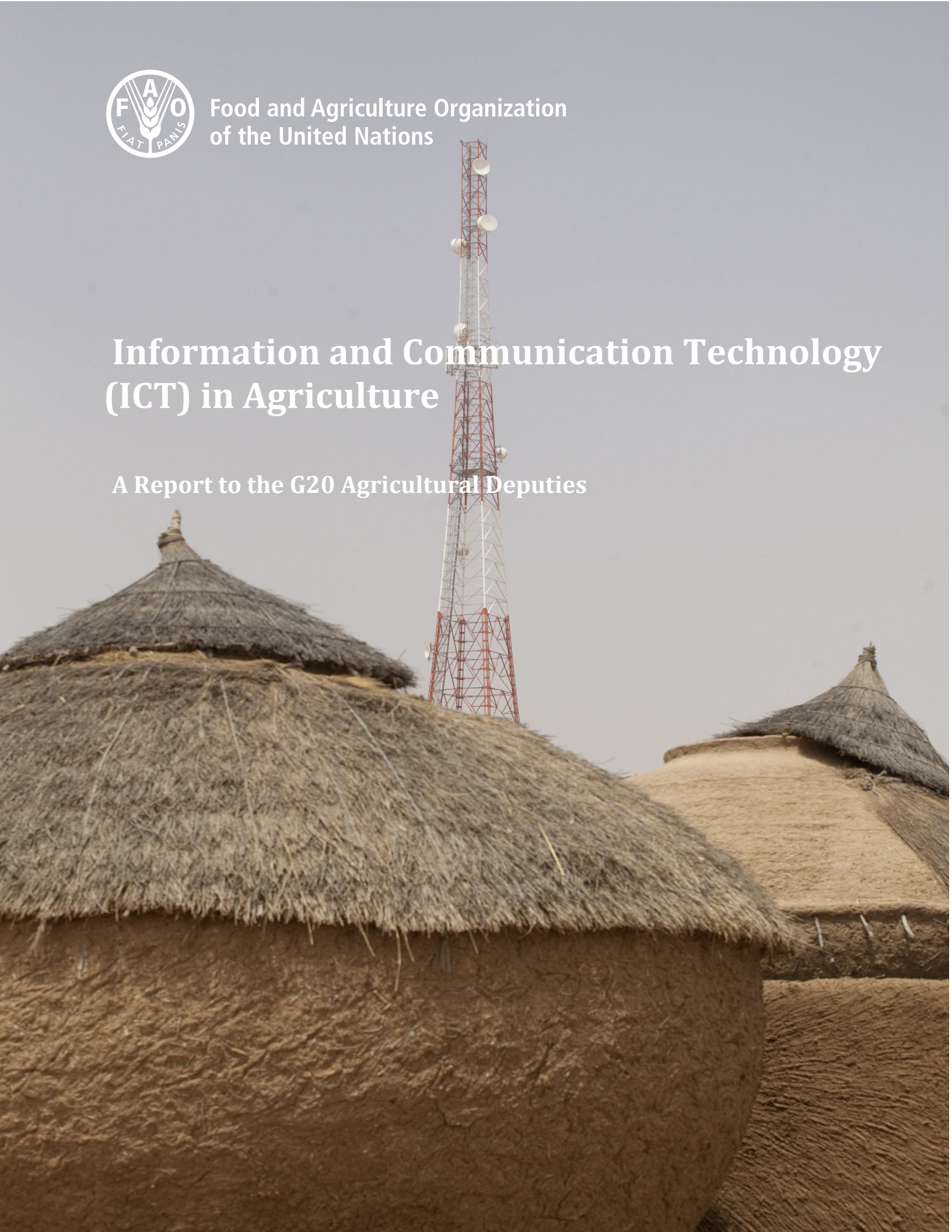

Food and Agriculture Organization
of the United Nations

Information and Communication Technology (ICT) in Agriculture

A Report to the G20 Agricultural Deputies

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Prepared by
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with inputs from
International Food Policy Research Institute (IFPRI)
Organization of Economic Cooperation and Development (OECD)

Food and Agriculture Organization of the United Nations
Rome, 2017

ISBN 978-92-5-109979-7

This publication has been printed using selected products and processes so as to ensure minimal environmental impact and to promote sustainable forest management.

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Preparation of the Document

This report responds to the request by the G20 Agricultural Ministers to FAO, IFPRI and OECD in June 2016 to build on their preliminary assessment of existing ICT applications and platforms and make specific proposals for consideration and action by G20 Agriculture Deputies ahead of the next G20 Agricultural Ministers meeting on the best possible mechanism to improve agricultural ICT exchange and cooperation.

The report is organized as follows:

(i) The section **Summary, Evaluation and Recommendations** is targeted to policy makers and draws from the detailed review undertaken in Sections 1 to 4 of the report. It provides a succinct but comprehensive account of ICTs in agriculture, including evaluating their impact. It identifies gaps, and puts forward a number of recommendations for the G20 in line with the G20 comparative advantage for collective action.

Policies and measures to promote ICTs are crucial for the G20 economies and for agriculture in particular. G20 Ministers of Agriculture can take action to integrate ICTs in agricultural policies and initiatives. The report makes a number of recommendations for concrete actions in the area of ICTs that promote sustainable food systems and contribute to the realization of the 2030 Agenda for Sustainable Development.

(ii) **Sections 1 to 4** contain a detailed, albeit not exhaustive review of ICTs in agriculture. There is plethora of ICT applications on agriculture, ranging from using radio to satellite remote sensing, and in Section 2 every effort has been made to provide a comprehensive picture through the discussion of selected applications. Section 3 reviews the platforms and initiatives that promote the use of ICTs, and Section 4 examines governance issues specifically related to principles, rights and privacy. A number of Annexes provide more detail to the reader on a number of areas related to governance.

Contents

Summary, evaluation and recommendations

World population is expected to surpass the 9 billion mark by 2050, and agriculture has to increase the production of nutritious food to meet the growing demand and ensure food security for all. It has to generate jobs, improve incomes and contribute to poverty eradication and rural economic growth. And it has a major role to play in the sustainable management of natural resources.

Most of the increase in food production will have to take place in developing countries. Agriculture is increasingly becoming knowledge-intensive and millions of smallholder farmers around the world are confronted by constraints such as poor access to markets and financial services, low levels of human and physical capital, poor access to education and weak information flows. With missing markets, low skills and weak capacity, agriculture across the developing world will have to overcome a number of challenges in the future.

The information needs of farmers in both developing and developed countries will only increase as they have to make more and more complex decisions on how to use their land, what crops to produce and how, in which markets to buy inputs and sell their products. Their decisions, which also include choices on how to finance their business and reduce the risk they face, impact the livelihoods of their families and society.

ICTs in development and agriculture

ICTs have been a significant contributor to growth and socio-economic development in business sectors, countries and regions where they are well adopted and integrated. Nearly 40 percent of the global population has access to the Internet, and among the bottom fifth of the poor, 7 out of 10 households have a mobile phone.[1] The large adoption and integration of ICTs has reduced information and transaction costs, improved service delivery, created new jobs, generated new revenue streams and saved resources.

In agriculture and food sectors across the world, ICT companies, multinational farm input business, large machinery manufacturers, but also small and medium farm input suppliers provide a number of services to farmers through ICTs, including extension advice. Downstream, supermarkets and agricultural product buyers also engage in the food value chain through ICTs, where the technology is also used by farmers' cooperatives, international organizations, the civil society and governments to effectively provide information on many aspects of farming, including regulation (see Section 2, pp. 14-22 for a description of selected ICT applications on agriculture).

ICTs have transformed how businesses, people and governments work. They reduce transaction costs and facilitate communication. People can be informed and communicate with each other at significantly lower costs than before. With this, digital technologies promote efficiency and inclusion – many tasks can be carried out at low costs and many services can reach people that previously lacked access.

In rural Niger, agricultural price information obtained through mobile phones reduces search costs by 50 percent.[2] In Senegal, a website facilitates vulnerable communities' access to information on climate change adaptation. It supports a community of practice where members can share updates

[1]World Bank Group (2016). Digital Dividends. World Development Report 2016.
[2] Aker, J.C, and I.M. Mbiti (2010). "Mobile Phones and Economic Development in Africa." Journal of Economic Perspectives, 24(3): 207-32.

on their work and adaptation techniques. In India, timely access to accurate weather information by smallholders can come a long way in helping them to manage uncertainty and risk.[3]

At broader level, digital technology tapping into satellite imagery is revolutionizing the way countries can assess, monitor and plan the use of their natural resources, including monitoring deforestation and desertification. Access to easy-to-use digital tools that monitor forest cover, land-use patterns and their changes over time are destined to become increasingly important as countries around the world implement measures to adapt to and mitigate climate change.[4]

When in developing countries ICTs can have a profound impact on both efficiency, resilience and inclusion, in developed economies innovations such as the Internet of Things, Cloud Computing and Big Data are revolutionizing agriculture. Remote sensors collect data on soil moisture, temperature, crop growth and livestock feed levels, enabling farmers to achieve better yields by optimizing crop management and reducing the use of fertilizers, pesticides and water.

Increased efficiency is also the result of remote management and control of machinery and irrigation systems using satellite positioning, while data from farm operations are collected and analysed, often in conjunction with information on weather to provide new efficient decision-making tools that promote agricultural productivity and manage natural resource effectively.

In developed countries large agribusiness, through their digital platforms, provide a wealth of private information to their clients on farm technologies. On the demand side, e-commerce platforms directly link the farmer to the food processing and retail stages of the value chain.

In the developing world, ICT applications are crucial in reducing information and coordination costs. The spread of mobile phones in rural areas has already led to important changes in the agricultural sector. Reducing these costs in the context of developing countries characterized by poor infrastructure, promotes market access, facilitates financial inclusion and risk management, contributes significantly to early warning, and can be central in revolutionizing agricultural extension.

A growing body of evidence suggests that in many circumstances ICTs, specifically mobile phones, are thought to increase access to both information and capacity-building opportunities for rural populations in developing countries. This brings tangible benefits. Farmers can achieve higher crop yields, as they get access to timelier and better-quality information on products and inputs as well as environmental and market conditions through ICTs.[5]

ICTs can promote learning, which in turn can facilitate technology adoption among farmers, but can also revolutionize early warning systems through better quality data and analysis. On the other hand, policymakers can also benefit from increased information sharing, which allows them to gather a more complete overview of the situation on the ground in their country. In this vein, ICTs also have enormous potential to reach the poorest of the poor—those without access to land or other assets—and also address gender issues by equalizing access to information and services by women and men.

Although more research is necessary, the review of several applications and studies in this report suggests that the information relayed by ICTs should be properly targeted and relevant if it were to affect farmers' production decisions. Content is crucial, and the existing evidence suggests that content quality matters. To have an impact, the information provided to farmers must be locally

[3] http://www.rmlglobal.com/web/
[4] http://www.fao.org/news/story/en/item/350761/icode/
[5] Torero, M. (2014). Information and communication technologies: Farmers, markets, and the power of connectivity. In 2013 Global food policy report. Eds. Marble, Andrew and Fritschel, Heidi. Chapter 6 Pp. 63-74. Washington, D.C.: International Food Policy Research Institute (IFPRI). http://ebrary.ifpri.org/cdm/ref/collection/p15738coll2/id/128049

relevant and specific to the needs of farmers. And the generation of local content requires local knowledge and significant resources – for example, it is the food prices that prevail in the local markets that are relevant to farmers.[6] Building up human capacity, as well as the infrastructure needed to facilitate better connectivity, are also critical.

The manner or mode by which information is delivered is also a crucial determinant of effectiveness. ICTs encompass many different types of technologies, from computers and the Internet to radio and television to mobile phones. Their impact varies widely depending on which specific technology is used, but also on farmers' level of literacy. Short message services (SMS), voice messages, short video trainings, audio messages, social media interventions and virtual extension platforms that can improve peer networks (though online platforms/websites) can effectively enable farmer-to-farmer and farmer to experts information sharing.

Audio or voice-based question and answers services may overcome the limitations of text-based platforms. SMS messages can be effective for simple price or weather information, but to facilitate and revolutionize learning and make knowledge widely accessible, especially in the context of adapting agriculture to climate change, other methods and modes will be necessary.

Finally, the review of ICT applications suggests that the development of digital technologies focuses on the supply side. With the exception of initiatives that facilitate certification, there is a substantial gap on ICT applications that provide public information on the consumer side both in developed and developing countries.

Recommendation 1: Developing an ICT application to reduce food waste at household level

Recognizing the importance of sustainable food systems for food security and growth, and the need to provide targeted information in order to reduce food waste and contribute towards the realization of SDG 12.3 in a cost-effective way, G20 members can consider to:

1. Provide support to FAO, IFPRI and other relevant organizations and stakeholders in the development of an ICT application, 'SAVE FOOD-SAFE FUTURE' to raise awareness and help reduce food waste at the household level.

The application will be developed within the framework of activities of the G20 Technical Platform on the Measurement and Reduction of Food Loss and Waste and will enable consumers to plan and manage their food purchasing and food use; receive alerts on the expiration dates of purchased food; and identify solutions for avoiding food waste by providing useful tips, such as links to outsourced recipes or donation points.

A more sustainable food system will require making serious changes on how food is produced, processed, transported, but also consumed. The G20 have highlighted the need to both measure and reduce food loss and waste. Under the Presidency of Turkey in 2015, the G20, FAO and IFPRI launched the *G20 Technical Platform on the Measurement and Reduction of Food Loss and Waste*.[7] Accurately estimating food losses and waste can significantly contribute to meeting the objectives

[6] Nakasone, E., M. Torero, and B. Minten (2014). The Power of Information: The ICT Revolution in Agricultural Development. Annual Review of Resource Economics, Vol. 6: 533-550

[7] http://www.fao.org/platform-food-loss-waste/en/

of the Rome Declaration on Nutrition and Framework for Action, following the FAO/WHO Second International Conference on Nutrition, and the 2030 Agenda's Sustainable Development Goal 12.3, 'to halve per capita global food waste at the retail and consumer levels and reduce food losses along the production and supply chains, including post-harvest losses' by 2030.

With about one third of the food produced in the world for human consumption every year — approximately 1.3 billion tonnes — getting lost or wasted, there is need to improve awareness on the importance of sustainable consumption patterns, and information provided by ICT technologies, such as smartphone apps, can influence individuals and society to focus on the social, economic and environmental dimensions of food waste.

Such ICT applications should allow consumers to manage their food purchases in line with their food consumption patterns in order to be effective – individualization of food and eating habits can influence the responsibility of a person for saving food – while at the same time they should provide options for promotion of interaction among users and between professionals and consumers in order to facilitate empowerment.[8]

Promoting ICTs: Platforms and programmes

At the global level, there is a plethora of ICT applications to agriculture, and platforms and communities of practice facilitate the exchange of information and experiences amongst farmers, policy makers, agriculture and development experts and international organizations. They raise awareness on how ICTs can contribute to many aspects of agricultural development (see Section 3, pp. 24-29 for a discussion of platforms, initiatives and projects that promote ICT applications on agriculture).

For example, the *e-Agriculture Community of Practice* (run by FAO) serves as a catalyst for institutions and individuals in agriculture and rural development to share knowledge, learn from others, and improve decision making about the vital role of ICTs in facilitating sustainable agricultural productivity and ensuring food security. The *ICT Observatory* (of the Technical Centre for Agricultural and Rural Cooperation) engages in identifying ICT policy issues, experiences and projects relevant to agriculture in the African, Caribbean and Pacific (ACP) Group of States. *InfoDev* (a project of the World Bank Group) supports mobile software entrepreneurs and offers training programs, testing facilities, and competitions in several areas, including agriculture. *InfoDev* promotes Internet entrepreneurship through supporting digital technology clusters – called *mLabs or tech hubs*. Currently, there are more than 100 tech hubs in Africa, where public private partnerships provide a fertile ground for governments, universities, the civil society and the private sector to boost development through innovative ICT applications (see p. 26).

The *ICT in Agriculture Sourcebook* is an on-line practical guide (provided by the World Bank) in understanding current trends, implementing appropriate interventions that promote ICTs, and evaluating their impact.[9] It combines expertise in ICT with empirical knowledge on agriculture and is designed to support practitioners, decision-makers, and development partners who work at the intersection of ICT and agriculture. The *FAO-ITU e-Agriculture Strategy Guide*, published in 2016, supports governments in the development of their national e-agriculture strategies.[10]

[8] Bouwman, L.I. G.J. Hiddink, M.A. Koelen, M. Korthals, P. van't Veer, and C. van Woerkum (2005). Personalized nutrition communication through ICT application: how to overcome the gap between potential effectiveness and reality. European Journal of Clinical Nutrition, 59, S108-S116.
[9] http://ictinagriculture.org
[10] http://www.fao.org/3/a-i5564e.pdf

Already, FAO and ITU work together towards promoting national e-agriculture strategies in Asia-Pacific and Central Asia regions based on a multi-stakeholder approach that brings together government agencies, the private sector (including mobile telephony companies and Internet providers), farmers and their cooperatives, research institutions, banks and other financial institutions, civil society and others.

Recommendation 2: Promoting good policy practices for ICT in agriculture

Recognizing that ICTs are crucial in reducing information costs and promoting sustainable agricultural development globally, G20 members can consider to:

1. Support efforts by relevant International Organizations, including by FAO, ITU and IFPRI, that promote ICT applications on agriculture, based on dialogue and knowledge-sharing communities of practice, and on capacity-building activities, including multi-stakeholder approaches for the development of national ICT strategies for agriculture.

2. Solicit a systematic identification of agricultural and food policy interventions and their compatibility with the wider G20 digital economy policy agenda, and incorporate, where appropriate, specific ICT considerations in OECD innovation policy country reviews.

3. Commit to support developing countries in promoting the application of ICTs on agriculture, including where relevant through Official Development Assistance and South-South Cooperation.

Identifying a gap for action: ICTs for sustainable production intensification technologies

The above platforms and programmes meet several objectives. They increase awareness about the impact of ICTs on agriculture and strengthen the focus on the need to build an enabling environment for digital technologies to facilitate agricultural growth and rural development. They promote and facilitate the exchange of information and knowledge on ICT applications, provide a forum for discussions among practitioners, contributing towards scaling-up successful projects. They also enhance coordination and collaboration among international organizations, the private sector and the civil society and boost e-agriculture capacity building efforts.

In spite of these efforts, many innovations fail to scale up, especially in developing countries where fee-based ICT services are characterized by weak take-up.[11] In developed countries, the private sector, such as large suppliers of seed and agrochemicals and machine manufacturers, engages in innovative ICT applications, providing commercial services to their clients who have access to the Internet and mobile devices.

These companies have made significant investments on ICT services, leveraging on economies of scale and their market shares. Through their ICT services they collect information on the farming practices of their clients, process and analyze it, and relay the knowledge they produce back to them, thus enhancing production efficiency and in many cases providing wider benefits, such as

[11] World Bank Group (2016). Digital Dividends. World Development Report 2016.

preserving natural resources as in the case of Precision Agriculture. The sale of innovative inputs and the provision of specific know-how to farmers through ICTs generate returns for these companies which often are protected by patents and copyright – otherwise business would have no incentive in engaging in research and development.

Nevertheless, many aspects of agricultural information constitute a public good and as a policy implication, governments must play some role to its provision, ensuring that is not undersupplied. For example, knowledge on how to adapt to, and mitigate the negative impacts of climate change on agriculture is considered as a global public good that will benefit generations to come. International organizations, including FAO, play a special role in the production and dissemination of this knowledge and governments, recognizing its public good nature, have affirmed the importance of education, training, public awareness, public participation, public access to information, and cooperation at all levels on the matters related to climate change.[12]

Currently, ICT applications related to agriculture and its adaptation to climate change are found either at a macro- or a micro-level. They range from large-scale projects such as weather monitoring by satellite and large-scale sensor networks, to projects that increase awareness for vulnerable communities and individuals to help them identify and manage their own adaptation needs.[13]

Climate change will increasingly challenge conventional, resource-intensive agricultural systems. Good agricultural practices, based on soil and water management and pest control, combined with improved access to markets, can lead to significant improvements in agricultural productivity, adapting to climate change and increasing resilience to supply shocks, whether due to climate change or due to resource limits.

Sustainable production intensification technologies are knowledge-intensive. Climate Smart Agriculture manages multiple objectives in agricultural growth and development under the specific constraints of climate change, building resilience and adaptive capacity in agricultural systems, while reducing and removing greenhouse gases to contribute to climate change mitigation. It requires knowledge on many aspects of farming including for example minimal soil disturbance, permanent soil cover and crop rotations.

Extension programmes that promote such technologies have to overcome a number of challenges. Agriculture is location-specific and knowledge has to be developed and transferred accordingly, while at the same time building on the hyper-local knowledge developed by international organizations and research centres that work towards promoting such sustainable production intensification approaches. There is also need for a great number of properly trained extension agents to reach geographically dispersed and remote farmers, interact with, and advise them.

Knowledge sharing and training methods based on ICTs are important vehicles to improve access to information and enhance knowledge on sustainable production intensification technologies. ICTs can facilitate dialogue between stakeholders and across levels, and trigger learning with knowledge networks and platforms that provide a venue where the diverse actors can connect.[14] By integrating local and hyper-local knowledge, ICT innovations can have a significant impact on improving the content for extension and training, and promote technology adoption that can enhance adaptation in both developed and developing countries.

[12] Conference of the Parties, Twenty-first session, Adoption of the Paris Agreement, Paris, 30 November to 11 December 2015.
[13] The World Bank, and the African Development Bank, with the support of the African Union (2012). The Transformational Use of Information and Communication Technologies in Africa. eTransform AFRICA
[14] FAO (2013). Climate Smart Agriculture Sourcebook, Rome.

Although existing communities of practice and initiatives are crucial in raising awareness and underpinning capacity building, they do not engage in creating sustainable ICT innovation laboratories that can develop capacity for state-of-art ICT applications to promote transformative agricultural development, especially as far as knowledge-intensive technologies that can facilitate adaptation to climate change are concerned.

Innovative applications such as virtual extension systems, though online platforms or websites, that are based on peer networks can enable farmer-to-farmer and farmer-to-experts information sharing. Serious gaming, played with a computer or smartphone can revolutionize extension services and significantly facilitate technology adoption. The applications of serious gaming on agriculture are at an initial stage, although gaming methods are utilized for training in the military, corporate management and education (see p. 22).

Building on existing communities of practice and complementing systems already in-place, significant improvements in the use of ICTs for facilitating the adoption of sustainable production intensification technologies could be achieved through a collaborative technical platform, the *ICT for Sustainable Agricultural Production Innovation Lab*. Its activities will aim at generating ideas, developing pilot state-of-art applications, create prototypes, test and scale solutions that can be adopted in different locations and within a multi-stakeholder context.

The *Lab* will be managed by the FAO Information Technology Division and will build on existing mechanisms, linking farmers, farmers' groups, application developers, agronomists, and extension agents. More specifically, it will adopt the practice of UN Innovation Labs[15] for 'top-down' and 'bottom-up' innovation by forging close synergies with: (i) the e-Agriculture Community of Practice, as well as local communities and networks; (ii) the FAO regional and country offices and those of other collaborative organizations and their technology adoption projects; (iii) non-profit tech hubs in G20 and non-G20 countries; and, (iv) the FAO-ITU programme that aims at building capacity for ICTs national strategies in developing countries.

Recommendation 3: ICT for Sustainable Agricultural Production Innovation Lab

Recognizing the urgency for agriculture to adapt to climate change by effectively promoting sustainable agricultural production intensification technologies through ICTs, G20 members can consider to:

1. Support a laboratory, led by FAO and other relevant organizations and built on existing mechanisms, to generate ideas, create pilot ICT applications and prototypes, and test and scale up ICT solutions that promote the training on, and adoption of sustainable agricultural production intensification technologies.

The *Lab* will develop a network linking knowledge-sharing communities of practice, such as e-Agriculture and other local initiatives, extension services, research centres, international organizations and tech hubs in order to promote innovative ICT applications based on dialogue and existing capacity-building activities.

[15] United Nations Development Programme (2015). Innovation for 2030: UNDP Innovation Facility, 2015 Year Review. United Nations Children Fund (2014). Innovation Annual Report 2014. Also http://www.unicef.org/innovation/

Internet governance

Since its inception, the Internet is governed through a multi-stakeholder process. Its governance has evolved around a culture of cooperation, involving the private sector, transnational institutions, academia, and governments, with the technical organizations that ensure its functionality reflecting a multi-stakeholder approach.

For example, the Internet Engineering Task Force (IETF) is open to anyone who wants to contribute to its functions – setting the rules that govern how computers and servers communicate worldwide, namely the Transmission Control Protocol (TCP) and Internet Protocol (IP). The Internet Research Task Force (IRTF) is formed by the private sector and focuses on longer term research issues on Internet protocols, applications, architecture and technology.

The Internet Society (ISOC) provides an institutional home and financial support for IETF, and is one of the main representatives of the technical community. Since 2010, ISOC is granted Consultative Status by ECOSOC and participates in relevant UN conferences and preparatory meetings.

The Internet Corporation for Assigned Names and Numbers (ICANN) is a non-profit organization that coordinates the operation of the Internet's systems of addresses that includes IP addresses and domain names. Although initially overseen by the US Department of Commerce, in 2014 ICANN initiated a transition process towards becoming a fully independent transnational and inclusive body.

At a broader level, the World Summit on the Information Society (WSIS) was initiated in 2003 by the UN in order to create an evolving multi-stakeholder platform to address ICT governance issues through a structured and inclusive approach at the national, regional and international levels. Internet governance issues have also been discussed at the World Conference on International Telecommunications (WCIT).

WSIS is co-organized by ITU, UNESCO, UNCTAD and UNDP and aims to achieve a common vision, desire and commitment to build an inclusive and development-oriented global Information Society. WSIS has strengthened the role of states in Internet governance, while at the same time retains an inclusive and multi-stakeholder nature. Its meetings follow a multi-stakeholder approach that includes governments, Internet societies and communities, the private sector, academia and the civil society, as well as International Organizations.

WSIS through its Geneva Declaration of Principles underlined the objective to build a global Information Society, where everyone can create, access, utilize and share information, respecting human rights. This common vision and guiding Principles are translated into concrete action through the WSIS Geneva Plan of Action that promotes the use of ICT-based products, networks, and services on many areas, including on agriculture, animal husbandry, fisheries, forestry and food. The *e-Agriculture Community of Practice*, managed by FAO, is an outcome of this Plan of Action (see pp. 33-34 and Annex A).

In Antalya in 2015, the G20 leaders recognized that the Internet brings both opportunities and challenges to global growth. In their summit in Hangzhou, the G20 leaders delivered the *G20 Digital Economy Development and Cooperation Initiative* to address both opportunities and challenges brought by ICTs, and propose some common understanding, principles and key areas for cooperation and the development of the digital economy (see Annex C).

Recommendation 4: Promoting ICTs for agricultural development in International fora

G20 members, through their engagement in the World Summit on the Information Society events can consider to:

1. Emphasize agriculture as a key component of the digital economy, and continue to support effective dialogue on the transformational role of ICTs in agriculture, including through concrete actions that foster reliable, inclusive and affordable connectivity in rural arears and integrate ICTs in agricultural and rural development policies and institutions to support food security and hunger eradication.

The *Initiative* affirms the G20 members' commitment to a multi-stakeholder approach to Internet governance, with active participation by governments, private sector, civil society, the technical community, and international organizations, in their respective roles and responsibilities. It also recognizes that Internet governance should continue to follow the provisions set forth in outcomes of World Summit on the Information Society.

Principles and data privacy

There is no international binding agreement on online human rights and often the debate centres on the freedom of expression and access to information – both fundamental human rights in the International Covenant on Civil and Political Rights. Still, the UN Human Rights Council has adopted a resolution preserving human rights on the Internet, affirming that people have the same rights online that they have offline (see Section 4, p. 35).

Many countries provide guidelines with information about rights and freedoms in the context of ICTs. Nevertheless, lack of access or inadequate national legal frameworks often create a fertile ground for arbitrary and unlawful infringements of human rights in communications. The Internet Governance Forum (IGF) – a multi-stakeholder platform that enables the discussion of public policy issues pertaining to the Internet under the UN – has provided a framework on how human rights should be interpreted to apply to the Internet environment, and the Internet policy principles which must be upheld in order to create an environment which supports human rights to the maximum extent possible (see Charter of Human Rights and Principles for the Internet in Annex B).

Governments collect large amounts of personal information for civil registries, social security, housing records and tax purposes. At the same time, with the rapid expansion of software and web search engine companies, social network platforms, and e-commerce, users disclose personal information that can result in a massive amount of identifiable information that is owned, controlled and used by digital service providers.

A challenge for privacy is the expanding use of Big Data – data that is subject to complex automated discriminatory technologies – that can classify users and customers into categories according to their preferences, income, ethnicity, political views and other sensitive characteristics. The Internet of Things that connects devices to the Internet, can also result in detailed user profiles and poses similar privacy challenges.

Nevertheless, meeting the 2030 Agenda for Sustainable Development requires a 'data revolution' to take advantage of new technologies, crowd sourcing, and improved connectivity to empower

people with information on the progress towards the SDGs.[16] Digital data provides an opportunity to gain a better understanding of changes in well-being and emerging vulnerabilities, and to get real-time feedback on how well policy responses are working.

Big Data initiatives already provide valuable information on land use changes around the world, crowd-sourcing facilitates the financial inclusion and market integration of small family farmers, but also provides real-time information on food price inflation (see Section 3, p. 28). Global Pulse is a flagship innovation initiative of the United Nations Secretary-General working towards harnessing the potential of Big Data safely and responsibly for sustainable development and humanitarian action.

Big Data creates unprecedented possibilities for informing decision-making, closing key gaps in access, transforming our society and protecting the environment. Increases in quality data and information will enable all stakeholders, governments, the private sector, the civil society and international organizations to identify problems, plan, monitor, and be held accountable for their actions. Nevertheless, such an increase in the usefulness of information should not result in invasion of privacy and abuse of human rights from misuse of data on individuals and groups.

About 107 countries – half of them being developing countries – have privacy laws ensuring that personal data are protected. These legal frameworks define the purposes for which personal data can be collected legitimately, and establish rules for its proper management and protection from misuse. For example, the Directive on Privacy and Electronic Communications in the EU, and the Africa Union Convention on Cybersecurity and Personal Data Protection, aim at strengthening fundamental rights and public freedoms, particularly concerning the protection of data (see pp. 36-38).

At a broader level, the UN Global Pulse has developed a set of Privacy Principles in consultation with experts from public and private sector, academia and civil society. The United Nations Secretary-General's Independent Expert Advisory Group on a Data Revolution for Sustainable Development has recommended to develop a global consensus on principles and standards concerning legal, technical, privacy, geospatial and statistical standards which, among other things, will facilitate openness and information exchange and promote and protect human rights. [17]

The issue of protecting personal information collected, stored and managed by ICTs becomes more complex as personal data are being processed and transferred on a regular basis across national borders. The OECD Guidelines on the Protection of Privacy and Transborder Flows of Personal Data represent a consensus on basic principles that can be built into existing OECD members' national legislation.

Nevertheless, there is no international binding agreement on cross-border digital data flows and although in many countries data protection and privacy laws are based on a common set of principles, they are locally adapted and often do not comply with each other.

Instead, digital data transfers, as well as digital trade, are often governed by bilateral, multilateral or plurilateral agreements. For example, the WTO General Agreement on Trade in Services (GATS) has an Annex on Telecommunications that supports ICT enabled services. The Cross-border Privacy Enforcement Arrangement Privacy Framework of the Asia-Pacific Economic Cooperation underpins the free flow of information in the region. The Trans Pacific Partnership allows for the cross-border

[16] High-Level Panel of Eminent Persons on the Post-2015 Development Agenda (2013). A New Global Partnership: Eradicate Poverty and Transform Economies through Sustainable Development. http://www.post2015hlp.org/wp-content/uploads/2013/05/UN-Report.pdf

[17] United Nations (2014), p.6. A world that Counts: Mobilizing a Data Revolution for Sustainable Development by the Independent Expert Advisory Group on a Data Revolution for Sustainable Development. New York.

transfer of digital information in line with national policies that provide for the protection of personal data.

Issues related to principles and data protection in the digital economy are important for agriculture, but are not under the mandate of the G20 Ministers of Agriculture. New technologies, such as Big Data and the Internet of Things, will result to an exponential increase in the volume and variety of data available, as well as the frequency by which information is collected. These data can inform policy-making and transform the economy, including agriculture.

The G20 Digital Economy Task Force[18] has been formed to facilitate dialogue among the G20 members, leverage opportunities and address the challenges brought about by ICTs. Given the importance of data for sustainable development, including in agriculture and the rural economy, the Task Force could increase awareness of the critical importance of information, promote dialogue and facilitate common understanding on principles and regulations related to digital data privacy and digital data transfers.

Recommendation 5: Developing a common understanding on principles on digital data

Recognizing that new technologies create unprecedented opportunities for informing agricultural and food policies, G20 Ministers of Agriculture, aware of the wider digital economy agenda, support the G20 Digital Economy Task Force to:

1. Acknowledge the importance of principles and guidelines related to the collection, storage and use of digital data, including information sourced through Big Data and Internet of Things technologies.

2. Take into consideration relevant discussions in relevant fora and initiatives, such as the World Summit on the Information Society, the UN Internet Governance Forum, the UN Global Pulse and the OECD.

[18] G20 Digital Economy Development and Cooperation Initiative, 2016. See Annex C.

1 Introduction

Information and Communication Technology (ICT) is defined by the World Bank as "[…] any device, tool, or application that permits the exchange or collection of data through interaction or transmission." It "includes anything ranging from radio to satellite imagery to mobile phones or electronic money transfers."[19] The application of ICTs in agriculture is often referred to as e-agriculture.

This report responds to a request by the G20 Agricultural Ministers to FAO, IFPRI and OECD in June 2016 to build on their preliminary assessment of existing ICT applications and platforms and make specific proposals for consideration and action by G20 Agriculture Deputies ahead of the next G20 Agricultural Ministers meeting on the best possible mechanism to improve agricultural ICT exchange and cooperation.

The report aims at discussing ICT applications on agriculture and rural development and reviewing the initiatives that promote their use in order to identify possible gaps, inform the G20 Ministers of Agriculture and make specific proposals for possible G20 actions in the area of ICTs in agriculture.

The next section provides a succinct review of ICT applications in agriculture in both developing and developed countries, discussing their uses and impact. It provides examples in the main areas where ICTs are contributing with creative solutions to traditional and emerging challenges faced by farmers, including smallholders.

Section 3 provides a review of international platforms that promote ICT application on agriculture, food security and nutrition and identifies potential gaps that could be addressed by the G20. It presents some of the prominent global platforms that facilitate ICT applications on agriculture. These platforms can consist, for instance, of initiatives that aim to engage and connect global stakeholders for information sharing (such as the FAO e-Agriculture Community of Practice) or programmes that inform and guide the development of national strategies on the use of ICT in agriculture (ICT in Agriculture Sourcebook; FAO-ITU national capacity building efforts). These platforms include initiatives championed by FAO, the World Bank, USAID and others.

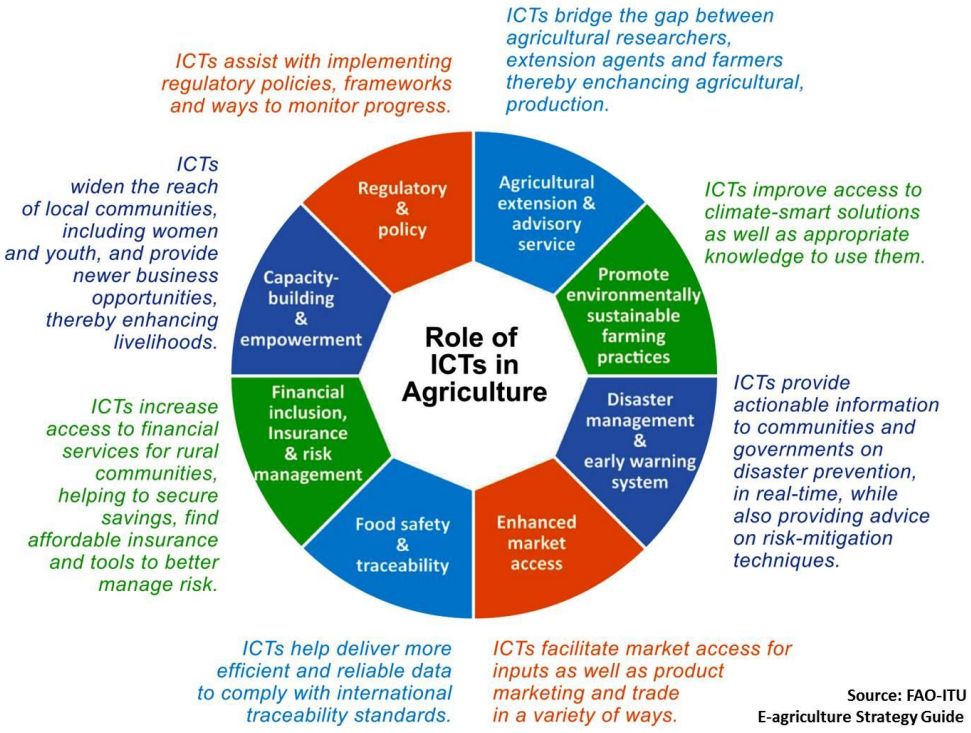
Finally, Section 4 discusses issues related to the global governance of the internet, including international efforts to promote an inclusive global Internet Society and ICT applications on agriculture, as well as issues related to the regulation of data collection and use in the digital world. It lists the key stakeholders involved in technical issues related to internet standards setting, the international fora on internet governance, and the complexity of issues related to data ownership, privacy and ethics.

19 World Bank (2011). E-sourcebook. ICT in Agriculture: Connecting Smallholders to Knowledge, Networks, and Institutions. Report Number 64605. P. 3.

2 ICT in agriculture

World population is expected to surpass the 9 billion mark by 2050, and agricultural production will need to increase by 60 percent from its 2005/2007 levels to meet this additional food demand. ICT applications can make a significant contribution to meet this future global food needs. Information and Communication Technology can do so by collecting and sharing timely and accurate information on weather, inputs, markets, and prices; by feeding information into research and development initiatives; by disseminating knowledge to farmers; by connecting producers and consumers, and through many other avenues. Some of the broad areas where ICT plays a crucial role in agriculture are shown in Figure 1.

Figure 1: Role of ICT in agriculture



Already, in the agricultural and food sectors of many countries, ICT companies, multinational farm input business, large machinery manufacturers, but also small and medium farm input suppliers provide a number of services to farmers through ICTs, including extension advice. Downstream, supermarket and agricultural product buyers also engage in the food value chain through ICTs, where the technology is also used by farmers' cooperatives, international organizations, the civil society and governments to effectively provide information on many aspects of farming, including regulation. In a number of cases, ICTs form an integral part not only of information flows, but of the

actual farming operations and food processing from testing the soil in the farm to using 3D printers to process food.[20]

Nevertheless, the digital divide between developing and developed countries is nowhere more evident than in agriculture. Across the developing world, rural communities are at a fundamental disadvantage to access this knowledge.

When farming their plots of land, smallholders are economic agents that make their choices using all of the information available to them. Based on this information, they choose what to plant, which inputs to use and how, when to plow, to seed, to harvest; how much to keep for consumption in the household and how much to sell to raise cash, or how much to store. They often make their choices in an adverse economic environment in which markets do not function well, and where very little information is available to inform them in time for their decisions. As a result, their choices are often not optimal. ICTs can play a crucial role in bridging this critical information and knowledge gap.

2.1 ICT in agriculture: developing countries[21]

Transaction costs explain why markets are missing or do not function well. Smallholders are not well integrated into markets due to high transport costs and their lack of ability to timely deliver consistent, quality and large volumes of produce.

Even if well-developed infrastructure reduced transport costs, small family farmers would face transaction costs to form a cooperative and aggregate their produce in larger volumes. They would also face costs to obtain information about consumer preferences and decide what and how to plant, and incur costs related to searching and screening for a partner with whom to negotiate a deal, bargain, reach and monitor an agreement.

Similar transaction costs characterize other markets such as those for labour, credit, and insurance. For example, low population density, isolated communities, and lack of information on collateral, increase the costs of financial services and result in missing credit and insurance markets. For a bank, often the fixed cost to establish a branch in a remote area is very high compared with the quantity of business it will conduct.

High transaction and operational costs also hinder services that in developing countries are often delivered by governments. In a developing country where agriculture makes up for a large part of the economy, there is need for a great number of extension agents to reach geographically dispersed and remote farmers, interact with, and advise them on innovative productive technologies that can be crucial for their livelihoods.

ICTs have the potential to reduce these costs – digital technology can be transformational. For example, *DrumNet* in Kenya helped link financial institutions, smallholder farmers, retail providers and agricultural product buyers through a cashless microcredit programme. Farmers gained access to inputs (e.g., seeds, fertilizers, pesticides) from local input providers by using a pre-established line of credit from banks, where *DrumNet* provided the bank with a credit rating score for each farmer.

[20] https://3dfoodprintingconference.com/

[21] An exhaustive list of ICT applications on agriculture in developing countries can be found in the FAO-ITU e-Agriculture Strategy Guide, http://www.fao.org/3/a-i5564e.pdf

Esoko, in Africa uses a combination of mobile and web services and advisory call centres to improve access to extension services. Voice, video, and call centres also have the advantage of being easily accessible to illiterate farmers.[22] In India, *e-Choupal*, a trading platform, reduces transaction costs by connecting buyers with farmers, using Internet kiosks. Through its ICT-kiosk platform, *e-Choupal* also offers farmers additional services, such as sharing of best practices to improve productivity, and price benchmarking to increase sales prices.[23]

The increase in the use of digital technologies has created benefits for all through easier communication and information sharing, and improving social connectedness. Inclusion, efficiency, and innovation are the main mechanisms for digital technologies to promote development. Nearly 70 percent of the bottom fifth of the population in developing countries own a mobile phone. The number of internet users has more than tripled in a decade, from 1 billion in 2005 to an estimated 3.2 billion at the end of 2015.[24]

Improving market access

In agriculture, ICTs can bring significant benefits through better information on markets. Prices signal opportunities to producers, consumers, and traders — such as when excess demand is creating more profitable opportunities to sell or when excess supply leads to cheaper deals. They also reflect changing consumption patterns and contain information that can be used by farmers when they decide what and how much to produce. With increased access to mobile phones, farmers can better plan production and investments, based on supply-and-demand fundamentals, thus increasing market efficiency.

Indeed, facilitating market access through the provision of information on prices is the most frequent ICT application on agriculture. Delivery of information is mainly through short message service (SMS), although voice messages, interactive voice response systems, or mobile applications are also used. *Reuter's RML Information Services* was launched in India in the state of Maharashtra in 2007, providing an affordable SMS service that shared daily updates on prices, markets, and weather with subscribing farmers. The platform evolved to offer this information through a smartphone application, and currently also provides customized market data reports to banks, procurement companies and other organizations on market prices, volumes and other information covering many crops and 1,300 markets across India.[25]

Many other e-commerce applications, such as e-Choupal, provide matching services, commodity exchanges, virtual trading floors and trading services that help the typically larger upstream and downstream firms, such as processors or exporters, to manage their operations and the quality of their produce better. Often, these platforms are based on specific contractual arrangements that define online negotiations conditions, the procedure to assess quality, the payment and delivery/withdrawal conditions – such standardized contracts can enhance transparency and efficiency.

A number of studies provide a range of estimates for the effect of price information on smallholders' sale prices and profits. For example, the dissemination of price information in Uganda

[22] www.esoko.com
[23] Miller, C., V.N. Saroja and C. Linder. (2013). ICT uses for inclusive agricultural value chains. FAO. See https://www.echoupal.com/
[24] World Bank Group (2016). Digital Dividends. World Development Report 2016.
[25] http://www.rmlglobal.com/web/

resulted in a 15 percent increase in farm-gate prices for maize.[26] Similar effects are suggested by researchers in Peru and the Philippines.[27] Other studies suggest impacts of lesser magnitude.

Emerging work by the International Food Policy Research Institute (IFPRI) and partners as part of the Government of Finland-funded Food Africa Programme sheds some light on the viability and of challenges associated with agriculture-related ICT services. In Ghana and Uganda, farmers receiving information on prices, weather, and extension through ICT applications indicated their willingness to pay US$0.30-$1 a month to cover the cost of the service. Researchers however did not observe an impact of the ICT service on the prices farmers were able to obtain from traders for their agricultural products.

Agricultural extension and advisory services

Traditional extension services face several challenges in developing countries that limit their efficiency. Poor infrastructure makes it harder and more costly to visit remote areas. For this reason, often extension programmes provide only one-time information to farmers, lessening their long-term impact. In addition, traditional extension is plagued by principal-agent and institutional problems, including a lack of accountability.[28]

ICTs can increase smallholder's access to timely extension information while addressing many of these challenges by reducing the cost of extension visits, enabling more frequent two-way communication between farmers and agents, and improving agents' accountability.[29] ICTs also enhance access to private information from social networks, thus facilitating learning from one's peers, which is crucial for technology adoption. By increasing communication linkages between farmers, extension agents, and research centers, ICTs can improve the flow of relevant information among all these agents.[30]

While *Esoko* is based on web services and advisory call centres, *Community Knowledge Workers,* an initiative of Grameen Foundation in Uganda, brings together a network of community agents who act as intermediaries between smallholders and smartphone app content developers. This initiative overcomes a number of challenges associated with traditional extension services - few professionals, difficult to reach rural areas – and the challenges associated with access and affordability of ICTs. Since the Community Knowledge Worker is the focal point and only s/he needs access to a smartphone, the technology is more accessible to poor communities. [31]

Digital Green, a non-profit international development organization, uses an innovative digital platform for community engagement to improve lives of rural communities across South Asia and Sub-Saharan Africa. Partnering with local public, private and civil society organizations the

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[26] Svensson, J. and Yanagizawa, D. (2009), Getting Prices Right: The Impact of the Market Information Service in Uganda. Journal of the European Economic Association, 7: 435–445.
[27] Beuermann D.W. (2011). Telecommunications Technologies, Agricultural Profitability, and Child Labor in Rural Peru. DT. N° 2011-002 Working Paper, Central Reserve Bank of Peru. Labonne, J. and C. Robert S. (2009). The Power of Information: The Impact of Mobile Phones on Farmers' Welfare in the Philippines. World Bank Policy Research Working Paper Series, July.
[28] Nakasone, E., M. Torero, and B. Minten (2014). The Power of Information: The ICT Revolution in Agricultural Development. Annual Review of Resource Economics, Vol. 6: 533-550
[29] Cole SA, Fernando AN. (2012). The Value of Advice: Evidence from Mobile Phone-Based Agricultural Extension. Working Paper 13-047, Harvard Business School, Harvard University.
[30] Aker JC. (2010). Information from Markets Near and Far: Mobile Phones and Agricultural Markets in Niger. Am. Econ.J.: Applied Economics. 2(3): 46-59.
[31]Yonazi, E., T. Kelly, N. Halewood and C. Blackman (2012). "eTransform Africa:
The Transformational Use of ICTs in Africa. Chapter 3: ICT for climate change adaptation in Africa. World Bank (2012). World Bank

platform shares knowledge on improved agricultural practices, livelihoods, health, and nutrition, using locally produced videos and human mediated dissemination.[32]

Analyses of the role of ICTs in agricultural extension highlight the heterogeneity of delivery systems which include one-way versus two-way communication between farmers and agricultural specialists, SMS versus voice messaging, and oral description of problems versus pictures taken in the field. Although these applications increase farmers' awareness, this does not automatically translate into behavioral changes such as increased adoption of improved agronomic practices or modern inputs. Overall, there remains however a lack of evidence regarding which services work and which do not, as most agricultural extension through ICTs is fairly recent.[33]

Climate change adaptation and early warning

The effects of climate change are already impacting agriculture, making the challenge of achieving food security and improving nutrition increasingly difficult. In the face of such challenges, information is key to preparedness; for farmers, this could mean the difference between a successful or a failed harvest. ICT-based tools related to climate change issues and early warning can assist in reducing the risks faced by smallholders.

At the micro level, the provision of timely updates on local meteorological conditions can push out early warning messages related to extreme weather events – such as possible flooding, for instance. For example, *AfricaAdapt*, in Senegal, facilitates vulnerable communities' access to information on climate change adaptation from researchers, policymakers and civil society organizations. It acts as a community of practice, and is supported by a website where members can share updates on face-to-face meetings about their work and adaptation techniques.

At the macro level, the World Food Studies (WOFOST) simulation model, developed by the Centre for World Food Studies (CFWS) in cooperation with the University of Wageningen, analyzes growth and production levels of annual crops and serves to calculate production levels for crops based on soil and weather conditions, among other factors.[34]

ICT-mediated early warning and disaster information systems to mitigate risks are found around the world. One of the most effective ways to disseminate early warnings as well as agricultural pest and disease information related information is through the use of SMS. The *Avian Influenza alert system,* developed by FAO and piloted in Bangladesh, extensively used mobile technology to track the outbreak of the deadly avian (H5N1) virus. Short message services (SMS) were used to collect and manage information from a large number of grassroot level volunteers, thereby enabling a coordinated and real-time response to contain the outbreak.

Remote Sensing and ICTs are crucial in assessing natural resources and providing information to tackle climate change. FAO and Google have partnered to enhance access to geospatial data and analysis through *Open Foris.* The initiative combines Google's Earth Engine with the Organization's international expertise to address complex issues relating to forestry, land cover and land use. The open source app allows even a smallholder equipped with a smartphone to better measure and monitor a piece of land no bigger than an acre and assess deforestation and forest degradation.[35] In addition, FAO's Locust Control Unit has used the Earth Engine to improve forecasts and control of

[32] www.digitalgreen.org
[33] Nakasone, E., M. Torero, and B. Minten (2014). The Power of Information: The ICT Revolution in Agricultural Development. Annual Review of Resource Economics, Vol. 6: 533-550
[34] http://www.fao.org/docs/eims/upload/295345/Sala ICT-climate change Agriculture.pdf
[35] http://www.openforis.org/

desert locust outbreaks. Satellites cannot detect the dreaded insects themselves but can accelerate identification of potential breeding areas and make ground interventions more effective.[36]

Food safety, traceability and certification

Foodborne illnesses pose a serious health threat to the world population. Increasingly, food traceability has become very important as a risk-management tool, by which the movement of food can be followed through specified stages of production, processing, and distribution, thereby improving customer confidence. Traceability of livestock also ensures that animal disease monitored and controlled more effectively, thereby facilitating regional and international trade. For example, an internet based electronic service, *TraceNet*, facilitates certification for export of organic products from India. It collects, stores and reports, forward and backward traces quality assurance data.

Financial inclusion

Transfers and payments, credit, savings, and insurance are examples of financial services that are offered through ICTs. ICTs can significantly help improve rural communities' access by providing financial institutions the means to enter rural markets through unconventional methods – through a reduced need for high-cost branches and improved productivity of the staff in place.

M-PESA enables urban Kenyans to send money home easily to their families in rural areas. Since its beginning, it has expanded significantly into other services, such as savings, and new clients, such as businesses. ICTs play a significant role in increasing access to credit by smallholders but also in facilitating the well-functioning and efficiency of the credit market, especially by reducing information and monitoring costs. Like *DrumNet* in Kenya, ICT platforms can link farmers with formal lenders (such as banks and microfinance institutions) but also informal ones (such as input suppliers and food processors or traders), and provide improved (credit) risk monitoring.

Smallholders lack access to formal banking services. Informal institutions, such as village savings and loan associations, allow them to save and access small amounts of money. Saving and taking loans facilitate investments and consumption smoothing, adding to resilience. While village savings and loan associations are both convenient and flexible, they are not as secure as formal institutions. ICTs can reduce costs and address this issue.

For example, the *Cooperative for Assistance and Relief Everywhere (CARE)* in East Africa is experimenting with connecting its village savings and loan associations to the formal banking system. Each association is to have a single account tied to a bank, which can be tracked and managed via a mobile phone. The advantages of these links and use of ICTs are that they provide access to additional products from the bank, reduce the likelihood of theft or loss of the savings, and improve the management and accounting of associations' finances.[37]

Digital finance promotes financial inclusion, providing access to financial service to the poor, but has also improved the delivery of public services. In Nigeria, an innovative mobile wallet system initiated jointly by the public and private sectors uses mobile technology to transfer fertilizer subsidies directly to farmers. The initiative relies on a database of more than 10.5 million farmers and operates at one-sixth the cost, as there is no need for the government to procure and distribute

[36] http://www.fao.org/news/story/en/item/410307/icode/

[37] AllAfrica (2011). Rwanda: rural savings groups to be linked to mobile banking. allAfrica, 11 August. (available at http://allafrica.com/stories/201108120952.html)

fertilizers. Based on this initial success, the system is expanding, aided by a digital identification system and biometric signatures, taking financial services far into Nigeria's rural hinterland.[38]

Insurance and risk management

Insurance services are a key determinant with respect to the adoption of sustainable production intensification approaches, especially in the context of climate change. Insurance builds resilience and unlocks opportunities that facilitate investment in new agricultural technologies or inputs. Innovative instruments, such as index-insurance differ from traditional indemnity insurance, where payouts are explicitly based on measured loss. Instead, in index-insurance farmers can purchase coverage based on an index that is correlated with those losses, such as wind speed, the amount of rain during a certain window of time (weather based indices) or average yield losses over a larger region (area yield indices).

ICT innovations in earth observation, satellite rainfall estimations and remote sensing, combined with in-situ data, have overcome high transaction costs associated with traditional multi-peril crop insurance with market-based index-insurance products reaching millions of smallholder farmers even in some of the poorest areas of the world, many of which were previously considered uninsurable.[39]

At the micro-level, micro-insurance programmes, such as *Kilimo Salama* use ICTs and enhance access to insurance products. *Kilimo Salama* allowed Kenyan smallholder farmers to insure farm inputs against droughts or excessive rain through prepaid mobile phone fees – a US$2 bag of seeds would be insured for 10 cents. The initiative evolved into the Agriculture and Climate Risk Enterprise Ltd. (ACRE) and now undertakes risk assessments, product development, and risk monitoring to facilitate access to insurance products for smallholders in Kenya, Rwanda, and Tanzania.[40]

[38] World Bank Group (2016). Digital Dividends. World Development Report 2016.
[39] Greatrex H, Hansen JW, Garvin S, Diro R, Blakeley S, Le Guen M, Rao KN, Osgood, DE. (2015). Scaling up index insurance for smallholder farmers: Recent evidence and insights. CCAFS Report No. 14. CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). Copenhagen.
[40] https://www.theguardian.com/global-development-professionals-network/2012/nov/27/farmers-mobile-phones-sms-agriculture http://acreafrica.com/

2.2 ICT in agriculture: developed countries

The digital divide between developing and developed countries is nowhere more evident than in agriculture. This is not only due to the different extent to which digital technologies have penetrated rural areas across the developed economies and the developing world, but also due to different farm structures. Farmers, their cooperatives, large, medium and small input suppliers, traders, processors and retailers use ICTs throughout the food value chain, from testing the soil in the farm to using 3D printers to process food.[41]

Over the last twenty years, farmers in developed countries have already been using ICTs in large scale farming for Precision Agriculture (PA)[42] including in in soil analysis, irrigation, farming equipment, weather forecasting, and more. The fast pace of technological development, which allows for increasing data storage and analytics and progressively lower costs has helped reach these farming advances.

Precision Agriculture

While the main incentive to adopt Precision Agriculture (PA) methods is to maximise profitability, it can also tackle health and safety issues as well as reduce environmental impacts of farming practices. The approach is currently used mainly by large arable farms in Central and Northern Europe, the USA and Australia. A successful example of the application of this method is the use of Controlled Traffic Farming, which reduces crop damage and soil compaction as it confines field vehicles to the minimal area of permanent traffic lanes with the aid of GNSS technology and decision support systems. Farmers in Australia and the UK have been able to reduce machinery and input costs and increase crop yields.

Precision Livestock Farming is another example of an approach that relies on the application of ICTs. They are utilised in the automatic monitoring of individual animals for animal growth, milk and egg production and detection of diseases, as well as for monitoring animal behaviour and their physical environment. The application of this approach has shown commercial benefits in farms, for example, in the South West of England.[43]

Even though PA methods are being progressively applied on farms in developed countries, there is still further need for research and investment in order to increase uptake. In the European Union, ICT AGRI coordinates regional, national and European research programmes in ICTs and robotics to develop a common research agenda, including for the adoption of PA in smaller farms.

In addition to the various on-farm benefits of the approach, Precision Agriculture operations often feed into and generate key elements of Big Data and its applications. Big Data, a collection and analysis of large and complex data sets, can be used to interpret past events and predict future ones. It has the potential to provide new efficient decision making tools to assist agricultural development as well as biodiversity protection.

In the USA, two significant examples of data exchange platforms that utilise big data are i) *FieldScripts*, a commercial service provided by Monsanto that analyses data and provides the farmer with seeding prescriptions that will potentially increase yield and reduce risk; and, ii) the

[41] https://3dfoodprintingconference.com
[42] Precision Agriculture (PA) is a whole-farm management approach using information technology, satellite positioning (GNSS) data, remote sensing and proximal data gathering.
[43] http://www.europarl.europa.eu/studies

Farmers Business Network (FBN), a data exchange platform that, by the middle of 2015, was able to assess the performance of 500 seeds and 16 different crops.

Serious gaming

A great number of people use on-line social networks to communicate, learn and experience new forms of expression and entertainment. These networks have developed to virtual communities, where people interact, and agriculture is an important part of society both real and virtual. For example, *FarmVille*, a farming simulation social network game involving various farming activities, was launched in Facebook in 2009 and held the top position in terms of popularity for two years. More complex digital games, such as *John Deere American Farmer*, introduce in their simulations a variety of crops, weather, natural disasters and crops, with players having to manage their farm workers and purchase inputs.

Digital games are not only for entertainment. Serious games are digital gaming environments that are designed for training the player in solving problems. They gain popularity in many areas, such as public policy, defence, corporate management, education and training. They are simulation platforms that allow learners to experience a number of scenarios and situations and provide solutions, having a positive impact on analytical skills, learning and recollection abilities, problem recognition and problem solving.

In these games, goals and rules define a set of solutions that are revealed through analytical and simulation methods. For example although in the area of food and agriculture serious gaming is at its infancy, *RESOTRES*, a stylized game on land use by smallholders, rich in social and ecological outcomes with a variety of incentives shaping farmers' decisions was applied in farming communities in Chiapas, Mexico, sharpening skills on communal land use patterns, negotiations and collective decision making.[44] *AgriManager*, a serious game developed by Credit Agricole, helps agronomy students to acquire farm management skills through problem solving, including in entrepreneurship, banking and insurance.[45]

At a broader level, the World Economic Forum with the Worldwide Wildlife Fund, the Center for American Progress, CNA Corporation, Cargill and Mars engaged in serious gaming exploring responses to food crises through Food Chain Reaction, a simulating environment conditioned in the context of climate change and extreme weather events, and informed by previous food shocks around the world.[46]

[44] Speelman, E.N.; García-Barrios, L.E.; Groot, J.C.J.; Tittonell, P.A. (2014). Gaming for smallholder participation in the design of more sustainable agricultural landscapes. Agricultural Systems 126.
[45] http://www.serious-game.fr/agrimanager-le-serious-game-du-credit-agricole-pour-les-agriculteurs/
[46] https://www.weforum.org/agenda/2015/12/what-gaming-can-teach-about-us-about-food-security/

Box 1 - Emerging policy issues and ICTs in agriculture

The opportunities to improve both productivity and sustainability of natural-resource use are very promising, but are not yet fully realized. There are also challenges for the adoption of disruptive data-driven technologies, not least because of the very large proportion of the work force engaged in agriculture in many emerging and developing economies.

Increasing productivity growth and improving the sustainable use of land, water and biodiversity resources are essential to ensuring sufficient food for a growing and more affluent global population. ICTs in agriculture can potentially contribute to improve both the productivity and sustainability performance of the agriculture and food sector towards the realization of the Sustainable Development Goals. For example, precision application of agro-chemicals can reduce the amounts of pesticides and fertilizers used, while at the same time increasing yields and reducing possible negative side-effects on soil and water; better weather and market data enables more effective farm production decisions, reducing waste and loss on the farm.

Government policy can enhance widespread adoption of appropriate ICTs, including by facilitating access to "hard" (physical) and "soft" (skills and technical support) infrastructure. Large input suppliers (like equipment manufacturers and the agro-chemical industry) and downstream food processing and food service firms generally have the capacity to adopt and to adapt ICTs to address the needs of farmers and consumers. The farm sector, on the other hand, is characterized by the presence of SMEs, many of which may find it difficult to adopt ICT-based solutions. In addition, barriers to adoption are relatively higher in developing economies and for small farmers operating in remote areas.

A particularly promising application of ICTs in agriculture relates to the design of **agri-environmental policies**. Because of limited means to monitor the environmental effects of policy interventions, agri-environmental policies typically provide incentives for farmers to adopt practices that are considered to be environmentally beneficial (such as subsidy payments to reduce pesticide use). With new IT-based technologies it may be possible to target such policies more directly to environmental outcomes, by reducing the information asymmetry between actions and observable impacts.

More accurate and timely information on climate change, natural perils and market developments is prerequisite for **risk management** on the farm and for designing effective public policies. Governments can facilitate the provision of the necessary ICT infrastructure and both the collection and dissemination of relevant information. While 'information deficits' are likely to exist in all countries, they are particularly present in developing countries.

3 Platforms and selected programmes facilitating ICT applications in agriculture

e-Agriculture Community of Practice (FAO)[47]

The e-Agriculture Community of Practice was established in 2007 to address the challenges that face the digital divide, especially in a rural livelihoods context as a response to the recommendations of the World Summit on the Information Society, initiated by the UN to create an evolving multi-stakeholder platform to address ICT governance issues (see section 4, p.33).

FAO, the UN Agency assigned to lead the development and subsequent facilitation of ICT activities on agriculture, engaged various stakeholders at all levels creating this global Community of Practice, where people from all over the world exchange information, ideas, and resources related to the use of ICTs for sustainable agriculture and rural development.[48]

The objective of the e-Agriculture Community is to serve as a catalyst for institutions and individuals in agriculture and rural development to share knowledge, learn from others, and improve decision making about the vital role of ICTs to empower rural communities, improve rural livelihoods, and build sustainable agriculture and food security.

The Community counts over 13,000 members from 170 countries and territories. This membership is made up by several organizations, and government departments, but also by individual stakeholders such as information and communication specialists, researchers, farmers, students, policy makers, business people, development practitioners, and others.

e-Agriculture focuses on knowledge exchange between UN agencies, governments, universities, research organizations, NGOs, farmers' organizations, the private sector, and the wider community. This exchange is based on constructive dialogue, facilitated by the e-Agriculture forum series.[49] Topics are demand-driven and are led by partner institutions who specialize in different areas of e-agriculture. Online forum discussions are used to produce Policy Briefs on various ICT-related subjects.[50]

In 2015 the e-Agriculture Community of Practice, along with FAO, the International Telecommunication Union (ITU), and the Technical Centre for Agriculture and Rural Cooperation (CTA) organized an online forum on “National E-agriculture Strategy Development”. The discussions were based on an ongoing work by FAO and ITU on a framework to support governments in the development of their national e-agriculture strategies.[51] The FAO-ITU E-Agriculture Strategy Guide was published in 2016, and the framework is being used to develop national e-agriculture strategies in Asia-Pacific and Central Asia regions.

[47] http://www.e-agriculture.org/
[48] e-Agriculture: A Global Community Facilitating Dialogue and Sharing Resources on the Use of ICTs for Sustainable Agricultural and Rural Development. http://www.e-agriculture.org/sites/default/files/e-Agriculture_leaflet_LOW.pdf
[49] http://www.e-agriculture.org/forums/discussions
[50] http://www.e-agriculture.org/policy-briefs
[51] FAO ITU (2016). E-agriculture Strategy Guide. http://www.fao.org/asiapacific/resources/e-agriculture/en/

FAO-ITU e-Agriculture national capacity building efforts

FAO and ITU are collaborating to support countries in formulating and implementing national e-Agriculture strategies that stipulate how ICTs can be strategically used at national level to overcome challenges and accelerate achieving agriculture sector goals and priorities. This support is facilitated by the e-Agriculture Strategy Guide, a framework that was jointly developed by FAO and ITU.

The formulation and implementation of national e-Agriculture strategies is based on a multi-stakeholder approach and a series of interactions with national stakeholders in countries from government agencies, private sector, including mobile telephony companies and Internet providers, research institutions, banks, civil society organizations and others. FAO and ITU are already working with Sri Lanka and Bhutan providing technical advice for formulating an e-agriculture development action plan, together with monitoring and evaluation mechanisms. Under an ongoing project, FAO and ITU would also be assisting Fiji, Philippines, Papua New Guinea and Vanuatu.

ICT in Agriculture Sourcebook (World Bank)

The ICT in Agriculture Sourcebook is an on-line practical guide in understanding current trends, implementing appropriate interventions, and evaluating the impact of those programs.[52] It combines expertise in ICT with empirical knowledge on agriculture and is designed to support practitioners, decision-makers, and development partners who work at the intersection of ICT and agriculture.

The Sourcebook addresses mainstreaming ICTs into 14 sub-sectors of agriculture, including rural finance, markets, agribusiness value chains, extension, innovation systems, farmers' organizations, agricultural marketing, agricultural risk management, food safety and traceability, and land administration and management.

The material illustrates more than 200 project-based case studies and examples, analyzing and disseminating evidence of the impact of ICTs on agricultural development and rural poverty reduction, exploring opportunities for long term and expansive efforts.

Through the illustration of these agriculture-specific ICT applications, the Sourcebook provides guidance for the implementation of a complex set of policy, investment, innovation, and capacity-building measures, which can encourage the growth of locally appropriate, affordable, and sustainable ICT infrastructure, tools, applications, and services for the rural economy. It provides rigorous analysis in how ICTs can support agricultural development, and under what conditions, as well as on how innovative ICT applications can be replicated, and scaled up to promote sustainable development for a larger and more diverse population.

InfoDev (World Bank Group) and Tech Hubs

InfoDev, a global trust fund program on Information and Development supports entrepreneurs in high-growth sectors in more than 70 countries.[53] Through innovative pilot programs on early-stage financing, business training, and regional and global networks, InfoDev focuses on climate technologies, agribusiness, and digital innovation, facilitating the growth of competitive ventures, and the creation of jobs and services that benefit communities.

[52] http://ictinagriculture.org
[53] http://www.infodev.org

Internet and mobile technologies lie at the heart of InfoDev activities being recognized as powerful tools for creating high-value jobs and strengthening social inclusion. The Digital Entrepreneurship Program supports the growth of competitive mobile application industries in emerging and frontier markets.

The program is scaling Mobile Application Labs (mLabs)—incubation facilities and innovation hubs for digital entrepreneurs—and Mobile Social Networking Hubs (mHubs), rolled out across eleven countries.[54] These thriving communities for mobile software entrepreneurs offer training programs, testing facilities, and competitions in the areas of education, health, financial inclusion, agriculture, employment, environment, mobility, and information technology.

Based on the network of mLabs and mHubs, InfoDev facilitate the development of building mobile innovation communities which research the app economy of emerging and frontier markets, including in agriculture. For example, *Mfarm* enhances market access by providing information on prices in Kenya, *GreenHouse Pro* is an application geared to facilitate productivity growth in greenhouse farming, when *MkulimaBima* links farmers and insurance companies.

InfoDev's efforts focus on enhancing entrepreneurial activity in ICTs by supporting technology clusters to contribute to the development of a digital economy. According to the World Development Report 2016, digital technology clusters, such as Silicon Valley in the US, are crucial in sustaining entrepreneurship and development. They are based on public private partnerships that entail close collaboration between academia and industry, easy access to venture capital, and high levels of government research spending.

Such digital technology clusters, often called 'tech hubs' have recently flourished in cities such as Bangalore, Berlin, Hangzhou, London, Nairobi, and New York, where internet infrastructure, penetration and density allow the development of the high tech industry. Nevertheless, in Africa more than 100 tech hubs, though nowhere similar in scale to Silicon Valley, demonstrate that close collaboration between academia, government, and the private sector can help develop a vibrant eco-system that facilitates ongoing innovation and market entry.[55]

Fostering Agriculture Competitiveness Employing Information and Communication Technologies (FACET), USAID

Fostering Agriculture Competitiveness Employing Information and Communication Technologies (FACET), was a technical assistance project designed to help U.S. Agency for International Development (USAID) missions and their partners in applying ICTs to improve competitiveness and productivity of agricultural value chains and to facilitate trade in agricultural products across sub-Saharan Africa.[56]

In line with USAID's call for an increased focus on evidence-based interventions and knowledge sharing, FACET incorporated lessons learned and best practices to build collaborative relationships. Activities focused on evaluation of sustainable and scalable approaches using ICTs; and on short-term technical assistance to projects to help them improve ICT applications.

The knowledge sharing objective was extended by making the main outputs, toolkits and case studies available to a global audience through the e-Agriculture Community of Practice. For

[54] The Business Models of mLabs and mHubs—An Evaluation of InfoDev's Mobile Innovation Support Pilots 2014 International Bank for Reconstruction and Development / The World Bank

[55] See pp. 229-230, World Bank Group (2016). Digital Dividends. World Development Report 2016.

[56] http://www.e-agriculture.org/usaids-fostering-agriculture-competitiveness-employing-information-communication-technologies-facet

example, FACET has provided technical assistance on how to use low-cost video to improve agricultural extension services and product marketing to USAID implementing partners and mission staff from more than 10 countries in sub-Saharan Africa. Other instruments include briefing papers, Agricultural ICT application profiles and webinars.[57]

ICT Observatory and ICTUpdate (Technical Centre for Agricultural and Rural Cooperation)

The Technical Centre for Agricultural and Rural Cooperation (CTA) is a joint international institution of the African, Caribbean and Pacific (ACP) Group of States and the European Union (EU). Their mission is to advance food and nutritional security, increase prosperity and encourage sound natural resource management in ACP countries.

CTA's ICT Observatory meetings were set up in 1998 as an instrument to advise the institution, and its partners on ICT strategies and applications relevant to ACP agricultural and rural development and to identify ICT policy issues, experiences and projects. The meetings' specific objectives are to review the need, design and implementation of ICTs for agriculture strategies in ACP countries; and, identify strategic actions and collaborations to be put in place to strengthen the formulation and implementation of effective and inclusive ICT strategies for agriculture.

CTA publishes ICTUpdate, a bimonthly printed bulletin, and maintains an online magazine and an accompanying e-mail newsletter and mobile Web site. Each issue focuses on a specific theme relevant to ICTs for agricultural and rural development in ACP countries, and features a selection of commissioned articles. The printed bulletin also contains a Guest editor contribution, Tech Talk, Resources, Dispatches and a 'Question and Answer' section.[58]

Joint promotion of the ICTUpdate series by CTA and e-Agriculture Community of Practice has attracted a new audience for the ICTUpdate articles and ensured a regular source of fresh content for the e-Agriculture online audience. Since 2013, ICTUpdate has published over 300 stories from practitioners, ICT developers and beneficiaries, thus adding new content to its collection of over 2,000 pages.

Advanced Agricultural Practice Knowledge Portal

In India, the International Food Policy Research Institute (IFPRI), in partnership with the e-Extension Centre of Tamil Nadu Agricultural University (TNAU), developed the Advanced Agricultural Practice Knowledge Portal for the ICICI Knowledge Park (IKP) Centre for Advancement in Agricultural Practice (ICAAP) in 2012. This portal serves as a gateway for knowledge and best practices from CGIAR and other international and national agricultural research centers.

Designed to respond to the information needs of local knowledge intermediaries such as research scientists, extension professionals, farmers associations, NGO staff, and agricultural entrepreneurs, the portal provides information that benefits both small and marginal farmers directly through improved extension services, and indirectly through the improved use of information by intermediary organizations.[59]

[57] http://www.e-agriculture.org/content/integrating-low-cost-video-agricultural-development-projects-toolkit-practitioners
[58] http://ictupdate.cta.int/Issues/(issue)/82
[59] . http://www.ikptrust.org.in/group-companies/ikp-centre-for-advancement-in-agricultural-practice-icaap/

ICT-AGRI – research on Internet of Things applications

ICT-AGRI is funded by the European Commission's ERA-NET scheme under the 7th Framework Programme for Research.[60] The objective of an ERA-NET scheme is to develop and strengthen the European Research Area by facilitating practical initiatives to coordinate regional, national and European research programmes in specific fields.

ICT-AGRI-1 began on 2009 and ran until 2014. The follow-up project ICT-AGRI-2 is scheduled to run for 4 years until the end of 2017. The overall goal of ICT-AGRI is to strengthen the European research within the diverse area of Precision Agriculture and develop a common European research agenda concerning ICTs and robotics in agriculture. The project focuses on ICT systems for site-specific applications of fertilizer, pesticides and water; Controlled Traffic Farming; automated technologies for precision livestock farming and indoor climate control; and automated quality control systems to improve quality, safety and traceability of food and feed. ICT-AGRI also focuses on Precision Farming applications on smaller farms.

Projects using Big Data for agricultural development

Big Data is not only a large data set, but a complex system of data sources, technologies and methodologies that result in an extreme volume of data of various types that can be rapidly collected, recorded and analyzed. As early as 1975, participants at the Very Large Datasets Conference discussed how to manage the US Census which at that time was considered massive. Since then, computing power and decreasing costs of storage have resulted in huge volumes of data being collected and analyzed.

In agriculture, large input suppliers and machinery manufacturers have initiated Big Data applications to provide better services to their clients in developed countries and emerging economies (see Section 2.2). Beyond commercial purposes, Big Data is being used by governments and international organizations to enhance inclusion, promote cost-effective assessments, and inform decision-making.

Open Foris (see Section 2.1 – Climate change adaptation and early warning) which improves access to geospatial data, is based on Collect Earth, a tool that enables data collection through Google Earth. In conjunction with Google Earth, Bing Maps and Google Earth Engine, users can analyze high and very high resolution satellite imagery for a wide variety of purposes, including land use changes, forestry assessments, and monitoring of agricultural land and urban areas.[61]

M-PESA (see Section 2.1 – Financial inclusion) in collaboration with Vodafone and USAID will work towards creating a better system for mobile services in the agricultural sector in Kenya, Tanzania and Mozambique. The pilot project is based on a remote crowdsourced data-collection method through mobile phones that identifies who and where farmers are and the crops they specialize in producing. The data set is highly structured and referenced both temporally and spatially, as well as highly person-identifiable, enabling enterprises to distinguish specific farmers and their products. Privacy is governed by Vodafone's data privacy policies to ensure ongoing protection.[62]

UN Global Pulse utilized Twitter data in order to track food price inflation in Indonesia. The data was generated between March 2011 and April 2011, including 100,000 Tweets and categorized through an initial filter of content based on keyword searches as being related to food price

[60] http://ict-agri.eu/
[61] http://www.openforis.org/tools/collect-earth.html
[62] The World Bank (2015). Big Data in Action for Development

increases or fuel price increases, thus enhancing the potential to implement ongoing real-time analysis and inform policy-making.[63]

International conferences

ICTforAg, 10 June 2016, Washington D.C.: This 1-day conference built on ICTforAg 2015 and brought together more than 275 thought leaders and decision makers in agriculture and technology from the international development community and the private sector to examine how new innovations can empower smallholder farmers, and the entire value chains that support them, through the use of information and communication technologies (ICT).[64]

World Congress on Computers in Agriculture, Asia Federation for Information Technology in Agriculture 2016, 21-24 June 2016, Sunchon, Korea: The WCCA AFITA 2016 conference, with the theme of "ICT for Future Agriculture", aimed to promote a wide range of ICT research and development for agriculture. It provided an opportunity to exchange the latest information and ideas, and debate on the issues in ICT convergence research.[65]

[63] UN Global Pulse. (2014). Mining Indonesian Tweets to Understand Food Price Crises. http://www.unglobalpulse.org/sites/default/files/Global-Pulse-Mining-Indonesian-Tweets-Food-Price-Crises%20copy.pdf
[64] http://ictforag.org/ http://www.ict4ag.org/en/
[65] www.afita2016.org

4 Governance

> '*For something so central to the modern world, the Internet is shambolically governed. It is run by a hotch-potch of organisations with three- to five-letter acronyms. Many of their meetings, both online and offline, are open to the public. Some—like the Internet Governance Forum...are just talking shops. Decision-making is slow and often unpredictable.*
>
> *It is in short a bit chaotic. But sometimes chaos, even one that adherents like to claim somewhat disingenuously is a "multi- stakeholder" approach, is not disastrous: the Internet mostly works. And the shambles is a lot better than the alternative—which nearly always in this case means governments bringing the Internet under their control.'*[66]

Governance issues, infrastructure, connectivity, data ownership, privacy and ethics, but also the emphasis on specific sectors, including agriculture are being shaped by the private sector, governments, national strategies, legal systems, but also by an international processes under the auspices of the UN.

Since the beginning of its existence, few decades ago, the Internet was a network of networks. Established initially as a research platform, it was, and continues to be characterized by openness, global interconnectedness, multiple layers, and a unique decentralized nature that is not entirely compatible with the traditional instruments of governance. Both borderless and unbounded, the Internet makes physical proximity irrelevant and its global infrastructure, formed by millions of servers that span across countries, provides a basis for fast and effective information exchange, as well as for trade in goods and services.

Being a global resource, and with billions of users, the Internet requires some degree of international cooperation on technical matters, but also on standards and norms that can ensure that it remains a global public good, facilitating information flows and contributing towards sustainable development globally.

Although the Economist's view of chaos may sound exaggerated, it is not far from truth. Internet is run by a number of technical organizations or communities, each carrying out a variety of tasks that ensure its functionality. The Internet Society, the Internet Corporation for Assigned Names and Numbers (ICANN), the Internet Engineers Task Force (IETF) and the W3C are such organizations that can be either loose affiliations of experts, or non-profit companies.

Sovereign states are also concerned with Internet governance, especially in terms of aligning standards and norms with national policies and regulations. Cybercrime - the crime, facilitated by the network and computer technologies – is also a priority concern for governments. Because of Internet's global reach, the anonymity of the user, and the possibility that even small participants have capacity to commit cybercrime that can affect millions, national legal frameworks that are tailored for the 'real world' cannot ensure effective monitoring – national jurisdiction is inherently linked to the notion of state sovereignty. [67]

Many states also consider Internet as a very important avenue in the provision of public goods, such as information dissemination and education. Other states are concerned with the content and other

[66] 'In Praise Of Chaos: Governments' Attempts To Control The Internet Should Be Resisted, THE ECONOMIST (Oct. 1, 2011), http://www.economist.com/node/21531011.
[67] Appazov, A. (2014). Legal Aspects of Cybersecurity. Mimeo, Faculty of Law, University of Copenhagen.

information that bypasses geographical borders and may clash with local cultures and social practices and goals.

Governments strive for a strengthened role of sovereign states in the governance of Internet, either within a *multi-stakeholder* context, or within *multilateral* fora.[68] The World Summit on the Information Society (WSIS) – a UN summit that was initiated in order to create an evolving multi-stakeholder platform including technical communities, governments, civil society and academics - aims at addressing the issues raised by ICTs through a structured and inclusive approach at the national, regional and international levels.

This multi-stakeholder model reflected by WSIS is not unchallenged. Many governments prefer to discuss Internet governance in intergovernmental or multilateral fora, such as the World Conference on International Telecommunications (WCIT). This multilateral model could assign the responsibility of governing the Internet to sovereign states, providing limited space for other stakeholders.

Technical organizations and communities

The Internet evolved around a culture of cooperation, and the technical organizations that ensure its functionality matured reflecting this culture. These organizations do not operate under government authority – most are inter-linked and have evolved through discussions and conversations in various forums, adopting more or less formal organizational structures to solve problems.

The openness, global interconnectedness, and decentralized nature of the Internet is mirrored on the structure of these organizations, which in essence are operating as multi-stakeholder platforms.[69] Although technical in nature, their operations can sometimes touch political issues, with decision-making based often on rough consensus through procedures that are characterized by openness.

Established in 1986, the **Internet Engineering Task Force** (IETF) has evolved together with the Internet, being responsible for setting standards for communication protocols, namely the Transmission Control Protocol (TCP) and Internet Protocol (IP) – a set of rules that govern how computers and servers communicate worldwide. IETF has a cooperative, consensus-based, decision-making process, involving a wide variety of individuals. IETF is open to any interested individual, including representatives of sovereign governments who are not accorded any particular deference and are expected to have the technical skills to engage in discussions and testing procedures.[70]

While IETF focuses on shorter term issues of engineering and standards making, the **Internet Research Task Force** (IRTF) focuses on longer term research issues on Internet protocols, applications, architecture and technology. The IRTF is composed of a number of focused and long-term Research Groups. For example, the Human Rights Protocol Considerations Research Group is mandated to assess the relationship between standards and protocols and human rights as defined in the Universal Declaration of Human Rights (UDHR) and the International Covenant on Civil and Political Rights (ICCPR). Its guidelines aim at informing future protocol development and decision making where protocols and standards impact the effective exercise of the rights to freedom of

[68] World Bank Group (2016). Digital Dividends. World Development Report 2016.
[69] Waz, J. and P. Weiser (2013). Internet Governance: The Role of Multistakeholder Organizations. Journal of Telecommunications and High Technology Law, Vol. 10, No. 2.
[70] Kurbalija, J. (2014). An Introduction to Internet Governance. www.diplomacy.edu

expression or association. Research groups are formed by individual experts, rather than by representatives of organizations.

The **Internet Activities Board** (IAB) traces its origins back to1972 when it was established by Vint Cerf – one of the Internet's early pioneers. IAB provides long-term technical direction for Internet development, ensuring the Internet continues to grow and evolve as a platform for global communication and innovation. IAB's membership is made up by private sector experts and academics. IAB also oversees the work of IETF and IRTF.

The **Internet Society** (ISOC) was formed in 1992 to provide an institutional home and financial support for the Internet Engineering Task Force (IETF) and its standard-setting activities and is one of the main representatives of the technical community. ISOC also provides a hub for IRTF and IAB. The Society facilitates open development of standards, protocols, administration, and the technical infrastructure of the Internet and plays an active role in international fora on Internet governance, such as the WSIS and ITU.

Since 2010, ISOC is granted Consultative Status by ECOSOC and participates in relevant UN conferences and preparatory meetings. Based on this status, ISOC participates in the Human Rights Council, and is recognized as "an NGO in operational relations with UNESCO" and is part of UNESCO's Communication and New Technologies Joint Program Commission. ISOC is also a Permanent Observer to the World Intellectual Property Organization (WIPO) and Observer organization to the Steering Committee on Copyright and Related Rights (SCCR). Participation in ISOC is open to everyone, including organizations, experts, academics and NGOs.[71]

Internet communication is based on addresses - every computer has an Internet Protocol (IP) address that is unique. The **Internet Corporation for Assigned Names and Numbers (ICANN)** coordinates and ensures the secure operation of the Internet's systems of addresses that includes IP addresses and domain names (such as .com, .int, or .org) but also generic country codes (such as .uk, .in, .cn). ICANN – a California based non-profit organization – is responsible for assigning unique names and numbers that constitute Internet addresses globally since 1998 initially through an agreement with the US Department of Commerce to undertake functions of the Internet Assigned Number Authority (IANA).[72]

In 2014, the US Department of Commerce relinquished its oversight role of ICANN and the organization initiated a transition process towards a fully independent transnational and inclusive body with the responsibility of assigning domain names and numbers. In addition to other stakeholders (such as IETF), ICANN has introduced government participation through the creation of the Government Advisory Committee (GAC) that is composed of over 140 governments. GAC's mandate is to 'provide advice particularly on matters where there may be an interaction between ICANN's policies and various laws and international agreements or where they may affect public policy issues'.[73]

The **World Wide Web Consortium (3WC)** is an international community that develops open and voluntary standards for building and rendering web pages to ensure the long-term growth of the web. W3C is also focusing on technologies to enable web access anywhere, anytime, using any device. This includes Web access from mobile phones and other mobile devices.

[71] https://www.Internetsociety.org/who-we-are/our-community-and-partners
[72] Sylvain, O. (2015). Legitimacy and Expertise in Global Internet Governance. Journal on Telecommunications and High Technology Law 31. Prior to 1998. It was the US Department of Defence in association with the University of Southern California Information Sciences Institute that administered Internet identifiers.
[73] https://gacweb.icann.org/display/gacweb/Governmental+Advisory+Committee

4.1 International fora on Internet governance

The World Summit on the Information Society

The World Summit on the Information Society (WSIS) was initiated in 2003 by the UN in order to create an evolving multi-stakeholder platform to address ICT governance issues through a structured and inclusive approach at the national, regional and international levels. Its goal is to achieve a common vision, desire and commitment to build an inclusive and development-oriented global Information Society.

The Summit, held in two phases in 2003 and 2005, developed a multi-stakeholder process including governments, international organizations, Internet and technical communities, non-profit organizations, the private sector and civil society. Since 2005, a series of WSIS-related events is being held on an annual basis. These are re-branded as WSIS Forum, and are hosted by the ITU and co-organized by UNESCO, UNCTAD and UNDP (see Annex A for a summary of the main WSIS events).

WSIS has strengthened the role of states in Internet governance, while at the same time retains an inclusive and multi-stakeholder nature, addressing challenges, such as the digital divide (the inequality in access to information and communication) and discussing the opportunities of the new information and communication environment.

The WSIS Geneva Declaration of Principles emphasizes the importance of the ethical dimensions of the Information Society, viewing ICTs as an avenue of progress with respect to the realization of human rights and fundamental freedoms. According to the Geneva Principles, the same rights that people have offline must also be protected online.[74] The United Nations General Assembly has expressed its support to the multi-stakeholder process of WSIS calling for close alignment between the WSIS process and the 2030 Agenda for Sustainable Development.[75]

The Geneva Plan of Action also identified eighteen areas of activity (or Action Lines), including agriculture, on which governments, civil society, businesses and international organizations could work together to achieve the potential of ICTs for development.

e-agriculture is one of the Action Lines identified in the Geneva Plan of Action of WSIS. On agriculture, the Plan of Action called stakeholders to (i) ensure the systematic dissemination of information using ICTs on agriculture, animal husbandry, fisheries, forestry and food, in order to provide ready access to comprehensive, up-to-date and detailed knowledge and information, particularly in rural areas; and (ii) to promote public-private partnerships to maximize the use of ICTs as an instrument to improve production (quantity and quality).

The Food and Agriculture Organization of the United Nations (FAO) was assigned the responsibility of organizing follow-up activities related to e-agriculture. FAO conducted an extensive survey on the subject of the action line, and then together with the Founding Partners, launched the e-Agriculture Community of Practice in 2007 as part of this follow-up.[76]

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[74] http://www.itu.int/net/wsis/docs/geneva/official/dop.html

[75] UNGA Resolution adopted by the General Assembly on 16 December 2015 70/125. Outcome document of the high-level meeting of the General Assembly on the overall review of the implementation of the outcomes of the World Summit on the Information Society.

[76] E-Agriculture's founding partners include the Consultative Group on International Agricultural Research (CGIAR); Technical Centre for Agriculture and Rural Development (CTA); FAO; Global Alliance for Information and Communication Technologies and Development (GAID); Global Forum on Agricultural Research (GFAR); Global Knowledge Partnership (GKP); Deutsche Gesellschaft für Internationale Zusammenarbeit, (GIZ); International Association of Agricultural

In 2014, on the basis of a report provided by FAO, a WSIS event (WSIS+10 High Level Event), reviewed progress on the Action Line e-Agriculture, underlining a number of future challenges, including ICT application content, capacity development, gender and diversity.[77]

The WSIS also promoted the development and implementation of national e-Agriculture strategies with the aim of providing reliable and affordable connectivity and integrating ICTs in rural development to support food security and hunger eradication. The meeting encouraged all stakeholders to:

> (i) foster collaboration and knowledge sharing in agriculture via electronic communities of practice, including the e-Agriculture Community;
>
> (ii) promote the creation and adaptation of content in local languages and contexts to ensure equitable and timely access to agricultural knowledge by resource-poor men and women farmers;
>
> (iii) foster digital literacy of institutions and communities in rural and remote areas;
>
> (iv) promote the use of ICTs to reinforce the resilience capacity of states, communities and individuals to mitigate and adapt to natural and man-made disasters, food chain challenges, socio-economic and other crises, conflicts and transboundary threats, diseases, and environmental damages; and,
>
> (v) support inclusive, efficient, affordable and sustainable ICT services by promoting Public-Private Partnerships in cooperation with cooperatives, farmer organizations, academia, and research institutions.

World Conference on International Telecommunications

The global multi-stakeholder process for the governance of the Internet proposed by WSIS is not unchallenged. A number of countries advocate for a stronger role of governments in Internet governance through a multilateral model in the context of the World Conference on International Telecommunications (WCIT).

WCIT, convened by the International Telecommunications Union in 2012, aimed at discussing the International Telecommunications Regulations (ITRs), which are the rules for the exchange of telecommunications traffic across borders that were last negotiated in 1988.[78]

At the Conference, a number of countries supporting multilateralism in Internet governance made a series of proposals related to Internet issues, such as access to Internet, IP addressing, cybersecurity, SPAM, IP interconnection, regulation of operators and Internet traffic.[79] Other countries favoured the multi-stakeholder approach, advocating that Internet issues should not be

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Information Specialists (IAALD); Inter-American Institute for Cooperation on Agriculture (IICA); International Fund for Agricultural Development (IFAD); International Centre for Communication for Development (IICD); United States National Agricultural Library (NAL); United Nations Department of Economic and Social Affairs (UNDESA); the World Bank.

[77] e-agriculture 10 year Review Report. Implementation of the World Summit on the Information Society (WSIS) Action Line C7.ICT Applications: e-agriculture. http://www.fao.org/3/a-i4605e.pdf

[78] ITRs facilitate the exchange of international telecommunications traffic across borders focusing on operator competition, mobile telephony roaming fees, and transparency.

[79] EU Telecom Flash Message 2/2013. Cullen International http://www.cullen-international.com/asset/?location=/content/assets/regulatory-intelligence/regulatory-news/wcit-12_post-mortem_culleninternational.pdf/wcit-12_post-mortem_culleninternational.pdf

discussed in WCIT. These countries also expressed their concerns that a number of the proposals would affect the Internet architecture, operations, content, security and the global interoperability,

The differences between delegations resulted in a highly political debate over the role of governments in the governance of the Internet with the ITRs but also over human rights, privacy and the freedom of speech.[80] With the end of WCIT, although 89 countries signed the revised treaty, 55 countries decided not to sign it. Although most proposals on internet governance and architecture do not appear in the final text, the treaty provides for a greater role of the WCIT in Internet issues.[81]

4.2 Human rights, privacy and ethics

Principles and human rights

There is no international binding agreement on online human rights and often the debate centres on the freedom of expression and access to information – both fundamental human rights in the International Covenant on Civil and Political Rights. Many countries provide guidelines with information about rights and freedoms in the context of ICTs.[82]

Nevertheless, according to a 2011 report of the UN Human Rights Council Special Rapporteur, countries are increasingly censoring information online through blocking or filtering of content, imposing impermissible restrictions on legitimate expression, disconnecting users from the internet, and not providing adequate protections to privacy and data. In other countries, even though individuals may have access to online content free of censorship, Internet access may not be widely available for the majority of the population. Both aspects of access affect the right to freedom of opinion and expression.[83]

Mass surveillance practices are also an important issue. In 2013, the Special Rapporteur on the promotion and protection of the right to freedom of opinion and expression issued a report suggesting that nations' laws on surveillance were inadequate or non-existent. Although concerns about national security and criminal activity may justify the exceptional use of communications surveillance technologies, such inadequate national legal frameworks create a fertile ground for arbitrary and unlawful infringements of the right to privacy in communications and, consequently, also threaten the protection of the right to freedom of opinion and expression.[84]

In June 2012, the UN Human Rights Council adopted a resolution preserving human rights on the internet, affirming that people have the same rights online that they have offline—in particular freedom of expression which is applicable regardless of frontiers and through any media of one's choice. [85]

[80] World Bank Group (2016). Digital Dividends. World Development Report 2016.
[81] http://www.internetsociety.org/wcit
[82] For example, Council of Europe Guide on Human Rights for Internet Users, adopted in 2014.
[83] Report of the Special Rapporteur on the promotion and protection of the right to freedom of opinion and expression. UNGA A/66/290, 10 August 2011.
[84] Report of the Special Rapporteur on the promotion and protection of the right to freedom of opinion and expression, Frank La Rue. Human Rights Council, A/HRC/23/40, 17 April 2013.
[85] The promotion, protection and enjoyment of human rights on the Internet. Human Rights Council, A/HRC/20/L.13 29 June 2012.

The Internet Governance Forum (IGF) – a multi-stakeholder platform that enables the discussion of public policy issues pertaining to the Internet under the UN – has provided a framework on how human rights should be interpreted to apply to the Internet environment, and the Internet policy principles which must be upheld in order to create an environment which supports human rights to the maximum extent possible. The Charter of Human Rights and Principles for the Internet covers the whole spectrum of human rights drawing on the Universal Declaration of Human Rights and other covenants that make up the International Bill of Human Rights at the United Nations (see Annex B).[86] The 2011 report of the UN Special Rapporteur on Freedom of Expression, and the 2012 landmark decision by the UN Human Rights Council on human rights and the internet have both affirmed the value of the Charter.[87]

Personal data protection and privacy

Governments collect large amounts of personal information for civil registries, social security, housing records and tax purposes. The collection of biometric data for passport issuance for identification purposes adds to a wealth of personal data that is collected, stored and managed by states through ICTs to increase efficiency and reduce bureaucracy. Often, governments face challenges to ensure a proper balance between the privacy rights of their citizens and national security.

With the rapid expansion of software and a web search engine companies, social network platforms and e-commerce, users disclose personal information that, although makes service delivery and social networking more efficient and relevant, results in a massive amount of identifiable information that is owned, controlled and used by digital service providers.

A challenge for privacy is the expanding use of Big Data – data that is subject to complex automated discriminatory technologies – that can classify users and customers into categories according to their preferences, income, ethnicity, political views and other sensitive characteristics. The Internet of Things that connects devices to the Internet, can also result in detailed user profiles and poses similar privacy challenges.

Many States have rules that ensure that personal data is protected – about 107 countries have privacy laws in place as of 2014 with half of them being developing countries.[88] These legal frameworks define the purposes for which personal data can be collected legitimately, and establish rules for its proper management and protection from misuse. For example in the EU, the Directive on Privacy and Electronic Communications (ePrivacy Directive) builds on the EU telecoms and data protection frameworks to ensure that all communications over public networks maintain respect for fundamental rights, in particular a high level of privacy, regardless of the technology used. This Directive was last updated in 2009 to provide clearer rules on customers' rights to privacy and another revision is currently under preparation.[89]

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[86] See Charter of Human Rights and Principles for the Internet at https://www.intgovforum.org/cms/dynamiccoalitions/72-ibr

[87] United Nations Human Rights Council, 2012, *Resolution A/HRC/RES/20/8: Promotion and protection of all human rights, civil, political, economic, social and cultural rights, including the right to development*, UN General Assembly: OHCHR. Rue, Frank, 2011, Report of the Special Rapporteur on the Promotion and Protection of the Right to Freedom of Opinion and Expression. Human Rights Council: UN General Assembly, A/HRC/17/27, May 16, 2011.

[88] UNCTAD (United Nations Conference on Trade and Development). 2015. Information Economy Report: Unlocking the Potential of E-Commerce for Developing Countries. Geneva: UNCTAD

[89] https://ec.europa.eu/digital-single-market/en/online-privacy. The ePrivacy Directive adopted in 2009 requires Member States to ensure that users grant their consent before cookies (small text files stored in the user's web browser) are stored and accessed in computers, smartphones or other device connected to the Internet.

In 2013, the OECD published its Guidelines on the Protection of Privacy and Transborder Flows of Personal Data, revising work originally carried out in the 1980s to enhance privacy protection in a data-driven economy.[90] The Africa Union Convention on Cybersecurity and Personal Data Protection provides for establishing legal frameworks aimed at strengthening fundamental rights and public freedoms, particularly concerning the protection of data.[91] At the international level, in 2015 the United Nations Assembly adopted a resolution on the right to privacy in the digital age and appointed a special rapporteur on the right to privacy to ensure its promotion and protection, including in connection with the challenges arising from new technologies.[92]

The UN Global Pulse, an innovation initiative of the United Nations Secretary-General to harness safely and responsibly the potential of Big Data for sustainable development and humanitarian action, has developed a set of Privacy Principles in consultation with its Data Privacy Advisory Group. The Group comprises of experts from public and private sector, academia and civil society, and provides a forum for a continuous dialogue on critical topics related to data protection and privacy and to how privacy protected analysis of Big Data can contribute to sustainable development and humanitarian action.[93]

The issue of protecting personal information collected, stored and managed by ICTs becomes more complex, as personal data are being processed and transferred on a regular basis across national borders. There is no international binding agreement on cross-border digital data flows and in many countries although data protection and privacy laws are based on a common set of principles they are locally adapted and often do not comply with each other.[94]

Instead, digital data transfers, as well as digital trade, are often governed by bilateral, multilateral or plurilateral agreements. For example, The Asia-Pacific Economic Cooperation initiated the Cross-border Privacy Enforcement Arrangement Privacy Framework to underpin the free flow of information in the Asia-Pacific region to improve consumer confidence and ensure the growth of electronic commerce.[95]

The US and the EU initiated a framework for transatlantic data flows – especially personal data of European consumers – in 2000 (Safe Harbor Agreement). In 2016, a new arrangement – the EU-US Privacy Shield – was negotiated establishing clear safeguards and transparency obligations on US companies that import personal data from the EU.[96] In other cases, countries establish rules that require the local storage of citizen's personal data. #

Trade in digital goods and services

Trade in digital goods and services is governed by the World Trade Organization (WTO). The Information Technology Agreement (ITA), originally signed in 1996, is an agreement whereby 82 WTO Members have agreed to extend zero tariffs to information technology products. Fifty of those WTO Members agreed at the Nairobi Ministerial Conference in December 2015 to further expand

[90] OECD (2013). The OECD Privacy Framework. http://www.oecd.org/internet/ieconomy/privacy-guidelines.htm
[91] African Union 23rd Ordinary Session of the Assembly of the Union (2014). African Union Convention on Cybersecurity and Personal Data Protection
http://pages.au.int/sites/default/files/en_AU%20Convention%20on%20CyberSecurity%20Pers%20Data%20Protec%20AUCyC%20adopted%20Malabo.pdf
[92] UNGA (2015). The right to privacy in the digital age. A/HRC/28/L.27, 24 March 2015
[93] http://www.unglobalpulse.org/privacy-and-data-protection
[94] World Bank Group (2016). Digital Dividends. World Development Report 2016.
[95] http://www.apec.org/Groups/Committee-on-Trade-and-Investment/Electronic-Commerce-Steering-Group/Cross-border-Privacy-Enforcement-Arrangement.aspx
[96] http://europa.eu/rapid/press-release_IP-16-216_en.htm

the list of products that would benefit from duty-free through the so-called ITA Expansion. Signatories of the ITA represent 97 percent of the world trade in information technology products. Both the original ITA and the ITA expansion eliminated import duties on products used as carrier media (e.g. CDs, DVDs, etc.) and trade in software and data, but include no further provisions concerning digital goods.

The WTO Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS), by setting minimum standards for the protection and enforcement of intellectual property rights, provides much of the legal framework necessary for international trade in intangible digital products. TRIPS disciplines on the non-discriminatory availability of Intellectual Property rights such as undisclosed information, copyright (including for software), patents and trademarks in WTO Members provide the framework in which the use rights to IP-protected digital products can be traded in the form of IP licenses, and which in turn shape much of commercial transborder information flows.

The WTO General Agreement on Trade in Services (GATS) has an Annex on Telecommunications that supports all other ICT enabled services and ensures that any suppliers of committed services will have reasonable and non-discriminatory access to telecom networks and services they need. A wide variety of services also benefit from bound commitments to cross border supply, some of which are not subject to any of the restrictions that may be listed in schedules, if applicable.

Many of these result in legal bindings on cross-border information flows and trade that is electronically delivered, both for ICT services, themselves, as well as for a significant number of ICT-enabled services. If necessary, governments may be able to avail themselves of exceptions to the GATS obligations in the interest of e.g. protecting privacy and preventing cybercrime or fraud, subject to disciplines to reduce the trade restrictiveness of the measures used.[97]

Increasingly, regional trade agreements contain specific chapters or sections on electronic commerce.[98] Such trade agreements are increasingly utilized to govern information flows including personal data transfers. For example, the Trans Pacific Partnership (TPP) E-Commerce chapter is the most comprehensive chapter on electronic commerce in regional trade agreements to date. It includes a number of commitments in order to facilitate trade in the digital sphere, while it also provides for commitments on consumer protection TPP requires its signatories to allow the cross-border transfer of digital information in line with national policies that provide for the protection of personal data. TPP signatories have also agreed to seek to achieve compatibility among privacy regulations. [99]

[97] GATS Article XIV specifies that any inconsistent measures taken must not only be "necessary", but also are "subject to the requirement that such measures are not applied in a manner which would constitute a means of arbitrary or unjustifiable discrimination between countries where like conditions prevail, or a disguised restriction on trade in services".

[98] Of the RTAs notified to the WTO to date, around a quarter contain provisions on electronic commerce. Cf. WTO Regional Trade Agreements Information System http://rtais.wto.org/UI/PublicMaintainRTAHome.aspx

[99] Aaronson, S.A. (2016). The Digital Trade Imbalance and Its Implications for Internet Governance. Institute for International Economic Policy Working Paper Series, Elliott School of International Affairs, The George Washington University, April.

Annex 1

The World Summit on the Information Society

- *First Phase of the WSIS, Geneva 2003 - the Geneva Declaration of Principles and Plan of Action*

In 2003, WSIS agreed on the Geneva Declaration of Principles and the Geneva Plan of Action. The Geneva Declaration of Principles underlined the objective:

> *to build a people-centred, inclusive and development-oriented Information Society, where everyone can create, access, utilize and share information, respecting human rights.*

The Principles also laid down the foundations of a multi-stakeholder process for Internet governance characterized by the effective participation, partnership and cooperation of governments, the private sector, civil society, international organizations, and the technical and academic communities. [100]

The Geneva Plan of Action identified eighteen areas of activity (or Action Lines) on which governments, civil society entities, businesses and international organizations could work together to achieve the potential of ICTs for development. These Action Lines put emphasis on the role of the public sector and other stakeholders in the promotion of ICT, information and communication infrastructure; the importance of access to knowledge, capacity building and building of an enabling environment, as well as issues related to cultural diversity and the ethical dimensions of ICT.[101]

Emphasis was also placed on ICT applications that could benefit all aspects of life, supporting sustainable development, in the fields of public administration, business, education and training, health, employment, environment, agriculture and science within the framework of national e-strategies.

Second Phase of the WSIS, Tunis, 2005 – Implementation and working definition of Internet governance

In 2005, WSIS set up an implementation mechanism at the international level for the Geneva Plan of Action through the endorsement of The Tunis Commitment and the Tunis Agenda for the Information Society. It was agreed that implementation of the Geneva Plan of Action will be moderated or facilitated by UN agencies when appropriate, with ITU, UNESCO and UNDP playing a leading facilitating role.[102]

In Tunis, WSIS participants discussed further on the governance of Internet. The discussion was based on a report by the Working Group on Internet Governance (WGIG), established by the UN Secretary General. WGIG also provided a working definition of Internet governance as:

> *the development and application by governments, the private sector and civil society, in their respective roles, of shared principles, norms, rules, decision-*

[100] WSIS (2003). Declaration of Principles Building the Information Society: a global challenge in the new Millennium. Document WSIS-03/GENEVA/DOC/4-E
WSIS (2003). Plan of Action. Document WSIS-03/GENEVA/DOC/5-E.
[101] WSIS (2003). Geneva Plan of Action WSIS-03/GENEVA/DOC/0005
[102] Second Phase of the WSIS (16-18 November 2005, Tunis), Tunis Commitment WSIS-05/TUNIS/DOC/7; Tunis Agenda for the Information Society. WSIS-05/TUNIS/DOC/6 (rev. 1). http://www.itu.int/net/wsis/docs2/tunis/off/6rev1.pdf

making procedures, and programmes that shape the evolution and use of the Internet.

The WGIG report also highlighted the respective roles and responsibilities of governments, intergovernmental and international organizations and other forums, as well as the private sector and civil society from both developing and developed countries.

Although the role of the private sector was underlined as 'taking the lead in day-to-day operations, and with innovation and value creation at the edges', it was recognized that governance includes social, as well as economic and technical issues, such as security and safety and developmental concerns, which warrant involvement of the public sector.

The Tunis Agenda recognized that the authority for Internet-related public policy issues is the sovereign right of States, while the private sector has had, and should continue to have, an important role in the development of the Internet, both in the technical and economic fields. Civil society, intergovernmental and international organizations were encouraged to continue to have an important role at the community level, the coordination of on Internet-related public policy issues, and the development of technical standards and relevant policies respectively.

The Tunis Agenda also proposed the establishment of new forum for multi-stakeholder policy dialogue, the Internet Governance Forum (IGF), as a platform for discussion of Internet governance issues. IGF (hosted by the UN Department of Economic and Social Affairs) provides a space for various stakeholder groups to discuss public policy issues relating to the Internet, exchange information and share good practices. While there is no negotiated outcome, the IGF informs those with policy-making power in both the public and private sectors.[103]

WSIS+10 High Level Event, 2014 – a review of implementation

The WSIS+10 High Level Event in 2014, coordinated by the ITU in close collaboration with all UN Agencies under their respective mandates, provided an opportunity for a 10-year review of progress on the implementation of previous World Summit outcomes. Discussions also focused on gaps and challenges, as well as on areas for future actions beyond 2015.[104]

The High Level Event reiterated their commitment on the Geneva Plan of Action of 2003 and the Tunis Agenda of 2005, recognized significant progress, but also underlined challenges.[105] The Action Lines of the Geneva Plan of Action were enhanced (including the Action Line related to ICT applications on agriculture) in order to reflect technological progress in ICT and the rapid growth of Internet.

In terms of governance, the High Level Event called for encouraging people-centered and inclusive governance models, the development of national ICT policies, e-strategies and regulatory frameworks that enable sustainable development.

[103] http://www.intgovforum.org/cms/

[104] Before this High Level Event, in 2013 UNESCO, in partnership with ITU, UNCTAD and UNDP, organized a First WSIS+10 Review Event. Both events providing a substantive contribution for the on-going WSIS+10 review, which concluded at the United Nations General Assembly in 2015. UNESCO (2013). Towards Knowledge Societies for Peace and Sustainable Development First WSIS+10 Review Event.
http://www.unesco.org/new/fileadmin/MULTIMEDIA/HQ/CI/CI/pdf/wsis/WSIS_10_Event/wsis10_outcomes_en.pdf

[105] WSIS+10 Statement on Implementation of WSIS Outcomes and the WSIS+10 Vision for WSIS Beyond 2015.
http://www.itu.int/net/wsis/documents/HLE.html

WSIS Forum 2015 – Sustainable Development Goals

The WSIS Forum 2015 built upon the outcomes of the UN General Assembly Overall Review of the implementation of the WSIS outcomes (UNGA Resolution 70/125), which recognized the necessity of holding this Forum on an annual basis and called for a close alignment between WSIS and the Sustainable Development Goals (SDG) processes. The WSIS Forum will therefore serve as a key platform for discussing the role of ICTs as a means of implementation of the Sustainable Development Goals and targets, with due regard to the global mechanism for follow-up and review of the implementation of the 2030 Agenda for Sustainable Development. The United Nations Group on the Information Society (UNGIS) developed a new tool to map how ICTs may contribute to the implementation of the Sustainable Development Goals (SDGs).[106] This mapping exercise draws direct linkages between the Geneva Action Plan and the SDGs aiming at strengthening the impact of Information and Communication Technologies (ICTs) for sustainable development.

[106] WSIS Forum (2015). WSIS -SDG Matrix: Linking WSIS Action Lines with Sustainable Development Goals. http://www.itu.int/net4/wsis/sdg/Content/wsis-sdg_matrix_document.pdf

Annex 2

Charter of Human Rights and Principles for the Internet

UN Internet Governance Forum

The Internet Rights and Principles Dynamic Coalition (IRPC) is an open network of individuals and organizations based at the UN Internet Governance Forum (IGF) committed to making human rights and principles work for the online environment. Since the 2009 IGF in Sharm El Sheikh IRPC has been working to outline how human rights standards should be interpreted to apply to the Internet environment, and the internet policy principles which must be upheld in order to create an environment which supports human rights to the maximum extent possible.

The Internet offers unprecedented opportunities for the realization of human rights, and plays an increasingly important role in our everyday lives. It is therefore essential that all actors, both public and private, respect and protect human rights on the Internet. Steps must also be taken to ensure that the Internet operates and evolves in ways that fulfil human rights to the greatest extent possible.

To help realize this vision of a rights-based Internet environment, the 10 Rights and Principles are:

1) Universality and Equality

All humans are born free and equal in dignity and rights, which must be respected, protected and fulfilled in the online environment.

2) Rights and Social Justice

The Internet is a space for the promotion, protection and fulfilment of human rights and the advancement of social justice. Everyone has the duty to respect the human rights of all others in the online environment.

3) Accessibility

Everyone has an equal right to access and use a secure and open Internet.

4) Expression and Association

Everyone has the right to seek, receive, and impart information freely on the Internet without censorship or other interference. Everyone also has the right to associate freely through and on the Internet, for social, political, cultural or other purposes.

5) Privacy and Data Protection

Everyone has the right to privacy online. This includes freedom from surveillance, the right to use encryption, and the right to online anonymity. Everyone also has the right to data protection, including control over personal data collection, retention, processing, disposal and disclosure.

6) Life, Liberty and Security

The rights to life, liberty, and security must be respected, protected and fulfilled online. These rights must not be infringed upon, or used to infringe other rights, in the online environment.

7) Diversity

Cultural and linguistic diversity on the Internet must be promoted, and technical and policy innovation should be encouraged to facilitate plurality of expression.

8) Network Equality

Everyone shall have universal and open access to the Internet's content, free from discriminatory prioritization, filtering or traffic control on commercial, political or other grounds.

9) Standards and Regulation

The Internet's architecture, communication systems, and document and data formats shall be based on open standards that ensure complete interoperability, inclusion and equal opportunity for all.

10) Governance

Human rights and social justice must form the legal and normative foundations upon which the Internet operates and is governed. This shall happen in a transparent and multilateral manner, based on principles of openness, inclusive participation and accountability.

Annex 3

G20 Digital Economy Development and Cooperation Initiative

I. Overview: Global Economy in a Digitized World

1. During their meeting in Antalya in 2015, the G20 leaders recognized that we are living in an age of Internet economy that brings both opportunities and challenges to global growth. In 2016, the G20 will address ways to collectively leverage digital opportunities, cope with challenges, and promote the digital economy to drive inclusive economic growth and development.

2. The digital economy refers to a broad range of economic activities that include using digitized information and knowledge as the key factor of production, modern information networks as an important activity space, and the effective use of information and communication technology (ICT) as an important driver of productivity growth and economic structural optimization. Internet, cloud computing, big data, Internet of Things (IoT), fintech and other new digital technologies are used to collect, store, analyze, and share information digitally and transform social interactions. Digitized, networked and intelligent ICTs enable modern economic activities to be more flexible, agile and smart.

3. The digital economy is experiencing high growth, rapid innovation, and broad application to other economic sectors. It is an increasingly important driver of global economic growth and plays a significant role in accelerating economic development, enhancing productivity of existing industries, cultivating new markets and industries, and achieving inclusive, sustainable growth.

4. While recognizing existing national, regional, and global strategies on digital and internet issues between and among different stakeholders, the G20 Digital Economy Task Force (DETF) has taken the unique advantage of the G20 to help address both opportunities and challenges brought by ICTs, and propose some common understanding, principles and key areas for the development and cooperation of the digital economy. The G20 promotes communication and cooperation among its members and beyond to make sure strong, vibrant and connected ICTs will enable a thriving and dynamic digital economy, which drives global growth and benefits for all.

II. Guiding Principles: A Compass for Navigation

5. G20 members agree on the following common principles to promote the development of and cooperation in the digital economy:

- **Innovation**

Technological innovation in ICTs as well as innovation in ICT-driven economic activities is among the key driving forces of inclusive economic growth and development.

- **Partnership**

In order to improve cooperation, address common challenges, and advance the global digital economy, closer partnership among G20 members can help share knowledge, information and experiences, so that differences can be narrowed and various interests can be advanced through constructive dialogues. The G20 recognizes the Internet is an important part of modern information network that sustain digital economy. Internet governance should continue to follow the provisions set forth in outcomes of World Summit on the Information Society (WSIS). In particular, we affirm our commitment to a multistakeholder approach to Internet governance, which includes full and active participation by governments, private sector, civil society, the technical community, and

international organizations, in their respective roles and responsibilities. We support multistakeholder processes and initiatives which are inclusive, transparent and accountable to all stakeholders in achieving the digitally connected world.

- **Synergy**

Since the digital economy touches almost all economic and social sectors and is closely related to other topics in the G20, particularly innovation and the new industrial revolution, it is the common aspiration of G20 members to create synergy among discussions of these topics in order to avoid duplication and ensure consistency.

- **Flexibility**

The G20 recognizes the importance of flexibility given the different concerns and priorities of members.

- **Inclusion**

The G20 members should work together with all stakeholders, to bridge all manner of digital divide and foster entrepreneurship, innovation, and economic activity, including further development of content and services in a variety of languages and formats that are accessible to all people, who also need the capabilities and capacities, including media, information and digital literacy skills, to make use of and further develop information and communications technologies. Accordingly, we recognize the vital importance of the principles of multilingualism to ensure the linguistic, cultural and historical diversity of all nations. Digital inclusion and the use of digital technology to enhance inclusion should remain key elements in promoting the digital economy to ensure that no one is left behind, regardless of their gender, region, age, disability or economic status. The G20 members recognize the potential of the digital economy to facilitate the implementation of the 2030 Agenda for Sustainable Development.

- **Open and enabling business environment**

The G20 recognizes the critical importance of private sector on digital economy as well as of enabling and transparent legal, regulatory, and policy environments, and fostering open, competitive markets. Recognize the importance of enforcing competition and consumer protection laws in the digital economy, which are conducive to market access, technological innovation in ICTs and the growth of the digital economy.

- **Flow of Information for Economic Growth, Trust and Security**

G20 members recognize that freedom of expression and the free flow of information, ideas, and knowledge, are essential for the digital economy and beneficial to development, as reaffirmed in paragraph 4 of the Tunis Commitment of WSIS. We support ICT policies that preserve the global nature of the Internet, promote the flow of information across borders and allow Internet users to lawfully access online information, knowledge and services of their choice. At the same time, the G20 recognizes that applicable frameworks for privacy and personal data protection, as well as intellectual property rights, have to be respected as they are essential to strengthening confidence and trust in the digital economy. The security of ICT enabled critical infrastructure needs to be enhanced, so that ICTs can continue to be a reliable driving force in accelerating economic development.

III. Key Areas: Unleash Greater Potential of Digital Economy

In line with the above principles, the DETF identifies priorities for cooperation in digital economy, to provide favorable conditions for its development, boost economic growth, and ensure digital inclusion. To this end, members are encouraged to:

6. Expand broadband access and improve quality

- Accelerate network infrastructure construction and facilitate interconnection. Promote the establishment of Internet Exchange Points (IXPs). Encourage all countries to make Internet access central to development and growth initiatives.
- Promote broadband network coverage, and improve service capacity and quality within a legally predictable competitive environment. In particular, explore ways to expand high-speed internet access and connectivity at affordable price.

7. Promote investment in the ICT Sector

- Improve the business environment through policy frameworks that facilitate research, development and innovation (RDI) as well as investment, including cross-border investment in the digital economy. Welcome Public Private Partnerships and commercial equity investment funds as well as social funds to invest in ICT infrastructure and ICT applications. Encourage development of open source technologies and other technologies.
- Encourage the organization of investment information exchange events among ICT companies and financial institutions, and mutual investment in the ICT sector among G20 members.

8. Support entrepreneurship and promote digital transformation

- Encourage internet-based RDI and entrepreneurship through an enabling, transparent legal framework, programs to support RDI and well-functioning capital markets for innovative enterprises. Support developing and emerging countries to build capacities in digital technology and internet-based entrepreneurship.
- Take advantage of the internet to promote innovation in products, services, processes, organizations and business models.
- Encourage the integration of digital technology and manufacturing, to build a more connected, networked, and intelligent manufacturing sector. Take advantage of ICTs to improve education, health and safety, environmental protection, urban plan, healthcare and other public services. Promote the continued development of service sectors such as e-commerce, e-government, e-logistics, online tourism, and Internet finance and the sharing economy. Promote digitization of agricultural production, operation, management, and networked transformation of agricultural products distribution.
- Create conditions for broadband providers to promote expansion, innovation, consumer protection, and competition, including examining the possibilities of introducing policies to prevent anti-competitive blocking, throttling, or prioritization of data by commercial broadband networks. We note the important regulatory and legislative processes in some members on the open Internet in the context of digital economy and the underlying drivers for it, and call for further information-sharing at the international level on the opportunities and challenges.

9. Encourage e-commerce cooperation

- Promote cross-border trade facilitation for e-commerce by using trusted digital means, such as paperless customs clearance, electronic transaction documents, mutual recognition of digital authentication, electronic payment and online payment. Meanwhile,

strengthen cooperation to prevent barriers to market access and other barriers. Attention should be given to issues relating to taxation, such as ensuring the efficient payment of appropriate taxes for international e-commerce, taking into account in particular the Base Erosion and Profit Shifting (BEPS) issues. Improve international efforts to measure e-commerce, and the macroeconomic consequences of digital economy.

- Strengthen cooperation in protecting consumers' rights and develop dispute resolution approaches, ensuring options for consumers that are adapted to the characteristics of e-commerce within the national framework of laws and regulations provided that they are consistent with member's international legal obligations.
- Build confidence of users which is an essential element of the digital economy by ensuring the respect of privacy and protection of personal data.

10. Enhance digital inclusion

- Use a variety of policy measures and technical means to bridge the digital divides between and within countries, in particular between developed and developing countries, regions and groups, including between men and women, and promote universal access, including open access to the Internet with equal digital opportunities for all. Promote the broadband connectivity among the poorest citizens, especially the poorest 20 percent of citizens, and citizens from low-density areas and strive to provide universal and affordable access to the Internet in least developed countries. Reaffirm the goal of ensuring the next 1.5 billion people are connected and have meaningful access to the Internet by 2020 in accordance with the Connect 2020 agenda.
- Promote the use of technology in primary and secondary education as well as in non-formal education, including in libraries, museums, and other community-based organizations to reduce disparities between income levels and promote development of a workforce for the digital economy. Strive towards ensuring an increased number of primary and secondary students have lawful access to educational content, and broadband connectivity as well as digital tools in their classrooms.
- Promote digital technologies for societal benefits such as food distribution, education, health, subsidy distribution, governance.
- Recognizing that the digital economy may pose risks and challenges in terms of skills shortages and mismatches and rising inequality for those who might be left behind because they lack skills, it is important to promote the dissemination of digital skills and more competitive workforces through cooperation among academic institutions and technical schools, libraries, businesses and community organizations. Improve digital skills of all people, the youth as well as the elderly, women and men, persons with disabilities, the illiterate and vulnerable populations as well as those in low income and developing countries, to enable their participation in the digital economy to unleash the potential of creating opportunities for quality job creation, decent work provision as well as for income growth and improving welfare. Strengthen cooperation in protecting labor rights.

11. Promote development of MSMEs

- Promote policies that support micro, small and medium-sized enterprises (MSMEs) to use ICT technology for innovation, improved competitiveness, and new distribution channels in markets.
- Promote affordable digital infrastructures needed for the digitization of MSME operations.
- Encourage MSMEs to provide ICTs goods and services to the public sectors and to participate in global value chains.

- Encourage participation in efforts, such as the Global Enterprise Registration initiative, to make transparent and simple the business registration mechanisms.

IV. Policy Support: For an Open and Secure Environment

The G20 aims to encourage exchange of views, promote mutual understanding and strengthen cooperation in policy making and regulation. To this end, members are encouraged to:

12. Intellectual Property

Recognize the key role of adequate and effective protection and enforcement of intellectual property rights to the development of the digital economy, as reaffirmed by paragraph 26 of the G20 Antalya Communique.

13. Promote cooperation with respect to independent choice of development path

Encourage members engaging in international cooperation to reduce, eliminate, or prevent unnecessary differences in regulatory requirements to unleash the digital economy, recognizing that all members should chart development paths that are consistent with their international legal obligations and their development situations, historical and cultural traditions, national legal systems, and national development strategies.

14. Cultivate transparent digital economy policy-making

- Develop and maintain open, transparent, inclusive, evidence-based digital economy policy making which takes into account the full input of all public and private stakeholders. Solicit their comments publicly before laws, regulations, policies and other instruments are deliberated, developed and implemented.
- Encourage publishing of relevant, publicly available government data, recognizing the potential to boost new technology, products and services.
- Encourage intelligent public procurement schemes to support the production of innovative digital services and products by the private sector, whilst keeping the need to be market led.

15. Support the development and use of international standards

Support the development and their use of the international standards for technological products and services that are consistent with the international rules including WTO rules and principles.

16. Strengthen confidence and trust

- Promote the availability, integrity, confidentiality and authenticity of online transactions. Encourage the development of secure information infrastructure to promote trusted, stable, and reliable internet applications.
- As part of our efforts to address security risks, threats and vulnerabilities in the use of ICT, including those to ICT-enabled critical infrastructures, endeavor to strengthen international collaboration, capacity building and public-private partnerships, including through constructive discussions in relevant international fora. Support and encourage the use of risk-based technical standards, guidelines, and best-practices to identify, assess, and manage security risk by both the public and private sectors.
- Jointly combat cybercrime and protect ICT environment by strengthening international cooperation on these issues in online transactions.

17. Manage radiofrequency spectrum to promote innovation

Recognize the importance of efficient management of radiofrequency spectrum to achieve the full potential of the mobile revolution in the time of digital economy.

V. Way Forward: Actions to Make a Difference

Recognizing that the digital shifts underway are reshaping economies and societies today and will continue to do so in the future, the G20 agrees to cooperate and continue to work closely on these matters. In this regard, the G20 will:

- Encourage multi-level exchanges, involving stakeholders such as governments, the private sector, civil society, international organizations, technical and academic communities as well as other parties such as industry organizations and worker organizations to share views and promote cooperation in digital economy.
- Encourage G20 members to exchange experience on policy making and legislation, and share best practices among members.
- Encourage training and research cooperation in digital economy issues to benefit the developing countries of the G20.
- Welcome and encourage efforts made by the United Nations, UNCTAD, UNIDO, ILO, IMF, ITU, OECD, World Bank Group and other international organizations to develop better metrics for important policy issues like trust in the digital economy, e-commerce, cross-border data flows, and the Internet of Things, as practical, relevant and appropriate.
- Look forward to IOs including the OECD and interested members, intensifying efforts to measure the digital economy in macroeconomic statistics through conducting a voluntary "good practices" survey of national statistical organizations, and organizing and hosting a workshop for statisticians and digital companies on source data to measure the digital economy.
- Interact actively with other engagement groups such as the B20, L20 and T20 to exchange views among industry, business, civil society, and academia to pool ideas on how to promote a sound digital economy.

ISBN 978-92-5-109979-7

9 789251 099797

I7961EN/1/10.17