

Access, capacities, and uses of digital technologies by market gardeners in Benin

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Abstract

The development of digital tools and services for market gardening and agriculture in general is regularly presented as a “revolution” in terms of development of good agricultural practices, management capabilities, market access and knowledge exchange. However, the reality of access and use is poorly described and quantified. This article presents the results of a study carried out in Benin among 1,500 market gardeners on their appropriation of digital tools. Using van Dijk’s framework for measuring digital divides, we measured the motivation, access, capacities and uses of digital tools, in particular cell phones, by these stakeholders. Telephones, the main tool, have become widespread and widely used in the market gardening sector: 80% of market gardeners owned one (20% have a smartphone). These tools were used in a simple way, via non-agriculture-specific applications: calls, digital financial services (mobile money), social networks and instant messaging, as well as videos. The use of tools dedicated to agriculture was marginal (<1%). These tools seemed to meet the needs of market gardeners, enabling them to, by priority order, communicate with their network, carry out financial transactions, access the market and exchange knowledge. All the classic digital divides (age, rurality, gender, literacy) and access to electricity, often solar power, were shown to be particularly critical. Policies for the development of better digital tools should target simple applications based on widely-spread, simple and useful capacities.

Keywords: digital applications, mobile phones, quantitative survey, market gardening, Benin

INTRODUCTION

Digital technology is seen as the basis for a new revolution in agriculture (Dooyum Uyeh et al., 2023). In Africa in particular, digital technology is one of the three “mega-topics” of agricultural transformation, along with mechanization and youth involvement (Daum et al., 2022). Infrastructures are expanding (Cariolle, 2021) and projects to develop digital ecosystems (Birner et al., 2021; Lajoie-O’Malley et al., 2020) and services are multiplying (CTA, 2019). In agriculture, digital technology is acclaimed for its potential to make farming more precise (Ncube et al., 2018), provide access to market information and knowledge, or strengthen market access and value chains (Kendall and Dearden, 2018). In this context, more and more people are gaining access to the main digital tool: the cell phone. Their use, more or less advanced, and their impacts have been the subject of much debate, between enthusiastic promoters (Huet and Morinière, 2020) and skeptical or nuanced observers (Aker et al., 2016; McCampbell et al., 2021).

In Benin, as in other sub-Saharan African countries, infrastructure is increasingly accessible, including in rural areas. Nearly 70% of the population lives in rural areas. Market gardening is a particularly important sector for food security and diversity. However, this sector is poorly supported and structured. Digital technology could support its organization and structuring, notably through the sharing of knowledge that it fosters, or in terms of market access through the creation of buyer networks and digital payment, as production is diversified, perishable, in short cycles and subject to various pests. Technologies, in particular cell phones, could be used to connect players and with the market.

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To our knowledge, only Houensou et al. (2023) have studied the impact of digital technology on market access for market gardeners in a large-scale study, demonstrating a positive effect for producers. No other study has yet delved into the appropriation of digital technology, by market gardeners in Benin in their professional lives. This article is based on a survey of 1,500 market gardeners across the country, and aims to provide quantitative elements and to discuss the contribution and limitations of digital technology in addressing market gardeners' issues.

MATERIALS AND METHODS

Theoretical framework

Digital divides can be approached via the use the framework of van Dijk (2013) framework. Developed to enable the study of digital divides, i.e., inequalities generated by digital technology, it structures the approach and measurement of complementary aspects of the relationship to digital technology. Firstly, it suggests studying access. We measured this through the presence of infrastructures and networks, the terminals owned and the costs of accessing the network, three necessary conditions for being able to use digital technology. Infrastructure is independent of individual choice. In this study, we focused on the perceived quality of these infrastructures, which makes it possible to relate them to the uses they enable. Finally, once access has been ensured, it encourages measurement of capacity and usage. In addition to these elements, we added a less frequently asked question: the possibility of abandoning the cell phone once it has been adopted. This question addresses the perception of potential backsliding. Classic digital divides relate to age, location, education or gender, with being older, more rural, of lower education or a woman increasing the risk of low access, capacities and uses.

Market gardening in Benin

In Benin, market garden production is mainly located along the coast in the south – in the Grand Popo, Ouidah, Cotonou and Sémé Kpodji areas (Avadí et al., 2021) – in the Ouémé valley, a fertile zone, as well as scattered around the country's other major cities, Parakou, Natitingou or Malanville. The main crops are tomatoes (*Solanum* spp.), onions (*Allium cepa*), chillies (*Capsicum* spp.), leafy vegetables such as gboma (*Solanum macrocarpon*), tchayo (*Ocimum gratissimum*), and vernonia (*Vernonia* spp.), as well as a wide variety of other products (Kouévi et al., 2023). This type of production is characterized by short cycles, a large diversity of crops in the same plot and a high degree of perishability. The market gardening sector is made up of individual farmers, organized into cooperatives of varying degrees of efficiency, under the supervision of the Fédération Nationale des Organisations des Maraîchers du Bénin (FeNOMA), the umbrella organization. The use of pesticides is widespread. The fact that pesticides residues are found on vegetables sold at the market (Avadí et al., 2021) shows that better knowledge of pest management practices and methods is needed to preserve the environment and the health of producers and consumers.

Market access is a key issue for market gardeners, as both informational and logistical transaction costs are high. Digital technology has the potential to enable better exchange of information and knowledge, as well as access to a wider range of buyers, thus helping to meet growers' needs, as Houensou et al. (2023) find.

Data collection and analysis

Data were collected in 2023. A questionnaire, digitized on KoboToolBox, was administered to 1,500 market gardeners throughout Benin (Figure 1). The sample was drawn from the database of all market gardeners listed by the FeNOMA at national level. This database comprises 15,467 market gardeners affiliated to a cooperative/ organization. We used two-stage random cluster sampling. The primary level is the communes and the secondary level the market gardeners of these communes.

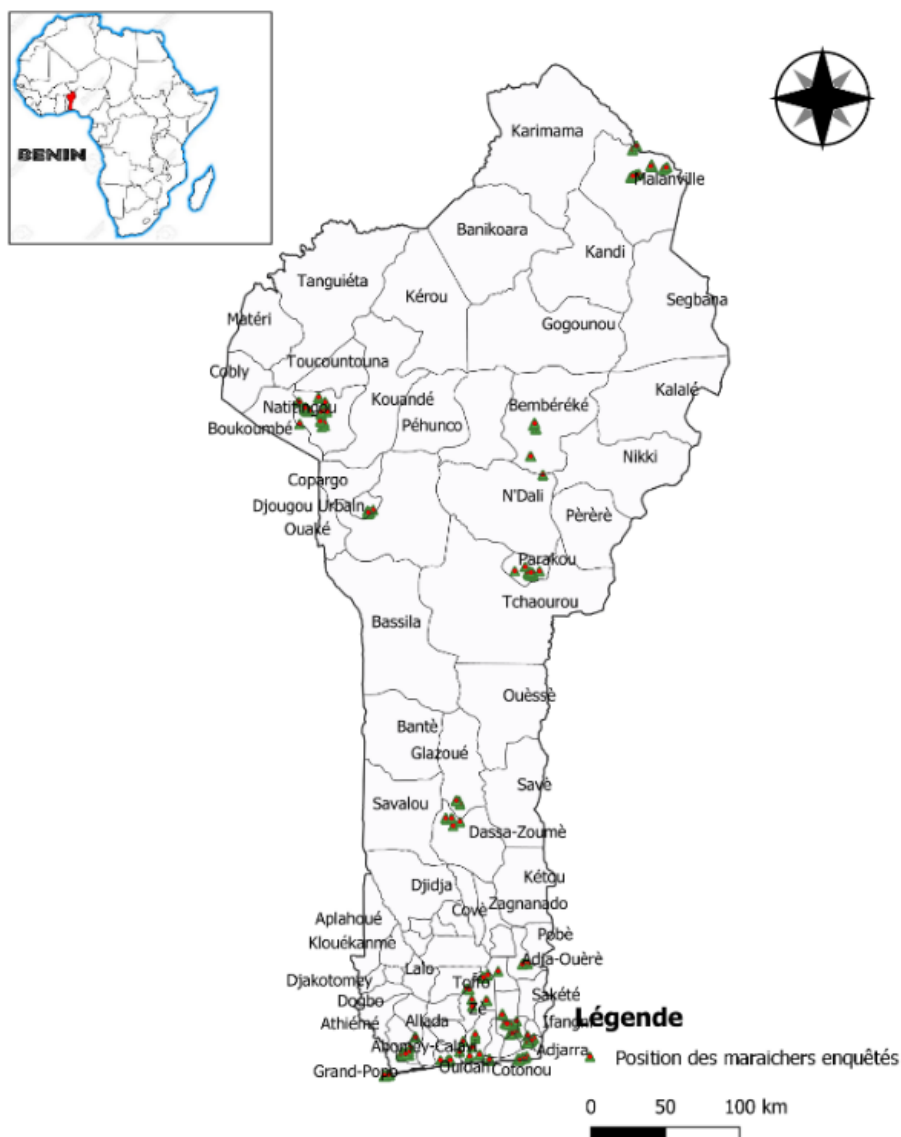


Figure 1. Sampling zones in Benin.

The questionnaire (Table 1) covered various aspects such as socio-economic characteristics, particularly those linked to classic fractures, agronomic elements, aspects linked to information and communication technologies (ICT) following van Dijk's steps (Figure 2): participants' motivation to use or abandon these technologies, aspects linked to access (infrastructures, terminals, costs), users' capabilities, and the various associated uses as these applications are the most commonly used. In terms of capabilities and uses, we differentiated according to the functionalities available on simple telephones and smartphones, and placed particular emphasis on instant messaging functionalities. The majority of questions were formulated in a closed format, although some were partially open-ended to allow more nuanced expression of responses. The questionnaires were administered with the explicit consent of the respondents, and each interview lasted approximately one hour. The validity of the questionnaire was initially confirmed after tests with the interviewers and a first group of market gardeners. The data collection was monitored daily by the supervisors to ensure the consistency of the data collected. In the event of refusal to participate or unavailability of the people initially selected, a new draw was made from the database to reach the total number of 1,500 surveyed.

Table 1. Questionnaire structure and main themes of investigation.

Parts	Main themes
Socio-economic characteristics	Occupation, age, gender, level of education
Farming-related characteristics	Area, crops, experience in farming
Access	Perception of telephone and Internet infrastructure, access to electricity, availability of refill kiosks and mobile money, type of digital tool and telephone, costs
Capacities	Telephone, mobile money, instant messaging, videos, other
Uses	Applications used, for what purpose

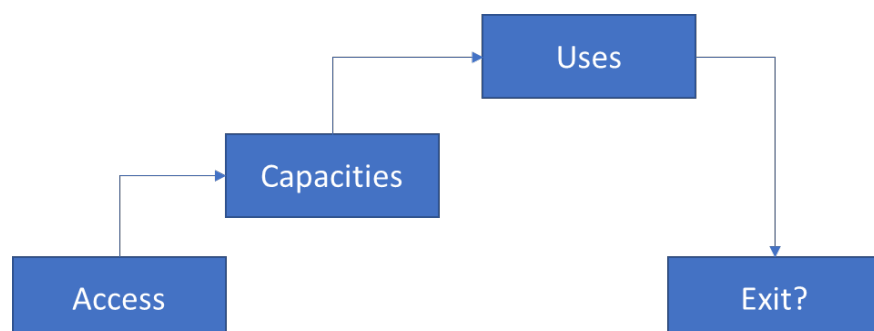


Figure 2. The digital divide framework. Adapted from van Dijk (2013).

RESULTS AND DISCUSSION

Characteristics of market gardeners and crops

Market gardening is the main activity and source of income for the studied farmers. The breakdown of 60% men and 40% women is consistent with the demographics of the market gardeners (Table 2). The overall level of education is low, with over 70% of the sample having no more than primary education. Over 90% of the sample are married or have been married. Nearly 60% of the sample speak or read neither French nor English, which can complicate the use of telephones, especially mobile money, or applications available only in international languages.

Table 2. Mobile phone possession according to main digital divide dimensions.

Dimension	Category	Total (n)	None		Simple phone		Smartphone	
			(n)	(%)	(n)	(%)	(n)	(%)
Gender	Female	608	215	35.36	315	51.81	78	12.83
	Male	892	81	9.08	412	46.19	399	44.73
Location	Rural	1,113	280	25.16	581	52.20	252	22.64
	Urban	387	16	4.13	146	37.73	225	58.14
Language	Local	857	267	31.16	496	57.88	94	10.97
	App-related	643	29	4.51	231	35.93	383	59.56
Age	<35	483	81	16.77	172	35.61	230	47.62
	35-54	794	171	21.54	414	52.14	209	26.32
	>54	223	44	19.73	141	63.23	38	17.04
Total		1,500	296	19.73	727	48.47	477	31.80

The main crops grown by the surveyed market gardeners are chili peppers (*Capsicum* spp.), leafy vegetables such as gboma (*Solanum macrocarpon*), tchayo (*Ocimum gratissimum*), crincrin (*Corchorus olitorius* L.), vernonia (*Vernonia* spp.), tomato (*Solanum lycopersicum*),

okra (*Abelmoschus esculentus*), lettuce (*Lactuca sativa*) and onions (*Allium cepa*). These crops are generally combined and vary according to season.

Access

Digital access is defined by three necessary and complementary components: electrical, telephone and Internet infrastructures, terminals, and associated costs. Infrastructure is present at all surveyed sites, despite variations in quality. In some places, networks are only accessible at specific points, such as high up or in the center of the village, and not from the fields.

Phones, simple or smart, are the only device used (Table 2). Near zero computers, tablets, drones, sensors or any other digital technology were found. Around 60% of respondents say that the telephone and internet networks are good or very good. Network quality is therefore judged positively. About 26% of market gardeners have at least two SIM cards, enabling them to make the best use of the available networks. Access to an electrical network is a prerequisite, as phones need to be charged to operate. Only 20 people (<1%) said they had no access to electricity at all, 45% via the national grid and 54% via individual or collective solar panels. We deduct that electricity is no longer a barrier to the development of ambitious digital programs in the rural Benin.

In terms of phone possession, we observed all classic digital divides (Table 2). Women, rural, elders and those who cannot speak French or English, the language of apps, tend to have less sophisticated phones. However, among those who do not possess a phone, 130 (44% of them) declare having no access to digital technologies, mostly due to the costs involved. The others use borrowed phones from relatives, friends or peers.

Interviewed farmers complained that the costs of airtime and data to access the various networks – electric, telephone or internet – are heavy. Charging the battery of a phone at the market costs FCFA 100 (€ 0.15), and people often buy airtime and data daily or every two or three days, at a cost of FCFA 100 to 500 (€ 0.15 to 0.75) each time. Despite this, farmers are eager to continue buying data and airtime as this investment is lower compared to the gains: transportation costs, efficiency of time allocation to various activities, easiness to secure clients and deliver produces.

Capacities

The most widespread capacity, and the most obvious, although it requires knowing how to dial a phone number, or getting help, is making a phone call. Nearly 30% of those without a phone know how to make calls, 90% of those with a simple phone know how, and nearly 100% of those with a smartphone (Table 3). For those without a phone, other capacities are limited. While 10% of those with a simple phone know how to send and read an SMS, other skills are rare. Smartphone ownership improves skills, particularly instant messaging related. Over 90% of smartphone owners know how to send and receive voice messages or photos, and almost 80% videos. More advanced group management capabilities are less widespread (~20%). Installing applications is a fairly widespread ability (60%), searching for information on the Internet less so (40%), and writing e-mail less so (20%). The positive relationship between capacities and phone ownership is clear.

Uses

A study of usage patterns reveals a more nuanced situation (Table 4). The most widespread uses among telephone owners are telephone calls (almost 100%) and mobile money services (85% of simple telephone owners and almost 100% of smartphone owners). Unsurprisingly, those without a phone or with a simple phone make almost no use of smartphone applications. Those with smartphones use almost all instant messaging applications, and over 50% other social networks. Nearly 30% say they use online video sites, and less than 3% an application dedicated to vegetable production. This demonstrates an appropriation of applications that are not designed specifically for agriculture and that are often already used for other purposes. This implies that agricultural applications may gain farmers interests only if they are closely related to their field of activities, adapted to the

devices they use and the capacities they already master. The design of such applications should be considered carefully taking these elements into account.

Table 3. Observed capacities according to possessed phones. Percentages are the frequency of people having a capacity related to their category.

	Capacity	None (n=296)	Simple (n=732)	Smartphone (n=472)	Total (n=1,500)
Simple phone Related	Calls	83 (28%)	638 (87.16%)	464 (98.31%)	1,185 (79.00%)
	SMS	1 (<1%)	69 (9.43%)	400 (84.75%)	470 (31.33%)
Instant messaging: basic capacities	Vocal	2 (<1%)	31 (4.23%)	450 (95.34%)	483 (32.20%)
	Pictures	2 (<1%)	35 (4.78%)	438 (92.80%)	475 (31.67%)
	Videos	1 (<1%)	27 (3.69%)	365 (77.33%)	393 (26.20%)
	Transfer content	0 (0%)	16 (2.19%)	210 (44.49%)	226 (15.06%)
Instant messaging: advanced capacities	Join groups	1 (<1%)	24 (3.28%)	259 (54.87%)	284 (18.93%)
	Create groups	0 (0%)	10 (1.37%)	107 (22.67%)	117 (7.80%)
	Admin groups	0 (0%)	8 (1.09%)	97 (20.55%)	105 (7.00%)
Other capacities	Install application	1 (0%)	23 (3.14%)	277 (58.69%)	301 (20.07%)
	Write email	0 (0%)	7 (0.96%)	104 (22.03%)	111 (7.4%)
	Search for information through search engine	1 (0%)	13 (1.78%)	198 (41.95%)	212 (14.13%)
	Follow online training	0 (0%)	6 (0.82%)	80 (16.95%)	86 (5.70%)

Table 4. Uses of mobile phones for agricultural-related objectives. One differentiated between the use of specific applications and the underlying objective – market participation and knowledge exchange.

		None (n=296)	Simple (n=732)	Smart (n=472)
Non agriculture- specific uses	Communication	160	722 (98.63%)	471 (99.79%)
	Mobile money	84	626 (85.52%)	463 (98.09%)
Applications	Instant messaging	3 (1.01%)	13 (1.78%)	456 (96.61%)
	Social networks	0 (0%)	3 (<1%)	265 (56.14%)
	Online videos	0 (0%)	4 (<1%)	134 (28.39%)
	Agricultural app	0 (0%)	0 (0%)	12 (2.54%)
Market participation	Access (find buyers)	43 (14.52%)	379 (51.78%)	472 (100%)
	Product placement	1 (<1%)	130 (17.76%)	296 (62.71%)
	Obtain price	17 (5.74%)	377 (51.50%)	282 (59.75%)
	Negotiate	41 (13.85%)	300 (40.98%)	304 (64.41%)
	Inputs (finding, negotiating)	1 (<1%)	38 (5.19%)	55 (11.65%)
	Workforce (hiring)	3 (1.01%)	182 (24.86%)	189 (40.04%)
Knowledge exchange	Knowledge exchange	3 (1.01%)	32 (4.37%)	472 (100%)
	Ask questions to family	3 (1.01%)	26 (3.55%)	223 (47.25%)
	Ask questions to others on instant messaging	0 (0%)	10 (1.37%)	221 (46.82%)
	Watch videos	0 (0%)	7 (0.96%)	110 (23.31%)
	Search and read over the internet	0 (0%)	5 (0.68%)	100 (21.19%)

Two main uses are studied: market access and knowledge exchange. 50% of simple phone owners use the phone to access the market, in particular to find out about prices and negotiate with buyers, and to a lesser extent to recruit labor. All smartphone owners use the phone to access the market, to obtain prices and negotiate or buy labor, but also via marketing approaches of product placement or advertising. In both cases, the search for inputs was not dominant as digital usage.

A major difference can be observed in terms of knowledge exchange: less than 5% of those with a simple telephone use it for this purpose, whereas all smartphone owners use it to exchange knowledge. The phone opens up the possibility of asking questions to large groups

of peers or resource people, or watching videos and carrying out online research. While calling peers or extension agents through simple phones remains possible, it seems that this practice is not common. More investigation on this topic could enable more detailed understanding.

Exit

In their vast majority, market gardeners equipped with a phone are not ready to step back and abandon their phone. Out of 1,204, only 58 farmers said they would not mind leaving their phone. Most of these farmers are those with the less capabilities and say that they can access phones through relatives (37 of them). Other reasons cited are education (16) or cost-related (14). Those who are not ready to abandon their phone (1146) cite reasons such as the ability to communicate with relatives (1,118), make financial transactions (806), efficient time allocation (629), communicate with peers (597) or advertise products (434).

CONCLUSIONS

The following conclusions can be drawn from the study:

- Improved network infrastructures and a strong access to airtime and data and mobile money recharging kiosks, as well as the availability of electricity recharging units, have made digital technology more accessible;
- Digital tools used by market gardeners in Benin are exclusively telephones, whether simple or more advanced;
- Network access and battery recharging costs remain high, but are assumed by growers as essential management costs;
- Market gardeners in southern Benin use telephones to address a number of issues: accessing the market by obtaining prices and buyers, and sharing knowledge among peers or with other players;
- They mostly use generic tools, such as instant messaging applications and social networks, or the possibilities offered by mobile money services;
- Telephones are now an integral part of the tools used by market gardeners to carry out their activities, almost none of whom would be ready to abandon this technology once they have adopted it.

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