Perceptions and Attitudes of Greek Farmers Towards Adopting Precision Agriculture: Case Study Region of Central Greece

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Abstract Modern scientific community after years of intensification of agricultural resources (soil, water, etc.) management, and with the actual risk of their depletion or degradation, is called to redefine standard agricultural practices with an environmentally friendly approach, focusing on their preservation, their enrichment and perpetuity of their yields. Also the nutritional stakes and environmental threats are high, brought about by the continuous growth of the world population which is expected to reach 10 billion in 2050 compared to 7.1 in 2013. In this context, the present study explores to what extent those directly involved, the crop producers, perceive the necessity of sustainable management of agricultural resources through the emerging practice of Precision Agriculture regarding the management of smaller parts of the fields according to the needs of each of them, while reducing inputs. This research aims to examine the concepts of crop producers regarding the prospects that arise through the adoption of Precision Agriculture in Greece, a country with problematic primary sector, with particular climatic conditions and varied microclimates while compete countries of low labour costs. The methodological approach is based on field research using questionnaires concerning a representative sample of crop producers in the Region of Central Greece. The choice of variables assessed as necessary for the adoption of the Precision Agriculture techniques by the producers, was based on empirical observations, as well as the use of literature sources. Then, an exploratory factor analysis is carried out on parameters that are considered necessary by producers to adopt new technologies and how they perceive the successive situation that will be shaped by the new digital revolution in agricultural practice. Finally, the possibility of restarting primary production is being discussed, now that, due to the economic recession, many young people more familiar with technology are returning to the province and undertake to cultivate the land in the absence of any other employment.

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1 Introduction

1.1 Sustainable Agricultural Practice: Precision Agriculture

The growing production of crop products over the past 50 years for food and clothing has led to severally aggravating environmental conditions such as water pollution, greenhouse gas emissions, soil erosion and chemical burden (Kurth et al. 2015).

Especially with regard to the agri-food sector, whilst arable land is degraded and diminished, recent surveys estimate the worldwide demand for cereals to rise by 75% between 2000 and 2050 (IAASTD 2009; FAO 2010).

As the requirements for changing land uses (urban fabric, industrial uses, road network, etc.) are increasing, it is possible to reduce the area occupied by agricultural land despite technological developments that may extend the limits of the territories that can be cultivated (Oliver 2013).
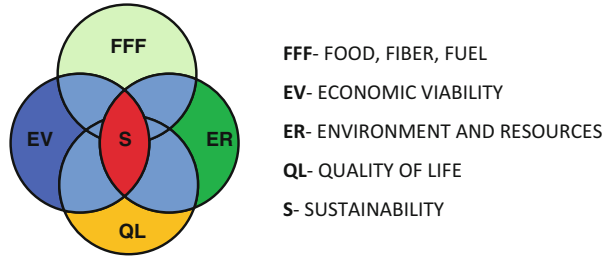
This possibility is particularly provided in developed countries, while the agricultural sector plays a huge role in the economies of developing countries, both because it contributes significantly to the national income but also because it mainly employs a large workforce.

Developed countries, in the first decade of the twenty-first century, focused in the direction of funding for the modernization of agricultural practices through Smart Farming Technologies (SFT), especially after the World Bank's report "Agriculture for Development" (World Bank 2007) and IAASTD's report "Agriculture at a Crossroads" (IAASTD 2009), triggered by three simultaneous global crises—food, climate and economic.

In the European Union (EU), with the implementation of the Common Agricultural Policy (CAP) and in particular with Agenda 2000, although food safety was ensured in a large part of it, environment was clearly degraded (Geiger et al. 2010). The mid-term review of 2003, incorporating Multiple Compliance, constricted everyday agricultural practice through norms, redirecting it towards the preservation of existing natural resources (Anthopoulou and Goussios 2007). With its revision in 2014, the weight was shifted from subsidizing quality products to environmentally friendly farming practices,—sustainable agriculture with the adoption of REG 1306/2013 (http://ec.europa.eu/).

Sustainable management of natural agricultural resources such as soil, water, seeds, coal, nitrogen, etc., by definition, deals with their continuous sustainable yield while keeping the environment operational and maintaining ecosystem's health. In other words, it strives to synthesize a denote positive sign equation for the environment, utilizing as mathematical operators natural resources, its high demand for productivity and its mostly feasible economy, so as to bring the well-being and

Image 1 Visualization of sustainable agriculture as a cross-section of four key assumptions. Source: National Research Council of the National Academies, USA, 2001

FFF- FOOD, FIBER, FUEL

EV- ECONOMIC VIABILITY

ER- ENVIRONMENT AND RESOURCES

QL- QUALITY OF LIFE

S- SUSTAINABILITY

euphoria of the living organisms that consume and live in to it (Image 1) (Gerakis et al. 2008).

The case study, Precision Agriculture (PA), is a form of sustainable agriculture that is part of the integrated crop and livestock management systems, in which the territorial units—parcels—for cultivation are divided into management zones where interventions are carried out based on the specific characteristics of the available territorial resources in each spatial zone and the time required inputs from the cultivation. Or as Gebbens and Adamchuk in 2010 simply and descriptively stated: "apply the right treatment in the right place at the right time" (Gebbens and Adamchuk 2010).

For example, based on soil analysis and in conjunction with the available propagating material and water requirements, a crop is set up and inputs are decided by "smart systems". These systems derive information from sensors located in the parcel or remote sensing it and combine data into spatial databases (GIS), generating thematic maps. They develop strategies for dealing with crises (e.g. water stress), agricultural practices (e.g. pre-emergence fertilization) and finally produce results maps with the productivity of each zone and, therefore, the reduction of the cultivation production cost (Oliver 2013; Chen et al. 2014) (Image 2).

During the process of PA, initially, the variability of parcels is recorded, then management zones are created in them and then the inflows are applied, according to the needs of each zone. So, using PA techniques, it is understood that the disadvantage of intensive cultivation, which is the uniform application of inputs, eliminates. Inputs become limited and already—in the absence of the productive effect, i.e. the yield of the crop—significant economic and environmental benefits arise (Headley 2014).

According to Oliver, Bishop and Marchant (2013), "Precision agriculture (PA) involves the application of technologies and agronomic principles to manage spatial and temporal variation associated with all aspects of agricultural production in order to improve crop performance and environmental quality".

It is a method that uses the cutting edge of information technology, Geostatistics, to predict the outcome of each input, and is capable of making corrective actions in future time.

Precision Agriculture deals precisely with this term, in its mathematical meaning, from which it got its name. In order to understand precisely this term, hence the

Image 2 Representation of an integrated crop management system using the Precision Agriculture technique. Source: www.ag.topconpositioning.com

purpose of this practice, the term "accuracy" should also be clarified. Accuracy is about how close you get to the right outcome. The accuracy is improved by properly calibrated machines and by constantly practicing a practice. Precision on the other hand is about how often you will achieve the same result using the same method. Precision is achieved with more reliable machines and minimum requirement calculations and corrections.

The US National Research Council, in a 1997 edition, defined Precision Agriculture as "strategic management using information technologies to analyze data from multiple sources and make decisions about agricultural production". It then defines its three main stages:

- the collection of scale data
- recording and analyzing data
- the decision to intervene in a specific spatial unit at the right time (National Research Council 1997).

The analysis and density of spatial information in the case of PA is also its great revolution, which means that it essentially involves changing the scale of manipulations. It is a methodology and a holistic approach that optimizes land use and preserves the environment (Auerhammer 2001; Katter et al. 2009).

The site-specific machinery used in Precision Agriculture are among the most specialized with high-speed processing and response sensors and always assisted by the methods of Geostatistical Science, and the use of data from Remote Sensing, Interpretation of Satellite imagery, Satellite Positioning Systems (GNSS Global Navigation Satellite Systems) and Geographic Information Systems (GIS). Thus, Precision Agriculture allows us to make decisions for small spatial segments—parcels based on

their demands but also to continue to cultivate extensively with the use of large machinery (Fountas and Gemtos 2015).

1.2 Brief Introduction of the Research

The research presented focuses on investigating the hypothesis that those directly involved—crop producers in the Region of Central Greece, understand the necessity for sustainable management of agricultural resources through the emerging practice of Precision Agriculture which concerns not only a new cultivation technique but mostly a new holistic management philosophy of the spatial variation of crop fields—an innovational method.

For this reason, a field survey through a questionnaire was carried out on a random sample of 375 crop production producers active in the Region of Central Greece during the period April–June 2016. Individuals were able to complete the questionnaire form via a website or in a printed form distributed through certified submission agencies of Unitary Application for Aid Schemes (UAAS), stores for agricultural supplies and geotechnical consulting offices across the geographical area of the study.

In general, this research aims at examining producers' perceptions of usefulness regarding crop production in relation to the prospects arising from the adoption of PA. It also examines the features that a new integrated cultivation management system should have. They could be able to adopt it once they realize its usefulness on every day agronomical practices.

A first attempt for studying the phenomenon (Mourtzinis et al. 2007) demonstrated that only 9% in a sample of 130 producers all around Greece really knew about PA.

Another survey, aiming to investigate producers' perception in relation to managing their time and saving money from adopting Smart Farming Technologies (SFTs), was held in 2009. This comparative study on the attitude towards adopting sophisticated information systems by producers in four European Member States (Denmark, Finland, Germany and Greece) showed that in all countries producers were uncertain about the benefits that would result from the use of this technology (Lawson et al. 2011).

Michailidis et al. (2010) conducted another study in order to determine the reasons leading Greek producers to adopt or not PA. A sample of 2070 farmers, all over Greece, was called to clarify their familiarity and their interest to adopt SFT and PA. Of this initial sample 1195 producers were separated for further evaluation. They were those who owned these technologies as well as those who would adopt them in the near future. The greatest interest to adopt was found in farmers sited in Thessaly and Central Macedonia Region, as well as their familiarity to PA. Central Greece Region farmers expressed little familiarity and limited interest to adopt (Michailidis et al. 2010).

Kountios (2014) studied the educational needs of young farmers in Central Macedonia. These farmers were beneficiaries of the Rural Development Program

of Greece (second term years 2000 to 2006—REG1268/1999 and third term years 2007 to 2013—REG.1698/2005) and the Agricultural Fund for rural Development (EU), in order to start a competitive agricultural business (Kountios 2014). In the same frame, examining the perceptions and educational needs of young farmers, at a most recent published study (Kountios et al. 2017) the PA knowledge rates were very high reaching 28% at the Regional Unit of Thessaloniki amongst young farmers. Young farmers were also asked about the sources affecting their decision to undertake PA methods. They replied that they were mostly affected by the opinions of other farmers, by successful examples and business consultants and less by public financial incentives.

So, a new research regarding the perceptions and attitudes of producers less interested to the subject was necessary to be attempted. Central Greece Region can be named a "late majority" area, towards adopting PA and SFTs according to Diffusion of Innovation Theory. Late majority people are skeptical of change, and will only adopt an innovation after it has been tried by the majority (Rogers 2003).

There was no previous research on the specific agronomic factors considered important by the observed population for the adoption of Smart Farming Technologies.

There wasn't also any other study aiming to draft policy proposals to incorporate new agricultural techniques and technologies into agricultural practice in the Central Greece Region.

The present aims to exam the perception of usefulness of PA and SFTs by using primary data from a field survey in a specific administrative area, and with specialized statistical analysis techniques tries to identify which factors can meet the demands of "late majority" crop producers in order for them to gradually adopt PA.

Finally, according to the collected information, a proposed policy strategy model, for adopting them, is attempted.

2 Study Area

2.1 Greek Crop Production

According to EUROSTAT (2014), the Greek territory covers an area of 131.621 km^2, 82.2% of which are rural areas. Its total population is about 11 million, 44.1% of which live in rural areas (http://ec.europa.eu/agriculture/rular-development2014-2020/country-files/el/factsheet-greece_en.pdf).

A key element of farm holdings is the small and much-sliced allotment that makes the agricultural production process difficult. 78% of the total utilized agricultural area (UAA), i.e. the total area of arable land, permanent pasture and meadows, permanent crops and vegetable gardens (http://ec.europa.eu/eurostat/ramon/nomen clatures), spans spatially within areas of natural constraints. 53.9% of the total UAA is in mountainous areas and only 19.8% is irrigated land. Although irrigated land is relatively small, 86% of water use in Greece is often used in agricultural activity with

significant losses. The agricultural practice of organic farming is practiced at only 3.8% of the land (http://ec.europa.eu/agriculture/rular-development2014-2020/country-files/el/factsheet-greece_en.pdf).

The agricultural sector in Greece is characterized by small farms with 76.7% of them occupying an area of less than 50 acres. Of the 723,010 agricultural holdings, more than half occupy an area of less than 20 acres. The average of the agricultural allotment is just 6.8 ha, much less than the European (EU-26) average of 16.1 ha.

The population of those engaged in agriculture and livestock farming is quite aged with just 5.2% of Greek farmers in the age group of up to 35 years old. Young farmers in this age group (<35 years old) are headmen of agricultural holdings at a percentage of up to 12.6% of the total and only 3.5% of them have received vocational training in agricultural practice. The indicator of the standard of living of those active in the sector is 64.4% of the level of life of people employed in other sectors (http://www.europarl.europa.eu/studies).

The sector's contribution to Greece's Gross Added Value is 3.7%, with the average of the European Union of 26 Member States at 1.6%. The workforce permanently employed in the sector reaches 13.6% of the total employed population, whereas in the 26 Member States the average figure is only 4.7% (http://ec.europa.eu/agriculture/rular-development2014-2020/country-files/el/factsheet-greece_en.pdf).

The above evidence demonstrates the great economic importance of the sector in Greece. Although the general climatic conditions favor the differentiated production of crop and animal products, trade balance figures demonstrate that Greek economy is strongly dependent on imports, while the income of those active in the primary production sector, compared to the other sectors of the economy, becomes more and more unstable year-after-year, from year 2003 to the present.

2.2 The Special Conditions of the Study Area

The Region of Central Greece (NUTS2) is located in the center of mainland Greece (Map 1), it has a total area of 15,549.07 km^2, a population of 547,390 permanent residents (http://www.ststistics.gr/el/statistics/-/publication/SAM04/) and is administratively subordinated to the Decentralized Administration of Thessaly-Sterea Hellas. It is divided into five Regional Units (NUTS3): Viotia, Euboea, Evrytania, Fthiotida and Fokida.[1]

In the study area, the primary productive sector plays an important role both in the Region of Central Greece and in the five NUTS 2. The lands with agricultural use cover an area of 69,214 km^2, of which the cultivated plant species have an area of 3336 km^2 (Hellenic Statistical Authority (ELSTAT) 2014) and are traditionally covered by cropland areas with trees (mainly olives) in most of the Regional Units,

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[1]According to the current EUROSTAT classification, NUTS 2 is referring to the basic regions for the application of regional policies.

GEOMORPHOLOGICAL MAP REGION CENTRAL GREECE

ESYE_ID	REGIONAL UNIT	POPULATION	AREA Km2	CAPITAL CITY
05000000	N. EVRYTANIAS	19518	18706.64	KARPENISI
07000000	N. FOKIDAS	37866	21263.79	AMFISSA
06000000	N. FTHIOTIDAS	169542	44369.01	LAMIA
04000000	N. EUBOEAS	207305	41608.26	HALKIDA
03000000	N. VIOTIAS	123913	29543.13	LEVADIA

Map 1 Geomorphological map of study area with demographic data

Table 1 Accumulative data from all five Regional Units of the Region of Central Greece. Summarized from Municipality Level and pertaining crops and their area coverage in acres, as declared in the Uniform Applications for Aid Schemes (UAAS 2014)

Type of cultivation	Area in 1000 m^2	Percentage
Fallow land	290,022.3	11.83
Flower crops	244.2	0.01
Olive/vineyard/trees	748,569.4	30.54
Industrial crops	392,126.2	16.00
Animal feeds	243,310	9.93
Vegetables	63,407	2.59
Human consumption crops	712,561.6	29.07
Nurseries/greenhouses	542.9	0.02
Total	2,450,783.6	100.00

Source: www.opekepe.gr aggregated after own processing

and secondly with arable crops either for human consumption (cereals, potatoes, etc.) or for industrial process (cotton, energy crops, etc.). To a large extent, animal feeds are also cultivated in all Regional Units.

There are 69,660 agricultural holdings in the Region of Central Greece which on average exploit an area of 41.97 acres (Hellenic Statistical Authority (ELSTAT) 2014). The most recent data on the type of crops and land declared by producers in the Unitary Application for Aid Schemes (UAAS—EAE) 2014, from the statistical data maintained by the Greek Payment and Control Agency for Guidance and Guarantee Community Aid (OPEKEPE) and are posted on its website (www. opekepe.gr, 2016) are presented in Table 1.
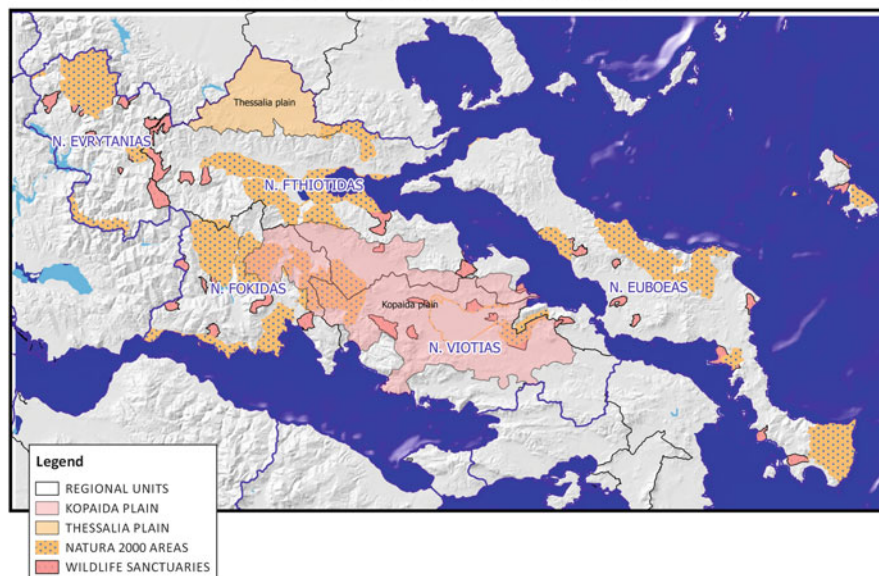
Map 2 Map of the region of Central Greece with NATURA 2000 areas, wildlife sanctuaries and sensitive zones to nitrates of agricultural origin

The study area was chosen because the Region of Central Greece, in addition to its large extent and its geographical location, is a typical example of the unevenness of the terrain relief, the diversity of the climate and the soils.

Also, within its geographical area, many areas of ecological interest are delineated, such as areas of the NATURA 2000 network and zones vulnerable to nitrates of agricultural origin (Map 2).

Finally, it was chosen due to the competitiveness of its products (olive oil, pistachios, figs, cotton, cereals, vegetables, livestock, milk, meat, etc.), as demonstrated on the latest data (2016) on the land regarding the crops declared by the producers in the UAAS 2015, from the statistical data maintained by OPEKEPE and are posted on www.iris.gov.gr.

It has a sufficient number of people employed in agriculture, several infrastructures, good access to the main road and a large number of products.

Thus, this Region possesses the elements that can create the conditions for the development of healthy agricultural enterprises with diversified production and good access of the products to the markets. However, development in an internationalized environment is not only achieved through means' availability but also through entrepreneurship and innovation.

3   Methodology: Sample

3.1   Materials and Methods

This study is based on a representative sample of producers engaged in crop production in Central Greece. The sample was 375 individuals/observations. Compared to the sample of Mourtzinis et al. (130 individuals) and Michailidis et al. (2070 individuals) that studied the phenomenon all over Greece; the sample of the present study was sufficient. The representativeness was tested through the comparison to the publicly available data base of the Greek Statistical Authority (ELSTAT) from the Census of Agriculture and Livestock 2009 and to the latest data provided by the Payment and Control Agency for Guidance and Guarantee Community Aid (OPEKEPE) (the plurality of year's 2015 UAAS—Uniform Applications for Aid Schemes to the Regional Units of Central Greece).

Taking into consideration the previous studies by Mourtzinis et al. (2007), and regarding their observation that only 9% of the producers were really aware of PA, and Michailidis et al. (2010) that refer to Central Greece Region as little familiar/interested in adopting; a re-investigation of the phenomenon of the perception of PA's and SFT's usefulness, is being attempted here. With 95% Confidence Interval and 3% sampling error, the respondents in the present study (375 crop producers) are considered sufficient to confirm the hypotheses.

Originally the profile of the participants concerning age, educational level, parallel employment, GPS possession and familiarization with new technologies (Smartphone, tablet, etc.), is presented through exploratory statistical analysis using frequency of responses as well as Cross Tabulation analysis (CTA). The CTA relates to creating contingency tables which exhibit the multivariate distribution of the frequency of responses after a Pearson Chi-Square test (Pearson 1900). Regarding the agricultural holding profile, the response frequencies of the individuals are presented concerning the type of the main culture (over 50%), the farm size in acres and the existence of mechanical equipment. Finally the responses of individuals are presented to questions relating to employment of other staff on their holdings and to their cooperation with geotechnical staff regarding either counseling on the production process, or compliance with the input-output files and a calendar listing of the operations under the European Commission REG 1306/2013 and the regulation of Multiple Compliance. These data are then examined according to the main characteristics of the respondents and holdings profiles (providing contingency tables and Pearson Chi-Square tests).

Finally, the data of two profiles were crossed using the same method (CTA and control of Pearson Chi-Square checks) in relation to:

  i. their knowledge on the term Precision Agriculture,
 ii. their understanding of the practice of Precision Agriculture
iii. and finally the extent that they perceive that, in the future, Precision Agriculture and Smart Farming Technologies will have to be adopted by farmers.

To detect factors that may support the decision by the target population for the adoption of Smart Farming Technologies (SFT) and Precision Agriculture (PA), an Exploratory Factor Analysis was performed on the basis of the producers' responses concerning their knowledge and understanding of the PA. That was extracted from their preferences of all the steps involved in this new technique (automatic navigation, recording technologies, variable dose applications and intelligent information systems of management—Computer Information Management Systems), whether they relate to offline or online data, as well as, the case that they get trained in the use of Precision Agriculture applications and the Smart Farming Technologies application means or get guided by the physical presence of specialized or non-specialized agronomist. The large number of items and the width of the sample led to the choice of the Principal Component Analysis method after first performing a Reliability Analysis test (Lei and Wu 2007), using the Reliability Indicator (internal demister type) Cronbach Alpha, to estimate the degree of cohesion or correlation of each variable/item with the scale and with the other variable and a Factor Analysis to confirm the relationship structure between the variables (Cronbach and Shavelson 2004; Hogan and Cannon 2007).

Principal Component Analysis (PCA) is an exploratory approach of observations (responses in the case study) on the phenomenon under examination and represents the linear combination that reveals the greater symmetry of the data variance. It concerns reduction of variables, expected based on the initial hypothesis to explain the factors that lead crop producers to adopt the techniques of the PA and the SFT. Concentration of information is achieved by creating new synthetic indicators/ factors, called main components, and are essentially hyper-variables. The Principal Components result from the linear correlation of the initial one-dimensional variables strongly correlated with each other (Duquenne 2016).

The Factor Analysis (FA) as it has prevailed in international terminology is a statistical technique which allows for the investigation and interpretation of complex phenomena that depend on multiple components. This method is intended to reduce the overall information, through search and confirmation of relations between variables based on a recognized theoretical background while losing a minimum of initial information. In the present case study three Principal Components were extracted in order to provide empirical content to the policy proposals subsequently drafted (Rogerson 2001; Pison et al. 2003).

3.2   Phenomenon Dimensions: Hypotheses

The actual agricultural holdings in Greece mainly consist of medium-sized family farms, which in the context of the spatial households, in the sense[2] given by Anthopoulou and Goussios (2007), are fragmented into a smaller size of individual holdings—an average of 41.97 acres in the study area (own process—Hellenic Statistical Authority (ELSTAT) 2014).

It is clear that this structure affects, in addition to the size of the holding held individually by the active farmers of each family, the management of mechanical equipment, the pace of work, decisions on cultivation techniques and future investments, let alone investments in mechanical and technological equipment, a major requirement for the adoption of SFT and PA.

Also, in the context of family holdings, as observed by Goussios and Duquenne (2003), on spatial employment in the primary sector,

> the organization and management of the agricultural holding is adapted and integrated into a strategic family-based program structured within the framework of relations with bourgeois/immigrants, relatives/shareholders and those who live in the village, by achieving to maintain this family holding embedded, within the social system of production of the village.

Here three groups of farmers are mentioned who, while appearing in statistical data, do not function in the same way. So, there are farmers who are locally based on the farm working at the holding full time and are the backbone of agricultural production, the near-distance exploiters who usually live in nearby towns and work in other sectors as well, and the long-distance exploiters living In large urban centers. The proximity between the place of residence and the site of the holding separates the third from the second category. All of them, however, are involved in decision-making on the exploitation and can influence any change in agricultural practice. This gradation is a phenomenon directly linked to the educational development of rural residents and urbanization, and as it becomes clear the size of agricultural holdings is misunderstood, since distance-farmers and family holdings are a Greek phenomenon (Goussios and Duquenne 2003).

Regarding age, persons mainly engaged in agricultural and livestock production in Greece belong to a large percentage to the ages of over 40 and have not been trained in agricultural practice, although the sector has a 13.6% share in a permanent workforce

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[2]Ibid.

and 3.7 % of the country's Gross Added Value (http://ec.europa.eu/agriculture/rular-development2014-2020/country-files/el/factsheet-greece_en.pdf).[3]

Demographically favored areas are those close to urban centers, seaside and mountain areas that use their natural resources also as tourist assets. Finally, the lowlands that are connected by road network and are served by transport networks (Anthopoulou and Goussios 2007; Chalkos 2013).

Adoption by Pannell et al. (2006) is the learning process in which information collected, then synthesized and finally evaluated for any brought results.

The farmer's adoption of the Precision Farming according to Katter et al. (2009) concerns:

> combined utilization of several site-specific technologies using Global Positioning Systems (GPS) such as auto guidance and variable rate applications (VRT) of inputs and/or yield mapping on farm. This definition does not imply that these practices have to be carried out by farm staff but can be offered by a third party as well.

In the same study, the methodology followed was based on Rogers' innovative theory hypothesis (2003) defining five categories of individuals based on adoption time: innovators, early adopters, early majority, late majority and laggards.

Due to the random sampling within the site that this survey was conducted and the fact that there were no responses from individuals that participated in the research, who have been in a learning or an adoption process, the method followed could not be supported from this theory and concerns exclusively the recording of existing trends and the detection of the following hypotheses with the aid of descriptive statistics aiming for the preparation of policy proposals for the adoption of SFTs.

The composition of the active population of crop producers within the study area has been maintained the same regarding the main age group active in the sector, but young producers have an increased level of education and adequate knowledge of new technologies, as it will emerge from the presentation of the participants' profiles.

The profile of the participants is presented in two stages. The first relates to their own data (gender, age, level of education, etc.) and the second relates to the data relevant to their farms (size of exploitation, type of main crop, etc.).

In the context of this study, three dimensions of the phenomenon examined will be detected and reported in corresponding hypotheses:

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[3]The "spatial household": *"... expresses as a concept the relationships that a group of people, with family or other social ties, exploits and develops through the distribution of the agricultural land they own, either in the form of renting or direct exploitation, within the framework of the organization and operation of an agricultural business. At the same time it expresses: 1) the geographical distribution and spatial position of members who participate with land and/or labor and capital in the organization and operation of a farm holding, 2) the size of the land under control, and 3) the organization produced and managed by the coordinating agricultural family within the spatial household with the aim of regulating land and labor relations"* (Anthopoulou and Goussios 2007).

Table 2 Data used to calculate the individuals of the sample per Regional Unit

Calculation table per regional unit of the population sample			
Regional unit	Number of agricultural holdings (ELSTAT 2009)	Number of UAAS 2015 declared crop production (OPEKEPE 2015)	Questionnaires collected
Viotia	16,474	14,976	90
Euboea	23,828	12,877	70
Evrytania	2266	403	30
Fthiotida	20,518	22,472	126
Fokida	6574	3624	59
Total	69,660	54,352	375

Source: ELSTAT and OPEKEPE data (after own processing)

Hypothesis 1 Few of the farm producers operating in the Region of Central Greece know the term of PA.

Hypothesis 2 Even fewer farm producers perceive the practice of PA.

Hypothesis 3 There should be many actions in the future in order for producers to understand that PA and SFT will be a prerequisite for their prosperity in terms of sustainable management of agricultural resources.

The factors that can contribute to assessing the effectiveness of SFTs by the target population and are therefore considered to be able to push producers into adopting PA farming practices can be evaluated as to formulate a proposed policy model. The factors studied here are related to the purpose of the cultivation techniques (questions 15–26), the support and monitoring of SFT applications by geotechnical staff (questions 27–29), education in new technologies (question 30), the possibility of investing (Questions 31–34), and finally distance counseling (questions 35–38) (Table 14).

Beyond investigating the responses of individuals of the sample to verifying the hypotheses, the specific conditions that have been developed in this sector in the period after the data from the two surveys mentioned above are being sought, as they relate to the 2007–2009 period, before the financial crisis of the Greek public sector and the increase of unemployment rates that followed.

The classical methodology for an empirical applied research was applied. It included a review of the relevant literature, the creation of a questionnaire, the selection of the study area, the formation of a representative sample of population, the sampling, and finally the statistical analysis of the data.

The number of questionnaires that were to be collected per Regional Unit was cross-checked to the published data of the Hellenic Statistical Authority (ELSTAT) from the Agricultural and Livestock Census 2009 and the most recent data provided by OPEKEPE (number of Unitary Application for Aid Schemes, 2015) as presented in Table 2.

More specifically, the research aims to produce safe conclusions in order to verify or reject hypotheses originally made through:

- the particular characteristics of the active population of crop producers
- the perceptions of crop producers about the term and practice of PA
- their attitudes towards the adoption of Smart Farming Technologies
- the factors that can contribute to assessing the effectiveness of Smart Farming Technologies by the target population.

3.3   Questionnaire Structure

The questionnaire was set up in four parts to detect:

- the profile of farmers and the profile of agricultural holdings of crop production
- knowledge of the term and practice of Precision Agriculture (quantitative information) and its origin (qualitative information)
- the factors assessed as being sufficient, by the target population, for the adoption of Precision Agriculture and Smart Farming Technologies
- Observed population's opinion about the future use of PA and SFTs.

4   Results

4.1   The Profile of Producers and Holdings

The profiles of the participants are presented in two stages (Tables 3 and 7). The first are the data concerning themselves (gender, age, level of education, etc.) and the

**Table 3** Summary presentation of the demographic profile of the individuals of the sample

Population characteristics	Categories/classes	Frequencies	Percentage
Gender	Male	253	67.5
	Female	122	32.5
Age	18–25	18	4.8
	26–35	81	21.6
	36–45	85	22.7
	46–55	100	26.7
	56–67	61	16.2
	>67	30	8.0
Age summary	N = 375; min = 18; max = >67; average = 46		
Education level	Without basic education	14	3.7
	Primary graduates	35	9.3
	Low secondary graduates	54	14.4
	Secondary graduates	153	40.8
	Sort circle tertiary graduates	74	19.7
	Tertiary graduates	45	12.0

Table 4 Education level in relation to the age profile of crop producers

Characteristic (education level)	χ^2	Degrees of freedom	p-Value
Age	209.879[a]	25	0.000***

Asterisks indicate the level of significance for p-value as: ***p $\leq$ 0.001
[a]13 cells (36.1%) have expected count less than 5. The minimum expected count is 0.67
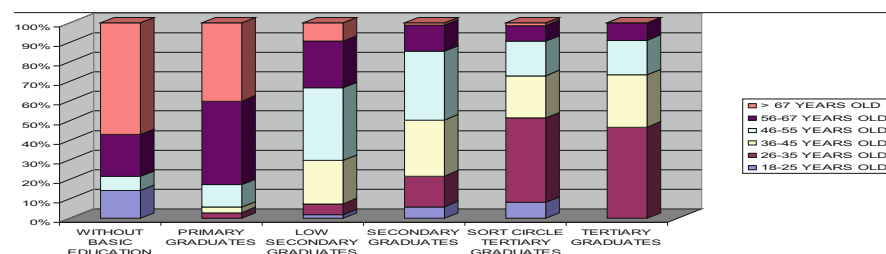
Fig. 1 Ranges of accumulated absolute response columns for the level of education versus the ages

Table 5 Hetero-employment in relation to the characteristics of crop producers regarding their level of education and age

Characteristic (hetero-employment)	χ^2	Degrees of freedom	p-Value
Education level	39.956[a]	5	0.000***
Age	14.964[b]	5	0.010**

Asterisks indicate the level of significance for p-value as: **p $\leq$ 0.01, ***p $\leq$ 0.001
[a]1 cell (8.3%) has expected count less than 5. The minimum expected count is 4.44
[b]0 cell (0.0%) has expected count less than 5. The minimum expected count is 5.71

second relates to the data on their agricultural holdings (size of holding, type of main crop, etc.).

The composition of the active population of crop producers within the study area has been maintained the same regarding the main age group operating in the sector, but young producers demonstrate a higher level of education and an adequate knowledge of new technologies.

The data on the level of education presented here (Table 4 and Fig. 1) give a significant differentiation of the young in age population regarding education. In the age groups 26–35 and 46–55, over 50% of the individuals have a Secondary Education (High School) certificate, while it is worth mentioning a percentage of 32.8% in this level of education of the age category of 56–67 years.

Graduates of Higher Education are also concentrated in the young ages 25–45 and with a clear lead of sort circle tertiary graduates. University graduates present a concentration in the age group of 26–35 years. This concentration of tertiary education graduates in the age groups 18–25 and 26–35 years old, is an element that reinforces the premise that many young people at the end of their studies in tertiary education return to the province and take over agricultural holdings, either seeking supplementary income, or changing career orientation, particularly amid the worst financial crisis (2009–2016) faced by the country for decades (Table 5).
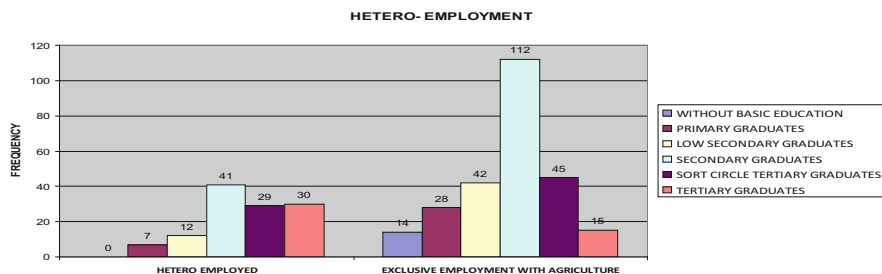
Fig. 2 Frequency response bar chart of hetero-employment and level education

Table 6 Age of respondents and possession of a Global Positioning System (GPS)

Characteristic (GPS possession)	χ^2	Degrees of freedom	p-Value
Age	21.138[a]	5	0.001***

Asterisks indicate the level of significance for p-value as: ***$p \leq 0.001$
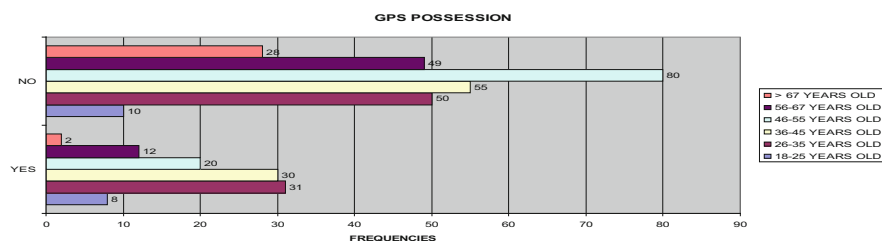[a]1 cell (8.3%) has expected count less than 5. The minimum expected count is 4.94

Fig. 3 Bar chart of absolute frequencies of responses in age groups and possession of Global Positioning System (GPS)

This hypothesis, regarding young people seeking supplementary income, is also reinforced by the evidence highlighted by the answers to the question on farmers' hetero-employment. In the question of whether they have a second occupation, 31.7% responded positively, and the cross-referencing data on their level of education, as shown here, shows a strong concentration (49.6%) of post-secondary education degree holders in relevance to their secondary employment (Fig. 2).

In relation to the question that is directly related to the understanding of the tools of the technology used for the application of Precision Agriculture, and concerns the possession of a GPS-Global Positional System, a necessary element for the mapping of information (spatial variability) and the application of the individual techniques (automatic navigation), positive responses support the hypothesis that the younger and the middle aged were already familiar with their use (Table 6 and Fig. 3).

Age and level of education are very much related to the familiarization of producers with new computing systems technologies and computerized applications

Table 7 Familiarity with new computing systems technologies and computerized applications in relation to the characteristics of producers regarding age and level of education

Characteristic (familiarity with new computing systems and computing applications)	χ^2	Degrees of freedom	p-Value
Age	187.665[a]	20	0.000***
Education level	189.440[b]	20	0.000***

Source: Own processing

Asterisks indicate the level of significance for p-value as: ***p $\leq$ 0.001

[a]12 cells (28.6%) have expected count less than 5. The minimum expected count is 1.58

[b]13 cells (31.0%) have expected count less than 5. The minimum expected count is 1.23
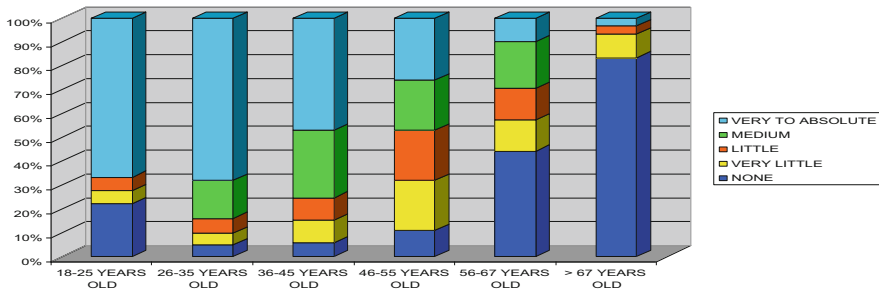

Fig. 4 Bar chart of accumulated absolute response frequencies columns for the degree of familiarity with new computing systems technologies and computerized applications in relation to ages
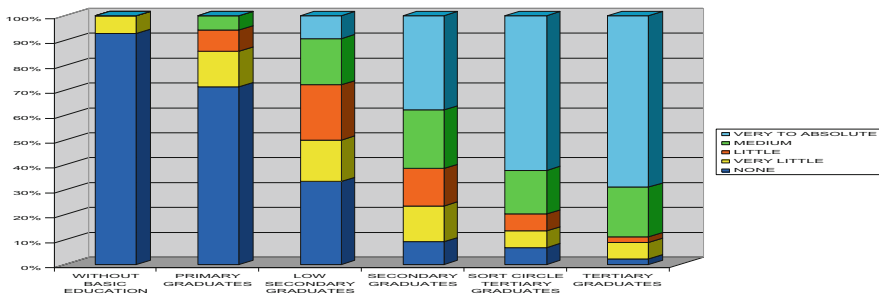
Fig. 5 Bar chart of accumulated absolute response frequencies columns for the degree of familiarity with new computing systems technologies and computerized applications in relation to the level of education

(Table 7). Thus, producers up to 35 years old presented the highest awareness of these technologies, at percentages ranging around 68%. Then, the age group from 36 to 45 years old presented a moderate to excellent awareness of them. As expected, individuals of the population who are not aware of them are those over the age of 56 (Fig. 4).

The level of education is strongly related to knowledge in new technologies, with the percentage increasing depending on the level of education completed by the

Table 8 Summary of the profile of the holdings of the sample individuals

Characteristics of agricultural holdings	Categories/classes	Frequencies	Percentage
Main crop type	Olive trees/vineyards/trees	152	40.5
	Arable crops for human consumption	52	13.9
	Arable crops for industrial process	75	20.0
	Crops for animal feed	66	17.6
	Vegetables	26	6.9
	Nurseries/greenhouses	4	1.1
	Flower crops	0	0.0
Farm size in 1000 m^2	0–10	42	11.2
	11–25	67	17.9
	26–50	78	20.8
	51–100	81	21.6
	101–150	35	9.3
	151–200	24	6.4
	>201	48	12.8
Agronomist consultant for production	No, I don't need	61	16.3
	No, I am in knowledge	48	12.8
	Auxiliary when needed	196	52.3
	Yes, constantly	66	17.6
	I don't know/I won't answer	4	1.0
Agronomist consultant for keeping files and registers	No, I don't need	101	26.9
	No, I keep on my own	105	28.0
	Auxiliary when needed	108	28.8
	Yes, constantly	41	10.9
	I don't know/I won't answer	20	5.3

population. Two of the three producers (62.2% and 68.9%) who have completed tertiary education were highly aware of these technologies (Fig. 5), while the secondary education graduates were familiar with this technology to a satisfactory up to an excellent degree at a percentage of over 50%.

As far as the agricultural holding profile is concerned, the response frequencies of the persons in terms of the size in acres and the type of the main crop (over 50%)—TEO/Technical-Economic-Orientation (Table 8) is presented.

The study area is traditionally covered by large areas of crop production with trees (mainly olives) in most of the Regional Units, and secondly with large-scale crops, either for human consumption (cereals, potatoes, onions, etc.), or for industrial processing (cotton, energy plants, etc.). To a large extent of the land, animal feeds are also cultivated in all Regional Units.

Finally, the responses of individuals to questions concerning their cooperation with geotechnical staff are presented, either advisory on the production process or on

Table 9 Summary of population perceptions on precision agriculture and intelligent farming technologies

Characteristic	Categories/ classes	Frequencies	Percentage
Knowledge of the term precision agriculture	None	150	40.0
	Very little	56	14.9
	A little	50	13.3
	Medium	58	15.5
	Much to absolutely	61	16.3
Knowledge of the practice of precision agriculture	None	168	44.8
	Very little	53	14.1
	A little	55	14.7
	Medium	52	13.9
	Much to absolutely	47	12.5
Perception of future use of smart farming technologies and precision agriculture	None	21	5.6
	Very little	18	4.8
	A little	36	9.6
	Medium	72	19.2
	Much to absolutely	228	60.8

keeping records of inputs and outflows and the work calendar recording under Regulation 1306/2013 and the Information Decision Support Systems.

So, it appears that:

(A) on the question of whether they cooperate with an agronomist consultant for the production process, 52.3% said that their cooperation is on a subsidiary basis

(B) on the question of whether they cooperate with an agronomist consultant to keep records of inputs and outputs and records in the Work and Financial Data Logs as set out in the Codes of Good Agricultural Practice and the Reg. 1306/2013, 28.8% replied that their cooperation is also on a subsidiary basis.

However, the answer, which highlights in particular a subsection of the subject that is being considered—the adoption by the producers of computerized applications for their observance in the framework of the Systems of Information Management Systems, and concerns their observance by them, possesses the non-insignificant percentage of 28% of all individuals. This observation is encouraging for supporting the assumption that crop production farmers in the study area understand the need for keeping records and data for assessment for future use.

The first two hypotheses are presented initially through the frequencies of the answers to the questions that detect the perceived knowledge level of the population on the term and practice of the PA (Table 9). Crop producers were familiar to the term of Precision Agriculture at a percentage of 16.3%, but they were familiar with its practice at just 12.5%.

In the question regarding the perception of the crop producers on the necessity of adopting Precision Agriculture and Smart Farming Technologies in the future, they were extremely positively predisposed. They, therefore, believe highly to absolutely, that it will be necessary in the future to adopt the new technologies at a percentage of 60.8%.

Then, with the aid of CTA and Pearson Chi-Square test, the influence of the two profiles was examined, i.e. the objective characteristics of the population and their holdings, on the perception of the target population for future use of Precision Agriculture and Smart Farming Technologies.

Producer profile elements that faithfully reflect this attitude (Table 10) are gender, education level, GPS possession, and familiarity with new technologies on computing systems and computing applications. Their perception is not at all related to age or to whether they are hetero-employed in crop production (Figs. 6 and 7).

The perception of the future adoption of PA and SFTs is strongly related to the profile of their holdings, except for the employment of permanent staff on the holding, but in this category the answers are statistically significant (Figs. 8 and 9).

Women at a percentage of 32.8% and the age group of 46–55 years old are the strongest trend here, whereas, regarding the education level completed by sample individuals, tertiary education graduates and holders of Postgraduate Diploma are again superior (Fig. 6).

Only 9.7% of individuals in the possession of GPS speculates that Precision Agriculture and Smart Farming Technologies will not be necessary in the future, and even the ones who poorly know the new technologies regarding information computing systems and computerized applications believe, at a percentage of 34.1%, that their use will be needed in future (Fig. 7).

Table 10 Perception for the adoption of SFTs and PA in relation to the characteristics of the profiles of producers and holdings

Profile	Characteristics	χ^2	Degrees of freedom	p-Value
A' Crop producers	Gender	9.572[a]	4	0.048**
	Age	7.730[a]	16	0.956
	Education level	54.134[a]	16	0.000***
	Hetero-employment	4.299[a]	4	0.367
	GPS possession	17.987[a]	4	0.001***
	Familiarity with new computing systems and computing applications	66.709[a]	16	0.000***
B' Farm holdings	T.E.O./Technical-Economic Orientation	33.105[a]	16	0.007***
	Size of household	53.360[a]	20	0.000***
	Employment of staff on the holding	11.525[a]	4	0.021**
	Employment of seasonal staff on the holding	15.709[a]	4	0.003***
	Agronomist consultant for production	32.621[a]	4	0.000***
	Agronomist consultant for keeping files and registers	31.347[a]	4	0.000***

Asterisks indicate the level of significance for p-value as: **$p \leq 0.01$, ***$p \leq 0.001$
[a]0-6 cells (0%–20%) have expected count less than 5 for each one of the characteristics

PERCEPTION FOR PRECISION AGRICULTURE AND SMART FARMING TECHNOLOGIES ADOPTION
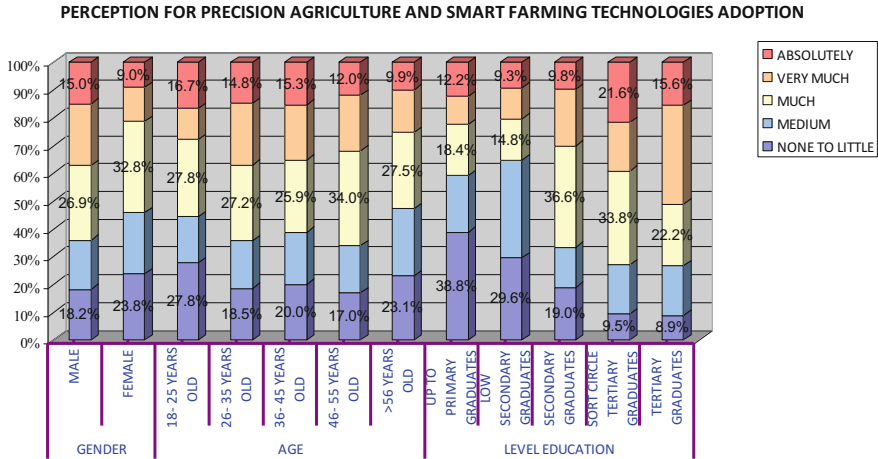

Fig. 6 Bar chart of accumulated absolute response frequencies columns for the perception for PA and SFTs adoption relating to the gender, age and level of education of sample individuals

PERCEPTION FOR PRECISION AGRICULTURE AND SMART FARMING TECHNOLOGIES ADOPTION

Fig. 7 Bar chart of accumulated absolute response frequencies columns for the perception for PA and SFTs adoption relating to hetero-employment, GPS possession and familiarity with new technologies regarding computing systems and computerized applications

In the case of the farm holdings profile, it is clear that new techniques are of no interest to producers who exploit a small area (42.9%) and grow olives, trees, vineyards (25.7%). Producers exploiting an area of 101–150 acres believe at a 40% percentage that Precision Agriculture and Smart Farming Technologies are

PERCEPTION FOR PRECISION AGRICULTURE AND SMART FARMING TECHNOLOGIES ADOPTION

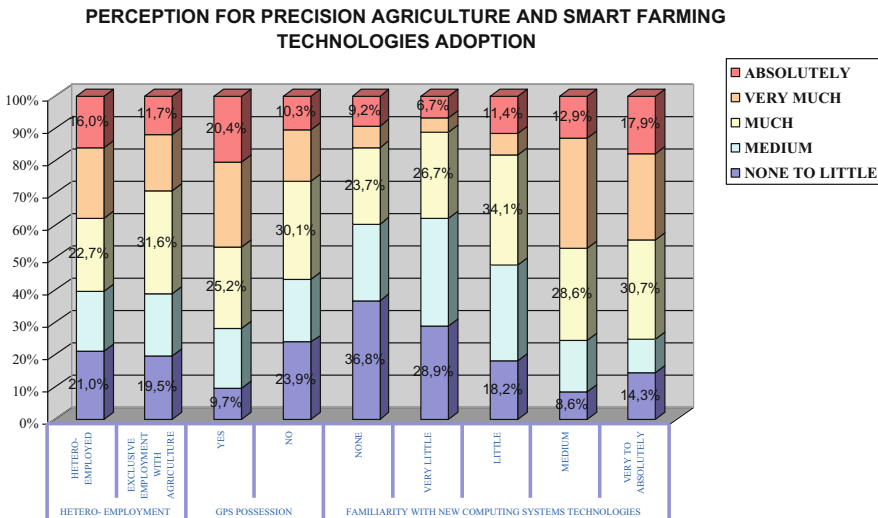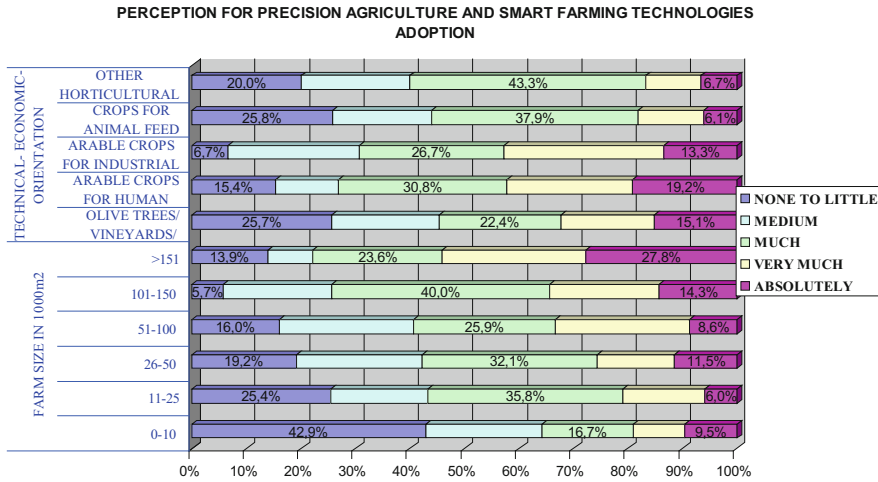**Fig. 8** Bar chart of accumulated absolute response frequencies columns for the perception for PA and SFTs adoption relating to TOP and farm size

most likely to be necessary in the future, and exploiters of over 151 acres do not consider them necessary at a percentage of 13.9% (Fig. 8).

The extremely positive view of producers for the future use of Precision Agriculture and Smart Farming Technologies is formed at high rates, when their farms are supported by an agronomic consultant, either for the production or for keeping records and data, and can reach individual rates of 36.9% (Fig. 9).

The perceived notion of individuals about the future usefulness of SFTs and PA as it emerged through the Contingency Table between the source of information and the perception of the future usefulness of PA and SFTs (Table 11), highlighted that agronomists and companies active in the field hold the lion's share (40.8%) of the absolutely positive perception of producers for them. The media also help in this
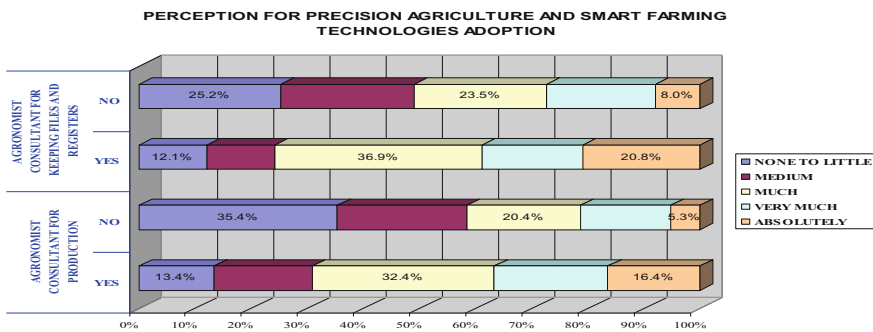
PERCEPTION FOR PRECISION AGRICULTURE AND SMART FARMING TECHNOLOGIES ADOPTION

Fig. 9 Bar chart of accumulated absolute response frequencies columns for the perception for PA and SFTs adoption relating to cooperating with an agronomist

Table 11 Producers' perception of the future usefulness of SFTs and PA in relation to their source of information about PA

Characteristic (source of information)	χ^2	Degrees of freedom	p-Value
Perception of future usefulness of SFT and PA	40.153[a]	12	0.000***

Asterisks indicate the level of significance for p-value as: ***p ≤ 0.001
[a]6 cells (20.0%) have expected count less than 5

INFLUENCE OF THE INFORMATION SOURCE ON THE PERCEPTION OF FUTURE
USEFULNESS OF PA AND SFT
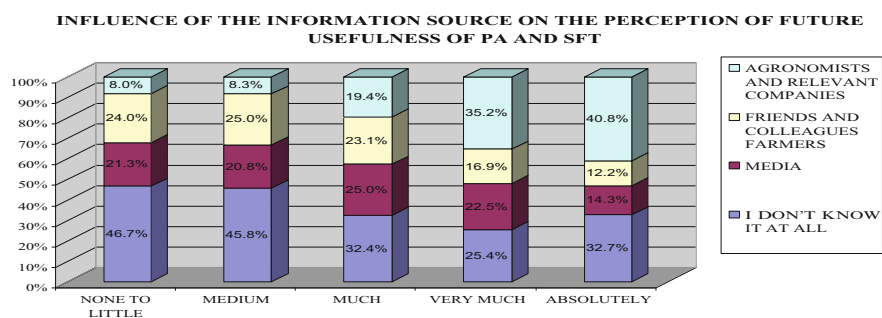
Fig. 10 Bar chart of accumulated absolute response frequencies columns for the influence of the information source on the perception of the future usefulness of SFTs and PA

direction, but far less as far as the intensity of the perception is concerned. So, although the category "high" intensity is at 25%, there is a strong core of the order of 21.3% that is not convinced of the usefulness of these technologies even if they were informed about them by the media. Discussions with friends and colleagues form a very modest perception among the individuals about the usefulness of SFTs and PA in the future (Fig. 10).

Control with a statistical analysis of Contingency Tables and Pearson Chi Square's tests of the individuals' profile data and the source of information demonstrated that statistically significant profile variable is gender, age, level of education and familiarity with new technologies. As far as the second profile of the farms is concerned, all its elements are important for the origin of the information they receive, but the cooperation with an agronomist either as a production consultant or as a consultant for record keeping is more important (Table 12).

Regarding Technical Economic Orientation, the media are the mainstay of informing producers in each category. Finally, although the cooperation with agronomists is absolutely statistically correlated, they do not participate in the dissemination of information beyond 13.3%. This alone is capable of reinforcing the hypothesis (No3) that many actions will be needed in the future for the adoption of SFTs and PA.

It is common for an increase in the capacity to meet the needs of each professional (in this case the farmers) to undergo a first stage of recognition of the new field that they can expand in. More simply, in order to develop a new model of agricultural practice, farmers of crop production would seek out more than one source of information on new and emerging techniques and technologies of primary

Table 12 The origin of PA awareness in relation to the characteristics of producers profiles (A) and farms (B)

Profile	Characteristics	χ^2	Degrees of freedom	p-Value
A' Crop producers	Gender	12.265[a]	4	0.015**
	Age	46.894[a]	16	0.000***
	Education level	61.692[a]	16	0.000***
	Hetero-employment	1.516[a]	4	0.824
	GPS possession	48.552[a]	4	0.000***
	Familiarity with new computing systems and computing applications	96.185[a]	16	0.000***
B' Farm holdings	T.E.O./Technical-Economic Orientation	28.184[a]	16	0.030**
	Size of household	40.558[a]	20	0.004**
	Employment of staff on the holding	24.678[a]	4	0.000***
	Employment of seasonal staff on the holding	36.868[a]	4	0.000***

Asterisks indicate the level of significance for p-value as: **$p \leq 0.01$, ***$p \leq 0.001$
[a]0-6 cells (0%–20%) have expected count less than 5 for each one of the characteristics

Table 13 Multiple or not, information on PA in relation to producers profiles data (A) and holdings (B)

Profile	Characteristics	χ^2	Degrees of freedom	p-Value
A' Crop producers	Gender	14.640[a]	2	0.001***
	Age	47.446[a]	8	0.000***
	Education level	56.504[a]	8	0.000***
	Hetero-employment	0.193[a]	2	0.908
	GPS possession	39.568[a]	2	0.000***
	Familiarity with new computing systems and computing applications	91.943[a]	8	0.000***
B' Farm holdings	TEO/Technical-Economic Orientation	15.071[a]	8	0.058*
	Size of household	14.983[a]	10	0.133
	Employment of staff on the holding	17.497[a]	2	0.000***
	Employment of seasonal staff on the holding	26.430[a]	2	0.000***

Asterisks indicate the level of significance for p-value as: *$p \leq 0.05$, ***$p \leq 0.001$
[a]0-6 cells (0%–20%) have expected count less than 5 for each one of the characteristics

production. From the statistical analysis of Double Input Tables and Pearson Chi Square's test regarding the producers profile data, it emerged that multiple information on PA is highly dependent on gender, age, level of education, GPS ownership and familiarity with new technologies. It also depends on the cooperation with an agronomist, whether he has the role of a production consultant or a scholar who monitors and keeps records of the holding (Table 13).

Naturally, the contribution of agronomic consultants to triggering producers' interest in obtaining information through more sources is not positive, since farmers

working with agronomists obtain information from only one source, at percentages of 55–63%.

4.2 Factor Analysis

The factors, that can contribute to assessing the effectiveness of PA and SFTs by the target population and are therefore considered to be able to impel producers into adopting PA farming practices and SFTs, can be evaluated and shape a proposed policy model. The factors studied are related to the purpose of the function of cultivation techniques, the support and supervision of SFT applications by geotechnical staff, training in new technologies, investment potential, and finally remote counseling.

Sample individuals were asked to respond to the preferred intensity of use of the various techniques and technologies that make up PA and SFTs, their desire to be trained in them or to be guided by consultants, as well as their willingness to adopt and invest in the new technique and technology, in questions 15–38 of the questionnaire (Table 14).

In Order to detect the perception of the target population for Precision Agriculture and Smart Farming Technologies, using the method of Factor Analysis a model was developed—as presented here—, which meets up to their preferences for the adoption of all their stages.

The production of the composite markers presented here is based on Exploratory Factor Analysis Methods and therefore the selection of the final markers requires a systematic evaluation of the results based on the multiple criteria recommended in the international literature (Duquenne 2016).

When using the total of the original independent variables (Questions 15–38), the ratio between the number of observations and the number of variables is in the order of 15 (375: 24), which is an ideal condition for the application of the Exploratory Factor Analysis, as long as the observations/responses are n > 200.

There is excellent consistency between the variables, with the Kaiser-Meyer-Olkin Index (KMO) being 0.952. Also, the independent variables show not only a significant degree of variability, with the CV variability factor systematically greater than 38% (Table 15), but also high correlation with p-values <0.5 (5%) (Table 16). The composition of the 24 independent variables leads to a satisfactory model in the sense of KMO and the limited number of composite indicators (four), which reflect 72% of the total inertia, i.e. a loss of information of 28%.

However, the initial positive evaluation of the model should not conceal its weaknesses, especially in terms of correlations and degrees of participation of the variables (Table 17).

With the exception of the V37 (on-line counseling versus actual) variable, all the others participate in a satisfactory ($H2 > 0.500$) to a very good degree ($H2 > 0.800$) in the composite indicator configuration. In this case, it is recommended to remove

Table 14 Presentation of the independent variables of Factor Analysis

Variable	Variable description
Question No 15	Attitude towards the need to detect the possible cultivation by computerized application with spatial variation mapping method (Recording Technologies) [None/1 to Absolutely/7].
Question No 16	Attitude towards the need for adoption of auto steering technology for planting/sowing [None/1 to Absolutely/7].
Question No 17	Attitude towards the need for adoption of Variable Rate application—VRA for fertilizers inputs [None/1 to Absolutely/7].
Question No 18	Attitude towards the need for adoption of Variable Rate application—VRA for irrigation [None/1 to Absolutely/7].
Question No 19	Attitude towards the need for adoption of Variable Rate application—VRA for pesticide and herbicide inputs [None/1 to Absolutely/7].
Question No 20	Attitude towards the need for adoption of Computer Information Management Systems to register inputs [None/1 to Absolutely/7].
Question No 21	Attitude towards the need to adopt computerized application with spatial variation mapping method (Recording Technologies) during harvesting [None/1 to Absolutely/7].
Question No 22	Attitude towards the need for adoption of Computer Information Management Systems to register outputs [None/1 to Absolutely/7].
Question No 23	Attitude towards the need for adoption of Computer Information Management Systems to register financial data [None/1 to Absolutely/7].
Question No 24	Attitude towards the need for adoption of Computer Information Management Systems to register farming/cultivation practices [None/1 to Absolutely/7].
Question No 25	Attitude towards the need for adoption of Computer Information Management Systems to register Balance sheets, debts, sales and warehouses [None/1 to Absolutely/7].
Question No 26	Attitude towards the need for adoption of Computer Information Management Systems to make future decisions on cultivation practice [None/1 to Absolutely/7].
Question No 27	Attitude towards the need to apply the above-mentioned techniques through a non-assisted online platform [None/1 to Absolutely/7].
Question No 27.1	Auxiliary/sporadically in answer to the question 27 [Yes/1, No/2, I don't wish to answer/3]
Question No 28	Attitude towards the need to apply the above-mentioned techniques with the assistance of an agronomist [None/1 to Absolutely/7].
Question No 28.1	Auxiliary/sporadically in answer to the question 28 [Yes/1, No/2, I don't wish to answer/3].
Question No 29	Attitude towards the need to apply the above-mentioned techniques with the assistance of a specialized agronomist [None/1 to Absolutely/7].
Question No 29.1	Auxiliary/sporadically in answer to the question 29 [Yes/1, No/2, I don't know or don't wish to answer/3]
Question No 30	Attitude towards the need to apply the aforementioned techniques after training [None/1 to Absolutely/7].
Question No 31	Interest in investing in new technologies [None/1 to Absolutely/7].
Question No 32	Estimation to the potential payback of capital invested [None/1 to Absolutely/7].

(continued)

Table 14 (continued)

Variable	Variable description
Question No 33	Estimation of the amortization time of the invested capital (1–15 years).
Question No 34	Estimation of the amount of money that can be invested in relation to the annual profits of the existing holding (percentage).
Question No 35	Interested in private counseling/guidance through mobile phone or personal computer in new technologies [None/1 to Absolutely/7].
Question No 35.1	Auxiliary/sporadically in answer to the question 35 [Yes/1, No/2, I don't know or don't wish to answer/3].
Question No 36	Interested for public counseling/guidance (e.g. Ministry of Rural Development and Food) through mobile phone or personal computer in new technologies [None/1 to Absolutely/7].
Question No 36.1	Auxiliary/sporadically in answer to the question 36 [Yes/1, No/2, I don't know or don't wish to answer/3].
Question No 37	Assessment of whether private or public distance counselling would replace the work of an agronomist as a physical presence [None/1 to Absolutely/7].
Question No 38	Assessment of whether guidance should be provided by a specialized agronomist in new technologies and techniques [None/1 to Absolutely/7].

Table 15 Variability degrees of the independent model variables

Independent variables	Mean	Std. deviation	CV = (Std/mean)%
V15_planing_Recording_Technologies	4.14	1.809	44
V16_auto_steering	4.24	1.813	43
V17_fertiliser_VRA	4.59	1.777	39
V18_water_VRA	4.59	1.824	40
V19_pest/herb_cides_VRA	4.77	1.811	38
V20_inputs_smart_view	4.27	1.880	44
V21_harvest_crop_Recording_Technologies	4.22	1.840	44
V22_yield_smart_view	4.15	1.835	44
V23_outputs_smart_view	4.39	1.816	41
V24_work_calenter_smart_view	4.27	1.763	41
V25_balance_sheet_smart_view	4.29	1.827	43
V26_predict_fut_crop_smart_view	4.22	1.862	44
V27_internet_smart_view	3.77	1.831	49
V28_prefer_agriclt_advisor	4.03	1.641	41
V29_prefer_specialist_agriclt_advisor	4.25	1.669	39
V30_prefer_to_learn	3.93	1.880	48
V31_tendency_to_invest	3.34	1.596	48
V32_estimate_to_regain	3.41	1.655	49
V33_estimate_time_to_regain	3.58	1.785	50
V34_estimate_value_over_annual_income	2.93	2.441	83
V35_internet_private_counseling	2.91	1.719	59
V36_internet_public_counseling	3.70	1.847	50
V37_online_counseling_vrs_actual	3.11	1.651	53
V38_specialized_servises	4.34	1.694	39

Table 16 Evaluation table of the correlations between the initial variables (p-value)

Correlation matrix[a]

Independent variables	V15	V16	V17	V18	V19	V20	V21	V22	V23	V24	V25	V26	V27	V28	V29	V30	V31	V32	V33	V34	V35	V36	V37	V38
V15_planing_Recording_Technologies																								
V16_auto_steering	.000																							
V17_fertiliser_VRA	.000	.000																						
V18_water_VRA	.000	.000	.000																					
V19_pest/herb_cides_VRA	.000	.000	.000	.000																				
V20_inputs_smart_view	.000	.000	.000	.000	.000																			
V21_harvest_crop_Recording_Technologies	.000	.000	.000	.000	.000	.000																		
V22_yield_smart_view	.000	.000	.000	.000	.000	.000	.000																	
V23_outputs_smart_view	.000	.000	.000	.000	.000	.000	.000	.000																
V24_work_calenter_smart_view	.000	.000	.000	.000	.000	.000	.000	.000	.000															
V25_balance_sheet_smart_view	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000														
V26_predict_fut_crop_smart_view	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000													
V27_internet_smart_view	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000												
V28_prefer_agriclt_advisor	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000											
V29_prefer_specialist_agriclt_advisor	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000										
V30_prefer_to_learn	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000									
V31_tendency_to_invest	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000								
V32_estimate_to_regain	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000							
V33_estimate_time_to_regain	.012	.010	.082	.034	.172	.024	.035	.006	.025	.045	.016	.058	.004	.333	.470	.473	.000	.000						
V34_estimate_value_over_annual_income	.482	.389	.324	.497	.379	.498	.499	.419	.363	.380	.464	.456	.269	.304	.420	.291	.034	.276	.000					
V35_internet_private_counseling	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.009	.235				
V36_internet_public_counseling	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.453	.305	.000			
V37_online_counseling_vrs_actual	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.001	.000	.000	.000	.000	.126	.005	.000	.000		
V38_specialized_servises	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.099	.002	.000	.000	.000	

[a]Determinant = 1.768E-012

Table 17 Indices of participation of the 24 independent variables

Participation indices		
Independent variables	Initial	Extraction
V15_planing_Recording_Technologies	1.000	0.764
V16_auto_steering	1.000	0.819
V17_fertiliser_VRA	1.000	0.844
V18_water_VRA	1.000	0.789
V19_pest/herb_cides_VRA	1.000	0.811
V20_inputs_smart_view	1.000	0.824
V21_harvest_crop_Recording_Technologies	1.000	0.743
V22_yield_smart_view	1.000	0.834
V23_outputs_smart_view	1.000	0.790
V24_work_calenter_smart_view	1.000	0.811
V25_balance_sheet_smart_view	1.000	0.772
V26_predict_fut_crop_smart_view	1.000	0.820
V27_internet_smart_view	1.000	0.655
V28_prefer_agriclt_advisor	1.000	0.756
V29_prefer_specialist_agriclt_advisor	1.000	0.859
V30_prefer_to_learn	1.000	0.510
V31_tendency_to_invest	1.000	0.655
V32_estimate_to_regain	1.000	0.638
V33_estimate_time_to_regain	1.000	0.700
V34_estimate_value_over_annual_income	1.000	0.557
V35_internet_private_counseling	1.000	0.513
V36_internet_public_counseling	1.000	0.573
V37_online_counseling_vrs_actual	1.000	0.474
V38_specialized_servises	1.000	0.707

Extraction method: Principal Component Analysis

the variable because, according to international literature, this variable is characterized as "irregular" in relation to the others.

Regarding the necessary correlations between variables—a prerequisite for applying the Factorial Analysis, there is an issue with two variables: V33 (estimated time to regain) and V34 (estimated value over annual income). These exhibit an absolute correlation between them (p-value = 0.000) and generally weak correlations with all others (Table 16). This result was expected since they are expressed not only on a different scale but they also refer to a different approach, i.e. they do not concern perception or interest but purely economic evaluation. The chances of producing a strong indicator of the economic dimension of the phenomenon under consideration would increase if the questionnaire included more economic variables (questions) and not just two.

The weaknesses mentioned above are confirmed when carefully examining the structure of the Main Components Table (Table 18).

The solution produced is not simple, i.e. each independent variable is not associated with a single component. Also, the fourth index participates in the overall

Table 18 Main component table of the four indices produced by the initial 24 variables

Rotated component matrix[a]	Component			
	1	2	3	4
V17_fertiliser_VRA	0.873			
V19_pest/herb_cides_VRA	0.858			
V16_auto_steering	0.854			
V18_water_VRA	0.831			
V20_inputs_smart_view	0.815			
V15_planing_Recording_Technologies	0.792			
V24_work_calenter_smart_view	0.774			
V22_yield_smart_view	0.771	0.406		
V23_outputs_smart_view	0.766	0.401		
V26_predict_fut_crop_smart_view	0.749	0.451		
V21_harvest_crop_Recording_Technologies	0.740			
V25_balance_sheet_smart_view	0.730	0.441		
V31_tendency_to_invest		0.703		
V27_internet_smart_view	0.459	0.661		
V32_estimate_to_regain		0.658		
V35_internet_private_counseling		0.629		
V37_online_counseling_vrs_actual		0.592		
V30_prefer_to_learn	0.413	0.578		
V36_internet_public_counseling	0.516	0.527		
V29_prefer_specialist_agriclt_advisor			0.868	
V28_prefer_agriclt_advisor			0.780	
V38_specialized_servises			0.719	
V33_estimate_time_to_regain				0.815
V34_estimate_value_over_annual_income				0.731

[a]Extraction method: Principal Component Analysis. Rotation method: Varimax with Kaiser normalization

Table 19 Test of α-Cronbach from the reliability analysis of the seven significant loads of the second index (without the V25 and V26 variables)

Reliability statistics		
Cronbach's alpha	Cronbach's alpha based on standardized items	N of items
0.854	0.854	7

variation by 5% and is therefore incomplete for the interpretation of the phenomenon. Finally, variable V36 (internet public counseling) is associated with almost the same load as the first two components.

The sequential check process confirms that both V37 and V36 variables must be removed from the analysis. Especially for V37, the test of α-Cronbach indicates that without this variable the alpha index increases while at the same time there is a difference regarding the average evaluation of the seven variables (scale mean if Item deleted). Below (Tables 19 and 20), the Tables of Reliability Analysis for the

Table 20 Total descriptive statistical survey of the seven significant loads of the second indicator (without the V25 and V26 variables)

Item-total statistics					
	Scale mean if item deleted	Scale variance if item deleted	Corrected item-total correlation	Squared multiple correlation	Cronbach's alpha if item deleted
V27_internet_smart_view	20.40	56.578	0.701	0.515	0.820
V30_prefer_to_learn	20.25	57.898	0.623	0.424	0.832
V31_tendency_to_invest	20.83	59.805	0.685	0.641	0.824
V32_estimate_to_regain	20.76	59.652	0.659	0.633	0.827
V35_internet_private_counseling	21.27	60.185	0.604	0.414	0.835
V36_internet_public_counseling	20.47	57.614	0.650	0.459	0.828
V37_online_counseling_vrs_actual	21.06	65.790	0.401	0.175	0.862

Table 21 Aggregate data of Exploratory Factor Analysis under the conditions (a) to (c)

	KMO	H^2	Number of components (total variation)	Remarks
(a)	0.952	V35 < 0.500	4 (73.6%)	4th component: 5.9%
(b)	0.951	V35 < 0.500	4 (72.5%)	4th component: 6.1%
(c)	0.952	V35 < 0.500	4 (74.6%)	4th component: 6.1% (here the components configuration improves)

Table 22 Aggregate data of Exploratory Factor Analysis under the condition (d)

	KMO	H^2	Number of components (total variation)	Remarks
(d)	0.950	$V_{1,2,..,6} > 0.500$	4 (76%)	4th component: 6.4%

second Index with seven significant loads without the V25 and V26 variables, which contribute substantially to the first Index, are presented.

Tables 21 and 22 show the figures of the Kaiser-Meyer-Olkin Index (KMO), the least satisfactorily observed in a variable degree of Participation (H^2), the Generated Indicators with the percentage of their total variance in the model and observations for the participation of the fourth Indicator in the overall variance of the model, when performing the Exploratory Factor Analysis, are successively subtracted as appropriate:

(a) V37 − and V36 remains
(b) V36 − and V37 remains
(c) V37 and V36 (Table 21)

And finally (d) V37, V36 and V35 (Table 22), since as observed in Table 21, by eliminating V37 and V36, V35 consistently presented a degree of participation below satisfactory ($H^2 < 0.500$).

Table 23 Factor Analysis load table for the four components of the model (d) without the variables V37, V36 and V35

Rotated component matrix[a]				
	Component			
	1	2	3	4
V17_fertiliser_VRA	0.863			
V16_auto_steering	0.852			
V19_pest/herb_cides_VRA	0.848			
V20_inputs_smart_view	0.830			
V18_water_VRA	0.820			
V24_work_calenter_smart_view	0.792			
V15_planing_Recording_Technologies	0.788			
V23_outputs_smart_view	0.787			
V22_yield_smart_view	0.784			
V26_predict_fut_crop_smart_view	0.766	0.414		
V21_harvest_crop_Recording_Technologies	0.757			
V25_balance_sheet_smart_view	0.751			
V31_tendency_to_invest		0.802		
V32_estimate_to_regain		0.779		
V27_internet_smart_view	0.499	0.611		
V30_prefer_to_learn	0.426	0.580		
V29_prefer_specialist_agriclt_advisor			0.875	
V28_prefer_agriclt_advisor			0.789	
V38_specialized_servises			0.730	
V34_estimate_value_over_annual_income				0.800
V33_estimate_time_to_regain				0.798

Extraction method: Principal Component Analysis. Rotation method: Varimax with Kaiser normalization

[a]Rotation converged in seven iterations

The model finally adopted is based on 21 initial items (Variables V15–V34 plus V38) presenting significant variability (CV < 38%) and significant interaction (correlation) between them (p-value = 0.000***). Through the implementation of the Factor analysis, it was possible to extract 4 indicators expressed as a linear function of the initial variables (Table 23). The model is characterized by an excellent consistency between the variables, with the Kaiser-Meyer-Olkin Index (KMO) having a value of 0.953 and their participation is very satisfactory with a minimum communality index for the variable V30 = 0.548.

The first principal component explains 63.6% of the total variance (Fig. 11) while it is related to 12 initial variables which present a particularly high score of the α-Cronbach statistics (Table 24), confirming the clear internal consistency between these 12 initial variables. The second component (7.4% of the total variance) is mainly related to four initial variables presenting also a very good level of internal consistency (α higher than 0.800) while the third component contributing around 6% to the total variance depends mainly on three initial variables (α higher than 0.800). The fourth principal component does not present an acceptable α-Cronbach, since, as
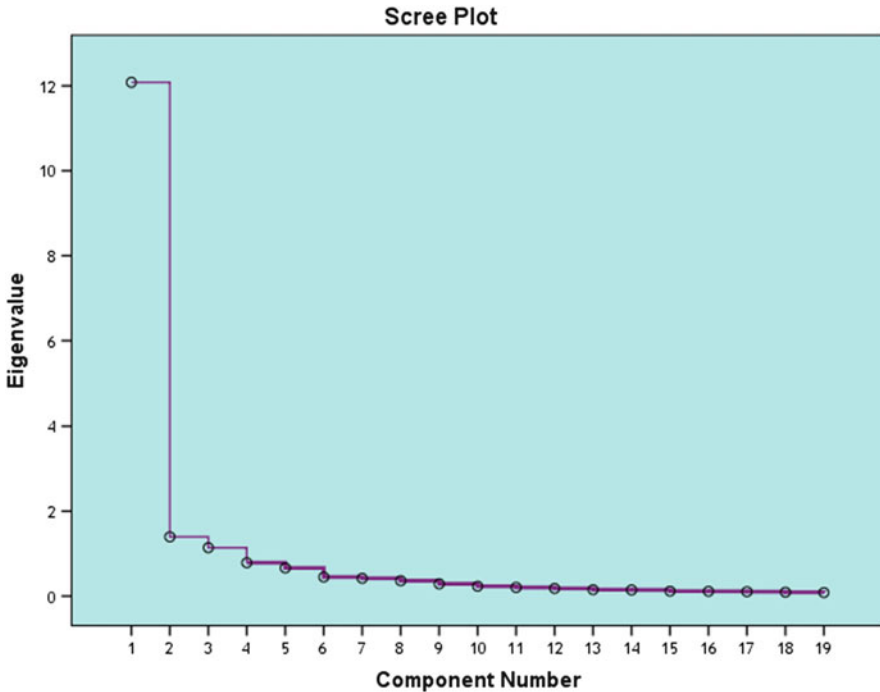
Fig. 11 Scree plot of the series (x-axis) and the eigenvalue value (y-axis) of the composite variables of the Factor Analysis

Table 24 Summary table for the reliability of the independent variables involved in each of the four indices deriving from the Factor Analysis of the independent variables V17–V34 and V38

Components	No of variables	α-Cronbach	Remarks
1st	12	0.976	Same average scale for the 12 variables. No need to remove variables.
2nd	4	0.842	Nearly the same average scale for the four variables. No need to remove variables.
3rd	3	0.848	Almost the same average scale for the three variables. Marginal problem with V38 ($\alpha = 0.861$).
4th	2	0.466	Not a reliable variable due to the different approach and scale ($\alpha < 0.700$)

already mentioned above; it has a different scale and concerns a different assessment-approach. Therefore, the Hyper-Variables/Indicators that are significant are in essence limited to three (Table 25).

Finally, the model based on the three first principal components, explains almost 77% of the phenomenon (Table 26), the loss of information is clearly limited (rate of up to 23%). The loads of the initial variables are over 0.4 and the majority of them

Table 25 Summary table of produced indicators/hyper-variables of Factor Analysis with the loads involved in each independent variable (Questions 15–32 and 38)

Rotated component matrix[a]	Component		
	1	2	3
V17_fertiliser_VRA	0.852		
V16_auto_steering	0.841		
v19_pestherb_cides_VRA	0.835		
V18_water_VRA	0.806		
v20_inputs_smart_view	0.801		
V15_planing_Recording_Technologies	0.763		
V24_work_calenter_smart_view	0.754	0.412	
V22_yield_smart_view	0.747	0.430	
V23_outputs_smart_view	0.747	0.420	
V21_harvest_crop_Recording_Technologies	0.717	0.416	
V26_predict_fut_crop_smart_view	0.716	0.484	
V25_balance_sheet_smart_view	0.708	0.460	
V31_tendency_to_invest		0.810	
V32_estimate_to_regain		0.787	
V27_internet_smart_view	0.423	0.683	
V30_prefer_to_learn		0.658	
V29_prefer_specialist_agriclt_advisor			0.880
V28_prefer_agriclt_advisor			0.797
V38_specialized_servises			0.751

Extraction method: Principal Component Analysis. Rotation method: Varimax with Kaiser normalization

[a]Rotation converged in six iterations

Table 26 Interpretation of the total variance through the analysis of main components

Total variance explained						
	Extraction sums of squared loadings			Rotation sums of squared loadings		
Component	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
1	12.082	63.588	63.588	7.859	41.363	41.363
2	1.396	7.346	70.934	3.866	20.345	61.707
3	1.140	5.998	76.932	2.893	15.224	76.932

are in the range 0.7–0.8 in the first and third indicator. The second indicator is equally strong—it explains cumulatively the phenomenon with the first one by 70%—but because it reflects dual information, entrepreneurship and innovation, terms compatible from a point of view, but also obscure by the general public, tends to concentrate loads on the spectrum 0.6–0.7.

Table 27 A summary presentation of the factors comprising Factor F1, regarding the required data as considered by the crop producers to be met by PA for the Cultivation Practice

Factor 1—Cultivation Practice Index	Factor loadings
V17_fertiliser_VRA	0.852
V16_auto_steering	0.841
V19_pestherb_cides_VRA	0.835
V18_water_VRA	0.806
V20_inputs_smart_view	0.801
V15_planing_Recording_Technologies	0.763
V24_work_calenter_smart_view	0.754
V22_yield_smart_view	0.747
V23_outputs_smart_view	0.747
V21_harvest_crop_Recording_Technologies	0.717
V26_predict_future_crop_smart_view	0.716
V25_balance_sheet_smart_view	0.708
V27_internet_smart_view	0.423

4.3   Interpretation of Hyper-values/Factors

From the responses/observations and the Exploratory Factor Analysis methods, four indicators initially derived, reflecting the whole spectrum of the independent variables tested. From these Hyper-Variables/Indicators, the fourth indicator, which constituted the attitude for investment in PA and SFTs, was excluded from the interpretation of the phenomenon, since, on one hand, due to the very different variables (in their nature) and the different measurement range, it did not show Consistency with the other independent variables, and, on the other hand, did not contribute more than 5% to the total variance (inertia).

The three resulting indicators eventually reflect 76.9% of the total variance, i.e. a loss of information of the order of 23% is recorded.

4.3.1   Factor 1: Cultivation Practice Index

The first factor [F (actor) 1], hereinafter referred to as the Cultivation Practice Index, and has been thus named since it aggregates all those independent variables that refer to the questions that focus on the main stages of the Cultivation Practice and Computer Information Management Systems and marginally the process of online counseling. Thus, it concerns the observations of questions 15–27. Table 27 and Fig. 12 show the Factor Loadings of factor F1.

Exercising the cultivation practice, with the contribution of the Computer Information Management Systems, as well as data on the application of techniques from web sites, is a fairly widespread process in the case of developing countries that are gradually orienting producers to familiarity with PA. It is also a key influx of entrepreneurship and innovation to increase the knowledge pool.
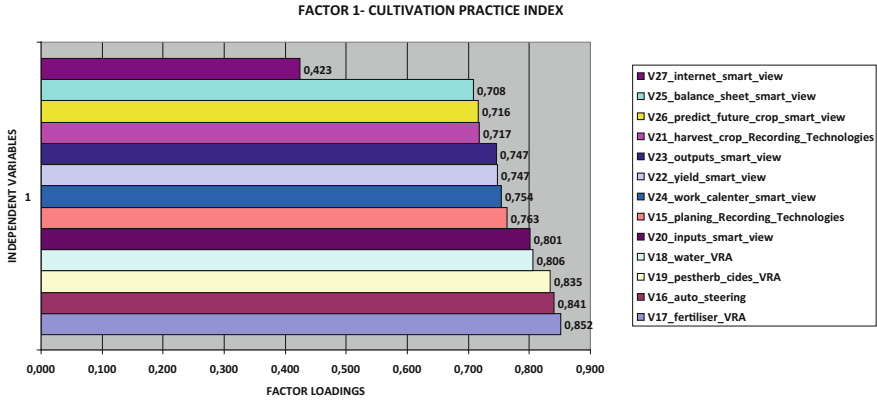
Fig. 12 Section Bar-chart for loads carried by the independent variables that make up the F1—Cultivation Practice Index

Crop producers evaluate elements relating to routine farming practices (fertilization, soil preparation, plant protection and irrigation) and the recording of inputs with a weight (charge) of more than 80% as much required (as it was expected). That is, they evaluate the technology of VRA, of Auto-Steering and input monitoring, more positively than the Recording Technologies and the registrations of other elements of their exploitation (>70%). The factor concerning assistance from a web site, related to the techniques and technologies of PA, is considered marginally (42.3%) important.

4.3.2 Factor 2: Entrepreneurship/Innovation Index

In order for new technologies and techniques to be adopted by the agricultural productive population, they should be evaluated through daily farming practice and then through their business performance in the context of an innovative investment.

The second index (F2) exported, concerned data regarding entrepreneurship and innovation. Trends for evolution and for the introduction of new innovative technical processes and organizing forms are weighted in this Index, along with the willingness for education and investing, and finally the provision/estimation for depreciation of the capital expended (Table 28).

The corresponding Factor 2 loadings as depicted in Fig. 13, which bear the evaluated gravity by the sample population, accrue high scores (>65%) in the predisposition for investment, evaluation for depreciation, assistance by a web site for implementation of the new techniques and the intention to train for their implementation, the main elements, namely, to increase profitability and to improve competitiveness. The existence of the V7 (internet smart view) variable at this

Table 28 Summary presentation of the factors comprising Index F2 regarding the data required, as evaluated by crop producers, to be complied with by the PA for Entrepreneurship and Innovation

Factor 2—Entrepreneurship/Innovation Index	Factor loadings
V24_work_calenter_smart_view	0.412
V22_yield_smart_view	0.430
V23_outputs_smart_view	0.420
V21_harvest_crop_Recording_Technologies	0.416
V26_predict_future_crop_smart_view	0.484
V25_balance_sheet_smart_view	0.460
V31_tendency_to_invest	0.810
V32_estimate_to_regain	0.787
V27_internet_smart_view	0.683
V30_prefer_to_learn	0.658
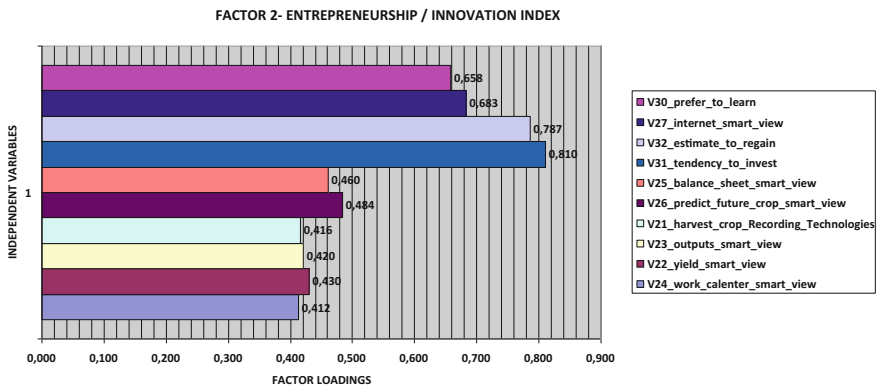
Fig. 13 Sections Bar-chart for loads carried by the independent variables that make up the F2—Entrepreneurship Index

indicator, and even braced by a score of 68.3%, reinforces the observation that PA and SFTs are treated as an input of innovation in agricultural holdings.

Regarding adaptability in the digital business environment, the remaining independent variables imprinting it burden the Index with loads from 48% to 41%, and this observation is indicative of the up until now incomplete or piecemeal information of producers.

4.3.3 Factor 3: Consulting Services Index

Finally, an important element for PA adoption is its support by specialized agronomists in it, so the final third index (F3) aggregates the independent variables relating to Counseling Services. It is logical, in the context of adopting innovative techniques such as PA and SFTs, to invest in the co-operation or employment of

Table 29 Summary presentation of the factors comprising the F3 Indicator, regarding the data that crop producers consider that the PA should meet for the Consulting Services

Factor 3—Consulting Services Index	Factor loadings
V29_prefer_specialist_agriclt_advisor	0.880
V28_prefer_agriclt_advisor	0.797
V38_specialized_servises	0.751
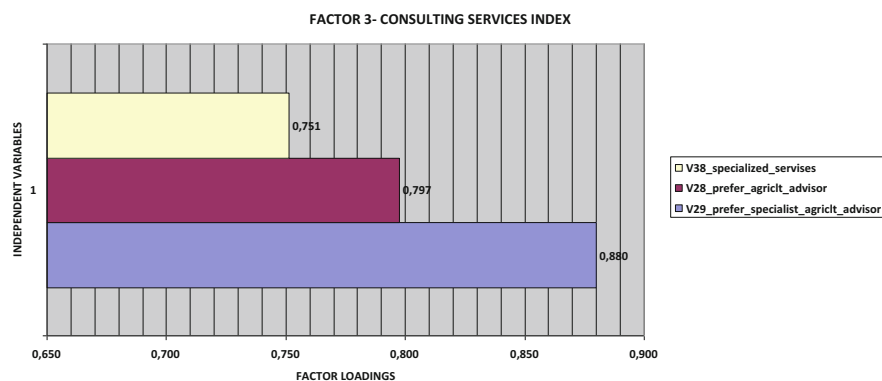
Fig. 14 Sections Bar-chart for loads carried by the independent variables that make up the F3—Consulting Services Index

skilled personnel in the overall Research and Development (R & D) framework. Here, the observations highlight the gravity of the counseling process by being valued as a separate index, with high scores (Table 29 and Fig. 14).

Producers, therefore, value the contribution of agronomists in the process of using PA techniques and SFTs to a very high score (>75%), with the highest of all, the presence of specialized advisors in agronomist-related issues (question 38).

5 Conclusions: Proposals

Although the percentage of producers who know the term PA appeared to be increased when compared to earlier studies (Mourtzinis et al. 2007), it did not exceed 16.3% in response rates. Far fewer, only 12.5%, were familiar with the practices of PA, mainly through information actions from companies and geotechnical practitioners that are involved in it. Even so, in a relevant question, people that are involved in crop production and in the research study by Michailidis et al. (2010) were found to be little interested in it, now foresee in a percentage of more than 60%, that the adoption of PA and SFTs will be a prerequisite for farmers in the future.

By examining the specific conditions that would help the crop producers to adopt the new cultivation techniques and technologies, the dimension of their inadequate

information and their almost non-existent education emerged. That results as the vague documentation of all the manifestations of these practices in their daily occupation vocation with agriculture. This lack of education in a large extend is the reason that they cannot implement this technologies. Such a result is consistent with the result of the study carried out by Kountios (2014).

The profile of Greek producers refer to people aged up to 46 years old with a Middle (40.8%) or Higher (31.7%) education Level and a good familiarization (37.3%) with computing technology—necessary conditions for their training. They have the right profile to recognize the usefulness of the technology involved and the essence of the techniques towards sustainable management.

The existence of other 'on a distance farmers' that are parts of the spatial householdings but really taking part in the family farm exploitation schemes and influence the decisions to redirect them, is another reason that impinge upon adoption of PA and SFTs. Until now such an aspect—specific to Greece—has not been studied and needs more investigation. This factor could not be included in the four nation comparative study of Lawson et al. (2011) and constitutes a unique phenomenon observed only in Greece.

For these reasons, the general attitude towards PA depicted by the present study concerned the intention to adopt practices related to the minimization of inputs and monitoring the company's performance rather than using intelligence decision support systems. The adoption of a business scheme that involves managing their exploitation by intelligent decision making systems, efficiency measurement and innovative practices of distance counseling is not understood. The most of them don't comprehend that an adoption of that kind of schemes requires a new approach of entrepreneurship which is inevitable.

In general, however, the innovation of the whole system of SFTs is recognized by producers, mainly driven by the recognition of information technology and web applications as a new business scheme, albeit less in intensity than pure entrepreneurship and excluding the factor of the economic dimension. The willingness to invest, as well as the depreciation estimate, was slightly increased, despite the current economic situation of the holdings. This disconnection is in line with the findings of the most recent research of Kountios et al. (2017) about Young Farmers willing to build a competitive agricultural business.

Particularly strong was proven to be the relationship between geotechnical consultants and the producers' decision to adopt PA and SFTs. Indeed, their evaluation was that they would need more specialized agronomists.

Based on the data gathered on the crop producers' profile and given the very large number of observations, it is not wrong to assume that the composition of the rural population has changed in recent years and younger and more trained producers undertake to produce agricultural products in Greece.

Their intentions with regard to cultivation practice related to better management of inputs and were able to recognize entrepreneurship and counseling as a means for the future development of their holdings.

Through actions concerning their information and support of their businesses to adopt PA and SFTs, it is possible to restart agricultural primary production in the sense of redirecting it to more environmentally friendly and more economical practices.

The new technologies presented here concern the maintenance and modernization of agricultural and livestock farm machinery and at the same time the reorganization of inputs and the rational management of natural agricultural resources and hence a fundamental restructuring of everyday agricultural practice. The target population, through its responses, recognized the added value of new techniques and technologies, although many actions will still be needed in order for them to be adopted. But, more than anything, the target population comprehended the role they will play in the future.

The precision relates, in substance, of exercise of cultivation practices using the same method and the same result, under the condition of using greater reliability machines and minimal requirement calculations and corrections, thus requiring the continuous collection and disposal of data and metadata and their management by scientifically trained staff.

Therefore, with the purpose of adopting SFTs and PA for the modernization of agricultural holdings of crop production in the Region of Central Greece, the following actions are recommended:

- training of producers of large-scale plantations who are up to 50 years of age, or growers of over 150 acres in new techniques and technologies,
- updating and training of producers with high-yield crops such as trees in PA and SFTs,
- education of agronomists and their continuous training in the computerized applications of GIS and Computer Information Management Systems, as well as the techniques of Auto-steering, Recording Technologies, mapping of spatial variability and Variable Dose Applications,
- developing internet applications regarding combinational data and metadata to find data for the production process,
- eligibility of expenditure for the 'main occupation' farmers for computing systems, sensors and automation of procedures,
- an effort to detect the possibility of diversifying the products produced with PA and then marking them as products of sustainable agricultural practice,
- enhancing the entrepreneurship of family holdings adopting PA and SFTs,
- support for the development of group actions at local level to create large-scale data exchange networks and finally
- funding research for the specialization of techniques and SFTs and their evolution.

The main reason for suggesting the above policies is because PA and SFTs will play a key role in the economic development of agricultural holdings in Greece, in the future, in the context of their alignment with the general trend in the Member States of the European Union (European Parliament Department B Structural and Cohesion Policies 2014). Even more so, because they will be a prerequisite in the future, since they harmonize the elements of space, time, data and doses of inputs into the agricultural holding units, within an evolving integrated cultivation system, aiming at the sustainable conservation of natural agricultural resources and the ever-increasing demand for agricultural-food products (Image 3).

Image 3 A logo depicting the key elements that are consistent with the PA's farming practices for sustainability of agricultural resources. Source: Own processing
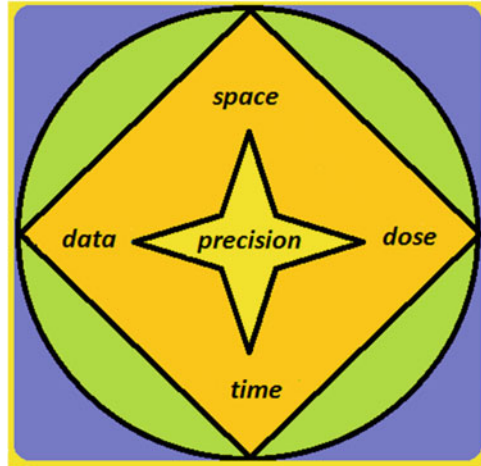
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