INNOVATIVE AGRIBUSINESS IN GREECE

Avraam Mavridis[1,2*], Maro Vlahopoulou[2], Athanasios Gertsis[1]

[1]Department of Agroenvironmental Management Systems, Perrotis College, Greece & Department of Applied Informatics, University of Macedonia, Greece

[2]Department of Applied Informatics, University of Macedonia, Greece

amavri@afs.edu.gr, mavla@uom.edu.gr, agertsis@afs.edu.gr

ABSTRACT

The heterogeneous framework of activities in the agricultural sector requires efficient, dynamic and holistic approaches in fair and equitable ways of management, cultivation practices and education, research, trade and policy strategies. Such demanding, interdisciplinary applications can be operated extensively today, more than ever before through Exploitation of Informatics. Such activities require a secure, yet powerful framework of hardware and software facilities in order to unlock the potentials of innovative agribusinesses for all agricultural products' value chain parties and end-users, while aiming to support and develop benefits of agro-environmental sustainability. Latest accomplishments in Earth Observation technologies, Geoinformatics, AI (Artificial Intelligence), IoT (Internet of Things), Smart Farming Sensors, Precision Agriculture, Digital Agriculture, Cloud Services and Modular Agricultural Robotics constitute a fruitful region of continuous development. Current approaches worldwide are trying to develop new agricultural curriculum developing the educational background of the scientist who will support such activities: the data agronomist. Additionally, new digital skills are required to be developed by all actors participating in this framework: the farmers, the agronomist, the researcher, the academics, the consumers, the entrepreneurs and the policy makers. This paper will approach and present the level of exploitation and incorporation of different Information Technologies in the Agricultural Sector of Greece towards the development of innovative agribusiness opportunities, regardless of the gender, age, or/and educational background. Such innovative agribusiness potentials will be based on current available data repositories and web-based networking, while providing elements of further advancements in the near future, so as to combat restraints of economic and environmental crisis in the country.

Keywords*:* logistics Earth Observation technologies, Geoinformatics, Artificial Intelligence, Modular Agricultural Robotics, Smart Farming Sensors, Digital Agriculture

1. INTRODUCTION

Agriculture, as we know it today, evolved through initiatives and activities at individual, collective and institutional level worldwide, starting 11,000 years ago, and it is continuously evolving, providing benefits to all sectors of economy with great impact to natural and socio-economic frameworks. The Agricultural framework has a very important role in the economy of countries at global scale, and is the main source of food, income and employment to their populations. At the same time, it is facing continuous economic, technological and regulatory pressures and changes, considering the fact that at the beginning of 2015, Agriculture accounted for one-third of global Gross Domestic Product (GDP). As worldwide population is estimated to increase over 9.5 billion people by 2050, there is a augmented

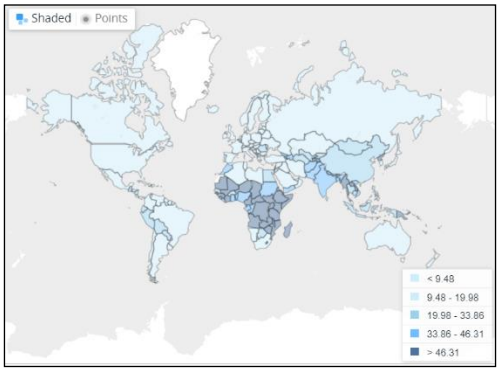
need to increase the agricultural activities in order to produce 50% more food, feed and biofuel than it was needed in 2012 (Table 1), so as to meet the demand (Alexandratos et al., 2012).

Table 1. Increase in agricultural production to match projected demand, 2005–2050 (percent)

	2005/07	2050	2005/07 2012	2013-2050
World				
As projected in AT2050	100	159.6	14.8	44.8
With updated population projections	100	163.4	14.8	48.6

Source: FAO 2017, based on UN 2015, and Alexandratos and Bruinsma, 2012

Businesses related with Agriculture (in short, Agribusinesses) were of worth of more than 3.5 trillion US dollars (World Bank, 2019) at the beginning of 2017 globally and Agriculture was occupying over one-third (1/3) of total land area (FAO, 2018). Additionally, labor characteristics in agriculture are confusing as they constitute a mixed operational framework which it may be formal and informal, characterized by high levels of multi-activities and seasonality and also, it can be self-employed or unpaid, and/or supplied by family members. Under these perspectives and, as income grows and new technologies are introduced, labor in agriculture is continually reducing, occupying in 2018 more than 1 billion people (28.3% of the world's total employment, from 43.77% in 1991), with significant variations between developing and developed countries (Fig. 1), that stands also for the agricultural sector in Greece (Fig. 2) (World Bank, 2019).



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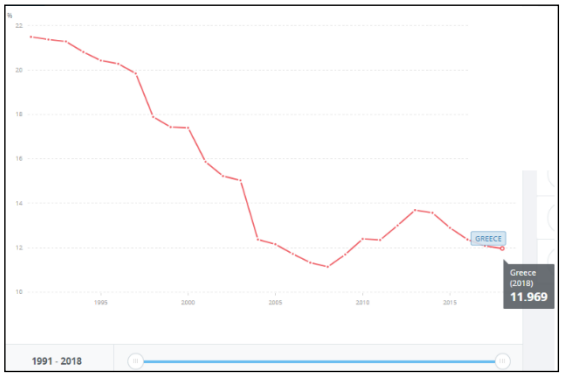

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Figure 1. Classification of employment in agriculture worldwide in 2018 (% of total employment)

Figure 2. Fluctuation of employment in agriculture in Greece (% of total employment) from 1991 up to 2018, with the comprehending percentage (11.969%) in 2018 (Source: World Bank, 2019)

Agriculture provides public goods, nutrition and labor worldwide, but it also contributes in severely degradation of agro-environmental resources and ecosystem services, as well as of humans' health. An additional point of interest is the fact that Agriculture both contributes to climate change and is affected by climate change into a framework of increasing scarcity of natural resources (such as arable land and water). However, the overall agricultural sector should be approached as a multi- and inter-operational framework, where "industry convergence" is applied with sectors that exist beyond the traditional fiber or food industries, which are based on raw products established by agricultural activities (such as bioenergy, bio-based plastic sector and pharmaceutical industry) (Boehlje et al, 2011), enhancing final demand for agricultural products in the medium and long-term.

In Greece, Agriculture is a major sector for the country's economy, comprising 2.9 per cent of GDP and 14 per cent of employment. European Union (EU) has an average of 1.2 per cent and 5 per cent, respectively. In Greek economy, in terms of contribution towards the GDP, we have the following sectors (and they can all be related with agricultural activities) (EU-MERCI project, 2018):

i) **Primary**: agriculture, 3.4%, 2) **Secondary**: industry, 20.8%, 3) **Tertiary**: services, 75.8%.

In addition, according to the future directives of the United Nations' (UN) Sustainable Development Goals (UN, 2015), supported and adopted by EU (European Commission, 2016), in front of the increasing scarcity of natural resources (such as arable land and water) and other socioeconomic burdens focused within the 17 SDGs, the agribusiness sector needs to change, pushing the agricultural-related productivity and activities through "industry convergence" to a new level.

New frontiers of agribusinesses should be connected with sustainable economic development, which is very much based on technological progress and innovation. As innovation-based industries create - in most cases - greater added value in an economy, they create products, services and metadata of extra value that are generally more efficient to manage, to produce and supply, being more exportable and offer more well-paid jobs and welfare throughout the horizontal and vertical agricultural-related chains and trade channels.

Future agricultural-related activities in Greece should incorporate innovation within, developing improvements and opportunities in the overall agricultural framework, focused on successful attainment of UN's SDGs, which are fundamental to achieving food security, poverty alleviation and welfare, as well as conservation of environmental resources and sustainable development.

2. Materials and Methods

As approaches to knowledge exchange, learning and innovation in agriculture and related activities are rapidly evolving, establishing a clear knowledge about current operation conditions and agricultural-related activities of innovative agribusinesses in Greece requires a "top-down / bottom-up" approach. Such consideration should be elaborated to all specific agricultural activities/practices, as well as towards horizontal and vertical agricultural-related chains and connections of industrial convergence sectors with Agriculture in Greece. According to FAO (2019): "*Agricultural innovation is the process whereby individuals or organizations bring new or existing products, processes or ways of organization into use for the first time in a specific context, to increase effectiveness, competitiveness and resilience with the goal of solving a problem*".

Under these perspectives, the following process will be followed in order to approach the overall current and future framework of the Innovative Agribusinesses in Greece (Fig.3): 1) Analysis of current Types of Agriculture and its Sectors in Greece, 2) Understanding of current and future trends of Innovation in agricultural-related businesses in Greece, 3) Presentation of best practices and approaches of Innovative Agribusinesses of EU, EU Member States and of organizations in Greece.

2.1 Analyzing current Types of Agriculture and its Sectors in Greece

Agriculture is related with many activities within the farm, as well as with other operational sectors of the industry which are widespread in different operational categories worldwide, but without uniformity throughout. One approach supports the fact that Agriculture is differentiated according to human intervention and mode of study of the surrounding nature. However, different patterns of agriculture which have been developed through centuries and especially during the last decades, can be classified into other types of agriculture through many and different ways. Some of the major criteria to be used for this scope include (Chandra, 2011):

i. Scale, ii)Type of crop, iii) Livestock combinations, iv) Intensity, v) Means of distribution of farm produce, vi) Level of mechanization/technologies used,

Agriculture sector is mainly divided into the following four sub-sectors were innovative technologies can be applied throughout the value chain:

a) Crops, b) Livestock, c) Fishery (Aquaculture), d) Forestry (Silviculture).

Agricultural sector covers the activities related to: a) Growing crops, fruits & vegetables, b) Harvesting & Threshing, c) Growing of trees & logging, d) Fishing & Breeding, e) Rearing of animals and poultry, f) Production of milk, eggs, etc.

Another approach (Bourbos et al., 1996) divides agriculture (overall agricultural Area: 3,254,078.9 hectares (HSA, 2019)) into three main categories:

a) **Natural**, b) **Conventional** (known also as Intensive, or Agrochemical), and c) **Sustainable**, including: i) Integrative (with Precision, Smart and Digital Agriculture), ii) Ecological (with Traditional, Organic, Biodynamic, Organic-biologic and Precision Organic Agriculture (Mavridis, 2008)). At early 2018, the total organic area (the sum of the "area under conversion" and the "certified area") in Greece was 410,140 ha.

The country covers an area of 131,621 km², of which 82.2% is rural, supporting the living of the 44.1% of the population (10,816,286 citizens). Over half of the country's 723,010 agricultural holdings are less than 2 hectares. Small and fragmented land parcels constitute one of the main characteristics of Greek agriculture, while the lack of skilled workers (only 3.5% of all farm managers have agricultural training) is a problem that innovation approaches should overcome.

Innovative Agribusinesses are a key challenge for such agricultural-related activities, as they could be based on the establishment of an increasing, skilled workforce with younger farmers (currently only 12.6% of farm managers are less than 35 years old), who are more receptive on new technologies.

2.2 Innovation in agricultural-related businesses in Greece

Digitization of agricultural activities in plant and animal production can improve in many ways the working conditions and welfare for farmers and their families, while reducing the environmental impact of agricultural practices, providing useful information to the end-user (e.g., the consumer). These technologies can offer significant benefits on aspects of remote measurement of soil conditions, on provision of better water/irrigation management and crop monitoring in Precision Agriculture. In Precision Livestock Farming (PLF) (Figures 3a, 3b & 3c), they can provide significant benefits for better nourishment and health of animals, by monitoring heat stress and their activity in the field through GPS (Global Positioning System) and better quality and quantity of milk and meat.

3a

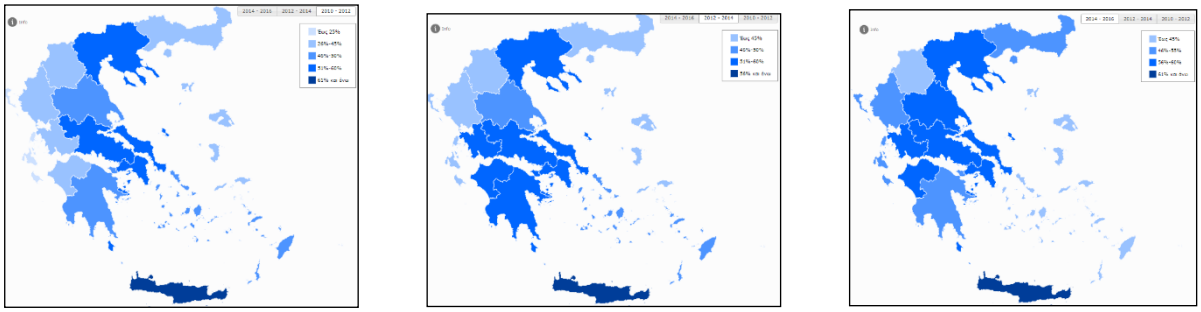
3b

3c

Figure 3 (a, b & c). DigitAnimal (https://digitanimal.com) enterprise can select and analyze data throughout the day with collars (3a), showing cows' readiness for insemination, and (3b) monitor daily activity from the office/home, or through a smartphone (3c) through GPS, in real time.

Further exploitation of selected data (spatial and non-spatial), which can be provided in real-time and continuously transferred to a mainframe, can give to farmers/entrepreneurs/end-users better understanding of the variability of soil elements into their farm, or the development of crop patterns, or variations of animal's activity through the day, so as to apply more efficient practices. Towards that scope, Smart Farming Technologies constitute an operational sector of increased capabilities and augmented synergies. Such technologies in agriculture include: i) Satellite Monitoring, ii) Soil/Plant/Weather Sensors, iii) Mobile devices with specific farm apps, iv) Smart Zone Seeding technologies, v) Autonomous - Modular Robotics, vi) Weather Modelling, vii) Smart Micro Irrigation, viii) Fertilizer Modelling, ix) "On-the-spot" and "On-the-fly" spraying systems, x) Internet of Things, xi) UAVs/UAS (Unmanned Aerial Vehicles/ Unmanned Aerial Systems).

We have to consider the fact that all these technologies could be related with the industry and the society in a developing way, advancing new operational schemes and opportunities. However, innovation in Greek enterprises, in the last years, has shown significant spatial variation (Fig. 4):



4a 4b 4c

Figure 4 (a, b & c). Differentiation in adoption of innovation activities by Greek enterprises through the years: 2010-2012 (4a), 2012-2014 (4b) and 2014-2016 (4c) (Source: NISRT, 2019).

2.3 Best practices and approaches of Innovative Agribusinesses

Among numerous forces at play across the innovation in agribusiness value chain, certain practices/examples discriminate among others in adopting and sharing innovation in Agriculture:

i) At EU scale: Pioneering activities are promoted by EU through the European Innovation Partnership for Agricultural productivity and Sustainability (**EIP-AGRI**) (https://ec.europa.eu/eip/agriculture/en/about), contributing to the European Union's strategy 'Europe 2020' for smart, sustainable and inclusive growth. Among them is a catalogue with innovative projects presented in EIP-AGRI events. Among them we can distinguish the project **SMART-AKIS** (https://www.smart-akis.com), a European Network mainstreaming Smart Farming Technologies among the European farmer community and bridging the gap between practitioners and research on the identification and delivery of new Smart Farming solutions. Also, the project **INNOVARURALE** (https://www.innovarurale.it), the Italian Portal of knowledge and innovation in the agricultural and food system

ii) At National (Greek) scale: a) A startup enterprise (**CENTAUR**) (https://centaur.ag/) solutions enable end-users to maintain and trace pristine product condition across the supply chain -- from harvesting, to storage, to milling, to retail, b) The Aristoleo® Test Kit (https://aristoleo.com/) measures the health promoting phenolic compounds oleocanthal (anti-inflammatory) and oleacein (antioxidant), the most widely researched phenols in olive oil. This “lab in a vial” is calibrated by NMR (Nuclear Magnetic Resonance), being quick and inexpensive for olive oil producers to analyze their batches of EVOO (Extra Virgin Olive Oil).

3. DISCUSSION AND CONCLUSIONS

Innovation in Agriculture-related businesses in Greece can become a significant asset for the future of Greek Agriculture, in connection with the international operational framework. Aiming at this goal, innovative agribusinesses should be transformative and adaptive towards future trends and challenges transforming the Agribusiness Industry such as: 1. Sustained low commodity prices, 2. Improving crop/animal yields, 3. Increasing focus on sustainability, 4. Growing investment in Agricultural Technology, 4. Transformation of the production methods and tools, 5. Adaptation of IoT (Internet of Things) requirements: connectivity, robustness and legacy technologies, 6.Dealing with legacy technology, 7. Transparency of productions, 8. Promotion of services, 9. Operation within connected ecosystems, 10. Consolidation of agribusiness subsectors, 11. Take under consideration water limitations and labor shortages, 12.Potential changes to established global trade agreements

REFERENCES

Alexandratos, N. & Bruinsma, J. (2012). 'World agriculture towards 2030/2050: the 2012 revision'. ESA Working Paper No. 12–03. Rome, FAO (Food and Agriculture Organization).

Boehlje, M., Roucan-Kane, M., & Bröring, S. (2011). 'Future agribusiness challenges: Strategic uncertainty, innovation and structural change'. International Food and Agribusiness Management Review,14(5), 53-82.

Bourbos, B.A., Skountridakis, M.T., (1996)."Conventional and Sustainable Agriculture, Development, Capabilities and Restrictions". Proceedings of Greek Conference on "Organic Agriculture Problems and Perspectives", February 28-29, 1996. Chania, Crete. Greece.

Chandra, D. (2018). 'Types of Agriculture'. (Website: https://owlcation.com/agriculture/Types-of-Agriculture).

European Commission (2016). 'Next steps for a sustainable European future: European Union action for sustainability'. (Website: https://ec.europa.eu/europeaid/sites/devco/files/swd-key-european-actions-2030-agenda-sdgs-390-20161122_en.pdf).

EU-MERCI project, (2018). 'D4.2 - Picture of efficiency projects implemented by the Industry sector-by-sector and process-by-process / Analysis of the industrial sectors in different Countries: Greece'. HORIZON 2020 Project Nr. 693845, (Website: http://www.eumerci-portal.eu/documents/20182/38527/3+-+Greece.pdf).

Mavridis A., (2008). 'Contribution of Geographic Information Systems in Spatial Planning of Organic Agriculture in Combination with the Sustainable Development of the Natural Environment'. Dissertation Theses for the Doctorate of Philosophy, Laboratory of Geodesy and Geomatics, School of Civil Engineering, Faculty of Engineering, Aristotle University of Thessaloniki.

FAO. (2017). 'The future of food and agriculture – Trends and challenges'. Rome. ISBN 978-92-5-109551-5 (Website: http://www.fao.org/3/a-i6583e.pdf).

FAO. (2018). 'WORLD FOOD AND AGRICULTURE – STATISTICAL POCKETBOOK 2018'. Rome. 254 pp. ISBN 978-92-5-131012-0 (Website: http://www.fao.org/3/CA1796EN/ca1796en.pdf).

HAS (Hellenic Statistics Authority). (2019). 'Annual Agricultural Statistical Survey (Final Results)'. (Website: http://www.statistics.gr/en/statistics/-/publication/SPG06/).

National Information System for Research and Technology (NISRT), (2019). 'Innovation in Greek Enterprises over time'. (Website: http://metrics.ekt.gr/el/node/391).

United Nations, Department of Economic and Social Affairs, Population Division (2017). 'World Population Prospects: The 2017 Revision, Key Findings and Advance Tables'. Working Paper No. ESA/P/WP/248.

United Nations, General Assembly (2015). 'A/RES/70/1 - Transforming our world: the 2030 Agenda for Sustainable Development'. (Website: https://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E).

World Bank national accounts data, and OECD National Accounts data files (2019). Website: https://data.worldbank.org/indicator/NV.AGR.TOTL.ZS