



mAgri

Weather forecasting and monitoring: Mobile solutions for climate resilience



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mAgri

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Executive Summary

In the developing world, the availability of localised, granular weather forecasts can provide immense value to the 500 million smallholder farmers who depend on rain for their daily agricultural activities. The need for accurate weather information is made greater by the impact of climate change that is resulting in weather patterns becoming more unpredictable and extreme weather conditions more frequent and harsh.

In theory, the dependency of the agriculture sector on rain should translate into high demand for weather forecasts. However, the lack of reliable data and resources, particularly from national meteorological agencies, has meant that weather forecasts available today through radio, TV and mobile have hardly provided value to people depending on agriculture.

This paper explores new use cases for weather monitoring and forecasting via mobile, and advocates for increasing focus and investment from mobile network operators (MNOs), value added service (VAS) providers and donors in enabling technologies that can provide more localised and accurate services.

In the field of agricultural value added services (Agri VAS), the article discusses localised forecasts enabled by improved weather modelling techniques; services that provide weather adaptive agronomic advice; and services that provide climate smart agronomic advice

for climate adaptation, mitigation and food security. In the field of agricultural mobile financial services (Agri MFS), it focuses on weather index insurance products (WII) that protect crops against exposure to weather calamities.

We argue that, in order to explore the full transformative potential of weather forecasts and develop holistic bundles including content and financial services for the rural segment, service providers should put weather services at the core of the value proposition. They should consider extending partnerships from local meteorological agencies to a broader range of local and international ecosystem players, including commercial providers and free and open data initiatives.

We also call MNOs to consider investing in location based services (LBS) to provide highly localised and relevant services, and to leverage the mobile network as the most pervasive ICT network in the developing world to collect weather monitoring data that is essential for weather modelling, as well as for financial products such as weather index insurance.

As a result of our research, we ask donors to put weather forecasting and monitoring at the core of climate adaptation funds, and to focus on mobile-centred projects in order to increase the opportunity to scale services and generate socioeconomic impact.

Key insights:

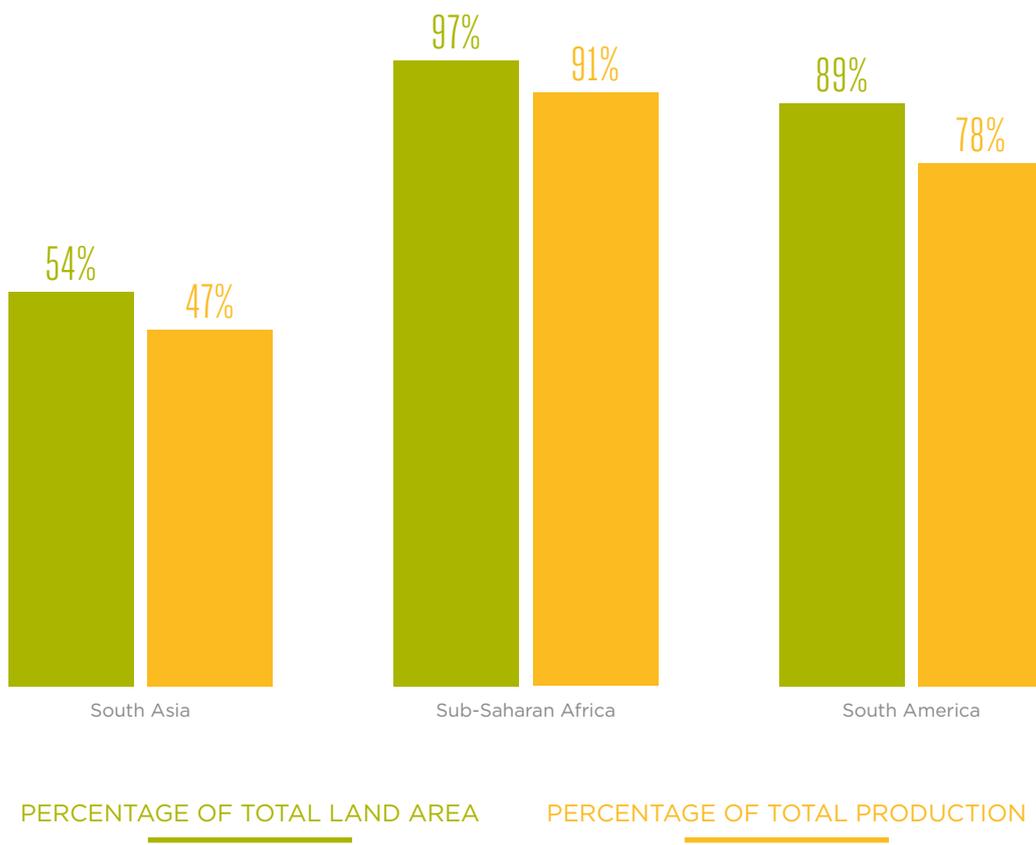
- The need of smallholder farmers in the developing world for accurate weather forecasts is made greater by the dependency on rain-fed agriculture, and by the global impact of climate change.
- To date, smallholder farmers largely rely on national meteorological agencies with low capacity for the provision of weather services that are distributed over radio, TV and mobile.
- MNOs can play a key role not only in disseminating weather forecasts but also in improving weather services by catalysing new content and technology providers.
- As a dynamic service component, weather forecasting presents an opportunity to drive stickiness of the overall mobile agriculture (mAgri) proposition, provided that services are of high quality and locally relevant.
- To exploit the potential of weather services, MNOs need to release their unique strategic assets, primarily the network intelligence to geo locate users, which in the absence of smartphones equipped with Global Positioning System (GPS) allows the provision of localised services.
- Besides information services, the digitisation of weather index insurance presents an opportunity for MNOs to use core capabilities (geo location and mobile money) to enable agricultural mobile financial services (Agri MFS), starting from insurance and extending to tailored credit and savings products.
- MNOs also have the ability to use their network for weather monitoring, either by rolling out weather stations or by analysing signal propagation from cell sites, but to release this opportunity they need to establish new partnerships at ecosystem level.
- By increasing their focus on weather services, MNOs can evolve the value proposition of their rural services towards more holistic bundles including dynamic agronomic advice linked to localised weather forecasts, climate smart agronomic advice, and mobile money enabled Agri MFS.
- A user centric approach in service design can help all mAgri providers to develop better weather services for smallholders. User centric design is also beneficial to mobile financial services such as mobile weather index insurance.

Introduction

Agriculture represents 32.3% of GDP value in low income countries and 16.7% in lower middle income countries.¹ In the developing world, agriculture depends largely on rain precipitations. Rain-fed agriculture represents the quasi-totality of agricultural land in Sub-Saharan Africa, and the largest proportion of agricultural land in South America and South Asia. Rain-fed agriculture is also considerably less productive than irrigated agriculture.

FIGURE 1 Source: International Food Policy research Institute (IFPRI)²

Rain-fed agriculture as a percentage of total agricultural land and total agricultural production



1. World Bank data. As of 1 July 2014, low-income economies are defined as those with a gross national income (GNI) per capita, calculated using the World Bank Atlas method, of USD1,045 or less in 2013; Lower-middle-income economies are those with GNI per capita between USD1,045 and USD 4,125 in 2013. <http://data.worldbank.org/income-level/LIC> <http://data.worldbank.org/income-level/LMC>.

2. "International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT)", International Food Policy Research Institute. Data is from 1999-2001. <http://www.ifpri.org/publication/international-model-policy-analysis-agricultural-commodities-and-trade-impact-0>. Today rain-fed agriculture still represents more than 95% of farmed land in Sub-Sharan Africa. See International Water Management Institute (IWMI) <http://www.iwmi.cgiar.org/issues/rainfed-agriculture/summary/>

The dependency of the agriculture sector on rain means accurate weather forecasts are in high demand. This need is made greater by the global impact of climate change, which has resulted in weather patterns becoming more unpredictable.³ In Sub-Saharan Africa, for example, Malawi has faced multiple weather shocks in the last twenty years, with shifts in rainfall patterns and severe storms, with increased instance of severe flooding and droughts. Such events have undermined the agricultural economy on which the majority of the population depends upon. In 2015, the extended dry spell followed by severe flooding in the South of the country wiped out 90,000 hectares of cropped land. After declaring a state of national emergency, the government reported that 2.8 million people, equivalent to 17% of the total population, will require food assistance.⁴ Overall, the impact of climate change will be most felt in the developing world. According to the World Bank, in Africa the effects of climate change could cause food prices to increase by as much as 12% by 2030, and by up to 70% by 2080.⁵

Smallholder farmers in the developing world need to adapt to changing climate conditions. For the provision of weather forecasts, however, farmers rely on national

meteorological agencies with low capacity and obsolete technologies. Over 60% of national meteorological agencies, the vast majority in emerging markets, are significantly challenged with respect to their core infrastructure (observational networks, forecasting systems and telecommunications).⁶ To improve weather services, there is a need for greater engagement and collaboration of different stakeholders, including government and transnational organisations with global weather data (e.g. the European Centre for Medium-Range Weather Forecasts, and the US National Center for Environmental Prediction), commercial weather forecasting companies (e.g. MeteoGroup, StormGeo, Foreca, Ignitia), and international research institutions and NGOs with open data.⁷

In addition, there is a need of greater engagement of all distributors of weather forecasts, primarily MNOs and VAS providers delivering weather forecasts to smallholder farmers on their mobile phones. As the only ecosystem players that can scale mobile agriculture services, MNOs can play a pivotal role in catalysing investment, including from donors, and drive forward innovation in weather services.

3. "Scoring Climate Change Risk: G20 vulnerability increases", HSBC Climate Change Global Research (2013).

4. FAO GIEWS Country Briefs <http://www.fao.org/giews/countrybrief/country.jsp?code=MWI>

5. "Shock Waves: Managing the Impacts of Climate Change on Poverty", World Bank (2015).

6. First Coordinated Capacity Assessment of National Meteorological and Hydrological Services (NMHSs) in Support of Disaster Risk Reduction (2006), World Meteorological Organisation.

7. Initiatives mentioned in this article include The Group on Earth Observations (GEO); The Global Open Data for Agriculture and Nutrition (GODAN); The Data Library of the International Research Institute for Climate and Society (IRI); the Trans-African Hydro Meteorological Observatory (TAHMO); and Toto Agriculture project, an initiative supported by the Bill and Melinda Gates Foundation and INSEAD North America.



Creating value proposition for smallholders

Alongside market price information and agronomic advice, weather forecasts are a typical component of mAgri services. As part of the content bundle, service providers in emerging markets have mainly offered weather forecasts from national meteorological agencies at regional, or at best at district level. The availability of this type of generic content across multiple channels (including radio and TV) has meant weather forecasts have mostly served as additional components rather than the core element of the Agri VAS value proposition. New emerging use cases, however, mean that weather services can become more central to the offering of MNOs and VAS providers for smallholder farmers, and potentially even transform the whole value proposition.

New use cases in weather services include localised forecasts enabled by improved weather modelling techniques for developing world regions;⁸ services that provide weather adaptive agronomic advice, including the use of predictive analytics;⁹ climate

smart agronomic advice related to climate adaptation, climate mitigation and food security; and, in the field of MFS, WII products that protect crops against exposure to weather calamities. By introducing financial services to high risk rural customers, this type of product can in turn open the floor for new MFS, such as credit and saving products that are tailored to or take into account the climate related risks.

In order to exploit the potential of weather services, MNOs need to partner with local and international ecosystem players with weather data and expertise. They also need to fully leverage their unique strategic assets, such as ability of the network to geo locate users at the farm level to provide highly localised services, and the ability to conduct transactions via mobile money platforms. By making weather services more relevant and more central to their product offering, MNOs have an opportunity to increase the value proposition of mobile agriculture, and eventually develop holistic bundles of content and financial services for rural users.

8. See Ignitia's iska™ Weather Service for Western Africa <http://www.ignitia.se/>

9. This approach is advocated by US company aWhere, whose Weather aWhere platform provides localised weather and agronomic data from dynamic agronomic models that are linked to daily observed and forecast weather <http://www.ewhere.com/products/weather-awhere>

Improving weather forecasts in Agri VAS

Of all of the key elements of mAgri, weather forecasts are arguably the most widely available to the market through traditional media, particularly radio and TV. Users of mFarmer Agri VAS have cited the benefits of having this information on demand, rather than having to catch a forecast at a specific time through traditional channels.¹⁰ Evidence from these services, however, suggests that the added value of accessing a weather service on their mobile may not be sufficient to encourage new users, especially since the source of information (government agencies) and the type of forecast (regional and district level) is the same as the radio offering.

FIGURE 2 Source: Operators, VAS Providers

mFarmer services, weather forecast providers

Service	Forecast	Weather Provider	Provider Category
Airtel Kilimo	7-day forecast	Kenyan Meteorological Department	Government
Tigo Kilimo	1,3 or 5-day forecasts	Tanzanian Meteorological Agency	Government
mKisan	1,3 or 5-day forecasts	Indian Meteorological Division, Agricultural Meteorology Department	Government

To improve the quality of weather forecasts and add to the value proposition, service providers should consider the offering of frequent, daily updates as a first step to drive usage, and the extension of partnerships from local meteorological agencies to a broader range of local and international data providers. In addition, MNOs should consider, in the absence of GPS, implementing alternative techniques to identify user location and provide forecasts specific to that location. All service providers should also seek to engage, when possible, with emerging weather companies that are developing better weather modelling techniques for emerging markets.

When service providers have been able to offer frequently updated weather forecasts, the value of this information has been recognised by users. In the case

of the Tigo Kilimo service in Tanzania, for example, repeat users accessed weather content more often than other types (agronomy tips, market prices), because weather forecasts were the most dynamic content on the service, changing almost every day. Out of a base of 88% of Tigo Kilimo users reporting making changes based on the service information, 23% reported greater ability to predict the weather to plan farming activities as the most important benefit of the service.¹¹ This information, while still at the district level, was clearly valuable to some users. Even so, many users still complained that the forecasts did not reflect their situation, and asked for more granular information. Looking ahead, users indicated that they would like more locally accurate weather information, including longer-term seasonal forecasts.

10. Three out of four mFarmer Initiative Agri VAS offered weather forecasts: Airtel Kilimo (Kenya), Tigo Kilimo (Tanzania), and mKisan (India). See mFarmer case studies, GSMA mAgri <http://www.gsma.com/mobilefordevelopment/mfarmer-case-studies>

11. Tigo Kilimo update: data and insights from the midline, GSMA mAgri (2015) <http://www.gsma.com/mobilefordevelopment/tigo-kilimo-project-update-insights-from-the-midline>

To improve the quality of weather forecasts, MNOs and VAS providers have formed new partnerships with alternative data providers, other than national meteorological agencies. It is important to note, however, that in some cases governments have tried to prevent third parties from distributing weather forecasts from sources other than national meteorological agencies. In Kenya and Tanzania, for example, the national meteorological agencies have in the past blocked MNOs from distributing weather information, referencing the government's monopoly on this type of data.

Service providers have benefited from the use and integration of multiple data sources, increasing their chance to provide better quality forecasts. In Bangladesh, for example, VAS provider Miaki sources weather data from online content aggregator Toto Agriculture, an agricultural open data platform funded by Bill and Melinda Gates Foundation that is able to compute agriculture-related data such as weather forecasts, soil health and planting tips from multiple sources to produce content in various formats and in over one hundred languages. In turn, Toto Agriculture sources weather feeds from weather forecasting company Foreca, which relies on its own modelling as well as on additional data sources with global weather models, such as the European Centre for Medium-Range Weather Forecasts, and the US National Center for Environmental Prediction (NCEP).

In recent times, MNOs have also formed new partnerships with commercial weather service providers with new modelling techniques allowing for higher resolution of forecasts. In Western Africa, weather company Ignitia has developed an atmospheric modelling system that is able to achieve up to 3KM resolution, resulting in forecast accuracy rates to up to 84%, compared to 27KM resolution and accuracy rates of 39% that are achieved by global weather models in tropical areas.¹² With the aim to drive stickiness

of the overall mAgri bundle, an operator group in Western Africa has formed a partnership with Ignitia to provide its weather service across its Western African operations. Under the partnership, the operator will be able to provide accurate 1-3 days rain forecasts for the equatorial belt. In Ghana, MTN has had a partnership with the same provider since 2014. While the aforementioned operator group plans to bundle the forecast with market prices and agronomic advice, as well as with core network services (dedicated farmer plans), MTN offers the weather forecast as a standalone product for their rural users. The service is charged GHP 0.08 (USD 0.02) per SMS with subscribers receiving five text messages per week during the rainy season.

Strategic MNO involvement can catalyse the development of new weather technologies and improve services. In the case of Ignitia, the service is currently only available for Western Africa, but depending on donor funding and MNO commitment, it may be extended to South Asia and Latin America. With services targeting the Bottom of the Pyramid (BOP) users, however, forming sustainable and mutually beneficial partnerships with content providers can be challenging. In markets such as India, for example, where the larger MNOs are used to favourable revenue share agreements with content providers - often in the range of up to 80-20% - negotiations between MNOs and third parties have proved to be challenging.

To drive service innovation, it is important that Agri VAS providers show a willingness to invest in new enabling technologies and that consider alternative partnership models besides revenue share. Introducing minimum fees in revenue share agreements could be a way to secure commitment by the service provider, in turn enabling the content provider to continue investing in the service. In addition, evidence from successful Agri VAS show the key role played by MNOs in driving service awareness in rural regions through above-the-line and below-the-line marketing.¹³

12. Data provided by Ignitia.

13. Although the range of assets that VAS providers and MNOs can use for marketing capabilities is very different, experience in Agri VAS shows that backing up targeted below-the-line marketing (e.g. using agent networks) with above-the-line channels (e.g. radio adverts) is a success factor for reaching rural areas and create awareness for services. See "Case Study: Vodafone Turkey Farmers' Club" GSMA mAgri (2015) - <http://www.gsma.com/mobilefordevelopment/case-study-vodafone-turkey-farmers-club>

TEXT BOX 1

Open data in weather and agriculture

National meteorological agencies are the primary sources of weather forecasts, as well as of historical weather data records that are needed for index insurance services. In recent years, free and open data initiatives for weather and agriculture have emerged to help national meteorological agencies and commercial weather companies provide better weather forecasts in the developing world. Many international research institutions and NGOs, especially those operating in the satellite sector, and some national meteorological agencies, for example in the US, Canada and Norway, have also increased efforts to make open data available.

The Group on Earth Observations (GEO) is a voluntary partnership of governments and organisations that has created an open data resource centre linking satellite observation resources for agriculture, biodiversity, climate, disasters, ecosystems, energy, health, water and weather. Global Open Data for Agriculture and Nutrition (GODAN) is an initiative that encourages private sector entities to share data to provide better evidence-based advice to farmers, including weather information. In the context of WII, an important open-data resource is the data library of the International Research Institute for Climate and Society at the Earth Institute of Columbia University. This resource offers free access to hundreds of high-value dataset, such as climate data including historical and projected precipitation levels.

While the availability and exchange of open data is undoubtedly important and should be encouraged, there is also a need for sustained private investment to interpret this data, and transform data into relevant services for the target market. Investment, including from donors attracted by the potential of weather services to address the productivity gap of smallholder farmers, should be therefore directed toward developing the technology and skillset of content providers with weather expertise focusing on developing markets. These are the ecosystem players that can make the best use of open data to provide relevant services.

Creating value with geo location

By sharing location data with partner service providers (e.g. weather forecast providers, agribusinesses, insurers), MNOs could increase the value of mobile services in rural areas, for example by providing highly localised forecasts and mobile WII products. In markets where Global Positioning System (GPS) is not common due to the low penetration of smartphones, MNOs could leverage their existing technology to provide precise location data for granular, localised weather forecasts. Precisely locating users is critical, especially in tropical countries where weather patterns can vary largely within short distances. MNOs could also leverage location data to increase the value of other products, for example in healthcare where location data is used for Geographic Information Systems (GIS) mobile applications to help health organisations optimise processes and reduce costs.

Location information can alternatively be obtained directly from users during a registration process e.g. by requiring users to select their nearest location from a list. However, this approach increases the risk of data inaccuracy, restricts the number of locations available to users, and can potentially result in registration failures by increasing the length of the process or having to include registration process in the first place. All MNOs can potentially obtain accurate Mobile Station International Subscriber Directory Number (MSISDN) location data by leveraging their network intelligence. In order to exploit this unique strategic advantage, MNOs have the option to implement Cell-ID techniques that identify each base station, or sector of a base station, with a Location Area Code (LAC). By knowing the location of the nearest base station, MNOs can obtain the approximate location of the user.

A more accurate method to retrieve location data is by triangulation techniques, which use location data of the two base stations closest to the user. This method requires the deployment of network-based location based software (LBS).¹⁴ In Kenya, Safaricom uses triangulation to obtain customer location data for the Agriculture and Climate Risk Enterprise (ACRE)¹⁵ seed replanting guarantee service (formerly Kilimo Salama), one of the pioneering mobile WII products. After purchasing a bag of insured seeds, farmers send via SMS a registration code found inside the package, with the MNO's LBS system identifying the farmer's location at the time the SMS was sent and passing it to the insurer. The experience of Safaricom with ACRE has shown that monitoring farms through LBS and satellite imagery is a feasible way to implement WII products.

As an alternative to using their network intelligence, or to complement location data retrieved from the network,¹⁶ MNOs have the option to leverage field agents during user registration to find the best possible approximation of a farm's coordinates. This technique is used in Ghana by Vodafone and its content partner Esoko for the Vodafone Farmers' Club service. Service registration is performed by field agents on behalf of the user through an app that stores 17,000 locations (town or village name), and from which the agent can select the closest location to the farm. Similarly, Econet Wireless in Zimbabwe has recruited agents (brand ambassadors) from the Zimbabwe Farmers' Union (ZFU)

to manually register users to the EcoFarmer Agri VAS and insurance product. Agents use the Union's location directory, a physical booklet listing wards and villages where the service is available, to select the correct location. Alongside methods that are implemented at the registration stage, MNOs have also the option to use service helplines and to perform verification calls from the call centre to inquire about the farm location and obtain missing data.¹⁷ However, when compared to manual location selection, an automated solution like triangulation presents the best chance to scale services.

As of 2013, only 40%¹⁸ of MNOs globally had deployed at least some type of location technology, with the primary driver being government mandates (e.g. public safety, national security and law enforcement). Given that both Cell-ID and LBS software for triangulation techniques would represent a minor cost element for MNOs, this lack of investment has been due to unclear use cases for commercial location based services. Provided that MNOs can rely on partners with high quality, granular forecasts, by using their network intelligence they can potentially provide weather services and agronomic advice at the farm level to the whole rural base. Geo locating the user at farm level would also offer the best potential to rapidly scale mobile insurance services. While alternative approximation techniques are viable solutions, in the absence of GPS, triangulation with LBS systems is the most reliable and scalable solution.

14. Location technologies can be divided into handset-based technologies (GPS) with intelligence mainly in the handset; network-based technologies (Cell-ID, RF Pattern Matching and Uplink-Time Difference of Arrival, U-TDOA) with intelligence mainly in the network, as well as hybrid technologies (for instance Assisted-GPS and Observed Time Difference of Arrival, OTDOA) with intelligence in both the handset and the network.

15. Micro-Insurance in Mobile Agriculture – Case study and takeaways for the mobile industry, GSMA mAgri (2015). <http://www.gsma.com/mobilefordevelopment/micro-insurance-in-mobile-agriculture-case-study-and-takeaways-for-the-mobile-industry>

16. The actual farm location in some cases may be different from the farmer's most frequent location logged in the MNO system (e.g. farmer's home) via triangulation techniques.

17. The helpline has been used in Pakistan by Telenor to obtain location data for its life insurance product Telenor Mohafiz. The MNO is now planning to use verification calls in conjunction with triangulation techniques to obtain granular location data for its new Agri VAS.

18. LBS Platforms and Technologies - 5th Edition, Berg Insights (2013).

Mobile weather index insurance

WII is a relatively new approach to insurance provision for rain-fed agriculture in the developing world against weather calamities, such as drought, floods, and extreme temperatures. WII products pay out benefits for loss of assets and investments on the basis of a predetermined rainfall index based on historical weather data. WII can be used by farmers to cover small amounts of land (e.g. a half acre farm) for a small premium (e.g. -USD 2). As WII programmes have been established and gained scale in many regions, their digitisation through the mobile channel represents an emerging opportunity for MNOs.

The key benefit of mobile WII products, compared to traditional models, is the cost reduction of in-person farm visits thanks to the use of geo data from satellites to determine damages to a farm, and the digitisation of weather station data for the compilation of indexes. In addition, key features and transactions of a traditional insurance model are replaced with technology based solutions, such as the use of mobile technology to locate, register, and pay farmers via mobile money. Bundling mobile micro insurance with core network services and agriculture focused content services and/or weather content enables MNOs to drive brand awareness and loyalty in the rural base. In addition, WII stimulates the diffusion of mobile money and mobile financial services to rural areas. By offering financial security to high risk rural customers, mobile insurance, in fact, represents an entry point to other financial services (savings and credit).

Few mobile insurance services have covered agriculture due to the low financial literacy of rural users, their wide geographical spread, and the lack of knowledge of the agriculture vertical by MNOs and insurers, as well as complexity of establishing a truly mobile-based product. The above mentioned example of ACRE in Kenya by Syngenta Foundation in partnership with seed company Seedco and MNO Safaricom,¹⁹ and EcoFarmer in Zimbabwe, a partnership between MNO Econet Wireless and Mercy Corps, are early examples of mobile WII products. While ACRE compensates

farmers via M-Pesa against failed germination of maize crops, Econet performs pay-outs via EcoCash mobile money system for lack or excess of rainfall during the rainy season based on a predetermined index. ACRE has been offered initially as a standalone product, while Econet has from the start bundled WII insurance with additional VAS such as market price information and agronomic advice. Moving forward, as it is extended to other African countries, ACRE is being positioned as an add-on MFS component to the mAgri bundle.

While initially WII products have relied on indexes based on ground level weather data, in recent years, the improvement of remote sensing techniques has meant that satellite geo data indexes can also be used. The availability of historical satellite data sets is an important area of development in WII, given the challenges related to weather stations coverage, particularly in large countries, and the gaps in ground level data sets. A project currently being implemented under the Weather Risk Management Facility, a joint United Nations partnership between IFAD and the World Food Programme, is testing the use of geo data for micro-level index insurance (village level) in Senegal. This is a new development for satellite data compared to meso and macro applications that are typically used. Indexes used for WII products have been created using twenty to thirty years of satellite data at high resolution (5x5KM). Satellite remote sensing is then used to depict yield loss at village level due to weather and other perils.

It has taken a decade of experimentation for established mobile insurance products (health and life insurance) to find the right commercial and partnership models. The provision of free cover in return for loyalty and the use of freemium models have proved effective to enable the uptake of these products.²⁰ In agriculture insurance, there are still challenges that need to be resolved. Technical hurdles with mobile WII products include registration failure, availability of quality forecast and historical weather data for the compilation of indexes, as well as the ability to provide timely pay-outs via

19. Under the partnership, Seedco subsidises the premium. Safaricom is responsible for registering users via SMS and for premium pay-outs via mobile money.

20. 2014 State of the Industry: Mobile Financial Services for the Unbanked, GSMA Mobile Money for the Unbanked - link: <http://www.gsma.com/mobilefordevelopment/state-of-the-industry-2014>

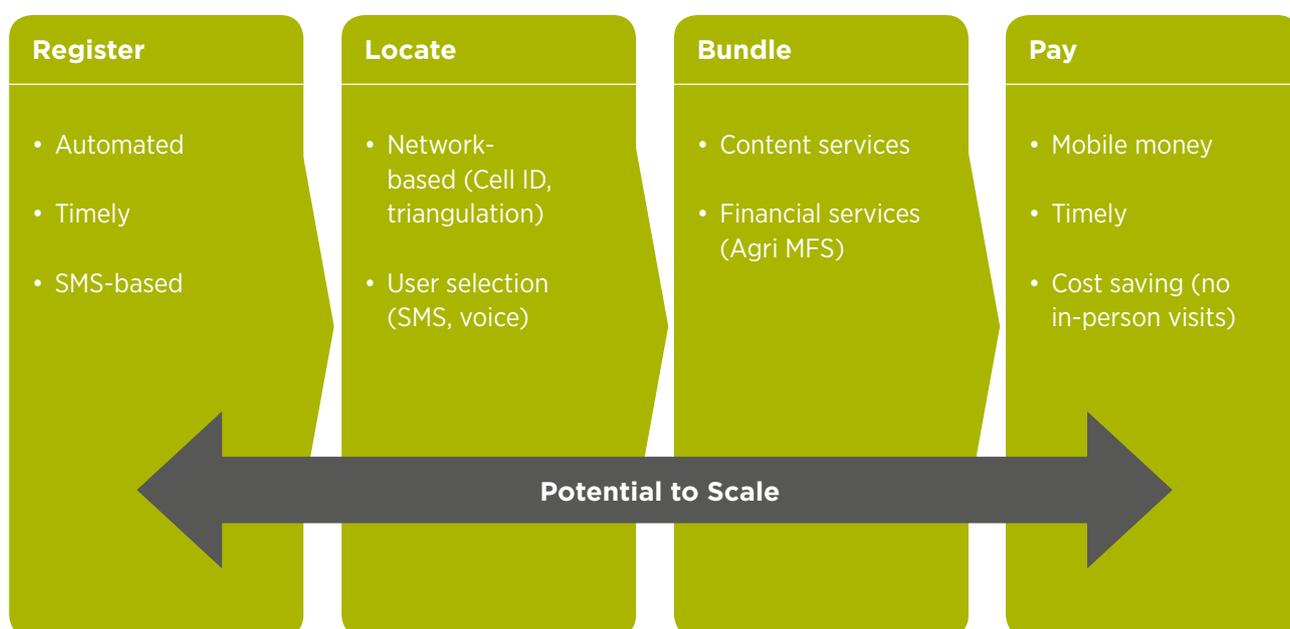
mobile money.²¹ The intrinsic narrowness of the service proposition represents an additional challenge for those interested in digitising WII.²²

Even so, MNOs are uniquely placed to use their key strategic assets - geo location, mobile money and the capability to bundle insurance with content

services - to boost the value proposition. Importantly, they are uniquely placed to catalyse partnerships with ecosystem players (input suppliers and financial institutions) and use WII as an entry point for a broader range of financial inclusion services (savings, credit) aimed at unbaked rural users.

FIGURE 3 Source: GSMA mAgri

MNO role in digitisation of weather insurance



21. In the case of ACRE the pay-out timing presented some challenges as it was often received about a month or more after planting. Receiving payment a month after first rains was considered too late for replanting.
 22. The narrowness of the value proposition of some WII products to customers is demonstrated by traditional (non-mobile) services where claims are often related to factors other than rainfall such as floods.

Evolution to weather adaptive and climate smart services

It is challenging for service providers to offer weather forecasts as standalone services. Even when bundled in Agri VAS with agronomy tips and market prices, the value proposition for smallholder farmers can be improved by linking forecasts directly to agronomic advice on how to react to weather conditions. Mobile's unique capability to customise services to the individual user presents an opportunity to evolve the value proposition to weather adaptive models. By accessing agronomic advice that is dynamically linked to localised weather forecasts, farmers could take better daily field-level decisions regarding key agricultural practices, ranging from crop planting, to weeding, applying fertilisers and pesticide, and

harvesting. All of this would ultimately improve productivity.

To improve the value proposition and drive Agri VAS stickiness, some service providers have developed in house the capability to offer agronomic advice based on dynamic weather data. For example, in the case of mKisan in India, a service by VAS provider Handygo Technologies, in house agronomists have taken prefabricated specific instructions based on weather warnings from the website of the Agricultural Meteorology Division of the India Meteorological Department and have them repackaged for the mAgri service (see text box 2).

TEXT BOX 2

mKisan: Weather adaptive agronomic advice

Below is an example of the publicly available content by the Agricultural Meteorology Division of the Indian Meteorological Department, which was then used by Handygo Technologies for mKisan (now Behtar Zindagi):

“Alerts and Warnings: Cyclone NILOFAR: Heavy to very heavy rainfall is expected from 30th October morning over Gujarat due to ‘NILOFAR’ cyclone. Harvest matured rice and picking of cotton immediately, keep harvested produce in safer places. Postpone sowing of chickpea, sweet corn and planting of sugarcane. Arrange for extensive drainage facilities to remove excess water from standing crop fields. Undertake propping in sugarcane and provide mechanical support to young fruit plants to prevent lodging due to high winds. Keep animals indoor during the period.”

In Sub-Saharan Africa, Esoko has taken a similar approach by sending to farmers voice SMSs, created by in-house agronomists with adaptation tips related to changing weather patterns, such as the use of specific seed varieties, techniques to conserve water, and timing on specific activities due to weather patterns.

There is an emerging new opportunity for service providers interested in offering weather adaptive agronomic advice to partner with technology companies that use predictive analytics for the computation of agronomy and weather data. This approach is advocated by weather and agronomic data provider aWhere.²³ A potential scenario for a new type of service under this approach is the provision of agronomic advice on crop planting dates depending on weather forecasts. As weather patterns evolve in specific agro-ecological zones, crop planting dates change following a dynamic crop calendar that is linked to localised weather forecasts. Another possibility, is the forecasting of pest outbreaks depending on weather forecasts. In India, planned developments of the Reuters Market Light Agri VAS include predictive analytics capabilities that are able to forecast pest outbreaks after certain weather conditions, allowing farmers to take preventative actions.²⁴

MNO's ability to provide the exact location of farmers remains a fundamental challenge to the adoption of predictive analytics for weather and agriculture data. Another challenge is the ability of service providers (both MNOs and VAS providers) to deal with a large and constantly changing content volume. Under this model, a service provider should be able to provide different agronomic advice for different locations, and depending on changing weather forecasts. A solution to this challenge would be focusing on a few selected crops (e.g. the main staple or cash crops in a given country) and locations (e.g. the major agricultural regions) with a view to develop the full content

proposition at a later stage when the service gains scale. All in all, it is clear that in order to develop this kind of service, MNOs must partner and share data (e.g. location) with a range of technology providers and organisations with weather and agronomic expertise.

Looking ahead, a further step would be the evolution toward climate smart services and the extension of the value proposition to advice related to climate adaptation, climate mitigation and food security. Climate Smart Agriculture (CSA) is defined by FAO as a three pillar strategy that helps the food system adapt to climate impacts (adaptation); helps reduce and remove greenhouse gas emissions (mitigation); and promotes increasing agricultural productivity and incomes (food security).²⁵ Though an ambitious aim, CSA is an area of opportunity for MNOs to innovate and lead the adoption of agricultural practices that will enable farmers to become resilient to the changing climate patterns.

Any climate smart ICT solution, alongside accurate localised forecasts, should provide advice related to three core CSA criteria (adaptation, mitigation and food security). An example of a CSA-oriented initiative is CABI's Plantwise programme, a network of plant clinics where farmers find practical plant health advice.²⁶ Under the next stage of development, the service plans to combine its plant health data with current and predicted weather data. In 2014, CABI tested this CSA approach in Kenya, where it used data on crops' vulnerability to pests and combined it with satellite weather data so to advise farmers at plant clinics about likely problems. In order to reach more farmers and to complement the face-to-face services provided by plant clinics, CABI plans to link Plantwise with existing Agri VAS. While on its own the provision of plant health advice addresses food security, the integration with weather data offers potential to extend the service to advice related to climate change adaptation and mitigation.²⁷

23. The company, which generates most of its revenues from developed markets, has a strategic focus to expand into emerging markets. In Sub-Saharan Africa, aWhere currently provides only rain forecasts to Esoko. It uses the US NOAA (The National Oceanic and Atmospheric Administration) weather service, in conjunction with its proprietary weather modelling achieving 12km resolution.

24. See "Connected farming in India. How mobile can support farmers' livelihoods", Vodafone Foundation (2015). For further information on Reuters Market Light see <http://www.rmlglobal.com/>

25. "FAO, Sourcebook on Climate-Smart Agriculture, Forestry and Fisheries" <http://www.fao.org/climate-smart-agriculture/72611/en/>. For an example of a CSA approach to rain-fed agriculture see a description of intercropping: "Coffee + banana: a climate smart combination" (CGIAR). <http://www.cgiar.org/consortium-news/coffee-bananas-a-climate-smart-combination/>

26. <https://www.plantwise.org/>

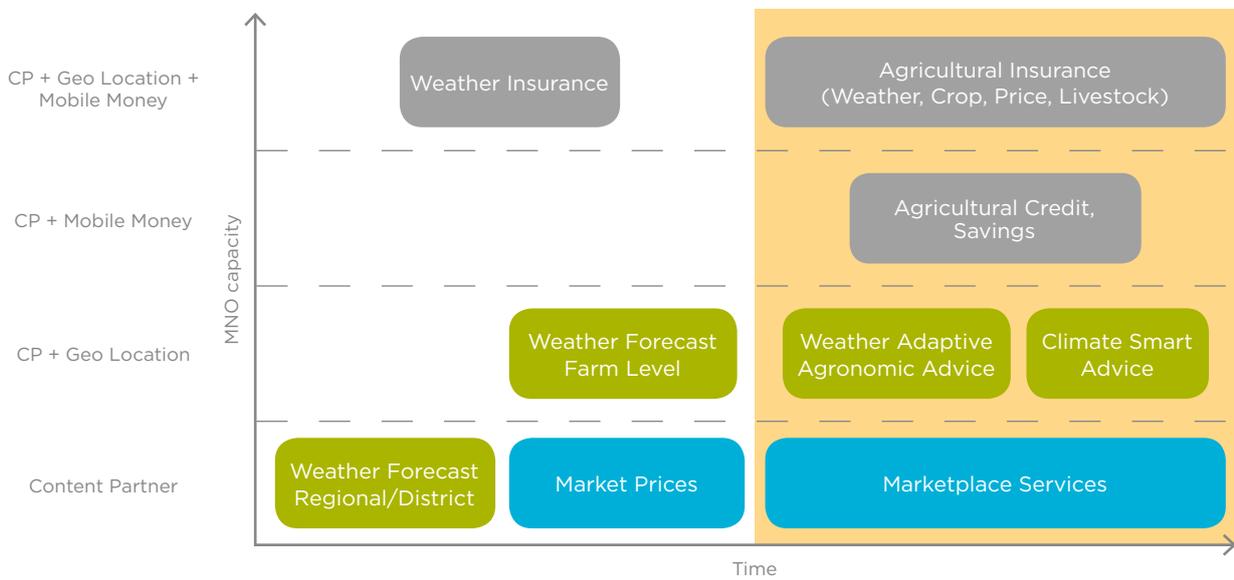
27. A potential service extension could be the offering of tips on crop varieties to choose for climate adaptation practices such as intercropping. The adoption of intercropping systems has been found as an effective strategy for climate change adaptation and mitigation. See "Putting banana-coffee intercropping research into action", CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS).

Offering weather adaptive and climate smart advice is an opportunity for MNOs to make the overall service offering more relevant for smallholder farmers. Ultimately, these service components offer potential to increase demand for the overall mAgri proposition. MNOs are uniquely positioned to fully exploit this opportunity due to their ability to bundle information services with core network services (voice and data plans), to enable highly localised services, and to bundle advisory services with mobile money enabled financial

inclusion services. As shown by the experience of EcoFarmer in Zimbabwe, a first step toward developing a holistic bundle for smallholder farmers is the bundling of weather forecasts with agronomic advice, marketplace services and WII.²⁸ Moving forward, there is an opportunity for MNOs to evolve the value proposition to more compelling packages and offer holistic bundles that integrate weather adaptive agronomic advice, and potentially climate smart advice, with a range of financial and marketplace services for unbanked farmers.

FIGURE 4 Source: GSMA mAgri

Evolution to mAgri holistic bundle



28. Services matching buyers and suppliers of agricultural products.

Opportunities for MNOs in weather monitoring

The availability of accurate historical weather records is a prerequisite for both weather forecasts and WII. Historical ground level data from weather stations on factors such as temperature, precipitation, barometric pressure, humidity and wind direction is used in weather modelling together with geo data from environmental satellites showing the evolution of weather systems for geographic regions. In WII, historical weather records, typically at least thirty years' rainfall data, are used to produce indexes that predetermine monetary compensation for farmers in the event of draught or inundation.

The underinvestment in weather stations by national meteorological agencies in the vast majority of developing countries has resulted in a lack of reliable ground-level weather data.²⁹ At the same time, the lowering capex and opex³⁰ required for weather station infrastructure has meant that an increasing number of parties other than national meteorological agencies, including NGOs, insurance companies, agribusinesses and MNOs, have considered the viability to deploy this infrastructure.³¹ Given the ubiquity of mobile networks and the key role of mobile in disseminating weather services, a question has arisen for MNOs on the opportunity to invest directly in equipping base stations with weather monitoring devices. When this

is not technically possible due to the inadequacy³² of base stations sites for weather monitoring, MNOs have also considered the opportunity to implement weather station infrastructure at different sites.

For MNOs, rolling out weather station infrastructure could potentially open up to new revenue streams from weather forecast providers, agribusinesses and insurance companies interested in this data. The lack of initiatives in this field is due in part to the telecoms industry trend toward disinvestment and outsourcing of mobile networks, which makes it challenging for MNOs to justify additional investment in network infrastructure.³³ At the same time, regulation has been an obstacle in those cases where weather information has been considered a public service that can only be provided by the government. In Tanzania, for example, the government has prohibited private companies to operate their own weather stations, allowing weather monitoring activities by non-governmental entities only for research purposes.

In spite of these challenges, there have been examples of MNOs deploying their own weather stations. In these early initiatives, rather than technical challenges, the main hurdle has been a lack of engaged partners with weather expertise. This was the case of the joint

29. In Bangladesh, for example, weather stations density is very low with 35 stations active, providing an average 100-150KM coverage area per weather station. Weather stations are concentrated in urban areas and in the southern regions, with the main agricultural zones located in the North and North West regions. According to International Finance Corporation (IFC), best results in WII models would be achieved with an average coverage of 10-15KM per station. This would call for deploying more than 500 stations in the agricultural regions.

30. The capital cost of weather stations depends on adherence to World Meteorological Organisation (WMO) standards. Fully certified WMO weather stations usually require an investment between USD 20,000 and USD 50,000 depending on the modules included. Site maintenance and operations, which entail the cost and availability of skilled personnel to operate sites, are the main operational cost. Due to the widespread availability of long life batteries and solar panels, power costs have decreased noticeably, while the cost of data transmission is almost negligible.

31. In Sub-Saharan Africa, the Trans-African Hydro Meteorological Observatory (TAHMO), a project by Oregon State University and Delft University of Technology, has plans to set up a network of weather stations across the region to provide data to a range of weather service providers including MNOs. For further information see <http://tahmo.org/>. In Sri Lanka, where there are only 21 government-owned automatic weather stations, Sanasa Insurance Company is deploying automatic weather station infrastructure to offer mobile WII in partnership with MNO Dialog.

32. To function efficiently base stations are typically located at the highest possible location. To provide reliable readings weather stations need to be located close to the ground.

33. In March 2015, Orange announced the intention to outsource mobile networks in Africa. In September 2014, MTN reached an agreement with IHS Holding for the transfer of its base stations in Nigeria. In July 2015, Vodacom announced plans to outsource network maintenance in South Africa.

initiative in 2009 by Ericsson and Zain, which aimed to implement an automated weather station network on up to 5,000 base stations in East Africa to provide accurate weather forecasts.³⁴ After the initial deployment in the Lake Victoria regions in Kenya, Tanzania and Uganda, the project struggled to pick up. As the ecosystem was far from mature, the availability of high quality ground-level data did not translate into better forecasts due to the lack of involvement of local meteorological departments. This challenged long-term sustainability in light of the investments required to expand the network. What is clear from this early project is that in order to transform weather data into actual services that provide value to farmers and agribusinesses, MNOs need to form viable partnerships, either directly or through content providers, with ecosystem players (weather and agriculture experts) that are able to interpret the data and develop relevant services.

A parallel area of development in the use of telecoms infrastructure for weather monitoring is the so-called passive weather monitoring approach of analysing radio spectrum propagation and degradation. This approach exploits the fact that the strength of electromagnetic signals is weakened by certain weather conditions, especially rain. Rainfall monitoring using microwave links has proved to provide accurate mapping and measurements. In the Netherlands, a 2013 research project conducted at Wageningen University with the national meteorological agency (KNMI) produced a country-wide rainfall map based

on data gathered throughout the T-Mobile network. Rainfall was estimated using data from over 1,400 base stations across the country, and over a period of three weeks. The initiative showed that it is possible to produce quality daily rainfall readings from mobile networks. In this field, the Raincell Africa Consortium, a network of environment and climate change research institutions, has been recently exploring the feasibility and applications of microwave rainfall monitoring for meteorology and climate in Sub-Saharan Africa.³⁵

While the technology is available, with the data being effectively a by-product of the MNO need to monitor signal strength, several challenges have so far hindered developments in this area. In order to extract this data from their regular network monitoring activities, MNOs still need to implement ad-hoc human and technical resources. Even when weather monitoring data becomes available, MNOs would then require in-house expertise to interpret data and use it, for example, to model weather forecasts in conjunction with other data sources.

Using base stations to obtain weather data, either by equipping them with weather monitoring devices or by analysing signal propagation, therefore represents a viable strategy when three preconditions are met: MNOs see real value in weather services; MNOs are prepared to invest in additional ad-hoc resources to generate weather data; and MNOs can rely on ecosystem partners to interpret data and develop services.



34. Automated weather stations typically consist of a weather-proof enclosure that contain a data logger, a rechargeable battery, and meteorological sensors connected to a wind turbine or solar panel, as well as telemetry, usually a GSM SIM card transmitting data via SMS. Capex for AWS depends on adherence to World Meteorological Organisation (WMO) standards and can be little as USD 10,000.

35. The Raincell Africa first workshop took place in Spring 2015 <http://raincell01.sciencesconf.org/>

Service design

Providers of weather information are presented with a broad range of possibilities including the option to offer short-term, long-term and seasonal forecasts, as well as the option of providing information on many indicators such as precipitation, humidity, temperature, wind and many more. The universe of service possibilities becomes even broader when weather information is tied to agronomic advice. Furthermore, the content proposition may vary vastly depending on the farmer's location. While gathering high quality weather data is the prerequisite for developing a successful service proposition, translating data points into meaningful information for the end user is critical to developing a successful value proposition.

For MNOs in particular it is fundamental to form partnerships with content providers that are able to bridge the gap between weather data points and complete weather information services. The ability to interpret and explain weather data in a meaningful way is central to any weather forecasting service, but it is especially important for services targeting BoP users. Once relevant content is available, a user centric approach to service design can help MNOs and other service providers to develop services that are relevant and actionable for the end users. To create meaningful products, service providers need to be closer to the user, the market, and the context

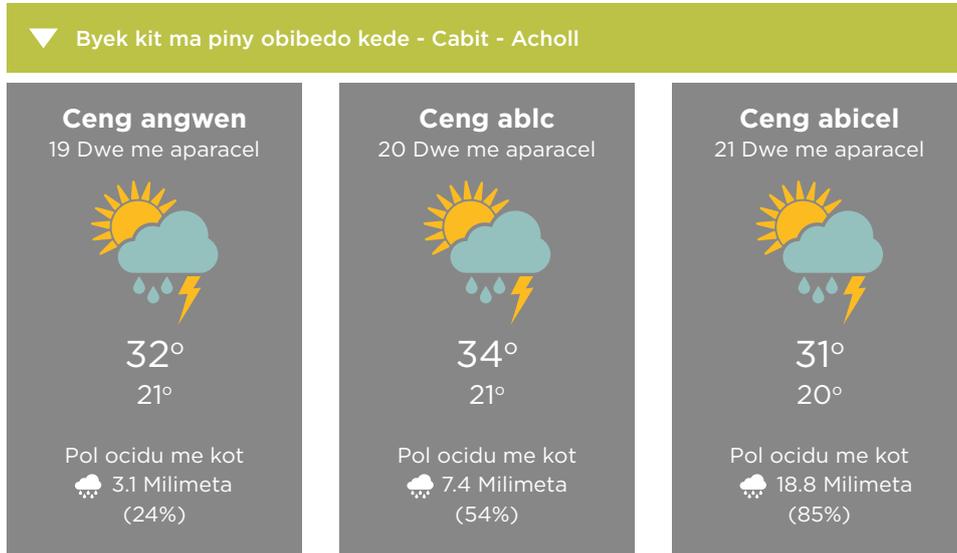
of use. This understanding starts with going out in the field, conducting end user research, and testing hypotheses with farmers to be guided throughout the design process. Understanding the farmer's needs and context is fundamental in order to develop the correct content proposition and to design an effective user interface. Understanding the context also means having an awareness of alternative weather information sources, ranging from radio broadcasts to local knowledge systems.³⁶

Developing user friendly interfaces is one of the key elements of effective service design, together with choosing the most appropriate service delivery channel (e.g. voice or SMS), translating information into local languages (or selecting content providers that are able to provide content in multiple languages), and organizing content in a way that is easily understood by farmers. An initiative that well illustrates both the importance of supporting multiple delivery channels and of translating content into local languages, is the above mentioned Toto Agriculture open data platform. Toto Agriculture, which is freely accessible online to any content provider, integrates a vast range of agriculture-related content from multiple sources, including weather forecasts, and is able to translate content into different formats (text, audio, video, calendar, charts and maps) and languages.

36. mAgri Design Toolkit, GSMA mAgri (2015) <http://www.gsma.com/mobilefordevelopment/magri-design-toolkit>

FIGURE 5 Source: Toto Agriculture

Weekly forecasts in Acholi language (Uganda)³⁷

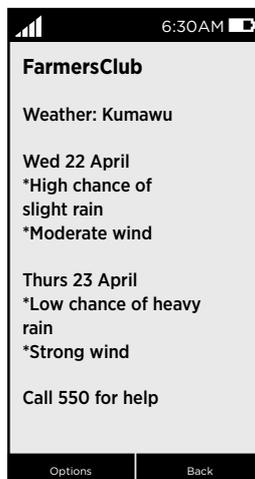


Several MNOs are making steps in the direction of designing services in a way that is easily understood by farmers. Telenor Pakistan, for example, is piloting a contextual weather service. The MNO, instead of describing temperature, rainfall and humidity through data points that are hardly understood by farmers

(e.g. Celsius degrees), wants to provide the same information through verbal description (IVR and SMS channels) of today's forecast as opposed to yesterday's weather for the farmer's location. Vodafone Ghana takes a similar approach by providing descriptions of meteorological data rather than giving raw data points.

FIGURE 6 Source: Vodafone Ghana

Vodafone Ghana Farmers' Club weather forecast



37. Format and translation of the weather forecast, top left quadrant: "Weekly forecast for Acholi (Northern Uganda); Day of the week, Monday November 19th; Temperature, 32 Max, 31 Min; Overcast, 3.1mm precipitation, 24% probability of rain".



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The importance of providing information in a way that is understood and relevant for farmers also applies to the use of iconographic symbols. Joint research by GSMA and MNO Ooredoo in Myanmar found that certain commonly acknowledged symbols in developed markets are in fact confusing and ineffective to communicate with rural population in the developing world. In Myanmar, the use of a white sun icon to describe weather or temperature has proved to be confusing to rural people because that colour is associated with moon cycles. Key findings from this user research showed that design needs be more skeuomorphic than in developed markets.

The opportunity to provide information in an effective way to farmers is obviously augmented in a rich media environment by the use of images, signs, symbols and videos. In addition, rich media services present a stronger opportunity to create linkages and establish two way communication between service providers and farmers, making services highly customisable and relevant. In India, for example, the Express Weather FarmNeed app for the management and mitigation of weather related risks for selected crops (grape, potato, mastered crop) allows farmers to take photos on pests and crop diseases, which are then sent to an agronomist who provides advice to the farmer.

Besides content services, a user centric approach is also beneficial to designing financial services such as mobile WII. While there are few service design

reference points for agri MFS, and even fewer for mobile WII products, it is clear that conveying the value proposition of insurance to unbanked farmers is a major challenge for mobile insurance providers. Early experiences such as that of the ACRE service in Sub-Saharan Africa show the importance played by a dedicated and incentivised network of distribution agents to overcome barriers around customer awareness. They also show the importance of identifying major areas of concern for farmers, and designing insurance products that address these concerns. In the case of ACRE, end user research suggested that seeds authenticity was a primary concern for farmers, given the occurrence of agricultural input counterfeiting in Kenya.

Human centred design has become such a major theme in design that it is now accepted by interface and application designers in most sectors. Digital companies, including over-the-top providers, have had human centred design at the core of their product ideation and creation processes from very early days. As MNOs and VAS providers transition their content proposition to rich media services, to remain competitive and offer relevant services, they need to be able to design around user needs from the early stages of product development. To do so, they must have in place flexible internal processes and resources supporting a user centric approach, and work in partnership with content providers and design agencies with experience in this field.

Recommendations

For MNOs:

Invest in LBS to exploit competitive advantage of geo location before GPS becomes widely available

While there is potential for MNOs in developing world to invest in weather stations, the success of those initiatives depends on their ability to form viable ecosystem partnerships to interpret data and develop services. Although for MNOs the business case for LBS systems has been challenging over the years, our analysis shows that there is an immediate opportunity to increase focus on this core capability and derive value from new services (Agri VAS and Agri MFS) targeted at the fast growing rural segment. In the current ecosystem, LBS is a unique strategic advantage over other service providers. When GPS becomes widely available, third party providers, including over-the-top players, will be in a similar position to provide localised information services directly to users. To lock in customers and pre-empt the market for new players, it is important for MNOs to capitalise on location based services.

Put weather services at the core of the value proposition with a view to develop holistic bundles

By increasing their focus on weather services, MNOs have an opportunity to evolve mAgri services to a more compelling value proposition, including the offering of agronomic advice that is dynamically linked to localised weather forecasts, and climate smart agronomic advice. Moving forward, there is potential to package information services with core network services (e.g. farmer tariff plans) and mobile money enabled Agri MFS. MNOs should therefore look at weather forecasts from the lenses of both information and financial services, starting from mobile WII as an enabler for other financial products such as savings and credit. At stake is the opportunity to develop holistic bundles for rural customers.

For donors:

Consider investing in technology projects that aim to improve weather forecasting in the developing world

To help developing countries build resilience and adapt to climate change, donors and investors should consider channelling climate adaptation funding initiatives into improved weather monitoring and forecasting. Donor funding can play a critical role in helping weather technology providers, and potentially national meteorological agencies, develop more accurate solutions, and increase coverage and range of services for developing countries. In addition, putting mobile at the core of donor-funded initiatives would offer a stronger opportunity to scale services and generate socioeconomic impact. It is therefore important for donors to consider MNO engagement as a critical element in new initiatives.

For all service providers:**Extend partnerships to new providers to improve quality of weather forecasts and drive service stickiness**

As dynamic service components, weather forecasts present an opportunity to drive stickiness of the overall mAgri proposition, provided that service providers are able to offer high quality services. To improve their weather forecasts, service providers should consider extending partnerships from local meteorological agencies to a broader range of local and international ecosystem players, including commercial providers and free and open data initiatives. MNOs and VAS providers have also a role to play in driving innovation by investing in new emerging technology providers, such as those developing better weather modelling technologies for emerging markets.

Adopt a user centric approach to transform weather data into relevant services

The availability of high quality, local weather data does not translate into better weather services, unless data is interpreted and transformed into information that is relevant and actionable for the end user. In order to offer a compelling value proposition, service providers must invest time and resources in designing services around user needs. To do so they should consider adopting a user centric approach in service design, including the partnership with companies with expertise in this field. The adoption of a user centric approach should also be a strategic priority in designing appealing mobile WII products, especially in light of the key role of insurance as a gateway to a broader range of financial inclusion products.



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