Appendix A – Glossary

Domain: ECONOMIC
Asset and resources used in the process of producing goods or services, the generation of income and value involving the working conditions and decision-making processes of producers.

Area of impact: *Organization*
All aspects related to working flow and management activity carried out in a production field.

Outcomes

Autonomy: decision making independence, the user gets the elaboration of collected data that can provide options regarding possible decisions to be made as well as future predictions; e.g., thanks to big data and field sensors, farmers get specific information concerning the crops, weather forecast and soil moisture humidity helping them to decide about how and when to intervene in the field [1-8].

Cooperation: the possibility to access to data, information and decisions collected and shared with other users; e.g., the utilization of artificial intelligence associated to the use of phone applications can be utilized by animal breeders to detect possible diseases and inform the other ones pertaining to the same community in order to activated preventive activities and share possible solutions [9,10].

Financial risk: the management of the financial risks associated to the conducted activities and the related investments considering the volatility of the market in the specific sectors, e.g., the utilization of artificial intelligence to gather and elaborate information regarding weather prediction, production and market changes to determine possible risks related to the agriculture production [7,9,11].

Incomes: the revenues related to the activity conducted using digital technologies; e.g., ICT applied to deal with bush encroachment providing to the producers the access to plant protection expertise through a smartphone with consequences upon crop losses [11].

Marketing: the activity characterized by the identification of clients or customers specific needs and the activity carried out to meet them; e.g., the utilization of timber technology in combination with online marketplaces to accelerate wood lots sales providing information about the entire process [8,12].

Product/process security: the identification and isolation of singles phases of the production and sales process with the possibility to identify security matters; e.g., blockchain technology applied to the food chain, from production to sale [2,13,14].

Productivity: the 'ratio between the output volume and the volume of inputs'[1]. The increase, in economic quantities or parameters, of the output - input volume ratio in the production process; e.g., the utilization of artificial intelligence and big data in the crops production enable farmers to identify the economic opportunity for irrigation to increase crop yield [3-5,7,9,11,12,15].

Resilience: the ability to anticipate, prepare for, respond and adapt to relevant changes in order to survive and prosper, e.g., collecting data on market risks and trends (big data) as well as weather and crop conditions (sensors), specialized service providers can offer solutions to face or take opportunities from disruptive changes to farmers and communities [16].

Resource efficiency: the cost-effective use of resources, both natural and technical ones, at the subject disposal to organize the production; e.g., remote infield sensing furnishes the information concerning precise plant needs of water/nutrients in a specific time [1,4,5,7,14].

Responsibility: the identification of single responsibilities in the production, transformation and consumption chains; e.g., blockchain (distributed ledger) technology allows to track the production process chain and to identify possible responsible subjects in case of food fraud [1,3,7,12,13-15,17].

Transaction costs: the costs associated to operations related to the activities carried out; e.g., the utilization of platforms or applications to conduct financial transactions eliminating the physical interaction to have financial services [8,11,13,18].

Area of impact: *value chain*
The 'sequence of activities that a firm undertakes to create value, including the various steps of the supply chain but also additional activities, such as marketing, sales, and service'[2].

Outcomes

1   OECD, *Defining and measuring productivity*, https://www.oecd.org/sdd/productivity-stats/40526851.pdf.
2   Deardorff's Glossary of International Economics in https://iate.europa.eu/search/standard/result/1601363661654/1.

Bargaining power: 'the strength of one person or group when discussing prices or wage settlements'[3]. It refers to the relative power of the parties and their exerting influence on each other, such as defining the prices of agricultural goods, wages, etc.; e.g., digital shopping platforms bypass agri-food intermediaries increase the power of farms and consumers in the food sector by creating a direct link between them [1,2,7,9,12,15].

Food quality: it is the characteristics of food that is acceptable to consumers according to legal and moral norms along food-chain, such as standards in production, provision and stocking conditions to preserve food appearance (shape, colour, consistency), texture, flavour and chemical, physical, microbial security; e.g., smart packaging informs costumers on the food quality [4,8,19].

Resource efficiency: the cost-efficient use of energy, materials, chemicals and water along the food-chain, like for stocking food or to provide food to costumers [1,14,15,20].

Transparency: it refers to the possibility of getting information about single phases of the food chain, allowing the access to information and therefore increasing the check of step; e.g., blockchain can be use to track the food supply steps to avoid fraud among passages in the food chain [1,2, 4,7,12,13,21].

Trust: it is defined by the fairness and correctness of the economic relations along the food-chain for several aspects (food quality, fair price, etc.); it is built on data accessibility and constant economic relations; e.g., platforms or social media can increase pear-to-pear economic and informational stable exchanges [7,12-14].

Area of impacts: *markets*
The real or virtual places where parties (usually buyers and sellers) with a different socioeconomic positions can gather to facilitate the exchange of goods and services; this process define market prices.

Outcomes

Equal opportunities: it refers to the opportunities to access the market for everyone; e.g., digital marketplace can facilitate market access for small-scale farmers or connection between rural communities and markets [11,12,18,22].

Market concentration: 'the extent to which market shares are concentrated between a small number of firms'[4]. When in a specific sector supply or demand side of the market is concentrated between a small number of firms or buyers effecting prices

3   Dictionary of Accounting, Collin-Joliffe,1992, https://iate.europa.eu/search/standard/result/1601363906761/1.
4   OECD, https://www.oecd.org/daf/competition/market-concentration.htm.

and market control / power; e.g., few hi-tech companies offer digital solutions or digital platforms collect rural communities demand [1,4,7,18].

Prices: it is the economic value of a good or service expressed in current currency at a given time and place, which varies according to supply and demand changes along the supply chain. It is also conditioned by technological changes that possibility reduce or increase intermediaries and production costs; e.g., e-commerce platforms reduce intermediaries but limit market interaction for low-digital skilled actors [23-26].

Stability: it does not refer to constant prices or constant volumes of transactions, but to the conditions of market efficiency (transparency, market access, etc.) that allow adaptation to demand; e.g., some digital technologies, such as artificial intelligence or big data, can be used to predict or adapt food production to changes in demand [1,2,4,7,11-13,17,18,22,27]

Transparency: the possibility of getting information about the single phases characterizing the market flow; e.g., blockchain can guaranty clear information about single phases in market flow or web solution like Apps can facilitate to get information by consumers for goods/service quality and prices [1,2,4,7,12,13,17].

Domain: ENVIRONMENT
The complex interrelationships of different biotic and non-biotic elements that define the living conditions of the individual and society. The environment thus consists of both the built and natural environment, including all natural resources (air, land, water, wood, etc.)[5].

Area of impact: *animal welbeing*
The animal body condition free from illness or resist illness. Actions adopted to reduce animal pain and stress according to the principle of species-appropriate housing. It can reduce livestock management costs and increase related livestock productivity and quality.

Outcomes

Animal health: the animal body conditions to which refer when indicating the fact that the body is free from illness or resist illness; e.g., sensors measure biological parameters and artificial intelligence predicts or detects disease outbreaks and informs the farmer [28,29].

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5   On this: European Environment Agency Glossary:
     https://www.eea.europa.eu/help/glossary#c4=10&c0=all&b_start=190&c2=environment

Animal control: it refers to monitor livestock feeding needs, to detect breeding season, to ego-localise livestock bred in the wild, etc.; e.g., sensors and automatize feeding system can made efficient livestock management [7,13,15,28,30].

Area of impact: *ecosystem services*
Benefits to human society provided by the natural environment and ecosystems, such as natural pollination of crops by bees, clean air by woods, and so on, that are also engaged in some services (drinking water system, waste decomposing services, etc.)[6].

Outcomes

Biodiversity: 'he variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems'[7] [1,5,7,11,31].

Clima: it refers to the variability of meteorological events over a period of time (months or millions of years) measured through parameters (temperature, atmospheric pressure, precipitation, etc.). Meteorological events are determined by the climate system, which includes also atmospheric gases concentration (CO_2, H_2O, N_2O, etc.)[8]; e.g., variable-rate application (VRA) technology detects the precise need of nitrogen fertilizer, it contributes to reduce both the nitro oxide emission (by soil micro-organisms reaction to nitrogen fertilization) mitigating agriculture's climate impact [1,9,15,18,29,32].

Area of impacts: *natural resources*
Resources that exist without any human actions but that include valued characteristics (commercial and industrial use, scientific interest cultural value). It includes sunlight, atmosphere, water, land and minerals, vegetation, and animal life, also called 'raw materials'[9].

Outcomes

Energy: it refers to energy sources, like fossil fuels and electricity, used in agri-food chain for its purposes (production, store, etc.); e.g., precise agriculture technologies

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6   On this: Millennium ecosystem assessment MAAE, MA (2005) Ecosystems and Human Well-Being: Synthesis. Island Press, Washington, DC; Science for Environment Policy (2015) Ecosystem Services and the Environment. In-depth Report 11 produced for the European Commission, DG Environment by the Science Communication Unit, UWE, Bristol.
7   European Environment Agency: https://www.eea.europa.eu/help/glossary/chm-biodiversity/biological-diversity.
8   On this: IPCC Glossary https://www.ipcc.ch/sr15/chapter/glossary/.
9   On this: OECD, https://stats.oecd.org/glossary/search.asp.

reduce energy needs for agricultural operations and it increases energy efficiency [7,12,18,26].

Nutrients: the chemical compounds or substances used by living cells for nutrition. They can refer to minerals for plants or food for livestocks[10]; e.g., sensors or satellites can detect nutrient deficit in soil indicating precise needs in specific portion of field reducing costs and ecological footprint [4,8,19,32].

Plant health: it refers to 'pests and diseases that impact on plant production in agriculture, forestry and the natural environment and whose objective is to contribute through plant health to sustainable production'[11]; e.g., field sensors, big data and artificial intelligence can predict or detect the onset of a disease suggesting an appropriate action [1,3,4,7].

Soil: the loose surface material that covers most lands consisting of inorganic particles and organic matter. It provides structural support to plants and it is their source of water and nutrients. Related aspect concerning soil aeration, soil moisture and drainage, fertility levels and eventual related issues; e.g., drones or sensors mounted on agricultural vehicles detect and elaborate data on soil status informing farmers or suggesting actions [1,4,8,12].

Water: the use of water in the agri-food chain is relevant. Controlling its utilisation and quality is relevant to the sustainable use of this natural resource that is indispensable for life on earth; precise agriculture technologies can reduce in an efficient way the use of water for strictly indispensable needs for plants and livestock detected by sensors, hi-tech camera, etc. [18].

Area of impacts: *risk management*
'The process by which early efforts and assessments are taken to prevent environmental risks or accidents'[12]. In our case it refers to the process to determine what risks exist and to determine how to manage those risk in a way best suited to protect production, human health and the environment.

Outcome

Prevention: the activities carried out in order to prevent environmental risks or accidents; e.g., drones and satellites collect information on forest status and weather condition suggesting action to preventing fires [33].

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10 On this: European Environment Agency, *Nutrients in European ecosystems*, Environmental assessment report, 4.
11 COMMISSION STAFF WORKING PAPER Accompanying the document REPORT FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT AND THE COUNCIL PROGRESS TOWARDS ACHIEVING THE KYOTO OBJECTIVES, CELEX:52012SC0353/EN, https://iate.europa.eu/search/standard/result/1601306544342/1
12 IATE, European Union terminology, https://iate.europa.eu/search/standard/result/1601307996433/1.

Proactivity: it refers to actions taken to actively react in order to reduce the damage that may be caused by an imminent risk; e.g., Internet of Things solutions can be implement to suggest actions to reduce damage by unusual rain condition [34].

Domain: GOVERNANCE

It refers to the processes of governing that involve 'a set of institutions, mechanisms nd processes through which citizens and their groups can articulate their interests and needs, mediate their differences, and exercise their rights and obligations at the local level'[13].

Area of impact: *operationality*

It refers to all the activities carried out in relation to operations and processes run while dealing with the public sector.

Outcomess

Cooperation: it refers to form of collaboration among users and between users and public body to administrative procedures or activities; e.g. apps to simplify official controls and communication from citizens/farmers to public offices or social media to share information on regulations [9].

Law compliance: controls concerning the compliance with legal requirements; e.g. blockchain technology to verify with the compliance with the legislation requirements regarding the utilization of quality food products EU signs by preventing false declarations [35].

Administrative burdens: it refers to the administration activities that need to be conducted to comply with the legislation requirements; e.g., data collection and field mapping (for examples plant health) gathering information and automatically communicated to the administration offices without the need of intermediaries to carry out specific activities [1,2,9].

Transaction costs: 'cost incurred by participants in an exchange, in order to initiate and complete the transaction'[14]. In our case it refers to define and mange the contractual relations and costs, like gathering information; e.g., web-solution and social media can offer information or form of "peer counselling" [1,2,4,7,12,13,21].

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13 Decentralised Governance for Development: A Combined Practice Note on Decentralisation, Local Governance and Urban/Rural Development, UNDP 2004, in IATE, European Union terminalogy. https://iate.europa.eu/search/standard/result/1601383395803/3.

14 Dudek, D.J., Wiener, J.B. *Joint implementation, transaction costs, and climate change*, OECD, Parius, 1996, http://www.oecd.org/dataoecd/17/33/2392058.pdf .

Area of impact: *equity*
Equal possibility to accesses information and instruments when dealing with administrative aspects.

Outcomes

Law enforcement: it refers to the equal access to instruments to address legal issues, e.g., digital database of regulations and law, social media to legal issues can contribute to reduce the barriers to instruments to address legal issues [36].

Participation: it is the equal possibility to participate accessing and dealing with governance issues and processes, e.g. social media and web-solution for sharing information, to express opinions or to vote [36].

Domain: SOCIAL
It refers to the conditions, resources and socio-cultural norms that define the forms of interactions between the different subjects in specific context of action and subject's characteristics.

Area of impact: *individuals*
The elements that can be specifically referred to single persons, their conditions and the endowment of social resources.

Outcomes

Health: it refers to the state of physical, mental and social well-being and not merely the absence of disease or infirmity that ca be services; e.g., tele-medicine solution contribute to reduce urban-rural gap in services [23,26,34,37].

Responsibility: the state or fact of being answerable for something within one's power, control, or management; e.g., blockchain technology, by identifying who is responsible for each step in the food chain, promotes greater accountability of actors [26,45].

Skills: abilities or competences that can be used for different purposes, for example at work; e.g., digital skills conditions the possibility to access the benefits of digitisation and defines digital asymmetries or gap between individuals and groups [23,26,37].

Wellbeing: here it refers to the feeling or state of satisfaction for own life condition; e.g., social media can enlarge relationship in a community of interest increasing the satisfaction of personal life [17,23,26].

Learning: the activity of acquiring new notions and knowledge; e.g., e-learning can offer opportunities to increase personal knowledge and skills for subjects who live in rural or remote areas [23,26,37,34,38].

Area of impact: *access*
The conditions that enlarge the possibilities of action for an individual or social groups.

Outcomes

ICT: The tools that make it possible to expand contacts and connections between social actors and between objects, and to facilitate the circulation and processing of information (between human and non-human actors). [34].

Information: data and notions that contribute to understand the condition of context of action for specific purposes, like economic market condition and trends; e.g., web-site, apps ad social media can share information in efficient way [34,38,39].

Resources: data and information makes easier to obtain financial resources, material goods or new knowledge to improve personal or group's condition; e.g., through web solutions it is possible to participate in funding calls, find cheap raw materials or learning proposal [34,38,39].

Area of impact: *rights*
It can be simply define as those fundamental rules on which there is a broad consensus concerning what people are allowed to do or what people are owed.

Outcomes

Autonomy: relates to an individual's ability to make informed decisions about personal matters, which may be compromised due to algorithms and automation; for example, the gps system limits the choice of routes or social media delimits contacts and information for each profile [23,26].

Equity: refers to equal access and opportunity to use tools, resources, and services to increase knowledge, skills, etc. for individuals and social groups; e.g., how digital tools may or may not increase social equity in different contexts and for whom [26,40].

Gender gap: social asymmetry based on gender status; e.g., digital technologies can increase gender asymmetries because women are discriminated in technological sector or they have poor digital skills that need to be improved [12,45].

Power: it is about social relations and the ability, of individual or groups, to influence other actors, events or resources to make what one wants to happen despite obstacles, resistance, or opposition, and digital tools can consolidate or redefine power relations; e.g., blockchain redefines power for intermediaries and it reduces transaction costs [23,26,34,37,38,].

Resilience: this is about the right to have resources and tools to be adaptive to relevant changes in order to survive and prosper; e.g., digital tools can facilitate access to information useful for resilience [16,23,26].

Area of impact: *social capital*
The social connections, and the institutions that foster relationships, that some social groups have, and that help generate/define social stability, the circulation of resources (such as information), the feeling of community and the definition of collective identity.

Outcomes

Cohesion: it indicates the set of behaviours and the relations of affinity and solidarity between individuals that mitigates social inequalities and contributes to community unity; e.g., ICTs promote the circulation of information on the members of a rural community, their needs and abilities and this can potentially encourage initiatives of support, collaboration and solidarity for a common interest [9,10,20,34,41].

Identity: in a broad sense, it is the feeling of belonging to a community, identifying with particular material and cultural elements common to several individuals; e.g., social media or messaging apps can contribute to reinforce or enlarge exchange of data, information and form of collaborations among community of local farmers and between farmers and local institutions consolidating a social identity, defining a new one or deconstructing traditional identities [42,45].

Inclusion: it refers to the processes and conditions that improve the participation in society for people in disadvantaged situations enhancing social relations, opportunities, access to resources, voice and respect for rights; e.g., digital tools can promote the social inclusion "in" and "for" rural community subjects? [12,45].

Participation: it refers to the rate of participation in community life evaluated by contacts and discussion on relevant community social topics; e.g. social media and

web-solution can contribute to sharing information and promote discussion among community members [36].

Trust: the fairness and correctness of the social relations in community life; it is built on constant contacts and relations among community members; e.g., platforms or social media can increase the rate and quality of social exchange and experiences [7,12-14].

Area of impact: *control*

It refers to the issue of the collection, storage and use of digital data by third parties with respect to their ability to predict and condition individual and collective behaviour. It concerns also the problem of personal privacy and freedom with pervasiveness of digital technologies.

Outcomes

Prediction: in this case is the estimate for personal or groups behaviours suggesting timely efficient actions according to a predefined goal.; e.g., deep learning solutions can estimate food needs in a specific period and market contributing to match crop supply with demand [12,34].

Privacy: it refers to the individual dimension (subjective states, actions and conditions) that a person may decide to selectively exclude from the knowledge of others, often sanctioned and defined by law; e.g., farmer and crop data collected with drones or sensors, stored in data centres and analysed with artificial intelligence by digital service providers may increase concern on the compromising of privacy [17,23,43].

Security: it concerns ways of protecting data and digital interactions from intrusion by an outside user; e.g., are farmer and crop information stored in data centres or in users personal devices? Are digitalization increasing concern on the data protection? [17,23,43].

Surveillance: it generally refers to actions to control the state of people, places and things, in some cases it can promote a specific range of standards of "correctness" for social activities.; e.g., digital tools report condition of plants using a predefined defined goal or not? Those information are directed to users or are they processed by digital service that alert users? [17,44].

Transparency: here it concerns the way how users are informed about the data collected and their use by digital providers to obtain personal benefits and how they use it for commercial or research scope; e.g., do digital technologies increase users'

awareness of transparency? Are they adequately informed by service providers? Do they know how to manage access to their data? [4,12,13,17,26].

<u>Responsibility:</u> in this case the identifying the party responsible for suggested/proposed behaviours or automated actions that cause a specific result with respect to the actors' freedom of action and decision; for example, who is responsible for a wrong manuring suggested by artificial intelligence? Does this technology limit farms responsibility or not? [1-3,7,12,17,26].

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