Developing agro-meteorological services in Sub-Saharan Africa: a scoping study

Hendrik Boogaard, Tomaso Ceccarelli and Steven Hoek

WAGENINGEN
UNIVERSITY & RESEARCH

Developing agro-meteorological services in Sub-Saharan Africa: a scoping study

Hendrik Boogaard, Tomaso Ceccarelli and Steven Hoek

This research was (partly) subsidised by the Dutch Ministry of Agriculture, Nature and Food Quality (project number 5200045229).

Wageningen Environmental Research
Wageningen, April 2021

Reviewed by:
Fiona van der Burgt (Weather Impact)

Approved for publication:
Sander Janssen, team leader of Earth Informatics

Report 3082
ISSN 1566-7197
ISBN 978-94-6395-822-6

WAGENINGEN
UNIVERSITY & RESEARCH

Boogaard, H.L., T. Ceccarelli and S.B. Hoek, 2021. *Developing agro-meteorological services in Sub-Saharan Africa: a scoping study.* Wageningen, Wageningen Environmental Research, Report 3082. 72 pp.; 22 fig.; 0 tab.; 46 ref.

Deze studie geeft Nederlandse publieke en private partijen inzicht in de kansen en belemmeringen van het opzetten van agro-meteorologische services in sub-Sahara Afrikaanse landen. Wij hebben met name services bestudeerd die weer en klimaat combineren met agronomische adviezen voor boeren. Wij hebben gekeken naar institutionele, technische en markt aspecten. Mogelijke bedrijfsmodellen voor het in de markt zetten van van agro-meteorologische services variëren van een publiek georiënteerd model (B2G), een publiek-private samenwerking met zowel commerciële partijen (B2B, B2C) als publieke partijen, de juiste lokale partners en gericht op het bundelen van verschillende services.

This study provides some guidelines for Dutch private and public parties on opportunities and constraints in developing agro-meteorological services in Sub-Saharan African countries. We focused on agro-meteorological services where there was evidence that weather and climate information was combined with agronomic centered advices for farmers. The potential for developing these services was analysed from the perspective of the institutional, technical and business environment. Several business development "pathways" were suggested varying from a public orientated business model (B2G), to public-private partnerships with an opening towards commercial partnerships (B2B, B2C), a balanced role of private and public actors, and the "right" local partners also in the perspective of combining more services ("bundling").

Keywords: agro-meteorological services, Sub-Saharan African countries, business development "pathways", climate variability, climate change, business models.

The pdf file is free of charge and can be downloaded at https://doi.org/10.18174/547102 or via the website www.wur.nl/environmental-research (scroll down to Publications – Wageningen Environmental Research reports). Wageningen Environmental Research does not deliver printed versions of the Wageningen Environmental Research reports.

Wageningen Environmental Research report 3082 | ISSN 1566-7197

Photo cover: Shutterstock

Contents

Verification

Report: 3082
Project number: 5200045229

Wageningen Environmental Research (WENR) values the quality of our end products greatly. A review of the reports on scientific quality by a reviewer is a standard part of our quality policy.

Approved reviewer who stated the appraisal,

position: Business Developer

name: Fiona van der Burgt

date: 28-04-2021

Approved team leader responsible for the contents,

name: Sander Janssen

date: 28-04-2021

Preface

Summer 2019 Weather Impact approached WENR to explore business opportunities for agro-meteorological services in Sub-Saharan African (SSA). The initial idea had two components:

- How to develop an agro-meteorological service for SSA, in partnership with local institutional, service and knowledge partners, which is easily scalable and sustainable;
- Strengthening capacity of local National Meteorological Services (NMS) (includes social responsibility aspect).

Both parties build on a vast knowledge and experience of co-developing and operational running of agro-meteorological services for the agro-sector world-wide and SSA specifically. The main bottleneck for creating larger impact is that these services are bound to projects serving a limited community.

With the financial support of the Dutch Ministry of Agriculture, Nature and Food Quality we studied the opportunities and constraints in scaling and further developing agro-meteorological services looking at different perspectives namely the institutional, technical and business environment. Several business development "pathways" are suggested varying from a public orientated business model (B2G), to public-private partnerships with an opening towards commercial partnerships (B2B, B2C). The study was done by means of a desk research, i.e. a comprehensive literature review based on a wide range of reports and other resources available from the web. We also asked experts in this field to critically review the outcomes of the desk study, providing more insights based on their experience.

We would like to thank Fiona van der Burgt and Michele Bernardi for their input and review and Ministry of Agriculture, Nature and Food Quality for the financial support.

Summary

This study is about developing agro-meteorological services in Sub-Saharan African (SSA) countries. It came as a request from a Dutch commercial provider of weather and climate services who wanted to gain more insights on the perspectives of establishing such services, in partnership with other actors, with a specific attention to this part of the African continent. We carried out this study through a comprehensive literature review and we complemented this by means of experts in this domain who shared lessons drawn from their experience. We focused on agro-meteorological services where we could get evidence that weather and climate information was effectively combined with agronomic centred advices.

The potential for developing these services was analysed from the perspective of three environments: institutional, technical and business. For each of these environments we looked at several dimensions, which we also considered as criteria for assessing this potential. In the case of the institutional environment, we looked at the policy and regulatory framework, the organisational readiness of a National Meteorological Service (NMS) to build such partnerships and at other local institutional actors operating in the agro-meteorological services 'value chain'. In terms of the technical environment we considered elements such as the mobile phone/internet infrastructure and penetration, the affordability of the services (in terms of phones, airtime and data bundles), the level of service and skills to operate such infrastructures, the attitude or level of (dis)trust in users due to possible government control over internet and services based on it and finally the consumer readiness. With regards to the business environment we looked at proxies like the number of existing services providing weather and agronomic advises as well as the level of funding by the international community. We also considered as an important element evidence that agro-meteorological services are reaching the ultimate users, i.e. the farmers. However due to lack of secondary sources it was not possible to capture this dimension, and this would need more in-depth analysis also in consultation with experts in each country.

For 10 priority countries we have conducted an analysis of the receiving environment when developing agro-meteorological services. We have also selected several agro-meteo (or simply weather) service providers (WSP) for whom we conducted a more in-depth analysis on whether they established public-private-partnerships (PPP) and with what modalities. This contributed to specific recommendations in case the establishment of a PPP seems to be the best way forward.

The outcomes of the study are: 1) profiles for the 10 priority countries which describe the institutional, technical and business environment, 2) a number of inventoried and characterised agro-meteorological services, with an in-depth analysis from the Public-Private-Partnership (PPP) perspective, and 3) a number of recommendations in order to develop the services in SSA countries. The country profiles can guide in identifying strategies ("pathways") for developing an agro-meteorological service in a specific country. The in-depth PPP-analysis can help devising specific recommendations in case the establishment of a PPP seems to be the best way forward.

Several business development "pathways" were suggested with reference to different circumstances. First a public orientated business model (B2G) with a strong collaboration with the NMS possibly moving towards forms of more commercially attractive PPPs. Second in the case of a conceiving institutional environment, PPP can be established with a balanced role of private and public actors, and the right actors in the value chain (not competitors, but partners) also to support the observed trends towards bundling agro-meteo with other services. In this case business strategies, more commercially oriented (B2B, possibly B2C), can be developed. Finally when a "level playing field" is established for commercial WSPs, the need for a PPP is not that stringent and limited agreements (e.g. for provision of weather station data) can be probably suffice. However, many of the factors in the technical sphere (e.g., the state of the mobile and internet infrastructure) cannot be influenced easily by a single WSP. In these circumstances the WSP can try to partner with other institutional stakeholders for more

investments which are strategic for the deployment of weather and climate services (on the infrastructure and technical skills). In fact, it is difficult to see an easy scalable business model without any local entity involved, which can include the NWS, a scaling partner, but also and increasingly, knowledge and technical partners.

1 Introduction

The objective of this document is to provide some guidelines for Dutch private and public parties, e.g. Weather Impact and WUR, on opportunities and constraints in developing agro-meteorological services in Sub-Saharan African (SSA) countries. We focused on agro-meteorological services were there was evidence that weather and climate information was combined with agronomic centered advices.

The study is mainly a desk research, i.e. a comprehensive literature review based on a wide range of reports and other resources available from the Web. We have then asked expert(s) in this field to critically review the outcomes of the desk study, providing more insights based on their experience.

The analysis is carried out looking at the dimensions below, which can be considered also as criteria for assessing the potential for developing the services:

1. Institutional environment
   - 1.1 Policy and regulatory framework
   - 1.2 Organisational readiness
   - 1.3 Local institutional partners
2. Technical environment
   - 2.1 Infrastructure
   - 2.2 Affordability
   - 2.3 Service and skills
   - 2.4 Attitude
   - 2.5 Penetration of the smartphone
   - 2.6 Consumer readiness
3. Business environment
   - 3.1 Existing agro- meteorological services
   - 3.2 International funding.

We also considered as an important element evidence that agro-meteorological services are reaching the ultimate users, i.e. the farmers. However due to lack of secondary sources it was not possible to capture this dimension: this would need more in-depth analysis also in consultation with experts in each country.

The outcomes of the study are: 1) a series of country specific profiles analysing the receiving environment for new agro- meteorological services, 2) a number of inventoried and characterised agro-meteorological services, with an in-depth analysis from the Public-Private-Partnership (PPP) perspective, and 3) a number of recommendations in order to develop the services in SSA countries.

The country profiles can guide in identifying strategies ("pathways") for developing an agro-meteorological service in a specific country. The in-depth PPP-analysis can help devising specific recommendations in case the establishment of a PPP seems to be the best way forward.

The following countries were selected based on the Africa strategy of the Dutch Government (VNO-NCW, 2019):

- Ethiopia
- Ghana
- Kenya
- Mozambique
- Nigeria
- Senegal
- South-Africa
- Tanzania
- Uganda
- Zambia.

2 Institutional environment

2.1 Method

With 'Institutional environment' we indicate the following components:

a. the policy and regulatory frameworks with reference to public-private partnerships
   This is seen in the perspective of the relationship between a National Meteorological Service (NMS) and a (commercial) Weather Service Provider (WSP). As highlighted in the study by USAID (Usher et al., 2018), the Weather and Climate Information Services (WCIS) market in SSA is often constrained by a legislation that restricts private-sector partnerships, and policies that prohibit or limit sharing and monetizing NMS data and services. At times it is unclear how effectively the legal framework is enforced, but this might anyhow discourage a private company from entering the market.

b. the (organisational) readiness of the NMS to build such partnerships
   The organisational readiness of an NMS strongly relates but is not necessarily the same as the policy and regulatory environment in which it operates. In other words, there could be the case of a favourable regulatory framework but with an NMS that is not willing or able to engage effectively with private weather service providers. Because of our focus on the agro- meteorological domain, in case the parent ministry is a Ministry of Agriculture (MoA), we assume a higher readiness to engage with private partners for value addition (e.g. for agricultural advisory). However, this readiness varies widely as partnering with the private sector has to do also with the operating model established by a government to manage the NMS. Enough autonomy of the NMS is, in this respect, also an important element.

c. the existence and capacity of other local institutional actors to operate in the agro-meteorological services 'value chain'
   The provision of WCIS also depends on what we call the WCIS 'value chain'. The existence of multiple actors which contribute to generate added value weather products and services is therefore of importance. This is especially the case in the delivery of the services, where private ICT partners are often the only ones capable of operating platforms for the sustainable dissemination of the end products (via SMS, IVR, web services, etc.). In some instances, it also applies to data collection (e.g. in case other actors operate weather station networks). Government agencies, private-sector companies and NGOs also gather climate and weather information, but efforts are often not coordinated. Also, knowledge partners are of importance, especially when it comes to crop and agronomic information (e.g. crop phenology and requirements, crop response to specific climate factors and risks, farm management). In SSA these are often related to extension services and research departments within a MoA and to other research organisations as well as universities. In some cases, such partners are part of international (FAO, CGIAR centres, etc.) or non-governmental organisations.

2.2 Proxies

As a proxy indicator for **policy and regulatory framework** ('legislation score') we consider:

1. If a favorable legislation towards Public Private Partnerships (PPP) exists. We draw this information from two main sources, the publication NEW VISION for Weather and Climate Services in Africa, by Snow et al. (2016) and the WMO Country Profile Database Portal (https://cpdb.wmo.int), and other minor sources. In case of a favorable existing framework, the score is +++; if there is no legislation but still there is evidence of an active policy towards PPPs, the score is ++; if none of the above applies, the score is +.

2. We also use the EBA, Enabling the Business of Agriculture Score 2019, as a proxy that assesses the laws, regulations and bureaucratic processes that affect the agricultural sector in general: https://eba.worldbank.org. In this case the original scale is 0-100, with higher values indicating better enabling conditions, further reclassified as follows: <= 50 +, >50 and <= 60 ++, > 60 +++.

Proxies for **institutional readiness** ('readiness score') are:

1. The operating model: if independent agency +++, if directly under a Ministry +; Sources: WMO Country Profile Database Portal and Snow et al. (2016).
2. The NMS parent ministry affiliation: If MoA or equivalent +++, if Ministry of environment or water management ++, if others +; Sources: WMO Country Profile Database Portal and Snow et al. (2016).
3. Track record of the NMS in terms of experiences or dedicated structures to engage with private entities and manage a PPP; Sources: WMO Country Profile Database Portal and Snow et al. (2016).

A proxy for **local institutional actors** is:

1. Evidence of inter-agency, inter-ministerial collaboration and their capacity (infrastructure and human resources wise), indicating potential partners in the WCIS 'value chain'. Sources: web search on portfolio and institutional web sites and Snow et al. (2016). For potential partners in the commercial sector, see Annex 1.

We finally calculated an overall score for the institutional environment as a median of the 6 partial scores above.

2.3 Insights

The institutional environment has a strong influence on the prospects of creating PPPs and therefore for commercial weather service providers. This environment is multi-facet, in the sense that the dimensions of a) policy and regulatory framework, b) readiness of the NMS and c) the nature and quality of the other public organisations in the 'value chain', may all play an important role.

On their relative importance Usher et al. (2018), mentioned that differences in the operating model used by a government to manage a NMS, does not appear to affect private-sector involvement and that the government policy and legal environment is more important.

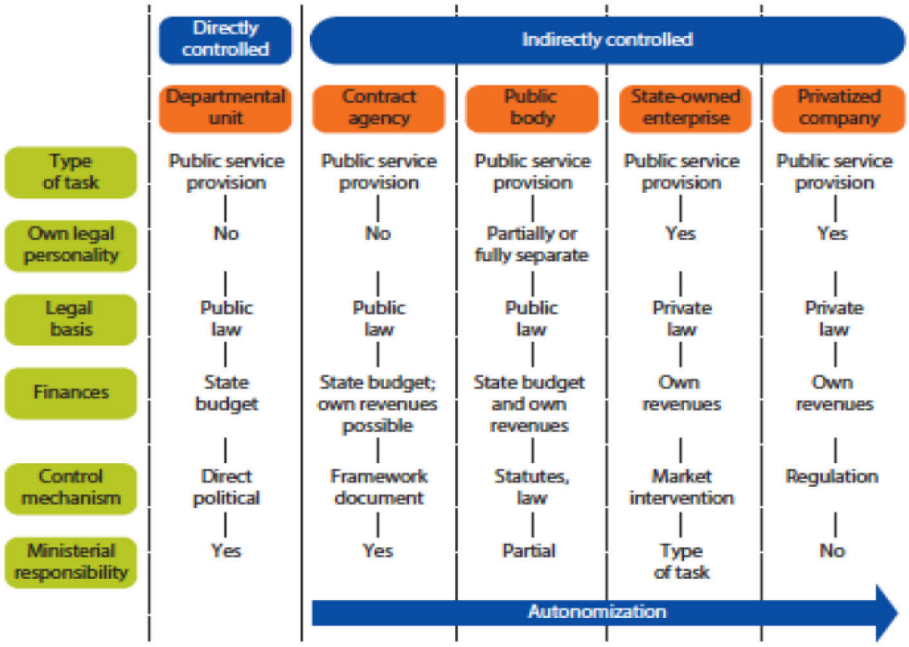

Figure 1 *NMS operating models by Usher et al., 2018*

According to Usher et al. (2018) practically all NMSs in SSA operate as government departments, although several countries are transitioning their NMS to contract agencies and public bodies, which is more favourable for private public partnerships. We argue, however, that the policy environment is not a 'good-enough' condition and that the organisations should also be motivated and capable of engaging with private providers, which is to some degree related to their operating model and affiliation.

2.4 References

EBA (https://eba.worldbank.org). Accessed summer 2020.

Snow, J. T., B. Biagini, G. Benchwick, G. George, J. Hoedjes, A. Miller, J. Usher, 2016. A New Vision for Weather and Climate Services in Africa. UNDP, New York, USA.

Usher J., C. Phiri, N. Linacre, R. O'Sullivan, U. Qadir, 2018. Climate Information Services Market Assessment and Business Model Review, USAID-supported Assessing Sustainability.

WMO Country Profile Database Porta (https://cpdb.wmo.int). Accessed summer 2020.

3 Technical environment

3.1 Method

We sent out a questionnaire distributed among contacts we have in Senegal, Ghana, Nigeria, Tanzania, Zambia and South Africa and studied publications about the development of the mobile economy in Sub-Saharan Africa – esp. publications from the GSM Association (or GSMA).

3.2 Proxies

We distinguished the following proxies to evaluate the technical environment for serving farmers with agro-meteo advices:

- Infrastructure
- Affordability
- Services and skills
- Attitude
- Penetration of the smartphone
- Consumer readiness.

3.2.1 Infrastructure

In general, the mobile network – and therefore mobile Internet – has been developing tremendously in Sub-Saharan Africa since 2000. There are differences between urban and rural areas, with the latter normally lagging behind with worse coverage and lower bandwidth. In the urban areas 3G is often available and providers have started with 4G in various countries. However, in rural areas sometimes only 2G is available.

Making 3G Internet available in rural areas is - above all - an economic challenge. Such areas typically have low population densities, low per-capita income levels, and less developed or non-existent infrastructure. It can cost up to twice as much to deploy new base stations in rural areas, while revenue expectations can be up to 10 times less than in the urban equivalent. All the same, telecom operators are working to cover most of these areas in efficient ways and to expand the reach of their networks as much as possible by driving down deployment costs through further technical innovation.

The figure below shows the Infrastructure Index as defined by the Global System for Mobile Communications (GSMA): the availability of high-performance mobile internet network coverage. It is based on indices for network coverage, network performance, other enabling infrastructure and spectrum. The darker, the better the infrastructure.

From the results of our questionnaire, it became clear how users cope with the sometimes disappointing network: in countries like Senegal, Ghana, Nigeria, Tanzania and Zambia more than half of those having a SIM card also have an additional SIM card from another provider. If at some point a user is not satisfied with the network quality provided by the first provider, the person can decide to switch to another network from the second provider. It is therefore not strange that of all the phones that are sold, more than 50% have two SIM-slots. The use of 2 SIM cards also helps the user to reduce the costs of cross-provider calls.

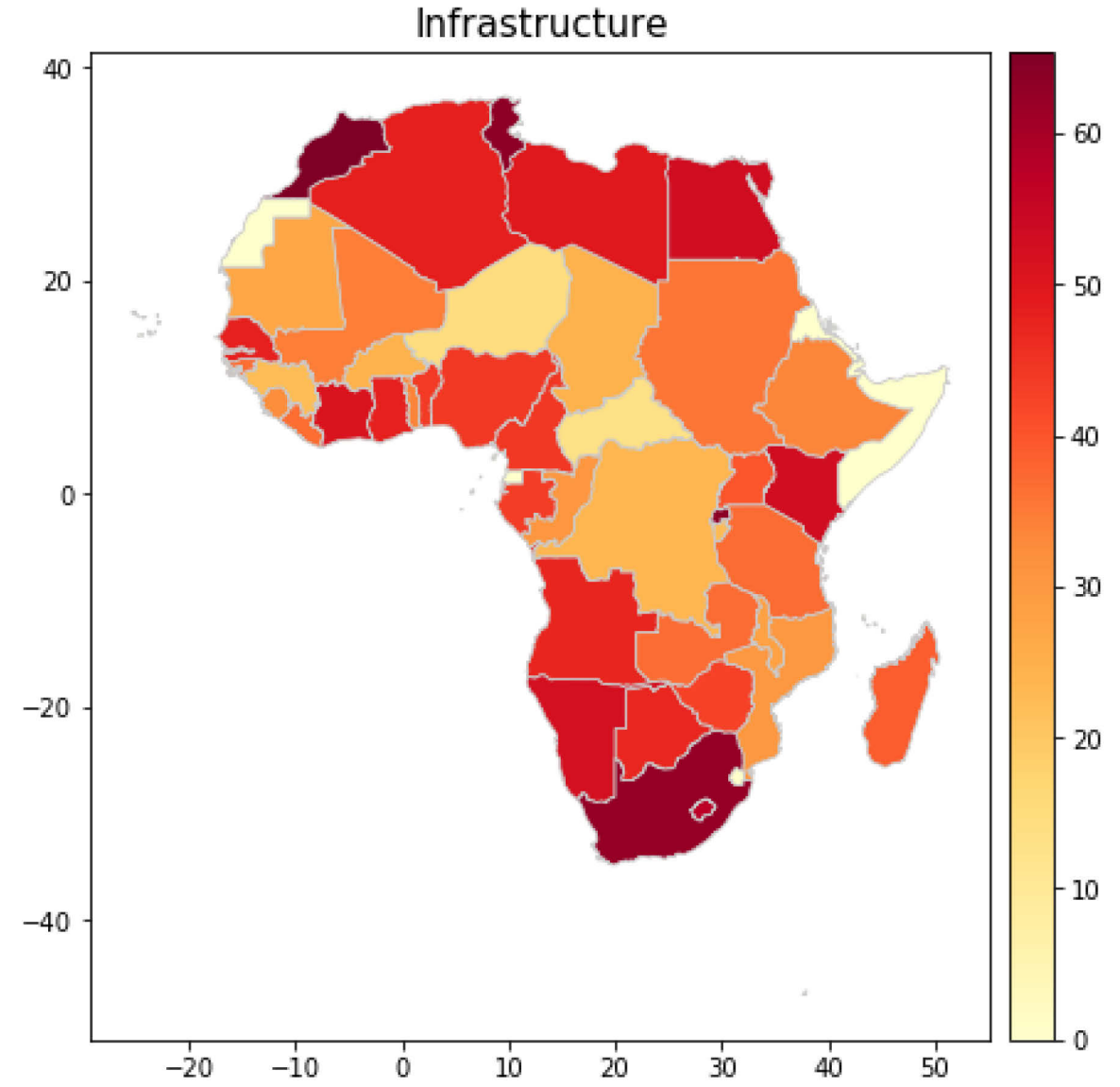

Figure 2 *Technical environment, infrastructure*

3.2.2 Affordability

Affordability is the most important factor that determines what type of phone people have in Sub-Saharan Africa. Many still rely on GSM-phones – or feature phones - because the purchase of a smartphone is expensive and because of the limited penetration of 4G as indicated in the previous section.

The cost of data bundles also plays a role. The GSM-phones can do with less-frequent charging, which is an advantage with the prevailing unreliable electricity supply in many of the countries. Roughly 75% of the phones are made in China, with Huawei, Tecno, Itel and Infinix being important makes. Samsung is an important make too. Apple phones are only used in larger numbers in more affluent countries like South Africa and Nigeria.

Different providers operate in different countries, but a few companies have tried to capture the market in more counties: e.g. MTN, Vodafone, Airtel, Orange and Tigo. It is hard to find data on how they have arranged the connectivity from the hinterland to the Internet backbones. In more developed countries like South Africa, Nigeria and Ghana almost all providers use modern, efficient fibre optics. In other countries, relay stations and satellite connections are probably still in use. The use of old, inefficient technology is one of the factors contributing to the high price of data bundles.

The figure below shows the overall affordability index of mobile phone technology, as defined by the GSMA: the availability of mobile services and devices at price points that reflect the level of income across a national population. This is based on indices for mobile tariffs, handset price, taxation and inequality. The darker, the more people can afford the tariffs etcetera and the lower the inequality is.

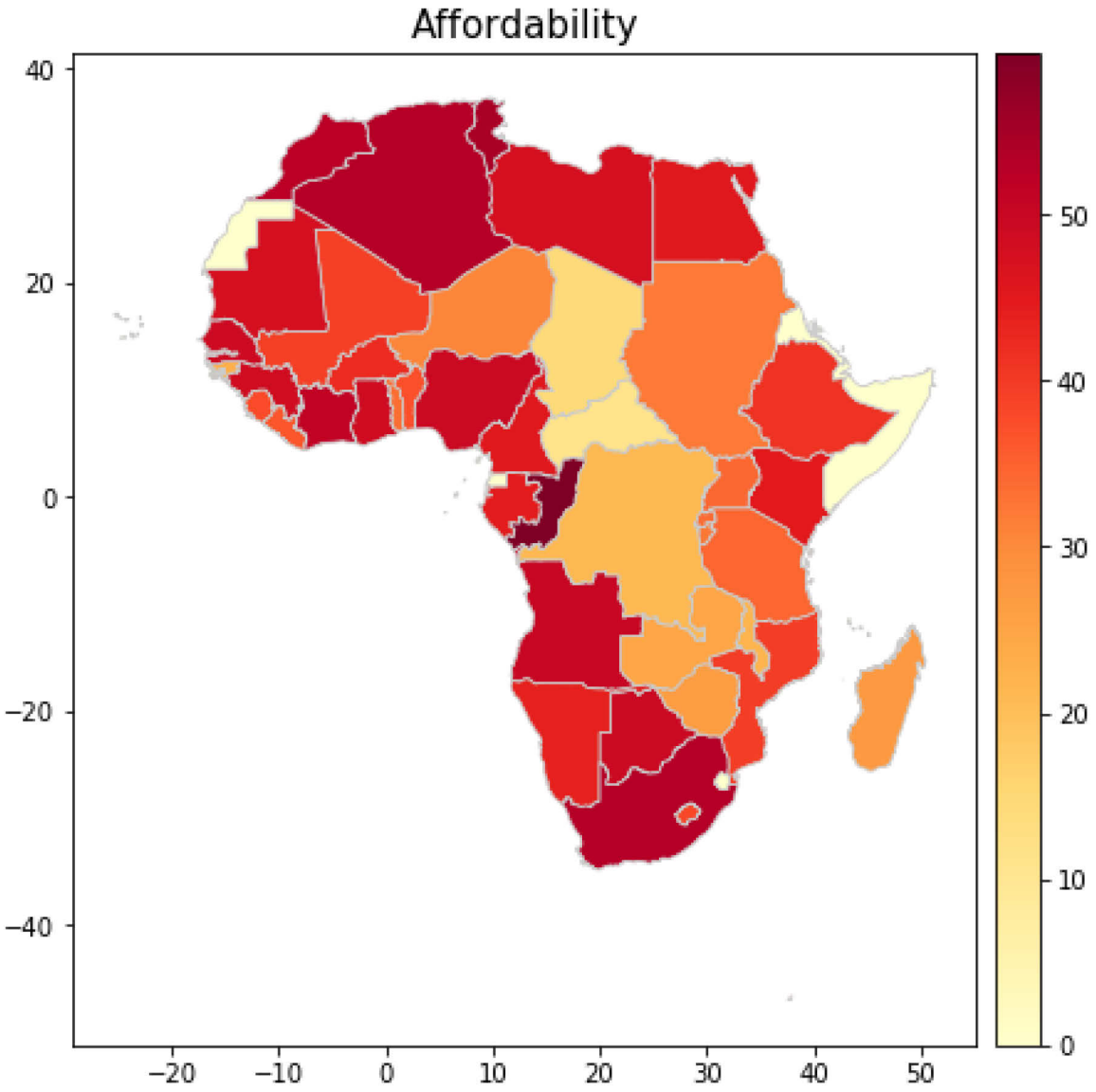

Figure 3 *Technical environment, affordability*

There is a lot of Internet traffic between Sub-Saharan Africa and the rest of the world. In the following, the background of this will become clearer. A lot of this Internet traffic could stay within the countries where it originated - or at least within the continent's borders – meaning that in principle part of the traffic is unnecessary. It means that technically speaking the capacity of the network can be used more efficiently and it should be possible for providers to reduce the average cost of a gigabyte of data further.

3.2.3 Services and skills

It's risky to try to generalise matters for a large area like Sub-Saharan Africa. It seems to be a general phenomenon though that most people living in Sub-Saharan Africa make use of webmail hosted on servers far beyond the borders of their continent (e.g. Gmail and Yahoo). Homegrown email / webmail services are used far less, although they exist: e.g. provided by companies with headquarters in South Africa (e.g. Webmail South Africa, Ananzi and Mailplus) and Kenya (Africa Online). More in general:

the people in Africa who access websites and electronic services seem to have more confidence in content hosted elsewhere.

The other side of the coin is that those looking to have their content hosted somewhere, most of the time decide to have their content hosted elsewhere. Hence there are relatively few servers in Sub-Saharan Africa itself. All African countries have their own top-level domain names – e.g. "ng" for Nigeria – but those names are used only rarely.

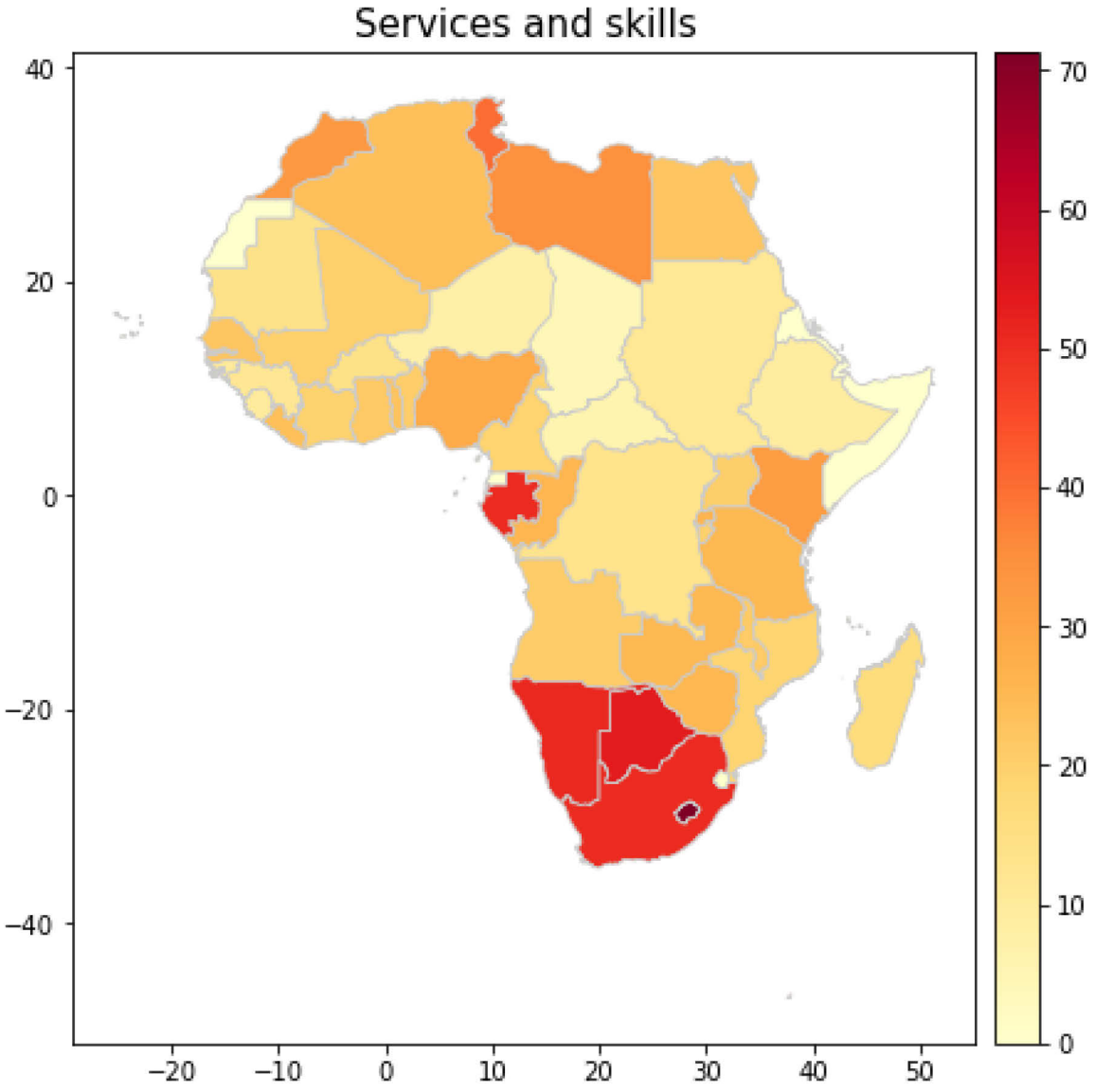

Figure 4 *Technical environment, services and skills*

Fortunately, the tendency to host content and electronic services elsewhere is slowly wearing off – at least the number of servers per caput is rising in all African countries since a few years. In 2019 Microsoft opened its first data centres in South Africa and Google opened its first artificial intelligence lab in the Ghanaian capital Accra. Chinese technology firms – and in some cases also South Korean technology firms – are investing more in information and telecommunication technology (ICT) infrastructures in Africa than Western companies[1]. With these developments, the chances are increasing to find hosting facilities and / or people with the needed technical skills. Besides, hosting of content and services closer by should also result in better response times.

[1] The Chinese influence is not limited to the phones. There have been tremendous investments by Chinese companies like Huawei, ZTE and China Telecom and these are continuing.

The figure above shows a proxy index for technical skills based on two indices of the GSMA: the number of servers per head and the number of Internet exchange points per head. These seem imperfect indicators as explained in the summary for Ghana (see section 5.2). The darker, the more services are available and the more people with technical skills can be expected.

3.2.4 Attitude (freedom)

The mentioned tendency to host content and electronic services elsewhere may be explained partially by the fact that under African circumstances it is not always easy for local Internet providers to keep needed facilities up and running and to compete with providers from abroad who in many cases have an enormous technical lead.

There is another factor too: in some countries of Sub-Saharan Africa, people seem to have an ambiguous attitude towards the Internet. To some extent they are afflicted with a fear that government could tamper with it or could even use it to control them. And indeed, Internet throttling and internet shutdowns are part of a practice still used too often by African governments, as an extension of more traditional forms of censorship (or in other words the restriction of press freedom). Democracy in Sub-Saharan Africa is still young and not practiced in all African countries yet. Many of the countries experience tense moments once in a few years, e.g. around the time of elections. This is the background of the mentioned fear.

It is felt that meddling with the Internet works counterproductively. The economic damage caused by such meddling was assessed by Deloitte in 2016: it is enormous. Internet has become ingrained into the tasks that people across the world perform each day – also in Africa. Businesses grind to a halt and even remittances sent from abroad cannot reach the intended beneficiaries when the Internet is shut down. This undermines the trust people have.

In this respect, the Chinese role as key investor in the ICT sector also raises some concerns as to whether this will also bring about a stronger political control e.g. over internet.

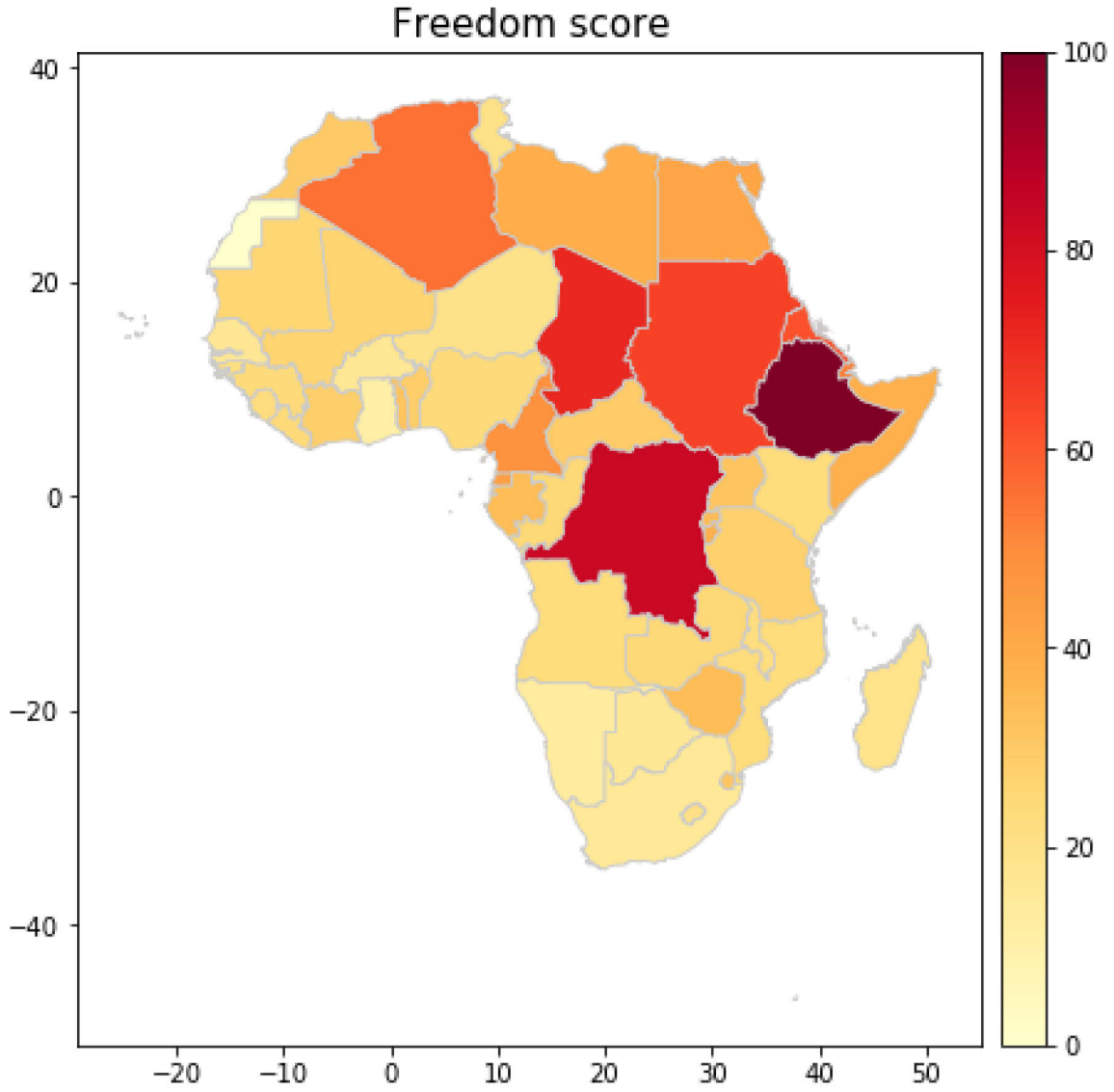

Figure 5 *Technical environment, freedom score*

The figure above shows an index of Internet freedom, based on data of shutdowns that occurred in the period 2016 thru 2019 as well as on an index of press freedom[2]. The darker, the more Internet shutdowns have occurred and the lesser the press freedom is.

3.2.5 Penetration of the smartphone

More than in other parts of the world, the web in Africa is accessed by means of smartphones rather than by means laptops, desktop computers and similar devices. The list of most popular African websites consists mainly of news sites. This is an indication that smartphone ownership and use is driven by the urge to remain abreast with developments – esp. with political developments. However, it is only those who can afford smartphones, who can do this. There are economic and social factors causing a divide.

In countries with more political control – e.g. Eritrea, Somalia, the Democratic Republic of Congo, Rwanda, Burundi, Equatorial Guinea and Zimbabwe, news sites as well as social media may be the only way people can get news other than from the government. Even in many of the countries with more freedom, highly polarised political landscapes exist - e.g. in Ethiopia, Kenya, Nigeria and Ghana -

[2] Sources: Data about Internet shutdowns were obtained from the non-profit organisation Access Now. Data about press freedom were obtained from Reporters without Borders, an international non-profit and non-governmental organisation.

and news sites as well as social media are the best way for the people to obtain information from other sources than those controlled by the government of the day.

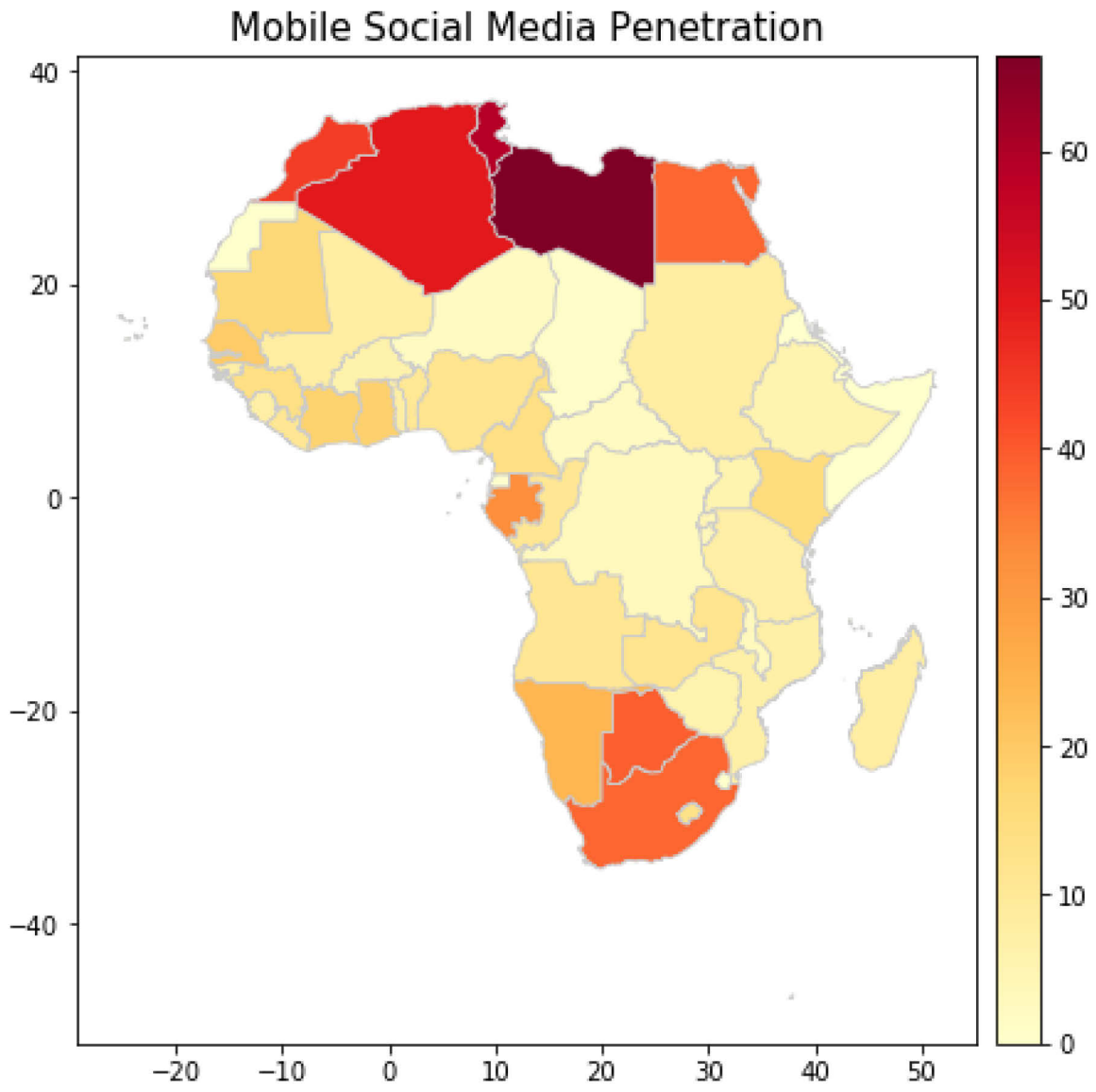

Figure 6 *Technical environment, penetration of social media*

The figure above shows the Mobile Social Media Penetration as defined by the GSMA: proportion of the population that are active users of mobile social media services; the correlation coefficient between this index and the gross national income for 2019 is 0.81. The darker, the more social media are being used in the country.

3.2.6 Consumer readiness

The educational background of farmers varies from country to country, ranging from illiterate farmers to farmers with enough digital literacy to use an app. This is reflected – together with some other indicators - in an index called Consumer Readiness defined by the GSMA as: citizens with the awareness and the skills needed to value and use the Internet. It is based on indices for mobile ownership, gender equality and basic skills, with the latter again based on indices for literacy, school life expectancy, mean years of schooling and tertiary enrolment. The darker, the more it can be expected that people are ready to use the services.

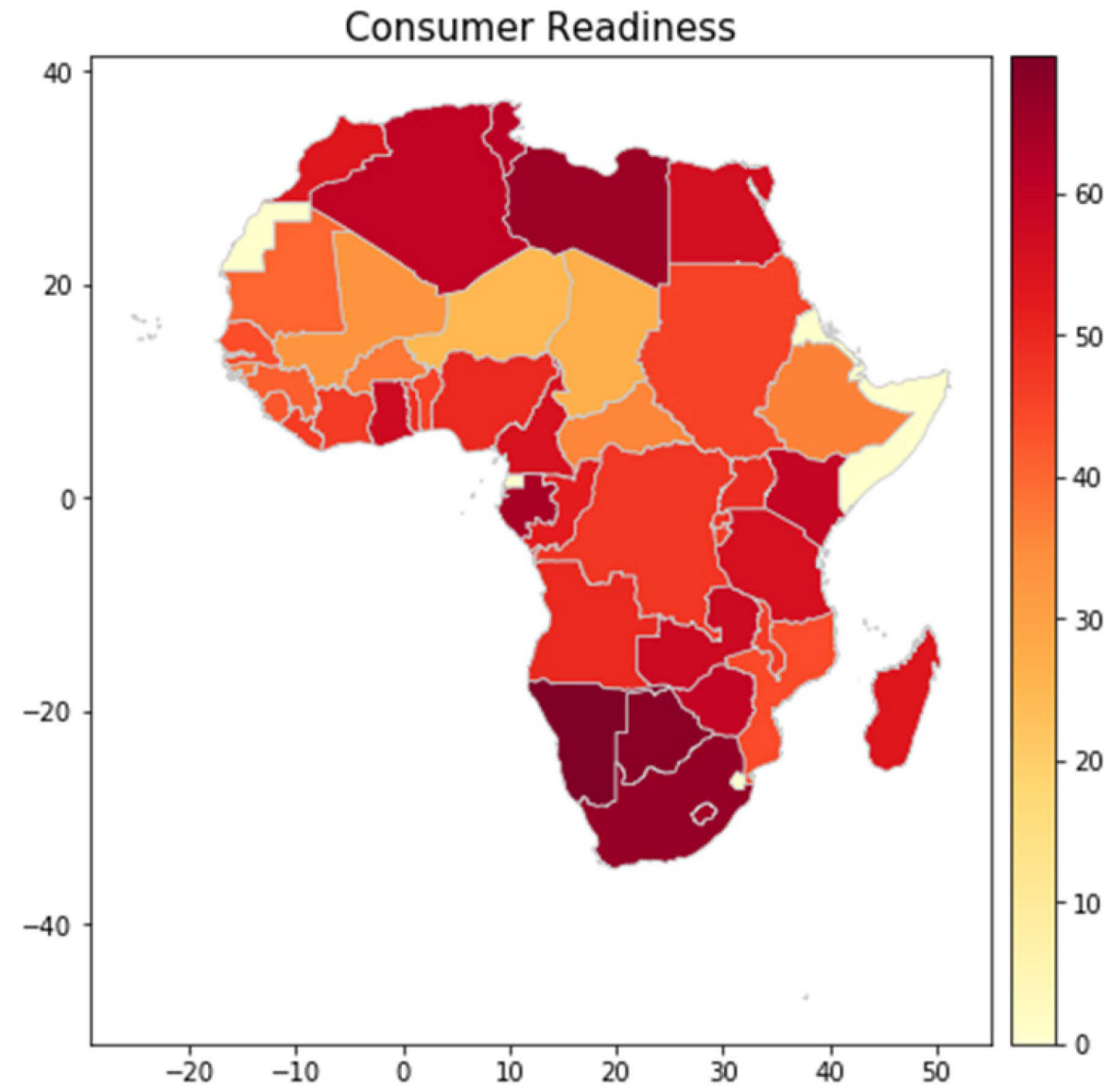

Figure 7 *Technical environment, consumer readiness*

3.3 Insights

The current technical environments in the various countries are of course the result of historical developments in the various geographical contexts. As general indicator that can "explain" those technical environments – or in other words can summarise the backgrounds of these technical environments - we consider this as most relevant: the economic situation in the various countries. These economic circumstances in turn are determined by many other factors – with as one of the important ones the lengths of time that there has been peace in the various countries. Geography plays a role especially in the sense that land-locked countries have to depend on their neighbours for access to the world wide web. As far as Internet freedom is concerned, two of the important factors at the background are the religious freedom in the various countries as well as the forms of government (dictatorial versus democratic).

3.4 References

Access Now, 2019, #KeepItOn, https://www.accessnow.org/keepiton/.

AnswersAfrica, 2020, 10 Most Popular African Websites in 2020, https://answersafrica.com/most-popular-african-websites.html.

China Global Television Network, 2020, Internet shutdown depriving millions in Ethiopia of important information, https://africa.cgtn.com/2020/03/24/internet-shutdown-depriving-millions-in-ethiopia-of-important-information/.

Deutsche Welle, 2019, Investing in Africa's tech infrastructure. Has China won already?, https://www.dw.com/en/investing-in-africas-tech-infrastructure-has-china-won-already/a-48540426.

Deutsche Welle, 2018, Despite Ghana's commitment to Internet expansion, problems persist, https://www.dw.com/en/despite-ghanas-commitment-to-internet-expansion-problems-persist/a-46508524.

Deutsche Welle, 2019, Will China's 5G 'digital Silk Road' lead to an authoritarian future for the internet?, https://www.dw.com/en/will-chinas-5g-digital-silk-road-lead-to-an-authoritarian-future-for-the-internet/a-48497082.

Deloitte, 2016, The economic impact of disruptions to Internet connectivity - A report for Facebook, https://www2.deloitte.com/global/en/pages/technology-media-and-telecommunications/articles/the-economic-impact-of-disruptions-to-internet-connectivity-report-for-facebook.html#.

Freedom House, 2017, East African States Adopt China's Playbook on Internet Censorship, https://freedomhouse.org/article/east-african-states-adopt-chinas-playbook-internet-censorship.

Freedom House, 2019, An Explainer for When the Internet Goes Down: What, Who, and Why?, https://freedomhouse.org/article/explainer-when-internet-goes-down-what-who-and-why.

GSMA, https://www.mobileconnectivityindex.com.

GSMA, The Mobile Economy - Sub-Saharan Africa 2019, https://www.gsma.com/mobileeconomy/sub-saharan-africa/.

Internet Sans Frontières, https://internetwithoutborders.org/.

Internet World Stats, Internet Users Statistics for Africa, https://internetworldstats.com/stats1.htm

Microsoft, 2019, Microsoft opens first datacentres in Africa, https://azure.microsoft.com/en-us/blog/microsoft-opens-first-datacenters-in-africa-with-general-availability-of-microsoft-azure/.

New York Times, 2019, Life in an Internet Shutdown, https://www.nytimes.com/2019/09/02/world/africa/internet-shutdown-economy.html.

Quartz Africa, 2019, The miscalculations African governments keep making with social media and internet blocks, https://qz.com/africa/1706217/why-do-african-governments-shut-down-the-internet/.

Quartz Africa, 2018, The story of Africa's longest internet shutdown, https://qz.com/africa/1349108/cameroons-internet-shutdown-in-blacked-out-documentary/.

Reporters without Borders, 2019, Ranking Table, https://rsf.org/en/ranking_table.

The Alliance for Affordable Internet, https://a4ai.org/.

Washington Post, Why are so many African leaders shutting off the Internet in 2019, https://www.washingtonpost.com/news/monkey-cage/wp/2019/01/30/why-are-so-many-african-leaders-shutting-off-the-internet-in-2019/.

Wikipedia, Internet in Africa, https://en.wikipedia.org/wiki/Internet_in_Africa.

World Bank, 2019, GNI per capita, Atlas method (current US$), https://data.worldbank.org/indicator/ny.gnp.pcap.cd?most_recent_year_desc=true&year_high_desc=true.

World Economic Forum, 2019, Three reasons why most Africans aren't on the internet, https://www.weforum.org/agenda/2019/08/3-reasons-why-most-africans-arent-on-the-internet-and-how-to-connect-them/.

3.5 Acknowledgements

Hereby we would like to thank the respondents who gave us input by means of interview / questionnaire: Azare, M. (Tamale, Ghana), Chingumbe, N. (Lusaka, Zambia), Gama, C. (Stellenbosch, South Africa), Meela, G.G. (Arusha, Tanzania), Orodeji, A. (Lagos, Nigeria), Paul, G. (Moshi, Tanzania), Sumbe, N. (Mbeya, Tanzania) and Anonymous (Senegal).

4 Business environment

For each of the selected countries we aim to provide more insight in some of the relevant agro-meteorological services and if there is room for new services considering competition and past international investments.

4.1 Method

For each service we described: the main business, use of weather data, presence of agronomy advices, experience in SSA (mainly listing countries and sometimes referring to specific initiatives) and the active Weather Service Provider (WSP) if present. We categorised the different services and tried to figure out whether the service would be a competitor or a potential partner for a new agro-meteorological service.

We have inventoried more than 60 services of which 56 were selected and described. This is based on the references listed in section 4.4. During our search we learnt about the extensive inventory done by CTA (Tan et al., 2019). Complete results of this inventory have been documented in a database. Unfortunately, we could not access this database and therefore relied on the CTA report only. Note that the services mentioned in the report largely overlap the services identified in our study. The work done by CTA will be continued in a new initiative called DAK-HUB which started early 2021 and is coordinated by WENR. The overview will be updated, extended and published in the form of a knowledge hub of D4Ag solutions.

The 56 selected services were grouped in competitors for an agro-meteorological service, and potential partners thus services lacking the agro-meteo component in their service. The services are described in Annex 1 also indicating their presence in the selected countries.

We also looked at the funding by the international community. Usher et al. (2018) suggested that donor funding for an agro-meteorological service may help increase private-sector participation in the market. It should be noted that donor funding can help create markets, but also distort markets if not programmed carefully. We assumed that the funding enable a more receiving environment for PPP. To value the amount of funding we used data from the Climate Funds Update. This is an independent website providing information and data on a growing number of multilateral climate finance initiatives designed to help developing countries address the challenges of climate change.

4.2 Proxies

We distinguished two different proxies:
- Number of existing services providing weather and in addition agronomic advises
- Level of funding by the international community.

Earlier, we also included the proxy "number of existing partners e.g. MNO, portals etc.". However, we dropped this proxy as valuing this proxy was too uncertain as we focused our inventory mostly on agro-meteorological services. This way we do miss certain services in our overview e.g. services only aiming at prices or logistics.

4.3 Insights

Below some insights are shared that we came across when defining the method and proxies.

4.3.1 WCIS service

According a Mercy Corps study (MercyCorp, 2019) a comprehensive agro-meteoroligical service for small holder farmers (SHF) should include five major services centered on key content areas:

- Weather and climate services (WCIS)
- Value chain advisory
- Soil management services
- Pest and disease early warning, monitoring and management advice
- Interactive farmer platform.

WCIS are part of the agro-meteorological services. Weather services provide weather forecasts and warnings about hazardous conditions (storm warnings, daily, 3-day, and 10-day (dekadal) forecasts) while climate services involve the provision of climate information over longer time scales like seasons.

Weather forecasts are often the most highly valued advisory service by farmers (Mercy Corps, 2019; study in Kenya). Usher et al. (2018) mention that in countries where Viamo can access WCIS data, this content is by far the most accessed resource on the platform. In their study "RCSA Farmers willingness to pay for improved climate services in Rwanda - Final WP" Tesfaye et al. (2020) report that farmers preferred daily weather forecasts over the seasonal forecast. This finding was contrary to recent studies that reported the benefits of seasonal forecasts in increasing agricultural income of African farmers and their WTP (willingness to pay) for these services (e.g. Gunda et al. 2017, Amegnaglo et al. 2017, Ouédraogo et al. 2018).

Companies interviewed by Usher et al. (2018) saw growth potential in providing expanded weather services to farmers and companies further along the value chain to help farmers with both short- and long-term planning, such as deciding which crops to grow (seasonal outlooks, drought forecast etc.), when to plant, when to harvest, and which investments to make. They identified opportunities to bundle weather information with other services to farmers such as access to buyers, health services and information, credit, and other financial services. Note that cyclical nature of demand for WCIS in agriculture is another reason to bundle services. Farmers need WCIS only during agricultural seasons, and at specific times of planting, production and harvesting. As a result, cash flow for WCIS providers in the agriculture sector can vary widely at different times of year.

WMO emphasises that a WCIS delivery should be available and timely, dependable and reliable, usable, useful, credible, authentic, responsive and flexible, sustainable (affordable and consistent over time), and expandable (to be applicable to different kinds of services). MercyCorp (2019) underlines this by stating that the hardest part of the implementation is not finding the providers (are available), finding the digital platforms (are available) but getting right data and messages to farmers, especially women.

4.3.2 CTA's inventory of agro-meteorological services

According CTA (Tsan et al., 2019) there are around 390 digital solutions (D4Ag) in Africa of which nearly 60% (227 out of 390 active solutions) launched in the last three years (2016-2018). These services serve 33 million users with provisional estimate of 15-30% active users. Out of the 390, 137 relate to advisory & information services e.g. agro-meteorological services and WCIS. Commercial enterprises are in for more than 50%[3], followed by MNO and government with both a share of 20%, NGO around 5% and finally agribusiness targeting specific commodities (Olam, Cargill, Mars, and ETG) for 1%. D4Ag registrations of smallholder farmers are highly concentrated by use case, actors, and geography. Advisory services account for over two-thirds of registered farmers today (easier to scale), the top 20 players reach more than 80% of registered farmers, and nearly 70% of all registered farmers are in East Africa.

[3] Among them also input dealers and buyers like Yara, Syngenta, John Deere and Barry Callebaut.

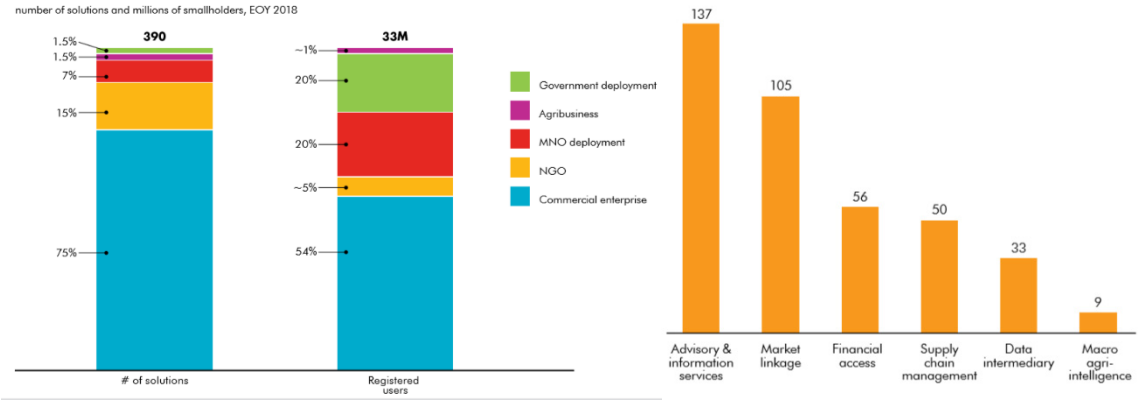

Figure 8 *D4Ag solution inventory taken from Tsan et al., 2019*

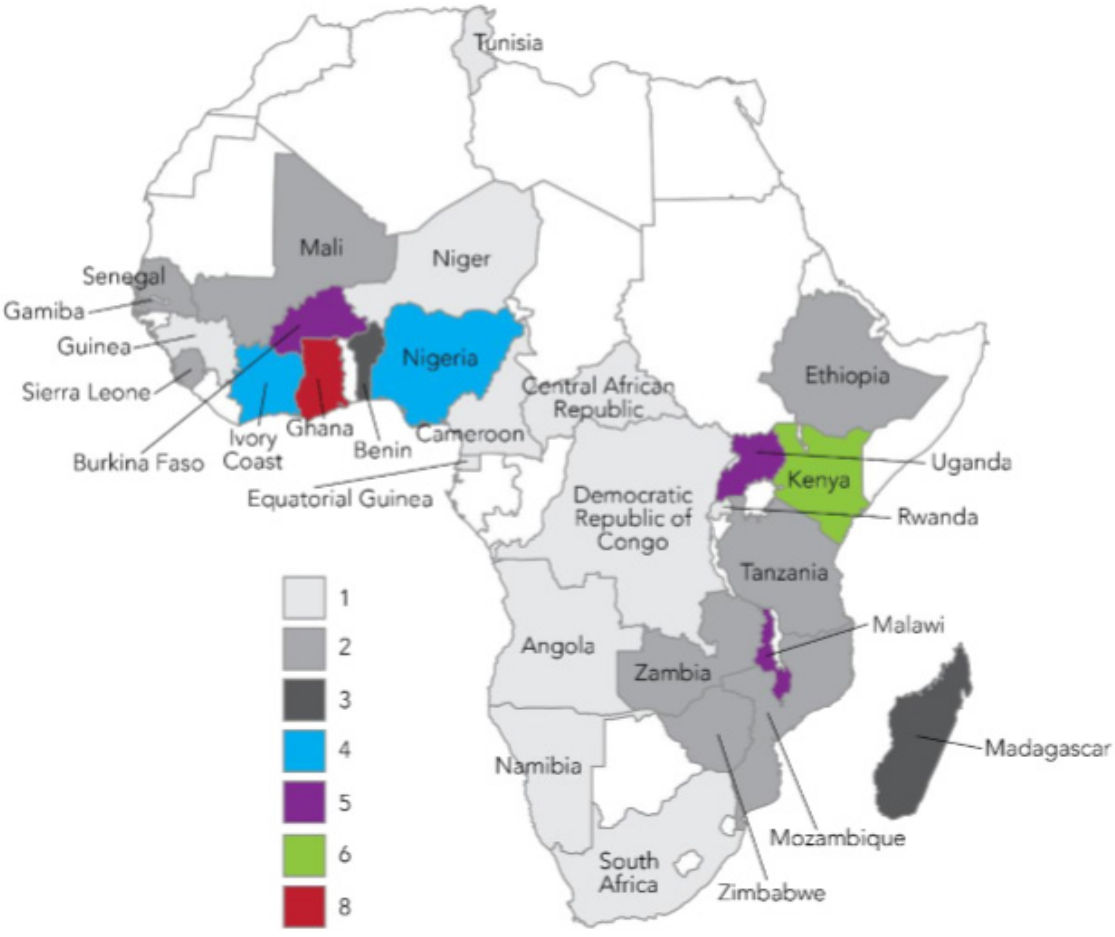

Figure 9 *Number of WCIS services inventoried Usher et al., 2018*

Although it is not always clear which commercial WSP is behind a service it seems there are a limited number of players: aWhere, Ignitia, NASA, IBM weather company and Climacell, the latter two both in an early stage. Besides, there are NMS delivering agro-meteorological services which very much differ from country to country. Some deliver bulletins with a general characterisation of past weather in terms of precipitation, drought indices and temperature within the country. Often the NMS relate to regional centres like ICPAC and AGRHYMET. There are examples where the NMS is serving farmers like in South-Africa or an NMS that is part of a broader partnership serving farmers such as Gmet Ghana (Esoko). Of course, there are also other players like AccuWeather, Speedwell Weather, DTN etc but these do not seem to be active in the provision of agro-meteorological services in sub Saharan Africa.

4.3.3 Revenue and business models

During our study we came across information on pricing of WCIS. Below a summary from several sources.

Vaughan et al., 2019:
Checked studies that ask or elicit what users would be willing to pay (WTP) for seasonal forecast. These estimates ranged from 1-15 dollar. For instance, a study in Burkina Faso found that seasonal information is much more highly valued (15 dollar) than decadal information (3 dollar) or even contextualised agrometeorological advisories (5 dollar). They also found that WTP varies over agroecological zones.

Usher et al., 2018:
Usher et al. (2018) interviewed NHMS directors and private companies. They found that one private sector company (Ignitia) had businesses and consumers who are willing to pay for WCIS services, and the cost was minimal at less than $6 per season.

Other companies cited low WTP in SSA as a barrier to growth:
- A lack of willingness to pay for WCIS e.g. information should be a free public good or lack of understanding on the value of a timely, reliable WCIS. On the other hand, studies show that smallholder farmers may be willing to pay for reliable weather information (see references 60-62).
- A lack of ability to pay.
- Market distortions caused by donors and NGOs.

Tsan et al., 2019:
D4Ag enterprises are increasingly moving towards bundled services and associated business models that combine market linkage, advisory services, and financial services, and often also have supply chain management and macro agri-intelligence features. Farmers tend to see more immediate returns from these services, which increases farmer uptake and WTP. In such models WCIS service work more according a B2B model than a B2C model.

4.4 References

Amegnaglo, C.J., Anaman, K.A., Mensah-Bonsu, A., Onumah, E.E. and Gero, F.A., 2017. Contingent valuation study of the benefits of seasonal climate forecasts for maize farmers in the Republic of Benin, West Africa. Climate Services, 6, pp.1-11.

Capterra: www.capterra.com/farm-management-software. Accessed summer 2020.

Climate Funds Update. https://climatefundsupdate.org, accessed 2 October 2020 (data dash-board, table of recipients, selected SSA and "adaptation" and "multi-foci").

Gunda, T., Bazuin, J.T., Nay, J. and Yeung, K.L., 2017. Impact of seasonal forecast use on agricultural income in a system with varying crop costs and returns: an empirically-grounded simulation. Environmental Research Letters, 12(3), p.034001.

MercyCorp, 2019. Service inventory in Kenya and Ethiopia. Visited www.mercycorpsagrifin.org summer 2020 and downloaded:
www.mercycorpsagrifin.org/wp-content/uploads/2020/03/Mercy-Corps-ADF-Digital-Precision-Ag_CaseStudy.pdf
www.mercycorpsagrifin.org/wp-content/uploads/2020/03/Mery-Corps-Agrifin-Ethiopia_Ecosystem-Report-2019-2.pdf

Ouédraogo, M., Partey, S.T., Zougmoré, R.B., Derigubah, M., Sanogo, D., Boureima, M. and Huyer, S., 2018. Mainstreaming gender and social differentiation into CCAFS research activities in West Africa: lessons learned and perspectives.

Tesfaye A., J. Hansen, D. Kagabo, E. Birachi, M. Radeny, D. Solomon, 2020. Rwanda Climate Services for Agriculture: Farmers willingness to pay for improved climate services. CGIAR-CCAFS Working Paper no. 314. Wageningen, the Netherlands.

Tsan, M., S. Totapally, M. Hailu, B. K. Addom, 2019. The digitalisation of African agriculture report 2018–2019. 1st edition, June 2019. © CTA 2019 EU financing. ISBN: 978-92-9081-657-7.

Usher J., C. Phiri, N. Linacre, R. O'Sullivan, U. Qadir, 2018. Climate Information Services Market Assessment and Business Model Review, USAID-supported Assessing Sustainability.

Vaughan, C., J. Hansen, P. Roudier, P. Watkiss, E. Carr, 2019. Evaluating agricultural weather and climate services in Africa: Evidence, methods, and a learning agenda. Climate Change, 10(4), p.e 586.

WMO, 2019. 2019 STATE OF CLIMATE SERVICES. WMO-No. 1242.

WMO Country Profile Database Porta (https://cpdb.wmo.int). Accessed summer 2020.

5 Results: Country Profiles

The 10 selected countries have been assessed to evaluate if conditions are relatively favourable for a (commercial) weather/climate service provider (the WSP) to consider developing a agro-meteo service in a specific country. Each of the three environments described in the previous sections of this document, have been scored based on several sub criteria. These sub criteria have been converted into three classes with increasing favourable conditions: 1 (low), 2 (medium) and 3 (high). This was done by defining three tercile intervals. Next, the sub criteria were summarised per environment taking the score with the highest frequency (modus). In case two different scores (low, medium or high) have both the highest frequency we selected the highest score; e.g. if there are two sub criteria with score "low" and two sub criteria with score "medium" we selected score "medium". We ended up with a score for the three environments for each country.

Below we summarise the results per country by means of the spider diagram and provided an analysis of the subcriteria whenever relevant.

5.1 Ethiopia

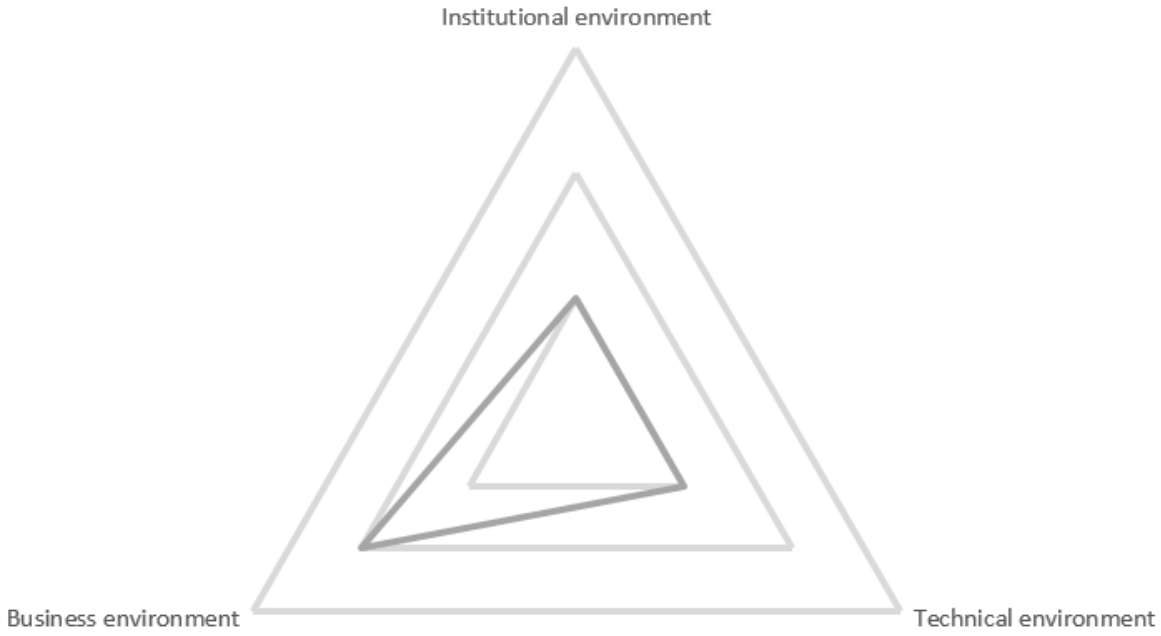

Figure 10 *Environments for new agro-meteo service: Ethiopia*

The current institutional and technical environments are not so favourable. The current infrastructure for instance, leaves much to be desired and there are concerns about free access to internet. Nevertheless, for some elements the scores are relatively good, e.g. capacity, especially looking at the level of education of many institutional actors in the value chain.

The positive score in terms of business environment is related to the scarcity of service providers operating in this domain at present (and hence, in principle, to low competition). However, this reflects the very limited room for providing services if not under the NMS (NMA) which is the mandated body given the current policy and legal framework and despite some positive openings from government in promoting PPPs in the agricultural sector. Also note that the level of donor funding for Ethiopia is substantial (especially from the USA); all this suggests that services will be based on large

donor and public funded initiatives for some time to come. Eventual partnerships cannot do without government organisations, including the NMA, the MOA and the ATA and should preferably include institutionally consolidated partners, such as Digital Green, and WUR. There are several providers which can operate delivery platforms of the weather services, although one should ultimately rely on Ethio telecom which so far retains a monopolistic position for SMS and IVR (and in perspective, Internet based) services.

5.2 Ghana

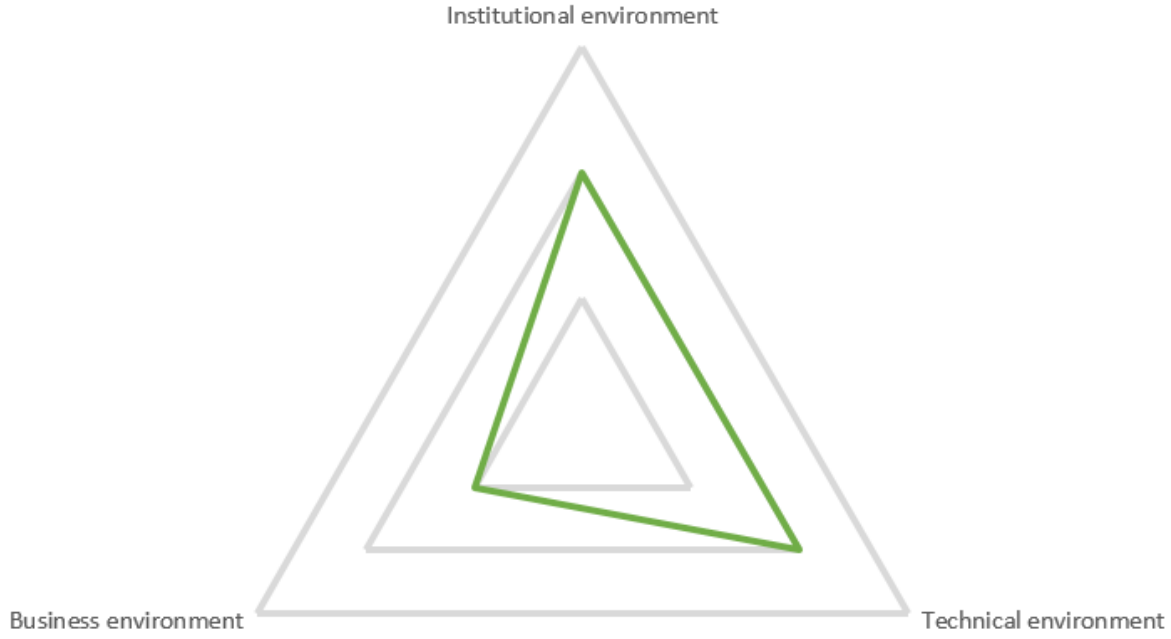

Figure 11 *Environments for new agro-meteo service: Ghana*

The institutional environment is relatively favourable, because the general policy environment is sufficiently open, and the legal framework does not limit agro-meteo services. There is evidence of establishment of PPPs by the NMS (GMet) and also the level of local institutional actors is good. This gives an overall good institutional environment.

On 2 technical indices, Ghana scores above average: the ones for internet freedom and penetration of the smartphone. Smartphone ownership is expected to even show considerable growth. On all other technical indices, Ghana scores average, also on the index for services & skills [4]. The average score for services & skills suggests that the people who can operate web servers and related devices are limited in number. The relative lack of skilled staff could become a constraint when the maintenance of potential services must be organised. The impression though is that the country is catching up since a few years, meaning that more young people are being taught technical skills than before.

There are many services already active including weather providers like Ignitia, aWhere, TAHMO (in collaboration with IBM weather company) and the Ghana met office (e.g. in a partnership with Esoko). This means that there is a strong competition leading to a low score. Funding from the international community in the climate sector is relatively low although the USA has invested substantially (US funding in agriculture 2011-2017). This enhanced preparedness for the forming of PPP around agro-meteo services.

[4] This index is calculated from two other indices: the number of servers per caput and internet nodes per caput. The former index is just above average and the latter rather low for Ghana. For a long time, Ghanaians have indeed preferred to rely on services from abroad. There is only one Internet Exchange Point (IXP's) in the country. Ghana's population is small enough to be served by one point and large enough to enable this point to work efficiently. In this case the number of IXP's per caput seems to be less suitable as indicator.

5.3 Kenya

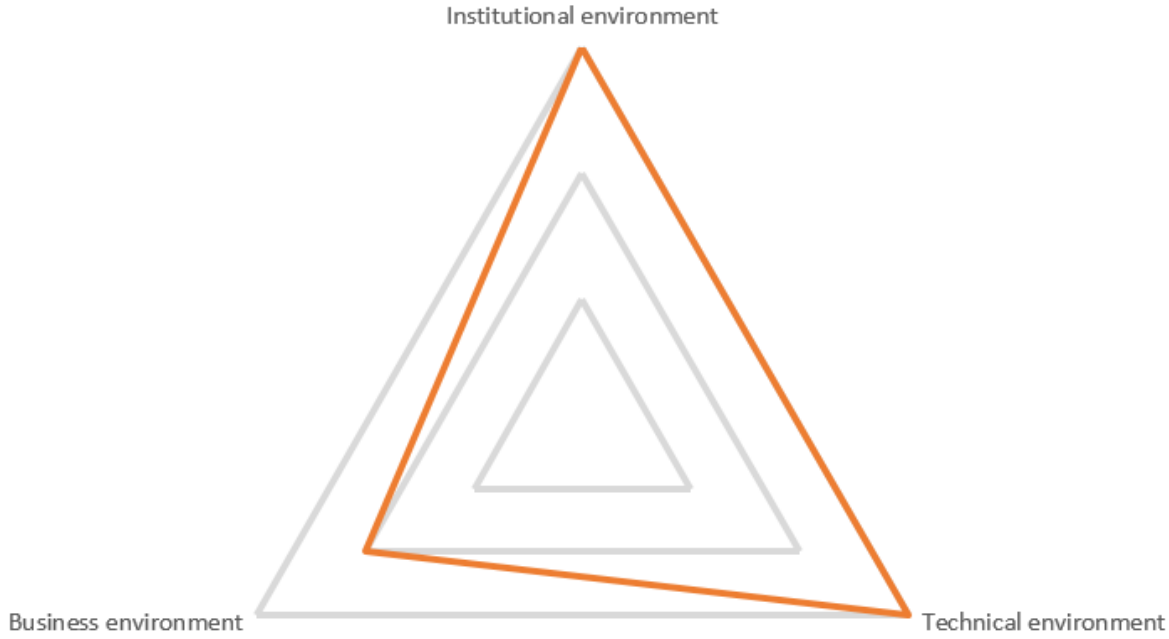

Figure 12 *Environments for new agro-meteo service: Kenya*

The overall policy environment for establishing PPPs is very favourable. Although there is no specific legislation concerning collaboration with the private sector in the weather-related domain, in real terms private service providers are permitted to develop added value services. Kenya has many institutional partners with high capacity operating in relevant fields for the value chain. This results in a high score in terms of institutional environment openness.

Kenya scores high on 2 technical indices: infrastructure and services & skills. On the other hand, smartphone ownership scores just above average. It is even showing growth but less steep than in countries like Ghana and Senegal[5]. Smartphone ownership is correlated with education level and income, which allows one to suspect what the underlying constraints are like.

The number of active services is high with an active role of the Kenya Meteorological Department (KAOP, M-Farm, IShamba, PAD). Besides, aWhere is partnering in several services such as iShamba and UjuziKilimo and Weather Impact is part of the CropMon initiative. International community is stimulating climate related research and services via substantial investments. It confirms an open and enabling environment for private initiatives.

[5] See https://www.pewresearch.org/global/2018/10/09/majorities-in-sub-saharan-africa-own-mobile-phones-but-smartphone-adoption-is-modest/. Income inequality in Kenya is relatively high, which may explain why the growth of smartphone ownership in Kenya is less than in similar countries. See e.g.: https://www.ezega.com/News/NewsDetails/6867/Income-Inequality-in-Africa

5.4 Mozambique

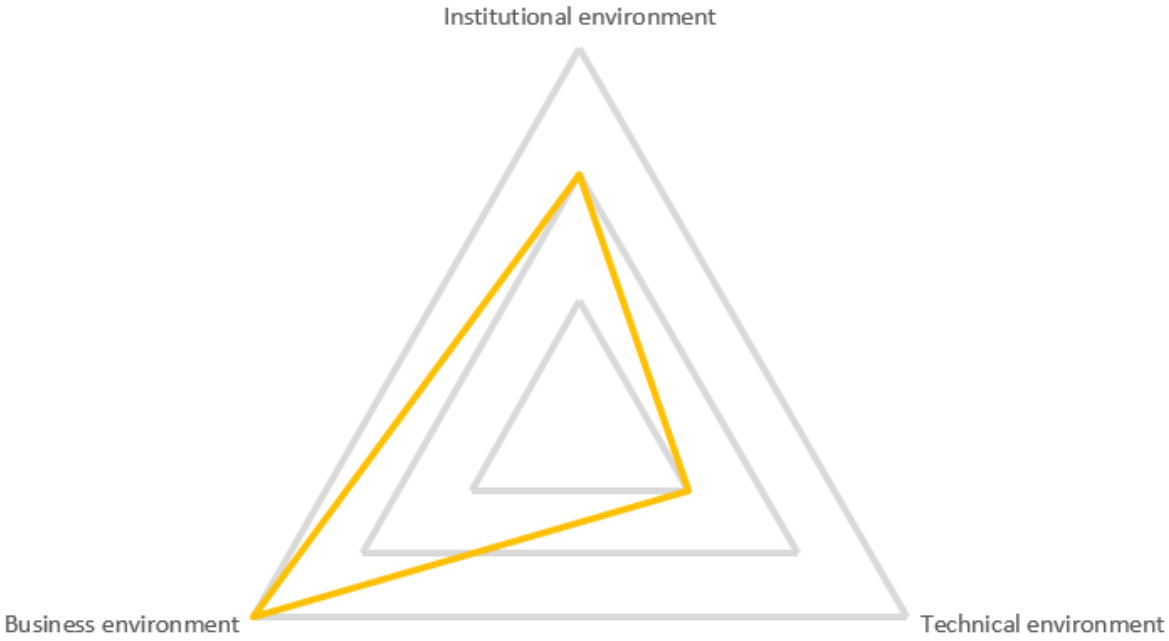

Figure 13 *Environments for new agro-meteo service: Mozambique*

Although the legal and policy framework seems to indicate a conceiving environment for the future, currently there is limited evidence of collaboration with private companies and opening towards PPP. Also, the capacity of institutional actors in the value chain is only average. This leads to an intermediate scoring in the institutional sphere.

The technical environment scores low due to the unfavourable economic situation discouraging investments in IT infrastructure and in technical education. As a result, young people cannot easily acquire technical skills. There are few jobs for people with technical skills. Technicians may easily be lured by greener pastures in neighbouring South Africa. The score for affordability is average. The prices of handsets are probably not very different from those in other non-landlocked countries. However, the cost of handset acquisition and associated ongoing costs are most likely considered as high by many people in the country, given their income. Overall, the technical environment is not so favourable.

The business perspective scores high. There are little other agro-meteo services (e.g. Smartfarm by CropIn and Farmerline) and there was/is a large international investment by donors on climate adaptation and early warning (e.g. Pilot Program for Climate Resilience (PPCR) and Global Climate Change Alliance (GCCA)) leading to a more favourable environment to explore possible PPP.

5.5 Nigeria

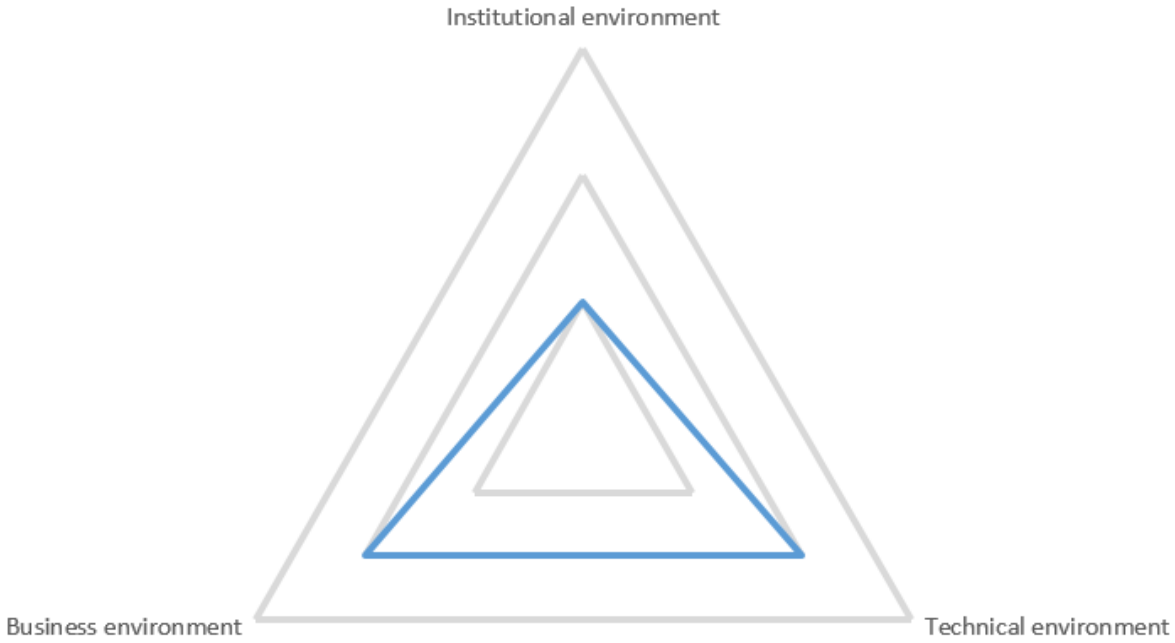

Figure 14 *Environments for new agro-meteo service: Nigeria*

In principle Nigeria has been opening the government sector and services to the contribution of the private sector. However specifically with reference to weather domain the legislation does not allow participation of other entities in the provision of information and services (in other words the Nigerian Meteorological Agency, NIMET is the sole provider). Despite statements that it is open to PPPs, there is little evidence of engagement by NIMET with private sector so far. The factors above yield a score in terms of the overall institutional environment which is low.

In the technical environment Nigeria scores high on affordability as well as on services & skills. However, the scores for smartphone ownership and consumer readiness are just above average. The growth in smartphone ownership is less steep than in e.g. Ghana and Senegal. The technical environment therefore seems to have the most constraints on the receiving end.

We found a limited number of operational agro-meteo services (FieldFocus by 6th grain, Smartfarm by CropIn, Farmerline, Ignitia) although the site www.seedstars.com[6] states that Nigeria is dominating the agritech market. International funding of climate related initiative is rather low. Altogether this led to an average score. It would be interesting to further explore to what extent external weather providers operate in the services mentioned above (e.g. Ignitia) and if so, how they corporate with NIMET.

[6] https://www.seedstars.com/content-hub/life/agritech-africa-paving-way-new-era-farming/

5.6 Senegal

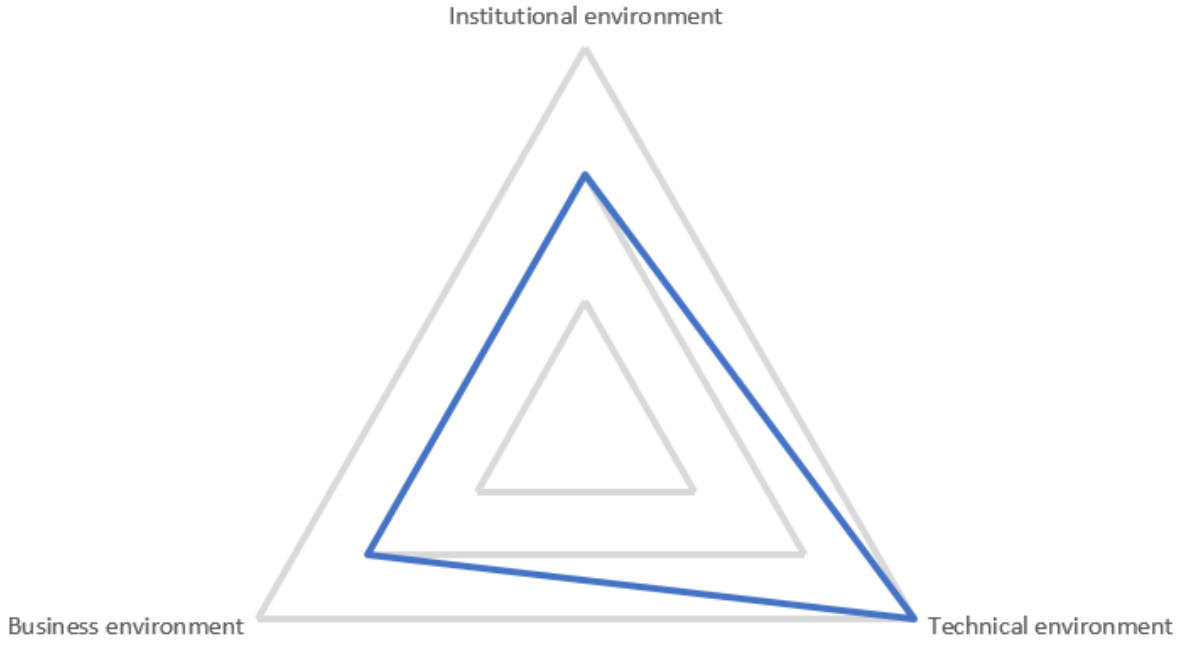

Figure 15 *Environments for new agro-meteo service: Senegal*

While there is no specific legislation concerning private sector participation in the delivery of weather information and services, there is a consultative platform for the public and private sector, fostering regular cooperative dialogue. There is, however, limited evidence of openings to private sector providers in running the services, except for the delivery segment e.g. through radio broadcasting. In Senegal there are also very good capacities and a collaborative attitude among institutional actors. Overall, this leads to an institutional environment score which is intermediate.

Senegal scores high on 4 technical indices: infrastructure, affordability, attitude and penetration of the smartphone. Smartphone ownership is even expected to show considerable growth. However, for the consumer readiness the scores are low and for services & skills they are average.

The business environment scores average due a moderate number of agro-meteo services and substantial funding from the international community. Example of agro-meteo services are FieldFocus by 6th grain, mAgri platform/agCelerant by Manobi SA and Ignitia. Note that the international climate funding is mainly targeting climate change in coastal regions. On the other hand, Senegal is one of the countries where USAID invested largely (US funding in agriculture 2011-2017).

5.7 South-Africa

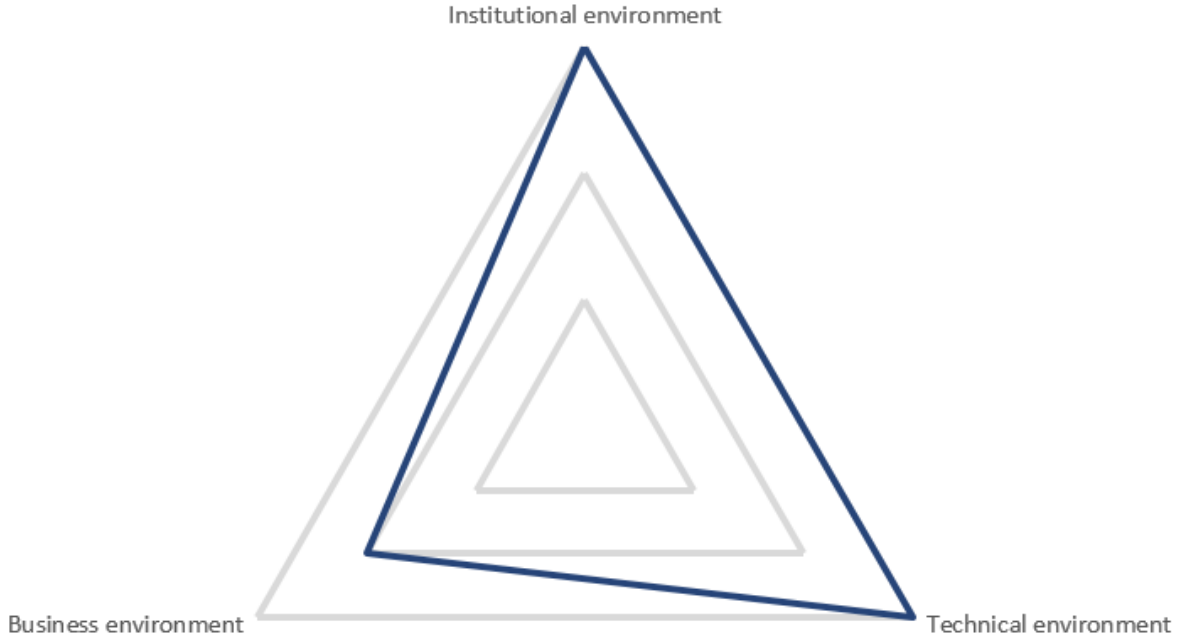

Figure 16 *Environments for new agro-meteo service: South Africa*

The legal framework (in general terms and specific to the NMS) allows the SAWS (NMI in South-Africa) to develop both public good services that are funded by government and paid-for commercial services. This favors the involvement of private sector. South Africa has numerous centers of excellence which can provide high level knowledge partners in the "value chain". Altogether the overall institutional environment score is therefore high.

South Africa scores high on all 6 technical indices, meaning that technical issues are not expected to form any constraints.

We found a moderate number of agro-meteo services e.g. FieldFocus by 6th grain, Africa Weather (with NMS), Manstrat Agricultural Intelligence Solutions, Olam, Weather Impact (Rain4Africa), and an early stage service called Ulima by TechnoBrain. Adding the low funding from the international community we obtained an average score. For South Africa the level of donor investments is probably a less relevant indicator of the business environment compared to capital investments, which are higher than in many African countries.

5.8 Tanzania

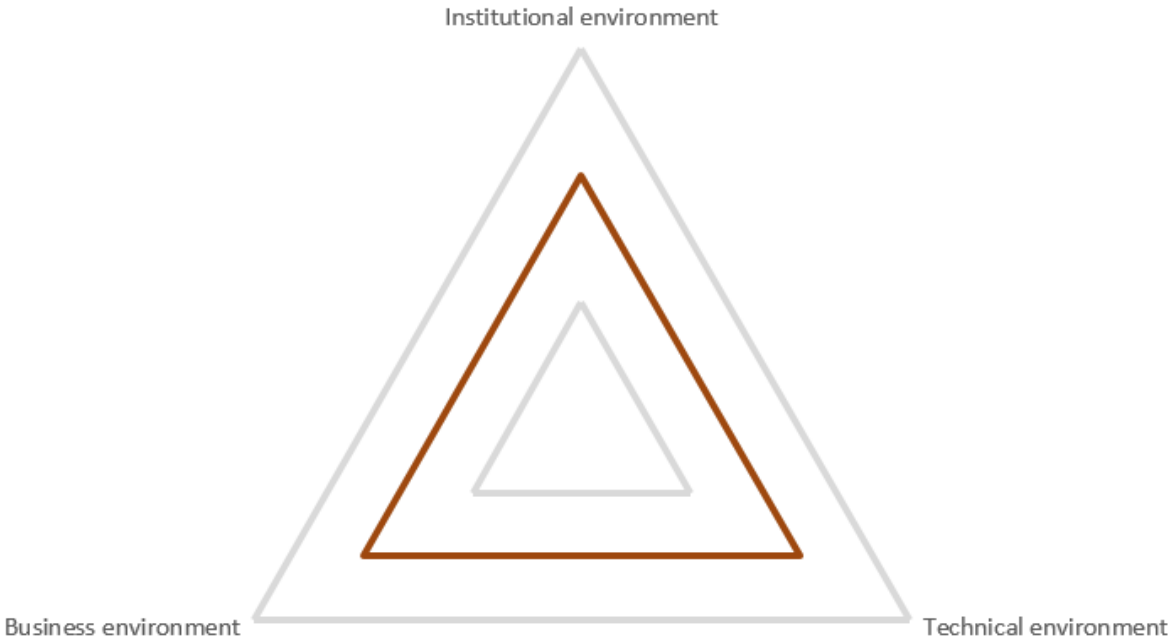

Figure 17 *Environments for new agro-meteo service: Tanzania*

Although the Tanzania Meteorological Agency (TMA) is the only mandated institution for provision of weather Services, there is a generic legal framework for PPPs and more specifically a national strategy under development for the exchange of weather and climate information. TMA however is not currently equipped to effectively engage with private partners and evidence of capacity/collaborative attitude is limited. The overall institutional environment score is therefore intermediate.

The country scores average on 3 technical indices: services & skills, the index penetration of the smartphone as well as the index for consumer readiness. However, it scores low on 3 other technical indices: infra-structure, affordability and Internet freedom. These include issues which will probably be solved only over a longer time.

There several agro-meteo services like FieldFocus by 6th grain, Esoko, Tigo Kilimo etc. International funding is substantial specifically from USA but also from the international climate funds, e.g. Adaptation Fund (AF), Least Developed Countries Fund (LDCF), Global Climate Change Alliance (GCCA) etc. One of these financed projects specifically focusses on strengthening Climate Information and Early Warning Systems in Tanzania. Finally, although it was not included in the score, there are quite a number of services that might not have weather information as part of their service: Farmforce, Eprod, Arifu, One acre fund, Viamo, Connected Farmer by Mezzanine Ware / Vodacom, FarmRadio, FarmAfrica and PICSA. These would be interesting to further explore. So, there is competition but also possible partners and international initiatives to hook on.

5.9 Uganda

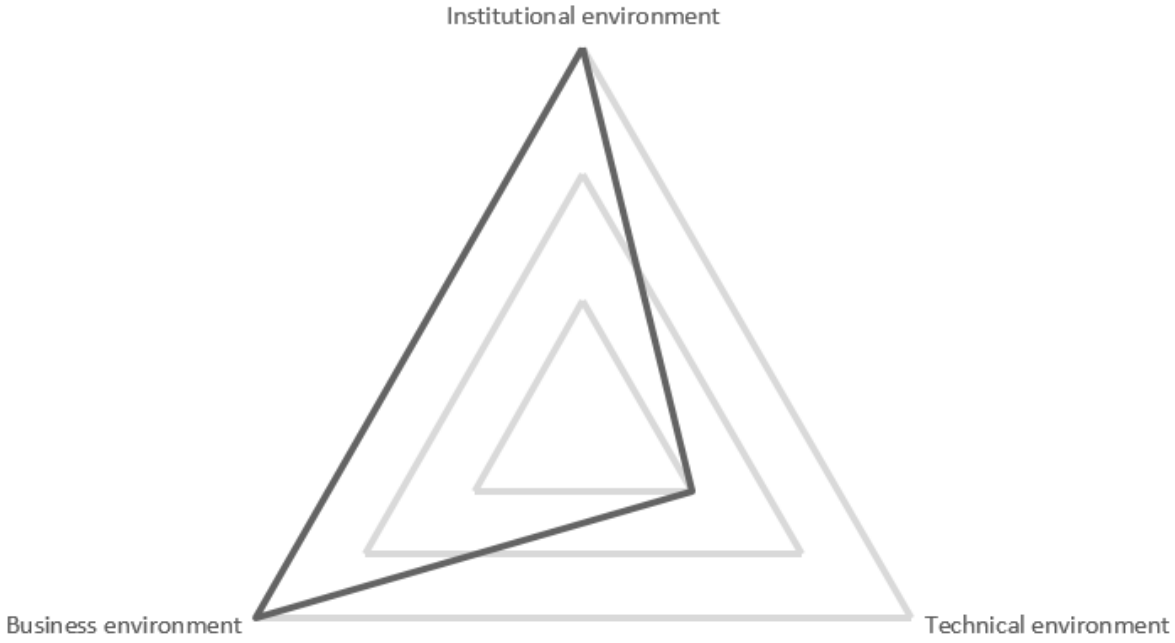

Figure 18 *Environments for new agro-meteo service: Uganda*

There is a specific enabling environment for revenue generation, providing the Uganda National Meteorological Authority (UNMA) with the legal authority to market weather and climate information products and services. It also allows partnering with existing commercial information companies. This, together with a general favorable policy environment and organisational readiness, makes it attractive to consider operating in a PPPs set-up. As a downside, there is limited coordination between organisations potentially operating in the 'value-chain'.

In the technical sphere the country scores average on services & skills as well as on consumer readiness. For all other technical indices, the scores are low. The technical environment is therefore not favourable.

In terms of competition the business environment does seem favourable because of the limited number of agro-meteo services. Services found are M-Shamba, Farmerline and Climacell (early stage). Further the international community has been active in working together with the local government and organisations. Funds are Adaptation for Smallholder Agriculture Programme (ASAP), Global Climate Change Alliance (GCCA), Least Developed Countries Fund (LDCF), Green Climate Fund (GCF) including projects like strengthening climate information and early warning system. Altogether this leads to a high score.

5.10 Zambia

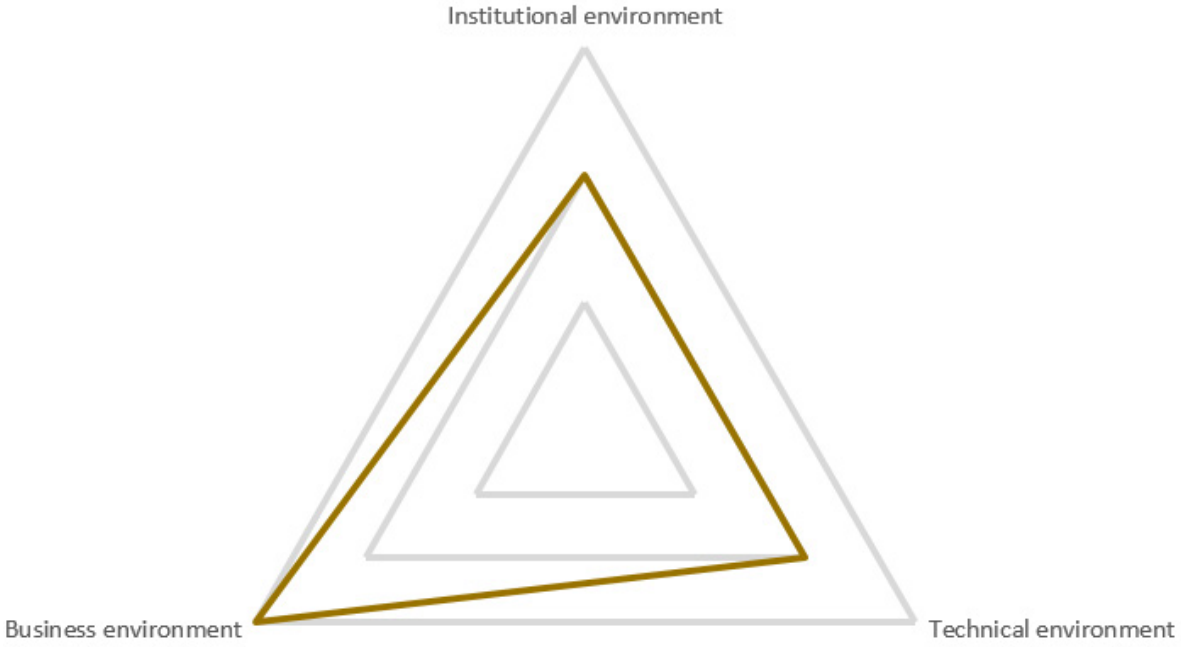

Figure 19 *Environments for new agro-meteo service: Zambia*

The general policy and regulatory framework is positive and there are some openings specifically in the national meteorology policy which will allow the NMS to generate additional revenues through the marketing of weather and climate information. The Zambia Meteorological Department (ZMD) current situation is that of a limited capacity due to deteriorating infrastructure and shortage of technical staff. The overall score is intermediate.

For most technical indices the scores are average. Only for affordability the score is low. This might be caused by the landlocked nature of the country. For consumer readiness, the score is even high.

There are not many agro-meteo services as it seems. Found services are for instance FieldFocus by 6th grain and Olam. Large international funding on climate comes from several funds including a project (financed by Pilot Program for Climate Resilience (PPCR)) targeting the private sector in support to Climate Resilience.

6 Summary of the results

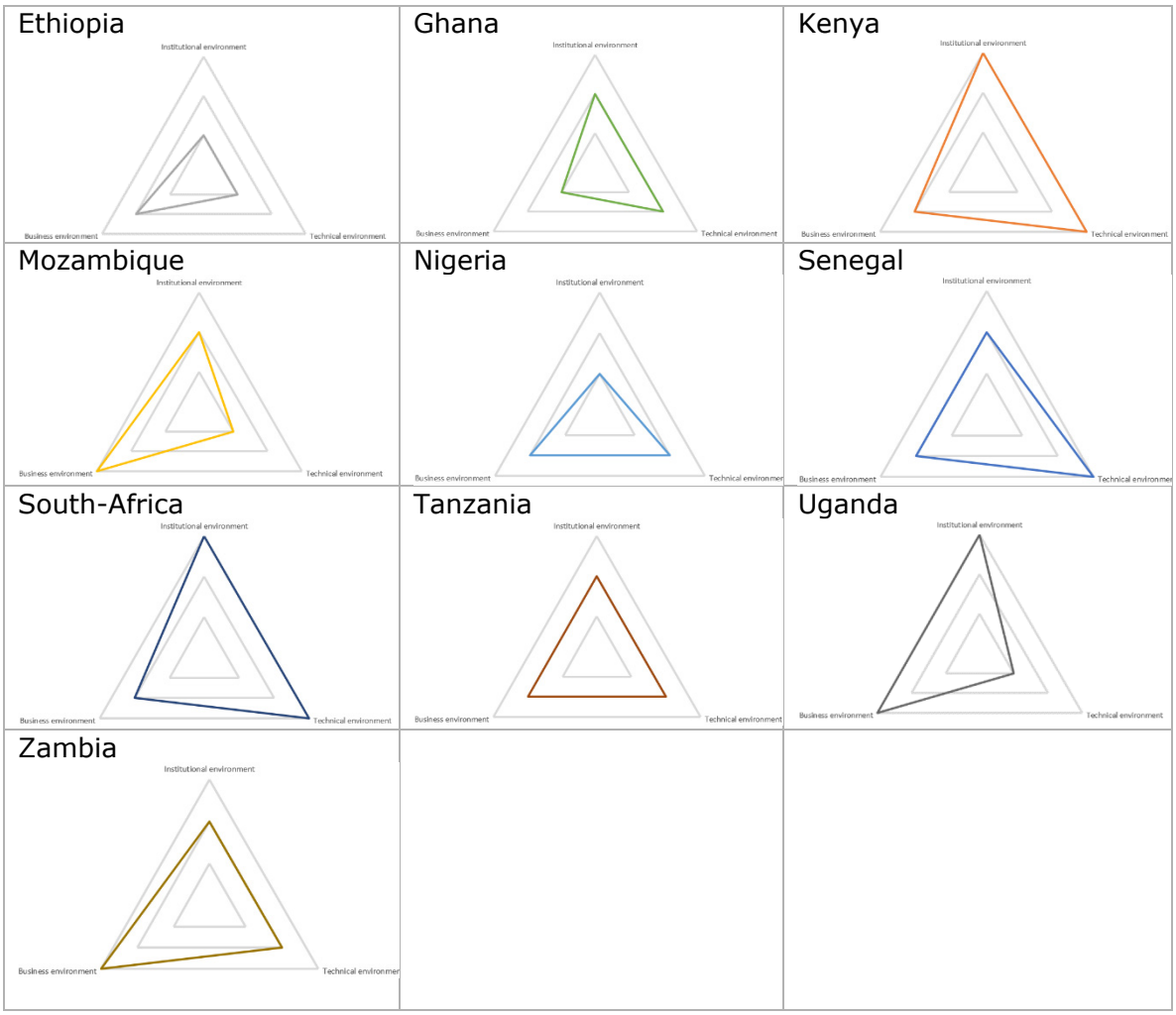

Figure 20 *Overview of country scores for new agro-meteo services*

6.1 Institutional environment

Out of the 10 countries analysed, three (Kenya, South-Africa and Uganda), attain the highest overall score for the institutional environment, which is 3. For Kenya the partial scores that are contributing most are a favorable specific legislation, the business environment and evidence of capacity / collaborative attitude among the different institutional actors. For Uganda what matters is especially a positive attitude towards engagement with the private sector. For South-Africa all the mentioned factors apply.

Zambia, Senegal, Ghana, Tanzania and Mozambique form a second group of countries with less favorable conditions but still some potential. For Tanzania and Ghana, the specific legislation is favorable. In Zambia the general business environment is positive. In Senegal there are very good capacities and a collaborative attitude among institutional actors.

Nigeria and Ethiopia are less favorable countries but for different reasons. For Nigeria there is limited interest of the NMS to engage with the private sector despite an overall pro-business climate in the country. For Ethiopia, despite the good quality of some of the institutional players, the overall policy framework and readiness is not favorable.

6.2 Technical environment

Kenya, Senegal and South Africa are the countries which appear to have the highest overall score for the technical environment. All score high on infrastructure and average to high on affordability, services & skills, internet freedom as well as on penetration of the smartphone.

Ghana, Nigeria, Tanzania and Zambia are the countries which appear to have an average overall score for the technical environment. There are however remarkable differences between these 4 countries.

Ethiopia, Mozambique and Uganda are the countries with the least favorable technical environments. All score low on services & skills as well as on penetration of the smartphone.

6.3 Business environment

Mozambique, Uganda and Zambia score high due to the low number of agro-meteo services found. In addition, substantial funding by the international community in climate related initiatives (especially Mozambique) might have created a more receiving environment for PPP including international private sector.
Lowest scores are for Ghana due to the high number of services identified and low international funding in climate, though USA invested substantially. Kenya received a medium score but also has a high number of services.

A large middle group exists of Senegal, Ethiopia, Nigeria and Tanzania scoring average as there are quite some services identified and for some countries international funding was substantial e.g. Senegal and Ethiopia (also by USA).

South Africa is less clear as the selected proxies and their valuing might be less applicable. For South Africa the level of donor investments is probably a less relevant indicator of the business environment compared to capital investments, which are higher than in many African countries. We expected many services but found a moderate number of agro-meteo services probably due to the consulted sources. Further research is recommended.

6.4 Business development pathways

As mentioned in the introduction, the country profiles can assist in identifying strategies for developing an agro-meteorological service in the selected countries, based on the 3 dimensions considered.

First of all we should acknowledge that, while addressing the institutional and business spheres, developing a business strategy (or "pathways") is, to some extent at least, within reach of an individual WSP such as Weather Impact, it is less so for some of the elements in the technical dimension. For example, a WSP can "adapt" its strategy to an unfavourable institutional environment by developing services in the form of service contracts under the mandated NMS. Or, in the case of a conceiving institutional environment, it can develop a PPP with the "right" actors in the value chain (not competitors, partners), and more commercially oriented business strategies with limited engagement with the public sector in case a level playing field is established in a certain context. On the opposite many of the factors in the technical sphere (e.g. the mobile and internet infrastructure) cannot be influenced easily by a single WSP. In these circumstances the WSP can try to be part of a broader network lobbying, together with other institutional stakeholders, for more investments in sectors which are strategic for the deployment of agro-meteorological services. Note that a WSP has some room to adapt to a limited technical environment by for example deliver the service to feature phones instead of smart phones though this also sets constraints to the business model such as mining local data from users.

6.5 In-depth analysis of PPP examples

An in-depth analysis can further suggest specific recommendations in case the establishment of a PPP seems to be the best way forward. For this in-depth analysis, from the initial inventory mentioned in Chapter 4, we selected 10 services that include agro-meteo advises and have some level of maturity. For these services we analyzed the level and way of collaboration between partners and the specific role of the WSP. The selected services were grouped based on two dimensions: 1) the level of integration of weather and other services (ranging from "specialisation" to "bundling") and 2) the level of collaboration and hence the importance of the public element in the partnership (ranging from high to low). See scheme below.

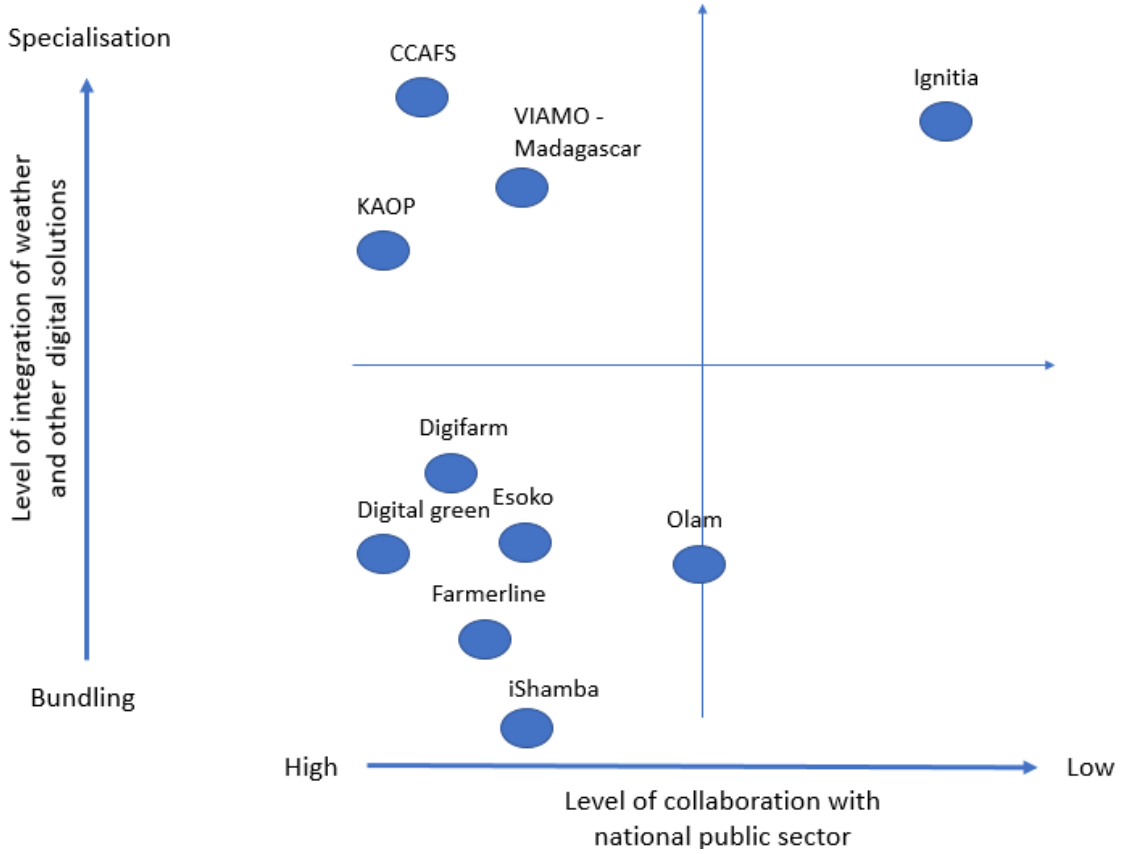

Figure 20 *Grouping of Public-Private-Partnerships (PPP) supporting in-depth analysis*

We can observe two clusters: a first one where service providers have a high level of specialisation in weather and climate services as well as a high degree of collaboration with the public sector (includes CCAFS in Senegal, VIAMO in Madagascar, KAOP in Kenya). A second one, also with a high degree of collaboration implying a more mature PPP, but where providers offer weather and climate services in conjunction with other service.

On the opposite, Ignitia seems to have developed its services independent from public partners. OLAM is a kind of intermediate case.

We then looked more closely at 4 of the selected agro-meteo services, always through the 2 dimensions described:

- Ignitia (specialised, mainly private partnership)
- KAOP (specialised, mainly public)
- Digital green (some level of bundling, mainly public)
- Farmerline (bundled, mainly public).

These 4 selected agro-meteo services are further detailed in Annex 2.

The more specialised PPP are moving towards more bundling e.g. initiatives by Ignitia and KAOP. In the case of Ignitia it is mainly a matter of diversification of business models like B2B (Ojo with input suppliers in Ghana and crop2 Cash in Nigeria). It is unsure whether these partnerships with Ignitia develop towards PPP with local public partners or remain purely private.

From our inventory it seems that highly bundled services are not offered by purely private partnerships only but by a combination of public and private partners in which the public partners bringing in local knowledge on agronomy, local data (e.g. weather, prices) etc. For the "public" KAOP bundling of services is a logical next step towards an envisioned inclusive platform.

This trend of bundling is one of the insights of the CTA survey (Tsan et al., 2019; Chapter 4). They wrote the following:

> *D4Ag solutions that focus primarily on data collection and the delivery of information and advisory services are important but insufficient. On their own, information and advisory services are unable to maximise farmer impact in the absence of parallel and closely linked systems that ensure farmers' access to inputs, markets and finance. In addition, solutions narrowly focused on information and advice delivery are highly constrained in their economics due to the limited willingness of farmers and other smallholder farmer value chain actors to pay for advice and information.*
>
> *..... Commercial D4Ag advisory solutions will broaden their mandate by combining the advisory service value proposition with digital market linkages (input, mechanisation and off-take linkage services)*
>
> *.... The second related observation concerning D4Ag business models recognises the value – in terms of both D4Ag impact and economics – of bundling solutions. Incipient evidence suggests that breakthrough impacts on farmers (>50% increases in incomes, >100% growth in yields) are possible with the help of D4Ag solutions. However, results like these typically require a holistic approach to serving the needs of smallholder farmers by providing digitally enabled market linkages, advisory services and financial services.*

The bundling approach is emphasised in the CTA report (Lohento et al., 2019; section 5.2.5):

> *Practices that have proven more successful include bundling services (for example advisory services and market linkages services), becoming a value chain player by bundling if appropriate, non-digital and digital agricultural services. Designing B2B or B2B2C services appears a good strategy to generate revenues, as individual farmers usually are not in a position or willing to pay for digital agro-information service.*

In general funding from governments (country or donor) is an important factor in developing a WCIS market in SSA (Usher et al., 2018). Donor funding has been substantial see e.g. recent initiatives (Vaughan et.al, 2017):

- ClimDev-Africa (African Development Bank, Africa Union Commission, and UN Economic Commission for Africa)
- the World Bank's Africa Hydromet Program
- DfID's Weather and Climate Information Services for Africa program
- CGIAR research program on Climate Change, Agriculture and Food Security (CCAFS)
- and sizeable projects7 implemented with support from the Green Climate Fund and bilateral donors (DfID, NORAD, SIDA, USAID, German Federal Ministry of Education and Research).

KAOP and Digital Green are fully donor funded (resp. WorldBank, BMGF) with local governmental entities in the lead: KALRO and ATA. Sustained service will depend on continued donor funding or governmental budgets secured for the long term. Ignitia and Farmerline have a mixture of commercial

[7] Recently also by the BMGF e.g. ATA in Ethiopia.

business models B2C and B2B with a tendency of the agro-meteo component being paid by other partners (B2B).

More information on PPP, focused on NMI and private weather companies, can be found in section 5 of the report: A new vision for Weather and Climate Services in Africa (Snow et al., 2016).

6.6 References

Lohento, K., M. Sotannd, 2019. Business models and key success drivers of agtech start-ups. © CTA 2019 EU financing. ISBN: 978-92-9081-666-9.

Snow, J. T., B. Biagini, G. Benchwick, G. George, J. Hoedjes, A. Miller, J. Usher, 2016. A New Vision for Weather and Climate Services in Africa. UNDP, New York, USA.

Tsan, M., S. Totapally, M. Hailu, B. K. Addom, 2019. The digitalisation of African agriculture report 2018–2019. 1st edition, June 2019. © CTA 2019 EU financing. ISBN: 978-92-9081-657-7.

Usher J., C. Phiri, N. Linacre, R. O'Sullivan, U. Qadir, 2018. Climate Information Services Market Assessment and Business Model Review, USAID-supported Assessing Sustainability.

Vaughan, C., J. Hansen, P. Roudier, P. Watkiss, E. Carr, 2019. Evaluating agricultural weather and climate services in Africa: Evidence, methods, and a learning agenda. Climate Change, 10(4), p.e 586.

7 Recommendations

Underlying study started with an idea to further explore business opportunities for agro-meteorological services in Sub-Saharan Africa (SSA). The initial idea had two components:

- One agro-meteorological service for SSA, easily scalable;
- Strengthening capacity of local NMS (includes social responsibility aspect).

These 2 objectives seem to contradict as, in our analysis, we have seen that countries very much differ based on the "dimensions" considered. We believe that business strategies need to be adapted depending on the specific cases. One possible way to realise both objectives and to have more chances of success in developing an agro-meteorological is to follow different business development "pathways".

For example, a WSP can adapt its strategy by developing agro-meteorological services in the form of service contracts under the mandated NMS. Or, in the case of a conceiving institutional environment, it can develop a PPP with the "right" actors in the value chain (not competitors, partners), and more commercially oriented business strategies with limited engagement with the public sector in case a "level playing field" already exists. On the opposite many of the factors in the technical sphere (e.g., the state of the mobile and internet infrastructure) cannot be influenced easily by a single WSP. In these circumstances the WSP can try to be part of a broader network lobbying, together with other institutional stakeholders, for more investments which are strategic for the deployment of weather and climate services (the mentioned infrastructure and the development of technical skills).

In the case of an "unfavourable" institutional environment the "pathway" would consist in:

- Developing **a public orientated business model (B2G) with a strong collaboration with the NMS**, aiming at donor and government subsidised contract services. What is important is to also aim at a multi-year perspective, allowing the consolidation of the service (e.g. in terms of improvement of the quality of the forecasts, partnering also with international centers of excellence with a recognised reputation) and possibly taking an active role in moving towards forms of more commercially attractive PPPs. Partnerships are to be pursued already at the early stages with partners having consolidated collaborations with the government. For example with respect to Ethiopia Weather Impact has already experienced this with the NMA in Ethiopia building upon existing G4AW services. The WUR RAISE-FS program should provide the needed multi-year perspective and can help promoting – also institutionally through the Embassy – more favorable PPP solutions in the future. Other partners such as Digital Green, eProd and of course WUR, should be involved. Possibly others in the financial services as to explore further bundling of the weather services. A similar "pathway" can be explored for instance in Nigeria, possibly also in Tanzania.
- In the opposite case when a "level playing field" is established for commercial WSPs, the need for a PPP is not that stringent and limited agreements (e.g. for provision of weather station data) can be probably enough. In principle both B2B and B2C services can be pursued. However, **commercial partnerships with the "right" local (private and to some extent public) partners** seem advisable as evaluations and current trends point to the need of bundling services (bundling on information and/or goods) to sustain the services. Moreover, to deliver the service to the farmer the WSP would most likely need a local partner, e.g. a MNO (see ***Figure 22***), public extension services or agri-business[8] operating in specific value chains (for inputs like fertiliser, seeds and off-takers), etc. In fact, it is difficult to see an easy scalable business model without any local entity involved. The trend seems to be to move from B2C to B2B (e.g. Ignitia) as the willingness (or rather ability) to pay for such services by small-holders in Africa is still questionable while B2B in a bundled service offers other revenue models with possibly higher margins. Based on the country profiles this "pathway" seems to apply to countries such as Kenya, South Africa, Uganda. For some of these countries more business "space" also means, more competition. The characterisation of the current

[8] Motivation to offer agro-meteo service could be to retain customers and show social responsibility.

services done in this study, helps devising an optimal strategy (searching for the "right" partners): to partner or to compete? and with whom, building which partnerships? What would then be the competitive advantage and ultimately the role of a WSP like Weather Impact? Is there more the need (the "market") for improving the quality of the forecasts or for a data management platform? For this, combined with the generation of high-quality farm advisory? Or maybe also the need for contributing to the effective delivery of the service through a multiple-channel platform? Which partners would contribute best bundling the agro-meteorological services with others? From our survey we do see some options thus services that seems lacking a developed agro-meterological component: FarmForce, Eprod, OneAcreFund, Precision Agriculture for Development (PAD), Adcon Telemetry[9], Earth Networks[10], TAHMO[11], Climate Edge, Farm.ink, Apollo Agriculture, MbeguChoice, PRISE-CABI and FarmRadio.

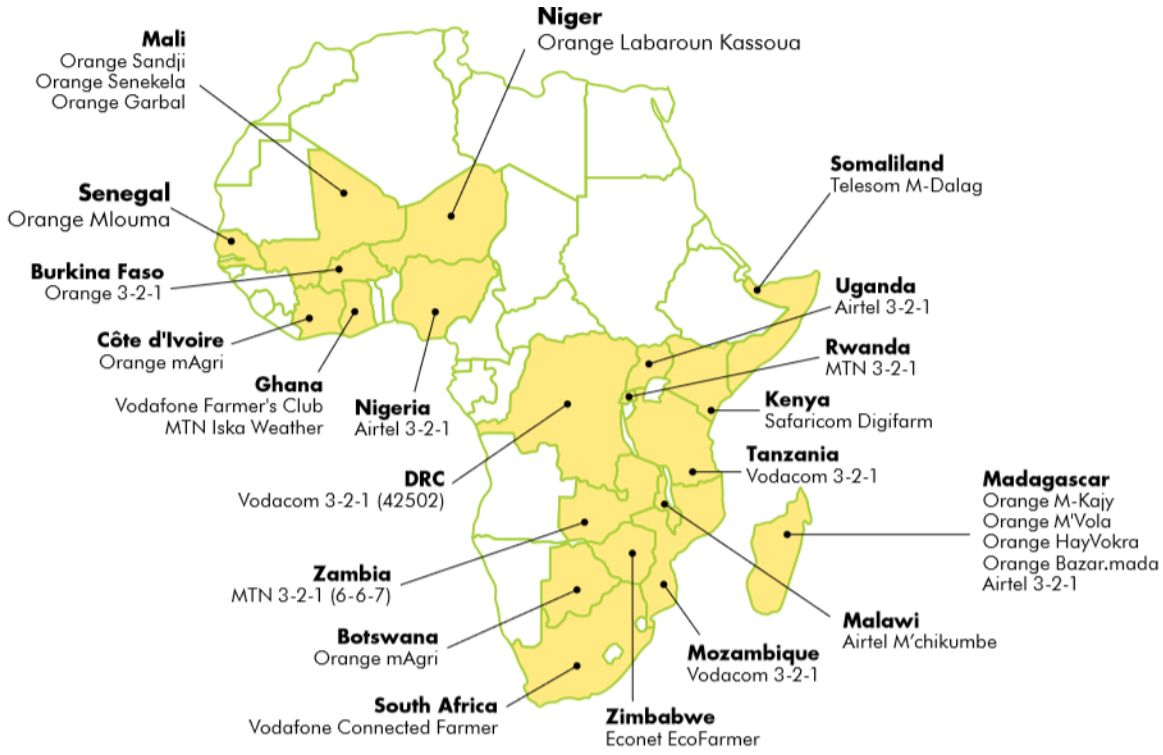

Figure 21 *CTA (2019a) provides an overview of MNO actors active in Dg4Ag solutions*

- An intermediate case applies to most of the other countries considered (Zambia, Senegal, Ghana, Mozambique, possibly Tanzania). In these cases, the "pathway" would include the search of **a PPP with a balanced role of private and public actors.** In this case there is the need to work towards building or joining existing PPPs, with similar questions on the current competitors (or potential partners). The just started DAK-HUB initiative, coordinated by WENR, will also aim at facilitating connections in this direction.
- As anticipated, there is also **a cross-cutting dimension,** which relates to the technical sphere. Where e.g. the mobile and internet infrastructure are lacking and strategic for the deployment of weather and climate services, the WSP can try to be part of a broader lobbying network. Ideally WSPs should partner with this objective and try to sit at the same table with mobile providers, agribusiness, institutional players, etc. to try to influence these high-level issues.

[9] No integrated services for farmers. Sourcing all kind of model and station data sets. Might be interesting partner to connect to NMSs.
[10] Focus at severe weather warning e.g. lightning, thunderstorms. No agronomy. Interesting partner?
[11] Interesting partner - wide network! Though in some countries they already work with a weather provider.

Annex 1 Overview of agro-meteorological services

This annex holds an inventory of agro-meteorological services found for the selected countries. Main references are services web sites, input from Weather Impact and the following references:

- Capterra: www.capterra.com/farm-management-software. Accessed summer 2020.
- MercyCorp, 2019. Service inventory in Kenya and Ethiopia. Visited www.mercycorpsagrifin.org summer 2020 and downloaded:
  - www.mercycorpsagrifin.org/wp-content/uploads/2020/03/Mercy-Corps-ADF-Digital-Precision-Ag_CaseStudy.pdf
  - www.mercycorpsagrifin.org/wp-content/uploads/2020/03/Mery-Corps-Agrifin-Ethiopia_Ecosystem-Report-2019-2.pdf
- Tsan, M., S. Totapally, M. Hailu, B. K. Addom, 2019. The digitalisation of African agriculture report 2018–2019. 1st edition, June 2019. © CTA 2019 EU financing. ISBN: 978-92-9081-657-7.
- Usher J., C. Phiri, N. Linacre, R. O'Sullivan, U. Qadir, 2018. Climate Information Services Market Assessment and Business Model Review, USAID-supported Assessing Sustainability.
- Vaughan, C., J. Hansen, P. Roudier, P. Watkiss, E. Carr, 2019. Evaluating agricultural weather and climate services in Africa: Evidence, methods, and a learning agenda.Climate Change, 10(4), p.e 586.

80-28 Farmer hotline

At http://www.ata.gov.et/programs/highlighted-deliverables/8028-farmer-hotline:

- Main business: ATA, in collaboration with the Ministry of Agriculture & Livestock Resources (MoALR), Ethiopian Institute of Agricultural Research (EIAR), and Ethio Telecom, developed an Interactive Voice Response and Short Message Service (IVR/SMS) platform to deliver information directly to farmers through mobile phones. The 8028 Farmer Hotline is toll-free and the callers receive information on a wide range of agricultural activities on all major cereal, pulses and high-value crops. Keypad menu options allow farmers and Development Agents to register to the service and to select their particular areas of interest and receive automated information whenever they call in. At the same time, the hotline administrator can also "push" or broadcast customised content. In cases of drought, pest and disease, for example, tailored information can be sent to callers based on crop, geography, or demographic data captured when farmers first register to use the system. The Farmer Hotline recently launched a Helpdesk that enables smallholders and Development Agents to ask questions and report issues to experts in their respective woredas. In a survey's pilot, MoALR, EIAR, CIMMYT, and the UK Met office to identify and verify the occurrence of Wheat Rust and develop detailed dispersal forecasts on how the disease will spread through time. Around 4 million users.
- Agronomy: information on a wide range of agricultural activities and warnings on drought, pest and disease tailored to crop and geography.
- Experience Africa:
  - Ethiopia.

6th grain

At www.6grain.com:

- Main business: A NASA associated digital agriculture technology company providing remote sensing and weather-based information (via NASA?) and technology to help farmers, institutions, organisations and large agribusiness through crop maps, crop monitoring, and ground data collection across low and high-income settings. NASA Harvest partner receives support from Gates, The Syngenta Foundation for Sustainable Agriculture (SFSA) and the African Development Bank and works together with agribusiness such as Syngenta, BASF.
- Agronomy: they merge information on field management with satellite observations of weather, crop extent, and crop health, resulting in timely, comprehensive and accurate information. Services:
  - Crop mapping: https://cropmapping.6grain.com
  - Crop Monitoring and Analytics

    - FieldFocus: Digitise fields and get information about crop health and weather. Using satellite remote sensing and client-provided specific crop and variety information to send recommendations and alerts that help improve yields and reduce problem response times. Adding chat box and developing towards a platform with also financial services.
    - Other tools: SalesFocus/VillageFocus, Field Productivity Index, Disease Early Warning System, Field Performance Tracker, seasonal metrics etc.
  - Ground Data Collection
- Experience Africa: Collaborations in South Africa, Zambia, Zimbabwe, Nigeria, Mauritania, Senegal, Kenya, Côte d'Ivoire, Ghana, Angola, Tanzania. Received a grant from the Bill & Melinda Gates Foundation (2019) to pilot an early warning system for Fall Armyworm (FAW) to be deployed to farmers in African nations.

Adcon Telemetry

At www.adcon.com:

- Main business: Based in Austria, specialised in both hardware and software solutions. Develops and produces turn-key solutions for all kinds of meteorological data collection, processing, visualisation and distribution activities, focusing on agro-meteorology, hydro-meteorology and hydrographics.
- Experience Africa: Strong presence in Africa with well documented long-term cooperation with Met Offices, Ministries and international organisations such as UNDP, World Bank (WB) and World Food Program (WFP). Focus on hardware and software e.g. installing stations. https://www.preventionweb.net/organizations/15689/profile
- Morocco, Egypt, Mauretania, Burkina Faso, Ethiopia, Kenia, Madagascar, Uganda, Rwanda, Burundi, Ghana, Guinea, Senegal, Liberia, Angola, Zimbabwe, Zambia Namibia and South Africa.
- Agronomy: have some tools like GDD (growing degree days).

Agrics-Geodatics

At agrics.org:

- Main business: The Agrics business model is based on the integration of products and services for smallholder farmers. The exact combination of products and services offered follows customer demand as well as local conditions and may vary between countries. Agrics generates revenue by procuring inputs in large quantities and selling them, on credit, with a target gross margin above 30%. Focus on effective credit management processes and strong customer relations have translated in credit repayment rates of up to 95%. Farmers are geotagged and by using a range of earth observation info combined with crop growth models they predict realistic yields and tailored fertiliser recommendations. They work with fertiliser companies to create customised blends and provide fertilisers with input credit. Follow-up with weather-based fertiliser management recommendations. Weather forecasts come from CROPMON.
- Agronomy: Tailored fertiliser recommendations and weather forecast via CROPMON.
- Experience Africa:
  - Kenya (20,000 farmers in Western Kenya).

AgroCares

At www.agrocares.com/en:

- Main business: SoilCares hand-held testing device provides in-field monitoring of soil nutrients via a smart-phone app and hand-held printer. Smart-phone app delivers soil fertility assessment and management advice including target yield, soil status, actual nutrient need, soil correction plan and suitable crop types. Supports B2B clients to integrate soil data into their advisory services. AgroCares is aiming to bundle the services with other products or to make the service part of a larger project or program. In the latter category, the company has teamed up with New Down Town Ltd, a Kenyan agro-chemicals and farm inputs company that has on-the-ground presence and also provides farm advisory services to farmers. The inputs company had an interest in improving their fertiliser recommendations to farmers, now using AgroCares services to help their farmer clients to improve yields and quality.
- Agronomy: fertiliser recommendations and crop type advise
- Experience Africa:
  - Kenya (20,000 users).

Africa Weather

At www.africaweather.com:

- Main business: Africa Weather (formerly known as WeatherSA) is a weather company based in South Africa offering weather risk management solutions in Africa. Services include real time storm tracking, lightening and storm warnings, detailed hyper-local forecasts up to seven days in advance. They also offer an online weather portal linked to automated weather stations (Campbell Scientific Weather Stations through a 2-year operating lease to its clients for hyper-local weather prediction) that are installed and operated at clients' sites. Africa Weather's products for South Africa come directly from the South African Weather Service (SAWS), the mandated national meteorological service. They selected the European Centre for Medium-Range Weather Forecasts (ECMWF) as a supplier for African forecasts, storm tracking via EUMETSAT. Africa Weather functions as a for-profit company which has a diverse portfolio of clients. They offer a free app with free content as well as paid-for packages. They cater to media with range of products from a 7-day forecast for one city in one country for R100 per month (7 USD/month) to 7-day forecasts for all cities in the country for R4815 (352 USD/month). Africa Weather targets:
  - the golfing business with a Lightning Warning System and Online portal
  - the logistics and mining industry with AfricaWeather RailGuard providing real-time weather.
  - insurance companies with severe weather and hail notification and verifying damage
- Agronomy: No evidence found for agro-meteo services.
- Experience Africa: focus on south-Africa but are also serving the African continent.

Apollo Agriculture

At www.apolloagriculture.com:

- Main business: Agricultural fintech company that helps small-scale farmers maximise their profits. Apollo Agriculture provides bundled input financing to small-scale farmers. Apollo builds credit profiles for unbanked smallholders using machine learning models that process large volumes of customer data, including satellite data of customers fields. To reduce the cost of reaching and financing farmers and enable rapid scale, they have built automated operations that overcome the need for expensive, manual processes. For instance, over the course of the season, Apollo customers receive guidance on farming techniques through highly engaging automated "IVR" phone calls, delivered to customers feature (non-smart) phones as a pre-recorded phone call. This IVR platform is one example of how Apollo's digital approach allows them to dynamically engage with customers, regardless of literacy levels and remote locations. Goal is to enable the transition from subsistence to commercial farming.
- Agronomy: farmer technique advices, no climate data
- Experience Africa:
  - Kenya (1 county in 2017 to 9 in 2019).

Arifu

At www.arifu.com:

- Main business: Arifu is a chatbot platform for engaging, training, and capturing insights on important and hard-to-reach audiences over basic and smartphones. With the Arifu Platform, users can access a growing collection of interactive educational content for licensing or have in-house education experts design users custom content offering.
  Work together with:
  - Mercy Corps' AgriFin Accelerate program.
  - DigiFarm product (designed for Safaricom) that bundles discounted inputs, farmer learning, input financing and other complementary value-added service.
- Agronomy: via other initiatives (Arifu provides platform), no evidence that they have their own service.
- Experience Africa:
  - Kenya, Senegal, Tanzania, Zambia, Rwanda. Agriculture content reaching 1,000,000 farmers across partners, including DigiFarm, Equity Bank and KCB in Kenya.

aWhere

At www.awhere.com:

- Main business: Provide actionable, field-level weather and agronomic information to agribusiness. They also provide information to investors on agriculture commodities to enable them to make informed purchasing and hedging decisions to reduce exposure. Governments and NGOs are provided tools and information to help manage food security and agricultural production, with information often shared with smallholder farmers via SMS. Data method and QC:
  - Combining the granularity of weather stations with the coverage of satellite to generate virtual weather stations. Seem to use GFS forecast?
  - Compares with neighbouring station and satellite data (e.g. CHIRPS) to clean data
  - Use provider and client feedback from the field
- Agronomy: aWhere's Advanced Agricultural Information include agronomically relevant values such as GDDs, PET, P/PET, along with comparisons to historical data. Offers Agricultural Insight products for field-specific, scientifically-vetted agronomic models to identify plant growth stages, maturity tracking and harvest readiness, pest and disease likelihood, and crop stress.
- Experience Africa:
  - Partnered with local organisations in developing countries to organise the Hack4Farming hackathon.
  - Partner in a consortium led by the Technical Centre for Agricultural and Rural Cooperation (CTA) to implement a project to harness ICTs to supply extension advice in Uganda.
  - Involved in numerous USAID, World Bank and Bill and Melinda Gates Foundation initiatives, recently completing a multi-year Gates Foundation project to engage specifically with ICT4Ag information services. See https://www.awhere.com/category/case-studies/.
  - Making agronomic and weather data available to farmers through intermediaries such as research centres, governments, information companies, mobile network operators and non-profit organisations which can integrate the data into their own information systems:
    - Esoko
    - iShamba
  - Partnership with the CGIAR Platform for Big Data in Agriculture to open climate data for analysts to analyse weather trends and provide timely advice to farmers and to policymakers looking to make strategic climate change adaptive investments. In-country agricultural researchers use their data in their models and workflows to make the best possible recommendations to farmers.
  - Use Apigee API Management Platform https://cloud.google.com/customers/awhere.
  - Partnership with the World Bank called the Agricultural Intelligence Observatory. The Ag Observatory is tasked with getting robust agricultural meteorological data into the hands of people across Sub-Saharan Africa. aWhere provides weather data with an agronomic focus and insights to governments, non-profits, and farmers who need to know when to plant or when the conditions might be conducive to pests or disease. The Ag Observatory teaches agronomists, meteorologists, and data analysts, mainly from the public sector, how to integrate this data into their reports. National organisations often create advisories which are sent out to farmers in countries that are struggling with extreme weather variability. The Ag Observatory project provides technical trainings on key open source programming and geospatial tools (R and QGIS). aWhere provides trainees access to its API, which is often the first time they've used one. Trainees also learn to access the developer portal where they become active participants in the community forum.
  - Active in Ethiopia according to Mercy Corps.

Climacell

At www.climacell.co:

- Main business: USA based weather company providing weather data – historical, real time, and forecast – globally and work with clients to give insights of how weather will impact the business.
- Agronomy: initiative on early warning of locusts.
- Experience Africa:
  - Established a new, independent non-profit organisation (ClimaCell.org; 2019) whose sole focus will be bringing MicroWeather Solutions to areas currently underserved by traditional means. Beginning in East Africa and working together with local governments, NGOs and local communities, ClimaCell's initiative aims to facilitate the rapid and collaborative implementation of novel technological approaches, and adoption of critical weather warnings and insights. First, the company will use its method for building a dense network of observation points, including virtual sensor network, satellite data, and ground-truth weather stations. Then, ClimaCell will generate

timely insights that can be used in real time via highly adaptable, proprietary, cloud-based high-resolution weather models. To maximise access, ClimaCell technology can quickly disseminate weather information via computer, radio, and mobile devices. The company will seek to build capacity for weather monitoring and forecasting in African countries such as Uganda and Kenya, including through partnerships with national meteorological agencies. Climacell state that western initiatives fail to close a crucial loop: working with local weather agencies to make sure weather and climate information goes from the computer model stage to the village and farmer level.

Climate Edge

At www.climate-edge.com:

- Main business: Based in the UK. Climate Edge works with agricultural service providers to make their services accessible to thousands of smallholder farmers using Climate Edge's Marketplace infrastructure. Broker connects agri-service provider to farmer or farmer organisations. Claims to offer simple data integration, growing network, invoicing etc. for service providers.
- Active in cash crops like tea, coffee, bananas and cocoa. Weather Impact provides state of the art weather forecast via API which they deliver to farmers as an SMS.
- Agronomy: Work with third parties like Cranfield University on irrigation and James Hutton Institute (potato late blight). For example, SMS irrigation schedule for smallholder Banana Farmers in Colombia.
- Experience Africa: Kenya (Nandi region, tea with Cranfield University and Sireet Tea Cooperative).

Cropin

At www.cropin.com:

- Main business: CropIn (Indian) Smartfarm is a farm management solution also serving buyers and aggregators by profiling and monitoring the farmer and fields. They are digitizing every farm, while data-managing the entire ecosystem. Simplified data gathering through a smartphone app that records activities & milestones. Ensuring efficient operations, lower costs and better visibility. Real-time actionable insights enable farm management companies to take planned & responsive business decisions. CropIn has raised $12 million funding (dd 2019), including BEENEXT, $8 million from the Bill and Melinda Gates Foundation Strategic Investment Fund (London & Seattle) and Chiratae Vent.
- Agronomy: services such as:
  - Alert Log & Management (pest infestation, diseases etc.).
  - Satellite and weather input based advisory. Weather taken via collaboration with IBM.
- Experience Africa:
  - In Ghana with Rainforest Alliance on management and monitoring cocoa crops.
  - In Nigeria on monitoring and yield prediction of sorghum.
  - In Mozambique on digitizing cashew and cotton farmers and sending them weather-based advisory.[12]
  - In Mozambique on chain traceability and advisory on weather risks and pest infestations and crop diseases.

CROPMON

At www.agrocares.com/en/cropmon:

- Main business: Dutch G4AW funded project with objective to develop sustainable business around an agro-weather advisory service based on geotagged location of farms. Leverages international partners for weather (Weather Impact) / crop monitoring data / data analytics. Management advice based on crop growth model utilizing satellite data which does not determine cause. Project closed in August 2019. Partners continue to work together with support from 2SCALE to find a clear pathway to a sustainable business model.
- Agronomy: Information about crop condition, farm management advice, and a local 7-day forecast of temperatures and rainfall via SMS.
- Experience Africa:
  - Kenya (April 2019: 20,000 farmers received 2 SMS/week weather and advisory; 50,000 received 1 SMS/week weather. August 2019: Project reported reaching 200,000 farmers).

[12] https://www.cropin.com/smartfarm/

DigiFarm – Safaricom/Mezzanine W

At www.safaricom.co.ke/business/digifarm:

- Main business: DigiFarm is an integrated mobile platform that offers farmers convenient, one-stop access to a suite of products, including financial and credit services, quality farm products and customised information on farming best practices. DigiFarm helps agribusinesses and small holding farmers share information and transact more easily. Addressing the following gaps:
  - Knowledge on best farming practices
  - Quality inputs
  - Access to financial services – credit & insurance
  - Access to markets

  DigiFarm (created through a partnership with mobile solutions provider Mezzanine) offers an easy-to-use, text-based service to Kenya's smallholder farmers. Farmers register on the platform and record details about the size of their farms and the nature of their farming activities. This information is then used to ensure that farmers receive support relevant to their specific farming activities. Once registered on the platform, farmers have access via mobile phone to a host of agricultural and financial services that the ecosystem offers. Over 1 million farmers have subscribed to the platform with more than 300,000 of whom are 30-day active customers. DigiFarm has also opened 144 depots around the country to enable farmer's access to quality inputs. Has link with Arifu. No evidence found on weather services but partners with aWhere. Also partners with NASA (remote sensing) and KALRO.
- Agronomy: Information about livestock and crops and learn about farming best practices.
- Experience Africa: Kenya. AgriFin Digital Farmer Program (ADF) of Mercy Corps AgriFin (AFA) program, funded by the Bill & Melinda Gates Foundation, support the development/design.

Digital Green

At www.digitalgreen.org:

- Main business: A global development organization from India that work with grassroots partners to create digital solutions for rural communities. Funded by Bill and Melinda Gates Foundation, DFID and USAID and many others (www.digitalgreen.org/partners). Tools:
  - Videos (6,000 locally relevant videos, in 50 languages)
  - Coco (Connect Online Connect Offline) and the Analytics Dashboard allow users to collect and visualise crucial insights.
  - Training Courseware: curriculum combines instructional videos and a mobile app to train trainers.
  - FarmStack:
    - Integrate Farm Data in secure manner
    - Combines information such as weather forecasts, market prices, soil health, irrigation availability – with in-built mechanisms to push advisories to farmers across multiple channels (e.g. face-to-face, video, IVR, SMS, radio)
    - Integrating Market Services
    - Connects public, private and civil society partners across the value chain to improve farmers' access to inputs and markets
- Agronomy: Farmstack – see above
- Experience Africa:
  - Prototyping use cases to farmers either directly or via extension service providers in Ethiopia (support wheat and dairy farmers).

DTN

At www.dtn.com:

- Main business: Around the world, farmers and the agribusinesses rely on DTN to provide expert analysis of commodity markets; hyper-local weather and disease insights to guide planting, growing and harvesting operations.
- Agronomy: Ag Weather Tools / Agronomic Insights provide:
  - Field specific forecasts
  - Customised alerts
  - Pest and disease alerts
  - 72-hour spray outlook
  - Growth Stage Models

- Sentinel Imagery

  Acquired ClearAg company (docs.clearag.com). Leverages its own proprietary weather station network alongside ClearAg's predictive agronomic solutions deliver insights in agriculture today. ClearAg, provides weather data for many of the agricultural decision support systems available to farmers around the world, including the UK. It is used by Bayer Crop Science, BASF, Hutchinson's' Omnia and Origin Enterprises' Rhiza platform among others. They offer several services (APIs):
  - Crop Growth & Health
  - Irrigation Decision Support
  - Soil Conditions
  - Spray Conditions
  - Field Accessibility
- Experience Africa: No evidence found, possibly via AgroGEO (http://site.geoagro.com/en) in South Africa. It seems DTNs ClearAg is aiming at larger farmers and businesses.

Earth Networks

At www.earthnetworks.com:

- Main business: operate weather observation and lightning networks around the globe and provide a range of value-added weather and environmental services in over 90 countries. Install & maintain own station network.
- Agronomy: no evidence for agronomy related services.
- Experience Africa:
  - In 2013, Earth Networks supported the development of the first Early Warning System for severe weather in Guinea, in partnership with the local NMS and Cellcom Guinea.
  - Earth Networks also has a presence in Uganda through the Global Climate Resilient Partnership.
  - Partnership with INAM Mozambique (2018) to scale up live storm monitoring, lightning detection and real-time observations that will power life-saving weather forecasting and alerting services across the country.
  - Partnership with the Regional Integrated Multi-Hazard Early Warning System for Africa and Asia (RIMES). Enhance NMHS capacity for early warning of severe weather.
  - Business models: In Africa (25 Sub-Saharan African countries), they help develop the business models and revenue streams of African NMHSs by building their capacities to improve the process of collecting information from observation networks and disseminating this information to the private sector and developing and selling weather products that can generate revenue. The profits of these sales are shared with the NMHS, thereby creating an additional revenue stream for the NMH.
  - Severe weather warning e.g. lightning, thunderstorms. No evidence on agro-meteo service.

Econet Wireless

At www.econet.co.zw:

- Main business: Market-leading telecommunications provider EcoNet Wireless is packaging and distributing information such as farming tips, health advice, weather information and mobile banking options to engage with rural customers, build brand loyalty, and support the overall image of the company. The company has launched feature phone-enabled subset brands, such as EcoCash, EcoHealth, EcoSchool and EcoFarmer. It also includes micro-insurance product designed to insure inputs and crops against drought or excessive rainfall. Ecofarmer Combo programme with three levels: General Farmers (very basic information for free), Registered Farmers (they provide some information (a monetizable asset for telecommunications firms) and receive expanded information) and Insured Farmers (receive all the information, plus a supporting insurance policy).
- Agronomy: weather information and farming tips
- Experience Africa:
  - Zimbabwe (80,000 communal farmers).

Eprod

At www.eprod-solutions.com:

- Main business: Kenya based. Solutions for advanced supplier management system (ERP = Enterprise Resource Planning) including:
  - Create comprehensive farmer profiles.

- Improve the productivity of farmers.
- Manage finances and farmer transactions.
- Offers an affordable ERP to manage agricultural supply chains. It assists buyers to organise buyers to register farmer and their fields, conduct field inspections, collections, traceability, payments, training programs etc. Company size 11-50 employees; B2B; privately held, founded 2015, CEO: Almut van Casteren.

- Agronomy: no evidence found.
- Experience Africa:
  - Ethiopia, Kenya, Malawi, Nigeria, Rwanda, Tanzania, United Republic of, Uganda.

Esoko

At esoko.com:

- Main business: Social enterprise established in 2008. Provides a suite of applications (mainly B2B) that a network can use to push and pull information to targeted and profiled users. Push market prices out to farmers via SMS alerts. Targets agribusinesses, smallholder farmers, network operators, NGOs, and ministries. Today the platform is referred to as the "Facebook for farmers" and provides weather forecasts (sourced from aWhere), agricultural tips, crop calendars and market prices and a platform where farmers can share knowledge and localised information. Today Esoko provides two key services:
  - Data collection: Insyt – an off-grid data collection service targeted at social protection and agricultural value chain profiling and mapping- and information services including CIS, market information and agronomic advisory service
  - Profiling: Greencard registry which is a centralised registry linking profiled farmers to a variety of services such as CIS, inputs, insurance

  A spin off, Tulaa (new mobile commerce business), enables farmers to access inputs, finance, information and markets in a virtual marketplace. Headquartered in Kenya, Tulaa focuses on growing its market share in Ghana and Kenya initially and eventually expanding into other markets.
- Agronomy: Provide extension advice. Good agronomic practices and crop protocols of 50+ crop. Push services. Channels include SMS, voice SMS, IVR and call centre in over 14 local languages.
- Experience Africa: Ghana, Tanzania, Burkina Faso and Zimbabwe:
  - Ghana: 300,000 farmers (21% women) served to receive climate information services and market alerts, out of this, 274,321 farmers are paying USD 0.20 for the service. Partnership: companies (Toto agric. and aWhere, Vodafone Ghana) and public institutions (GMet, the Council Scientific and Industrial Research - CSIR, the Ministry of Food and Agriculture - MoFA) and farmers.

Farm.ink

At farm.ink:

- Main business: Digital training platform for farmers, coupled with a platform for farmers to join together and form trusted networks. Use Learn.ink, a digital learning, to make it as simple as possible to get training content online and in the hands of target users. Since 2017 Farm.ink built an active online community of over 120,000 farmers and used machine-learning classifiers to turn their unstructured social feed into actionable insights. They combined these insights with content and data from the International Livestock Research Institute (ILRI) to deliver tailored information back to livestock farmers through a mobile chatbot service. They are expanding to include maize (with a focus on the recent outbreak of Fall Armyworm) as well as common horticulture crops such as tomato. Farm.ink team came up with a sub-brand 'Africa Farmers Club' in 2017, which included the effort to setup a Facebook group which has over 120,000 members across 17 African countries. Farmers use this group to ask questions, share advice and experiences. All this work was enabled by both DFID and CGIAR support. The success of the Africa Farmers Club group led to the Africa Farmers Club chatbot. Through the chatbot farmers can search over 300,000 farmer-generated questions and answers and get timely, actionable notifications delivered to their phones. No mentioning of use of weather data.
- Agronomy: Creating a link between farmers and the agronomic & technical knowledge across the wide range of organisations under CGIAR.
- Experience Africa: At least Kenya.

FarmAfrica

At https://www.farmafrica.org:

- Main business: Farm Africa is an NGO focused on rural Africa, specifically farmers to increase their harvests, build their incomes and sustain natural resources. FarmAfrica partners with governments and the private sector and work closely with local communities mainly on a project basis (workshops, trainings). Staff are from the local area, can speak the local language and have an understanding of the local context.
- Agronomy: Helps farmers in growing the most appropriate and profitable crops. Help farmers prevent pests and act as a bridge with suppliers (gain access to the high-quality seed and fertilisers, warehouses to store crops and the vaccines to protect animals)
- Experience Africa:
  - Ethiopia (most activities), DRC, Kenya, Uganda, Tanzania.

Farmer Field Schools

At www.fao.org/farmer-field-schools/overview/en:

- Main business: Farmer Field School (FFS) is an approach based on people-centred learning. Participatory methods to create an environment conducive to learning: the participants can exchange knowledge and experience in a risk-free setting. Practical field exercises using direct observation, discussion and decision making encourage learning--by--doing. Claim to have improved skills of over 4 million farmers, pastoralists and fisher folks in the world.
- Agronomy: Hands-on learning & training, knowledge transfer (workshops, field visits). Several initiatives on Fall armyworm, integrated pest management etc. No on-line apps but the global farmer field school platform team is working hand in hand with FAOs e-learning academy to produce an e-learning course for project formulators, field staff and FFS specialists, to support the understanding and formulation of quality FFS programmes (thus for organizing FFS).
- Experience Africa:
  - Present in East, West and South Africa.

FarmBeats

At https://www.microsoft.com/en-us/research/project/farmbeats-iot-agriculture:

- Main business: The goal of FarmBeats is to augment farmers' knowledge and intuition about their own farm with data and data-driven insights. The idea behind FarmBeats is to take in data from a wide variety of sources, including sensors, satellites, drones and weather stations, and then turn that into actionable intelligence for farmers (e.g. decisions on pest management etc.), using AI and machine learning. Sensors, drones, and the like connect to the base station (connected to farmer's home internet connection), which draws power from a battery-backed solar panel pack.
- Agronomy: Example of advanced precision agriculture and proxy for others like John Deere and Monsanto
- Experience Africa:
  - Not found.

Farmforce

At farmforce.com:

- Main business: Supply a digital solution to secure sustainable sourcing. Farmforce is a cloud-based mobile platform that extends digital management to the agricultural "first mile" and specifically to the management of smallholder farming schemes. Farmforce uses mobile technology to replace existing paper-based processes and thereby provide traceability to the field level, increase management information and transparency, document compliance with any food and sustainability standards (FairTrade, Rainforest Alliance, Organic) and simplify audits. Supported by: Norad, Syngenta foundation, Clinton foundation etc.; used by e.g. Cargill.
- Agronomy: Farmforce provides the management information required to organise growing activities, but at the same time provides all the documentation, traceability, and compliance with the required standards for buyers/aggregators. Farmforce's software isn't a tool directly in the hands of farmers, although they can communicate and receive information from the service via SMS.
- Experience Africa: Active in many countries.

Farmerline

At farmerline.co:

- Main business: Ghana based. Social enterprise seeking to leverage technology and data to transform millions of farmers into successful entrepreneurs. Mergdata (mergdata.com), its innovative information product delivers good agricultural practices, weather reports (location-specific weather information, also delivered in their local languages; sourced from about 80 weather stations across the country, ensuring accurate prediction), and market information systems for nine crops to farmers. Farmers services:
  - Digital identity & financial records
  - Farmer training & behaviour change (see agronomy)
  - Information access (only weather)
  - Inputs on credit
  - Efficient distribution on inputs

  B2B:
  - Engagement Platform Powered by Mergdata
  - Know your farmer
  - Conduct Certification Audits
- Agronomy:
  - Workshops: field officers conduct weekly community-based workshops to train farmers on improved farming practices and better business practices. Using digital mediums such as voice calls and talking books in local language to bridge the illiteracy gap.
  - The CocoaLink (also financed by Hershey Company) mobile app features weather information and free courses and quizzes on climate smart agriculture and income diversification. It also features access to finance, discounts on agro-inputs and social media linkages. Content has been integrated through partners such as World Cocoa Foundation's industry-recognised Climate Smart Cocoa program.
- Experience Africa: Reaching over 200,000 farmers across 11 countries in Africa: Ghana, Ivory Coast, Benin, Sierra Leone, Cameroon, Mozambique, Malawi, Kenya, Uganda, Nigeria and Tunisia.

FarmRadio

At farmradio.org:

- Main business: Canada based non-profit focused on using radio to strengthen African farming communities. Offer:
  - Resources and training to improve rural radio programs
  - Run targeted projects that use radio to get results at scale.

  Work with a range of knowledge partners such as agricultural research institutions, government extension officers and farmers' organizations to identify priority issues, gather useful information and monitor radio programs for quality and accuracy.
- Agronomy: through partners
- Experience Africa:
  - Burkina Faso, Ethiopia, Ghana, Kenya, Malawi, Mali, Mozambique, Nigeria, Senegal, Tanzania and Uganda. Plus, broadcasting partners in other countries.

Hershey Company

A www.thehersheycompany.com:

- Main business: Food company. Launched Cocoa for Good program, a comprehensive cocoa sustainability strategy designed to address the most pressing issues facing cocoa-growing communities: poverty, poor nutrition, at-risk youth and vulnerable ecosystems. To help thousands of farmers in West Africa.
- Agronomy: GAP & weather information focused on cocoa.
- Experience Africa: Partnership with the World Cocoa Foundation, the Ghana Cocoa Board and FarmerLine, Hershey reached over 50,000 farmers in over 1,200 communities with SMS and voice messaging (CocaoLink) on good agricultural practices. Plus, interactive mobile application and voice messaging to deliver both agronomic advice and weather information to cocoa farmers and agricultural extension agents in Ghana. CocoaLink will be introduced in Cote d'Ivoire by end 2020 through a similar public-private partnership mode.

IBM/The Weather Company

At https://www.ibm.com/weather:

- Main business: The company offers its forecasts globally, with personalised and actionable weather data and analysis. Delivers 25 billion forecasts daily and has a network of 250,000 personal weather stations. Their customer base includes aviation, insurance, energy, and media and several other industries. They draw from several numerical weather prediction models and also from IBM's own proprietary Deep Thunder model. Their models also use data from surface observations, precipitation, radar, satellite, personal weather stations, lightning sources and data collected from planes daily. Recently PAIRS was launched. It is a platform, specifically designed for massive geospatial-temporal data (maps, satellite, weather, drone, IoT), query and analytics services. It frees up data scientists, developers from the processes that dominate conventional data preparation and provides search-friendly access to a rich, diverse, and growing catalogue of continually updated geospatial-temporal information.
- Agronomy: No evidence found, mainly focused on weather.
- Experience Africa: Partnered with the Trans-African Hydro-Meteorological Observatory (TAHMO) to deploy more than 300 personal weather stations across Kenya, Nigeria, and various other African nations, in close cooperation with NMS. Discussed partnership with the Kenya Met Department to offer information to small farmers in one region of the country, tailored to specific crops.

iCow

At icow.co.ke:

- Main business: Service has an extensive value chain specific learning content. Soil and seed recommendation based on farmer location (county/constituency). Farmers can access a list of service providers based on location. Interactive platform for responding to farmer queries. Does not provide weather forecasts. No back-end data-analytics. Report that 90% of users used some content, 60% changed a behaviour. Connect farmers to the vital players in their agricultural ecosystem. These include input providers, agricultural financial service providers, veterinary experts, agricultural extension service providers, NGO's, Govt and more. Services:
  - Value Chain Advisory: Full season advice by crop; seed variety recommendation for maize/potatoes based on county
  - Soil Management: Soil type by sub-county but not linked to advice; info on locally available soil testing services
  - Pests & Disease: Farmers query based on symptoms and get automated management advice for tomato and maize pest and disease.

  It is designed for the most basic feature phones and is available in different languages depending on the county of deployment. Partner with Safaricom, USAID, Accenture AG, Elea Foundation, Infonet biovision and the indigo trust.
- Agronomy: Soil, seed and pest management recommendation based on farmer location
- Experience Africa:
  - Kenya (95,992 active users) and Tanzania (unknown).

Ignitia

At https:/www.ignitia.se:

- Main business: Ignitia's flagship product is a 48-hour forecast message, delivered daily via SMS (simplistic text format - English and focused on just a few keywords), directly to the subscribers phone (*coordinates of the most common location of the subscriber during daytime and matched to the forecast category at the closest model grid points*). The forecasts also feature monthly and seasonal predictions and detail the likelihood, timing and intensity of the weather. Subscription to Ignitia's service is around $0.04 a day. High satisfaction resulted in strong customer retention. To date, daily subscribers to exceed 900,000 in Ghana, Mali and Nigeria. Works with six mobile network operators (MNOs - through a revenue share agreement), giving them access to over 100 million subscribers and 50 percent of the mobile lines in the three countries. At the core, a special high-resolution (3-9 km) edition of the research version of the WRF model has been developed specifically for the tropics. USP is that no smartphone or app. download is required. Partnered with Hack VC, FINCA Ventures and Norrsken Foundation. Ignitia also partners with international agriculture and development partners (FAO, WFP, USAID, GIZ) to test and iterate its product and to enter new markets.

- Agronomy: recent product (Ojo) geared towards agricultural input suppliers (B2B). They can buy Ignitia's weather forecasting service and bundle it with their input product to make it more attractive for farmers.
- Experience Africa: Ghana, Mali, Nigeria, Cote d'Ivoire, Niger, Senegal, and Burkina Faso.

iShamba

At ishamba.com:

- Main business: iShamba is a program of the Mediae company. It is a call centre of agricultural experts where a farmer can SMS in questions or call in to speak to an expert for instant help. Once a farmer signs up, (s)he will also receive agri-tips on crop and livestock, market prices and weather updates. iShamba links users to farm input companies and service providers, from whom can get discounts on sales. Farmer receives weekly weather forecast including rainfall expectation for the area. The farmer who has subscribed is also able to get agronomy tip text messages aligned to the season in his region. This enables the farmer to get to know exactly when the expected harvest for their crops and which pest and disease to look out for. Plans: freemium and premium (900 KSH per year includes weekly, monthly and seasonal weather updates agri-tips on 4 commodities). Get its data on weather forecasts from aWhere and seasonal county forecasts from Kenya Meteorological Department, while the market prices come from the Kenyan Government body National Farmers Information Service (NAFIS). Popular via farm makeover TV show: Shamba Shape Up.
- Agronomy: farmer support via SMS and call centre, agri-tips, weather forecast
- Experience Africa:
  - Kenya. According Mercy Corps iShamba is active in 48 countries but there is only content on Kenya (300,000 farmers).

KAOP

At www.kaop.co.ke:

- Main business: KAOP (Kenya Agricultural Observatory Platform) creates valuable insights for farmers through weather, agronomics and analytics. Partners are the World Bank, KCSAP (Kenya Climate Smart Agriculture Project), KMD (in collaboration with aWhere) and KALRO. Provides:
  - Weather forecasts: real time and historical records of all relevant weather variables including short-term weather forecasts
  - Agronomic advisory: right information to monitor and predict the current situation
  - Agricultural insights: actionable information and predictions to make better decisions

  Part of larger initiative (World bank, 100 million U.S. dollar) e.g. striving to a platform that will aggregate field and farm level data into mapping information that provide insight in addressing where it rained, where crops failed and how many people were impacted
- Agronomy: Seems to give only general agronomy advices (based on info found on the portal)
- Experience Africa:
  - Kenya.
  - Ambition to extend to Ethiopia.

M-Farm

At mfarm.co.ke:

- Main business: MFarm is a digital platform offering market price information for various agri-commodities, weather data and provides a platform for farmers to sell their agri-produce and connect with other farmers and agribusinesses. The information service is available on a subscription basis for 6 and 12 months. Funding USD 235K (Ksh1 million an information technology competition organised by an organisation from Estonia); Investors: Safaricom Foundation, Novastar Ventures, 88mp. Blog is outdated -> latest news from 2016.
- Agronomy: they are planning a new service: Plant wisely. Step by step guide on how to plant crop and reach optimum production.
- Experience Africa:
  - Kenya.

M-Shamba

At www.m-shamba.net:

- Main business: M-shamba is one of the pioneering Agritech social enterprises in Africa. M-shamba is an interactive platform that provides up to date information to farmers, about the agricultural activities they undertake or wish to partake, helps farmers manage their farms efficiently and connects farmers and traders to potential markets using various features of a mobile phone. Means:
  - Interactive Voice Service
  - Virtual Call Centre
  - Interactive SMS
- Agronomy: Broadcast short messages on agronomy, weather forecast (Kenya Meteorological Department), climate change adaptation. Farmer enters dates of specific events into an automated database, and then receive push notifications to remind them when to plant, weed and apply pesticides.
- Experience Africa:
  - Subscriber base of 12,000 farmers in Kenya and another 4,000 in Uganda.
  - For example, helped over 6,000 rice farmers in Kenya to adopt new rice farming technology called System Rice Intensification (SRI).

Manobi SA

At www.manobi.com:

- Main business: Catalogue of integrated services that enable major operators (states, international NGOs, development aid agencies, large companies...) to rapidly deploy services in the field:
  - Producers listing and precise georeferencing of their plots.
  - Marketplace (offers and demands) between large and small producers and traders, buyers, importers.
  - Price monitoring.
  - Agricultural information: epidemic alerts, weather forecast, yields.
  - Collaborative platform for cooperatives, associations, etc.
  - Traceability of crops: monitoring agricultural operations step by step over time

  Financing through World Bank, Bill & Melinda Gates Foundation, USAID, LuxDev, UNICEF and WSA. Strong ties with CGIAR. Company size: 11-50 employees. Type: Partnership. Developed by Manobi Africa PLC with technical support from ICRISAT, the CGIAR-CCAFS and the European Union's Horizon 2020 research and innovation program. One initiative jointly done with CGIAR is installing cheap, recyclable IoT rain gauges thus limited to the sole measurement of daily rainfall as the single most important agro-meteorological variable under the tropics. They see this as the next LEGO block of IoT mainstreaming in rural smallholder communities.
- Agronomy:
  - The 'mAgri 2.0' platform is mentioned in the introduction but seems to be outdated. Has a separate site (magri.manobi.com – looks a bit outdated) listing the following services (rolled out in Burkina Faso):
    - Monitoring of plots, crops
    - Choice of the most profitable crops in the different destination markets
    - Management of agricultural interventions, irrigation management
    - Management of investments and input costs.
    - Yield forecast
    - Real-time information on the value of your productions on your local and regional markets.

  Another tool is agCelerant (physical agriculture = physical asset management with digital solutions). It is an advanced value chain orchestration and business development ecosystem connecting smallholders with credit, insurance, input and output markets (e.g. field scale profiling and monitoring. agCelerant (www.agcelerant.com) does not seem to have agronomic services.
- Experience Africa:
  - Manobi SA is in Dakar, Senegal, with branches in West Africa: Mali, Cote d'Ivoire, Benin, Niger, Burkina Faso. Active in 14 African countries.

Manstrat Agricultural Intelligence Solutions

At https://www.manstratais.co.za:

- Main business: Manstrat Agricultural Intelligence Solutions is a South African developer of internet based agricultural decision support systems. Manstrat offers two online resources:
  - AgriSuite NEO: A free app developed and maintained for farmers. The system can be accessed on tablets and smartphones. Guides farmers in making decisions related to animal production, plant production, markets and agricultural infrastructure. See Agronomy section.
  - Extension Suite: An online platform, targeting more professionals working with farmers and provides mechanism to transfer information between Agricultural Research and Extension Services and the farmers that they serve: collecting, collating, interpreting and transforming scientific agricultural related data into useful and user-friendly formats for use by Extension Practitioners and Farmers. Farmers, extension practitioners and advisors can consult experts and use the Extension Suite Online. This tool facilitates easy access to, and the effective dissemination of; agricultural related information and best practices break down informational, geographical and political borders and constraints. Components: Beef Cattle, Vegetables, Infrastructure, Discussions, Environment, Search, Farm Records, Question and Answer, Plant Production, Animal Production, Geographic Information System, Knowledge Base, Farm Information System, Expert Linkage and Support.

  Manstrat partners with governments, private businesses and civil society organizations. All products are supported through an in-house information centre as well as external networks of agricultural experts and information partners. Manstrat is also a key partner Connected Farmer, where Manstrat provides agricultural information and content. It is assumed that revenue streams are generated through the sale and/or subscription to propriety software that Manstrat offers.
- Agronomy: free AgriSuite Online:
  - Crop description (basic production requirements, popular varieties).
  - Production Programme (when and where to plant crops as well as key activities and resources required to grow crops e.g. soil preparation, planting, crop maintenance. Guidelines on growth temperatures, water requirements, fertiliser requirements and the control of pests and diseases, harvesting, disease/pest/weed control and solver).
  - Handling, storage and transport (guidelines on the post-harvest handling, storage and transport of each crop).
  - Processing and Marketing (guidelines on the processing of each crop as well as marketing strategies).
  - No evidence found on weather services except climate watch bulletin updated 2 years ago.
- Experience Africa: South Africa.

MbeguChoice

At www.mbeguchoice.com:

- Main business: MbeguChoice is an online Android app – in other words a tool for farmers, agro-dealers and extension workers to get information on the crop varieties best suited to their area and production goals and plans. Partners are: STAK, Kenya Agriculture and Livestock Research Organization (KALRO), Kenya Plant Health Inspection Service (KEPHIS), KMT, Agri Experience Ltd. The data is gathered from KALRO, KEPHIS and seed companies. All information about suitable agroecological zones has been gathered from breeders and seed companies, based on their testing and knowledge about product performance.
- Agronomy: Crop variety recommendations only. User selects county, ecological zone and crop – and desired maturity, special characteristics and rainy season if desired – and receives variety recommendation. Newest varieties are listed first. No weather information.
- Experience Africa:
  - Kenya (website and app have over 30,000 users).

Mezzanine Ware / DigiFarm / Connected Farmer

At mezzanineware.com:

- Main business: South African-based company, member of the Vodacom group, works with MNO. Via their shared services platform, Helium, they develop cost-effective and scalable solutions for governments, development agencies, multinationals and private businesses in South Africa, Ghana, Nigeria, Mozambique, Zambia, Kenya and Tanzania and with governments in Ethiopia and Uganda to

increase digital benefit to last mile user. Mezzanine offers comprehensive solutions for agribusiness to interact and transact with smallholder farmers in Africa (e.g. dairy industry). Three services:

- DigiFarm: it is a mobile solution which smallholder farmers can efficiently exploit multiple 3rd party products and services. Initially, the service enabled farmers to buy inputs through the M-Pesa mobile money system. It also provided farmers with Push-Agri-learning content, supporting farmers with guidelines on how, when to plant a certain crop, how and when to harvest. Service to buy inputs via an input package loan based on credit scores. Other services include Weather Forecasting, Schedule Management and Animal Health tracker. In the planned final version rollout, farmers will also get access to an online marketplace to sell their produce to buyers. The service is currently being deployed in Kenya with Safaricom supporting its expansion and market penetration.
- Connected Farmer: An agnostic digital platform that improves productivity, revenue and resilience for small scale farmers by connecting them to information, inputs, credit, insurers and buyers at scale. The platform runs on mobile GSM networks and conveniently connects farmers across widely dispersed geographic areas. Connected Farmer is currently being used in Kenya, South Africa, Zambia and Tanzania.
- MyFarmWeb (public.myfarmweb.com): A cloud-based web platform that allows a producer to capture agricultural information, from the ground to the market, into a system that aggregates and calibrates the data to assist in best practice decision-making. This product is a partnership with Agri Technovation and Laeveld Agrochem, companies well known for their expertise and specialised service offerings within the agriculture industry in South Africa. Producers can use the system to measure and record data ranging from soil physical, chemical, and microbial analysis, pest presence, satellite and remote sensing information and data from various internet connected farming sensors like soil moisture probes, vehicle trackers and weather stations, to produce the most profitable yield from the available land and environment under their control. Introduced in several Sub-Sahara African countries.
- Agronomy:
- DigiFarm: provide farmers with Push-Agri-learning content, supporting farmers with guidelines on how, when to plant a certain crop, how and when to harvest etc. Includes weather forecast. Being deployed in Kenya.
- Connected Farmer: did not find evidence on agronomy advices, more aimed at financial trans-actions.
- MyFarmWeb: very complete and sophisticated tool mainly targeting large advanced farmers e.g. growing cash crops.
- Experience Africa:
- DigiFarm: Kenya
- Connected Farmer
  - Private businesses in South Africa, Ghana, Nigeria, Mozambique, Zambia, Kenya and Tanzania and governments in Ethiopia and Uganda
- MyFarmWeb: several Sub-Sahara African countries.

Olam

At https://www.olamgroup.com:

- Main business: Olam International is a leading and the third largest agri-business in the world. Olam is one of the world's largest suppliers of cocoa beans and products, coffee, cotton and rice. Olam is active in most SSA countries. One of Olam's targets on climate change is to reduce the agricultural vulnerability to climate risks of Olam farmers. The company has developed the Olam Farmer Information System ("OFIS"). The software aims to collect and analyze farm gate data to streamline Olam's processes and support farmers. The software also provides services to farmers, including digital financial services and farm development plans. The Farm Development Plan is a module using data uploaded from farm surveys and transaction records and seeks to maximise farm productivity by making key recommendations on fertiliser use, farm rehabilitation, and Good Agricultural Practice support. SMS functionality also allows users to directly contact farmers with information such pricing, weather and agricultural tips. Olam partners with international organizations, research institutions, and local organizations to achieve its Corporate Social Responsibility agenda. Examples:
  - http://www.africancashewinitiative.org

- Africa Cocoa Initiative bringing together WCF, cocoa industry members, the Sustainable Trade Initiative (IDH) and USAID through its Global Development Alliance, in concert with key government institutions in the four countries of Cameroon, Côte d'Ivoire, Ghana and Nigeria. The goal is to institutionalise effective public and private sector models to support sustainable productivity growth and improved food security on diversified cocoa farms in West and Central Africa.

- Agronomy: Olam focusses on Coffee, Cocoa, Dairy, Edible Nuts and Spices. OFIS' Farm Development Plans including key recommendations on fertiliser use, farm rehabilitation, and Good Agricultural Practice support. SMS functionality also allows users to directly contact farmers with information such pricing, weather and agricultural tips.
- Experience Africa: most SSA countries.

One-acre fund

At oneacrefund.org:

- Main business: A nonprofit social enterprise. Supplies smallholder farmers with the financing and training. Invest in farmers to generate a gain in farm income. Offer a complete bundle of services, using a market-based model. Model:
  - Asset-Based Loans. Farmers receive high-quality seeds and fertiliser on credit following a flexible repayment system.
  - Delivery. Deliver inputs to locations within walking distance of every farmer.
  - Training. Farmers receive training throughout the season on modern agricultural techniques.
  - Market Facilitation. Offer crop storage solutions and teach farmers about market fluctuations, so that they can time crop sales to maximise profits.

  Farmers can choose from a range of crops and add-on products in the loan packages: maize, sukuma wiki, beans, and onions, to solar lights, energy-efficient cookstoves, menstrual hygiene products, and crop storage bags and trees and crop insurance. Staff manages several innovation programs, including crop research stations, tree nurseries, test livestock and poultry farms, and **trials around the use of digital technology to support farmers**. Work with governments across Eastern and Southern Africa e.g. in Rwanda partnered to train agricultural extension agents. Building partnerships with e.g. in the microfinance they are a founding member of Propagate, a coalition that's encouraging financial service providers to offer more and better services to farmers. See annual report on supporting organizations (oneacrefund.org/about-us/reports). Have a Dutch Board: Robert Amelung, Cor Oudes and Femke Rotteveel and foundation oneacrefund.nl.
- Agronomy: staff deliver in-field training on best farming practices. And at harvest time, they provide farmers with the tools and knowledge to safely store their harvest and sell during the off-season for significant profit.
- Experience Africa:
  - Kenya (country staff: 2,919; farmers served: 364,000), Burundi (country staff: 808; farmers served: 83,000), Malawi (country staff: 290; farmers served: 15,500), Rwanda (country staff: 1,904; farmers served: 275,000), Tanzania (country staff: 491; farmers served: 50,000) and Uganda (country staff: 256; farmers served: 10,700). Pilot in Nigeria.

PICSA – CGIAR-CCAFS

At ccafs.cgiar.org/participatory-integrated-climate-services-agriculture-picsa#.X3L0HWgzaM-:

- Main business: The PICSA approach (Participatory Integrated Climate Services for Agriculture), developed by University of Reading under supervision of CGIAR, involves agriculture extension staff working with groups of farmers ahead of the agricultural season to firstly analyse historical climate information and use participatory tools to develop and choose crop, livestock and livelihood options best suited to individual farmers' circumstances. Then soon before and during the season extension staff and farmers consider the practical implications of seasonal and short-term forecasts on the plans farmers have made. The project works directly with National Meteorology Agencies, government extension agents and non-governmental organisations.
- Agronomy: targeted training on farm and crop management
- Experience Africa:
  - The project was first piloted in Zimbabwe and then in Tanzania and Kenya. It is now being scaled out in Ghana, as part of the CCAFS supported CASCAID project, Tanzania and Malawi via the Global Framework for Climate Services (GFCS) project and Lesotho via International Fund for Agricultural Development (IFAD).

Precision Agriculture for Development (PAD)

At precisionag.org:

- Main business: PAD is an NGO to support smallholder farmers in developing countries by providing customised information and services that increase productivity, profitability, and environmental sustainability. Introducing a new model for agricultural extension: reaching farmers with personalised agricultural advice through their mobile phones sourcing from innovations in technology and research e.g. mobile soil analysis labs with spectroscopy, satellite and drone photographs, new weather prediction models, widespread mobile phone use facilitates information delivery and collection. They implement this model in collaboration with partner organizations and government. For:
  - Kenya: One Acre Fund, Viamo, Echo Mobile, Innovations for Poverty Action, Busara Center for Behavioral Economics, The Center for Agriculture and Biosciences International (CABI), Ministry of Agriculture (MoA), KALRO, Kenya Meteorological Department (KMD), Kenya Plant Health Inspection Service (KEPHIS), Seed companies, National Potato Council of Kenya
  - Ethiopia: ATA.
  - Rwanda: Tubura (~One Acre Fund)
  - Uganda: CGIAR-IFPRI (Coffee Agronomy Training program (UCAT))
  - Zambia: CABI, MoA (Zambia Integrated Agriculture Management Information System (ZIAMIS), a government-owned e-subsidy platform)

  Operates entirely on philanthropic donations and governmental funds of our partnering countries (see web site).
- Agronomy: Send farmers following services but mainly via the partner organizations:
  - Climate Information Services: Weekly forecasts localised to climatic zones (2 counties in Kenya)
  - Value Chain Advisory: From pre-planting to postharvest. Timing of messages based on location. Maize seed selector based on farmer selected duration and suitability for area.
  - Soil Management: tailored fertiliser recommendations for maize based on amount of land and amount of $ available for fertiliser (4 counties in Kenya).
  - Pests & Disease: Users can assess the extent of FAW infestation on their maize based on sampling 5 spots in their field and then receive advice on whether or not pesticide use is recommended.
- Experience Africa:
  - Ethiopia, Kenya, Rwanda, Uganda, and Zambia. Not clear if all services are rolled out in all these countries. Found mainly info for Kenya. Fall Armyworm 366,000+ farmers; piloting weather forecasts and other advisory services in 2019 cropping seasons.

PRISE-CABI

At https://www.cabi.org/projects/prise-a-pest-risk-information-service:

- Main business: Developed Pest Risk Information Service (PRISE) based on a combination of earth observation technology, satellite positioning and plant-pest lifecycle modelling. PRISE is working to forecast the risk of pest outbreaks and, through Plantwise plant clinics, allows local plant health extension officers to provide farmers with advice on how to protect their crops from a range of pests and diseases such as the Fall armyworm, tuta absoluta and African bollworm. Trying to develop a sustainable business model by selling the service to large-scale producers and agriculture insurance sector. Partners are Assimila (British remote sensing company), King's College London, local extension services, UK Space Agency (donor). Unclear how service will be continued after project end (2021).
- Agronomy: Pest risk forecasting system, messages to farmers via Plantwise plant clinics (https://www.plantwise.org/about-plantwise/plant-clinics) for managing the pest at the right time in the crop and pest stage. County level target.
- Experience Africa:
  - Project implemented in Kenya, Ghana, Zambia, Rwanda and Malawi 2017-2021.
  - Also active in Ethiopia according Mercy Corps.

Proagrica

At proagrica.com:

- Main business: Proagrica is a global provider of independent connectivity and data-driven support solutions for the agriculture industry e.g. seamless supply chain management, supply chain standards compliance, and customer insight and engagement. Proagrica also encompasses performance-boosting farm management software brand Farmplan, and industry-leading media platforms, Farmers Weekly and Boerderij.
- Agronomy: No evidence found of farmer specific agro-meteo service.
- Experience Africa: South Africa.

Tigo Kilimo

At tigo.co.tz:

- Main business: Tigo Kilimo is an agricultural value-added service provided by MNO Tigo in Tanzania. The service offers information for farmers via mobile phone and can be accessed via four mobile channels: USSD, push SMS subscription, IVR and a helpline. Tigo Kilimo provides agronomic tips on 10 major crops (maize, rice, Irish potato, cassava, onions, banana, citrus, sweet potato, tomato and cashew). The app provides market prices and weather forecast information. While it reported a high number of registered users, the IVR channel remains underused, with an average of less than 250 accesses per month, owing to the high costs (at TZS 50 ($0.03) per access). Source: supporting economic transformation, 2020 – platform in agricultural value chains - emergence of new business models.
- Agronomy: Tigo Kilimo provides agronomic tips on 10 major crops (maize, rice, Irish potato, cassava, onions, banana, citrus, sweet potato, tomato and cashew.
- Experience Africa:
  - Tanzania.

Techno Brain – Ulima

At technobraingroup.com / ulima.co:

- Main business: African ICT company with early stage plans with Microsoft, aWhere and Export Trading Group to use intelligent cloud with farm/weather data to give info to farmers to make better decisions globally. In Kenya, Ulima app was rolled out in Kiambu, Nakuru and Lakipia counties. Early stages with limited localised data other than weather forecast but functionality to provide precision recommendations. Will take 2-3 years to reach scale. Piloting a B2C business model charging for 25% of the info/services and providing 75% for free. Ulima is a mobile platform providing access to crop and livestock management information, weather and market price information (via www.emlima.com? (online platform linking farmers to market)), as well as customised crop and livestock calendars.
- Agronomy: Give access to access to crop and livestock management information, weather.
- Experience Africa:
  - Has 14 agronomists in Kenya/S. Africa and precision ag programs in 5 countries in SSA. 30,000 farmers on the Ulima app in Kenya.

Trans-African Hydro-Meteorological Observatory (TAHMO)

At tahmo.org:

- Main business: TAHMO is a public-private consortium (Dutch/USA). TAHMO installs a network of automatic weather stations across Africa. TAHMO leverages the mobile telecommunications platform, crowdsourced technology that is durable and cost-effective (e.g. partnered with METER Group in the co-design of robust weather station), and partnerships with local schools to achieve its goals. Most TAHMO stations are in schools (from primary to university), where a teacher "hosts" the station, and gets free access to TAHMO teaching materials and data from their station. The first station was installed in 2012 and by the end of 2019 500 weather stations are operational in 21 countries. The projection for 2020 is to have 800 stations running and reporting. TAHMO also works on developing better weather stations appropriate for Africa, educating youth on climate change and supporting local entrepreneurs to cover running costs of weather stations. A key partnership is with the USAID, SIDA, the World Bank, and Rockefeller Foundation funded Global Resilience Partnership. TAHMO also works with other development partners and businesses including agreement with IBM / Weather Underground with a major investment to add 333 stations. Data is

free for NMHSs, researchers, and the public. To ensure long-term financial sustainability, TAHMO provides data services to commercial users. Clearly, value chains run from raw data to actionable information. Willingness to pay increases exponentially along that chain. For this reason, TAHMO has become part of a network of entities that bridge the gap between weather station and information market.

- Agronomy:
  - Information services for Rwandan Potato Farmers (ISRPF): TAHMO and Severe Weather Consult, a Rwandan SME, collaborate to inform potato farmers in Rwanda when to spray.
  - The West African Monsoon: false starts and actionable information (TWAMFSAI): With simulations, fed by ground and satellite observations, it is possible to accurately determine whether the ITCZ has indeed shifted and thus whether the actual rainy season has started. This is done by means of TAHMO weather stations and satellite data. This study has the aim to identify the market opportunities and financial feasibility for this service for farmers in Ghana.
  - Cooperation with the Ghana Agricultural Insurance Pool (GAIP). Offers services to local insurers with 'Weather Index-based Crop Micro-Insurance'. GAIP uses data from TAHMO weather stations. If there is a drought during a certain time period and the farm is within 10 kilometres of a certain weather station, the farmer will be paid.
- Experience Africa: 500 weather stations in 22 countries among them: Benin, Burkina Faso, Cameroon, Chad, Democratic Republic of Congo, Ethiopia, Ghana, Kenya, Madagascar, Malawi, Mali, Nigeria, Rwanda, Senegal, South Africa, Tanzania, Togo, and Uganda. In addition, the services in Rwanda and Ghana (see above).

Tulaa

At www.tulaa.io:

- Main business: Marketplace leveling the playing field for smallholder farmers in Africa by providing them with the goods, services and information. Tulaa provides smallholder farmers with quality agricultural inputs on credit (M-PESA) and brokers the sale of their crop at harvest time. Launched in 2017, Tulaa uses mobile technology and artificial intelligence to connect farmers, input suppliers, and buyers in a digital marketplace. Services:
  - Inputs on credits.
  - Advisory services.
  - Market linkage.

  Incubated inside of Esoko and launched in Ghana in 2016. Investors: Global partnerships, beyond capital fund, Acumen, AHL venture partners. Some figures: 2019, 21 000 farmers registered (mainly potato, cabbage), of whom 8 000 applied and 3 300 were approved for loans. In 2019, 410 farmers opted for market linkage services, of whom 75 also received credit from Tulaa. The company sold produce to 171 unique buyers in 2019. Partnerships with input suppliers such as Syngenta, Toyota and OCP. Also, partnerships with banks and MFIs such as KCB, Juhudi Kilimo, Musoni and Rafiki Microfinance.
- Agronomy: using satellite data and artificial intelligence, Tulaa sends tailored agronomic advice to farmers during the crop cycle based on their location, crop and inputs purchased.
- Experience Africa:
  - Kenya and Ghana.

UjuziKilimo

At https://www.ujuzikilimo.com:

- Main business: UjuziKilimo is a Kenya based company delivery services (through data analytics and interactive SMS):
  - Location specific 5-day weather forecast (via aWhere): delivers weather updates tailored to the farm location and provides advice on crop management based on weather variations
  - Farm Specific Advice e.g. fertiliser application based on soil testing (Ujuzi hand-held soil-testing device)
  - Market information.

  Has a partnership with Farmers Pride: provide smallholder farmers with timely and relevant quality Farm inputs at affordable prices through a comprehensive and innovative franchise model of agro-dealers.

Received US$174k support (COVID-19 relief partnership agreement) from Wadson Ventures, an Africa-focused early-stage venture capital house, to extend free access to digital tools to enable farmer support organizations to sustain smallholder farmer operations while fighting the COVID pandemic and making food production systems resilient.
- Agronomy: Location specific weather updates and agronomic advices
- Experience Africa:
  - Kenya (Nyeri and Embu and expanding to Trans-Nzoia and Kakamega May 2019; 10,000+ farmers).

Viamo

At viamo.io:
- Main business: Canadian Viamo (Via Mobile) is a social enterprise created by development professionals and technologists with a deep understanding of mobile technology[13]. Viamo launched and manages the 3-2-1 service, a free, on-demand voice and text based mobile information service that is delivered in partnership with MNOs. Viamo works with NGOs (e.g. Earth Networks) and government ministries to create local content across a range of topics. In detail Viamo is convening working groups, seeking government approval, and packaging the content to reach the customer segments. The service answers the challenge of limited internet accessibility and stubbornly high illiteracy (5 in 10 women in Sub-Saharan Africa cannot read). Content includes weather information, often in relation to emergency preparedness or agriculture. The 3-2-1 service is provided free of cost to the end user. Users access the service via different channels including IVR (Interactive Voice Response), SMS and USSD services. The IVR channel offers access to the richest range of content and is best suited to users with lower literacy levels. Recently, Viamo found that using interactive voice response (IVR) instead of SMS text messages in Ghana resulted in participation rates that were two times higher for women, four times higher for rural populations and ten times higher overall. IVR has the distinct advantage over SMS texts as a medium to reach people as it transcends language and literacy barriers.
- Viamo offers:
  - Full-featured mobile engagement solutions to serve complex programing on IVR, SMS, Apps, Web and IM bots
  - Strategic connections to telecoms to offer special services and guarantee the lowest price, highest reliability, largest scale
- Agronomy: Viamo works with NGOs and government ministries to create local content across a range of topics.
- Experience Africa: The following MNOs are providing 3-2-1 service in each respective country: Orange: Botswana, Mali, Niger; Airtel: Burkina Faso, Uganda, Nigeria, Malawi; MTN: Rwanda, Zambia, Ghana; Vodacom: Tanzania, DRC, and Mozambique. In addition, Viamo is active in Ethiopia, Kenya, Senegal, Zimbabwe and South Africa. Among these countries a subset has weather as an option for calls. This subset at least includes Uganda, Madagascar, Ghana, Mozambique, Nigeria and Burkina Faso.

Waterwatch Cooperative

At waterwatchfoundation.com:
- Main business: Builds a variety of technical precision services into apps depending on client and country/crop context and starting with the clients' needs. The Crop Disease and Tracking Solution (CDAT) smartphone app, which combines weather data, satellite imagery and pictures from farmers to diagnose and track crop disease, is being developed for potatoes in Kenya. The AgriCoach app in Burundi supports farmers with weather forecasts, a Crop Selector (what to plant), Activity Timer (when to implement management practices) and information on how to optimise yield. A Value Chain Advisory app is under development combining services from multiple applications including FinTech solutions. Partners: Satelligence, eLeaf, Vito, Weather Impact, ExtraReality, KALRO, KEPHIS.
  - Agronomy: several apps e.g. CDAT, AgriCoach, Crop Selector, Activity Timer
- Experience Africa:
  - Kenya (potatoes, weather forecast), Burundi (weather forecast – via Weather Impact), Ghana (cacao).

[13] Staff from Human Network International (HNI) joined VIAMO and VIAMO took over the 3-2-1 service.

Yara / IBM

At https://www.yara.com/crop-nutrition/digital-farming:

- Main business: Yara and IBM are working together to deliver a comprehensive global digital farming platform for Yara's clients globally by drawing on the two companies' complementary capabilities: Yara's deep expertise and footprint in the agriculture business and IBM's digital platforms, expertise and services in data analytics, AI, IoT, Blockchain and research. The platform's digital solutions target professional and smallholder farmers and aim to optimise farming practices to increase yields, crop quality and incomes in a sustainable way. First, Yara and IBM will establish joint innovation teams, collaborating at digital hubs in Europe, Singapore, the US and Brazil. The teams will work closely with IBM researchers to develop new capabilities, such as visual analytics and machine learning techniques for crop insights. One specific area of collaboration is on weather data. By merging analytical insights from IBM's Watson Studio, IBM PAIRS technology, The Weather Company and other services, with Yara's crop knowledge and modelling capabilities, the joint platform will provide hyperlocal weather forecasts and real-time actionable recommendations, tailored to the specific needs of individual fields/crops. Yara / IBM also started the Open Farm & Field Data Exchange which aims to bring data together from various players such as farmer associations, industry players, academia and NGOs from the food and agriculture industry to address concrete issues and enable innovation.
- Agronomy: agronomy knowledge of Yara combined with weather data/forecast of the weather company.
- Experience Africa: No evidence found. No digital hub in SSA.

Yielder

At http://www.yielder.org:

- Main business: For-profit company launched in 2018. Provide farmer information and communication platform for dairy and arable crops through the Yielder app. Farmers can pull existing data and information from NGOs, research institutions, and other content providers. Farmers can receive digital trainings. Provides relevant and timely push notifications to farmers based on their profile (region and crop): weather forecast, value chain advisory (market prices and crop production information), basic soil management info, crop specific pest management decision guide/info on important diseases and pests. Free for farmers business model unclear. Funding: LearningStone, MediaHQ, Incentro, Contentful, DalbergResearch, SNV, RabobankFoundation. Partners: Technoserve, FarmAfrica, Hortfresh, WUR, AbelDerks, Biovision Africa Trust
- Agronomy: weather forecast and crop information services
- Experience Africa:
  - Kenya (fully functional app launched in 2019; 6000 direct downloads and 20,000 users).

Yazmi

At yazmi.com:

- Main business: USA based remote sensing company. Collaborates with governments, international development partners and private sector entities (on project basis?) to deliver information about education, health and agriculture to populations in Africa, the Middle East and Asia. Deliver transformative and timely agriculture information to rural communities to increase production and productivity. Claim to provide end-to-end satellite-based solution to seamlessly deliver content, irrespective of the Internet and electric grid.
- Agronomy: Provide agriculture information to rural communities to increase production and productivity.
- Experience Africa:
  - Ethiopia (at least).

ZIAMIS

At appsazambia.org/ziamis:

- Main business: Integrated Agriculture Management Information System (ZIAMIS) aims to effectively distribute farming inputs. Have been developed in line with Zambia's Government's National Development Plan of promoting information and communications technology in the agricultural sector. Developed with support of FAO, implemented by Ministry of Agriculture (MoA), Ministry of Fisheries and Livestock (MoFL) and Smart Zambia Institute (SZI). Background: owing to the success

of the EU-CASU project (Conservation Agriculture Scaling Up) and the FIVMS (Farmer Input Voucher Management System), the GRZ sought to adopt the system as the backbone for the development of the Zambia Integrated Agriculture Management Information System (ZIAMIS), which would include access to e-vouchers and other forms of support, such as e-extension, insurance, crop forecasting, marketing and financial services. Unclear if all have been implemented. See http://www.fao.org/3/cb0806en/CB0806EN.pdf.

- Agronomy: e-extension (not finished due to budget constraints, dd May 2020)
- Experience Africa:
  - Zambia (1.5 million farmers registered).

Annex 2 Detailed description of 4 PPP

Ignitia

- Partners:
  - MNO (MTN, Airtel, and Orange); MNO does the delivery, sign-up and charging for the service.
  - Ignitia: provides 48-hour forecast message.
- Type of partnership (degree of public):
  - Avoid local data / NMI: buying satellite data is cheaper, more flexible, scalable and is independent of local geographical, infrastructure and regulatory conditions. This is particularly important in tropical regions where the geography (e.g. long distances, adverse weather conditions), the local infrastructure and the regulatory environment are more difficult.
  - Mainly private, to what extent Ignitia must deal/co-operate with the public e.g. NMI?
- Overall services:
  - A 48-hour forecast message. The forecasts also feature monthly and seasonal predictions and detail the likelihood, timing and intensity of the weather.
- Level of bundling:
  - Basic initial service is specialised in weather (B2C).
  - But moving towards bundling:
    - Ignitia developed Ojo geared towards agricultural input suppliers (B2B). They can buy Ignitia's weather forecasting service and bundle it with their input product to make it more attractive for farmers.
    - Also partners with international agriculture and development partners (FAO, WFP, USAID, GIZ → Crop2Cash in Nigeria) to test and iterate its product and to enter new markets.
- Way of delivery:
  - Delivered daily via SMS (simplistic text format - English and focused on just a few keywords which illiterate farmers can recognise), directly to the subscribers phone (coordinates of the most common location of the subscriber during daytime and matched to the forecast category at the closest model grid points).
  - Feedback mechanism: no evidence found.
- Details weather provider:
  - Public/Private: private party.
  - Funding:
    - First research funds to develop weather model.
    - Also, USAID was involved
    - Later equity for scaling: $1.1 million Hack VC, FINCA Ventures and Norrsken Foundation for funding.
  - Business model:
    - Revenue share agreement with MNO. Ignitia's pricing model varies from country to country depending, in part, on what the telecom provider's SMS charges to subscribers are.
    - Also sells its forecasting service to NGOs and companies like agricultural suppliers, financial institutions or consumer good companies.

KAOP (Kenya Agricultural Observatory Platform)

- Partners:
  - KALRO (lead): agronomic advices.
  - WorldBank: funding agency.
  - KCSAP (Kenya Climate Smart Agriculture Project): overarching project financed by GoK and World Bank to develop components of KAOP.
  - KMD: real time and historical records of all relevant weather variables including short-term weather forecasts.
  - aWhere: providing weather data to KMD.
  - MoA Kenya: agricultural statistics and market information.

- Type of partnership (degree of public):
  - Mainly public, obtain weather data from aWhere.
  - Part of larger initiative (Worldbank, 100 million U.S. dollar) e.g. striving to a platform that will aggregate field and farm level data into mapping information that provide insight in addressing where it rained, where crops failed and how many people were impacted.
- Overall services:
  - Climate information and weather forecasts: real time and historical records of all relevant weather variables including short-term weather forecasts.
  - Agronomic insights: seems to be only general agronomy advices.
  - Agronomic advisory: informing farmers of actions they need to take in the various stages of the growing period (preparation of soil, sowing, adding manure and fertilisers, irrigation, harvesting and storage) and marketing period based on the weather conditions predicted.
- Level of bundling:
  - Currently limited as it focusses on climate and weather and agronomic advices.
  - However, the wider initiative includes more e.g. market advisory services.
- Way of delivery:
  - Web site, mobile app and SMS messages to registered farmers.
  - Feedback mechanism: no evidence found.
- Details weather provider:
  - Public/Private: public (KMD – G2G) and private (aWhere – B2G) (Quote from WorldBank report: "KMD will also been testing aWhere algorithms by feeding its own data into their models").
  - Funding:
  - Worldbank and GoK
  - Business model: the services are currently subsidised entirely by donors, sustained mandate for KALRO?

Digital Green

- Partners:
  - Federal Ministry of Agriculture (MOA) and Agricultural Transformation Agency (ATA), Ethiopia and "consortium of partners in the country" (TBD).
- Type of partnership (degree of public):
  - Digital Green (DG) is in the lead of the project "Improving Digital Agricultural Advisory Services (2019-2024)", with a strong partnership with the government through MoA and ATA.
- Overall services:
  - Services were initially only focusing on dissemination of advisory coming from MoA (extension packages). In the context of the mentioned project DG has developed its solution "FarmStack", an agricultural advisory services platform that integrates advisory, input availability and market information. It aims at generating farm-level data such as soil type and crop varieties; content on agricultural practices, local weather, input availability and market information; it is not clear what the source of the local weather information is, although, given the strong public partnership, it is likely coming from the National Meteorological Agency of Ethiopia (NMA).
  - The program started recently, and it is not clear to what extent "FarmStack", is already operational.
- Level of bundling:
  - As mentioned, "FarmStack" is moving towards bundling several services. ATA has also other potentially complementary programs e.g. on microcredit through an eVoucher system.
- Way of delivery:
  - Originally video and now moving towards multimodal information delivery channels (also radio, mobile phones).
  - Feedback mechanism: no evidence found.
- Details weather provider:
  - Public/Private: not clear what the source of the local weather data is. But likely the NMA.
  - Funding:
    - It receives funding from the BMGF and other donors.
  - Business model: the services are currently subsidised entirely by donors.

Farmerline

- Partners:
  - In Ghana, Farmerline partners with food manufacturers (e.g. Hershey and World Cocoa Foundation) and with Government (GMet, MoA, public knowledge organisations). They cooperate with government (e.g. with extension on advisory dissemination) and research (for advancements in the quality of the services).
- Type of partnership (degree of public):
  - Both private and public. See above.
- Overall services:
  - In Ghana a portfolio of services is offered including high quality seed provision (delivered at the farm gate), linkages connecting farmers with food manufacturers ensuring a reliable market outlet, access to competitive agricultural credit (including credit scoring) and free training throughout the crop cycle on farming, food nutrition and safety, and business.
  - Farmers also receive free voice messages (in different local languages) on their mobile phones with information on agro-practices, weather forecasts and prices. Moreover, all farmers in the network are registered and given digital identity cards, which they use for all transactions.
  - Weather services are based on forecasts of the NMS (GMet) but also on additional, purchased data (source to be confirmed). Quality, according to Farmerline, could be improved. They also started using Machine Learning for improving forecasts (TBC).
- Level of bundling:
  - High level of bundling, namely of input provision, market linkages, credit, advisory.
- Way of delivery:
  - SMS, IVR
  - Feedback mechanism: not known
- Details weather provider:
  - Public/Private: source of the local weather data is a combination of GMet and purchased data (source unknown).
  - Funding: The revenue stream relies on a B2B model where input providers and output off-takers are involved.
  - Business model: B2B, see above.

Wageningen Environmental Research
P.O. Box 47
6700 AA Wageningen
The Netherlands
T +31 (0)317 48 07 00
www.wur.nl/environmental-research

Wageningen Environmental Research
Report 3082
ISSN 1566-7197

To explore the potential of nature to improve the quality of life

Wageningen Environmental Research
P.O. Box 47
6700 AB Wageningen
The Netherlands
T +31 (0) 317 48 07 00
www.wur.eu/environmental-research

Report 3082
ISSN 1566-7197

The mission of Wageningen University & Research is "To explore the potential of nature to improve the quality of life". Under the banner Wageningen University & Research, Wageningen University and the specialised research institutes of the Wageningen Research Foundation have joined forces in contributing to finding solutions to important questions in the domain of healthy food and living environment. With its roughly 30 branches, 6,500 employees (5,500 fte) and 12,500 students, Wageningen University & Research is one of the leading organisations in its domain. The unique Wageningen approach lies in its integrated approach to issues and the collaboration between different disciplines.