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Digital Tech in African Agriculture: The Case of German Actors

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ABSTRACT

This study examines German actors involved in the digitalisation of agriculture in Africa. In order to understand the underlying structures, a typology was developed on the basis of literature. This typology was then applied to the German case using qualitative methods, which led to adjustments and the development of a preliminary typology of German actors. The main actors identified were Agricultural Machinery Manufacturers, Agricultural Input Companies, Software and Big Data Companies, and Donors. These actors are characterised by extensive interactions, with commercial activities and development cooperation identified as central motives. The size of the actors acts as an intervening variable that plays a role within the types. The results contribute to a structural understanding of German actors and form the basis for further empirical studies. These can be used to test, adapt and refine the developed typology. The results of this study are relevant for researchers, decision-makers in the agricultural sector, development organisations and companies involved in the digital transformation of agriculture in Africa.

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1. INTRODUCTION

Digitalization is one of the key drivers of future making worldwide and the basis for many utopian and dystopian visions in Africa. The digital revolution in global agriculture has begun. Currently, many agricultural systems are in a significant transitional phase (Klerkx & Rose 2020; Mc Michael 2019) characterised by new technologies, new actors, new motives and possible new outcomes (Hartmann et al. 2021; Prause et al. 2021).

A wide range of digital tools are being used in several African countries. Over the past few decades, we have observed a progression from rudimentary "thin" solutions, primarily reliant on mobile applications, to more intricate and all-encompassing systems designed for precision agriculture (Krone & Dannenberg 2017; Hartmann et al. 2021; Fraser 2021). Academic discourse tends to focus on input and farm-level technologies, although Prause et al. (2021) recently showed that digital technologies are used throughout the value chain.

In addition to technologies and their impact on agricultural structures and outcomes, it is also crucial to understand who are the actors behind the technologies. Especially in times of discussions about a neoliberal food regime, the green revolution and political economy, it becomes clear that the digitalisation of agriculture is structurally shaped by certain actors (Birner et al. 2021; Giles & Stead 2022; Prause et al. 2021; and many more). In order to anticipate possible outcomes, we first need to understand who the actors are, in what structures they are interconnected, what their motives are, and what variables influence their actions.

European and especially German actors are being very present before and in this transitional phase of the digitalisation of African Agriculture (CTA 2019). This can also be observed on the German side: Traditional players such as Bayer as a multinational agricultural input company are undergoing a transformation towards a data-driven organisation (Thompson et al. 2020). And big tech companies like SAP are entering the agricultural business in the current phase. In addition, German donors like GIZ are promoting digital agriculture in African countries for example within the SAIS (Scaling digital agriculture innovations through start-ups) start-up readiness project (GIZ 2022).

So far, there have been studies that focus on individual actors or create types of actors on an international scale (Birner et al. 2021). It has already been established that actors from the Global North play a critical role in the digitalisation of agriculture in countries of the Global South and in African countries in particular. German actors in specific have not yet been considered in the literature to this point, although, as shown above, they are highly relevant. By looking at the German actors as a case, we want to gain a structural understanding of the actors. To this end, we have derived the following questions: Who are the German drivers of digital solutions for agriculture in Africa? How are they interrelated? What motivates them to get involved? In order to cut through the complexity, a typology of these actors will be created on the basis of a case study. This typology contributes to a framework for future empirical testing and further analysis of potential outcomes.

To achieve this understanding, we provide a historical context by summarising the literature on the third food regime (2.1) in order to be able to place the current developments (2.2) in this context. Chapter 2.3 uses the existing general typologies and the literature to construct a preliminary typology and thus the analytical framework for our own empirical study. Chapter 3 explains the case study method. Chapter 4 then integrates the results of the empirical study into the analytical framework. It turns out that a new typology needs to be developed specifically for German actors in the digitalisation of agriculture in Africa. An example of what such a typology could look like is then presented in 4.2. The conclusion (5) states, among other findings, that this new proposal for a typology requires further empirical testing.

2. BACKGROUND AND STATE OF THE ART

Whether it is the Third Food Regime, the Fourth Digital Revolution or other theories of agricultural history, they all have one thing in common: they see the time now as a transition to something new, and the new phase of digital agriculture comes with new technologies, actors, strategies and opportunities as well as risks.

2.1 Historical context: the third food regime

The concept of food regimes, introduced by Friedmann and Michael in 1989, defines the formal and informal structures that shape the global food system (Otero 2013; McMichael 2009). These structures influence the production, distribution and consumption of food (Friedmann & Michael 1989; Otero 2013) and are subject to change over time (McMichael 2019; Otero 2013).

The first regime, the 'colonialist food regime' (1870-1914), resulted from British imperialism and Eurocentric power dynamics (Friedmann & McMichael 1989). The second regime, characterised by 'post-war American imperialism' until the early 1970s, laid the foundations for the Green Revolution (Friedmann & Michael 1989; Patel 2013). The creation of the World Trade Organisation (WTO) in the mid-1990s established the third and current food regime (McMichael 2009; Prause et al. 2021).

The concept, which has been analysed and revived by McMichael (2009) during the global food crisis, defines the third regime as a 'corporate food regime' in which the market is the organising principle. While seemingly driven by corporations, McMichael (2009) emphasises that states have to some extent shaped this regime through subsidies and liberalisation, legitimised by the WTO. Otero (2013) supports this in his reflection on a 'neoliberal food regime', attributing the third regime to the state and neoliberalism, challenging the notion of a pure market transition.

The literature highlights the importance of the third food regime in the cyclical nature of food regimes, which currently experiences periods of crisis, restructuring or transformation (McMichael 2019; Otero 2013; Tilzey 2018). Characterised by multipolarity, in contrast to previous regimes, the EU, particularly Germany, emerges as a key actor, reflecting the diverse structure of the neoliberal regime, particularly in food value chains.
The Third Food Regime, a corporate/neoliberal food regime, has transformed the global food system with corporate dominance and pervasive neoliberal principles, while the state retains a crucial role in market design and regulation. The ongoing transformation and multifaceted nature of this regime provides the framework for the analysis that follows.

2.2 Digital dynamics within the corporate food regime: Agriculture 4.0

The concept of food regimes is important as a conceptual background for this paper. But in concrete terms, a transformative process can be seen in the practices of agriculture. Prause et al. (2021) have already shown that digital technologies are now being used throughout the food value chain. On the one hand, the digitalisation of agriculture deepens existing cooperative and neoliberal structures in the third food regime, but also creates new levels where they can infiltrate (Prause et al. 2021).

Some authors also speak of the fourth agricultural revolution following the Neolithic Revolution, the British Agricultural Revolution and the Green Revolution (Klerkx & Rose 2020; Rose & Chilvers 2018). Abdulai (2022) is contextualising the ongoing transition under the umbrella of a “New Green Revolution”.

The term "Agriculture 4.0" refers to the latest phase of development in agriculture, which is characterised by advanced technologies and digitalisation (Rose & Chilvers 2018). In Agriculture 4.0, innovative technologies such as the Internet of Things (IoT), artificial intelligence (AI), drones, sensor technology and Big Data analysis are increasingly used (Rose & Chilvers 2018). We have already seen that much lower-threshold technical innovations have led to changes. Dannenberg and Krone (2018) were able to show in the early phase of digitalisation in the African context that the use of mobile phones already influences agricultural value chains. Hartmann et al. (2021) then looked at the development from mobile phones to smartphones. They did not find that digital control or value appropriation by lead firms had increased as a result of increasing digitalisation. However, at the current state of agriculture 4.0, there are initial indications that the new level of digitalisation has the potential to have a disruptive effect and fundamentally change existing dynamics (Klerkx & Rose 2020).

However, despite the increasing availability of mobile phones and internet services, we can see a digital divide in Africa, a divide in access to digital technologies (Abdulai 2022). Sub-Saharan Africa has seen a steady increase in mobile phone and internet usage, but disparities remain within and between countries (Abdulai 2022). Several reports and scientific literature on the digitalisation of agriculture in Africa highlight connectivity and the digital divide as key challenges to the continent's prospects for digital agriculture (Abdulai 2022; CTA 2019; Rotz et al. 2019a; Aker et al. 2016). It is therefore crucial to address issues such as connectivity, the digital divide, scalability of digital solutions and weak enabling environments to unlock inclusive benefits (Abdulai 2022).

2.3 Current types of German actors in digital agriculture

As a basis for the empirical analysis, an analytical framework is developed in the following chapter from the existing literature. Birner, Daum and Pray (2020) have already identified a typology of drivers of the digitalisation of agriculture. However, this typology refers to international actors and not specifically to the digitalisation of agriculture in Africa. Nevertheless, it can be helpful in providing a framework for analysis. Birner, Daum and Pray (2020) were able to identify 5 types, 4 of which they explain in more detail:

1. Large multinational agricultural input companies

As typical actors in agriculture, the large multinational agricultural companies were already operating before the digitalisation phase, selling seeds, fertilisers and pesticides (DÃ¶rr 2018; Birner et al. 2020). A German example is Bayer (Giles & Stead 2021). Birner et al. (2020) also identify manufacturers of agricultural machinery (e g. Claas) as part of this type. German companies are strongly represented in this type, both quantitatively and in terms of influence. It is usually easy for them to enter the digital business because they have a high level of capital and can easily expand with strong partners in the economy and through existing networks (Birner et al. 2020). The empirical work in this paper takes up this type of actor and discusses the separation of agricultural machinery manufacturers into a new group.

2 Non-agricultural "hardware" companies

While companies such as Claas have traditionally focused on agricultural machinery, former non-agricultural hardware companies are also entering the agricultural sector (CTA 2019; Birner et al. 2020). For example, the German company Bosch used to supply hydraulic components for tractors, but has now moved into sensors and technical software (Birner et al. 2020; CTA 2019). We will include this type in the empirical analysis, but it is debatable to what extent.

3. Large multinational software and big data companies

These actors have not traditionally been at the centre of agriculture. With increasing digitalisation, they are finding their way into agriculture in different ways (CTA 2019; Birner et al. 2020). This can be through partnerships with large companies, but also through start-ups, or they can enter the market as capital providers. For example, technical solutions from the German company SAP are being used in African agriculture. The extent to which it makes sense to distinguish between large software groups as independent actors and their role as suppliers of software system components for large machine manufacturers also needs to be discussed.

4. Start-up companies

The fourth type according to Birner et al. (2020), the start-up companies, are by nature new to the field. In general, however, these actors are already present in the agricultural sector. Start-ups can already be found along the entire value chain with digital solutions. In addition to the many African start-ups, the following section discusses the extent to which start-ups are still relevant when transferring the concept to German actors.

5. Agricultural processing and trading companies

Birner, Daum and Pray (2020) did not include agricultural processing and trading companies on the argument that they were beyond the scope of the article, which is also the case here.

6. Donors

The donors are not named by Birner, Daum and Pray, but the literature points out that German donors in particular (e.g. GIZ) are important actors in the digitisation of agriculture in Africa (CTA 2019). On the basis of this literature, it was decided ex ante to include donors as a 5th type.

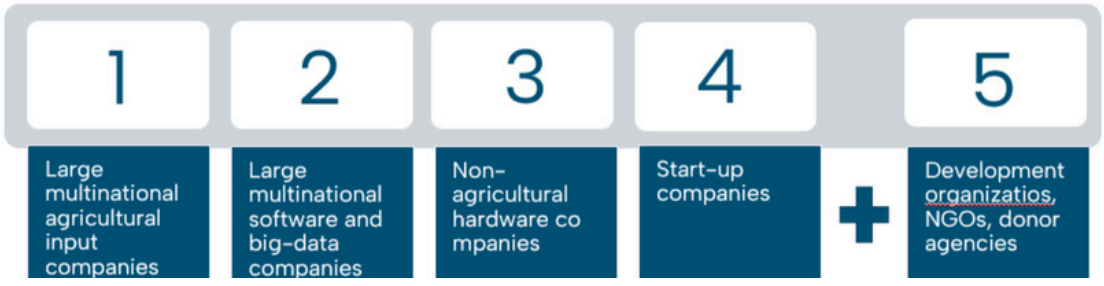

Figure 1: Types of Actors: Empirical Framework (Source: 1-4 Birner, Daum & Pray 2020)

Figure 1 shows the preliminary structural typology derived from the literature. In the empirical part of this paper, it will be tested whether these types remain in place when the German/African context is added and when the motivations of the actors are considered.

3. METHODS

Introduction to the case study
The purpose of this case study is to address the research questions and to test the applicability of a typology derived from the literature to the German/African context. By applying the literature-based typology to the German/African case, a new typology for this specific case will be derived through discussion of the findings.

Selection of the case
German actors were selected because of their relevance to agricultural digitalisation, as justified in Chapter 1. The geographical focus on German actors is not intended to extrapolate results to actors from the Global North in general. The feasibility of such generalisations will be explored in subsequent steps.

Data collection
To obtain data, an explorative approach was initially taken and various methods were used to obtain data, including systematic desk research, direct (formal and informal) interviews and phone calls, attendance at the world's largest trade fair for agricultural technology, AgriTechnica (14.-17.11.2023; presentations, discussions, informal talks, interviews), attendance at the Indaba. A two-day workshop on the topic was also held with stakeholders from research, development cooperation and many more.

Data Analysis
The collected data were categorised and the analysis included the dimensions of motivation and interaction as markers derived from the research questions. The empirical data were triangulated with the literature-based typology and other scholarly sources.

Limitations
However, the limiting factor is that it was not possible to speak to all the players from all the groups, or in some cases only to a few. This was due to the fact that, despite several requests, there was no willingness to talk. We tried to minimise this by means of triangulation. The study is not intended to make generalised statements, but rather to test the transfer of the results through further empirical research.

4. RESULTS AND DISCUSSION

In the following section, the findings of the case study are described, analysed using the analytical framework derived from the literature and discussed in relation to the current state of research.

4.1 German actors in the digitalization of agriculture in Africa and their motivations

For the description, analysis and discussion, the types from the state of the art are used as a framework and a transfer to the German case is tested in order to develop a typology for the German case in a next step.

4.1.1 Large multinational agricultural input companies

According to Birner, Daum and Pray (2020), the category of large multinational agricultural input companies includes multinational agricultural companies and agricultural machinery manufacturers. In the following, Bayer's Climate Field View is presented as a digital solution of the German input company Bayer. It also discusses the digital strategy of agricultural machinery manufacturers in the context of Africa. Their orientations, characteristics and motivations can then be compared in order to assess the category.

Bayer's Climate FieldView is a digital platform and software solution for agriculture according to the definition of Duncan et al. (2022; stated above), that is actively operational in South Africa regarding our research area and has a global presence. Climate FieldView operates on a subscription-based model with various levels. In South Africa, the basic one-year version costs 6000 Rand (approximately 300 euros), with options for additional upgrades and the option of a free trial (Climate FieldView 2023, web). This pricing structure can lead to some farmers being able to afford these technologies and others not, opening up the digital divide debate on an additional level. Even if we assume that the same access to the preconditions of a digital infrastructure (access to internet/mobile devices, etc.), as Abdulai (2022) demands, would be given equally, additional costs can be a divider. One indication that this may already be occurring could be the focus on South Africa, where the digital infrastructure is stronger. The focus on South Africa also speaks in favour of a commercially driven motivation. Within the large multinational agricultural input companies, however, there also appear to be different strategies in the orientation of the business model. BASF, for example, with its xarvio Field Manager app, has made the app free to download from the app store, which suggests that "the aim is to sell data-driven farm management services â€“ including traditional inputs â€“ while collecting valuable on-farm data" (ETC 2022). Scepticism regarding data usage was also expressed at the Indaba: "when you do not pay for the app, then the owner of the app will use your data, because nothing is for free" (Indaba). However, the motivation for Bayer to commercialise the data is just as possible, even if a different business model is chosen.

The platform involves the use of sensors, drones, and satellite imagery for data collection. This raises concerns about farmers dependence on such technology. It's important to note that the terms and conditions explicitly prohibit users from employing FieldView services to combine with any competitive products or services or derivative works without prior written consent (FieldView 2023a, terms and conditions). At the same time, the use of different hardware, software and data is also an interface at which new actors interact. For example, the company planet (from California) sells satellite data to BASF for their digital systems (source: conversation with planet at AgriTechnica 2023).

Giles & Stead (2021), in an anticapitalistic perspective, argue that farmers can be viewed as unpaid workers in this case for Bayer, contributing to data collection. They suggest that the practical applications of Big Data are reliant on the constant input of countless users. Much like the Green Revolution, these applications depend on integrating farmers into new circuits of production. But this is not a phenomenon that only applies to large companies. Start-up AI also needs to learn. And it needs data to do that.

The issue of data ownership is of critical importance in the context of agricultural technology platforms. According to the terms and conditions in the case of ClimatFieldview, the customer is recognised as the owner of all the customer's farm data (FieldView 2023a; terms and conditions). However, users grant Climate a "non-exclusive license to access, use, reproduce, display, modify, and prepareÂ derivative works" based on this data (FieldView 2023a; terms and conditions). This licence is granted for the express purpose of providing FieldView services, internal operations, research and development, and the performance of the Agreement (FieldView 2023a; terms and conditions). This process of accumulating and exploiting agricultural data is reminiscent of the concept commonly referred to as 'platform capitalism', as Srnicek (2017) explains.

Moreover, major players in the agricultural industry, such as Bayer, Deere & Company, Corteva, Syngenta and Nutrien, are undergoing major restructuring to centre their operations around big data platforms (ETC 2022). Bayer's Field View digital platform extracts billions of data points from 78.2 million hectares of farmland in 23 countries (ETC 2022). This vast amount of data is then fed into cloud servers operated by Microsoft and Amazon (ETC 2022). The transformation is exemplified by Deere, the world's largest agricultural machinery company, which now has more software engineers than mechanical engineers on its staff (ETC 2022).

By offering farmers a digital solution, Bayer aims to strengthen brand loyalty and retain customers over the long term, not least by recommending their own products. The company communicates its motives as promoting sustainable agricultural practices, helping farmers increase crop yields, and making agriculture more efficient and environmentally friendly through technology (Bayer 2023). This self-portrayal can certainly be seen in contrast to the motives addressed by critical scholars (see above).

Climate FieldView collaborates with various partners, including Microsoft, John Deere, Agrarian, SST Summit, Claas, and Horsch. We therefore see cooperation between the largest agricultural input companies, the largest agricultural machinery manufacturers and software companies. On the one hand, this collaboration enables technological progress, but on the other hand, it can also inhibit local innovation and knowledge (Abdulai 2020). Through such collaborations, we see that in practice there also seems to be a "tendency for incumbents to dominate emerging fields of innovation" (Klerkx et al. 2019). And as far as the present case is concerned, German companies are also involved in these structures. These structures seem to reflect the theory of the capitalist food regime (McMichael 2009), as the power of capitalist forces also seems to be driven by the new commodity of data. The market produces a "perpetuation and dominance of the same firms" (Bronson & Sengers 2022).

This analysis of Climate FieldView illustrates the complex interplay of factors in the digital agriculture industry, including accessibility, data ownership, and motives of major players like Bayer. However, Birner, Daum and Pray also include agricultural machinery manufacturers in this category. German agricultural machinery manufacturers differ from other input companies not only in terms of their product range, but also in terms of their suppliers, company size and motives. This will be explained in the following.

In general, it can be said that modern agricultural machinery can hardly do without digital technologies. Therefore, in terms of digitalisation, all German agricultural machinery manufacturers come into question. Within the agricultural machinery manufacturing sector, several German companies, including Claas (5), GEA (7), Krone (8), and Wacker (9), hold positions among the top 10 in terms of highest turnover (Agrarzeitung 2022). Notably, there is an observed activity in digitalization in Africa across the industry. Claas, as the 5th largest agricultural machinery manufacturer in the world, is at the forefront from the German side. Desk research has already revealed that the large companies are active on the African market. It revealed a geographical component in terms of motivation. Due to the advanced level of technology, activity in South Africa is particularly commercially motivated. Claas is already represented here with its app. In addition, in other African countries, there are small commercial projects supported by foreign direct investment. Another motive is development cooperation, where Claas is also active. Claas has already been contacted regarding this, unfortunately since now there has been no reply. Discussions about this with the company would be very helpful for further discussion and future academic work.

The picture for medium-sized agricultural machinery manufacturers is certainly more varied, which is due to the intervening variable size. Companies that are not yet on the African market with their (digital) products cite a high risk of missing out on revenue as an obstacle to entering the African market as a medium-sized company: "we are not active in Africa, we are a medium-sized company" (AgriTechnica 2023), or "Africa is not within our scope."(AgriTechnica 2023). But size is also a factor for those German medium-sized agricultural machinery manufacturers that are on the African market: "You have to be able to afford Africa.

As a medium-sized company, we try to be there somehow with as little effort as possible" (AgriTechnica 2023). The motives for the activities of SMEs are also clearly divided between commercial activities and development cooperation. There is also an interesting spatial distribution. Due to the advanced level of digitalisation and the high level of technology, the South African market is not seen as commercially differentiated from the EU, US or Australian market (AgriTechnica 2023). In other African countries, commercial activities are more related to foreign direct investment and are thus more likely to be seen as isolated large orders (AgriTechnica 2023). With regard to foreign direct investment, Arab investors are often mentioned in the conversations (AgriTechnica 2023). On the one hand, maintaining contacts with German politicians was mentioned as a motive for participating in development projects (AgriTechnica 2023). Further considerations could be, for example, consideration in future tenders, which is illustrated by the quote from an employee of a medium-sized agricultural machinery manufacturer, "there's a significant amount of banking capital behind this" (AgriTechnica 2023). On the other hand, there is also the idea of showcasing one's own product on the future market of Africa and thus demonstrating a presence on potential future commercial markets.

The differences between the (non-)activities of agri-input companies in terms of size and motives suggest that it could be more intuitive to separate the two types of company into two different categories, even though both are traditional players. We therefore suggest separating them in a future typification and then testing this in future research. Especially if more dialogue can be conducted on the part of the companies.

4.1.2 Non-agricultural hardware companies

German non-agricultural hardware companies are involved in the digitalisation processes of agriculture in Africa, particularly as manufacturers and suppliers of system components for the major agricultural machinery manufacturers. The range of products and services is thus geared towards the requirements of agricultural machinery manufacturers. The motive here is that the company's own system components are installed in the agricultural machinery and thus generate sales and turnover. In addition to the commercial orientation, other motives such as research or development co-operation are also possible. Previous discussions have given the impression that the hardware companies in the digitalisation of agriculture tend to act more as suppliers and therefore as actors, but as passive and not as strategic drivers. The idea is therefore to include them in a restructured typology, but to test whether they play a central role beyond the system components, particularly in terms of motivation, and if not, to consider removing them.

4.1.3 Large multinational software and big data companies

The first point to note is that large multinational software and big data companies are typically US companies, but the top 10 software companies by revenue also include a German company, SAP. As with hardware, software can be installed as a component.

However, because of the large amounts of data involved, it is often much more than a component. Unfortunately, no talks have taken place. However, Michael Pittelkow, Executive for Economic Development Cooperation at SAP, has already commented on this in the German media. He said that more and more digital solutions are being developed in African countries themselves, and that SAP is using them (Deutschlandfunk 2019). SAP provides the basic framework and African solutions are docked onto it, with start-ups playing a major role (Deutschlandfunk 2019). The involvement of large software companies also supports the effect of centralisation of power and commercial food regimes described in the state of research. More empirical evidence is needed to further discuss this in relation to German actors.

4.1.4 Start-up companies

The findings from the section on software and big data companies show how important start-ups seem to be for the digitalisation of the agricultural value chain in Africa, but these are mostly local start-ups and not German start-ups. Although there are examples such as the fintech start-up Agribora, it is also based in Darmstadt and Kenya. The start-up also has a relationship with the German development agency GIZ. So far, it has not been possible to clearly identify classic German start-ups as examples of active drivers of the digitalisation of agriculture on the African continent (desk research, AgriTechnica 2023). A number of start-ups were represented at the AgriTechnica trade fair, particularly in the areas of agricultural software and digital agtech. When asked, none of the companies interviewed were strategically active in the African market, nor did they have any plans to do so. Some had isolated customers in southern Africa or made statements such as "In theory, our solution could be used on the African continent. In theory, it could be used worldwide" (AgriTechnica 2023). It seems that German entrepreneurs in particular tend to focus on more capital-intensive markets because they expect more commercial success in the early stages.

These observations suggest that while German start-ups are a category, they are not actively relevant as shaping actors when applying the analytical framework to the German-African context. This leads to the consideration not to include start-ups in the updated version of the analytical framework and to test this hypothesis in future empirical studies.

4.1.5 Donors

“Donors express a strong intention to increase their investments in Digital for Agriculture (D4Ag) in the near future, signifying growing support for this sector.” (CTA 2019)

The already strong position of donors (CTA 2019) is being further centralised by the decline in private venture capital in recent years (Interview GIZ). However, development funds are also becoming scarcer, which could lead to more investment in digital projects, given the expected higher impact and the current high demand for the topic (Interview GIZ). The importance of the donors strengthens Otero's (2013) thesis that this is not a pure corporate food regime but a neoliberal food regime in which states actively shape market conditions.
On the German side, especially the BMZ (Federal Ministry for Economic Cooperation and Development), the GIZ (Deutsche Gesellschaft fÃ¼r Internationale Zusammenarbeit) and the KfW (Kreditanstalt fÃ¼r Wiederaufbau) are investing in the digitalisation of agriculture in Africa.

Taking GIZ as an example, one of the ways this happens is through the Scaling digital agriculture innovations through start-ups (SAIS) programme. The SAIS project runs from 2019 to 2027 and is a programme that aims to help African technology start-ups in the agriculture, food and livestock sectors to develop towards investor readiness (Interview GIZ 2). This Investment Readiness Programme (IRP) includes, for example, networking with internal and external GIZ experts, other founders and specialised training. GIZ therefore does not act as a direct investor. The project was commissioned by the BMZ and is co-financed by the Bayer Cares Foundation and the Bill & Melinda Gates Foundation (GIZ 2022).

The objective of the IRP is the growth of the selected start-ups. This should serve the overall objective of contributing to the achievement of several sustainable development goals (GIZ 2022). This is to be achieved by increasing incomes, promoting gender equality, creating jobs, generating economic growth and fostering innovation (GIZ 2022). One of the requirements for participation in SAIS is to register and operate in Africa. This has led, for example, to support for the half-German, half-Kenyan start-up agribora. Projects such as these have the potential to slow down the concentration of power in large companies discussed above and also bring local knowledge into the digitalisation process.

In general, it can be stated that the approach of the GIZ can be assigned to the "ICT4 development" perspective (Abdulai 2022; others). The targeted promotion of tech start-ups in the agricultural sector fits Abdulai's (2022; 1588) statement that "(disruptive) digital technologies are promoted by developmental organisations as tools that will lead to new development opportunities in Africa". However, the extent to which the technologies supported by SAIS have a disruptive effect on smallholder farmers or actually contribute to the achievement of the sustainable development goals would have to be investigated in a future study on outcomes. As an effect of this German actor, the dependence on foreign direct investment through integration into global markets must also be discussed in future studies. The extent to which this promotes endogenous African growth could also be further explored.

The BMZ project "Digital Agriculture in Africa" also takes up discussions from the literature. The digitalisation of agriculture promises to "bridging the information gaps and increasing access to valuable agricultural knowledge", as already characterised by Abdulai (2020) using international examples. In this way, the BMZ wants to take up the challenge that "Insufficient access to information, markets and investment, degraded soils and poor water management are just some of the pressing challenges which face many smallholders and may have a negative impact on productivity" (BMZ 2023). The use of the new platform along the value chain should provide farmers with more information and thus increase crop yields and farmers' incomes. In another example, Abdulai (2020) criticises that the provision alone does not guarantee free access to this knowledge or its acceptance by smallholder farmers. In addition, the question arises here of how such platforms can be designed so as not to further advance the digital divide. Another question is who provides this knowledge? Is it knowledge from the Global North or from the Global South? In this regard, it would be useful to conduct research to evaluate the measures. It would be useful to conduct a study focusing only on donors as actors.

4.2 New Typology and Interrelations

Figure 2 summarises the results of the discussion from 4.1 and suggests a new typology that should be investigated in future qualitative studies. Essentially, the following deviations from the analytical framework have been made:

1. splitting into Agricultural Machinery Manufacturers and Agricultural Input Companies
2. extraction of System Components (hardware and software) into a new category, which is seen as a relatively passive actor
3. excluding start-ups for the time being, as they seem less relevant as German actors on the African market.

Figure 2: New Typology: German Actors in Digital Tech in African Agriculture (author's own)

Figure 3 exemplifies the intricate web of relationships between key German actors involved in the digitalisation of African agriculture. At the forefront is Bayer, which extends its influence through its subsidiary Climate Cooperation. It is worth noting that Climate Cooperation was founded by former Google employees and went through several changes of ownership before being acquired by Bayer, which also absorbed Monsanto.

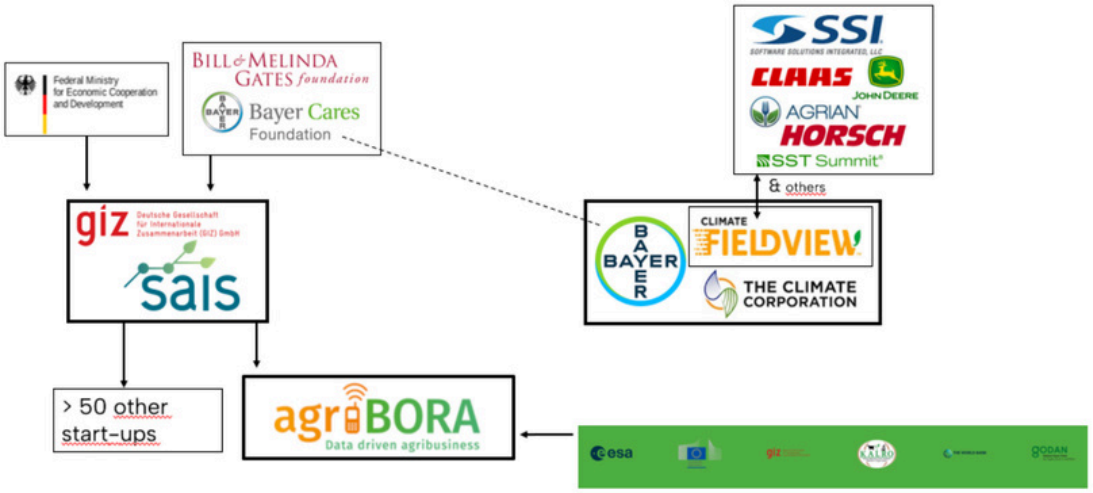

Figure 3: interactions (source: desk research)

At the heart of Bayer's digital agriculture efforts is Climate FieldView, a major player in this landscape. Climate FieldView collaborates extensively with other large multinational agricultural input companies, such as Claas of Germany. This inter-company cooperation underscores the interconnectedness of key players in the German agri-tech sector.

At the same time, Bayer's influence extends through the Bayer Cares Foundation, creating indirect links to the SAIS initiative. SAIS is linked to GIZ. The complex relationships extend to start-ups such as Agribora, which was one of the Kenyan start-ups supported by SAIS. This dynamic network of relationships highlights the collaborative efforts and cross-sectoral linkages that are shaping the digital transformation of agriculture in Africa, with German actors playing a key role in this landscape.

In particular, the mixture of commercial and development cooperation or foundations on the one hand, but also the mixture of private and state actors on the other, underpins the formation of a "philanthropic-corporate-state complex" described by Giles & Stead (2021), also when applied to German actors. The relevance of German development cooperation was particularly evident in the German context, which underpins Otero's (2013) thesis that, due to subsidies from the global North, among other things, it is more appropriate to speak of a neoliberal food regime.

5. CONCLUSION

By looking at the role of German actors in the digitalisation of agriculture in Africa, we wanted to develop a structural understanding in this study. It turned out that the typology derived from the literature needs to be adapted when applied to the German/African case. After adaptation, the following active types of actors were identified: Agricultural Machinery Manufacturers, Agricultural Input Companies, Software and Big Data Companies, and Donors. Based on the analysis so far, Start-Ups and Suppliers of System Components can be seen as more passive. The analysis has also shown that there are strong interrelationships between all actors. These relationships can be public-private, across types, but also within types. Taking motives into account, it can be seen that two basic motives are commercial and development cooperation. Spatially, this shows that commercial motives are particularly related to South Africa, while activities in other African countries are more related to development cooperation or are isolated projects (partly financed by foreign direct investment). Large players in particular have different motives in different regions. Thus, a preliminary typology for the German case could be created, but it definitely needs to be tested by further empirical research.

Future research could therefore use this typology as a preliminary framework to see if it stands up to application in a larger qualitative study and adapt it if necessary. In addition, future research should also look at the possible outcomes (digital divide, revenue enhancement, retention) and among which types of actors these can be found and which variables influence their expression (policy, infrastructure). Attempts must also be made to explain current developments (motives, driving forces, structural embedding, power relations).

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