that were induced to register and use the VFC service. Standard errors are in parentheses and clustered at the enumeration area level. * p<0.10 **p<0.05 ***p<0.01.

Source: Authors' own, based on Billings *et al.* (forthcoming, 2020)

Some evidence for potential impacts of VFC in sub-groups

Although there were no impacts on average of being offered the VFC service, there were a few differences in the impact of VFC across the gender of the farmer targeted, the region, and poverty

level. However, these impacts among sub-groups need to be interpreted carefully as many statistical tests were conducted and some significant impacts may have occurred by chance.²¹

First, targeting a female farmer with VFC services made her significantly more likely to report having consumed dairy (e.g. milk and milk products); the same was not true if a male farmer was targeted. These differences were significant, suggesting that, at least in the case of dairy consumption, targeting matters. Dairy consumption levels in Ghana are among the lowest in Africa and globally (Kunadu *et al.*, 2019). The main reason for the low consumption of milk and milk products in Ghana is that milk is very often contaminated with pathogens, and thus is perceived as a high-risk food in terms of contracting food-borne diseases (Addo *et al.*, 2011). In the qualitative interviews, none of the farmers referred to the consumption of dairy products. However, there were many voice messages on how to improve food hygiene when processing food (and also recorded voice messages promoting dairy consumption), which may have positively influenced female farmers' attitudes towards, and consumption of, milk and milk products.

Second, impacts on household dietary diversity were positive and significant in CR but not in UWR and differences across regions were significant. Based on qualitative data, obtaining access to diverse foods was often easier for households in CR (as distances to markets are shorter there and there are fewer socio-cultural mobility restrictions for women) compared with UWR. There were also some slight differences with regard to women's access to financial resources, with women in CR usually having more autonomy than women in UWR.

Thirdly, there was some indication that VFC had larger impacts on poorer households with regard to increasing their maize production. In particular, impacts on maize yields were larger the more likely a household was to be below 150% of the poverty line.²²

5.2.2 Nevertheless, VFC triggered a variety of individual-level changes in nutrition and agricultural behaviours

Despite the lack of a measurable impact of VFC on the primary and secondary outcomes of interest, the majority of treatment farmers (75%) who reported having listened to recorded voice messages (n=582) said that they had translated at least some of the VFC advice into practice. Similarly, 65% of farmers who had read SMS messages with weather information (n=594) and 50% of farmers who had read SMS messages with price information (n=576) said that they had changed their agricultural practices in response. There was no difference between self-reported changes across gender or region.

The qualitative data from the midline case studies and the final qualitative follow-up study corroborate these findings and also suggest that farmers were more likely to have acted on the agricultural advice than on the nutrition advice.

Based on the qualitative data, farmers were generally more willing to act on VFC advice that they perceived as low risk and involving no expense (e.g. using weeds as fertiliser rather than burning them, producing fertilisers from composted manure, eating beans without flour, following hand-washing routines, etc.). Acting on high-risk advice (e.g. purchasing fertiliser, herbicides, and seeds, or changing how they planted their crops) was less commonly reported. Several female farmers

²¹ For example, interpreting impacts based on the convention that a p-value below 0.05 is significant, we should expect to observe a significant difference for 1 out of every 20 tests simply by chance.

²² The poverty status of households included in the quantitative sample was determined based on the Poverty Probability Index (PPI). PPI scores map households in relation to the likelihood that they will fall below different national and international poverty lines. We use the likelihood that households will fall below 150% of the national poverty line in Ghana as our primary PPI score.

also explained that there were many competing demands on their very limited financial resources and that allocating money towards better and more nutritious foods just could not be their main priority. For further information, see Section 5.3.1.

The qualitative evaluation also found that farmers adapted VFC advice to work within their financial conditions (e.g. applying two bags of fertiliser per acre instead of four bags, as recommended by VFC, or consuming eggs whenever possible, rather than several times a week, as recommended by VFC). Farmers often also adapted and contextualised how and for what they used VFC information. For example, most farmers who reported using the market price information used it to decide where and for what price to sell their crops. However, many farmers (especially subsistence farmers) also used the information in a different way, such as to decide where to purchase the least expensive crops for consumption.

To sum up, the evaluation findings indicate that VFC was able to trigger at least some change in agricultural (and to a lesser extent) nutrition behaviours and practices among those farmers who actively engaged with the service. Farmers usually selected what advice to act upon and developed their own context-specific approaches and adaptation within their financial conditions and capacities.

5.2.3 VFC had a positive impact on loyalty to Vodafone

The quantitative evaluation found that offering VFC free of charge led to a significant increase in the proportion of phone numbers that used Vodafone as the network provider (an increase of about 9.6 percentage points for the primary female and 11.4 for the primary male) and the likelihood that Vodafone was the main network provider (an increase of about 8.9 percentage points for the primary female and 9.4 for the primary male).

The qualitative data further elaborate these findings and suggest that membership in VFC affected many farmers' attitudes towards, and use of, Vodafone in general. Several farmers who were satisfied with VFC said that they trusted Vodafone more now, especially as Vodafone had never reduced their credit when they used the service. The farmers went on to explain that they were more loyal to their Vodafone SIM now (as they did not want to miss voice message calls). Some farmers said that they did not use Vodafone before the intervention but that Vodafone was now their favourite network. However, it should also be noted that the majority of farmers said that their attitude towards Vodafone had changed because the network offered VFC free of charge to them. Reintroducing user fees for the services might therefore negatively affect attitudes towards Vodafone.

Based on the quantitative data, the VFC service did not, however, increase use of Vodafone to make or receive calls, or to make or receive text messages, or the total amount spent on airtime, and it also led to a significant decrease in the probability that the female and male farmers used their main mobile phone to send mobile money.

5.2.4 Lessons learned and recommendations: impact of VFC

Being offered the VFC service or having used it at least once had no impact on households' and women's dietary diversity, agriculture production and income, or nutrition or agriculture knowledge or practices. Sub-group analysis suggests some small potential impacts, with female farmers being more likely to consume dairy compared with male farmers, a small increase in households' dietary diversity in CR compared with UWR, and an increase in maize yields among poor households compared to less poor households. The lack of impact of VFC can in part be explained by the low

reach and very limited sustained engagement with VFC (the evaluation also found various contextual barriers that prevented farmers from translating VFC advice into practices; see Section 5.4).

Despite these disappointing overall impact findings, quantitative and qualitative data suggest that farmers who actively engaged with VFC made at least some changes in their agriculture behaviours and practices (and to a lesser extent their nutrition-related behaviours and practices). The types of changes farmers made varied greatly and depended on their financial circumstances, capacities, and contexts.

To capture the multitude of granular effects VFC had on farmers' behaviours and practices while also considering the varying lengths and intensities of engagement with the service and the dynamics of the service, future evaluations of mobile phone-based interventions should consider complementing rigorous experimental designs with more agile, short-term, and adaptive evaluation methods.²³ Such methods are also well suited to informing the ongoing development and adaptations of a mobile phone-based intervention alongside its implementation (Mohr *et al.*, 2015).²⁴

5.3 Process of content development for VFC

This section answers the evaluation question – Has the process of adapting globally agreed messages to local contexts led to content that is relevant to the needs of poor farmers and their families?

Recap of the process of content development for VFC:

The content for the recorded voice messages with nutrition message tips was developed by GAIN in 2015. 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. In 2017, to further strengthen the nutrition content, the Grameen Foundation developed 26 additional nutrition messages focused on animal-sourced foods, including eggs, dairy, fish, and meat. VFC subscribers received both general nutrition tips and crop-specific nutrition tips according to their profiled crop.

Esoko provided the VFC content for the crop-specific agricultural tips for 24 widely cultivated crops in Ghana. Many of these tips already pre-existed from the predecessor of VFC, which was also operated by Esoko. Agriculture tips covered the recommended planting time and information on best practices for cultivation and harvest. Messages were sent according to planting cycles for specific crops and agro-climactic zones based on farmer profile information.

Esoko was appointed as the local agriculture content partner for Ghana, on the strength of its experience in generating agricultural content for mobile systems. Esoko has a long history of developing content for mobile services, and employed qualified and experienced content specialists for VFC, one for agriculture and one for nutrition. Its bid for the GAIN contract to develop local nutrition content was separate from the VFC contract with GSMA. A report by CABI

²³ This recommendation is also in line with advice an international panel of experts recently issued with regard to the evaluation of digital behaviour change interventions (Michie *et al.*, 2017).

²⁴ It should be highlighted that the evaluation approach that was used also informed the ongoing development and implementation of VFC.

(on behalf of the global content consortium) endorsed this choice, highlighting the value of the Esoko team and its expert network (CABI, 2017).

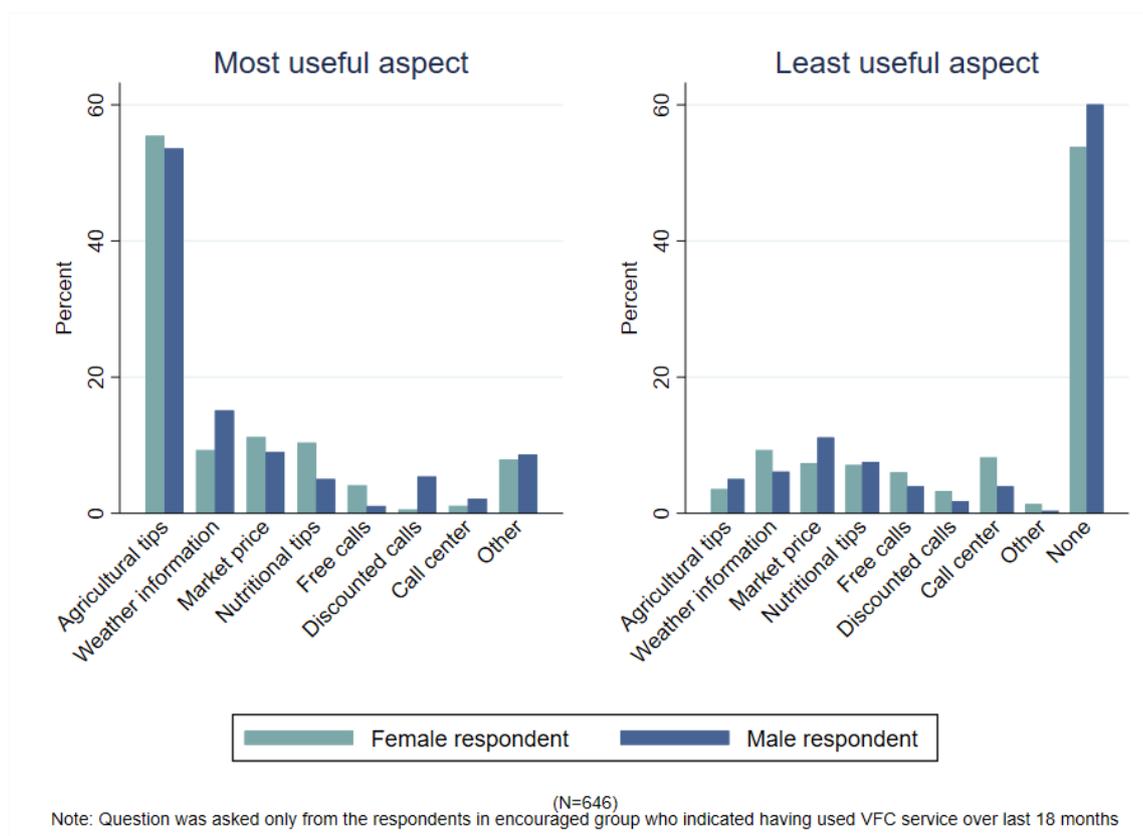
5.3.1 High levels of overall acceptance of the VFC content by farmers

The qualitative midline conducted an in-depth assessment of the acceptance of VFC among farmers based on the technology acceptance model (Davis, 1993). The assessment covered perceived usefulness, perceived ease of use, trust, and social influences on use related to both the content of VFC and the mode of delivery. Overall, the VFC content received positive feedback from most farmers on all levels.

Farmers generally perceived the agriculture tips as relevant and useful, easy to understand, and self-explanatory. The quantitative data elaborate these findings and show that 72% of households that had received the voice messages perceived the agriculture and nutrition tips as useful. In particular, female farmers (who are often excluded from traditional information sources, such as farmer-based organisations and agriculture meetings, due to time and mobility constraints) described the agricultural tips as useful and relevant (based on both the quantitative and qualitative findings).

In the quantitative endline survey, farmers who had used VFC (n=646) were asked to identify the most and least useful functions of the service, and then to rate the quality of different aspects of the service (see Figure 8). Agricultural tips were the most useful aspect, with 56% of females and 54% of males identifying them as such. This was followed by weather information (9% of females and 15% of males) and market price information (11% of females and 9% of males).

Both the qualitative and quantitative data also showed that farmers trusted the credibility of the agriculture and nutrition content. Even so, many farmers were unsure about the source of the information. Reasons for trust included the perceived relevance of the content, assumptions about the source of the information (e.g. Vodafone or the team that visited them for the quantitative survey and follow-up), and the accuracy of the weather forecast (i.e. if weather predictions are true, other information must also be true).

Figure 8: Most and least useful aspect of VFC, by gender

Source: Billings *et al*, forthcoming

Despite the overall positive perceptions about the agriculture and nutrition tips in VFC, the evaluation findings indicated that not all content was perceived as equally relevant by farmers. Moreover, quantitatively we only assessed the perceptions of those that used the service, and thus we do not know the perceptions of the majority of farmers that did not use the service.

Nutrition tips were a welcome add-on for (female) farmers, but there were shortcomings in content and frequency

Nutritional tips were identified as the most useful element of the VFC bundle by only 10% of females and 5% of males, with the difference being statistically significant at the 5% level. This finding is supported by the qualitative data, which suggest that nutrition tips were valued mainly by female farmers, who are usually responsible for all domestic chores in rural Ghana, including food preparation and childcare. Female farmers praised tips on food safety, storage, and preparation, and environmental hygiene, as the advice was perceived as very practical and easy to implement (with no additional costs and only little effort). Nutrition information provided as part of VFC also enhanced female farmers' general attitudes towards the service, as nutrition was close to their hearts and was perceived as an indication that VFC cared for the health and well-being of families in Ghana.

A review of the VFC nutrition tips by the evaluation team concluded that the focus of the nutrition content might have been too narrow to trigger the desired wider changes in dietary practices, and dietary diversity in particular. Especially in the initial months of the implementation, most of the nutrition tips focused narrowly on the crops identified in the farmer's profile, rather than promoting good dietary habits across multiple food groups. Eventually, more general nutrition messages and messages on animal-sourced foods were added to the repository of messages, but the focus on dietary diversity as a main objective and target of VFC still got side-tracked by too many messages

on other issues (e.g. hand-washing, food preservation, and food safety). As shown in the initial landscaping review, a mobile phone-based intervention is more likely to change a specific behaviour if messages mainly evolve around promoting this specific behaviour change (Barnett *et al.*, 2016).

Another concern was the very low frequency with which nutrition tips were sent out. Initially, farmers only received one nutrition tip per month (and some of these nutrition tips were so strongly focused on crops that farmers did not recognise these messages as nutrition tips). The frequency was later increased to three messages a month.²⁵ However, even three messages was likely to be too few to trigger any meaningful changes in nutritional practices (especially as the take-up of voice messages was generally low and farmers often missed a large proportion of the messages; see Section 5.1).

Recent literature implies that there might be a dose–response relationship with regard to the effectiveness of digital behaviour change interventions (Muench and Baumel, 2017). This means that a higher frequency of recorded voice messages with nutrition tips, as well as a stronger focus of the messages on improving the dietary diversity of farming households, might be more effective in triggering the desired improvements in dietary diversity.

Farmers especially valued hands-on practical and low-cost advice, which they lack from other sources

The qualitative data showed that farmers especially valued practical information and hands-on advice on low-/no-cost agriculture practices. This type of advice was often lacking from other sources of agricultural information (e.g. the radio or community meetings), or could only be accessed infrequently (e.g. as overburdened agricultural extension workers only rarely visited their village). Low-cost agricultural practices were particularly relevant to poor smallholders, who often lacked the financial resources to purchase improved seed, pesticides, or other agricultural inputs.

It should be highlighted that only some of the agricultural and nutrition tips contained practical, low-cost advice. There were also a large number of tips with general agriculture and nutrition information (based on the international evidence on best practices). While most farmers appreciated these messages (especially as they received them free of charge and only had limited access to agricultural extension services), they also highlighted that these messages merely repeated or reminded them of knowledge that they had already heard from other sources or that was already common knowledge. They felt that these messages often did not add any further details. Repeating knowledge is not automatically a bad thing as behaviour change theory indicates that receiving the same knowledge from different sources and through different channels might be most effective in triggering change (Briscoe and Aboud, 2012). However, if messages focus mainly on reinforcing existing knowledge, farmers might not feel sufficiently enticed to sign up and potentially pay for the service.

The business model analysis provided further insights into some related tensions that arose during the development of the content for VFC. Content developers had to find a balance between advocating for best agricultural and nutritional practices and providing content that was adapted to the local context and actionable by resource-poor farmers (and thereby relevant). For example, it was necessary for the agricultural tips to only recommend practices that were within the remit of farmers, otherwise farmers might have dismissed the service as unachievable and irrelevant. Locally adapted practice may well be different from best practice, and this caused some disagreements between the Esoko team and GSMA. In these instances, members of the mNutrition expert network were useful in resolving disagreements. Perhaps as a result of these

²⁵ In part, this was prompted by requests from the evaluation team.

tensions, the evaluation team's assessment of the messages concluded that many of the agriculture and nutrition tips lacked local contextualisation and remained quite 'scientific' and abstract (rather than actionable and achievable).

Messages provided relevant agricultural and nutrition information, but often did not help farmers to address specific and pressing needs

While farmers generally appreciated the agricultural tips and (to a lesser extent) the nutrition tips, they often complained that the content was too generic to help them to address their specific, acute, and frequently changing farming and nutrition challenges and needs.

Farmers said that they often looked for specific information that would help them address pressing individual farming problems (e.g. pest infestation of crops, spoilage of maize during storage, low yields, etc.) or nutrition problems (e.g. low weight of children as detected during growth monitoring check-ups, frequent illness of household members, etc.). It was relatively unlikely that they would receive recorded voice messages that would help them to address their specific challenges at the time when they needed the advice, thus limiting the perceived relevance of the content. A potential solution would be to also offer pull services (meaning services where farmers can actively search for information) as part of VFC.

The disadvantage of pull services is that they are passive, and users can easily get out of the habit of searching for information (especially if the process of searching is time-consuming because of a weak network signal). GSMA therefore concluded (based on its own research) that a hybrid of push and pull services might be the most engaging and effective way forward.

Farmers adapted and contextualised content further to meet their individual needs and capacities

Financial constraints emerged as a major obstacle to the translation of agricultural and nutrition tips into practices. For example, many agricultural tips recommended that farmers purchase fertiliser, herbicides, or specific seeds. Some farmers directly dismissed these messages as they were outside of their financial capacity, while others tried to adapt the advice to work within their financial conditions (e.g. applying two bags of fertiliser per acre instead of four bags, as recommended by VFC, or consuming eggs whenever possible, rather than several times a week). While some of these adaptations might have still resulted in some benefits for the household, others might have had no benefits (e.g. applying considerably less fertiliser is likely to have no measurable benefits on agricultural yields but still increases the input costs for already poor farmers).

Farmers also adapted and contextualised how and for what they used the VFC information. For example, most farmers who reported using the market price information used it to decide where and for what price to sell their crops (and there was a small increase in the price that female farmers received for maize as a result; see Table 6). However, a few farmers used the information in a different way, i.e. to decide where to purchase the least expensive crops.

Accurate profiling is vital for tailored messages, but it is difficult to implement at scale

The qualitative data showed that farmers highly valued agricultural tips that were tailored towards their specific agricultural activities (i.e. the crops they cultivated). Tailored information was much needed and was perceived as more relevant compared with the general information farmers received during agricultural meetings in their village. Accurate tailoring also helped to build farmers'

trust in the relevance of the service (which was important as there was no human interaction to facilitate trust-building and maintenance).

Insufficient or poor tailoring could quickly result in disengagement with the service (as highlighted by several farmers during the qualitative interviews; these farmers had mistakenly received messages on crops that were not grown in their location). Careful profiling of farmers during the initial registration process ensured that farmers received tailored content. However, as discussed above (see Section 5.1.4), the profiling process was laborious, time-consuming, and challenging for both Vodafone agents and Esoko. Therefore, default profiling was introduced in early 2017 as a means of providing a simplified registration process. Farmers were profiled based on the location where they were registered (district level) and then received messages for crops that were dominant in that location. Such generic profiles are likely to be less engaging, relevant, and useful for farmers.

5.3.2 Vodafone was not involved in the content development and thus was not invested in it

Vodafone was not involved in the development of content for VFC; rather than investing in internal agricultural and nutrition capacity, it brought in this expertise through a third party (i.e. Esoko). This offered advantages in terms of speed, capital cost, and flexibility, as Esoko had agricultural experts, a pre-existing agricultural information database, and a tried and tested platform. Given this, it is unsurprising that VFC was the first of the mNutrition products to be launched. Sub-contracting the service meant that it could be set up quickly, and Vodafone had the option to change the service by changing / adding contractors. Moreover, up-front costs were minimised by utilising Esoko's expertise and platform. However, this also meant that Vodafone was less invested in the product, and lacked a detailed understanding of farmers as consumers.

5.3.3 Lessons learned and recommendations: content development for VFC

The evaluation found high levels of overall acceptance of the content of VFC for the sub-sample of farmers that used the service, through both the qualitative and quantitative assessments. Farmers perceived the agriculture tips as easy to understand, useful, and relevant. In particular, female farmers (who are often excluded from traditional agriculture extension services, for example due to time constraints) valued the agricultural and nutrition content. Trust in the credibility of the content of the service was generally high. Nevertheless, not all content was perceived as relevant to farmers' specific needs and the evaluation also suggests some potential areas for improvements:

- Nutrition tips were mainly valued by female farmers, who liked the practical advice, which covered a wide range of topics, including crop-specific nutrition advice, food safety, preparation and storage, environmental hygiene, and dietary practices. While the variety of nutrition content was appreciated by female farmers, there was a lack of focus on the main nutrition-related behaviour that VFC aimed to improve (i.e. dietary diversity). Furthermore, the frequency of nutrition tips (one to three per month) was likely to be too low to trigger any quantifiable changes in behaviours. We recommend increasing both the frequency and the focus of the nutrition tips to promote a change in dietary practices more effectively. Given that women are responsible for the bulk of the domestic and caring activities in Ghana, nutrition information is most likely to get traction with females.

Poor farmers were very interested in and receptive to tips on practical, low/no-cost agricultural practices, especially as this information was often missing from other sources. Given their financial constraints, content that recommended the purchase of agricultural inputs or equipment (while

based on international best practices to increase agricultural productivity) was often perceived as less relevant as such purchases were not possible given the resource constraints faced by smallholder farmers. Future interventions should focus on providing practical, low-cost agriculture and nutrition advice that is actionable and achievable within resource-poor contexts. Farmers drew on VFC to inform their own contextualised and adapted agriculture practices. We should not expect a unilineal knowledge transfer, meaning a direct translation of VFC content into practice; rather, the flexible use of the information to inform learning should be encouraged.

- The information needs of farmers change dynamically and the farmers frequently looked for information that would help them to tackle individual, pressing agricultural or nutritional problems. Poor tailoring of the content could have resulted in frustration and disengagement with the service, as farmers perceived the content to be less useful and relevant. Despite the time-consuming nature of the process, careful and individualised profiling during the initial registration process is vital to build trust and to ensure well-tailored content. Finding new ways to profile might help achieve optimal tailoring without increasing costs significantly. Additionally, introducing and strengthening existing two-way communication channels (e.g. the VFC call centre or interactive dialogues) could enable farmers to actively seek the information they need at the time they need it, and could also assist with the profiling process.

5.4 Mobile phone-based services for behaviour change

This section answers the evaluation question – What factors make the mobile phone-based VFC service effective in promoting and achieving behaviour change (if observed), leading to improved nutrition and livelihood outcomes?

Recap of FCDO/GSMA's rationale for using a mobile phone-based service to change behaviours:

The mNutrition initiative aimed to harness the power of mobile phone-based technologies to improve access to information and change behaviours related to nutrition, health, and agricultural practices, especially for women and poor farmers (both male and female).

mNutrition has two major outcomes. One outcome is the development of cost-effective, sustainable business models for mobile phone-enabled nutrition and agriculture services that can be replicated across many countries. The second outcome that is expected is that these services result in new knowledge, behaviour change, and adoption of new practices in the area of agriculture and nutrition practices among the users of these mobile phone-based services.²⁶

As presented in Section 5.2, having access to and using VFC services had no impact on the primary outcomes of interest (i.e. dietary diversity, agricultural production, and agricultural income) or the secondary outcomes of interest (i.e. nutrition and agriculture knowledge and market practices). There were some marginal impacts of VFC on specific sub-groups. Nevertheless, the majority of farmers who reported having used the service also said that they had made at least some changes in their agriculture and/or nutrition behaviours in response to the service. In the following section, the evaluation's findings on features that give mobile phone-based channels an advantage over other traditional channels for behaviour change information will be presented. Also discussed will be the perceived shortcomings of mobile phone-based behaviour change interventions. To better understand how the mobile phone-based VFC service was able to trigger

²⁶ Description based on the terms of reference for this evaluation.

(at least some) changes in behaviour, we will also discuss common pathways of behaviour change and key barriers to change that emerged.

5.4.1 Advantages of mobile phone-based services compared to other communication channels for behaviour change

Despite the barriers to use laid out above, the mobile phone-based VFC service was used, and was found to be helpful, by most farmers who successfully received and used the service.

VFC addressed area-specific and time-sensitive information needs that are currently not being addressed by other sources

The qualitative data highlighted that the VFC service delivered important, area-specific information in a very timely manner (e.g. weather and market price information). When profiling had been successfully carried out, the information was highly tailored, making it uniquely useful compared to other sources (or, if it could be accessed elsewhere, this required additional time and effort). While the radio also provided weather and price information, this information was usually for the entire region and not specific to the area where the farmers lived. Time-sensitive information also included recorded voice messages with agricultural advice for key agricultural periods (e.g. before planting or during harvest).

Mobile phone-based information services can be used flexibly whenever and wherever there is a demand for information

In contrast to 'traditional' behaviour change communication channels (e.g. via an agriculture or nutrition counsellor), farmers had the flexibility to access VFC SMS messages, the call centre, and voice messages (when voicemail was set up) when and where they wanted to (and not only when the nutrition counsellor arranged a community meeting, the agriculture extension worker was visiting a village, or an agriculture programme was broadcast on the radio) (Michie *et al.*, 2017). This was important as farmers engaged considerably more with VFC (and in particular with the call centre and voice messages) when they faced an acute agricultural problem, such as pest infestations or the failure of their crops to thrive. Farmers were actively seeking solutions for their specific problem during these times and VFC was often able to provide help (especially the call centre, for the farmers who used this service).

Busy farmers (and especially female farmers) found mobile phone-based agricultural information more convenient and valued the frequency of messages

Many farmers explained that they lacked the time and resources to seek advice from agriculture extension workers or to attend local meetings on agriculture practices (in particular, female farmers were often unable to attend meetings). As agriculture extension workers did not come to their communities regularly, farmers often had to travel to the local agriculture office to seek advice. Some farmers had the mobile phone numbers of local agriculture extension workers, but many farmers did not. In this context, mobile phone-based messages were appreciated as a more convenient and inclusive information source. Farmers also appreciated that VFC provided advice on an ongoing basis (and not only occasionally, as traditional agriculture extension services do).

Mobile phone-based information was perceived as more personalised and easier to absorb

Several farmers felt that mobile phone-based information was more personalised and private than other sources. One farmer felt that the recorded voice message came solely to him and his phone.

This made him feel special and motivated him to take the messages seriously and listen carefully. Other farmers described how they found it easier to concentrate on and absorb information that they received in private on their phone than information delivered in group settings (e.g. during an agricultural meeting).

5.4.2 Shortcomings of mobile phone-based services compared with other communication channels for promoting behaviour change

Lack of interpersonal contact and a chance for interaction was perceived as a major shortcoming of the VFC service

The behaviour change literature suggests that the transmission of information to passive audiences without an element of interactive engagement has limited effectiveness in changing behaviour and practices (Adewuyi and Adefemi, 2016). Our findings reflect this, as outlined above, as while purely information-based VFC messages were perceived as useful, farmers sought interpersonal contact. Including a face-to-face component in the delivery of VFC is likely to increase uptake and long-term engagement. Examples could include local VFC groups, regular VFC community events, or local VFC agents that continuously promote the service. Social support has been shown to be critical in effective behaviour change interventions (Portsmouth *et al.*, 2012).

Radio is perceived as a more accessible, inclusive, and ubiquitous communication channel for agriculture information than mobile phones

When asked (in the qualitative midline) which communication channel for agriculture information they would prefer, almost half of all farmers still replied that the radio was their channel of choice. Farmers said they usually listened to the radio most of the day (or all evening). They used the radio function on their mobile phone (in the field) or a traditional radio with batteries. Listening to the radio was perceived as easier than picking up a recorded voice message as it did not interrupt their other activities (as picking up a call did).

A few farmers also believed that the radio might be a more reliable (as it was not dependent on network strength) and inclusive (most farmers owned a radio) medium through which to share information, although of course the information provided is not tailored.

Farmers also suggested that the content of VFC information could be sent through both the mobile phone and radio to increase both reach and impact. Combining radio and information technology, also known as technological blending, has become increasingly popular in development in recent years (e.g. participatory community radio campaigns in which farmers can participate in radio shows through their telephone) (see, for example, Farm Radio International²⁷; and FCDO's New Alliance ICT Challenge Fund²⁸).

5.4.3 A key barrier to the translation of VFC advice into action: poverty

It is well established that information (knowledge) alone is not necessarily enough to change behaviour (Beer *et al.*, 1993). There are complex relationships between mediators (e.g. knowledge, attitudes, and beliefs) and actual behaviour: farmers may gain the knowledge, confidence, and intention to change agricultural practices, but this will not have an impact on their agricultural practices unless their environment enables them to act.

²⁷ <https://farmradio.org/>

²⁸ <https://devtracker.FCDO.gov.uk/projects/GB-1-204423>

Financial constraints were the most commonly cited reason that prevented farmers from adopting new practices suggested by VFC (in regard to both agriculture and nutrition-related practices).

VFC was a service mainly focused on the provision of information; it did not support the generation of an enabling environment that would support farmers willing to adopt new practices. The behaviour change literature suggests that behaviour change interventions that provide both (i.e. information and a supportive enabling environment) may be more effective in changing behaviour (Briscoe and Aboud, 2012). To facilitate behaviour change, mobile phone-based services could be joined up with other ongoing interventions (e.g. livelihood improvement programmes or social protection programmes) that aim to alleviate poverty.

Based on the business modelling evaluation, mobile money would have offered farmers new opportunities to get access to financial resources and thus be able to act on VFC advice. Mobile money has been instrumental in increasing financial inclusion in Ghana, which increased from 41% in 2010 to 58% in 2015. The mAgri industry has picked up on the possibilities for digitising financial transactions throughout the value chain and for offering a range of financial services to farmers. There is a distinction between ICT for agriculture (ICT4Ag) products like Esoko, which are mostly information dissemination VAS deployed in partnership with MNOs, and the new landscape of digitalisation for agriculture (D4Ag) innovations, which use digital technologies and data to transform practices across the agricultural value chain. Transactional services (or tools) may prove to be more effective in changing behaviour than pure information services, given that farmers said that they were unable to implement advice because of a lack of financial resources.

5.4.4 Pathways of behaviour change

Overall, the specific mechanisms of behaviour change are likely to be different for different types of farmers, and within different household- and community-level settings. Also, agricultural behaviours do not take place in a social vacuum, but are shaped by ideas and practices negotiated by the social groups in which they are necessarily embedded (Murdoch and Lowe, 2003).

Effective engagement with VFC to trigger behaviour change does not need to be continuous engagement

The qualitative data (and Esoko's user data) suggested that farmers' engagement with VFC services often followed a dynamic process, with periods of higher-intensity engagement and periods of lower-intensity or no engagement. Based on the recommendation of an international workshop on the development of digital behaviour change interventions, effective engagement with mobile phone-based interventions does not need to be continuous and high-intensity: more important is that the engagement is sufficient to trigger the desired change in behaviour (Michie *et al.*, 2017). The qualitative follow-up study suggests that even limited engagement may have been sufficient to result in far-reaching change. For example, several farmers described how they decided to rear chickens after they had talked to a VFC call centre agent (Barnett *et al.*, 2019).

This finding adds weight to the suggestion that ongoing engagement might not be necessary for a mobile phone-based intervention to trigger desired changes in agricultural or nutrition practices. Effective engagement with a few messages (i.e. sufficient engagement to trigger a change in behaviours) or advice from the call centre might be enough – and might result in large improvements in farmers' lives. From a commercial point of view, only occasional or sporadic engagement with VFC would, of course, have not been desirable; in such a context, ongoing engagement would be preferred as it increases the likelihood of increased spending (e.g. on air time).

VFC was not usually a stand-alone agent of change, but it may have facilitated change in combination with other information sources

As indicated by the qualitative data, many farmers said that they did not want to rely on a single source of information when considering whether to change an established farming practice. To judge and validate the trustworthiness and accuracy of the content of VFC information, they tried to consult other sources of information (including informal sources, such as a discussion with peers). Both the quantitative and the qualitative data suggest that most farmers have at least one trusted source of agriculture and nutrition information (with public extension services being the favoured source for both). Farmers who heard the same information from different sources (including VFC) said that they were more likely to trust and follow the advice.

5.4.5 Lessons learned and recommendations: factors that make mobile phone-based interventions effective in changing behaviours

Several features give mobile phones an advantage over 'traditional' channels for behaviour change communication:

- Mobile phones can help to address area and time-sensitive information needs (e.g. weather and market price information or time-sensitive agriculture advice) more effectively and with less effort than most other information sources, even in remote, inaccessible settings (as long as there is sufficient network coverage).
- Mobile phone-based services are more convenient as information can be accessed at a time that is convenient for the farmer (assuming they have voicemail set up). This can help to address information asymmetries and saves time and resources as regards information-seeking.
- In particular, female farmers, who often struggled with multiple demands on their time (including household duties, care commitments, and farm work), and/or had mobility constraints, valued mobile phone-based information on an ongoing basis.
- In a context of declining access to agricultural extension workers and radios, mobile phone-based services potentially offer a low-cost mechanism for reaching farmers, and one that is more inclusive of low-income and female farmers.

There were also several shortcomings of VFC that would have to be addressed to increase its effectiveness for behaviour change:

- The transmission of information (i.e. SMS and recorded voice messages) to passive audiences without an element of interactive engagement is likely to have limited the effectiveness of VFC in changing behaviour significantly as farmers did not experience any peer, social, or emotional support when attempting to adopt the advice VFC provided. Social support has been shown to be critical in effective behaviour change interventions. Strengthening call centres and introducing other interactive components into mobile phone-based services is likely to increase their effectiveness in changing behaviours drastically.
- Radios were preferred over mobile phones for the delivery of information by a large proportion of farmers. The reasons for this are that radios were perceived as more inclusive (not everybody can afford or access a mobile phone), not dependent on network coverage, and as less distracting during farm work and daily chores than voice calls. The blending of mobile phone-based information and radio might make use of the advantage of both technologies and be more inclusive.

Other findings regarding the effectiveness of mobile phone-based services to change behaviours include the following:

- While VFC used strategic applications of different types of messages tailored to farmers' specific needs (e.g. based on the crops they cultivate), it did not support the generation of an enabling environment that supported farmers willing to adopt new practices. To increase the effectiveness of mobile phone-based behaviour change interventions, they could be joined up with other ongoing interventions (e.g. livelihood improvement programmes or social protection programmes) or mobile money services that provide farmers with the financial resources required to obtain agricultural inputs.
- Mobile phone-based advisory services such as VFC are unlikely to be effective as a stand-alone channel for behaviour change; instead, they may perform best when integrated with traditional media and channels as part of a multi-level strategy. Mobile phone-based information could therefore be one part of a broad, many-pronged policy, and not the only component aiming to change behaviours and practices.
- Effective engagement with selected mobile phone-based messages might be sufficient to trigger change. Thus, rather than focusing on increasing levels of ongoing engagement with mobile phone-based interventions, it should be acknowledged that farmers' engagement with the intervention is likely to vary over time.

5.5 Commercial viability of business models for VFC

This section answers the evaluation question – How commercially viable are the different business models for a mobile phone-based platform such as VFC? And how cost effective is VFC?

Recap of the business idea behind VFC:

Vodafone's initial target (as stated in the grant agreement with GSMA) was to sign up 400,000 users to VFC in Ghana by January 2017. The target of 400,000 users was based on a projected 18% take-up rate for the service. The grant application also stated that VFC would achieve an operational profit over a two-year period.

However, uptake was slower than expected and by September 2016 there were only approximately 70,000 subscribers. Vodafone then undertook two key actions. The first was to revise the target down to a more realistic 200,000 users. The second was to remove the monthly VFC charge and broaden the eligibility criteria for the product. This resulted in a steady rise in subscription numbers, and in February 2017 the target of 200,000 was reached.

5.5.1 Comparison of different business models for VFC

One of the underlying premises of the mNutrition initiative was that the business models should be financially viable. The business model evaluation used financial data provided by Vodafone and GSMA to create a financial model that was then used to model the financial viability of VFC under various assumptions. The main metric used in the model is internal rate of return (IRR), a measure

of financial return on an investment.²⁹ Key to the model is an estimated profile of subscriber numbers.

VFC has an unusual profile of subscriber numbers, given that the service was offered under two different business models during the evaluation period:

Business model 1: Subscription model

The subscription business model was built on a hybrid approach, generating revenue from both selling airtime (discounted airtime tariffs) and from subscription fees. Based on the original subscriber price of GHS 2 per subscriber per month, this gives a total projected revenue over a four-year product lifetime of £7.8 million, with 56% of this revenue coming from airtime and 44% from subscription fees. The IRR on an investment of £387,000 would be an attractive 80%.

However, in practice Vodafone was not able to achieve these subscriber numbers at this subscription rate. At the reduced subscription rate of GHS 0.5 per subscriber per month, revenue drops, with only 17% raised from subscriptions. Assuming that the amount passed on to the content provider was also GHS 0.5 per subscriber per month (i.e. 100% revenue share), then the IRR on the investment drops to 22%. However, this is only valid if a subscriber base of 270,000 can be achieved after four years (as shown in Figure 9 below).

After reintroducing the subscription fee, and reducing the amount paid to Esoko, the subscriber base fell to nearer 60,000. Figure 9 indicates that charging the reduced subscription rate (and paying GHS 0.5 per subscriber per month to Esoko) only starts to become financially viable if subscriber numbers of over 200,000 can be achieved.

Figure 9: Sensitivity of IRR to subscriber numbers (low subscription rate)



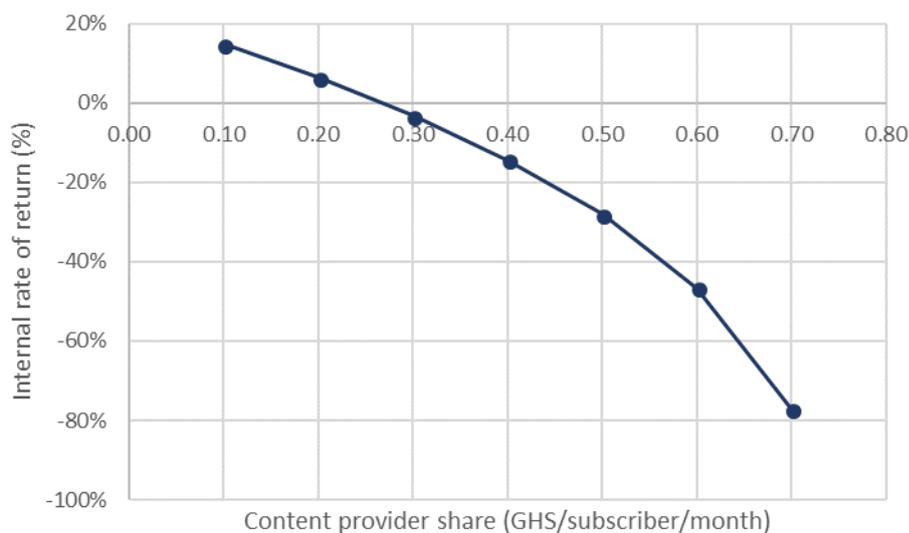
Source: Scott and Batchelor, 2020

²⁹ The model was based on the cost structure and cost data reported by Vodafone. This was full cost data, of which the mNutrition grant made up a part. The model was used to analyse two hypothetical business models using this cost structure; no allowance has been made for grant payments, as this would affect the commercial viability metrics.

Business model 2: Freemium model³⁰

The freemium model offered VFC free of charge to farmers. Farmers had access to information and free calls to other VFC users, with upselling of airtime (i.e. efforts to persuade users to purchase more Vodafone airtime). Financial modelling shows that, under the freemium model, revenue dropped, resulting in an operating loss over a four-year lifetime. The sensitivity analysis presented in Figure 10 suggests that if the revenue share of the content provider were reduced to around GHS 0.2 per subscriber per month, then the investment might start to look attractive, given an assumed subscriber base of 270,000.

Figure 10: Sensitivity of IRR to revenue share of content provider



Source: Scott and Batchelor, 2020

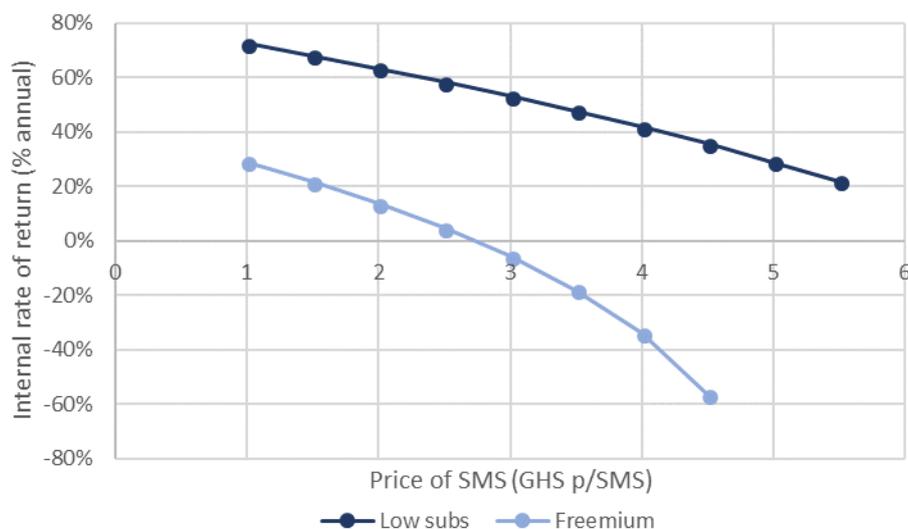
This analysis also showed how financial performance was highly sensitive to ARPU from this base. This suggests that if the product could be marketed to slightly wealthier farmers (with an ARPU of GHS 3.5 per month, rather than the GHS 2.5 per month reported by Vodafone), this would be enough to make even a freemium model financially attractive.

5.5.2 Other factors that may affect the commercial viability of VFC

Sending SMS messages as the largest single component of operating costs

The cost of sending SMS messages is the largest single component of operating costs. The model assumed a figure of GHS 0.055 per SMS, which is the price that an individual customer would pay to send an SMS. However, given that the MNO is sending out messages to thousands of subscribers, it could be argued that a bulk SMS price would be more realistic: a figure of GHS 0.03 per SMS was quoted in the baseline report for this project. Figure 11 shows how returns on the investment look much more attractive at this level of SMS price. If the real cost of SMS messages is discounted still further, even the freemium model (with GHS 0.85 per subscriber per month paid to the content provider) can show a reasonable rate of return.

³⁰ Under a freemium model, a business provides a service at no cost to the consumer as a way to establish the foundation for future transactions, typically paying for advanced features but, in the case of VFC, paying for supplementary features (airtime).

Figure 11: Sensitivity of IRR to SMS message price (low subscription and freemium models)

Source: Scott and Batchelor, 2020

Farmers' willingness to pay for VFC services

As part of the quantitative baseline survey, the evaluation team conducted a WTP game designed to explore potential levels of demand for the VFC product at difference price points. This has been used to estimate potential subscriber numbers at different prices. On this basis, modelling indicates that a subscription model could be financially viable at a fee rate of GHS 1 per month, thus being affordable for around 80% of the potential market. There is another peak in financial return at a fee rate of GHS 2 per month, but due to the elasticity of demand predicted by the WTP experiment, the product would be taken up by only 50% of the potential market.

This is significant in that it shows the potential disconnect between commercial and donor incentives: while a commercial organisation's goal is to maximise financial returns, the goal of donors is to maximise social impact.

Low attrition rates (around 5%) during the most recent phase of VFC (after fees were reintroduced) indicated that repeat users were willing to pay (at a reduced fee rate of 0.5 GHS/month). The more pressing challenge is to persuade new users to subscribe. Experience from other mNutrition projects also suggests WTP need not necessarily be a problem if fees are low enough.

Driving product development

VFC was developed by a small team in Vodafone that had cross-functional support within the MNO (for the duration of the grant) but that lacked internal user experience expertise, agricultural expertise, and content platform resources. Vodafone bought in this expertise from a third party, Esoko. This offered advantages in terms of speed, capital cost, and flexibility since Esoko had agricultural experts, an agricultural information database, and a tried and tested platform (see Section 5.3.2), meaning that Vodafone did not have to invest in these resources to launch the product. However, the downside of this arrangement was that the contractual relationship with Esoko provided little incentive to innovate. The partnership may well have appeared to have all the skills needed for agile product development but, in practice, key personnel moved on and took this expertise with them.

Implications of contractual partnerships

The partnership relationship between Vodafone and Esoko was always a contractual one. This diluted the incentive of either party to innovate and drive product development. Delays in contract negotiations created a climate of uncertainty that was not conducive to agile product development, which could have improved the product in reaction to user needs.

There was a lack of continuity in product development. Vodafone experienced multiple changes of management at the most senior level, at the level of managers with responsibility for VFC, and at the level of product manager. This led to a lack of continuity of ideas discussed with partners to develop VFC, to the point where the product was eventually suspended.

Vodafone's goals for the Ghana market changed throughout the evaluation period

The VFC concept was created in 2013 and in the subsequent years there were significant changes in the mobile communications landscape, particular in terms of the massive increase in mobile subscribers. Vodafone's original goal was to increase its rural base by specifically targeting new mobile subscribers from rural areas but, as the market has matured, the number of potential customers who aspire to phone ownership has diminished. Despite being highly regarded by users of the service, the bundle does not appear to have been sufficiently attractive to encourage people to continue to sign up with Vodafone (or any other operator for that matter). The strategy may have been appropriate at a given time, but only for a given duration. Vodafone has since shifted its priority to maximising the revenue generated by its rural base.

VFC in the context of other mNutrition projects

In terms of implementation, VFC has not been the most successful of the six mobile agriculture projects supported through the mNutrition programme.³¹ It is important not to dismiss the potential value of using mobile technology to support smallholder farmers solely on the finding that no substantial impacts were measured. A comparison of all six services highlights some learning points:

- Some cases relied on strategic partners to drive product development. In the case of two of the more successful products (Govi Mithuru in Sri Lanka and Khushaal Zaminder in Pakistan), the MNO sourced product development expertise internally. Where product development is driven by a strategic partner, the nature of the relationship is key.
- Esoko was unique among technical platform partners in providing services to farmers under its own brand prior to the partnership with Vodafone. This may have made it less flexible than other partners in making substantial changes to the product and the platform.
- Face-to-face contact is highly valued by farmers, especially in terms of building trust, but on-the-ground marketing activities were universally found to be prohibitively expensive. Three projects tried working with field partners (non-governmental organisations) to facilitate a field presence, but with limited success.
- OBD³² was commonly used as part of low-cost marketing activities targeting existing customers. However, VFC appears to have been unique in targeting new mobile subscribers, so low-cost activities such as OBD/SMS messages were not an option.
- VFC was also a uniquely complex product, being both a customer plan and a VAS. Other products provided farmers with information only, while one provided information on market prices and a mobile money service.

³¹ These were Airtel Malawi, Dialog Sri Lanka, Grameenphone Bangladesh, Vodafone Ghana, Ooredoo Myanmar, and Telenor Pakistan.

³² Also called 'voice SMS' or 'robo-calling' – where a pre-recorded message is sent over the network.

- Almost all the products initially had difficulty with the registration and onboarding processes. All the products, including VFC, went on to devise some form of single-click registration. User experience research conducted by other operators found that it was important for the pathway from registration to accessing data to be as short as possible, which VFC did not manage to achieve.

5.5.3 Cost recovery of VFC

Under certain circumstances, this kind of service can generate a positive IRR, in which case the cost of the VAS has been effectively zeroed, so that even minimal effectiveness among a limited proportion of the subscribers could be presented as worthwhile. Our sensitivity analyses have had to be based on theoretical subscriber rates informed by other mAgri services in other countries rather than by VFC itself. Financial modelling suggests that the service could be financially viable if a number of criteria can be met, e.g. increased subscriber numbers, low subscriptions, low revenue share with the content provider, and low SMS message price.

If that is the case, then measurable impact in terms of disability-affected life years is not the be-all and end-all of effectiveness, and the marginal effects on certain sub-groups of subscribers could be considered beneficial; this may speak to the FCDO agenda of 'leaving no one behind'. However, for this to be truly cost neutral there would have to be a mechanism for recovering the public investment back into a public agency.

5.5.4 Telecoms market developments

Mobile data use is set to grow across sub-Saharan Africa. By the end of 2018, there were 456 million unique mobile subscribers in sub-Saharan Africa – an increase of 20 million over the previous year – and it remains the fastest growing region (GSMA, 2019). Data generates an increasing share of total revenue and is likely to come to generate more revenue than traditional voice calls and SMS messages. Smartphone sales are increasing and initiatives are exploring low-cost internet technologies. However, poor network coverage means that voice-based features are likely to remain the most effective media for engaging with smallholder farmers in the medium term.

A new generation of mAgri products are integrating financial services into a broader range of farmer support services that address different parts of the value chain.³³ Access to financial services (and credit in particular) has been consistently articulated by farmers as their priority need. Even transactional services that enable farmers to conduct activities with greater ease (e.g. transport) take advantage of mobile money payment facilities. It is speculated that these more comprehensive services are likely to lead to greater impact because they enable farmers to overcome more pressing barriers associated with buying, selling, saving, insurance, logistics, etc., thereby enabling them to make more significant changes to their agricultural practices.

5.5.5 Lessons learned and recommendations: a commercially viable business model for mobile phone-based information services

- VFC was offered under both subscription and freemium business models and it is possible for both of these approaches to be financially viable. Creating a simple product and employing a

³³ www.gsma.com/mobilefordevelopment/resources/digitising-the-agricultural-last-mile-in-ghana-mtn-mobile-moneys-magric/

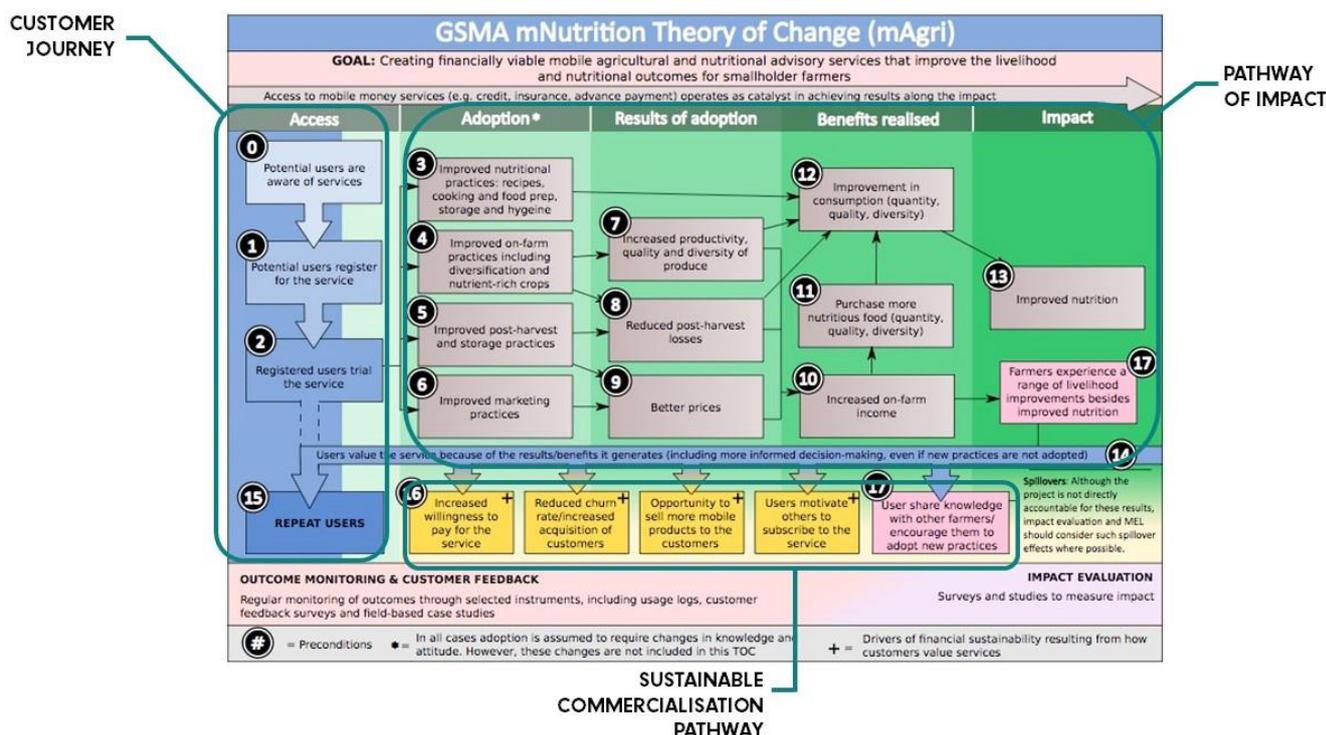
well-informed salesforce is key in order to achieve sufficiently high subscriber numbers (in the region of 200,000).

- Subscriber numbers for a mobile phone-based information service are crucial for commercial viability, but they have to be the right customers to maintain high retention rates. Extensive marketing is needed to reach rural markets, and registration and profiling needs to be straightforward.
- Contracting in VAS services (e.g. as Vodafone did with Esoko) enables an MNO to set up a service quickly and with minimal up-front costs. The drawback is that the MNO might then lack market understanding and expertise, making the product vulnerable to the partnership relationship. Contractual relationships provide little incentive to innovate. Future programme design should reflect the nature of partnerships and be designed accordingly.
- Mobile phone-based information services depend on multiple partnerships. Effective partnerships depend on good relationships and should be agile enough to respond to changing markets. Support initiatives should include some form of future-proofing to help mitigate changes that will invariably occur over the duration of a programme.
- Mobile phone-based agricultural advisory services offer the potential to improve agricultural practices among low-income farmers at low cost. However, there are a number of ways in which scaled-up SMS-based systems are not a good fit with this target group:
 - Each information delivery channel (e.g. SMS messages, OBD, and IVR) has advantages and disadvantages in terms of cost, literacy, timing, permanent record, and so on. Hybrid approaches would be ideal, but financial sustainability is highly sensitive to the price of messages, making it difficult to take advantage of expensive, voice-based technologies.
 - Low-income farmers are risk averse, making them reluctant to implement new practices, and making it more difficult to convince them to subscribe.
 - The process of onboarding is crucial; it needs to be simple and immediate. However, providing a local presence to assist (e.g. through well-informed agents) is expensive.
 - VFC offers a complex bundle of services that customers struggled to understand, especially when agents had a poor understanding of the product, tending to sell it as a SIM rather than as a VAS package.
 - Financial sustainability is most challenging when serving customers with the lowest ARPU.

6 Assessment of the assumptions that underpin the ToC

VFC was expected to improve agricultural and nutritional outcomes while generating direct revenues and indirect commercial value for Vodafone (see Figure 12 and Section 2.2). This section will revisit the ToC of VFC, and in particular the assumptions that lay behind each component of the ToC (i.e. customer journey, pathway of impact, and sustainable commercialisation pathway). For each assumption we assess whether the assumption ‘holds true’, ‘partially holds true’, or ‘largely does not hold true’ using evidence from all three evaluation components.

Figure 12: GSMA mNutrition ToC for mAgri



Source: Source: GSMA 2016, reproduced with permission

Table 7 presents the assessment of the assumptions that underpin the customer journey. As can be seen, the majority of assumptions did not hold true in practice, or only partially held true. Consequently, it is likely that the farmers would not take up and engage with VFC, even if they received VFC free of charge (which is exactly what the evaluation found, as seen in Section 5.1). To facilitate a more effective and successful take-up of VFC, extra effort would have to be put into addressing these assumptions (e.g. by changing the design of VFC).

Key:

	Assumption holds true
	Assumption partially holds true
	Assumption largely does not hold true
	Insufficient information/not applicable

Table 7: Customer journey

Assumptions	Rating	Comment
Farmers can access mobile phones to subscribe to and use the service		While mobile phone ownership was moderately high (47% of women, 80% of men), farmers who did not own a phone (e.g. poor farmers) or had only limited access to a phone (e.g. female farmers) were excluded from VFC.
Farmers can get sufficient Vodafone signal coverage and strength to subscribe to and use the service		Insufficient strength and stability of the Vodafone network posed a barrier to the reach of VFC, especially in CR.
Farmers are comfortable with receiving voice messages and SMS messages		Recorded voice messages are the delivery modality of choice in areas with high levels of illiteracy (such as rural Ghana). However, misconceptions about recorded voice messages, timing of delivery of messages, and lack of voicemail limited reach. Take-up of SMS messages was low, given the high levels of illiteracy or inability to understand English.
Farmers have enough money to use the service		As VFC was offered free of charge to all farmers in the encouragement sample, lack of financial resources did not pose a barrier to take-up of VFC.
Farmers have access to electricity to charge their mobile phones regularly		While three-quarters of households were able to charge their mobile phone at home, one-quarter had to charge it outside of the house (and often in a mobile phone kiosk for a fee).
There are no social norms or attitudes that may hinder farmers engaging with mobile phone-based information services		Levels of trust in the credibility of the content of VFC were consistently high and not influenced by social norms or perceptions about Vodafone. However, there were issues around content sharing and this reduced the reach of VFC considerably.
The subscription to VFC and the profiling of farmers is user-friendly		The initial registration process included several steps (i.e. registration, profiling, activation) and was time-consuming and laborious.
Service is successfully delivered to farmers' mobile phones		Shortcomings in the supportive infrastructure, limited capacity on the part of end users, and implementation challenges (e.g. delays in voice messages being sent due to network traffic) all negatively affected successful delivery.

Source: Authors own

Table 8 shows the assessment of the assumptions that underpin the pathway of change of VFC. Most assumptions held true or partially true, except those assumptions that related to access to the different components of VFC. This suggests that farmers who successfully took up and engaged with VFC and its components might be likely to adopt at least some of the advice, especially if common barriers to change are addressed (e.g. access to financial resources).

Table 8: Pathway of impact

Assumption	Rating	Comment
Take-up of new information		
Farmers have information gaps related to agricultural and nutrition practices		There were considerable gaps in the nutrition and agriculture knowledge of farmers, and a lack of access to public agricultural extension workers.
Farmers lack access to credible information on agricultural and nutrition practices		Farmers have a multitude of reliable information sources of agriculture and nutrition information; however, access is often infrequent or very difficult.
Farmers perceive the information as credible and trust the information provided		Levels of trust in the credibility of the content of VFC were consistently high.
Farmers perceive the information as actionable and context-relevant		While farmers valued practical and actionable VFC messages, there were also many theoretical and less actionable messages that merely reinforced existing knowledge.
Farmers use the different components (e.g. voice messages, call centre, SMS messages) and perceive them as useful		Access to the different components varied and depended on the capacity of farmers (e.g. literacy). In particular, the call centre was not used effectively due to misconceptions about the service and implementation challenges.
Farmers understand the information provided (both language and content)		Recorded voice messages were offered in different languages and were accessible. However, SMS messages were only offered in English and were inaccessible to the majority of farmers.
The information provided is accurate and correct		The messages were based on international best practice.
Adoption of new practices and results		
Farmers have the resources (e.g. economic, time, labour) to act on the advice		Lack of financial resources emerged as a huge barrier to the adoption of VFC advice. Advice regarding low-cost or no-cost agricultural or nutritional practices was more likely to be followed.
Farmers have the power to make decisions based on advice received		No barriers related to power to make decisions emerged.
Other contextual factors support a change in agricultural and nutritional practices		Mixed findings: access to markets emerged as a barrier to change.
Farmers implement the agriculture and nutrition advice correctly		Farmers often developed their own versions of the advice that was adapted to their capacity and context. This could reduce the effectiveness of the advice with regards to achieving the primary outcomes.
Farmers act on the new information and change their agricultural and nutrition practices		Farmers who engaged said they made some changes. However, these changes were highly individualised and did not result in overall impact of VFC.
Results of adoption/benefits realised/impact		
Farmers have access to more and better foods and agricultural equipment		Access to markets for food and equipment posed a problem for farmers in UWR as they lacked resources to travel.
Farmers have access to functioning markets and can sell agricultural products at the best price		Access to markets posed a problem for farmers in UWR as they lacked resources to travel. Subsistence farmers had no products to sell and so did not perceive the market price information as useful.
Contextual factors that may interact with agricultural		There were no contextual factors that interacted with the primary outcomes.

productivity and income and nutritional outcomes are not a barrier		
There are no national-level crises or humanitarian emergencies, such as conflict, war, droughts, etc.		There were no national-level crises.

Source: Authors' own

Table 9 presents the assessment of the assumptions that underpin the sustainable commercialisation pathway of VFC. As can be seen, the majority of assumptions did not hold true in practice, or only partially held true. This casts doubts on the commercial viability of the VFC product.

Table 9: Sustainable commercialisation pathway

Step	Rating	Comment
VFC targets viable customer segments		Low-income farmers have difficulty understanding a complex product, do not have the resources to change farming practices, and are the lowest ARPU segment. Evidence suggests that once signed up, they liked the service. Customer acquisition activities were not specifically targeted for women and nutrition content was not targeted enough for men.
The value proposition of the service satisfies the identified customer segments		Quality and satisfaction metrics were high. - 73% listened to the agriculture and nutrition voice messages always or often. - 72% found information from the agriculture and nutrition tips useful (always or very often). However, the qualitative evaluation suggests that nutrition tips were not perceived as relevant by the majority of male farmers.
Farmers are willing to pay		High quality and satisfaction metrics, as well as the qualitative findings, suggest farmers are willing to pay. However, adoption was confounded by conflicting price signals (subscription then free) and by poor onboarding.
Channels for reaching the customer remain in place and customer relationships are able to reach and maintain the desired customer segments		Although women largely signed up for VFC, it is men (i.e. husbands) who usually received the messages. Loss of SIM/handset was the biggest reason for not using VFC (among the quantitative sample). Freelancers and retailers were the local channels for Vodafone, neither of which were fully engaged with the VFC product. Poor network coverage.
Users motivate others to use the service		The concentration of VFC users remained too low for networking effects to become evident. High satisfaction levels among users suggest this is likely to be the case, however.
Revenue streams, both direct and indirect, fulfil the key performance indicators required by the supply partners		The contribution margin for VFC was within the target range for the mass market segment. VFC users were more likely to use Vodafone as their main network provider. The proportion of phone numbers owned by an individual on the Vodafone network increased. There was no evidence that VFC helped close the mobile ownership gender gap. There was no evidence of reduced churn among VFC subscribers. The ARPU for the VFC base was below the mass market average (GHS 2.5 per month, compared with GHS 3.0).

<p>Seeing the performance of the product, resources are made available from key supply partners</p>		<p>When problems were evident, partners took steps, e.g. automatic profiling, Esoko recorded messages. The product did not perform as well as expected (in terms of numbers) but the Vodafone team did not allocate additional internal resources to combat this.</p>
<p>Key partnerships in the supply chain are valued by each partner and maintained</p>		<p>The contractual nature of the partnership meant that Vodafone had the option of contracting other content providers. Esoko was motivated about going to scale, but has reached larger numbers of farmers through other projects. Esoko also claims that other projects (principally business-to-business) are more profitable.</p>
<p>A balance of cost, expenditure, investment, and income, both direct and indirect, makes for sustainable commercialisation of the product</p>		<p>Financial modelling indicates that VFC was not financially viable in any of its stages, but that it could be under various assumptions that depend on marketing and onboarding.</p>
<p>Alternative approaches found in-country do not supersede the value proposition of the product</p>		<p>Ghana is characterised by a vibrant technology industry, so there are many start-ups providing services targeted at farmers, some of which provide services similar to Esoko. Farmers cite financial services as their priority need; financial constraints were a major barrier preventing them implementing the advice they obtained from VFC. Emerging digital agriculture products integrate financial services into a broader range of farmer support services that address different parts of the value chain.</p>

Source: Authors own

7 Discussion

This section will outline how the mNutrition evaluation findings compare to the current evidence and existing literature within the field of mobile phone-based advisory services for agriculture. It will also draw links to the impact evaluation of the mNutrition programme in Tanzania that took place at the same time (Barnett *et al.*, 2020).

7.1 Reach, engagement and uptake by target population

In Ghana, the reach and uptake of mNutrition services among the target populations was lower than expected. Our evaluation of mNutrition in Tanzania similarly found very low reach of the mNutrition programme. In both contexts this can be explained by shortcomings relating to: (1) the available supportive infrastructure; (2) limited capacity of the intended target group; and (3) issues in the implementation and design of the programme. All three shortcomings are echoed in the wider literature on mobile phone-based interventions that seek to change behaviours in low- and middle-income countries. A recent review of mobile phone-enabled agricultural information services (m-Agri services) in Africa also concluded that mAgri services are more likely to fail or be abandoned if these three barriers are not considered and addressed by implementers and designers (Emeana *et al.*, 2020)

Firstly, in the existing mAgriculture and mHealth literature, shortcomings in the available supportive infrastructure have been identified as a key limiting factor to the effective uptake of mobile phone-based interventions targeted towards behaviour change. For example, a recent comprehensive review by Fabregas *et al.* (2019) concludes that mobile phone technology could play a more significant role in agricultural practices and improvements if the necessary infrastructure to support the technology is available more widely. In another review, Aker *et al.* (2016) found that limited mobile phone coverage and shortcomings in the supportive infrastructure negatively affected possibilities for effective sharing of agriculture information. Other recent reviews and studies further corroborate these findings and suggest that low-income, uneducated and female small-holder farmers are particularly at disadvantage when it comes to effective access to mobile phone-based agriculture information services (e.g. Larsen-Cooper *et al.*, 2015; Chan and Kaufman, 2009; Misaki *et al.*, 2018).

The second barrier to reach and up-take was the limited capacity of the target group to engage with mNutrition text messages and recorded voice messages, due to illiteracy and lack of familiarity with voice messages. This finding again resonates with the wider literature (e.g. Kansime *et al.*, 2019; Dodson *et al.*, 2013). Aker *et al.* (2016) found that many agricultural mobile phone-based services were not available in local languages, preventing access for some users. In some contexts, existing marginalisation was exacerbated further by mobile phone-based services, which favoured male, richer, younger, and more educated sections of the population, who were more experienced mobile phone users. Females, poorer, and less educated individuals were often excluded from the service (Fabregas *et al.*, 2019; Larochelle *et al.*, 2019; Khan *et al.*, 2020). Several studies and reviews from different contexts have all concluded that women are usually considerably less likely to have access to a mobile phone and are less digitally literate; consequently they are more difficult to reach with mobile phone-based behaviour change interventions (Alam *et al.*, 2020; Misaki *et al.*, 2018; Fabregas *et al.*, 2019; Scott *et al.*, 2003; GSMA and Cherie Blair Foundation, 2010; Kansime *et al.*, 2019).

The third barrier faced was issues in the design of the service: for example, a lack of human support to encourage trust in the service and ongoing continuous engagement. Aker *et al.* (2016) and Fabregas *et al.* (2019) found that design features within mAgri programmes that include face-

to-face interactions with trusted sources may increase uptake, and increase recognition that the messages are useful and not spam.

Studies have also shown that scaling up mAgri information programmes, particularly those based on a subscription model, such as VFC, has been problematic (Fabregas *et al.*, 2019; InfoDev, 2014; Qiang *et al.*, 2012; Aker *et al.*, 2016). Agricultural information is non-excludable, meaning that it can be passed on at little or no cost, making a subscription model potentially unsustainable: one person can easily pass on information to countless others. However, creating that information does have a cost associated with it for the mAgri service, a cost that may not be fully appreciated by the 'buyer' of that service (Fabregas *et al.*, 2019). It is these three elements (non-rivalry, non-excludability, and information asymmetry) that create barriers to scalability (Fabregas *et al.*, 2019; and Aker *et al.*, 2016). Despite this, evidence does suggest that the benefits of digital extension programmes far outweigh the costs, but that subscription-based models will not reach optimal scale (Aker *et al.*, 2016). Programmes that have been more successful in scaling up have required significant time and investment, and several funding cycles (Qiang *et al.*, 2012; Batchelor, 2012).

7.2 Effectiveness of services in changing behaviours

The effectiveness of mNutrition services in changing behaviours at scale was limited. In Ghana, there was no impact of VFC, on average, on households' or women's dietary diversity, agriculture production or income, or nutrition or farming knowledge. In Tanzania, we found some modest impact on knowledge and some limited improvements in dietary diversity, but no impact on nutritional status. This lack of impact can in part be explained by the low reach of these services in relation to, and very limited sustained engagement with them by, households in both settings. Other studies have found mixed impacts of mobile phone-based interventions on agricultural behaviours. Programmes usually were more successful when they addressed one specific key information need and when the content was frequently adapted to address emerging new information needs (rather than providing information on a wide variety of topics and without much change in the content over time, as mNutrition in both Ghana and Tanzania did), or when information asymmetries were high (in favour of the provider) (Aker *et al.*, 2016; Qiang *et al.*, 2012; Larochelle *et al.*, 2019). For example, an experimental evaluation of a mobile phone-based agricultural advice service in India found that treatment farmers were more likely to change agricultural practices and lost less crops to pests compared to control farmers (Cole and Fernando, 2016). However, it should be noted that this mobile phone-based advisory service was based on a small-scale intervention (and not a national-level programme like mNutrition) and was also more intensive compared to VFC (i.e. several weekly messages, constantly changing content in response to farmers specific needs, farmers could access several interactive components). In their mixed methods evaluation of CABI-Direct2Farmer (D2F) programme in India, Kansime *et al.* (2019) reported that while there was a high attrition rate of users within the programme, those who remained engaged reported an increase in both knowledge and behaviour. A very high proportion (90%) of active users also reported sharing information with other farmers. These findings are not dissimilar to the findings in mNutrition (both in Ghana and Tanzania). Indeed, based on the qualitative evaluation mNutrition, users who actively engaged with the programme throughout the intervention period frequently reported an increase in knowledge and also a change in behaviour. However, the types of behaviour change varied greatly depending on the users' motivation, interest, and capacity, and there were also many context-specific adaptations of the advice received. Larochelle *et al.* (2019) evaluated an mAgri programme in Ecuador, aimed at changing farmers' behaviour regarding pest management through text messages. They found that participating farmers' knowledge increased, and that there was a positive and significant impact on the adoption of complex pest management practices (this was not the case for simple or time-sensitive practices). However, they also found that participants with lower education levels were

less likely to report increased knowledge or behaviour change, again reinforcing the issue that mAgri programmes do not circumvent pre-existing societal divides or impact the most marginalised groups.

There is also some convincing evidence (from RCTs) suggesting that SMS messages can be very effective as a follow-up to training sessions to remind farmers to adopt new agriculture practices (Laroche *et al.*, 2019; Fabregas *et al.*, 2019). However, even if agricultural knowledge increases due to a mobile phone-based advisory service, this does not necessarily translate into behaviour change, higher yields, or profits (Laroche *et al.*, 2019). Interestingly, some studies also found that even when agricultural behaviour change was achieved, the change was not automatically associated with increased agriculture knowledge, suggesting that some farmers followed advice without really understanding the reasons for it (Laroche *et al.*, 2019).

Aker *et al.* (2016) argue that for ICT-based information provision to change behaviour it needs to address three things. Firstly, information must be a constraint in a given market context and for the specific target population. Secondly, the information provided must be relevant to the target population. And finally, the source of information must be perceived as credible, since information that is provided via faceless SMS messages may not be trusted. To address the issue of trust, the availability of some kind of real-time human support (e.g. through a call centre) has been shown to increase continued engagement with digital behaviour change interventions (Michie *et al.*, 2017). The literature further suggests that interactive digital interventions, in which users are given the opportunity to contact experts for support and advice, report higher levels of engagement than one-way interventions (i.e. interventions in which information is only pushed out) (Couper *et al.*, 2010). VFC was a multi-platform programme, with SMS messages, voicemail, and a call centre. However, there were multiple capacity issues with the implementation of the interactive call centre, as well as barriers to accessing the call centre (e.g. a misconception that one would be charged when contacting the call centre, and feeling too uneducated). The mNutrition programme in Tanzania had no interactive component.

7.3 What makes mobile services different, compared to traditional channels?

The evaluation has identified several features that distinguish mobile phone-based information services from traditional services for agriculture and nutrition information. Mobile phone-based information services are well suited to the delivery of both area- and time-sensitive information, and they can do this more effectively than most other information sources, even in remote, inaccessible settings (provided, of course, that there is network coverage).

The ubiquity of mobile phones makes it possible to reach and contact target audiences for behaviour change interventions at all times and in a cost-effective manner, overcoming issues with 'contactability', which often poses a challenge for 'traditional' behaviour change interventions, especially in geographically spread-out populations (Hall *et al.*, 2014). Mobile phone technology also offers the opportunity to overcome the lack of personnel and lack of resources faced by many traditional extension services (Laroche *et al.*, 2019). Another potential strength of mobile phone-based behaviour change interventions may be that participants often perceive the anonymous provision of information as less stigmatising than face-to-face counselling (Fielden, 2011). Mobile phones offer an opportunity for increased communication, not only between providers of information (non-governmental organisations, governments etc) and farmers, but also from farmer to farmer, and between farmers and markets (Aker *et al.*, 2016). The use of mobile phones for financial services also offers great advantages, particularly for small-scale farmers (Aker *et al.*, 2016).

In their review of existing mobile phone-based interventions, Fabregas *et al.* (2019) recognise the significant impact mobile phone technology could have on agriculture, and argue that the reach of such technologies could be vast. However, they find that this potential has not yet been fully utilised. Suggested uses of mobile technology to improve agriculture in developing countries includes: providing GPS-based personal information for farmers to address their specific needs, such as soil conditions, or localised pest outbreaks; to improve and monitor agricultural extension workers; to improve the functioning of supply chains; and, importantly, to provide opportunities for two-way communication with farmers. The limitations of mobile phone-based services include: a lack of trust on the part of the farmers in the source of the information; the fact that some messages are seen by farmers as inappropriate or harmful to their businesses; the fact that messages may be seen as too complex or as requiring too much investment to carry out; the fact that in some cases smartphones are required to receive video messages; and the fact that if messages are seen to come too often, they may be ignored or considered as spam. Barriers to effective services include: the problem of customisation – e.g. needing GPS coordinates for farmers requires GPS-enabled phones; the fact that gathering information from farmers is challenging because response rates are low; and the fact that some information, such as exact yields, can be difficult to quantify.

7.4 What does the mNutrition evaluation add to the emerging evidence base on mobile phone-based advisory services?

The evaluation of the mNutrition programmes confirms, quantifies and explains many of the current challenges and limitations of mobile phone-based advisory services and also supports some of their previously reported successes (e.g. increase in knowledge of users, moderate changes in practices). However, mNutrition is a national-level programme based on an innovative public-private partnership rather than a small-scale pilot intervention (as most mobile phone-based advisory services currently are). A major shortcoming of most studies on the use of mobile phone-based advisory services in low-and middle-income countries is their poor methodological quality (as highlighted in literally all reviews cited above). The evaluation of the mNutrition programme addresses this major flaw. The data presented here is based on a large-scale rigorous mixed methods evaluation including an experimental quantitative design, in-depth longitudinal case studies with a variety of service users (including female farmers, and farmers from different socio-economic strata) and a business model analysis. This unique multi-pronged approach allowed valuable and in-depth insights into the underlying causal processes of the mNutrition services and suggested many practical and actionable lessons of how remaining challenges in mobile phone-based advisory services can be addresses effectively.

8 Conclusions and lessons learned

The objectives of this mixed methods evaluation were to assess the impact, cost effectiveness, and commercial viability of VFC, a mobile phone-based information service that aimed to promote behaviour change around key farming decisions and practices, and around other household practices, that is likely to result in improved nutritional health within a household. In this section, the key findings from the evaluation are summarised and recommendations are presented.

8.1 Effectiveness of VFC in reaching smallholder farmers

The reach of VFC was low; female farmers and poor farmers in particular were often excluded. This can be explained by shortcomings in the available supportive infrastructure, the capacity of the target audience, and limitations in the implementation and design of VFC.

In order that these groups are not left behind in future, interventions should be designed with the option of alternative modes of delivery, such as through radio and community workers. It is important that the capacities of the target audience in terms of literacy and language spoken are factored into programme design, since illiteracy and the inability to understand English were major barriers to the take-up of VFC SMS messages on prices and weather. Recorded messages are a good delivery channel for overcoming this barrier but many farmers missed such messages because they did not have voicemail set up to capture these calls. The introduction of a new SIM card that was not on the preferred local network was also a barrier to uptake for farmers who already owned a mobile phone.

Design features can help to increase reach and uptake. This should include easy registration processes, preferably assisted by a trusted person (e.g. an agriculture extension worker).

8.2 Impacts of VFC on nutrition and livelihood outcomes

Being offered the VFC service or having used it at least once had no impact on households' and women's dietary diversity, agriculture production and income, or nutrition or agriculture knowledge or practices. The lack of impact of VFC can in part be explained by the low reach of, and very limited sustained engagement with, VFC.

Nevertheless, farmers who actively engaged with VFC made at least some changes in their agriculture behaviours and practices (and to a lesser extent their nutrition-related behaviours and practices). The types of changes farmers made varied greatly and depended on their financial circumstances, capacities, and contexts. To capture the multitude of granular effects VFC had on farmers' behaviours and practices, future evaluations of mobile phone-based interventions should consider complementing rigorous experimental designs with more agile, short-term, and adaptive evaluation methods.

The evaluation findings also suggest that offering VFC free of charge positively affected farmers' attitudes towards, and use of, Vodafone as their network provider. However, the main reason for the change in attitudes was likely to be the fact that VFC was free; reintroducing user fees for the service may negatively affect attitudes towards Vodafone.

Based on the learnings from the evaluation, the following recommendations are made, to increase the effectiveness of mobile phone-based information services in changing behaviours:

Introduce interactive components (e.g. call centres and/or active information search functions) and face-to-face contact (e.g. local support groups and/or a local service promoter) to promote behaviour change. Do not rely on just pushing out information to passive audiences.

Combine mobile phone-based information services with financial services or ongoing interventions (e.g. livelihood improvement programmes or social protection programmes) that provide poor households with the financial resources needed to act upon the information they receive. Users of mobile phone-based services can only act upon information if they have the financial resources to do so.

Intensive and interpersonal support is necessary to motivate farmers to try out higher-risk changes in their agricultural practices, and should be offered to complement mobile phone-based services (e.g. by encouraging users to seek interpersonal support from local services).

8.3 The process of content development for VFC

The evaluation found high levels of overall acceptance of the content of VFC. Farmers perceived the agriculture tips as easy to understand, useful, and relevant. In particular, female farmers valued both the agricultural and nutrition content. Trust in the credibility of the content of the service was generally high. Nevertheless, not all content was perceived as relevant to farmers' specific needs and the evaluation also suggests some potential areas for improvements.

An increase in the frequency and focus of nutrition advice might result in an increase in effectiveness of the service, as would a focus on advice that is free or low-cost to follow. Farmers would also benefit from two-way communication channels (such as the VFC call centre), since these can deliver time-sensitive, tailored agricultural, or nutritional advice. To engage male farmers with nutrition issues, alternative channels may be more effective (e.g. nutrition education during antenatal care sessions that are mandatory for both parents; and community events or radio spots specifically targeting fathers).

Including features and content in mobile phone-based services that aim to strengthen self-motivation and improve subscribers' perceived locus of control (e.g. through the tone of the messages) could help to motivate a wider audience to continue to engage with VFC.

8.4 Mobile phone-based services for behaviour change

Mobile phone-based services are more convenient as information can be accessed at a time that is convenient for the farmer, which can help to address information asymmetries and saves time and resources in regard to information-seeking. In the case of VFC, this was especially true for female farmers, who often struggled with multiple demands on their time and/or had mobility constraints, and in settings where access to regular information was challenging.

8.5 Commercial viability of business models for VFC

VFC was offered under both subscription and freemium business models and the evaluation found that both of these approaches could be financially viable. However, such success relies upon a simple product and a well-informed salesforce. Since SMS message costs are the largest single component of cost of sales, including an MNO partner that can cover these costs can help to make mobile phone-based information services more commercially viable. It may thus be more

financially viable to have an MNO host an agricultural advisory service, rather than a third-party content provider.

Mobile phone-based information services require complex partnership arrangements between content and platform providers, and the MNO; these arrangements need to be based on good relationships and need to be designed to respond to changing technological and market environments to be truly future-proofed.

For a mobile phone-based information service to be commercially viable there needs to be a high number of customers and high retention rates. In a country the size of Ghana, the numbers required (in the region of 200,000 subscribers) represents a large proportion of the potential rural market, meaning that extensive marketing would be needed to reach all of this market. More importantly, barriers to adoption of the service would need to be overcome.

Our business model analysis shows how services such as VFC will be financially sustainable only under certain circumstances. This raises questions over the ethics of spending public money on services that result in financial benefits for the private sector. There would, therefore, be value in the donor community engaging in discussion on how commercial returns can be used to reimburse expenditure from public funds.

While mobile phone-based agricultural advisory services offer the potential to improve agricultural practices among low-income farmers at low cost, this study has highlighted a range of ways in which scaled-up SMS-based systems are not a good fit with this target group. These include the extra costs of incorporating hybrid, voice-based approaches and employing local agents to assist with registration. Financial sustainability is most challenging when serving customers with the lowest ARPU.

Emerging digital agritech services that take advantage of platforms such as WhatsApp may well provide more comprehensive packages of support for farmers, which result in significant improvements. However, the barrier to adoption of these data-driven services is higher in terms of the digital literacy required to use them effectively, so they risk widening digital divides and leaving the poorest behind.

8.6 Conclusion

Mobile phone-based services are not a magic bullet, but they are valued by users who engage with the service, so could be a valuable addition to programmes aimed at improving nutrition and agriculture-related knowledge and changing behaviour. Mobile phone-based advisory services alone tend not to be enough to affect agricultural and nutrition outcomes, which generally have complex determinants. Human interactions are vital to support, facilitate and ensure sustained engagement with the service.

Mobile phone-based services to change behaviour are likely to be most effective if embedded in trusted structures (such as agriculture extension services), if they are linked up with other programmes that address underlying barriers to change (such as social protection programmes) and paired with established low-tech, inclusive approaches (such as radio).

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Annex A List of all study outputs

Publication title	Type	IDS website link
IDS Working Paper 481: Dial 'N' for nutrition? A landscape analysis of what we know about m-Nutrition, m-Agriculture and m-Development	Technical report	www.ids.ac.uk/publications/dial-n-for-nutrition-a-landscape-analysis-of-what-we-know-about-m-nutrition-m-agriculture-and-m-development/
Desk review: Smallholder farming, nutrition and m-Agriculture services in Ghana	Technical report	www.ids.ac.uk/publications/desk-review-smallholder-farming-nutrition-and-m-agriculture-services-in-ghana/
Desk review: Determinants of undernutrition and existing m-Health services in Tanzania	Technical report	www.ids.ac.uk/publications/desk-review-determinants-of-undernutrition-and-existing-m-health-services-in-tanzania/
Inception report: External evaluation of mobile phone technology-based nutrition and agriculture advisory services in Africa and South Asia	Technical report	www.ids.ac.uk/publications/inception-report-external-evaluation-of-mobile-phone-technology-based-nutrition-and-agriculture-advisory-services-in-africa-and-south-asia/
Research methodology brief: Using quantitative methods to evaluate mobile phone technology-based nutrition and agriculture advisory services in Ghana	Briefing	www.ids.ac.uk/publications/using-quantitative-methods-to-evaluate-mobile-phone-technology-based-nutrition-and-agriculture-advisory-services-in-ghana/
Research methodology brief: Using quantitative methods to evaluate mobile phone technology-based nutrition and agriculture advisory services in Tanzania	Briefing	www.ids.ac.uk/publications/using-quantitative-methods-to-evaluate-mobile-phone-technology-based-nutrition-and-agriculture-advisory-services-in-tanzania/
Research methodology brief: Using qualitative methods to evaluate mobile phone technology-based nutrition and agriculture advisory services in Ghana and Tanzania	Briefing	www.ids.ac.uk/publications/using-qualitative-methods-to-evaluate-mobile-phone-technology-based-nutrition-and-agriculture-advisory-services-in-tanzania-and-ghana/
Research methodology brief: Using a business model and cost-effectiveness analysis to evaluate mobile phone technology-based nutrition and agriculture advisory services in Tanzania and Ghana	Briefing	www.ids.ac.uk/publications/using-a-business-model-and-cost-effectiveness-analysis-to-evaluate-mobile-phone-technology-based-nutrition-and-agriculture-advisory-services-in-tanzania-and-ghana/

Mobile phones, nutrition and agriculture in Ghana: Initial exploratory qualitative study report	Technical report	www.ids.ac.uk/publications/mobile-phones-nutrition-and-agriculture-in-ghana-initial-exploratory-qualitative-study-report-external-evaluation-of-mobile-phone-technology-based-nutrition-and-agriculture-advisory-services-in-afr-2/
Mobile phones, nutrition and health in Tanzania: Initial exploratory qualitative study report	Technical report	www.ids.ac.uk/publications/mobile-phones-nutrition-and-health-in-tanzania-initial-exploratory-qualitative-study-report-external-evaluation-of-mobile-phone-technology-based-nutrition-and-agriculture-advisory-services-in-afric-2/
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Mobile phones, nutrition and agriculture in Ghana: Business modelling baseline report	Technical report	www.ids.ac.uk/publications/mobile-phones-nutrition-and-agriculture-in-ghana-business-modelling-baseline-report/
Mobile phones, nutrition and health in Tanzania: Cost-effectiveness baseline report	Technical report	www.ids.ac.uk/publications/mobile-phones-nutrition-and-health-in-tanzania-cost-effectiveness-baseline-report/
Mobile phones, nutrition and agriculture in Tanzania: Business modelling baseline report	Technical report	www.ids.ac.uk/publications/mobile-phones-nutrition-and-agriculture-in-tanzania-business-modelling-baseline-report/
Mobile phones, nutrition, and agriculture in Ghana: Quantitative baseline Report	Technical report	www.ids.ac.uk/publications/mobile-phones-nutrition-and-agriculture-in-ghana-quantitative-baseline-report/
Mobile phones, nutrition, and health in Tanzania: Quantitative baseline report	Technical report	www.ids.ac.uk/publications/mobile-phones-nutritionand-health-in-tanzania-quantitative-baseline-report/
Ghana mixed methods baseline report	Technical report	www.ids.ac.uk/publications/ghana-mixed-methods-baseline-report-external-evaluation-of-mobile-phone-technology-based-nutrition-and-agriculture-advisory-services-in-africa-and-south-asia/
Ghana mixed methods baseline report – executive summary	Summary paper	www.ids.ac.uk/publications/the-ghana-mixed-methods-baseline-report/

Tanzania mixed methods baseline report	Technical report	www.ids.ac.uk/publications/tanzania-mixed-methods-baseline-report-external-evaluation-of-mobile-phone-technology-based-nutrition-and-agriculture-advisory-services-in-africa-and-south-asia/
Tanzania mixed methods baseline report – executive summary	Summary paper	www.ids.ac.uk/publications/the-tanzania-mixed-methods-baseline-report/
Mobile phones, nutrition and health in Tanzania: Qualitative midline study report	Technical report	www.ids.ac.uk/publications/mobile-phones-nutrition-and-health-in-tanzania-qualitative-midline-study-report-external-evaluation-of-mobile-phone-technology-based-nutrition-and-agriculture-advisory-services-in-africa-and-south/
Mobile phones, agriculture, and nutrition in Ghana: Qualitative midline study report	Technical report	www.ids.ac.uk/publications/mobile-phones-agriculture-and-nutrition-in-ghana-qualitative-midline-study-report/
Lessons learned brief for Ghana and Tanzania	Summary paper	www.ids.ac.uk/publications/lessons-learned-brief-for-ghana-and-tanzania/
Mobile phones, agriculture, and nutrition in Ghana: Qualitative follow-up study report	Technical report	www.ids.ac.uk/publications/external-evaluation-of-mobile-phone-technology-based-nutrition-and-agriculture-advisory-services-in-africa-mobile-phones-agriculture-and-nutrition-in-ghana-qualitative-follow-up-study-report/
Mobile phones, health and nutrition in Tanzania: Qualitative follow-up study report	Technical report	Available on IDS website shortly
Mobile phones, nutrition, and agriculture in Ghana: Quantitative endline report	Technical report	Available on IDS website shortly
Mobile phones, nutrition, and health in Tanzania: Quantitative endline report	Technical report	Available on IDS website shortly
Mobile phones, nutrition, and agriculture in Ghana: Cost-effectiveness endline report	Technical report	Available on IDS website shortly
Mobile phones, nutrition and agriculture in Ghana: Business modelling endline report	Technical report	Available on IDS website shortly
Mobile phones, nutrition and health in Tanzania: Cost-effectiveness endline report	Technical report	Available on IDS website shortly

Mobile phones, nutrition and agriculture in Tanzania: Business modelling endline report	Technical report	Available on IDS website shortly
Mobile phones, nutrition and health in Tanzania: Final mixed methods evaluation report	Technical report	Available on IDS website shortly
Mobile phones, nutrition and health in Ghana: Final mixed methods evaluation report	Technical report	Available on IDS website shortly