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**Documentation and data handling:
How can Africa promote record keeping and investment in data management?**

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Abstract

The presence of quality data and data management is important for the future of food in Africa. Data management can impact agriculture sector performance and food security because it facilitates the identification of agriculture sector problems and planning. However, existing systems, data collection practices, record keeping and handling are all challenged by a myriad of factors that undermine quantity and quality of data output. This paper discusses how countries can improve and implement data capture, record keeping and investment in data management. Using past literature and data management, we assess the current status of data management systems and challenges faced at the farmer, local/NGO, national and international levels. Drawing on best practices currently at work in the private sector and amongst NGO-supported projects, we identify potential investment opportunities and incentives that could promote a culture of record keeping, documentation, data management. Over time, investing in projects that have built-in incentives that solve farmer needs can facilitate record keeping at the farmer level. Putting in place mechanisms such as central registries and platforms for sharing information and coordinating local initiatives can promote the culture of documentation and data management at the local/NGO level. Improvements at the national level may stem from investing more in human and financial resources, capitalizing on public-private partnerships to develop and deploy innovative digital tools for data collection and management, as well as building stronger linkages and tapping into international capacities of agricultural data collection.

Key words: Documentation, Data management, Africa, Agriculture, Non-governmental organizations



Introduction

Agricultural development is widely considered to be a critical driver of social and economic transformation in Africa. Economies within the continent largely depend on the agricultural sector to generate jobs, trade prospects and food for their growing populations. Improved agricultural performance is needed for raising incomes for rural poor, improving standards of living, eradicating poverty, and promoting food security. Capitalizing on these opportunities demands the presence of quality data. Data can be used to examine sector problems, aid in planning and inform policy formulation.

Given deficiencies in data collection and maintenance of agricultural statistics, this is more easily said than done. A recent action plan by the African Development Bank (AFDB), African Union (AU), United Nations Commission to Africa (UNECA) and Food and Agriculture Organization (FAO) (2011) notes that, African countries have by and large failed to develop structured National Agricultural Statistical Systems (NASS) with well-defined objectives and clear strategic directions. Country NASS lack resilience, are poorly coordinated, insufficiently resourced, and essentially unsustainable. Many of them speak to donor interests and not national agendas. This has resulted in low demand for data which has in turn led to fewer resources being invested in budget allocations, skilled and motivated staff, financial and technical assistance for statistical production, and development. The end result has been poor output of data quantity, quality, and dissemination.

Aside from the above institutional problems, there are methodological and measurement problems surrounding key variables such as crop area, and production (Carletto, Jolliffe, and Banerjee, 2013; Desiere, Staelens, and D'Haese, 2016; Debatsa *et al.*, 2016). These tend to rise out of the fact that much of the farming is done by small holder farmers with limited education and use a variety of agricultural practices. The collection of data is further complicated by nature of the local decision-making processes in African countries. Agricultural practices in Africa are often informed by decision making by producers are also consumers and have to make tradeoffs between production for market and home use.

Another factor affecting the adequacy of agriculture statistics is the rapidly changing nature of the agriculture sector. The emergence of issues such as climate change demand more effective methods of data capture in relation to agriculture. Currently, many African countries are involved in economic liberalization and regional integration processes that require the use of agricultural data particularly trade (UNECA, 2010; Rampa, 2012). For instance, decisions to undertake regional economic cooperation under East Africa Community (EAC) are based on prospects of increasing trade including agriculture among member countries (EAC, 2012). The on-going negotiations for deeper integration for the Common Market for Eastern and Southern Africa (COMESA) regional block are also being driven by potential trade gains particularly in agriculture for the country. The success and maximum exploitation of benefits within these blocks is dependent on having quality and timely data by all partner countries. However, the integration negotiation processes have exposed substantial weaknesses in the available data. In some cases, agricultural data is

nonexistent, inaccessible, non-digitalized, inconsistent and incomparable to facilitate harmonization across countries (UNECA, 2010; AfDB, 2010; AfDB *et al.*, 2014).

Given the dire consequences that inaccurate and unreliable data can have on policy making, it is important that countries recognize and address the above challenges pertaining agricultural statistics documentation, records and handling. This paper aims to contribute to these efforts by discussing how countries can improve and implement the culture of data capture record keeping and investment in data management. Using past records and literature on records and data management, we assess the status of data management systems and challenges faced. While the problems present in the current data management systems in Africa create difficulties in improving food and agriculture, they also offer an opportunity to tap into existing technologies. Thus the paper presents best practices currently working in the private sector and NGOs (Non-Governmental Organizations) supported projects to identify innovations and potential investment opportunities that could promote a culture of record keeping, documentation, and management. The discussion is structured at the farmer, local/NGO, national and international levels given the unique nature of data management systems. There after the paper ends by presenting a conclusion.

Farmer level

Record and data management systems

Generally the practice of documenting agricultural data by farmers in Africa is uncommon. The few farmers that do participate in record keeping, are often facilitated and encouraged by donors, NGOs, public programs, farmer associations or cooperatives (Minae, Baker, and Dixon, 2003; Johl and Kapur, 2001). For example, farmers in the Ecosystems and Extension Service (EES) and the international small group tree planting programs in Kenya are engaging in the keeping of records for farming activities. These programs are initiated by NGOs (Olatunbosun, Blum and Maarten, 2016). Another example is livestock farmers in Ghana from Oyarifa Livestock Farmers Association and the Oyarifa Area Women Poultry Farmers Association (Tham-Agyekum, Appiah and Nimoh, 2010). Often the documentation of data involves simple records of input and output dynamics for specific enterprises and may focus on only certain farm activities under the supervision of a researcher, extension specialist or personnel of NGO/donor supported projects. Although there are signs of transiting to digital processes, many farmers still depend on the manual processes of handwritten information using books and simple ledgers.

The challenges

The lack of record keeping and data management at this level is attributed to high levels of illiteracy and low numeracy in most African farming communities (Minae, Baker, and Dixon, 2003). According to the World Development Indicators database (2016), the average literacy rate of the adult population in Sub-Saharan Africa (SSA) was 60% in 2011. The implication is that about 40% of SSA lacks the basic literacy and numeracy skills required for everyday life. Women who are the majority of farmers in Africa account for more than 60% of the region's total illiterate population. Some countries such as Chad, Ethiopia, Mali and Niger are highly disadvantaged with

illiteracy rates higher than 60% (United Nations Educational, Scientific and Cultural Organization [UNESCO], 2010).

Another constraint is the time demand imposed by record keeping. The nature of farming systems by households in Africa is complex and diverse. Many households carry out more than one enterprise simultaneously making record taking cumbersome and time consuming. Record keeping at this level often does not capture the complex nature of resource allocation and production structures of agriculture. In addition, there is a general lack of appreciation of the importance of records among farmers in Africa majority of whom remain in subsistence agriculture and whose low returns provide no incentives for record keeping. The small sizes of landholdings with limited knowledge and means to intensify further discourage the practice. Furthermore, there is limited awareness and sensitization of farmers by extension agents on the importance of record keeping in relation to the performance of businesses in many of the countries (Johl and Kapur, 2001). Poor record keeping by farmers is also blamed on the informal nature of farming practiced in many parts of the continent thus providing no incentives for farmers to keep records.

Promoting a culture of documentation record keeping and data management

Despite these drawbacks, documentation and record keeping at the farmer level offers various benefits to various actors and may provide answers to real issues affecting farmers. These answers can be capitalized upon to promote the culture of record keeping, documentation and data management. Amongst these is the increasing the demand for information by farmers across Africa, who need it to make decisions about their enterprises (Minae, Baker, and Dixon, 2003; ESGPIP, 2009). With many African governments advocating for commercialization of agriculture, more and more households are beginning to view and engage in farming as a business. The ability to have a profitable business requires a good records and data. Indeed the New Vision online media documents a prosperous farmer in Uganda who attributes his success to record keeping which has facilitated farm business planning (Kalyango, 2014).

The need to access quality information, is driving many to adopt new information and communication technology tools and technologies for agriculture. Small devices especially mobile phones and phone-based applications are penetrating African countries and into rural areas where farmers are using them to gather, store and exchange information across communities. In fact, mobile phone subscription and usage has increased and it is projected to increase in the future. Current statistics from the World Development Indicators (2016) show mobile phone subscriptions at 71% in the 2014 for SSA region. Table 1 shows that the increase in subscriptions in some countries to be over 50% in the last decade.

Mobile phone applications are now more sensitive to development country needs in terms of price, design and capacity to convey the relevant information. This has made them adaptable and useful to small holders who are mostly limited in education and exposure to technology. A sizable volume of information on how to increase yields, access markets, and adapt to weather conditions are being communicated and stored by farmers faster, with greater ease, and increased accuracy via the mobile phone. Several



questions can also be answered through dialogue, with farmers, experts, and government.

This suggests that more investments in similar information technologies will enhance the gathering, storing and exchange of data. The task lies in being able to identify those farmers that highly adopt and use to maximize the gains. The recent upsurge of cable investments and infrastructure in several countries across sub-Saharan Africa, infers that connectivity and accessibility of IT services is likely to grow the rural areas. However, several other countries in the region are yet to make such steps especially if they are located in conflict regions.

Table 1: Change Mobile phone subscriptions for African from 2004 to 2014 (World Bank, 2016)

Country	%Change	Country	%Change	Country	%Change	Country	%Change
Angola	58.85	Eritrea	5.96	Mali	145.55	Swaziland	59.08
Burundi	29.12	Ethiopia	31.38	Mozambique	66.36	Seychelles	98.79
Benin	93.85	Gabon	135.05	Mauritania	77.1	Chad	38.48
Burkina Faso	68.7	Ghana	106.68	Mauritius	86.93	Togo	58.42
Botswana	139.11	Guinea	70.45	Malawi	31.7	Tunisia	90.94
Central African Republic	23	Gambia, The	107.06	Namibia	99.48	Tanzania	57.63
Cote d'Ivoire	96.48	Guinea-Bissau	60.64	Niger	43.08	Uganda	48.23
Cameroon	67.03	Equatorial Guinea	55.83	Nigeria	71.11	South Africa	105.37
Congo, Rep.	97.03	Kenya	66.53	Rwanda	62.54	Congo, Dem. Rep.	49.7
Comoros	49.47	Liberia	70.39	Sudan	69.4	Zambia	63.18
Cabo Verde	107.9	Libya	152.04	Senegal	88.62	Zimbabwe	77.47
Djibouti	27.89	Lesotho	74.76	Sierra Leone	76.66		
Algeria	78.36	Morocco	100.44	Somalia	44.84		
Egypt, Arab Rep.	103.48	Madagascar	39.33	South Sudan	24.5		

Apart from providing information to farmers, good records and data can enhance access to agricultural credit which remains a major challenge for many farmers in Africa (Denkyirah *et al.*, 2016; Tham-Agyekum, 2010). Banks regard agriculture as a very risky business to finance. This is made worse by a lack of information on enterprise types, activities and transactions that can be used to assess the viability and upraise farm enterprises (Meyer, 2015). The presence of records reduces on information costs of financial institutions by availing such data. After noting the farmer financial needs and limitation versus financial institution demands, a number of advocates for agricultural development have initiated farmer projects that involved record keeping in-turn facilitating credit extension.

Examples of successful initiatives include the Farmer to Farmer projects initiated by the United States Agency for International Development (USAID) and ACIDI/VOCA. They work hand in hand with farmer associations, cooperatives, non-profit organizations, commercial farms and government in Ghana, Liberia and Nigeria. Under these projects it was recognized that poor record keeping was a major constraint to profitability of farm enterprises and access to finance by farmers. Consequently, the



projects proceed to train farmers and other value chain actors engaged in the production of staple foods such as yam, horticultural crops, and livestock production in recording keeping of farm activities and transactions to improve access to credit (Tracey, 2013).

Beyond these projects, farmers are seizing opportunities provided through digital products with built-in systems enabling data capture or generation of farm business risk profiles which can be used to access credit. Farm Drive a mobile phone-based app which is spreading among young farmers in Kenya to document farm transactions. The data is used to assess credit worthiness and risk for their enterprises, facilitating potential receipt of credit from formal financing institutions (Kinami and Bosire, 2016). Investments in the continual use and up-scaling of the practice to other communities and other African countries can encourage the culture of record keeping.

Another issue potentially addressed through record keeping and data management is traceability of agricultural products. Traceability is increasingly demanded for certifications like fair trade and to access certain markets, particularly those relating to organic products. African governments have gained awareness of this and are trying to respond accordingly. The benefit to farmers is that they are able to access niche markets (e.g. organic markets) and obtain higher premiums for their products. They are also able to link to and build stronger relationships with buyers and other actors and throughout the value chain. A prime example is coffee where a number of agricultural development actors including government, NGOs and private sector have come together to improve traceability along the entire supply chain from the farmer to the consumer (CORE, 2016; CARANA cooperation, 2016).

Another successful example of record keeping's impact on traceability is the breeding of livestock in Kenya. Kenya has a nation-wide livestock registration system managed by the Kenya Livestock Breeders' Organization (KLBO) to support livestock breeders and link them with government agencies. Initial registration of animals is carried out by breeder societies, which are grassroots organizations connected through KLBO. Each breeding society has certified inspectors who are mandated to inspect the animals and register them as a particular breed. A certificate is then issued for all registered animals. The KLBO works with the Kenya Stud Book, which maintains the pedigree herd register and a grading register for all breeds of cattle, goats, sheep, pigs and camels. The Stud Book maintains a database of the births, crosses and deaths of Kenya's livestock population. It also conducts livestock registration, sets animal inspection rules and breed standards, issues certificates for both pedigree and grade stock, promotes proper animal identification, and issues transfer or export certificates in liaison with breed societies and government. The KLBO also collaborates with the Dairy Recording Service of Kenya (DRSK) which conducts milk recording for pedigree and grade stock. The DRSK supervises proper milk recording and issues lactation certificates at the end of each lactation cycle. For the system to work, all farmers maintain records on standardized templates which information is remitted to the societies. Digital tools and technologies are also used to document and manage data. The system was initiated by private sector breeders, and when successful, elicited government recognition and participation.



The above cases are clear examples of systems where incentives can encourage farmers to participate in documentation. The systems both encourage record keeping, and facilitate access to information, finance and markets. A culture of documentation can be developed widely at the farmer-level when these types of systems are promoted. Governments also stand to gain from such initiatives. This is because in the process of keeping records for something like traceability, farmers also document information on issues such as production, agronomic practices, land use, and natural resources, which can be passed onto governments and institutions to facilitate planning. Farmers participating in this process can become key informants and contact points for rapid appraisals. These practices can ease on data collection processes and enhance the building of databases for long-term planning and formulation of appropriate farm policies. The information may also inform research and innovation processes by tracking changing agricultural patterns and needs of farmers.

Given the potential benefits to farmers and constraints to implementation, African governments are responsible for the promotion of record keeping systems and to identify similar successful initiatives. Investments in scaling up and further developing collected data sets will be necessary to capitalize on these potential opportunities. Government investment in policy options that can put digital tools such as mobile phones into the hands of farmers, by lowering taxes on imports, and setting up supporting infrastructure in rural areas, including fiber optic cables that can help increase bandwidth and lower the costs of connection. Several African countries such as Uganda and Kenya are creating ICT hubs in remote areas to act as communication centers where farmers can access data and information on a range of issues. In these cases, enhancing access to ICT hubs is a critical step toward prompting farmers to value data and record keeping.

The Local/NGO level

Record and data management systems

Agriculture and food data management is also done by several institutions including universities, research institutes, NGOs, private sector organization and externally funded projects. These organizations tend to conduct studies and compile data either manually or digitally on specific issues and in small, localized study areas or project sites such as provinces, counties, villages. These efforts often utilize innovative practices and tools of recording, collection and managing data. For example, the computer assisted personal interview (CAPI) technology initially used to gather data in health, education, and behavior in small Kenyan communities by the population council (Hewett, Erulkar and Mensch, 2003), is now being applied to gather data in agriculture and food in other countries in Africa (FISN, 2014; Caeyers, Chalmers and Weerdt, 2010). CAPI involves direct, on-site data entry into portable computers. The data is remitted and stored remotely in a central server. The advantages of the technology over paper-based techniques, are improved quality due to customized questions, computerized calculations, and elimination of routing problems within the questionnaire and errors in data entry. The CAPI method also produces data in a timely manner and reduces costs where large-scale surveys are involved (Sainsbury, Ditch and Hutton, 1993).



A number of other development organizations are also demonstrating the use of new digital devices, tools and applications to gather data on African agriculture. For instance, in 2012, a project funded through USAID’s Feed the Future Initiative, used Google Nexus tablets and open data kit software to administer surveys about agriculture in local communities in 19 countries (Agrilinks, 2013). Similarly, Concern Worldwide is expanding the use of digital data collection (DDC) tools to agricultural rural communities in all their project countries including Malawi, Kenya, and Uganda. Field staff of Concern Worldwide, who serve as agricultural extension advisors use handheld devices to survey farmers on issues such as land preparation, seeding, harvesting. As mentioned earlier, NGOs and private sector organizations are engaging in the development of mobile applications that are being used by smallholders to record, exchange and receive data via their phones some of which are demonstrated in Table 2.

Table 2: Examples of agricultural technology applications in Africa

Technology application	Location	Description
ICow	Kenya	Web based platform aimed to increase farmer productivity through access to knowledge and experts and to encourage the development of a younger generation of farmers. It provides a series of dairy agriproducts that are available over a simple menu system.
Rural eMarket	Madagascar	Used to communicate market information, using smartphones, tablets or computers.
Esoko	Kenya, Malawi, Ghana, Burkina Faso, Zimbabwe and Mauritius	Platform for tracking and sharing market intelligence. It links farmers to markets with automatic market prices and offers from buyers, disseminate personalized extension messages based on crop and location, and manages extension officers and lead farmers with SMS messaging.
Farmer Connect	Africa	Mobile-enabled platform that delivers personalized agricultural extension services and text/audio information intelligence in local languages to smallholders and farmers. One-stop market place for agricultural communities, and stakeholders interested in agriculture development including farmers, Government, NGO and Private agencies and service providers.
M-Shamba	Kenya	An interactive platform that provides customized information on production, harvesting, marketing, credit, weather and climate to farmers through the use of a mobile phone. M-Shamba is currently being used by 4000 rice farmers in Kenya to help them adopt new technologies in rice farming.
Agro Sim		It works primarily on data collected online and provides a virtual representation crop growth and development. It is an event simulator able to anticipate the quality and quantity of the productivity of a desired crop by taking into account data related to seed, soil, hydraulic climate, geography, macro-economy and the demographic of the targeted area. Can be used by all platforms.
M-Farm	Kenya	A mobile phone-based service that provides up-to-date market prices directly to farmers via application or text message. It also offers a group selling tool which allows farmers to team up and bring produce to designated collection points. It facilitates trading and financial transactions between farmer and buyer.



The challenges

The small study areas for many of these innovations limit their applicability to national analysis and processes that support larger scale agricultural planning and development. In addition, there is a lack of harmonization of field approaches which limits effective integration of data into farmer decision support services and tools to scale up their use.

Furthermore, many of the institutional actions data collection and management efforts are scattered across various projects sites (although in some cases related or similar), with limited coordination amongst actors resulting in duplicity of efforts and limited synergies towards large scale impact. This results, in part, from the lack of a central registry that is coordinated by one entity, and from overlapping organizational mandates. For instance, the Uganda National Council of Science and Technology (UNCST) assesses and provides approvals for methods used in the conduct of research, while the National Agricultural Research Organization (NARO) is responsible for coordinating all agricultural research in the country. In most cases institutions or organizations seeking to conduct agricultural research will get approval from UNCST but will not register their research with NARO thus undermining its ability to coordinate efforts.

Promoting a culture of documentation, record keeping and data management

New project ideologies and innovations offer opportunities to reduce cost and length of data collection, and improve data quality. Establishing a central registry where projects conceived by various players can be tracked and coordinated can help to avoid duplication of efforts. This will also help build synergies among various organizations, increase efficiency of resource use and promote success at the landscape level, rather than in small pockets. A coordinated approach would ensure greater recognition and awareness of successes in data management and encourage mainstreaming into policy to enable national scale-up of innovative and successful data management approaches by government. While such a department is best situated under the Ministries of Agriculture, a careful institutional analysis is needed, because of the bureaucratic tendencies and governance challenges in many institutions, which lead to underperformance and poor service delivery.

Putting in place physical or virtual platforms where researchers and the NGO community can harmonize methods and approaches for data collection, can further promote the culture record keeping and documentation. Through these platforms, best practices can be identified and shared to benefit the community at large and further develop new ideas.

Public-private partnerships between government and private sector/NGOs that develop and deploy digital tools for data documentation along agricultural value chains can offer greater returns to investment. The successes of digital tools have driven private sector companies to invest more in technology development, particularly mobile phone applications, software design, local language customization, and remote transaction services. Private companies interested in these prospects collaborate with the



government to facilitate deployment of their products and services to smallholders, as is the case of fair-trade coffee.

Innovations should focus on the priorities of men and women farmers and the trade-offs imposed by their resource constrained environments. Often women do not own or have access to mobile phones or related applications. Applications that are addressing the specific needs of farmers, such as facilitating access to market information, financial services, or pest and disease management recommendations, are likely to be used by farmers thus enabling a culture of data management. The institutions involved in the development of these technologies must involve farmers from the initial planning and design stage to ensure relevancy, trust and interest. Innovators should also monitor use of these applications to judge the extent to which they are actually used for agricultural learning, data management and sharing.

The national level

Record and data management systems

National data collection and documentation is primarily constituted by periodic gathering and management of a wide range of agriculturally relevant information such as farm production land issues, household consumption patterns, livestock husbandry practices, mechanization trends, market prices and socioeconomic data and environmental concerns. This information is used for policy formulation, program planning, and monitoring and evaluation of interventions. Periodic data collection and compilation is often in the form of comprehensive agricultural surveys or censuses. Crop and livestock surveys, for example, are more expensive, less frequent and often require external assistance. Surveys may be annual, while national censuses occur every ten years. Regular data collection focuses on a limited set of information such as production and market price data because it occurs on a more frequent basis (monthly or quarterly) and data collection cannot be too time or resource intensive (Minae, Baker and Dixon, 2003; Carletto C., Jolliffe D. and Banerjee R., 2013).

Actors and structures responsible for data collection at the national level encompass central statistical bodies and local governments. The central statistical bodies are responsible for compilation, housing and dissemination of country agricultural data. They are also responsible for conducting periodic integrated agricultural surveys and censuses. The local governments undertake regular compilation of estimations, gathering of data within their constituencies, and ongoing monitoring. These data are then remitted to the central bodies for analysis and compilation.

The central statistical bodies also receive specialized data from other national agencies. These agencies have the technical expertise and infrastructure for collecting and processing this information that the central bodies lack. For instance, data for mapping the production of agro-ecological zones, climate change or market information is often left to specialized bodies. For example, many countries in Africa have metrological departments which produce climatic forecasts, which are then remitted to central bodies for compilation at the national level.



A number of central statistical bodies are beginning to transition to computerized techniques of data collection for surveys, including those pertaining to agriculture. Most recently, the South African national statistics body used CAPI to collect information on agricultural activities for a community survey. These actions indicated a shift away from traditional paper-based surveys to digitized techniques (Pieterse, 2016). Uganda, Kenya, Nigeria and Ethiopia are using CAPI in similar applications. However, many other African countries are yet to extensively adopt the technique.

Digital technology and tools are providing an increased opportunity for data storage, remote access and sharing to the public sector. Advances in Cloud computing, hard drives, GIS and GPS systems, and the speed of microprocessors have continued to rise, making it dramatically cheaper to store, link and share data between agricultural departments and levels of government via the internet. The sharing and exchange of data has increased opportunities for stakeholders to network with one another and get involved in agricultural research. This has also made it possible to address some of the information and communication constraints of agricultural research institutions, government offices, cooperatives, and development organizations.

Technologies are also facilitating open access and release of information held by governments and making it publicly available. This has promoted transparency and increased participation of the public, private, and research sectors in solving long-term socioeconomic problems pertaining to agriculture. African countries that have established open data access portals include Kenya, Nigeria, South Africa and Tunisia, though many countries have yet to implement this approach.

The challenges

Countries encounter several challenges in data collection, handling and management at the national level. Most nations focus on the role of central statistical bodies and ignore local governments. The fact is that the multiplicity of institutions involved in data gathering leads to multiple challenges that tend to spill over into the entire data collection and management process.

Generally, data compilation and management process at this level are constrained by inadequate human and institutional capacity of national governments, and insufficient funding, which limits development and use of statistical systems. Human capacity issues are largely caused by overall under supply and inadequate training of existing staff in statistical bureaus. These human resource constraints often result in raw data being left for too long and consequently it is never analyzed or channeled into policy-decision making processes. This is further compounded by the limited capacity to analyze data from a policy perspective in the first place. Staff personnel's lack of skills with regard to new forms of data management cause an inability to address emerging issues.

Infrastructure problems are largely related to the use of paper-based data management systems in most countries and use of outdated survey tools and statistical methodologies. Paper-based methods are very costly, time consuming and largely susceptible to human error. They can take months to complete from research design to



data input, to processing and analysis. By the time they are released they are of limited use due their outdated nature.

Financial constraints include limited budget allocation to data collection and management by governments, coupled with low donor interest. The lack of budgetary support is attributed to the limited understanding by governments of the linkages between agriculture and other sectors of development such as industry, environment, land use, foreign exchange earnings and interest rate stability. Most financing is done by donors to meet interests that may not be aligned to national goals and agendas. Hence capacity built in such initiatives usually remains unutilized because of lack of demand from national systems. Aside from data collection, the institutions have low remuneration levels resulting in absenteeism and low motivation towards ensuring consistent data.

Lack of institutional coordination in several African countries results in lack of harmonized data limiting its use and meaningful interpretations. In addition, data is not remitted in a timely manner in a way that can be processed by users. People in charge of approving requests to data are not always available.

Due to lack of functional websites, in Democratic Republic of the Congo (DRC) and Eritrea for instance, data from Ministries of Agriculture can only be accessed on-site from annual reports. According to Nzuma *et al.* (2012) in DRC, even though the data are supposed to be publicly available and free, accessing them is near impossible due to bureaucratic impediments. On the other hand, countries like Ethiopia have more consistently compiled datasets available through their agency websites. In addition, certain datasets can only be accessed for a fee. For instance, fees for meteorological datasets for most of the countries in eastern and central Africa including Burundi, DRC, Ethiopia, Kenya, Madagascar, Tanzania and Uganda may vary from US\$10 per parameter per station per month in Kenya to US\$10 per parameter per station per year in DRC and Tanzania to about US\$1-2, per parameter per station per year in Sudan and Uganda. Based on 2010 data, Rwanda was the only country in eastern and central Africa providing meteorological data for free (Nzuma *et al.*, 2010).

Other challenges include the inability of politicians to value data unless it furthers their political interests. Hence they cannot recognize that data can be used to effectively target programs that can transform livelihoods at the grassroots level. Furthermore, political instability and sporadic conflicts in countries like Burundi, DRC, South Sudan, limit national data collection processes. Countries such as Burundi experienced political instability in the early to mid-1990s, and most data for these periods are either unavailable or unreliable.

Promoting a culture of documentation, record keeping and data management

Data is needed for national planning purposes, and countries should be emphatic in ensuring adequate investment in regular record keeping and data management. Using available records and data, governments can identify national priorities and appropriate targets for development programs. Data can also ease fundraising processes for development projects from international funding sources. Given the benefits, informing



political leaders, donors and policy makers on the valuable contributions of agricultural data management systems is critical, especially given that these players are in charge of budgetary decision making. It is important that they recognize the linkages between agriculture and other sectors in driving development. Ideally, leaders and donors would increase budget allocations for human resources, infrastructure, technologies and technical capacities needed for the analysis and processing of data.

Developing and instituting coordination frameworks that are productive to the data collection, compilation and sharing processes can also play a role in promoting the culture of data management and record keeping. Lessons can be learnt from the Kenya Agricultural Sector Data Compendium, which had success in consolidation of data sources to increase user access. The aim of the dataset is to make available, in one convenient location, data on crops, livestock and fisheries that would otherwise be scattered across different institutions. Compilation of the last two versions (2003, 2008) was led by the Kenya Institute for Public Policy Research and Analysis (KIPPRA) in collaboration with lead ministries and agricultural agencies.

It is important that national governments recognize the promise of digital technologies to the future of data handling, and increase investments in infrastructure, tools and services which can be used to encourage record keeping, data collection, distribution and use. Currently, most national datasets are available online in limited formats. In some countries make data available on a limited basis. Thus, investments are needed especially in countries where websites of critical agencies are not online, are infrequently updated or largely outdated. These investments should encourage the building of interactive websites and skills training of personnel to enable information communication in a manner easily understood by users.

International level

Record and data management systems

International agriculture data documentation and management systems involve the compilation, processing, validation, analysis and dissemination of global agricultural statistics of which Africa is part. Examples of such databases include those housed by the United Nations (UN) Food and Agriculture Organization (FAO), the World Bank, UN-COMTRADE, World Food Programme, International Futures, World Clim (World Climatic Dataset), and regional bodies such as EAC, AU-Socioeconomic database, and COMSTAT. These systems also store a limited amount of national statistics. Such data address global and regional issues of a transboundary nature related to hunger, food production, poverty, agro-environmental degradation, climate change, biological diversity; rising food prices which affect Africa and the food security situation are considered global nature thus requiring global statistics.

Similarly, to the national level, statistical information collected covers a wide range of sectors from crop agriculture, livestock, forestry, fisheries to land and water. Some databases also have statistics on markets and risks of food insecurity for early warning and forecasting purposes at regional, national and sub-national levels. Institutions are also increasingly engaging in production of new statistics on integrated issues such as



agriculture and environment, climate change, and bio-fuels because of the growing global demand for such information.

Often institutions obtain this data from national statistical bodies which they harmonize and process into regional and global estimates. These institutions also engage in collaborations with other international agencies to produce integrated statistics to inform the specific agricultural situations in a region and country. For instance, FAO collaborates with the UN Statistics Division, DG-Eurostat and the Organization for Economic Co-operation and Development, to produce trade data for agriculture.

The challenges

Dependency on national data systems to facilitate compilation processes, causes issues at the national level to spill over into the international/regional level. Indeed many of these institutions decry the local capacities in human capital, finances and infrastructure which affect the quality and timely delivery of national data. However, there are some unique challenges that are only faced at this level. Amongst these is the lack of harmonized standards for data collection and collation including varying systems of classification, metric units, sampling techniques, and levels of disaggregation/aggregation, across countries. In some national datasets, data may be aggregated into categories such as cereals, root crops, and oil crops, which makes it difficult to separate contributions of certain sectors to the whole (see for instance Burundi datasets on crop production from the 1970's – 1992 and 1992 - onwards). In addition, international organizations themselves use different classification systems which further challenge data harmonization procedures.

Most countries only maintain limited subsets of their datasets online. Access to full datasets requires international organizations to go through a range of bureaucratic hurdles, including payment, sometimes in huge amounts, to ensure access. Some datasets may also be archived in local languages, constraining sharing. For instance, in Rwanda between 1998 and 2008, annual reports of agricultural ministries and agencies were published in Kinyarwanda.

Promoting a culture of documentation, record keeping and data management

African countries do not function in isolation, and the data provided at national level informs of the regional status on issues such as trade, climate change or food security. To address these issues, it is critical to use data to identify proper solutions only possible at the international level and only effectively applied at the national and local levels.

The dynamics between the national and international levels imply that addressing challenges at the national level can improve quality of data at international level. However, these international bodies have a role to play in assisting African countries in improving their documentation culture. This is because international players are able to see changing patterns and emerging issues in agriculture given their global outlook. International organizations can quickly recognize the changing landscape of agriculture, and transboundary issues demanding policy action. These institutions also have the skills to identify the types of data needed, and the measures, tools and



frameworks needed to collect and harmonize data. They may also be able to leverage a range of resources to enhance capacities at national level. Their capacity can be harnessed to train national teams more frequently, especially in countries with weaker data management systems.

International data is utilized for regional and global planning purposes but with a direct bearing on national states. These may include economic integration processes, international negotiations such as on the World Trade Organization, climate change processes, as well as fundraising for cross-cutting regional projects on country-level issues that may have spillover effects on another, such as food security or disease pandemics. Increasing levels of integration becomes important and can only be well coordinated if transboundary datasets are available and utilized effectively.

African governments also need to recognize that there is existing infrastructure and capacity in international and regional bodies that can be harnessed to inform national decision-making processes for data management. These institutions can conceptualize, develop frameworks and train national teams. Institutions operating at this level including FAO, the World Bank need to team up with the AU and Regional Economic Communities (RECs) to champion and raise the profile of good data and its relevance to Africa. Further, data synthesis and documentation done at a global level may not trickle down to inform national systems. More should be done to ensure that analytical reports are shared with governments in Africa through national level dissemination channels.

It is important that harmonized policies and guidelines that govern the way data is managed at country, AU and REC levels be enforced. National governments need to remit data in a manner that is in congruence with the needs of international data management systems but lack enforcement systems. The New Partnership for Africa's Development (NEPAD), EAC, COMESA already have policies on data collation and management such as COMSTAT monitoring and evaluation to ensure implementation is inadequate. Strengthening existing regional and international platforms for knowledge sharing on various harmonization practices, may further inspire the culture of data management.

Conclusions

The improvement of agriculture in Africa to generate more jobs, increase trade and food security relies in part, on having quality data to guide problem identification, planning and policy formulation. However, current data management systems are undermined by a number of challenges that render them the systems unsustainable and unable to support policy planning.

The main constraints at the farmer level include high illiteracy, nature of farming systems and the lack of appreciation for data and record keeping; at the local level, it is the lack of harmonization of frameworks and limited coordination and collaboration; at the national level are coordination and insufficient resources while data documentation and management at the international level is limited by the problems that face the national systems.



African countries do have opportunities to promote the culture of data capture, record keeping and management. Promoting and investing in the culture of record keeping and data management lies in being able to understand the benefits that accrue from the practices at each level. At the farmer level, investing in projects that have inbuilt incentives of solving real needs facing farmers such as the need for information or finance can facilitate this culture of record keeping over time. Identifying and scaling up of such successful initiatives can further create greater impacts. Establishing platforms for sharing best practices; and a central registry for coordinating and creating awareness of existing local initiatives can further the culture of documentation and data management at the local level.

It is important that African countries invest and capitalize on public-private partnerships to encourage continuous development and deployment of innovations and digital tools for data collection and management along agricultural value. Governments need to make efforts in drawing in the private sector to contribute towards stronger data management in Africa than they are already doing. It's vital to have a strong business case for investing in systems for data management and observing technologies. Products that entail the demands of farmers and their environments will offer greater rewards. The digital technologies are the future of data handling and thus countries must take the necessary strides to invest in the required infrastructure and services. Data collection, handling and management processes will further be strengthened where countries invest more resource both human and financial as well as build on the linkages and readily tap into the internationally available capacities in agricultural statistical documentation.



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