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Food and Agriculture
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Platform for
Big Data
in Agriculture

Digital Agriculture Profile

• Côte D'Ivoire

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HIGHLIGHTS

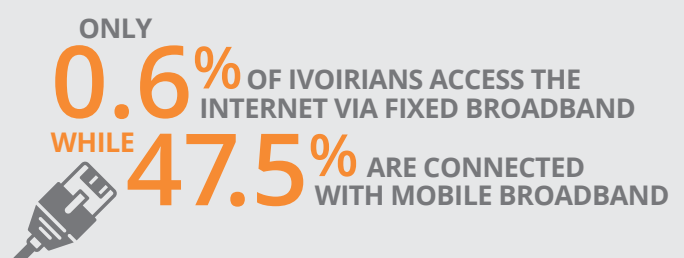
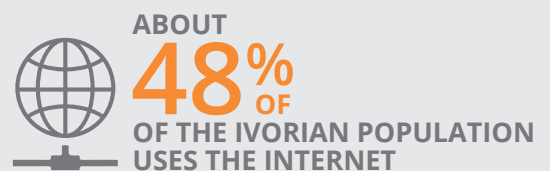
Agriculture contributes 20% of Côte D'Ivoire's GDP and employs over 48% of the labor force.

Natural resource degradation, climate change, lack of basic services, and policy distortions challenge Côte D'Ivoire's agriculture sector.

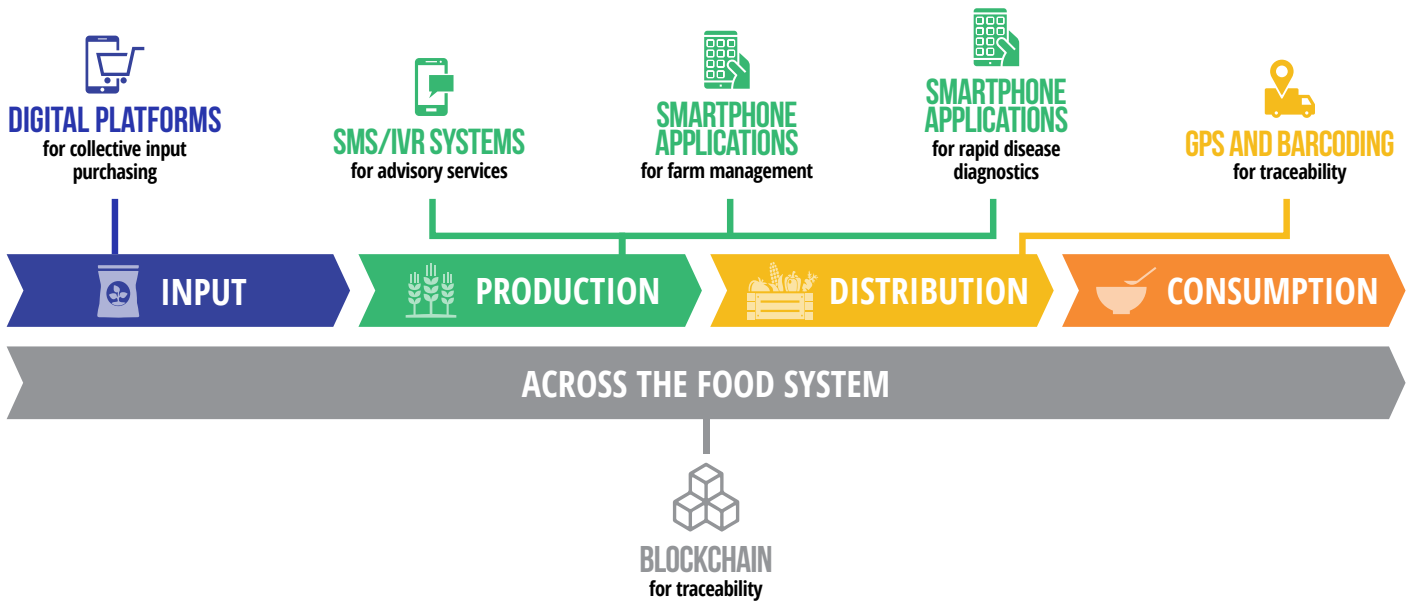
Access to digital technologies in Côte D'Ivoire rose sharply in the last decade; nearly all Ivoirians now have mobile phone access, and nearly half use the Internet.

Database technologies, satellites and GPS, mobile money, smartphones apps, and remote sensing are the most promising technologies for the agricultural sector in Côte D'Ivoire.

The public sector, non-profit organizations, private industry, and international community all have important and distinct roles to play in creating sustainable digital agricultural solutions in Côte D'Ivoire.



PRIORITY TECH SOLUTIONS



Introduction

Agriculture is one of the key sectors of the Ivorian economy, contributing 20% of total GDP¹ and employing nearly half of the national labor force.² Nevertheless, agriculture in Côte D'Ivoire faces ongoing challenges in terms of environmental degradation, policy, basic services, and unsustainable or non-resilient practices.³ Addressing these constraints offers the potential to revolutionize national economic prosperity even as population growth and climate change progress.

The emergence of digital agriculture provides a new portfolio of potential solutions to address these challenges. Digital agriculture is the use of new and advanced technologies, integrated into one system, to enable farmers and other stakeholders to improve their products and processes.⁴ Integrating digital solutions into agriculture can improve efficiency by decreasing financial and labor costs, providing information to support management decisions, increasing product quantity and/or quality, reducing losses, and/or ensuring effective and sustainable use of resources. Ultimately, the transition to digital agriculture presents a unique opportunity to spur sustainable economic growth and development by addressing major challenges in the Ivorian agriculture sector.

The Digital Agriculture Profiles are knowledge and policy advisory products of the African Development Bank's Digital Agriculture Flagship. The profiles for Côte d'Ivoire, South Africa and Rwanda join a series of similar inter-organizational guides, first conceived by the World Bank which also include countries such as Argentina, Grenada, Turkey, Kenya and Vietnam, This Digital Agriculture Profile for Côte D'Ivoire leverages the expertise of stakeholders to evaluate the current landscape of digital agriculture in Côte D'Ivoire, including its key players across value chains, the main barriers they face, and the potential to overcome these barriers through the adoption of innovative technologies. In identifying and prioritizing these technologies, we aim to support investors and implementers in maximizing their impact by focusing on the opportunities of highest potential. Once enabling factors are identified and understood, the mainstreaming of digital agriculture in Côte D'Ivoire can begin.

National Context

Economic relevance of agriculture

Côte D'Ivoire has one of the fastest-growing economies in Africa,⁵ and agriculture is at the heart of the Ivoirian economy. Agriculture accounts for 20% of the national GDP, employs over 48% of the labor force, and accounts for about 80% of total export earnings, or \$1.96bn

1 The World Bank, "Cote d'Ivoire."

2 Kovacevic et al., "Human Development Indices and Indicators."

3 FAO, ICRISAT, and CIAT, "Climate-Smart Agriculture in Côte d'Ivoire."

4 United Nations, "Digital Agriculture."

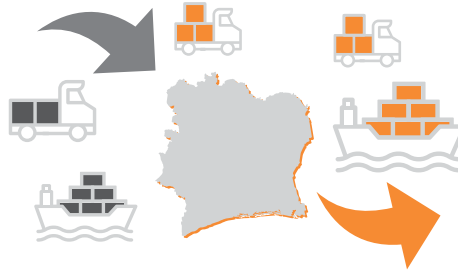
5 World Bank, "Côte d'Ivoire Ninth Economic Update."

TOP 3 AGRICULTURAL IMPORTS 2017

RICE
1.3 Million Tonnes/Year

WHEAT
648,984 T/Y

ONIONS/SHALLOTS
196,808 T/Y



TOP 3 AGRICULTURAL EXPORTS 2017

COCOA
1.5 Million Tonnes/Year

RUBBER
644,446 T/Y

CASHEW NUTS
607,306 T/Y

PRIMARY CROPS ACCORDING TO PRODUCTION QUANTITY 2018

YAMS
7.2 MILLION TONNES/YEAR

CASSAVA
5.0 MILLION TONNES/YEAR

OIL PALM FRUIT
2.1 MILLION TONNES/YEAR

PADDY RICE
2.1 MILLION TONNES/YEAR

COCOA BEANS
1.9 MILLION TONNES/YEAR

Source: FAO stats.

annually. Côte D'Ivoire is a major exporter, and the largest producer of cocoa in the world. Cocoa beans alone account for 37% of total export earnings and 10% of total exports volume. Côte D'Ivoire is also among the world's largest producers of kola nuts, cashews, and yams. Other major exports include rubber (11%), cocoa butter (6%), coconut (3.8%), bananas (3.4%) and coffee (1.1%).

Staple food crops include rice, maize, cassava, yam, plantain, and vegetables. These crops are overwhelmingly produced by the smallholder farmers. In several cases imports fill the local demand gap; rice accounts for 4.1% of 2017 imports, and is second only to crude petroleum (7.9% of total imports).⁶

20% forest cover and growth rates of 6.8% for the food crops sub-sector, 7.6% for cash crops, and 3% for animal products. In spite of these efforts, however, sectoral growth has slowed in recent years compared to the overall annual GDP growth of 7.4%.⁸ This is due in part to climate shocks, as well as unfavorable terms of trade for key agricultural exports.⁹ As a result, the National Agricultural Investment Plan objectives remain to be achieved.

Agricultural production systems

There are four broad agro-climatic zones in Côte D'Ivoire: the Sudan savannah (900-1,400 mm precipitation annually), the Guinea savannah (1,000-1,500 mm), the Western semi-mountainous forest zone (1,200 - 1,600 mm+) and the forest zone (1,200-1,600 mm+).¹⁰ Of the country's more than 32 million hectares, approximately 20.6 million (64%) is agricultural land. Approximately 17.7 million ha of the total agricultural land is under permanent crop or pasture production, and the remaining 2.9 million ha is under arable cropping systems.¹¹

Perennial tree cropping systems dictate the agricultural landscape. These crops are almost exclusively for export, and include cocoa, rubber, cashew, brazil nut, kola nut, coffee, and palm oil. Annual food crops revolve around these perennial systems, and are primarily produced by smallholders for domestic markets. There are two main animal husbandry systems: sedentary herds are found primarily in the savannah zones, and nomadic or semi-nomadic pastoralists move regionally with the seasons. About 65% of smallholders own chickens, and about 35% own sheep and/or goats.¹²

GDP PER CAPITA
IN 2018
US\$1,715

20% OF GDP COMES FROM AGRICULTURE

The Ivorian government had aimed to bolster the agriculture sector growth rate to 9% annually by 2016 through its National Agricultural Investment Plan,⁷ which outlined a reduction in food insecurity, job creation, and poverty alleviation via increased diversification, productivity, international competitiveness, and self-sufficiency. The plan specifically focused on achieving

6 LandLinks, "Côte d'Ivoire."

7 Government of Côte d'Ivoire, "Programme National D'Investissement Agricole de Deuxième Génération." (Second Generation National Agricultural Investment Program).

8 The World Bank, "Cote d'Ivoire."


9 World Bank, "Côte d'Ivoire Economic Outlook."


10 FAO, ICRISAT, and CIAT, "Climate-Smart Agriculture in Côte d'Ivoire."

11 World Bank, "Arable Land (Hectares)."

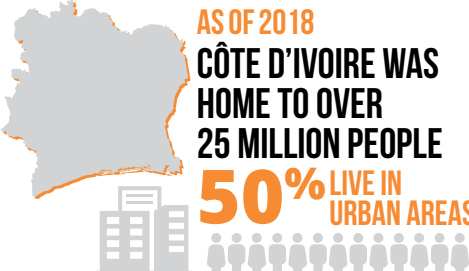
12 FAO, ICRISAT, and CIAT, "Climate-Smart Agriculture in Côte d'Ivoire."

APPROXIMATELY
64%
OF THE COUNTRY'S
MORE THAN **32 million hectares**
IS AGRICULTURAL LAND



APPROXIMATELY
17.7 million hectares
OF THE TOTAL AGRICULTURAL LAND IS UNDER
PERMANENT CROP OR PASTURE PRODUCTION,
THE REMAINING
2.9 
IS UNDER ARABLE CROPPING SYSTEMS
million hectares

AS OF 2018
CÔTE D'IVOIRE WAS
HOME TO OVER
25 MILLION PEOPLE
50% LIVE IN
URBAN AREAS




LIFE EXPECTANCY AT BIRTH IS
57 years

RANKED
170 / 189 COUNTRIES ON
THE HUMAN DEVELOPMENT INDEX



AS OF 2015 OVER
28% OF IVORIANS
LIVED BELOW THE POVERTY LINE OF
US \$1.90/day



People, livelihoods, and agriculture

As of 2018, Côte D'Ivoire was home to over 25 million people, approximately half of which reside in urban areas.¹³ Average population density is approximately 79 people/km². Current life expectancy is 57 years¹⁴ and more than 60% of the population is under the age of 25. In combination with low contraception rates, this suggests that the current population growth rate of approximately 2.6%¹⁵ is likely to continue for the foreseeable future.¹⁶ Côte D'Ivoire's Human Development Index score for 2017 was 0.492, which puts the country in the low human development category and positions it at 170 / 189 countries.¹⁷

As of 2015 over 28% of the population lived below the international poverty line of US\$ 1.90 / day, and more than 46% lived below the national poverty line. The situation is worse in rural areas, where nearly 57% of households living below the national poverty line, versus about 36% in urban areas.¹⁸ Approximately 13.3% of the population is undernourished, and 29.6% is malnourished.¹⁹ The agricultural sector employs an outsized percentage of those living in poverty. Only 15% of the smallholder Ivorian farmers have an education of secondary school or above.²⁰ In 2016 62% of the population had access to electricity: 31% of rural residents and 88% of those in urban areas.²¹ Wood is the primary national fuel source; charcoal is used by approximately 47% of the urban population.²²

Challenges in the agricultural sector

Despite the importance of agriculture in Côte D'Ivoire, the sector is confronted with several challenges, including high deforestation rates, soil erosion, land tenure insecurity, rising average temperatures, falling average precipitation, and frequent extreme climate events.²³ Since the early 1960s forest cover has declined from 16 million hectares to 2 million hectares, primarily due

¹³ World Bank, "Population, Total | Data."

¹⁴ World Bank, "Life Expectancy at Birth, Total (Years)."

¹⁵ The World Bank, "Cote d'Ivoire."

¹⁶ Ministry of Planning and Development, "Survey of Household Living Standards in Côte D'Ivoire."

¹⁷ Human Development Reports, "Côte d'Ivoire."

¹⁸ The World Bank, "Poverty & Equity Data Portal."

¹⁹ The World Bank, "Cote d'Ivoire."

²⁰ FAO, ICRISAT, and CIAT, "Climate-Smart Agriculture in Côte d'Ivoire."

²¹ Power Africa, "Power Africa in Côte D'Ivoire."

²² Centre d'échange d'informations de la Côte d'Ivoire, "Rapport Pour Les Etats Généraux de La Forêt, de La Faune et Des Ressources En Eau." (Côte d'Ivoire Information Clearinghouse, Report for the General Meetings on Forestry, Wildlife and Water Resources).

²³ FAO, ICRISAT, and CIAT, "Climate-Smart Agriculture in Côte d'Ivoire."

to overharvesting of timber and fuel, bush fires, and agricultural expansion.²⁴

Most agricultural production is subsistence-based, and smallholder farmers rely on rain, manual family labor, traditional knowledge and practices, and agricultural expansion to maintain productivity.²⁵ Smallholders have very limited access to the services and inputs necessary to innovate, including robust extension services, high quality crop inputs, information services (e.g. weather, pests, markets), credit and insurance services, mechanization, good postharvest processing, robust transportation infrastructure, and stable markets. Urbanization has drastically reduced the number of youth and skilled workers in rural areas. Policy distortions create barriers to young people and women securing land tenure;²⁶ this dissuades investments in sustained land fertility and health.²⁷

Current landscape of digital tools and policies

Digital infrastructure, availability and access

Huge progress has been made in readying Côte D'Ivoire for digital innovation, and much work remains to be done.²⁸ In the year 2000 there were only about 3 mobile subscriptions for every 100 inhabitants of Côte D'Ivoire. This had risen to 75 by 2010, and by 2018 it had reached 135 mobile subscriptions per 100 inhabitants. As of 2010 only 2.7% of the population had Internet access; by 2018 this had risen to nearly 47%, with an overwhelming majority of access occurring via mobile connections.²⁹ Approximately 95% of the country has 3G or 4G LTE coverage.

Côte D'Ivoire ranks 106/139 on the Networked Readiness Index behind other African countries such as South Africa (67), Seychelles (74), Rwanda (80), and neighboring Ghana (102).³⁰ The country ranks 131/176 on the Information Communication Technology Development Index with a score of 3.14, putting it in 9th place among African countries. This is an improvement on its 2016 score and

24 Centre d'échange d'informations de la Côte d'Ivoire, "Rapport Pour Les Etats Généraux de La Forêt, de La Faune et Des Ressources En Eau." (Côte d'Ivoire Information Clearinghouse, Report for the General Meetings on Forestry, Wildlife and Water Resources).

25 LandLinks, "Côte d'Ivoire."

26 Teyssier, "Cote d'Ivoire Land Policy Improvement and Implementation Project."


27 FAO, "Country Programming Framework 2012-2015."

28 HeraldKeeper and Comtex, "Cote d'Ivoire Telecoms, Mobile and Broadband Market Research 2019-2022 Industry Key Players."

29 The World Bank, "Cote d'Ivoire."

30 World Economic Forum, "Networked Readiness Index."


APPROXIMATELY
13.3%
OF THE POPULATION IS UNDERNOURISHED
AND **29.6%** MALNOURISHED



ONLY
15%
OF THE SMALLHOLDER IVORIAN FARMERS HAVE
AN EDUCATION OF SECONDARY SCHOOL OR ABOVE




WOOD IS THE PRIMARY
NATIONAL FUEL SOURCE;
CHARCOAL IS USED BY
APPROXIMATELY **47%**
OF THE URBAN POPULATION




SINCE THE EARLY 1960S FOREST COVER HAS DECLINED
FROM **16 million** TO **2 million**
hectares hectares



APPROXIMATELY
95%
OF THE
COUNTRY HAS 3G OR 4G LTE COVERAGE



CÔTE D'IVOIRE
RANKED
106TH
OUT OF **139**
ECONOMIES ON THE
NETWORK READINESS INDEX
OF 2016

CÔTE D'IVOIRE SCORED
131 / 176 ON THE
INFORMATION COMMUNICATION
TECHNOLOGY DEVELOPMENT INDEX
IN 2016



rank of 2.84 and 134/176, respectively.³¹ While mobile connectivity has become widely accessible, Internet costs remain high. 1GB of data costs about 7% of GNI³² per capita; this would be the equivalent of paying US\$4,220 in the USA for 1GB of data.³³

The country has a unified service operator for fixed, mobile, and data services. CI-Telecom dominates the fixed-line sector, and merged with the mobile network operator Orange Côte D'Ivoire in December 2016. The fixed internet and broadband sectors have remained underdeveloped; this is in part due to a legacy of high international bandwidth costs resulting from a single provider's monopoly access to the only international fiberoptic submarine cable serving the country.³⁴

End-user diversity and demand

Digital agriculture end users are generally grouped into four hubs. Each hub has unique resources and needs in terms of digital agriculture, and each hub faces unique challenges for which digital agriculture could offer solutions. The hubs are not mutually exclusive; any given individual may function within multiple end user hubs.

The **Input hub** includes all actors providing agricultural inputs, such as seeds, feeds, agrochemicals, machinery, and finance. The key challenges confronting stakeholders in this hub are limited access to seeds, high price of mechanization, few finance services, and a lack of advisory information services.

The **Production hub** is mainly made up of farmers and livestock keepers. The challenges they face depend on the size of their operation. Large scale farmers face land tenure issues, decreased soil fertility, and poor access to markets. Small scale farmers grapple with challenges related to input access, technology innovation, advisory service access, finance services access, irrigation infrastructure, and climate change impacts. Both large and small scale farms deal with plant and animal disease issues.

The **Distribution hub** consists of all actors in the value chain between farmers and the consumers; this includes traders, transporters, and processors, among others. This hub grapples with poor road quality, particularly in regards to routes connecting rural communities to urban markets. Insufficient or a total lack of access to postharvest facilities, high taxes, and low security of goods and personnel in transit are also major constraints.

31 International Telecommunication Union, "Global ICT Development Index."

32 gross national income

33 Alliance for Affordable Internet, "Cote d'Ivoire."

34 Herald Keeper and Comtex, "Cote d'Ivoire Telecoms, Mobile and Broadband Market Research 2019-2022 Industry Key Players."

The **Consumer hub** includes all consumers of food products—in effect, the entire population. This group can be subdivided into rural and urban consumers. The main challenges for both are a lack of information access regarding production origin, processing, and ingredients to support purchasing decisions.

Several key issues are **Cross-cutting**, including limited access to finance services and decision-support information.

Institutions and policies for Digital Agriculture

Côte D'Ivoire's major gains in digital infrastructure and access have been propelled by key policy reforms. The 2012 Digital Solutions Program for e-Agriculture and the Opening of Rural Areas (PSNDEA)³⁵ realigned telecommunications laws with regional priority issues and defined a national strategy for digital solutions in agriculture and rural areas. The policy addresses crucial topics such as convergence, universal service, licensing and authorizations, market power, and consumer protection.³⁶ This policy shift was supported by the World Bank and led by the five governmental institutions at the helm of digital technologies in Côte D'Ivoire:

- Ministère de l'Économie Numérique et de la Poste (MENUP), which addresses the digital economy
- Autorité de Régulation des Télécommunications de Côte D'Ivoire (ARTCI), which deals with licensing, wholesale market regulation, telecommunications spectrum management, and consumer protection.
- Agence Nationale du Service Universel des Télécommunications (ANSUT), which is charged with the implementation of universal service programs and digital infrastructure
- Agence Ivoirienne de Gestion des Fréquences Radioélectriques (AIGF), which manages radio networks
- Société Nationale de Développement Informatique (SNDI), a state-owned company supervised by the Prime Minister's office which leads governmental ICT³⁷ projects.

The second iteration of the National Agricultural Investment Plan (PNIA II) provides an additional framework for public programming and private investment in the

35 République de Côte d'Ivoire, "Ministère de l'Agriculture et Du Développement Rural"; Kra Valerie et al., "Mission d'Identification des Services Numeriques pour le Secteur Rural." (Republic of Cote d'Ivoire, Ministry of Agriculture and Rural Development; Kra Valerie et al., "Identification Mission of Numerical Services for the Rural Sector").

36 Abidjan Urban Mobility Project, "Combined Project Information Documents / Integrated Safeguards Datasheet (PID/ISDS)."

37 information communication technology

agricultural sector. The PNIA II is well aligned with PSNDEA in terms of digital agricultural innovation, and specifically addresses projects in electronic producer profiling, geolocation, and technologies such as GPS³⁸, satellites, and smartphones, among others. The 2015 Agricultural Orientation Law defines the regulatory framework for all agricultural activity, and regulation is also in place for general ICT³⁹ activities.

Côte D'Ivoire is also heavily involved in regional and international cooperation in support of digital agriculture. The country is signatory to the United Nations 2030 Agenda for Sustainable Development, which emphasizes new and digital technologies;⁴⁰ all 17 Sustainable Development Goals are supported by the provision of mobile connectivity.⁴¹ In April 2019 Côte D'Ivoire participated in the first regional Digital Agriculture in Africa⁴² symposium in Senegal, which brought together several research institutions of the region and their partners.⁴³ Côte D'Ivoire has also very recently worked with CIRAD⁴⁴ and AFD⁴⁵ on the smart agriculture and technological innovation.⁴⁶

Digital agricultural services and applications available

Côte D'Ivoire is at the early implementation phase of its newly adopted national policies supporting the development of digital solutions. A number of the programs are being successfully piloted and have not yet been scaled out.

The most well-known digital agriculture solution in the country, Lôr Bouôr, was developed by the Ivorian ICT⁴⁷ and agricultural development specialist Jean-Delmas Ehui. Lôr Bouôr means "productive planting" in the Lobi language, and is a strong example of the use of ICT to improve efficiency, communication, and productivity at the cooperative level.

Lôr Bouôr offers five services for farmers:⁴⁸

- Cooperative management

- Information and training for various value chain actors
- An SMS- based virtual market linking agricultural cooperatives with customers
- An SMS-based market information system
- A voice server called Djassi that disseminates agricultural advisory information to farmers in local languages

As of 2015, 840 cooperatives serving 20,000 farmers were registered on the Lôr Bouôr platform. Lôr Bouôr plans to work closely with the government in the digitalization of the agricultural sector, and ultimately aims to extend its activities to a large part of West Africa, including Benin, Burkina Faso, Cameroon, Mali, and Togo.

Orange offers mAgri⁴⁹ information services in Côte D'Ivoire via USSD⁵⁰, SMS⁵¹, call centers, IVR⁵², and web chatbots. Services currently include weather forecasting, market prices, and crop and livestock extension. Additional Orange services are available in other African countries, including market access, finance, IoT⁵³, and agribusiness data management.⁵⁴

WeFly Agri leverages drones, sensors, and VR⁵⁵ helmets in precision farming to improve yields and optimize management practices⁵⁶. SIFCA⁵⁷, a large private sector conglomerate, has digitized many of its points of connection with employees and smallholders.⁵⁸ INVESTIV, an Ivorian company, specializes in precision agriculture service, and has pioneered the use of drones in West African agriculture. INVESTIV's services include aerial cartography, phytosanitary diagnoses, and aerial spraying via drone, among others.⁵⁹

In December 2008, Orange became the first mobile network operator to launch mobile money services in Côte D'Ivoire. MTN followed suite in October 2009, and Moov in January 2013.⁶⁰ Operators have generally made efforts to increase adoption of ecosystem transactions beyond person-to-person transfers. Cocoblock is testing blockchain-based traceability to increase transparency,

38 geographic positioning system

39 information communication technology

40 Servent, "Plan d'Action Du Gouvernement Développement et Numerique." (Government Action Plan on Digital Development)

41 Lucini and Bahia, "Cote d'Ivoire."

42 Abbreviated in French as AgriNumA

43 CIRAD, "AgriNumA 2019 : Le 1er Rendez-Vous de l'Agriculture Numérique En Afrique de l'Ouest." (AgriNumA 2019 : The 1st Digital Agriculture Meeting in West Africa)

44 La Recherche Agronomique pour le Développement (Agronomic Research for Development)

45 Agence Française de Développement (French Development Agency)

46 CIRAD, "SARA | Le Cirad et l'AFD Se Mobilisent Pour Promouvoir Un Modèle Agricole Africain Durable et Innovant." (SARA | CIRAD and AFD Mobilize to Promote a Sustainable and Innovative African Agricultural Model)

47 information communication technology

48 Rahman and Fong, "Innovate for Agriculture."

49 mobile agriculture

50 unstructured supplementary service data

51 short message service

52 interactive voice response

53 internet of things

54 Hello Future Orange, "Innovative Services That Are Supporting Agriculture in Africa - Hello Future Orange."

55 virtual reality

56 WeFly Agri, "Drones for Optimum Agricultural Production in Côte d'Ivoire."

57 Société immobilière et financière de la côte africaine (the Real Estate and Finance Company of the African Coast)

58 De Feligonde, "La « révolution digitale », nouvelle panacée pour sortir les agriculteurs africains de la pauvreté ?" (The "digital revolution", a new panacea to lift African farmers out of poverty?)

59 Investiv, "Investiv."

60 GSMA, "Mobile Money Deployment Tracker."

reduce transaction costs, and improve profit margins.⁶¹ Advans offers farmers a mobile savings account.⁶²

Another recent startup is the *Djori Djori* SMS application. Djori Djori translates 'how much, how much' in the Malinké language. *Djori Djori* is an information system for price information and product trends on urban and rural agricultural markets, and is currently operating in six regions of Côte d'Ivoire. *Agri Conseil* was launched by the same founder, and offers training in e.g. climate phenomena, water management, and fertilizer usage through SMS and voice messages in local languages. Every week, five messages are sent to some 5,000 farmers via partner mobile phone operator MTN. These services are provided in close coordination with research institutes, agricultural schools, and many others partners.⁶³

Barriers to Digital Agriculture

Côte D'Ivoire has made significant progress in infrastructure and access over the last decade that opens up new opportunities for digital technology to address ongoing challenges in agriculture. Nevertheless, some barriers to successful digital solutions remain.⁶⁴ A lack of electricity and last mile digitization remain major bottlenecks in rural areas.⁶⁵ Affordability is by far the most commonly cited barrier to mobile Internet usage across the whole of Côte D'Ivoire (Figure 1).⁶⁶ High prices disproportionately impact vulnerable populations such as the poor, women, and youth.⁶⁷ In addition to paying for access, stakeholders must also invest in hardware to connect with network services. There is currently a dearth of accessible credit and loan services that would enable actors to invest in such technologies on both the consumer and producer ends.

There is also a marked lack of digital skills among potential users as well as potential providers across both urban and rural areas. Significant human resource gaps remain to be filled. This includes the technical capacity to develop and maintain technologies, services, and solutions, as well as users' digital literacy to employ services and solutions. At present very few opportunities exist for Ivorians to build their technical capacity and digital literacy. Low digital literacy, particularly within the Producer hub, is the major limiting factor for achieving impact at scale.

61 Nitidae, "CocoBlock."

62 GSMA, "Opportunities in Agricultural Value Chain Digitisation - Learnings from Côte d'Ivoire."

63 CTA, "Innovate for Agriculture - Young ICT Entrepreneurs Overcoming Challenges and Transforming Agriculture."

64 Herald Keeper and Comtex, "Cote d'Ivoire Telecoms, Mobile and Broadband Market Research 2019-2022 Industry Key Players."

65 Lucini and Bahia, "Cote d'Ivoire."

66 Kra Valerie et al., "Mission d'Identification des Services Numeriques pour le Secteur Rural." (Identification Mission of Numerical Services for the Rural Sector)

67 Lucini and Bahia, "Cote d'Ivoire."

Enabling Digital Agriculture

An important first step in leveraging digital agriculture to solve real-world problems is identifying the most promising technologies across multiple end user barriers.⁶⁸ This enables investors and implementers to focus their efforts on areas of highest impact. Once enabling factors are identified and understood, the mainstreaming of digital agriculture in Côte D'Ivoire can begin. Supportive national policies, public-private partnership investments, and the support of donors and development partners will all be crucial in ensuring the success digital agricultural solutions.

Technologies with greatest potential⁶⁹

The main challenges the **Input Hub** actors face are limited access to seed, high fertilizer prices, low mechanization rates, lack of advisory information services, and limited access to finance. The most promising solutions to these issues include SMS/IVR,⁷⁰ smartphone applications, and database technologies. On the short term, SMS/IVR would enable provision of timely advisory information and services. On the medium term, smartphone technology will improve the feasibility of linking across hubs and strategizing for economies of scale. On the long term, database technology will enable robust finance services.

Challenges facing the **Producer hub** include low digital literacy, high cost of services, and poor access to credit and loan to invest in on-farm innovations. The most urgent issues facing small scale farmers are low input access, constrained access to technology, scant financial services, a lack of irrigation infrastructure, and high climate change vulnerability. The most promising technologies for addressing these issues on the smallholder scale include SMS, mobile money, and digital platforms. Recent research showed that most

68 In this analysis, we focus on identifying, for each of the end user hubs, the main challenges confronting the agriculture sector. We then identify, using participatory methods, a set of technologies and associated functions and outcomes. Table 1 shows the results of the technology prioritization across hubs. Next, each technology was assessed across six dimensions: Progress (the current degree of development, use, maturity, scaling, uptake, and profitability of the technology), Policy and enabling environment (the degree to which policy, programs, and investments enable further development, adoption, and impact of the technology), Potential impact (the expected uptake and return on investments of the technology over the next decade), Efficiency (the extent to which the technology enhances food systems efficiency in terms of labor, inputs, yield, transport, and transaction cost reduction), Equity (the degree to which the technology breaks down barriers to equity, particularly in terms of youth and gender inclusivity), and Environment (the extent to which the technology supports environmental sustainability through waste reduction, greenhouse gas intensity reduction, and improved natural resource use efficiency). Each of these is assessed using a number of indicators. The results of the technology identification and assessment are described below, followed by a discussion of the policies, the role of the public and private sector, and the financing options available to support the promotion of the most promising technologies.

69 Disclaimer: These results are based on a combination of desk research and stakeholder consultation. The latter included 8 interviews with government representatives, academics, farmers, and entrepreneurs, as well as a one-day workshop with 25 key experts in digital agriculture.

70 short message service / interactive voice response

Ivorian cocoa farmers do not have bank accounts, but over half have mobile money accounts.⁷¹ Finance services play a major role in improving equity for economically disempowered groups, particularly women.⁷² Leveraging mobile money and digital market platforms to reduce inequity in access to finance services will significantly support economic growth and stability in female-run households and farms. Infrastructure must be well-established on the short term in order to make these services widely available on the medium term.

Large scale farmers generally have greater access to more expensive and complex digital solutions, such as database technologies, digitized farm records, remote sensing, GPS,⁷³ and communication platforms. These technologies hold great promise for addressing large-scale operations' issues with land tenure insecurity, decreased soil fertility, lack of warning systems, and poor market access. On the short term, communication platforms will enable early warning systems to monitor and control pest and disease issues more effectively. On the medium to long term, database technologies will enable essential value chain connections among hub actors, remote sensing and GPS will automate farm processes, and digitized farm records will create transparent connections with other hubs, particularly consumers. It is worth noting that automated pesticide and fertilizer application is prone to rebound effects, wherein efficiency gains lead to higher overall use of inputs and, consequently, greater environmental degradation and greenhouse gas intensity. In order to have positive environmental impacts, increased efficiency must be paired with sustainable intensification practices.

Actors in the Distribution Hub grapple with weak postharvest storage infrastructure, poor road networks, and compromised transit security for both goods and transporters delivering agricultural products. On the short term, the most promising technologies for addressing these challenges include smartphone applications, GPS⁷⁴, IVR,⁷⁵ and e-payment platforms. On the medium term, certification systems and CCTV⁷⁶ would further support transparency and security. On the medium to long term, blockchain, barcoding, and IoT⁷⁷-based solutions will also become viable.

The **Consumer Hub** has issues related to limited knowledge of agricultural product availability, nutritional value, source traceability, and pricing. The most promising

71 International Finance Corporation, "Opportunities for Digital Financial Services in the Cocoa Value Chain."

72 Leora Klapper, "Financial Inclusion Has a Big Role to Play in Reaching the SDGs."

73 geographic positioning system

74 geographic positioning system

75 interactive voice response

76 closed-circuit television

77 internet of things

technologies for addressing these issues include digital marketplaces, price monitoring, e-payments and SMS/IVR⁷⁸ on the short term, e-learning platforms on the medium term, and virtual markets on the long term.

Potential avenues for the public sector

In terms of maximizing progress towards the country's Sustainable Development Goals, resources should be focused on scaling mobile voice on the short term, mobile Internet on the short to medium term, and mobile IoT⁷⁹ services on the medium to long term.⁸⁰ Robust access to decision-support, including early warning systems, weather stations, pest and disease forecasts, and advisory services is foundational, and is a key challenge across all hubs. Such services are public goods, and thus most effectively provided by public sector institutions. The public sector will also play a crucial role in creating an enabling environment for private sector stakeholders to develop and scale cutting-edge digital agricultural solutions.

Public-private partnerships between the national government and mobile operators could enable the implementation of digital identity services, which would facilitate the establishment of health and social welfare e-services, including social security contributions and disbursements, health insurance contributions and disbursements, digitization of agricultural value chains, and transportation payments.⁸¹ This may also be an area where financial and technical support from international organizations could be particularly helpful.

Enabling regulations are an important predictor of success for public and private initiatives alike. For example, mobile money solutions can be supported with policy that permits non-banks to issue electronic money, requires proportional capital requirements, and does not prescribe specific interoperability models.⁸² Piloting, demonstration plots, and public awareness campaigns will help ensure that all stakeholder hubs are familiar with the digital innovations, solutions, and opportunities available to them.

Sufficient funding is a prerequisite to successfully implementing and scaling public services, and is one of the main challenges for the development of digital agriculture in Côte D'Ivoire. Robust public financing will be needed for digital technology infrastructures and innovations that may not be profitable in the short

78 short message service / interactive voice response

79 internet of things

80 Lucini and Bahia, "Cote d'Ivoire."

81 Lucini and Bahia.

82 GSMA, "Mobile Money Deployment Tracker."

term. Currently available funding for digital agriculture in Côte D'Ivoire is built around two primary sources: the PSNDEA⁸³ World Bank funding (US\$ 210 million over 15 years) and the PNIA II⁸⁴ engagement (US\$ 784 million). The latter figure represents about 35% of the estimated cost of full implementation of the PNIA II. The remaining 65% of cost must be garnered from donor contributions.⁸⁵ Committing the recommended 10% of annual budgetary allocations to the agriculture sector as stipulated by the Malabo Declaration is an excellent first step. This level of engagement from the government is a strong signal to private organizations that often unlocks crucial private capital and development assistance to support the rapid evolution and mainstreaming of digital agriculture solutions.

Potential avenues for the private sector

The private sector encompasses a very diverse set of actors, ranging from farmer associations, cooperatives, and small to medium enterprises to the largest international companies.⁸⁶ Many public-private cost sharing models beyond that outlined by PNIA II will be necessary to achieve sustained digital transformation of the agriculture sector. One interesting example of a successful partnerships spearheaded by the private sector comes from the policy domain. The National Office of Technical Studies and Development (BNETD)⁸⁷ is supporting the Government of Côte D'Ivoire via the consulting, design, implementation, and monitoring of large-scale engineering development projects. As part of this, the BNETD advises the government on policy for digital transformation in multiple domains, including agriculture.⁸⁸

The global demand for Côte D'Ivoire's key exports—particularly cocoa—continues to rise, as does awareness and demand for fair-trade and climate-smart cocoa production. This implies significant private sector funding is available for digital solutions that help advance sustainable production and traceability.

Mobile programs have historically been most successful when led by mobile network operators. Last mile digital tools benefit agribusinesses through optimization of

operations targeted and systematic information delivery, as well as by driving ongoing sustainability initiatives such as certification, traceability schemes, and capacity building. They offer the potential to support more reliable supply chains through the digitization of records, payments, and other crucial transactions. Such digital solutions also benefit the government by lowering the cost of distributing payments, harnessing economies of scale and real-time transactions across great distances, mitigating cash handling risks, such as theft and fraud, and enabling transparent and traceable transactions.⁸⁹

There are not currently any agricultural business-to-person digital initiatives in the country; this is particularly promising for sectors with high economies of scale, such as cocoa.⁹⁰

83 2012 Digital Solutions Program for e-Agriculture and the Opening of Rural Areas

84 National Agricultural Investment Plan

85 Ivory Coast Ministry of Agriculture and Rural Development, "Programme National D'Investissement Agricole de Deuxième Génération, 2017-2025, Final Report." (Second Generation National Agricultural Investment Program, 2017-2025, Final Report)

86 Food and Agriculture Organization of the United Nations, "With the Private Sector."


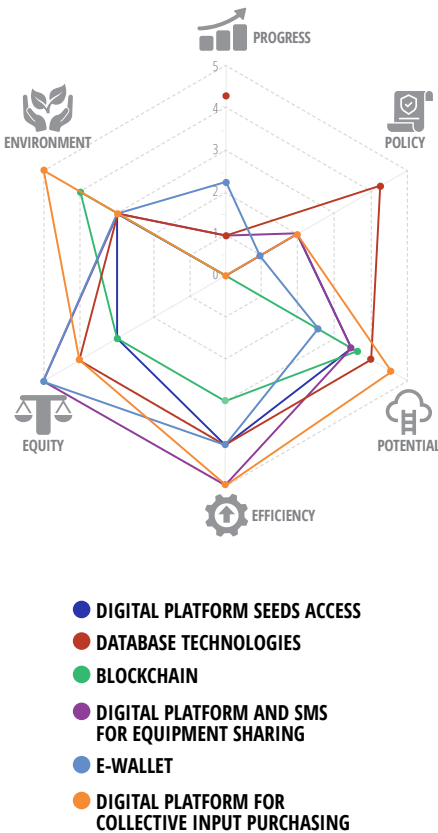






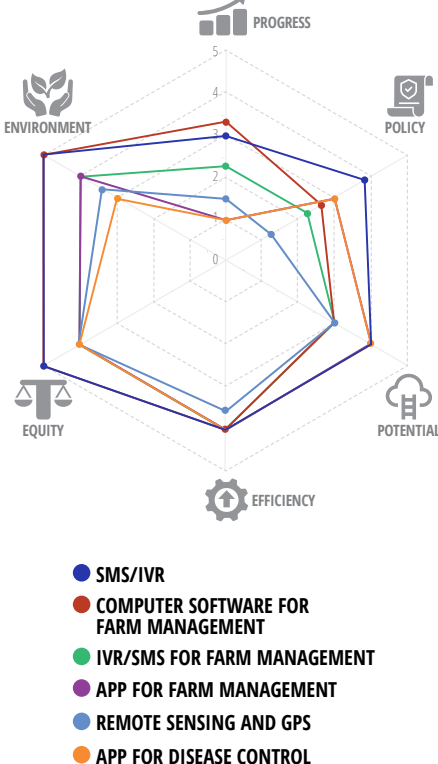





87 In French, Bureau National d'Etudes Techniques et de Développement


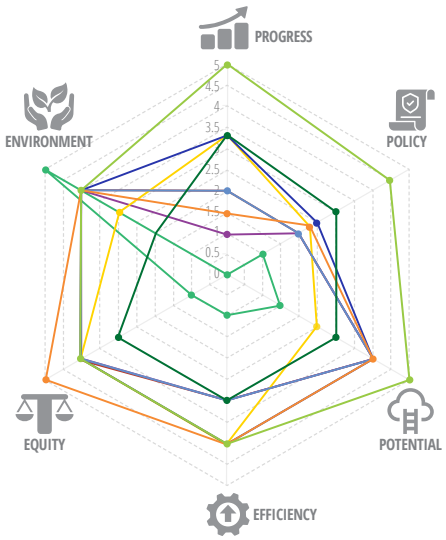









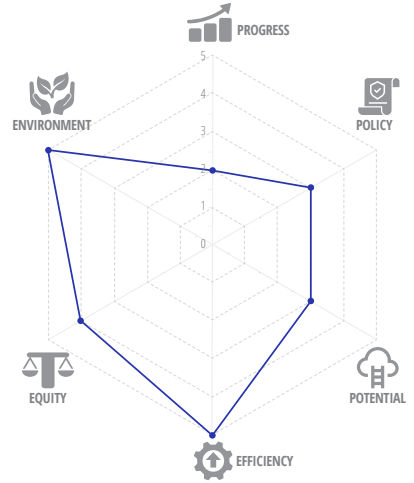
88 Bureau National d'Etudes Techniques et de Développement, "Pole Agriculture Information Geographique et Du Numerique." (Office of National Technical Studies and Development, "Agriculture Geographic and Digital Information")

89 GSMA, "Mobile Money Deployment Tracker."

90 GSMA, "Opportunities in Agricultural Value Chain Digitisation- Learnings from Côte d'Ivoire."

Table 1: Prioritized technologies

	Challenge	Technology	Outcome	Analysis
INPUT HUB	Poor access to quality seeds	 Digital platform to facilitate seed access	Enhanced access to high quality and improved seed varieties	 <ul style="list-style-type: none"> ● DIGITAL PLATFORM SEEDS ACCESS ● DATABASE TECHNOLOGIES ● BLOCKCHAIN ● DIGITAL PLATFORM AND SMS FOR EQUIPMENT SHARING ● E-WALLET ● DIGITAL PLATFORM FOR COLLECTIVE INPUT PURCHASING
	Poor availability and access to quality inputs	 Database technologies	Improved connection among value chain actors and improved access to government input support services for farm producers	
		 Blockchain for traceability	Transparent sourcing, quality, ingredients, and destination	
	Low mechanization of farming systems	 Digital platform and SMS for local equipment sharing platforms	Improved productivity and reduced labour/drudgery	
	Lack of finance services	 E-wallet for credit access, insurance, and other finance services	Distributed risk, increased resilience, and increased capacity to innovate	
	Inconsistent input price, access, and quality	 Digital platform for collective input purchasing	Improved access, lower transaction costs for input distributors and retailers, lower input costs for producers, and enhanced yields	
PRODUCER HUB	Lack of access to advisory services	 SMS/IVR	Dissemination of information on best practices, new or improved technologies, weather, pest and disease risks, markets, and particular individual circumstances	 <ul style="list-style-type: none"> ● SMS/IVR ● COMPUTER SOFTWARE FOR FARM MANAGEMENT ● IVR/SMS FOR FARM MANAGEMENT ● APP FOR FARM MANAGEMENT ● REMOTE SENSING AND GPS ● APP FOR DISEASE CONTROL
	Poor access to farm management technologies	 Computer software for farm management	Improved productivity, resource use efficiency, and sustainable intensification	
		 IVR/SMS for farm management		
		 Smartphone applications for farm management		
	Recurrent plant and animal diseases	 Remote sensing and GPS	Land/crop monitoring and timely responses to issues. Effective quarantine in cases of localized outbreaks	
 Smartphone applications and SMS Improving early detection and control		Rapid disease diagnostics and decision support		

	Challenge	Technology	Outcome	Analysis
DISTRIBUTION HUB	Low market access	 IVR for market information	Improved access to farm communities across seasons	 <ul style="list-style-type: none"> ● IVR FOR MARKET INFORMATION ● E-MARKET ● IoT ● BLOCKCHAIN ● CERTIFICATION ● GPS FOR STORAGE FACILITIES ● GPS TRACKING FOR SECURITY ● ELECTRONIC PAYMENT ● CCTV
		 Smartphone applications for e-markets	Online stores and e-markets, improved market access, greater connectivity between farmers and distributors.	
		 IoT linking farmers to markets	Link stakeholders, reduce transportation time and cost	
	Lack of processing and storage facilities	 Blockchain for traceability	Higher economies of scale, greater value-addition, export opportunities, and new job opportunities.	
		 Certification systems	Standardized weighing and packaging of produce	
		 GPS and barcoding for traceability	Mechanized and efficient storage and warehouse facilities	
	Goods and personnel in transit are not secure	 GPS tracking	Tracking of personnel and goods in transit.	
		 Mobile money, electronic payment systems	Greater trust and transparency in distribution networks and value chains.	
		 CCTV for security	Secure and timely payment processing. All fostering increased volume of agricultural product transactions.	
CONSUMER HUB	Low awareness of market conditions	 SMS/IVR for product information	Improved awareness of product information, nutrition, origin, ingredients, and markets. Provision of market price and product availability information	 <ul style="list-style-type: none"> ● SMS/IVR

Outlook / synthesis of recommendations

Côte D'Ivoire has made great strides over the last decade in establishing the foundational infrastructure and access to enable digital innovations. Mobile subscriptions rates are in excess of 100%, nearly half the population has Internet access, and connectivity continues to improve. A number of persistent issues in the agricultural sector could be resolved or significantly ameliorated with digital innovations, including inadequate access to quality inputs and services, high postharvest losses, low mechanization rates, poor transparency and traceability, and unreliable markets.

Digital agricultural solutions are already being piloted and hold scalability potential. Côte D'Ivoire's government has established a strong enabling policy environment for digital agricultural innovations, and is now presented with the opportunity to demonstrate further financial commitment to digital projects. The country's position as a world leader in key export crop production creates significant opportunities for private sector investment. Potential barriers to the success of digital agricultural solutions include poor infrastructure, inadequate network connectivity and service, and low technical capacity and digital literacy across hubs.

Our in-country research indicates that the highest potential technologies for addressing these issues include database technologies, remote sensing, GPS,¹ SMS/IVR,² smartphone applications, electronic payment systems, digital information boards, and satellites networks. Stakeholders who focus their efforts on solutions that engage these technologies are most likely to bring scalable, high-impact solutions with strong adoption rates. In all cases, piloting, demonstration plots, and public awareness campaigns will help ensure that farmers remain abreast of the digital innovations, solutions, and opportunities available to them.

Supportive national policy, public-sector investment, private sector engagement in innovation and monetization, research and development contributions from organizations such as the African Development Bank, World Bank, CGIAR and FAO, and other international donor support will all be crucial to ensuring the success of such solutions.

1 geographic positioning system

2 short message service / interactive voice response

Case Study 1: INVESTIV

INVESTIV is an Ivorian company specializing in precision agriculture services for both public and private sector clientele. It is a pioneer in the use of drones in agriculture in West Africa. Services include geo-referencing, aerial cartography and contouring, vegetation index calculations, water stress assessments, biomass and yield estimations, phytosanitary diagnoses, and aerial spraying, among others. INVESTIV's diagnostic drones use multi-spectral sensors to identify e.g. areas of disease, lower fertility, water stress, and other field issues. This data enables highly efficient fertilizer spraying, phytosanitary treatments, and water resource management, thus economizing inputs per unit yield. INVESTIV recently launched a pilot project with SECO cotton, of the OLAM group, to test aerial drone spraying and phytosanitary diagnosing on cotton plots.³

Case Study 2: RiceAdvice

Rice is an important staple food in sub-Saharan Africa. Consumption rates have increased 50% over the past two decades. Yet many countries, including Côte d'Ivoire, are facing serious rice productivity challenges, with gaps of 30-40% between actual and potential yields. As such, 40% of rice consumed in Africa is imported.

In response to this issue, AfricaRice has developed an Android-based decision support tool called RiceAdvice. The application provides farmers with field-specific management guidelines for rice production systems in Africa, including target yield, nutrient management, crop calendaring, and good agricultural practices. The tool is interactive; guidelines are generated based on farmers' responses to multiple-choice questions regarding farm conditions, current crop management practices, and the prevailing market. The application can largely be used without an Internet connection, although an active connection is required from time to time to synchronize information with the database server. Expected users include farmers, extension workers, development agencies, and other stakeholders in the rice value chain.

As of early 2017, more than 20,000 RiceAdvice guidelines had been generated, the majority of which are specific to Nigeria, Mali, and Senegal. Farmers using RiceAdvice have reported yield gains of 0.6 - 1.8 tonnes per hectare and income gains of US\$100 - 200 per hectare. Over 95% of farmers who have used RiceAdvice aim to continue using it.⁴

3 Investiv, "Investiv."

4 RiceAdvice, "Tools for Improving Rice Value Chains in Africa."

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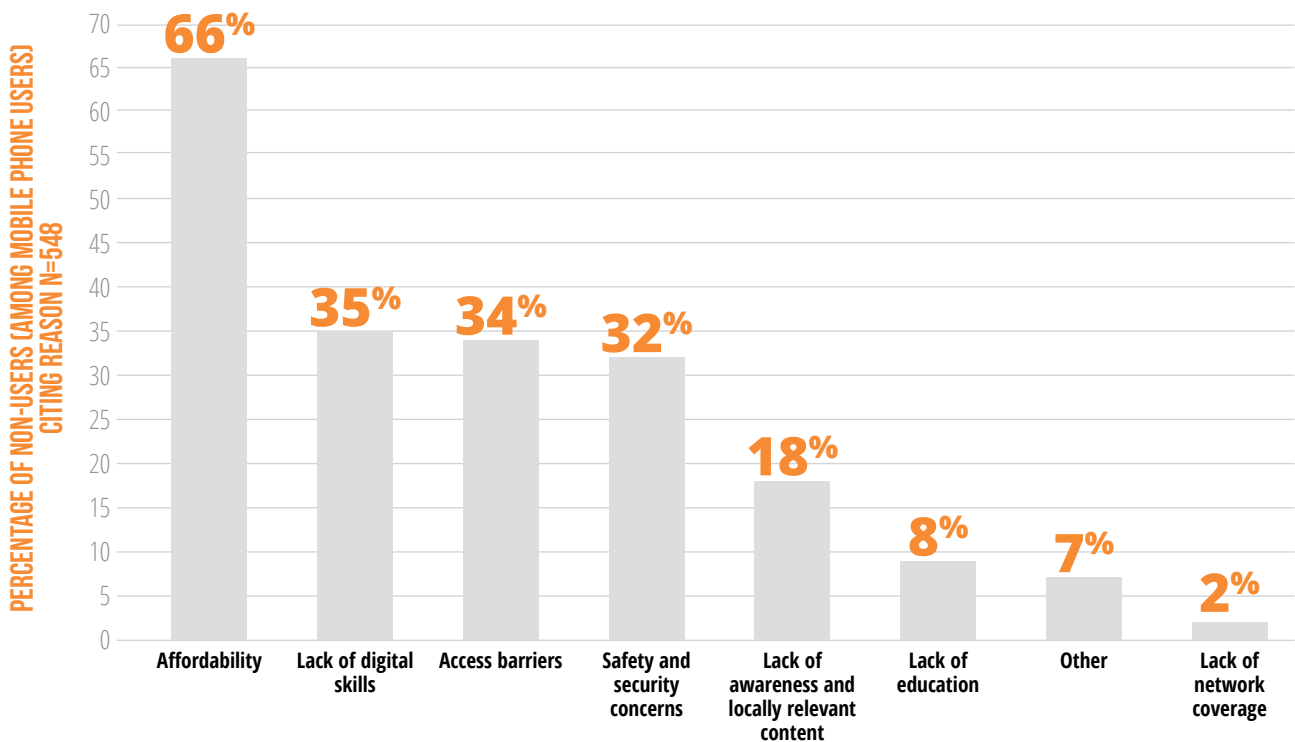
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Figure 1: Barriers to Mobile Internet Usage in Côte d'Ivoire



Team

Sekou Amadou Traore¹, Edward Mabaya², Olukemi Dolly Afun-Ogidan², Bunmi Ajilore², Evan Girvetz¹, Andy Jarvis¹ and Wietske Kropff¹.

This document has benefited from comments received from: , Carlo Bravi³.

Editor: Megan Mayzelle

Design: Daniel Gutiérrez¹

1 The Alliance of Bioversity International and the International Center for Tropical Agriculture (CIAT)

2 African Development Bank

3 FAO, Food and Agriculture Organization of the United Nations



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