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SUSTAINABLE AGRICULTURE AS A BASE OF SUCCESSFUL FOOD PRODUCTION AND EXPORT IN HUNGARY.

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CHAPTER I

INTRODUCTION

1.1. Study background

In the study of sustainable agriculture or any of the topics related to it, the ideas come back to the main source of the idea of agriculture first, which is productive and effective behavior for the continuation of life and maintenance of the balance of the planet dynamically. Secondly, from the economy, which is the engine of the production wheel of all kinds, agriculture is the basis for many economies of many countries around the world.

The origin of agricultural economics probably can be traced back to ancient Egypt, perhaps to the first agricultural economist who was Joseph when he interpreted the dreams of the Pharaoh of Egypt and properly predicted seven years of feast and seven years of famine in Egypt that time. Scientifically, agricultural economics comes from two intelligent and rational streams in economic science. The first was the neoclassical political economy, which is related to enlightenment and a preoccupation with the land as a factor by the French Physiocrats in the 18th-century,where Francois Quesnay‘s (1758) classified and categorized the logical clarification of the conversion of land inputs to agricultural outputs and return, anticipating modern production economics, input-output analysis, and general equilibrium theory. The second was the theory of the firm applied to farm production, which had been carried out by an economic crisis and slump in American agriculture in the late 19th century, which was, later on, focused on the strategies for organized marketing of agricultural goods and commodities through combined bargaining and cooperatives.

Agricultural economics consider as an applied social science which deals with how producers, consumers, and the behavior of the societies which use scarce and natural resources in the production, processing, marketing, and consumption of food and fiber products. With the world's population likely to reach 9 billion by the middle of 21^{st} century, many organizations concerned with agriculture and food believe that there is an urgent need for 60 percent of food by 2050 to maintain all of these people, where possible this food should be produced where needed - in developing and agricultural countries. Therefore, these countries will have to increase their production significantly to achieve this goal, with resources scarcity and with an increase in the negative impact on the limited natural resources on which agriculture depends, especially water allocated for irrigation and livestock purposes, lands designated for crops and grazing, limited nutrients and fertilizers. In many of the places, the soil already suffers permanent damage, while water resources are overexploited or polluted by fertilizers and pesticides. Furthermore, diminished agricultural biodiversity as agriculture became industrial, all these conditions have prompted the world to pay attention to increasing global awareness of the fact that agriculture produces more than just the production of food, animal feed, and its impacts on climate and global human health and ecosystems. Nowadays, when the agriculture has been already well developed around the world, most of the well-being countries are trying to upgrade it to the next level to make it more environmentally friendly, less harmful and more useful. This is called sustainable agriculture, which is the branch of sustainable development. Sustainable agriculture is the new management way of obtaining important and effective ways to get to the sustainable development. Also sustainable agriculture is the way to increasing the national income, which in turn will affect all members of the agricultural productive society.

According to the best knowledge of the author of this study, there is no previous study that had highlighted sustainable agriculture, food production and food export at the same time. Moreover, this study explores the relationship between food production, food export and the effectiveness of sustainable agriculture. Therefore, this study fills the gap in the existing literature by proposing an empirical framework that links the role of sustainable agriculture effectiveness through sustainable agriculture practices and the indicators of sustainable agriculture with food production and food export. In addition, this study also attempts to recognize the need for a sustainable agriculture in Hungary's agricultural sector, to play its influential role in society. In fact, this sector has the components of the application of agricultural work and the farmers and their tools to apply sustainable agriculture along with dimensions of sustainable agriculture. The importance of this study can be determined through its theoretical importance by raising a modern topic that plays a key role in achieving the higher performance of the food and environmental security. As well, the economic and practical importance of this study is to provide solutions and proposals for the sustainable agricultural application in agriculture sector put in the research and put into practice, in order to improve the level of performance and excellence that will be reflected positively in the level of food production and the food export. In terms of food production and the food export, this study will play a key role in developing the sustainable agriculture capabilities in solving the challenges that it faces within these sustainable food products until export, in order to achieve additional capabilities to meet the current and future challenges and achieve superior performance.

1.2. Problem statement

Hungary is a country of important areas in Eastern Europe due to its location Geographical as an intermediate between Eastern Europe and Western Europe and its agricultural importance. The author then asks whether the agricultural land in Hungary suffers from lack of exploitation despite the extension of agricultural land and that causes problems to limit the sustainability of agriculture in which throughout the year, which increases the problems related to agricultural production, water availability, ways of irrigation, prevention methods, equipment availability, expertise of the peasants in the area of crop selection or mode of action.

Agriculture in Hungary is a strategic sector and as such its performance changes is dependent on the weather. In spite of the improvements in recent years, the potentials are largely unused, mainly because of technological weaknesses and lower irrigation rates. In terms of specific productivity per hectare, the EU has done poorly in that, and the improvement is essential. The expert farmers became old, and professional awareness and knowledge are mostly imperfect for small farmers, local agriculture supplies food outputs, but the ratio of processed products in the exports is little. Sustainability has been developed, but organic producing and precision farming has been spreading quite slowly(Szűcs, Vanó, & Korsós-schlesser, 2017).

The empirical research focused on, how sustainable agriculture becomes an applied reality between world foundations strategies, and the countries have tried to adopt sustainable agriculture, but they didn't focus on sustainable agriculture, food production, and food export, so this research has considered all of it as comprehensive work in the farm's level. This gap led us to propose the research questions as below.

1.3. Questions of the study

The study seeks to answer the main question, "What are the possibilities for developing sustainable agriculture in Hungary? The following research questions will be addressed in order to guide the acquisition of data required to satisfy the statement of the problem:

1. What are the effective indicators of sustainable agriculture in Hungary?
2. What extent has sustainable agriculture influence food production?
3. What extent has sustainable agriculture influence food export?

4. What extent has sustainable agriculture influence on food security?

1.4. Objectives of the study

The primary objective of this study is to examine the impact of sustainable agriculture on food production and food export in selected Hungarian farms. The study specifically sought to:

1. Test the proposed model empirically and investigate the relationship between sustainable agriculture and food production.
2. Test the proposed model empirically and investigate the relationship between sustainable agriculture and food export.
3. Examine the relationship between selected variables that shared between sustainable agriculture by its indicators and food security by its determinants in Hungary in the long term.
4. Evaluate the effective indicators of sustainable agriculture in Hungary.

1.5. Significance of the Study

This study tries to meet the needs of the agricultural sector in Hungary for its influential role in economics and society. This sector has the components of the application of all types of a cultivated farms in Hungary. the importance of this study can be determined through its theoretical importance by raising an important topic which plays a key role of achieving the higher performance of the food production and exporting, the economic and practical importance of this study is to know the obstacles through the application of sustainable agriculture work to put solutions and proposals for this type of sustainable work. This research focuses on useful practices. In order to improve the level of performance and excellence that will be reflected positively in the level of agriculture. On the other side, this study will play a key role in developing the farmers' capabilities to solve the dilemmas that it faces in its agricultural work to adopt sustainable production, in order to achieve additional capabilities to meet the current and future challenges and achieve superior performance. The findings of the study have the potential to help decision-makers of the agricultural sector and ministry of rural development in Hungary to develop strategies that will enable them to improve the farmer competency to reach the sustainable agriculture easily.

1.6. Research Methodology

The study utilized a quantitative research methodology to determine the extent to which sustainable agriculture by the indicators and tools, which influences food production and food export, agricultural sustainability assessment for the development of sustainable agriculture has been needing a unified approach of modernistic science blended with proficient knowledge and active sharing of stakeholders. Therefore, Roy and Chan (2012)suggests the integral of approaches with the participatory tactic in sustainability assessment, which essentially helps to combine a comprehensive strategy for the sustainable agricultural framework.

This study used a survey questionnaire for collecting primary data. The survey questionnaire was distributed to farm owners in Hungary. The survey questionnaire was divided into five sections, namely, respondent and firm information, sustainable agriculture tools, sustainable agriculture dimensions (economic, environment, social, and political), agriculture export sector, and agriculture production sector. The measurements were developed based on an extensive review of the literature (Valkó, 2015; Rovira et al. 2015; Muema, et al. 2018;Dong et al., 2016; Fami, et al., 2007; Gaviglio, et al., 2017; Mavrogiannis et al., 2008). All measurements used a five-point Likert scale. The sample was selected randomly from the complete list of farm owners, Hungarian food and beverage exporters and producers. An online survey took place during February -April 2020 and yielded 106 usable responses.

According to the research questions and hypotheses, this study used the Statistical Package for the Social Sciences (SPSS) softwareversion23andtheAnalysisofMomentStructure (AMOS) software version 24 to test the reliability and validity analyses, and descriptive statistical analyses. In addition, this study used Partial Least Squares Structural Equation Modeling (PLS-SEM) in order to test research hypotheses. SEM is commonly used in the social sciences because of its ability to explain the relationships between unobserved constructs (latent variables) from observable variables (Rahman et al., 2015). SEM is comparable to common quantitative methods, such as correlation, multiple regression, and analysis of variance to estimate and test the relationships among constructs.

In this study also by the secondary data, the empirical investigation used Principal Components Analysis (PCA). PCA is a statistical multivariate methodology used to study large sets of data. This method reproduces a great proportion of variance among a big number of variables by using a small number of new variables called principal components (PCs). Components were extracted and rotated using the varimax method in order to facilitate the interpretation. High absolute values of loadings of the variables on the PCs imply that the indicator has a large bearing on the creation of that component.

Thus, we considered all the variables that scored more than 0.50 as being related to the definition of the component (Li & Wang, 2014; Jolliffe, 2002). In this study also by the secondary data, the historical approach will be used to identify and analyze the reasons for the relationships, among the variables, as well as the study of their direction and growth; the collected data was subjected for analysis by using VAR model on Gretl program (version, 2017).

1.7. Research structure

To address the research questions and objectives, I conducted seven chapters, which were combined to constitute this dissertation. The researcher conducted three empirical studies to test the proposed model empirically and investigate the relationships among sustainable agriculture, sustainable agriculture tools, dimensions of sustainable agriculture, and food production and food export and food security. Furthermore, the evaluation of sustainable agriculture in Hungary as will be shown in chapters 4, 5 and 6.

Chapter one describes a brief overview of the background to the study, defined the research problem, stated the research questions, research objectives. Additionally, a brief description of the research methodology is stated, the study's limitations and lastly, the definition of terms. Chapter two describes a general prologue with bibliography (literary review) which is relevant to thetopicofthisstudyandliteraturerelevanttooneofitstopicsandvariables.Additionally,provides analysis and discussion of the literature, the benefits of the literature review and the research gaps. Chapter three provides a detailed discussion of the methodology adopted for the study. This chapter is divided into five sections. Section one describes overview and research questions. Section two presents research hypotheses. Section three discusses the research design. Section four shows the research design. Section five discusses the historical overview of Hungarian sustainable agriculture. In chapter four the study examines the relationship between selected variables that shared between sustainable agriculture by its indicators and food security by its determinants in Hungary in the long term.

In chapter five the researcher examines the efficiency, impact and real existence of sustainable agriculture by identifying economic, environmental and social indicators on some components of these dimensions. In chapter six the study examines the effect of sustainable agriculture on food production and food export. Chapter seven presents an overall dissection and conclusion regarding the several studies building this dissertation thesis and provides new scientific results and the theoretical and practical implications.

1.8. Definition of Terms

1. Sustainable Agriculture: This means meeting the existing food and requirements of society without compromising the capacity of present and future generations to meet their needs by several ways to improve agricultural sustainability. Sustainable agriculture provides a possible solution for enabling farm systems to feed an increasing population in the changing climate.

2. Food Production: Production and subsequent crops for human consumption of animal and plant material.

3. Food Export: The edible products that are manufactured and bought in one country by the citizens of another.

4. Sustainable Agriculture Indicators: They are tools to measure the state of environmental, economic, and social resources or in the agricultural activities which affect the status of these resources or are used or affected by agriculture. The soil quality, water quality, agroecosystems, biodiversity, climate change, farm resource management, and production performance are examples of a sustainable agriculture process monitored by these indicators.

5. Organic Farming is a method of production that avoids or prohibits in large part the use of synthetically compounded fertilizers, plants, and animal feed additives. In order to maintain the productivity and smoothness of soil, to deliver plant nutrients and to manage insects, weeds and other parasites, organic farming systems rely on a large extent of rotation of crops, crop residues, animal fungi, legumes, green fungus, organic waste off-farm, mechanical growth, mineral rocks, and biological parasite management.

6. Sustainable Agriculture Dimensions: The factors that affect agricultural sustainability and its influenced by the application of sustainable agriculture. These include economics, environmental, social and political dimensions.

7. Sustainable Agricultural Practices: These are methods that overlap in many principles that are sustainable in the long run and maybe 100 percent organic or at least from the biggest part, such as Conservation tillage, Contour planting, Inter cropping, Biological control and culture control.

8. Food security: is characterized by food quality and access. When its inhabitants do not live in poverty or fear of hunger, a household is considered food free. Stages of food insecurity vary from food health to hunger.

CHAPTER II. LITERATURE REVIEW

2.1 Introduction

This chapter discusses the extant literature and theories relevant to sustainable agriculture in the agricultural, economic, social, environmental sector with a focus on sustainable agriculture in Hungary, food production and export. Firstly, it discusses the evolution of the sustainable agriculture concept. Next, it reviews the available definitions of sustainable agriculture and every term related and linked with the sustainable agriculture. Moreover besides dimensions, indicators, tools, factors, measure, models, future and challenges of the sustainable agriculture its roles are also discussed and how we can reach to real sustainable agriculture and the influences by the big role in the farmer life and then the effects in all life parts.

The chapter reviews literature and other key theories in studying sustainable agriculture in the agro economic sector. It especially focuses on studying the most important indicators of the sustainable agriculture in Hungary, sustainable practices with beneficial explanation and identifies their potential to achieve sustainable development goals.

2.2 Sustainable agriculture and the Evolution of the Concept

Agriculture in Hungary

According to Oros (1999) the agriculture sector was dominated by semi-feudal large estates in the early stages of the 20th century. Almost one-third of the fitting area for agriculture was held by about 4000 landlords (Oros, 1999). Agriculture production has been the mainstay of the Hungarian people for centuries and agriculture is seen as the outstanding strategic sector of the Hungarian national economy (Ministry of Agriculture, 2016). At the beginning of the 20th century other sectors of the Hungarian economy were seemingly abandoned, when compared to other western European countries and this made way for agriculture to become the leading sector of the national economy (Oros, 1999).

This is effectively captured in the ministry of Agricultures publication in 2019 that "“The Hungarian agriculture and food industry is a sector of high importance, its share in GDP growth was 0.2 percentage points in 2018 and while contributing to the performance of the national economy it’s resistant to crises”.

Burger (2009) also mentions that agriculture represents an essential sector of the Hungarian economy, and approximately 70% of its land area is suitable for agricultural production.

New Hungary Rural Development Programme (NHRDP) (2014) observes that the contribution of agriculture to GDP was one that has lagged behind when it comes to volume and direction. Agriculture has continued to play such a compelling role in the living of the population of the country, and many settlements have benefitted from it as a source of livelihood (NHRDP, 2014). This is so according to NHRDP despite the decreasing share in the total economy indicated earlier.

According to Katona et al., (2005) from the historical perspective, agriculture has changed the fact of many European landscapes over centuries. The authors indicated that this has ensured the upsurge of "unique semi-natural environments with a rich variety of habitats and species dependent on the continuation of farming" (Katona et al., 2005). It has been argued that sustainable agriculture system is geo-specific (Horrigan, Lawrence, & Walker, 2002). This means that there are systems that best work for some specific geographical locations and an attempt to adopt the same system at a different location could fail. The type of soil, the natural resources and other factors are largely specific to a location. The best situation here is for a successful sustainable agriculture system to be adapted to suit another environment.

The concept of unsustainability in agriculture is not a new issue (Horrigan, Lawrence, & Walker, 2002). Ponting (1992) mention in his book "A Green History of the World" that there were a period where great civilizations have arisen on the power of their agriculture activities, and these activities have in a later time contributed to the collapse of the farming method and had therefore eroded the natural resource base. Horrigan, Lawrence, & Walker (2002) then argue that the modern conventional or industrial agriculture is considered unsustainable in the sense that it is similarly eroding natural resources even faster than the environment can generate, largely due to heavy reliance on nonrenewable resources. The concept of agriculture sustainability was put out first in 1798 when Thomas Malthus wrote "An Essay on the Principles of Population" when he at the same time pointed attention to an unlimited of the growth population that might exceed the ability of food production (Judit, 2013). Sustainable agriculture is part of a larger movement toward sustainable development, which acknowledges the limited nature of natural resources (Horrigan, Lawrence, & Walker, 2002). From the viewpoint of Feher & Beke (2013) the concept of sustainability is explained to mean the attainment of the balance between its three pillars, namely, economy, society and environment. It has the eventual resolve to improve on the overall well-being of the society. It is argued that sustainable agriculture comprises two main approaches; a smaller system approach and a broader approach. Semida et al., (2019) add that the first approach views the farming system as a closed area where agriculture is needed to sustain itself by way of protecting its productive resources such as the maintenance of soil fertility, protecting surface and groundwater supplies and developing renewable energies among others. The second approach as stated by the authors has broader goals which does not see any difference between a rural and urban communities (Semida et al., 2019).

The importance of sustainable agriculture cannot be underestimated as it provides hope for food security in the future. Sustainable agriculture is a wide-ranging concept that involves more than a specific methodology. Reganold, Papendick and Parr (1990) mention that sustainable agriculture involves different variants of nonconventional agriculture that are often called organic, alternative, regenerative, ecological or low-input. It includes improvements in agricultural management technology and practices, and the growing recognition that shows that the conventional agriculture that developed years back would not be able to meet the needs of the growing population in the 21st Century (Singh, Pandey, & Singh, 2011). In the work of (Pretty, 2019), the 1987 Brundtland Report explained sustainability as "meeting the needs of the present generation without compromising the ability of future generations to meet their own needs".In an agricultural term, sustainability can usually be considered in relation to agricultural economic growth, regional stability, and environmental protection (Juwana et al., 2010).Erbaugh, Bierbaum, Castilleja, da Fonseca, & Hansen (2019) mention that the study and implementation of sustainable agriculture production are usually predicted on formal and informal definitions. Study of Judit(2013) categorized the definitions of the sustainable agriculture in to four groups: The first group point to the maintenance of human welfare, to make the situation of future generation better than the present generation, the second group also emphasize on the survival of the human race, the third group argue for the concept of flexibility of production system, and the fourth group of noneconomic notion which is the major role to preserve cultural heritage and societies and maintain the diversity of ecological system.In observing all the four arguments, one thing that seems to be running through all of them is that sustainability has to do with the long-term survival of humans. This has called for varied means of maintaining the survival of humanity. In this case, it is essential that soil is protected and nurtured to ensure its long-term productivity due to is complex and fragile nature (Reganold, Papendick and Parr, 1990).To ensure sustainability of the farm, the farm must be able to produce suitable amount of high-quality food, protect its resources as well as being both environmentally safe and friendly (Reganold, Papendick and Parr, 1990). According to Rural Investment Support for Europe, (2014)the term (sustainable intensification) in agriculture which points to a multi-development path for all agricultural systems or farms practices, the trend of the path and the actions required to meet it will depend partly on the conditions, particularly the current agricultural productivity and environmental performance of a farm, the system there and farmer action. As explained by Singh et al., 2011),sustainable agriculture has to do with the successful management of agricultural resources to satisfy human needs and at the same time maintaining environmental quality and conserving natural resources for future. The essence of this definition is to state the importance of maintaining or conserving the natural resources for the long-term benefits for different generations in the future. Sustainable agriculture changes with time and so must always respond to the changes in its physical environment (Horrigan, Lawrence, & Walker, 2002). The concept does not embrace the total dependence on purchased materials which include fertilizers. It however relies on beneficial natural processes and renewable resources drawn from the farm itself (Reganold, Papendick and Parr, 1990). Current agricultural management activities have the capability of influencing the future agricultural management activities. So it is imperative to optimally use and manage soil fertility and its physico-chemical properties in order to ensure improvement in agricultural sustainability (Singh et al., 2011). Horrigan, Lawrence, & Walker (2002) were of the opinion that sustainable agriculture systems should be based on relatively small, profitable farms that use less off-farm inputs, integrate animal and plant production where appropriate, maintain a higher biotic diversity, underscore the importance of technologies that are suitable for the improvement of production, and make the transition to renewable forms of energy.

2.3 Tools of sustainable agriculture

Sustainable development indicators as tools in short-term decision support but it needs conceptual approach to the measurement and management social transformation and transition process that required to compliment the ideas that can be derived from the using of indicators (Adelle & Pallemaerts, 2005). According to Singh et al., (2011) decreasing supplies which come from irrigational water and other environmental concerns are a cumulative challenge that we face to meet the existing requirement for the growth of population. The authors suggested that technologies of microbial have been applied to various type of agriculture and environmental problems and challenges, environmental pollution by excessive soil degradation and erosion and water transport for chemical, fertilizers and pesticides and sediment to ground and surface water. In essence the microbiologist and microbial ecologist can enhance the nutrient recycling and produce bioactive materials and compounds such as vitamins, enzymes, and hormones that increase the soil quality, growth of the crops, yield and environmental productivity, promote plant growth by using the recent interest in eco-friendly and sustainable agricultural training and practices with bio-fertilizers and bio-pesticide (Singh et al., 2011). The soil microbial biota is one of the sustainable agriculture practices or tools, and it considers dimension to optimizing the soil and crop management practices such as an organic amendment, conservation tillage, crop rotation, crop residue recycling soil fertility restoration, bio-control of plant disease, and maintenance of soil quality.

Csathó & Radimszky (2012) in their study have indicated the role to keep the soil sustained by using sustainable agriculture and NP turnover. It was applied on 27 European countries to explain that instead of some agronomic factors such as NP concentrate or status, added farmyard manure also the per capita gross domestic product and population density were the major factors that affect the magnitude of organic and mineral NP application. The study mentioned that the countries with the highest livestock densities do not take into account previous farmyard and application and the soil P status as mineral NP dose diminishing factors (Csathó & Radimszky, 2012). Corviniensis, Vii, & Ir, (2014) concluded that only organic farmers who can succeed in ecological agriculture and the worldview of their lives, who truly believe that organic products are healthier, safer and more positive than traditional ones, believe they really contribute to protecting the environment, Natural assets and who want an alternative to conventional agriculture based on chemicals. The study concluded that pressure should be reduced to maximize profit during eco-policy formulation; farmers must accept (theoretically) that the creation of a quality environment (including animal welfare, gentle landscapes, and safe food) is to prevail over profits and to that end, to lower profitability. Profit should be seen as the end result, most importantly when quality of life in improved. Those farmers who first put environmental production down and reduce productivity and profitability want to boost their financial resources, which they see as shaky in the absence of direct financial assistance.

The biggest problem for ecological agriculture is the lack of proper processing facilities and slaughterhouses. The slaughterhouses and treatment facilities can carry large labor and thus can reduce unemployment. The promotion of eco-agriculture can promote the expansion of product breeds, which will bring more eco-farmers to consumers, thus the number of farmers who can only traditional market will a majority of their products, and the growth of ecological livestock breeding a farmer can help solve the problem of soil fertilization of plant production.

According to (Mészáros, Landert, Sipos, Schader, & Podmaniczky, 2015) there is no assessment tool for the farm and that agriculture sustainability has been adjusted to the Hungarian circumstances which can measure all aspects of sustainability. However, current sustainability tools are often limited to select aspect of sustainability, also social and economic sustainability was as a matter of fact not measured and no selection method was applied when selecting test farms. The goals of this study to evaluate and measure the sustainability performance of farms in Hungary and to compare the sustainability performance of conventional and organic farms, the methodology of this paper by selected of the sustainability assessment tools and then indicators analysis with the expert involvement, the result of the study was selected the farm process which named (SMART) as sustainability analysis and assessment.

Box & Padula, (2016) indicated in their research which is written by the European Commission on agriculture and rural development, the common agriculture policy emphasizes the priorities of restoring, preserving and enhancing the ecosystem and developing viable farms, increasing and improving economic performance to increase the sustainability of the Hungarian farms and securing the supply of safe, affordable and quality food for the Hungarian citizen and through that to also respond to market difficulties, knowing the Hungarian agriculture characteristics and adding value with quality schemes.

Whitehead, MacLeod, & Campbell, (2020) in their study on comparative analysis of agricultural sustainability tools mention the assessment tools (The New Zealand Sustainability Dashboard Project (NZSDP) were developed between 2012 and 2018. According to the authors, each of the tools had some specific needs they addressed and did come with a common theme that all supported sustainability assessment and reporting system (Whitehead, MacLeod, & Campbell, 2020).

Sustainability tools can be used to help an entity perform an action in any stage from monitoring, data gathering and communicating performance (Whitehead, MacLeod, & Campbell, 2020). A single tool may either perform single function for specific task or multiple functions for wide-ranging requirements. (Whitehead, MacLeod, & Campbell, 2020). Tools are developed to suit the relevant needs of decision-makers, and this is done to ensure smooth adoption and implementation for desired results (Van Meensel et al., 2012). The nine tools developed by the NZSDP project are as follows (Whitehead, MacLeod, & Campbell, 2020).

1-Power analysis tool

This tool looks at the power of different monitoring designs and to detect trends in data monitoring. It also helps to recognize cost-effective designs to meet specific goals

2- Materiality assessment

This tool also gets its data from the internet searches. This is to measure saliency for different sustainability issues and according Whitehead, (2017) the initial development for this tool was in 2016.

3- Choice modelling

This tool was first used in 2016 and the purpose was to determine strategies for setting sustainability targets. It was also experimented in a workshop with the Beef and Lamb industry

4- Wine industry – Benchmarking tool

This tool provides an interactive visualization of sustainability assessment data especially vineyard and winery. The tool was developed by industry with assistance from researchers and the operators for the tool are individual farmers and processors.

5- Ngāi Tahu – Kohuratia

According to the authors (Whitehead, MacLeod, & Campbell, 2020) Kohuratia is a best practice farm sustainability assessment tool for Māori Trusts, Rūnanga (sub-tribes), and Incorporations. There are different users of the tool, as they span from farmers to executives and board-level governors.

6- Irrigation tool

It's a dashboard provided online which allows dairy farmers to comply with local regulations. The tool further makes it possible for farmers to record non-regulatory sustainability information. It was developed by the industry which was assisted by researchers. The main users of the tool are farmers

7- Kiwifruit industry – Assessment Tool

This assessment tool was mainly designed for the kiwifruit industry. Thus, a customized software solution developed by the NZSDP and was developed and tested from 2015 to 2017. Apart from the kiwifruit growers other users are packhouse operators and marketers.

8-Biodiversity tool

This tool makes it possible for farmers to assess and report on their farm management actions in respect of their biodiversity results. This tool was designed to purposely deliver a user-friendly tool that met multiple biodiversity monitoring and reporting needs.

9- National dashboard tool

This tool enables the visualization of sustainability data form a wide range of international and national sources. It collects data from large scale databases such as the World Bank. It was advanced by researchers with the intention of usage by several groups from government policy analysts to industry leaders.

One of the importance of sustainability tools is to provide an instrument for the implementation of sustainability frameworks on different farms (Whitehead, MacLeod, & Campbell, 2020). Bartzas G. and Komnitsas K. (2020) identified some sustainability assessment tools in their research, these are the following.

SAFA: Sustainability Assessment of Food and Agriculture Systems

IDEA: Indicateurs de Durabilité des Exploitations Agricoles

MOTIFS: monitoring tool for integrated farm sustainability

SMART: sustainability monitoring and assessment routine

SAEMETH: Sustainable Agri-Food Evaluation Methodology

2.4 Factors of sustainable agriculture

It is argued that agriculture becomes sustainable when natural resources are effectively managed properly to prevent the emergence of pollution, land degradation and negative climatic conditions (Ahmadpour, 2016). Sharghi, Sedighi and Eftekhari (2010) in their study on effective factors in achieving sustainable agriculture conclude that there are three major factors that help in achieving sustainable agriculture. These include; the needed attention for sustainable agriculture through research and extension bodies, interaction among the relevant bodies, and farmers must be seen to be the basic building blocks for sustainable agriculture. Communities that are in the areas earmarked for sustainable agriculture must be encouraged to take part in sustainable agriculture as well (Ahmadpour, 2016).

It is critical to understand the importance of soil in order to fully grasp the rationale for sustainable agriculture (Reganold, Papendick and Parr, 1990). This is because soil should not be misconstrued to limit its function as just another instrument of crop production. It goes far beyond that. The study of (Kniivilä, Mili, & Mekki, 2013) identified the most important factors of sustainable agriculture and forestry in Egypt, Morocco, Tunisia and Turkey to include the resources and its productive function and the environmental degradation and its impact on land, soil and water, and its direct economic and social consequences on employment. The authors added that it considers biodiversity as the most important factor affecting sustainable agriculture in the long term, finally, the study also considered the factor of cultural values as an important and influential factor, the study was based on the review of existing literature and country level analyses.

2.5 Goals of sustainable agriculture

One of the goals of the sustainable agriculture movement is to create farming systems that alleviate harms to the environment which are usually associated with industrial agriculture (Horrigan, Lawrence, & Walker, 2002). Vasilevski (2003, p.179) also mention the goal of sustainable agriculture to include the effective utilization of fertilizers, chemicals, manure efficiency by using "soil testing, innovative crop management techniques, integrated pest management, use of natural growing regulators and bio stimulators and control of water and air pollution". Fertilizers that are meant for agriculture purposes are to be used efficiently. It is also essential to point out that as mentioned earlier sustainable agriculture has the objective of ensuring chemical and manure efficiency. This this happens there is the likelihood that these little chemicals and manure can be used for a long term. A lot of long-term interest is giving by a sustainable agriculture and this includes preserving topsoil, biodiversity, and rural communities rather than only short-term interests such as profit (Horrigan, Lawrence, & Walker, 2002). The preservation of the topsoil and the rural communities alike are going to ensure a long-term survival of agriculture.

Feher & Beke (2013) stated that there three (3) wide-ranging goals for sustainable agriculture. These they mention as stewardship of the environment, long term profit and realization of social and economic equality. Stewardship of the environment is essential to maintain the life of the environment. It is explained as the responsible application of natural resources in such a way as to “balanced account of the interests of society, future generations, and other species, as well as of private needs, and accepts significant answerability to society” (Worrell & Appleby, 2000, p. 263). Maintenance of the environment has been a long-standing intention of modern agricultural. Secondly, long-term profit is important to keep agriculture going for the long foreseeable future. When profit is made, it ensures that most of the factors of production like people, land, machines and other resources are adequately maintain. This helps to ensure continuous existence of agriculture. Social and economic quality of the society is also essential to maintain the quality life in the long-term. In essence, the three goals mentioned by (Feher & Beke, 2013) are inter-related in terms of achieving sustainable agriculture. Pretty, (2019) mention some of the goals of sustainable intensification agriculture to include:

1-Resource efficient agriculture which will invariably achieve a significantly higher environmental performance.

2-Productivity of crops would also be improved as well as those of animals.

3-The leakage of nutrients is also expected to reduce. It is also aimed at expanding the conservation output of agriculture.

It is instructive to note that Pretty’s work suggests the above goals as the goals for sustainable agriculture. The author indicated that resource efficiency in agriculture is important and this is quite important in achieving environmental performance. The productivity of crops is also essential as well as prevention of the leakage of nutrients and this would go a long way to enhance the expansion of the conservation output of agriculture.

Pretty (2019) adds that controlling insects, diseases and weeds without chemicals is also a goal of sustainable strategies, and the evidence for its feasibility is encouraging. Reganold, Papendick and Parr (1990) in their work on sustainable agriculture mention some of the goals of sustainable agriculture. They mention that sustainable agriculture would achieve the following goals when planned and implemented well. These goals are “to reduce reliance on fertilizer, pesticide and other purchased resources to farms; to increase farm profits and agricultural productivity; to conserve energy and natural resources; to reduce soil erosion and the loss of nutrients; and to develop sustainable farming systems”. Fertilizer and pesticide are seen to be chemicals that may not be able to help farming activities in the long run and this is largely because of the side-effects it may have on the soil or crops. Sustainable agriculture aims at reducing the over reliance on those chemicals. This is supported by Pretty (2019) who indicated the need to control insects and other diseases without necessarily using chemicals is an important goal of sustainable agriculture. Another goal the authors mentioned is profit. Profit as mentioned early on is always needed to keep an activity going. Agricultural productivity is also seen as important objective for sustainable agriculture. More importantly, the authors (Reganold, Papendick and Parr, 1990) also state that on the important objective of sustainable agriculture is the prevention of soil erosion and loss of soil nutrients. These two important things if not taken care seriously would lead to unsustainable agriculture in the long run.

Sustainable agriculture is viewed in the long-term goal which seeks to overcome problems and seeks to confront the economic viability, environmental soundness as well as social acceptance of agricultural production systems in the world (Pharm & Road, 1987). Pharm & Road (1987) adds that the main objective of sustainable agriculture is to develop farming systems that are productive and profitable, retain the natural resources in their right form, protect the environment as well as to enhance health and safety. Agriculture is needed to help eradicate hunger, poverty and all other forms of societal problems.

2.6 Dimensions and indicators of sustainable agriculture

According to Katona et al., (2005) there has been a key outcome of the Report to get an improved capacity to assess agriculture' s environmental performance. This has been achieved by building on countries' experiences, and through establishing a common framework, harmonized methodologies and data sets to calculate indicators; advance knowledge of agri-environmental interactions and linkages; and foster an exchange of national and international approaches and experiences in developing indicators. Katona et al., (2005) has mentioned that the indicators of sustainable agriculture serve many purposes, to give an idea or information on the current state of the farming environment to understand, know, and to monitor the impact between agricultural practices and their influence on the environment. It also helps to identify the key aspects of agri-environmental issues that related to agriculture sustainability in Europe and to provide information concerning the diversity of agri-ecosystem in the European union countries (Katona et al., 2005). It further aims to minimizing agriculture effects on the environment when the pressure is highest to the extent of responding to agriculture and rural development policies to the needy in order to improve environmentally friendly farming activities and sustainable agriculture. This contributes to the global assessment process of agriculture sustainability (Katona et al., 2005). The study also confirmed that agriculture has horizontal and vertical role so it can be considered multifunctional in agro-economy and in agribusiness to make harmonized between them. (Kovách & Megyesi, 2006) considered that the food supply chain is a significant building block for a new theory of rural development with attention on the specificity of the agricultural production and food market deriving from the socialist past, along with the influence of land re-privatization, land use, consumers' demand, multi-nationalization and retail-sale and globalization of food-processing industry.

Fehér and Beke (2013) mentioned that the most important period following the change of the regime in Hungary, was that there are three pillars approach to sustainability. The economic dimension of sustainable agriculture in Hungary links with the agriculture by the macro economy when its focus on profitability production and the financial opportunity; the social dimension of sustainable agriculture is clear by larger scale system of the organization and production appeared, leadership, and ideologists; The environmental dimension of sustainable agriculture focus on the industrial production system such as realizing heavily on chemical input such as synthetic fertilizers and pesticides.

This study (Reytar, Hanson, & Henninger, 2014) referred to measurable indicators of environmentally sustainable agriculture aimed at reducing the environmental influences of agriculture on the environment to guide the world towards a sustainable food future. The study also mentions that the indicators are able to guide decision-makers, policies, farmers, employers and civil society to better understand the nature of the current circumstances, set goals, identify trends and compare performance between regions and countries. This paper also answered the question "What are the most appropriate indicators for tracking progress?", The study identified three general stages of the "causal chain" of work that indicator candidates can represent or seek to influence the relation between the agriculture and the environment, such as public policy, farmers' practices, and biophysical performance. The indicators were limited to water, weather changes, land conversion, soil health, contamination of its nutrients, pesticides, and fertilizers, the study also reported that there is no indicator reflects the reality perfectly because each has limitations.

According to Valkó (2015)the indicator system for sustainable agriculture was compiled in the European Union, also the indicators for sustainable agriculture areas that reflect the performance of agriculture in specific areas were calculated, the "Sustainable Agriculture Index" which gives a brief assessment of the sustainability of agricultural production in the EU Member States, was developed with reference to an increase in the value of sustainable agriculture averaging between 2000-2010 as European agriculture moved towards sustainability (Valkó, 2015). The index values were towards the largest increase in the economy, while the lowest rate of growth in the environment was measured and there were significant differences between the performance of sustainability in the member countries, Hungary's sustainability performance was lower than the EU average in 2010 due to lower performance in the economy and society, therefore the recommendation was to develop Hungarian agriculture and rural areas in Hungary. The index of sustainability was measured by analyzing the spatial relations of the index using the spatial auto-correlation method, the result was a large spatial auto-correlation of the composite indicators in the economy and society and revealed spatial auto-correlation between them, on the other hand, there was a weak correlation between the indicators of food supply and the environment, so in these areas there is a smaller role for regional relations.

2.7 Measure of sustainable agriculture

From the work of Pretty (1995), the author remarked that "when specific parameters or criteria are selected, it is possible to say whether certain trends are steady, going up or going down". It may be near impossible to have an accurate measurement of sustainable agriculture but some important criteria could be set to provide some bases for measurement. Lynam and Herdt (1989) opined that sustainable agriculture could be measured by monitoring the changes in yearly yields as well as total factor productivity. This suggests that the trends in yields must be observed in periodically (annually).

Beus and Dunlop (1994) in their work provided a view for measuring sustainability to reflect the use of pesticides and inorganic fertilizers as well as maintenance of diversity. Hayati, Ranjbar, and Karami (2010) postulate that in order for sustainable agriculture to be effectively measured, a major requirement is the sustainable management of land and water resources. Land and water represent the two major factors that determine the effectiveness of agriculture in whole.

According to (OECD, 2001b)(which has been a key outcome of the Report to get an improved capacity to assess agriculture's environmental performance) this has been achieved by building on countries' experiences, and through establishing a common framework, harmonized methodologies and data sets to calculate indicators; advance knowledge of agri-environmental interactions and linkages; and foster an exchange of national and international approaches and experiences in developing indicators. The report concluded that the Indicators in terms of GHG emissions per unit of output could also be developed, which would add to the information and data on the economic efficiency of energy use in agriculture. The development of such indicators should consider an appropriate choice of units, for example monetary, energy or weight of dry matter.

In sustainability assessment the availability of time series data of regional data is essential because regional data would be needed more profound and elaborate analyses and lacking of regional data complicates specification of suitable policies and decision making (Kniivilä et al., 2013)**.**

2.8 Future and challenges of sustainable agriculture

Adelle & Pallemaerts (2005) have suggested that more work may be increased and needed to fundamentally rethink and restructure the sustainable development indicators (SDI) landscape in many important areas of the governance-related and cross-cutting dimension of SDI and organization of the existing indicators. The study furthermore, stated that indicators may need to be more developed to be able to assess progress on issues of transition management to achieve the objective of sustainable development (Adelle & Pallemaerts, 2005). Indicators depend on complex processes of social activities to be sure the transition from unsustainability to sustainability patterns in production and consumption.

Francis et al., (2008) argued that given the complication of challenges in agriculture and food, one objective is to commit more energy to transdisciplinary approaches which makes it possible to look at the whole picture in a systemic way. This they add that the systems approach addresses production, economic, environmental, and social challenges that must be resolved in order to produce food and maintain a habitable environment (Francis et al., 2008). There are different forms of challenges agriculture faces and as time passes on, more and more complex ones keep on coming,Aznar-Sánchez, Piquer-Rodríguez, Velasco-Muñoz, & Manzano-Agugliaro, (2019) contend that agricultural in its current form faces different challenges and among the challenges is the need to increase food production to meet the demands of a growing world population. As Aznar-Sánchez (2019) mentioned above these challenges has everything to do with increasing food production in order that the demands of the ever-growing world population would be met. The population of the world is increasing at an astronomical level and the need for survival has become even more important, thus the need for increased food production.

Adenle, Wedig, & Azadi, (2019) in their study on sustainable agriculture and food security in Arica noted that as a result of the growing sustainable development pressures such as food crisis and a change in climate conditions, international donors, governments and private sector actors gradually identify the necessity for spending on Research and Development (R&D) that is directed at specifically introducing agricultural innovations to address the challenges of different agricultural actors, including resource-poor smallholders. As noted earlier, food production has become vital to survival, and this has caused some crisis in food availability. Change in climate conditions has been hitting hard on agriculture and it continues to evolve as it shows no sign of ending soon. This has therefore necessitated the ever-reliance on research and development. R & D has the capability of introducing a more efficient and dependable forms of innovations into agriculture sustainability which will invariably help to address the challenges that may arise head on.

Chhachhar, Qureshi, Khushk and Ahmed, (2014) have noted the challenges of population growth, rapid environmental change and food insecurity and some of the notable challenges that could confront sustainable agriculture in the future. One of the challenges of sustainable agriculture has been related to the soil fertility decline. In this respect Nkomoki, Bavorová, & Banout (2018) noted that the challenge of growing agricultural productivity is mostly related to the soil fertility decline as a result of low adoption of sustainable agricultural practices. The soil fertility is seen as the most important element to sustainable agriculture. Once the fertility of the soil begins to decline, it affects food production and therefore makes agriculture unsustainable. It is highly important therefore that sustainable agricultural practices must be adopted to ensure continuity of agriculture production.

Fouladbash and Currie, (2015) was of the view, however, that the common obstacle to the adoption of sustainable agricultural practices has been land tenure insecurity. Some activities come up against the expansion of agricultural practices and the use of agricultural crops to produce biomass for biofuels is another increasingly widespread activity (Piquer-Rodríguez, Velasco-Muñoz, & Manzano-Agugliaro, 2019). The authors add that these practices compete for an increasingly limited area. Another area of concern is the loss of biodiversity which is associated with agriculture, as well as climate change (Piquer-Rodríguez, Velasco-Muñoz, & Manzano-Agugliaro, 2019). Francis et al., (2008) mentioned some major challenges facing the future of agriculture. These include fossil fuel and chemical dependence, monocultures and loss of biodiversity, dependence of most farmers on subsidies, potential disruption of a specialized production system, and inequitable distribution of food in the present system (Francis et al., 2008).

Adegbeye et al., (2020) also mention some challenges that could be associated with sustainable agriculture. They note thus, Ruminant greenhouse gas emissions, Environmental pollution of manure and agro industrial waste, agricultural wastewater and adaptation to climate change are the various challenges confronting sustainable agriculture. Environmental pollution has a direct effect on some factors of production such as land and labor (health of labor force). Singh, Pandey, & Singh, (2011) noted that when there is a decrease in irrigational water supplies as well as other environmental concerns worsens the challenges we face in meeting the nutritional requirements of the growing population

In order to ensure a rise in food security, it is imperative to maintain soil fertility and higher food productivity in respect of environmental challenges (Wagstaff and Harty, 2010). With this Lovo (2016) advocates for the critical role of adopting environmentally friendly sustainable agricultural practices (SAP) to maintain soil fertility. Pursuing environmentally friendly sustainable practices would seek to maintain or at least help to maintain agriculture production for a long period. Lovo (2016) further argued that when effective sustainable agricultural practices are pursued farmers are likely to be motivated by the soil fertility increase which would result in the rise of crop yields, food security and household incomes.

Sustainable agricultural land use could play an enviable role to contribute to solving some challenges, such as guaranteeing the food supply for all populations, promoting regional economic development, and contributing to the conservation of natural resources for future generations (Piquer-Rodríguez, Velasco-Muñoz, & Manzano-Agugliaro, (2019). It has been advocated by (Thestar, 2019) that some of the challenges farmers do face in their farming activities could be solved through the use of information and skills. It is argued that sustainable agriculture could be one of the best futuristic solutions which integrate technological advancements for efficient use of both renewable and non-renewable resources while keeping the overall system easy to implement and use (Rockström, J. et al., 2017).

However a study by (Kniivilä et al., 2013) reveals the following five issues as the major challenges for all studied countries:

1. Water availability for agriculture and water quality
2. Increasing the agriculture productivity and the gross value added in agriculture
3. Rural poverty also rural unemployment and employment
4. Desertification and soil degradation
5. Unbalance regional development also rural and urban inequality
6. Maintain the food security, urbanization and gender equality was not considered as one of major challenges for agriculture sustainability but still as relatively important, designing future policies for the agricultural sector in order to assess and to reach the current and evaluate the success of policies.

2.9 Sustainable agriculture and food production

Singh, Pandey, & Singh, (2011) noted an essential shift taking place worldwide in agricultural practices and food production. They argue that, previously the main driving force was to increase food yields as well as their productivity (Singh, Pandey, & Singh, 2011). Subsequently, the projections of demand for food and its corresponding supply points to the fact that production efficiency might be insufficient to meet future food demand without imposing additional environmental burden on the food systems (Davis, 2016). A sudden drop of food production is going to cause lots of problems especially in terms of the manipulation of food prices (Lobell et al., 2011). This would eventually affect the destitute and vulnerable in the society (Azadi et al., 2011). This could also result in scarcity of food around the world and may also lead to lots of death associated with hunger. It is mentioned in the work of Skaf, Buonocore, Dumontet, Capone, & Franzese, (2019) that the projection of world will reach 9.7 billion by the year 2050 (UN, 2017). As a result it is expected that the overall food production will increase by approximately 70% (FAO, 2009) (Skaf, Buonocore, Dumontet, Capone, & Franzese, 2019). Sustainable agriculture is essential in ensuring the consistent food production for the people. This is necessary to meet the ever-growing demand for food in the ever-growing world population. Sustainable agriculture involves successful management of agricultural resources which would be used to satisfy human needs and at the same time maintaining environmental quality and conserving natural resources for future (Singh, Pandey, & Singh, 2011). As mentioned earlier, the purpose of sustainable agriculture is to ensure long-term sustenance of food and the environment. When the environment is healthy for the long foreseeable future, it would in turn help to produce quality food for the world population. Even though the demand for food continues to surge higher, the global food production capacity even with the newest farming technology would gradually be limited by the availability of land (van Ittersum et., al. 2013). Shameer, Naika, Shafi, & Sowdhamini, (2019) stresses the need to know the link between sustainable agriculture and improvement in food production. When agriculture is sustained, food production is likely going to be affected positively. In the event that agriculture becomes unsustainable due to any remote or immediate causes, food production is going to be affected negatively. Food security is therefore essential for the long-term survival of humans. If effective sustainable agriculture practices are applied, food is going to be abundant in future, hence food security

There are four (4) main scopes of food security that have been identified by (FAO et al., 2017). These are 1) availability; the supply of food in an area, 2) access; the physical and economic capability of people to have access to food, 3) utilization; the proper consumption of food, and 4) stability; the sustainability of food production and supply (FAO et al., 2017). Of important notice here is that, to ensure food security, food must be available first (specific to geographic area). Secondly, people must be able to have access to the food, not only physically but their economic strength must be able to afford the food as well. Thirdly, food must be used for the right purpose and lastly the production of food and its corresponding supply must be maintained or sustained.

2.10 Sustainable Agriculture and food export

Pursuing export-oriented agriculture could be said to have increased agricultural productivity. Petridis et al. (2018) in their study found out that export promotion activities positively influence agri-good business across countries. Narayan & Bhattacharya, (2019) noted that a survey of the literature indicate that different approaches are applied in measuring the relative competitiveness in the exports of agricultural commodities. Zaman, (2020) argued that agriculture machinery is expected to increase food production, and which will provide a push for food export. Rising productivity has an important benefit of creating and entering new export market (SDSN, 2013). Sustainable agriculture targets rise in productivity and so if this is achieved export of food products is also achieved.It has been suggested that export competitiveness is hugely gauged through relative domestic and foreign country prices over time (Narayan & Bhattacharya, 2019). In a study by Zaman, (2020) on “Sustainable technologies in Agriculture Sector”, findings indicated that agriculture machinery mostly increases food production in terms of food export. Singh, Pandey, and Singh (2011) contend that an important share of the national income as well as serves as export earnings in different countries. It further ensures that food security and employment to a larger quantity of the population although farmers regularly complain of soil fertility decline (Singh, Pandey, and Singh, 2011). It has been mentioned earlier that improving soil fertility represents one of the important objectives of sustainable agriculture. When soil fertility is improved and sustained, agriculture is invariably sustained, hence food export.

2.11 Benefits of literature review

Literature review provides enormous information for a study. It follows that, this study provides some vital benefits of the literature reviewed for the purpose of the study. It enabled the researcher to get better comprehension of the subject matter at hand; sustainable agriculture. The clarity of the research is made possible due to the expansive review of the literature. It created the right path for the selection of important variables such as dimensions of sustainable agriculture, indicators of sustainable agriculture as well as Measurement of sustainable agriculture for consideration. The review made it possible for the researcher to identify some important tools used in the assessment of sustainable agriculture.

Extensive literature review provided the possibility of analyzing methods used in different studies. The review of the extant literature made it possible for the researcher to describe how the proposed research is related to prior studies. This ensured the creation of a clear path for consideration and as such enabled the researcher to choose an appropriate method for the study.

2.12. Research gaps

Many countries in the modern times are striving hard to maintain some level of consistency with respect to food production. This is as a result of the corresponding increase in the population of the people in a particular country. For some countries, the population increases at an exponentially higher rate than others. With this in mind, each country would likely have their own varied strategies for meeting the food needs of the growing population. Sustainable agriculture advocates for the interest in the current agriculture activities without necessarily endangering the future.

The key motivation for this study is focusing on sustainable agriculture, food security, food production and export with some details from farmers and food producers concurrently. The other motive for the research is to also look at sustainable agriculture indicators with regards to four dimensions. This is an improvement on the otherwise three (3) exhaustive dimensions (Environmental, social and economic) already mentioned in some studies. The additional dimension for this study is the political dimension. The political dimension must be regarded as important as the other three (3) dimensions extensively studied in other papers.

CHAPTER III.

RESEARCH METHODOLOGY

3.1 Overview

The purpose of this study is to examine the level of sustainable agriculture and food export in Hungary. The study further discusses the relationship between sustainable agriculture and food security. This study employed a quantitative research methodology to address the proposed research questions and hypotheses. This section presents a detailed discussion of the methodology for the study. The section is divided into nine. The first part provides research questions. The second aspect presents research hypotheses. Section three discusses the research methods. The fourth aspect indicates the research design. Section five describes the population and sample selection. Section six presents the instrumentation development. Section seven describes data collection procedures. Section eight discusses the data analysis techniques. The last part of this chapter discusses the validity and reliability of the instrumentation.

3.2 Historical overview of Hungarian sustainable Agriculture

Agriculture is one of the most important sectors of the Hungarian national economy. According to the Central Agricultural Office (2008), Hungarian agriculture is traditionally export-oriented, and most of its products can be found in almost all countries of the World. At the beginning of the 1870s, Hungary as the Empire's granary had already covered a great distance on its way to becoming an export-oriented agricultural economy. After 1870, export-induced agricultural development further accelerated and reached a new stage (Central Agricultural Office, 2008).

After 1870, export-induced agricultural development further accelerated and reached a new stage. Even if the driving force of Hungarian agricultural growth – export demand – remained the same before and after 1870, the level of market integration within the Habsburg Empire reached a new high during the 1870s, creating a nearly perfect environment for demand driven, market-oriented agricultural growth for the next two decades (Kopsidis, 2008). Kopsidis (2008) further explained the three developments that caused the customs Union between Austria and Hungary to include: declining prices on international grain markets outside of the Empire during the "grain invasion"; the "transport revolution" which created for the first time an Empire–wide, unified, domestic agricultural market, and third, the influx of Austrian capital.

Traditionally agriculture has played a significant role in the economy of Hungary than it has in most industrialized nations. After World War II the intensive industrialization had dramatically decreased the share of agriculture in the gross domestic products in most of the countries, but agriculture and food manufacturing in Hungary was recorded 15 percent and 20 percent of national income during the 1970s and the 1980s. Out of 9.3 million hectares of land in the country, 70 percent is arable and 19 percent is forest. Food and Agriculture Organization (FAO) data on the amount of arable land per capita for Hungary is one of the highest among the European countries. Most of its agricultural land is relatively fertile, and climatic conditions are favorable for temperate agriculture. The most important natural resource of the country is its fertile land. Thus, provide an essential basis for a strong food and agricultural sector (Csaki & Lerman, 2003).

According to FAO data between 1960 and 1989, the gross agricultural product almost doubled, rising an annual rate of 2.5 percent as compared to 1.7 percent for CMEA nations (Council of Mutual Economic Assistance) and 1.3 percent for the USSR. Even the crop’s yields and livestock products in comparison to many developed market economies and among all CMEA countries were the highest. Hungarian agriculture's comparatively strong performance was because of the innovative way in which central planning was administered in years between 1970 and 1980. With persistent attempts to reform and improve the performance of the socialist system of agriculture, Hungary was always considered at the forefront. The reforms in this period by the Hungarian regime asserted individual initiative along with the decentralized decision-making to a much greater extent than any other country with a socialist regime (Csaki & Lerman, 2003).

Hungary entered the transition phase after the collapse of the Warsaw Pact. During this transition phase, some important steps that were made about territorial decentralization and market liberalization analogous with the process of transition there was the process of privatization. Thus, it had changed the structure of agricultural farms and as a result, they become too weak to survive in the market. it is observed that market liberalization has negative impact on agriculture and rural areas particularly (Jazic & Joncic, 2017).

After becoming an EU member, the position of agriculture became complicated and the high expectations were not entirely fulfilled. The distribution of direct payments was one of the significant challenges. In the first years of Hungary as a member of the EU, in 2004 the level of direct payments progressively has been increased from 25% of the EU level. The high level of subsidies has increased the competitiveness of the agricultural products entering Hungary, which trigger unequal conditions for Hungarian farmers. Agricultural subsidies increased remarkably compared to past years. During 2004 and 2014 of Hungary’s EU membership, there were important changes in the production framework, the agricultural trade of agricultural production and the role of agriculture in delivering rural labor opportunities (Beke, 2015).

3.3 Research questions

In order to achieve the objectives of the study certain questions need to be answered. This section provides relevant questions for the study. Generally, the study seeks to ask questions pertaining sustainable agriculture, food production, food security and food export, as well as their respective relationships.

1. What are the indicators of sustainable agriculture of Hungary?
2. What is the effect of food production and food export with sustainable agriculture in Hungary?
3. What is the relationship between sustainable agriculture and food security?

3.4 Research hypotheses

In order to achieve the objectives of the study the following hypotheses are proposed:

1. H1: Sustainable Agricultural indicators have positive relationship with food security determinants.
2. H2: Indicators of sustainable agriculture effect has increased in Hungary.
3. H3: There is a positive relationship between sustainable agriculture, food export and food production in Hungary.

3.5 Research design

In order to get results for this study, quantitative research approach is employed. This deals with quantifying and analyzing variables using specific statistical techniques to answer questions like who, how much, what, where, when, how many, and how by utilization and analysis of numerical data (Apuke, 2017)**.** Quantitative research is used for testing of hypothesis, and to find out the cause and effect along with making the prediction. This traditional scientific research method generates numerical data and also used to find out the association between two or more variables, using statistical methods to test the strength and significance of the relationships (Apuke, 2017). To address the purpose and objectives of the study primary and secondary data is used.

Bird, (2009) mentioned that to collect the primary data a study needs to adopt the survey questionnaire method. Survey questionnaire is a common and fundamental tool to obtain information on sustainable agricultural practices in Hungary and how it has impacted its export of food crops. Close-ended questions are largely used in the questionnaire. Close-ended questions give respondents a limited set of particular responses to choose from. These questions are considered appropriate when the respondent has a certain answer to give and when the researcher has a limited set of answers in mind, when in detailed narrative information is not necessary or when there is a limited number of ways to answer a question, so these questions which are used in this survey research covered by four main types exist for close-ended questions which are Binary, Ranking questions, Multiple choice, and Checklist (Sreejesh et al., 2014).The questionnaire included the design to measure the variables of the study by using a five-point Likert scale. The scale ranges from 1= strongly disagree to 5= strongly agree. The questionnaire was electronically distributed to the selected group of respondents through email. Responses from 105 respondents were received and analyzed. The online survey was done between the period 15th January 2020 and 27th April. To be responsible, the research provided an option for the respondents to request for a copy of their responses in case they deemed fit.

This study adopted the survey questionnaire method to collect the primary data. Creswell, (2003) states that in general, researchers and scholars adopt a quantitative research often employ questionnaire method because it is considered an economical and efficient method to gather quantitative data concerned to a given population for the purpose of generalizing the result. Furthermore, Quantitative research commonly employs survey method as it is considered the most appropriate for collecting data (Creswell,2003). This study adopts a web-based survey for collecting data from the sample of the study. Online questionnaire was developed using Google-Forms tool. According to Grohmann and Kauffeld (2013) questionnaire is often used while adapting survey method. The online questionnaires were distributed through e-mail designed to collect the primary data from the Hungarian farmers and food producers.

To appropriately address the research questions and hypotheses, this study adopted the Statistical Package for the Social Sciences (SPSS) software version 23 and the Analysis of Moment Structures (AMOS) software version 24 to test the reliability and validity analyses, and descriptive statistical analyses. In addition, this research used Partial least squares structural equation modeling (PLS-SEM) in order to test research hypotheses. SEM is commonly used in the social sciences because of its ability to explain the relationships between unobserved constructs (latent variables) from observable variables (Robert, 2007). SEM is comparable to common quantitative methods, such as correlation, multiple regression, and analysis of variance to estimate and test the relationships among constructs.

One of the reasons for adopting quantitative methodology in this study is that the method is suitable for use in hypotheses testing of relationship between independent and dependent variables (Valkó, 2015; Rovira et al. 2015; Muema, et al. 2018;Dong et al., 2016; Fami, et al., 2007; Gaviglio, et al., 2017; Mavrogiannis et al., 2008).The purpose of this quantitative method is to verify the research hypotheses., a quantitative research approach is appropriate when specific hypotheses are tested, concepts are defined as distinct variables, procedures are standard, and analysis occurs using statistics, tables, and charts. This study meets these criteria. This study uses a primary data and secondary data to address the purpose and objectives of the study. This study adopted the survey method to collect the primary data.(Roy & Chan, 2012)states that in general, researchers and scholars adopt a quantitative research often employ survey method because it is considered an economical and efficient method to gather quantitative data concerned to a given population for the purpose of generalizing the result.

Furthermore, this study also employed the use of secondary data in an attempt to achieve the overall research objectives. Consequently, the collected data was subjected for analysis by using Gretl program (version, 2017). Results were summarized cointegration relations to examine the relationship between the variables, using VAR model, the study analyzed the dynamic relationship between Macroeconomic variables which have been chosen to be the link between sustainable agriculture and food security by the selection of some indicators of sustainable agriculture (Emission gas Greenhouse, Fertilizers consumption, Organic Farming, Agriculture Area).

In addition Principal Components Analysis (PCA) as a statistical multivariate methodology is used in this study because it makes use of large sets of data. This method reproduces a great proportion of variance among a big number of variables by using a small number of new variables called principal components (PCs). As a result components were extracted and rotated using the varimax method in order to facilitate the interpretation. High absolute values of loadings of the variables on the PCs imply that the indicator has a large bearing on the creation of that component. Thus, the research considered all the variables that scored more than 0.50 as being related to the definition of the component (Li & Wang, 2014).

3.4.1 Validity and reliability

Reliability and validity in quantitative research are essential in validating the results of the study. As a result both tests were conducted to measure the study instruments. Reliability refers to the extent to which an instrument measuring a phenomenon provides stable and consistent result (CarminesandZeller,1979). Validity shows the extent to which constructs are related. Before establishing the relationship between the dependent and the independent variables the scale must pass the test of reliability and validity. To pass the test of reliability a factor must have a value above 0.7 for Cronbach's alpha. The variables used passed the test of reliability. Construct validity and discriminant validity were also checked to confirm the overall validity of scales.

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CHAPTER IV.
Food Security and Sustainable Agriculture: A Case of Hungary

4.1 Abstract

Sustainable agriculture plays a vital role in the economies of both under-developed and developed countries. This role is more vital for agricultural countries. The first task is to achieve a state of food security for all the population through sustainable agriculture. Sustainable agriculture includes the investment of available natural resources, the employment of all potential opportunities for the rural population, and agricultural raw materials to increase agricultural exports in order to reduce the balance of payments deficit. The purpose of the study is to examine the relationship between selected variables that shared between sustainable agriculture by its indicators and food security by its determinants in Hungary in the long term, the descriptive analysis. This study was based on data collection and information that helps to accurately describe the problem and analyze it, will be used to deliver accurate results. The historical approach will be used to identify and analyze the reasons for the relationships among the variables, as well as the study of their direction and growth; the collected data was subjected for analysis by using Gretl program (version, 2017). Results were summarised cointegration relations to examine the relationship between the variables, using VAR model, the study analyzed the dynamic relationship between Macroeconomic variables which have been chosen to be the link between sustainable agriculture and food security by the selection of some indicators of sustainable agriculture (Emission gas Greenhouse, Fertilizers consumption, Organic Farming, Agriculture Area).

4.2 Introduction

Sustainable agriculture plays an important role to enhance food security and nutrition by increasing the quality and diversity of the food. It is considered an engine of economic transformation, added to the fact that agriculture is the major source of income (Godoy & Dewbre, 2010)for the majority of the population living in agricultural and agricultural areas. Sufficient income from agriculture is considered essential for all those working in agriculture because it is the one that directly secures their food requirements (HLPE, 2014).

Sustainability is considered to be an essential part of long term food security assessment dimensions, in order to reach the nutritional well-being, also affected by policies and programmes representing sustainability to increase food security in the future (Peng&Berry, 2019)(Berry et al., 2015).Ultimately, food security gradually and consistently enlarged to involve not only the food availability and food production but also its expansion to ensure explicitly and accessibility of food, simultaneously, live up to the present challenges without compromising the renewable resources and the continuity for future generation's sustainable development. Intensive experiences in different countries over many years indicate that agricultural development and economic growth are both necessary for the improvement of food security and nutrition. Also, sustainable agriculture can promote economic growth(HLPE, 2016), pressure on food demand is because of the rising population, an increase of stagnation in global crop production, environmental pollution. To meet more and more of a sustainable future food system needs a strategy in intensifying agricultural production and the extensification of the agricultural areas, which holds risk and opportunities. The integration of extensification, intensification, and decreasing food dissipation and changing diets with fewer animal products have significant advantages for the environment and human health (Hans et al., 2015).

Nevertheless, the issues facing sustainability and agricultural development are particularly complex (SDSN, 2013); what is needed for the most pressing matters is an integrated and long-term vision. Furthermore, This means examining thoroughly the dynamics of the agriculture sector, which necessitates the existence of a very comprehensive vision of the agricultural sector, including its relevance to overall economic development, natural resources, demographic, social issues, cultural issues, and all other trends that are influencing these sections in the long term. As a next step, the interactions between the three dimensions of sustainability (environmental, economic and social) should be secured, harmonized, and strengthened for future generation transitions. Therefore, it is essential to identify the pathways to minimize the adverse environmental, economic and social impacts of livestock and vegetation to promote beneficial impacts (Nations, 2015). Based on the early mentioned, the plant production and livestock sectors could serve as a miniature model for the broader agriculture sector to find the possible pathways for sustainable agricultural development for access to food security and nutrition (Reytar et al., 2014). The recommendations of food security and revealed determinants are the first responsible for food development and land policies and recommendations (Nighat et al., 2019). The purpose of the study is to examine the relationship between selected variables that shared between sustainable agriculture by its indicators and food security by its determinants in Hungary in the long term. Study the relationship and effect between variables conclude to effect of sustainable agriculture on food security. The variables used in the study were chosen based on their impact on sustainable agriculture and/or food security.

4.3 Definition and differences between Economic Growth and Economic Development

Most of the proponents of economic theories consider the economic development as a method that creates economic, social, quantitative, and qualitative changes, which in turn would make the national economy to raise its real national commodities in an aggregate and durable manner (N & U, 2015).

Indifference and in comparing with development, economic growth holds a limited meaning, an increase of the national income per capita, including the analysis, and especially in quantitative terms, of this method with emphasis on the functional relations through the endogenous variables; through a wider lens, it involves increasing the GDP, GNP, and NI (Kwong, 2009). Therefore, it is the national wealth, including the production capacity, expressed in both absolute and relative size, per capita, while also involving the structural modifications of the economy.

Economic growth is the way of improving the sizes of domestic economies, the macroeconomic indications, especially the GDP per capita, with a rising but not necessarily linear orientation. Additionally, leading to positive influences on the economic-social sector, while development illustrates how growth affects society by increasing the level of life (Haller, 2012).

4.4 **Definition of Sustainable Agriculture**

Sustainable agriculture is more than a specific methodology, and it is a wide-ranging concept. It includes both the advancements in agricultural management technology and practices ((Hochschule für Agrar- & Lebensmittelwissenschaften, 2015), and the growing recognition specifies that the conventional agriculture that was developed post World War-II would not be able to meet the needs of the growing population at the 21st Century (Singh et al., 2011), Studies of (Judit, 2013)(Veltenet al., 2015)categorized the definitions of the sustainable agriculture into four groups. The First group emphasizes on the maintenance of human welfare to make a situation for the future generation that it will not be worse than the present. The second group agrees on only emphasizing on the survival of the human race. The third group agrees with the concept of flexibility of the production system. The fourth group is of the noneconomic notion, which is the significant role in preserving the cultural heritage, societies, and maintains diversity through the ecological system. In sustainable agriculture, the focusing on methods and processes that are enhancing soil productivity while reducing the harmful effects on the environment, climate, soil, water, air, biodiversity (FAO, 2018)and human health, aims to reduce the use of inputs from nonrenewable sources and petroleum-based products, then attempting their replacement with those from renewable and clean resources, furthermore, to focus on local and domestic people and their needs, knowledge, awareness, skills, institutional structures and socio-cultural values.

Sustainable agriculture ensures that the basic nutritional requirements of present and future generations are and will be met, in both quality and quantity terms, providing long-term employment, a sufficient income, dignified and equal working, excellent opportunities and living conditions for everyone involved in the agricultural chains of value (Wörner & Krall, 2012). Ultimately, it lessens the agricultural sector's vulnerability in order to reverse natural conditions, climatic changes, and socioeconomic factors such as strong price fluctuations and different risks. Sustainable rural institutions have been boosted by sustainable agriculture that can encourage and augment the participation of all shareholders and promote the reconciliation of interests and benefits (Krall, 2015).

4.5 Food Security and the Sustainable Agriculture

In the opinion of the World Food Summit which held in 1996, Food security work out when whole people, at all times, they have material safe, economical access to enough nutritious and nourishment that use to meet their dietary of necessity and food preferences for an active and healthy life (EC- FAO, 2008;Stringer, 2016).

According to the EC-FAO, 2008 report, the main four dimensions of food security can be specified: (i) food physical availability, (ii) economic and physical food accessibility, adequate supply of food at the domestic or global level does not in itself ensure the food security at the household level, (iii)food utilization, which is recognized as the method the body makes all the different nutrients in the food and final point was the stability of food security dimensions for a while. Even though your food intake is enough today, nevertheless your food will be considered insecure if you have unsuitable access to food on a periodical basis, the chance of decline of nutritional status, drastic weather conditions, political mutability, or economic factors such as unemployment and food price rises, may have an influence on your food security situation.

Fuel or food? This question has often been discussed in recent years, energy, crops of fibre and food such as cotton regularly contend for arable lands. This is a potential threat to global food security, also accompanied by increased global demand for biofuels, population growth, and demands for the highest quality food and nutrition. Speculation, all these conditions led to a rise in food prices where attention was considerable and notable in 2008 when social and political unrest broke out in many countries (Krall, 2015).

Biofuel has been considered a better in-utilize carbon footprint than fossil fuels, which makes it seems some more sustainable, but the closer view detects that its output highly resources and utilizes the soil and the water. Biofuel production in the cultivation of a single crop in a given area affects the variety of agricultural methods and biodiversity. Rainforest deforestation and the overindulgent use of fertilizers for increasing energy crops will reduce biofuels' carbon footprint (Krall, 2015).

In addition, sustainable farming practices and tools can create a career and increase the income in rural areas, which in turn share into raise food security. The advantage is to layout the land use and production by methods that enable plants and food to be produced in a sustainable way for energy and other critical use, so food crops and producing energy as parallels, beside by-products and residues efficiently. Nevertheless, increasing the world's steadily population must clearly take a particular place and priority (Deelstra &Girardet, 2000).

The same status goes to the raising of the growth of animal feed because the global demand for the meat is significant; a worldwide output that provides the world's increasing population increased four times between 1963 and 2014 and predicted to increase by an additional 50 percent by 2050. Pigs and poultry are mostly fed on cereal and soy, that considerable amounts are also used, with forages, to feed both dairy and beef (Richter, 2016).

Almost 40 percent of the cereal consumed and wasted around the world ends up for cattle, and feeding troughs, so more than 70 percent of land put to use for the farming globe is used for domestic animal breeding and feeding. However, the large number of the lands used for livestock breeding is adequate only for this objective, such as the pastureland used by nomads in some regions, so meat consumption can consequently help to secure the nutrients for the earth's population by the future.

4.6 Indicators of measuring economic development

The measures of economic development vary according to different development concepts, and growth indicators such as income or national products are not valid, because they are a quantitative measure. What is needed is the non-standard measurement, where it is difficult to measure development, for it includes social variables that are difficult to evaluate, such as the fairness of income distribution (Ray, 2012)

1. The Physical Quality of Life Index (PQLI): A composite social indicator reflecting the average of three indices: life expectancy at birth, literacy rate, and infant mortality rate (Ray, 2012).

2. KOSOV scale: According to this scale, it is possible to distinguish between two indices, the first of which is the growth index expressed as the growth rate of the gross product, the second is the development scale expressed as the growth rate of the gross product, in addition to the degree of change of the economic structure towards the most vital sectors.

4.7 The main indicators which linked food security with sustainable agriculture in Hungary and OECD countries

4.7.1 Food indicators

The security of supply, which is the production of an adequate amount of food and fibres, is covered by indicators of export and import of agricultural products and production value of food processing within the processing industry. Although in the context of security of supply, the free trade in the European Union seems to be less important to meet its own needs, situations may arise for example natural disasters, when it can be of strategic importance, the 'food volatility index indicator is also linked to the issue of giving producers and consumers greater security when food prices are stable (KSH, 2017).

Food safety and food quality are linked to indicators of 'organic farming in proportion to agricultural land used and 'cultivation of genetically modified crop products in proportion to the utilized agricultural area. While the health of foods produced in organic farming - chemically free - is not disputed by experts (although there are some main fungicides that are more common in organic food in the absence of plant protection), the production of genetically modified plant products is shared by both experts and public opinion. Among the arguments that lie next to it is that in order to provide for the rapidly growing population of the Earth, there is a growing need for yields that can be achieved by the cultivation of genetically modified plants, and fewer chemicals are used for their production, and it is primarily about not knowing the full effects on the human and animal organism. The EU is increasingly united against the production of genetically modified plant products, which is why I have included the indicator in the indicator system. Food safety is also linked to the indicator of "microbiological, food-borne diseases per 100,000 people, which is a proxy indicator for the "food safety performance" of agriculture and the food sector, additionally to the inclusion of "per capita annual average consumption of vegetables and fruits", which covers the topic of healthy nutrition, the ratio of exports of processed food and agricultural products would have been a good indicator, but no suitable data source was found for this indicator.

The share of organic farming in the agricultural area used has increased, Austria ranked first in the ranking of countries (19.5%) in 2010, while the highest growth was recorded in Latvia and Lithuania. Hungary ranked 23rd in the ranking of countries in 2010, and the rate of growth of organic farming was also low in Hungary in Europe. In 17 European countries (including Hungary) genetically modified (GMO) plant products have not been cultivated in the decade under review, which is due to the ban on GMO crop production in most countries. In the EU Member States, GMO plant products increased from 0.2 % to 0.5 % between 2000 and 2010. GMO production reached the highest rate in Spain (3.2), the Czech Republic (1.4) and Portugal (1.3) in 2010.

The share of exports and imports of agricultural products (103) in the EU as a whole showed only a slight change between 2000 and 2010 (from 0.96 to 0.99), while the proportions of individual Member States have changed significantly. In 2000, Hungary had the most favourable foreign trade position of agricultural products in the EU, which reached the highest rate of decline over 11 years (1.5 in 2010). With this, Hungary still showed the third-best rate after Denmark and the Netherlands, and again in 2012, Hungary was the first among the EU member states. The largest growth occurred in Latvia and Romania. Among the EU Member States, small island states (Cyprus and Malta) are most in need of agricultural imports, followed by the United Kingdom and Finland in terms of the share of exports and imports (KSH, 2017).

The production value of food processing showed a slight increase for the EU as a whole between 2000 and 2010 (from 16.8% to 17.9%), while the share of the food industry has increased or stagnated in the older member states of the European Union, the decline in all of the newly acceding Eastern-Central European countries. The largest decrease occurred in Slovakia and the Czech Republic, while the most significant increase was in the UK and France. In 2010, the food industry reached its highest rate in Cyprus and Croatia, while the lowest in Slovakia and Sweden. In Hungary, the ratio decreased from 16.0% to 11.9% in the period under review.

The volatility of food prices showed a slightly different picture in time and space. For the EU as a whole, there was a decline between 2000 and 2005, followed by an increase after 2005, the most significant increase was seen in Slovenia and Germany, while the most significant decrease was seen in Italy, Poland and the Czech Republic. In 2010, the lowest volatility for Luxembourg and Italy, while the highest for Lithuania, Latvia, and Hungary and Slovakia were much lower than for the two countries (KSH, 2017).

4.7.2 Environmental indicators

Indicators of "greenhouse gas emissions per unit of value-added in agriculture and indicators of "ammonia emissions per unit of value-added in agriculture" are the emissions of agricultural pollutants. The nutrient balance of the soil is characterized by the indicators of "one hectare of nitrogen per hectare of utilized agricultural area" and "the proportion of organic manure used in total nutrient intake (N content)". The indicator "Sales of plant protection products per unit utilized agricultural area" is an approximate indicator of pesticide use (KSH, 2017).

The ratio of 'livestock and crop farms based on their standard output' is a form of sustainable agricultural activity. The 'change in the proportion of arable land within the utilized agricultural area' is an indicator from an environmental point of view shows an unfavourable change in the proportion of arable farming. Farmers' qualifications and agricultural training are concerned with the indicators of "standard output of a farmer with a higher education degree and the "proportion of graduates in agriculture and veterinary medicine as a percentage of all graduates". The inclusion of the two indicators was justified by the fact that the farmer with a higher level of agricultural education is presumed to be more attentive and more attentive to the environment. An instance ofthe latter is the use of water in agriculture - an important indicator of the environmental dimension of sustainable agriculture, but the quality of data for EU Member States did not allow it to be included in the indicator system - and waste agriculture. Indicators on soil erosion, soil quality and use of precision technology (KSH, 2017).

4.7.3 Economic indicators

Three indicators deal directly with efficiency, namely: "output per unit of intermediate consumption in agriculture" "gross value added per hectare of utilized agricultural area and the 'unit labour value added in agriculture' indicator. The three indicators look at the effectiveness of inputs, agricultural land used and labour used. The 'grain yield per hectare' indicator gives an overview of the efficiency of a country's agriculture through yields. The indicator of the "share of agricultural exports and imports” shows the competitiveness of the country's agricultural trade, the "non-utilized agricultural area for all agricultural products”, “Ensuring economic viability and profitability", the indicator "gross fixed capital formation in agriculture per unit of depreciation" provides an indication of the replacement of depreciated production assets, which is an essential factor in viability. An essential indicator of viability - the diversified activity of farms - is the indicator of "standard output of non-agricultural holdings as a percentage of total standard output". The research and development in agriculture” characterizes research and development as one of the conditions for viability. The age composition of farmers is also an essential aspect of viability as if the farmer population is ageing, and their place is not taken over by younger ones, it will harm viability. Information on this is provided by the indicator "Proportion of farmers under 35 years of age and over 65 years in standard output". "Agricultural income development" this indicator gives a general picture of the profitability of agricultural production. The viability of agricultural production, if the profitability of agricultural production is less dependent on subsidies, is addressed by the indicator "agricultural subsidies as a percentage of added value" (KSH, 2017).

4.7.4 Social indicators

The ratio of "per capita GDP in rural areas to national data" (401) is characterized by variations in the level of development of rural areas, while the indicator "per capita rural development support in rural areas" gives an indication of rural development support. The indicator "rate of change of the rural population" and the indicator of "dependency of 65 years of age on the rural population" deal with the demographic characteristics of the rural population that are important for sustainability. The 'employment rate in sparsely populated areas (20–64 years)' is an indicator of employment, while 'poor households in sparsely populated areas' and 'low-density housing in sparsely populated areas' Indicators of poverty and housing conditions. Indicators of "households with Internet access in sparsely populated areas" and "pollution incidence in residential areas in sparsely populated areas" characterize sparsely populated areas in terms of penetration of the Internet and subjective perception of environmental pollution (KSH, 2017).

Among the indicators of 'society' (improvement of the quality of life in rural areas, social justice, attractive rural environment and landscape design), the value creation indicator (the ratio of GDP per capita in rural areas to national data) is negligible; declined between 2000 and 2010 for the EU as a whole (from 78.7% to 77.4%). In 2010, rural GDP in the Netherlands and Italy was the highest in terms of national data. In the sparsely populated areas, the employment rate has hardly increased in the EU average between 2000 and 2010, from 66.1% to 67.1%. Growth was highest in Italy, while the largest decrease occurred in Romania and Lithuania. The highest employment rate in Sweden was reported in 2010, while the lowest in Hungary (58.9%, 60.4% in 2000).

The rate of rural development support per capita in rural areas increased from € 55.5 to two and a half, to € 138.9 per capita on average in EU Member States between 2000 and 2010. In 2010, the Netherlands had the highest per capita value, and the lowest in Croatia, while in Hungary it was 96.9 euros, which was below the EU average. The rate of change in the population in rural areas deteriorated from 3.45 to 1.19 between 2000 and 2010, averaged over EU member states, which led to a decline in the previous growth rate for rural population from 2009 onwards. The rate deteriorated most in Lithuania, while the most significant improvement was observed in Sweden. In 2010, the most favourable change in the rural population was characterized by Belgium and Luxembourg, while Lithuania and Latvia were the most unfavourable. Hungary was also among the developing countries: the rate of change of the rural population decreased from -3.9 to -7.3 in the examined period (KSH, 2017).

The proportion of poor households in sparsely populated areas decreased in EU member states between 2000 and 2010, from an average of 32.4% to 28.1%. It was lowest in the Netherlands, Austria and Sweden in 2010, while Bulgaria, Romania and Latvia had the highest poverty rates. In Hungary, the poverty rate declined between 2000 and 2008, then began to increase, reaching 34.7% in 2010 and 37.9% in 2012, above the 2000 level.

The proportion of households living in severe housing conditions in sparsely populated areas fell from 13.5% to 7.7% in the decade after 2000 for the EU as a whole. In 2010, the lowest rates were recorded in Belgium, the Netherlands and Ireland, while the highest rates were in Romania, Latvia and Hungary (19.1%) (KSH, 2017).

Indicator of the age composition of the population - the dependency ratio of those over 65 in the rural population, which measures the proportion of people over 65 years of age compared to the active age group, showed an unfavourable trend: from 26.7 to 28.5% in 2000 and 2010 EU average. In almost all EU countries, the value of the indicator increased during the period under review, most notably in Denmark. In 2010, Spain and Greece had the worst rural age composition, while the least-aged rural population lived in Slovakia, Ireland and Poland. The Hungarian rural population was ageing below the EU average in 2010; the value of the indicator increased from 21.7% to 24.4% in the period under review. Among the indicators of “society”, the indicators for Internet access, rural development support, housing conditions, environmental damage, poverty and employment are favourable for the EU as a whole. At the same time, population change, age composition and population are unfavourable in terms of gross value added in rural areas. (KSH, 2017).

4.8 Agricultural area and food production in Hungary

agricultural census (AC) until 2010 had been considered as 567 thousand private holdings and 8800 agricultural enterprises, the number of private holdings were decreasing between 2000 and 2007 and consequently the number of enterprises had attained a lightly increase (KSH, 2013).

The areas which were applied for agriculture have decreased by 300,000 ha, on one side portions of cereal take up to about 70% of all arable lands, and the significant cereals are maize and wheat. The average yield of maize 65t/ha and the wheat is 45t/ha, and other significant crops are potatoes, oilseeds, fruits, vegetables, and wine grape, on the other side Livestock accounts for 40% of the total agricultural production of livestock, 70% of cattle and cows, 63% of pigs and 50% of poultry are raised in farms (cooperative farms and companies). However, 86% of sheep are kept in individual farms, before moving, sheep were raised on larger farms (Burger, 2009).

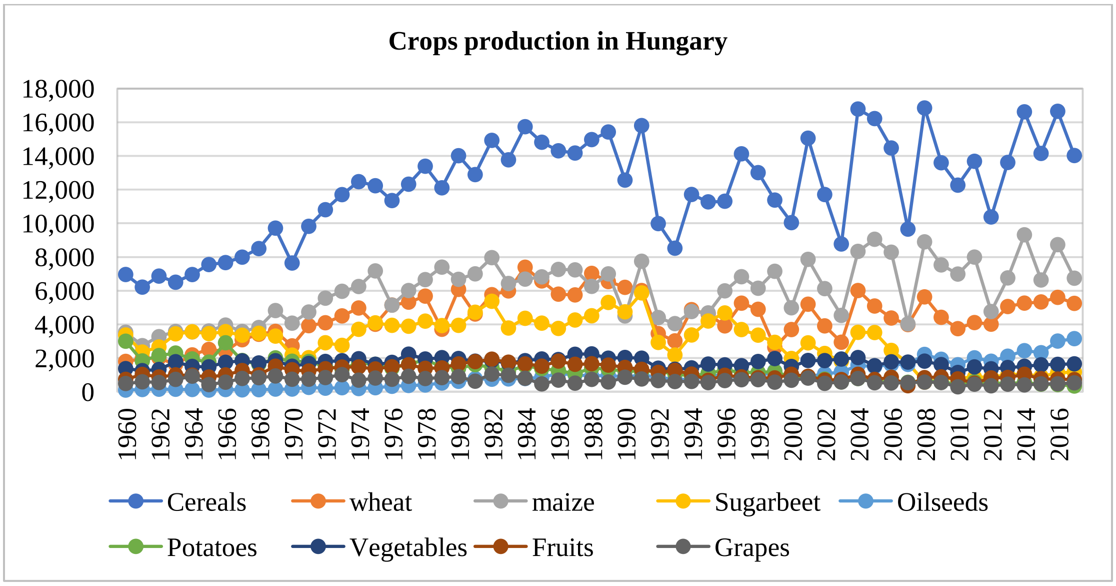

Figure 4.1 Crops production in Hungary from 1960-2016

4.9 Emission Gas Greenhouse (EGG)

Farmers usually want to produce and sell products, but GHG reduction is severe by this sense. It takes on an integrated and comprehensive food systems way (“from farm to fork”) will be essential to support coherent and harmonious changes along the entire chain included to promote more sustainability in agriculture, to healthier food, and finally to have an effective reduction of food waste through using ecosystem services, such as clean water bodies accountable and biodiversity in the same units with GHGs. Focusing on the debate about climate-smart agriculture, an integrated view of agricultural systems is complicated, but it is due, farmers and politicians require simple guidance, counsel, and advice (FMFA, 2018) Organic agriculture practices which have been provided to reduce GHG, the following points: animal waste, nutrient management, livestock management, soil management, crop management, crop legume rotation (WMO, 2004), sustainable agriculture and improvement of quality of environmental, will be at the forefront in realizing mitigation challenge and potential in agriculture.

4.10 Value added in the agricultural sector in Hungary

Despite the decrease in the key factors that connects agriculture to the macroeconomic, agriculture has a remarkable role in the economy. For example, after 1990 earlier economic inactivity shows a dramatic increase while labor intensification of agricultural activities declines, agriculture played a prominent role in Hungary even when the industry was highly preferred in the socialistic economic policy (Judit& Fehér, 2014). The changing of production and ownership coincided with the small role of domestic and foreign market opportunities after the transition, and there was a sharp drop in production, profitability and significant narrowing in financial opportunities (Judit& Fehér, 2014).

About 70% of the lands of the country is appropriate for agricultural production, while one-third of the terrains and soils are unfavorable for efficient and effecting farming and because there is a great part of the country is considered lowland (Burger, 2009).The role of agriculture in the national economy is the best characterized by the continuously shrinking share of agriculture in GDP, so in (figure 4.2) in 1990 the share of agriculture was 12.5% compared with it in 1985 which was almost 20% of GDP, in 2004 it was decreased to 4.5% and stayed nearly the same until 2017.

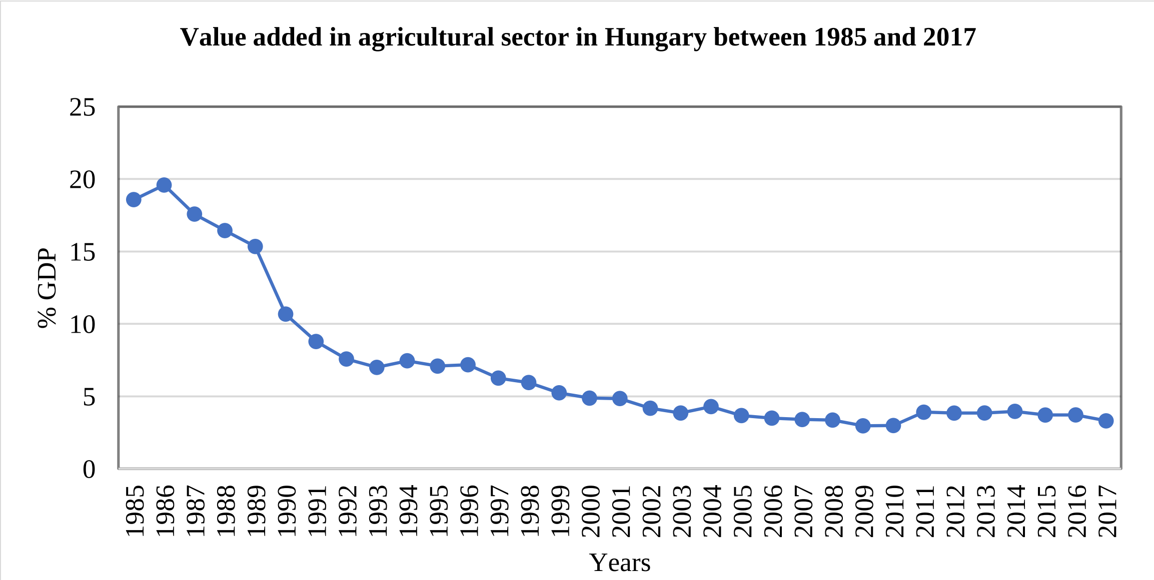

Fig 4.2 value added in the agricultural sector in Hungary

4.11 Fertilizer consumption in Hungary

Through the progressive reforms, the Common Agricultural Policy has improved European agriculture's market trends and orientations through the provision of income support and assistance to farmers. This helps to improve the integration and combination of environmental requirements, and fortified support for rural development as an integrated policy for the development of countryside areas across the EU. The same repair process has increased demands for a better distribution of support through and within the Member States, further to call for better targeting of measures aimed at addressing the environmental challenges and the increased market volatility (FE, 2012).

The worldwide challenge for farmers and their affiliates will be to increase production in a sustainable manner that reduces environmental impact and at the same time provides enough, safe, and nutritious products. Many believe that biotechnology holds the key to higher food production rates, but it is only one piece of the puzzle. The employment and further progress of many technologies (irrigation, equipment, pest control, fertilizers, and seeds) will be required to confront the challenge ahead while bridging the gap between actual and potential yields. Hence, the positive interactions between many advanced technologies carry the key. Nutrient management, practices, and fertilizer technologies are among those that demand continuous improvements because adequate and balanced nutrition is the basis for healthy crops (Stewart & Roberts, 2012).

According to (Mózneret al.,2012.), the world population grows, so there will be increasing demands for increased agricultural production. These demands exacerbate the difficulty of managing agriculture sustainably. The study showed the importance of defining so-called marginal productivity concerning the effective use of chemical fertilizers, also it concluded to that structural differences in agriculture have a significant impact on the calculation of biological capacity, and suggest a reflecting on how this indicator has been calculated so far. So it suggested that the long-term environmental impact of intensive agricultural practices should be built on the ecological footprint model; that is, the factors involved in national productivity must be adjusted when calculating the country's biological capacity.

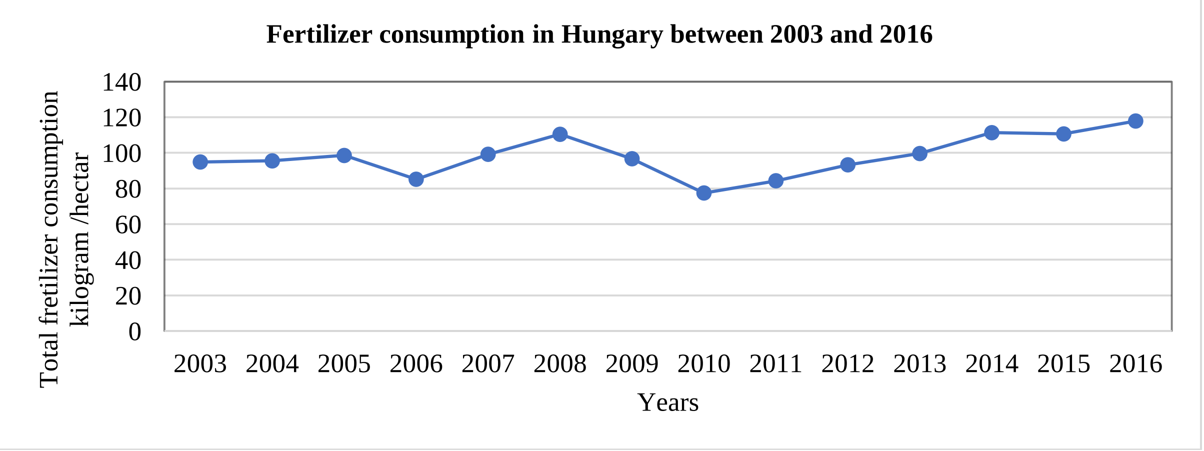

Fig 4.3 fertilizer consumption in Hungary, Source: Own author

4.12 METHODOLOGIES

Aim of the study:

The study was designed to examine the relationship between selected variables that shared between sustainable agriculture by its indicators and food security by its determinants in Hungary in the long term, Study the relationship and effect between variables conclude to effect of sustainable agriculture on food security, variables used in the study were chosen based on their impact on sustainable agriculture and/or food security.

Data Collection

The study uses observations of the term between 1980 and 2016 for seven variables. All variables are expressed in logs. Furthermore, the data sets were obtained from International Finance Statistics (IFS), Food and Agriculture Organization (FAO), the Statistics, Hungarian Central Statistic Office (HCSO), and World Bank (WB). The seven variables used in this paper are defined as follows:

1. Food production index (FPI): involves food crops which considered edible for human consumption and contain nutrients except for Coffee and Tea, because despite them being edible, they do not have nutrient value

2. Emission Gas Greenhouse (EGG): it is considered as an indicator of sustainable agriculture, defined in Metric tons of carbon dioxide equivalent (MtCO2e).

3. Real gross domestic product (GDP): is a measure of total production for the Hungarian economy, this variable is expressed in HUF million.

4. Fertilizers consumption (F): it is considered as a tool and indicator of sustainable agriculture. The variable collected is expressed in kilogram/hectare.

5. Organic Farming (OF): it is considered as a tool and indicator of sustainable agriculture, expressed in hectares.

6. Hungarian Population (P): the variable is regarded as an indicator for both sustainable agriculture and food security. This variable is expressed in million individuals.

7. Agriculture Area Hectares (AAH): it is considered as an indicator of sustainable agriculture, expressed in hectares.

Study Hypothesis

The study has one hypothesis, which is:

H1: indicators of sustainable agriculture and food security determinants have a positive relationship with each other's

Data Analysis

The collected data were subjected to analysis by using the Gretl program (version 2017, YEAR). Results were summarized cointegration relations to examine the relationship between the variables, using the VAR model. Regression and multicollinearity were applied to investigate evidence of variable impact on other variables. The invariable significant difference was determined under the P-Value < 0.05. The seven variables, which are macroeconomic variables, were chosen based on work of Metz and Thomson (1998) (Thomson &Metz,1998), Lemtouni and Aker (1999)[5] but in this model, the variables were chosen and replaced to represent food security and sustainable agriculture separately or jointly to study the impact of each of these variables on each other directly and indirectly on each of the food security And sustainable agriculture, given these variables are determinants and indicators for both terms, depending on the empirical model which outlined in Lemtouni and Aker (1999) (Lemtouni &Aker,1999) the food security has been considered as the dependent variable, but in this model food security has been represented by indicators which are common between sustainable agriculture and food security to investigate how these indicators or somehow determinates influenced by each other in long term years from 1980 to 2016. The food production index has been included because it's related to food production which is the main goal for getting ecologically and economically sustainable to meet the world need as well. The pattern of sustainable agriculture most chosen or practiced by local proponents is “organic agriculture” or “organic farming”. Organic agriculture is a holistic production system, which promotes and consolidate biodiversity, biological rotation, and soil biological activity, however, the link comes indirectly with GHG emissions depending on the farming system form(Hosam et al.,2011)at the same time food security has been as a response of the production aspect, the fertilizers which consider as an indicator of sustainable agriculture also consider as drivers to food production to reach the food security (Porteret al.,2014.)The using of RGDP is compatible with previous literature that uses income as one of the factors which affect food security, (see Ahmed & Siddique, 1995), Hungarian population reflects the increasing or decreasing population in a country.

4.13 Empirical Results

This section shows the empirical results of the data analysis, which begins with the summary of the unit root test the stationarity of the variables used to test the empirical study. Augmented Dickey-Fuller (1979) tests were employed. Table (4.1) shows that the variables expressed at the level are non-stationary but when all the variables are first differenced there is evidence that all the variables are stationary.

Table 4.1: Unit root test results

variable	Level		1st difference	
	No	**With**	**No**	**With**

	Trend	Trend	Trend	Trend
FPI	-0.147	-0.132	-0.010*	-0.032*
P	0.042	0.098	0.045*	0.044*
GDP	0.087	0.020	-0.031*	-0.030*
OF	-2.85696	0.032	-0.023*	-0.021*
F	-0.000	0.058	-0.033*	-0.058*
EGG	0.802	0.875	0.660*	0.635*
AAH	-0.074	0.078	-0.009*	-0.082*

*= significant at 5% *FPI= Food Production Index, P=Population, GDP= Real Gross Domestic Product, OF= OrganicFarming, F= Fertilizer, EGG= Emission Gas Greenhouse, AAH= Agriculture Area Hectares.

The next step is to test if there is a long-run relationship exists among the variables by using a cointegrating relations method. Table 4.2 presents the Johansen test for the cointegration relations among all seven variables, on the basis of trace statistics and the maximal eigenvalue statistics at 5 percent. The trace statistic reveals that there is one cointegrating relationship among seven variables. Since the trace statistic considers all of the smallest eigenvalues, it possesses more power than the maximum eigenvalue statistic. Johansen and Juselius (1990) recommend the use of the trace statistic when there is a conflict between these two statistics. Therefore, this result indicates that there is a long-run relationship between these seven variables. In other words, the variables have also cointegrated the equations of the VAR, including the lagged values of the variables in levels to capture their long-run relationships.

Table 4.2: Cointegration test results

Null hypothesis	**Trace statistics**	**Maximal eigenvalue statistics**	**Critical Values (5%)**	
			Trace	**Max-Eigen**
r=0	131.13	41.635	153.57	42.085
r ≤1	89.493	32.216	111.49	41.595
r ≤2	57.277	23.255	69.893	25.501
r ≤3	34.022	21.505	44.392	21.791
r ≤4	12.517	9.6242	22.601	13.151
r ≤5	2.8930	2.7557	9.4497	6.8504
r ≤6	0.13732	0.13732	2.5994	2.5994

The output of the regression is presented in Table 4.3 with several lags of the same variables, each estimated coefficient might not be statistically significant due to multicollinearity. The VAR result reveals the statistical and theoretical significance of the parameter estimate. The results show that population (p), gross product index, fertilizer (F), emission gas greenhouse (EGG), and agriculture area hectares (AAH) have a significant positive impact on food production index (FPI). In contrast, the results show that organic farming has an insignificant impact on FPI.

Table 4.3: Vector Auto Regressive estimates

Variable	FPI	P	GDP	OF	F	EGG	AAH
FPI_1	0.414	−0.004	−0.208	0.547	−0.142	1.738	0.023
	(0.311)	(−0.0002)	(0.340)	(−0.173)	(0.498)	(2.099)	(−0.061)
P_1	−4.029	1.327	−26.19	−49.62	−3.031	54.98	−1.803
	(8.288)	(−0.439)	(−10.34)	(44.63)	(4.480)	(−26.62)	(2.947)
GDP_1	−0.051	−0.0001	0.188	−0.110	−0.050	−0.109	−0.004
	(−0.0142)	(0.001)	(0.024)	(0.004)	(0.039)	(−0.321)	(−0.002)
OF_1	−0.116	0.0004	−0.530	0.368	0.0621	−0.181	−0.026
	(−0.191)	(−0.001)	(0.130)	(−0.072)	(0.136)	(0.087)	(0.008)
F_1	0.388	0.005	0.196	0.581	0.230	−0.247	0.088
	(0.053)	(−0.009)	(−0.228)	(−0.088)	(−0.111)	(−1.116)	(−0.002)
EGG_1	0.001	0.0007	0.745	−0.026	0.0261	−0.498	−0.003
	(0.024)	(0.001)	(0.773)	(0.103)	(0.0482)	(−0.366)	(−0.002)
AAH_1	−1.891	0.032	−0.075	−0.190	−0.217	−3.743	0.583
	(0.453)	(0.006)	(3.342)	(0.883)	(−2.202)	(−6.862)	(0.146)
R-squared	0.801	0.995	0.925	0.583	0.846	0.763	0.972
Adj. R-squared	0.663	0.991	0.872	0.292	0.738	0.597	0.953
Sum sq. resids.	0.158	0.0001	0.785	0.625	0.088	2.123	0.004
S.E. equation	0.089	0.002	0.198	0.176	0.066	0.325	0.015
P-value	0.0002	4.56e-20	2.86e-08	0.076	0.000	0.001	1.57e-1
Log likelihood	45.62	36.073	-142.732	167.413	-52.652	52.021	42.761
Akaike AIC	19.46	12.301	2.092	-0.301	0.715	12.541	3.098
Mean dependent	4.995	16.14	16.70	7.394	4.296	9.229	8.698
S.D. dependent	0.153	0.025	0.556	0.210	0.129	0.513	0.072

FPI_1= Food Production Index, P_1= Population, GDP_1= Real Gross Domestic Product, OF_1= Organic Farming, F_1= Fertilizer, EGG_1= Emission Gas Greenhouse, AHH_1= Agriculture Area Hectares.

4.14 Discussion and Conclusion

This paper analyzed the dynamic relationship between Macroeconomic variables which have been chosen to be the link between sustainable agriculture and food security by the selection of some indicators of sustainable agriculture (Emission gas Greenhouse, Fertilizers consumption, Organic Farming, Agriculture Area) and some other related variables (Hungarian Population, Real gross domestic product). Subsequently, to examine the effect of each variable in a long time series (1980-2016) through each other's, also the effects of those variables on FPI, In contrast, the GDP had a positive relationship with all variables except organic farming, which make the opposite side with the study (Nkomokat et al.,2019) of that considered the GDP affected positively with all macroeconomic and environmental variables.

The results showed that the data of variables which had been selected in this study depending on (Dick Fuller) tests, that all are stationary, also there is long term relationship between all seven variables. Furthermore, there is a significant positive impact of EGG, AAH, F, GDP, and P on FP, while the effect of on FPI was insignificant. The recommendation is increasing and improving organic farming with an effective method to reach the massive food production with sustainable products. The results indicate the positive relationship between greenhouse gas emissions and the use of fertilizers and the agricultural production index, where this result corresponds to the study (Mihaela et al.,2019.)of greenhouse gases that concluded a positive effect between greenhouse gases resulting from agricultural consumption and fertilizers, which explained this increase to the slow increase in the volume of irrigated agricultural lands. In the results as well, the relationship was negative in relation to organic farming with the rest of the variables. This is a logical result in respect of the relationship between the use of fertilizers and the agricultural production index positively, while the use of fertilizers was harmful with the production of organic agriculture because the fertilizers used are inorganic or the using extensively for non-biological fertilizers. This result is also compatible with the study (Mariangela et al.,2019.), which concluded that the emission ratios differ with the use of multiple-source fertilizers, which recommended the encouragement of the recycling of agricultural waste, thus preserving the soil from depletion and preparing it for more organic production. On the other side the positive relationship between growth population with the food production index, it will cause big challenges to maintain food security with the sustainability at the same time particularly with the vulnerable population, because of food insecurity occur when estimated per capita food consumption for a consumer at a certain income level shorts of nutritional target of 2.100 calories per person per day depending on(Thome et al.,2019). The food production should be increased more than the rising population, with sustainable ways to get sustainable agriculture and food security in parallel with each other.

4.15 Contribution of the Study

The study confirmed through research, analysis, and conclusion that the systematic path must be followed to obtain sustainable agriculture and food security achieved because many indicators and determinants of both are overlapping and affecting each other directly or indirectly. This leads the decision-maker who is the direct responsibility for both sustainable agriculture and food security should be in constant contact with the scientific research regarding both agricultural production and the environment with the increasing of research development in both fields.

CHAPTER V.

Evaluation of sustainable agriculture in Hungary

5.1 Abstract

Sustainable agriculture is the necessary means to achieve comprehensive development because it is an important source for improving agricultural production by quantity and quality in conjunction with maintaining the natural resource base and developing the farmer's awareness in environmental and social issues to achieve the main goal of maximizing the contribution of the agricultural sector to the GDP. The efficiency, impact and real existence of sustainable agriculture are examined by identifying economic, environmental and social indicators on some components of these dimensions., with the use of Principal Component Analysis (PCA).

Keywords: sustainable agriculture, environment, economic, social, profit, indicator, data analysis.

5.2 Introduction

Many institutions like EU-Commission for Agriculture and Rural Development are working together to find solutions and answers for insistent questions like how the earth is going to feed more than 2 billion people by 2025, and how we can do to promote sustainable agriculture (European Commission, 2012). The patterns in sustainable agriculture are advancing towards nearby endeavors, little scale, neighborhood markets and diminishing of synthetic inputs. Most of the time, the framework that accounts for horticulture still supports substantial scale ventures, agribusiness activities, and cross-outskirt development of, and centres around expanding awareness on crop variation. The most critical achievement elements to accomplish the sustainable, genuine execution of economical and organic farming requires instruction, cooperation localization, and limit building (UNDP, 2012).

Sustainable agriculture and sustainable development shared together to achieve a healthy and productive life in collaboration and harmony with nature, sustainability today must be a basis to progress to achieve the environmental availability, which is needed for the present and future generations by using the natural resources without degradation, damage or with the precautionary approach to protect and save the resources and the environment, encourage public awareness to make information about sustainability widely available. In addition to that, there is the need to get the scientific understanding, full participation of women and the interdependence of economic, environment and society at large (Ugurlu, 2016).

The concept of sustainable agriculture, in particular, is meant to combine and integrate the economic, social, and environmental dimensions of agriculture. This does not mean an artificial construct but a recognition of the fact that all these aspects collaborate. Even though it might be outstanding to have a particular piece of legislation, initiative or research project devoted to such dimensions of sustainability as soil preservation or technology of low input farming, sustainability demands that all government policies and all agricultural research meet the three components of sustainability (Weil, 1990).

Twenty-five years ago, Hungarian agriculture lost its status; the rapid growth of the world's population meant the need to increase food production because as it stands, one-seventh of the population is still starving, and the development of agricultural output and the food industry is the foundation for the development in rural areas. Two percent of EU agricultural products are produced in Hungary, which is far behind its potential. Agriculture, food industry and food exchanging can only enhance and develop together. Food manufacturing is a critical point in the product chain; it lags back the performance of European countries, and resources are insufficient as well. Long-dated collaboration between farmers and processors is also inadequate; the common organizations of the markets are minimal. Sustainability increasingly emphasizes the intensity of environmental and nature protection and at the same time, be appreciated. The agriculture and forestry sectors are not only appropriate for the production of food and other raw materials but they can also replenish the natural resources and have a useful effect on biodiversity as well. The problems can only be solved by taking sustainability into consideration (Szűcs et al., 2017).

In spite of the reality that sustainable agriculture estimation and assessment have been on the examination time table of numerous organizations for a long while, their real effect on strategies, practices, and results on the truth past pilot activities have been restricted. Manageability estimation and evaluation can possibly diminish the long haul chance and enhance the supportability plan well past (Häni et al., 2006). Agriculture is determined by a set of economic, social and environmental indicators because it reveals the influence of macroeconomic forces on agricultural and environmental relationships, rural continuity, biodiversity, the using of land changes, and the financial of agricultural resources, including farm income, public and private spending, farm management, environment, practices and various farming systems, organic farming, pests, soil, parasites and irrigation management (OECD, 2001a).

5.3 Sustainable Agriculture and its importance

The idea of agricultural sustainability was first recognized in 1798 when Thomas Malthus wrote the article "Principle of Population" that drew attention on the thoughtfulness regarding the gigantic populace development that could outweigh the capacity to produce food and could subsequently lead to starvation and war (Winch, 1992) which until the beginning of the 21st century, had not happened (Pretty, 2008). The growing demand for food can be met through technological development. Consequently, the constraints of growth and the detrimental impact of agricultural productivity have become an important point of controversy and analysis (Beke, 2013).

Sustainable agriculture is a "combined agricultural system by improving and enhancing plant and animal production methods to become environment-friendly and enhance productivity in the short and long term to be able to: 1. meet the needs of food and human fibers, 2. promote environmental quality, 3. operative use of non-renewable resources and farm, and the proper natural biological controls, 4. preserve the economic viability of agricultural productive operations, 5. progress the quality of life of farmers and society both together (Velten et al., 2015)**.**

Sustainable agriculture is helping to produce abundant food without polluting the environment or draining the piles of earth and world resources. It is agriculture that follows and uses the principles from and to nurture to promote and improve crop and livestock breeding systems that are, like nature, self-sustaining. Sustainable agriculture is also the agriculture of economic and social values during the production operation, whose success cannot be distinguished from life-like rural communities, the rich life of families on farms, healthy and sanitary food for all. In the first decade of the twenty-first century, sustainable agriculture is still defined as a set of accepted and agreeable practices in general or a typical perfect agricultural and environmental economics, in its beginning - more than an idea. Although sustainability in agriculture is linked to more global affairs and impacts on the world economy, dropping oil reserves, and local and international food security. The implementers were environmentalists, small farmers and a continuing cadre of agricultural scientists but not government policymakers. Because the aforementioned set of individuals had seen the devastation caused by agriculture in the late 20th century in the means of agricultural production ways - water, soil, air, and even food - and so began the search for better means to agriculture, an exploration and searching that continues to this day (Lancker & Nijkamp, 2000).

5.4 The goals for sustainable agriculture

Sustainable agriculture can sustain the economic viability of agribusiness by meeting the energy and food needs of both farms and consumers and strengthening the resource-base on which they depend. This can be done by emphasizing soil conservation, nutrient recycling, biological management of agricultural pests, conservation of biodiversity, assessment of knowledge and skills Farmers. Strong resistance to disturbances, market fluctuations and pest outbreaks, which makes the most efficacious use of non-renewable resources on simple and small farms and integration of natural rotation and the biological cycles and pest control tools into For daily production and agricultural practices habits (Menalled et al., 2008).

5.5 The requirement of sustainable agriculture

To be sustainable, agriculture produces fiber products healthy and of good quality foods while taking full consideration of the costs of production and environmental costs so as to maintain a price that reflects these costs. And not only the pricing, but the art to conserve and restore the natural resource basin agriculture depends, avoiding opposite on-site and off-site effects on the environment and any other sector of the society, being flexible in order to accommodate regional differences and changing economic, environmental and social circumstances such as drought or terms of trade, and be financially viable (Ogaji, 2005; Charles et al., 2014).

5.6 Making Sustainability measurable

How can agricultural sustainability be estimated? Switzerland's School of Agricultural, Forest and Food Sciences in Bern has developed the Response-Inducing Sustainability Evaluation (RISE) method to assess sustainability in purposes and universal ways as possible. RISE has been in use since 2000 and has been used by a range of organizations to evaluate several hundred farms of varying sizes. The Deutsche *Gesellschaft für Internationale Zusammenarbeit* (GIZ) GmbH has been using the RISE method since 2012. RISE aims to make the sustainability of the farm and communicable and measurable operations. It works in a single farm, by using interviews and collecting data to gather information about indicators of sustainability, such as soil using and livestock farming towards the economic, environmental and social dimensions, and then evaluate it. RISE supply a basis for advice on farming habit practices to the farms. Farms receive an evaluation of their sustainability so that the farm manager can take instant action to either improve or develop their sustainability. GIZ's use of rising has so far shown that farms sited in a single zone often have typical patterns, by analyzing few samples of development, representative groups, development cooperation programmes to identify and recognize the shortcomings and advisory improved strategies. Even though development cooperation typically includes family-run businesses, it often does not do especially well when it comes to sustainability. Economic terms like profitability, productivity, operations management, and ecological aspects (like management of nutrients and carbon footprint) are frequently in need of particular development. Family-run smallholder farms are not, therefore, necessarily more sustainable than massive operations. Further to helping to counsel farms, RISE can also supply valuable insights for political advice, since some shortcomings in sustainability are the consequences of the structural framework rather than of farm administration (FAO, 2013).

Sustainable agriculture is a multifunctional concept, so it is not easy to measure and make an evaluation(Wilson & Tyrchniewicz, 1995). Many different pieces of research (Lin et al., 2013; Latruffe et al., 2016; (Diazabakana et al., 2014); Fallah et al., 2018) used to evaluate and measure the sustainability at the level of the farm. Häni et al., (2006), mention that some researchers like (Keatt, 2015) used regression analysis to find statistically significant difference between farm-level data which provide the indicator to measure the performance of some sustained technology adoption but the regression analysis does not indicate causality, it only tests the relationship between many variables and estimates correlation and covariance between variables.

5.7 The indicators of sustainable agriculture in Hungary

Several global and national organizations have improved their regulations for sustainable development and indicators of sustainable agriculture. In addition, there are also many foundations and researchers who formulate many sets of indicators with different aims, objectives, structure, and methodology. Prior to collecting the set of indicators, they examined the key indicator systems available for sustainable agriculture (Eurostat, 2013; Stevens, 2011).

The indicators were chosen for the three dimensions separately and collected taking into consideration the attached requirements of indicators: – relevance, reliability, accuracy, – comparability, easy interpretation and good quality basic data. There are two possibilities of choosing an indicator for a particular topic such as using raw data (e.g. consumption and production of energy in agriculture), using a ratio (e.g. ratio of agriculture in energy consumption) and using a relative indicator (e.g. energy consumption per gross value added). When making a temporal comparison, pure raw data is the most appropriate indicator because there is no distortion and deformation of the information by other data. If our aim is a spatial or locative comparison, using raw data may be misleading since there is a considerable discrepancy between the different countries in the area and in production style. For instance, the indicator of energy consumption which uses a relative indicator like (energy consumption per gross value added) may not show the pressure on the environment properly and correctly. In a certain year, it may reduce since the gross value added increases due to the suitable weather for crop products however the energy consumption stayed the same. The same case, although less likely, to the ratio 71 type indicators. It may also be misleading and would not give the truth to compare the indicators of variable countries using raw data. The environmental performance of Hungary as regards the energy consumption of agriculture without using a ratio or a relative indicator that cannot be compared is a choice that has to be made when collecting an indicator set. Since our main aim is the temporal comparing, they usually utilize raw data and ratio style indicators in the compilation. In future research, this compilation or groups of indicators is intended to use as a starting point in developing composite indicators for sustainable agriculture dimensions. In the process of improving composite indicators, normalization will be carried out that makes the indicators spatially comparable, the essential data source is the database of Eurostat for the compilation of indicators in Hungary, the main goal is to compile similar data for the EU Member States for years. When choosing indicators, the availability of data is an important factor. There are indicators where time series were too short, for example, only 2010 data for soil cover and tillage methods, or some other indicators, the quality of data encounter as waste comes from the agriculture, 10-fold raise within 4 years for Hungary. In the case of the environmental expense, data are not available for the majority of member states. The result of collecting these indicators is twenty-six indicators related to the environmental dimension, fifteen indicators related to economic dimension and sixteen indicators related to the social dimension. Losing data usually handled by trend function of Excel in case a clear trend can be observed, or by repeating the first (or last) available data if data are volatile (Tóth et al., 2011).

5.7.1 Economic dimension

Fifteen indicators which are covered by the performance, gross value added and income created by agriculture. Foreign trade, the structure of the production, subsidies, research, and development are also from the indicator set. Prices were removed from the set of indicators because it is not relevant for sustainability. The volatility of prices could be a possible sustainability matter; proper methodology should be improved for this indicator. Data were only partially available for the wealth and resources of the agricultural sector in terms of machinery, buildings and land prices. Find the details in the table below;

Table 5.1 Indicators of sustainable agriculture for Hungary, economic dimension.

Code	indicator	Unit
EC_1	Output intermediate consumption in agriculture	
EC_2	Gross value added	Million Euro
EC_3	Gross fixed capital formation	Million Euro
EC_4	Export of agriculture products	Million Euro
EC_5	Foreign trade balance of agriculture products	Million Euro
EC_6	Agricultural income	2005=100
EC_7	Crop output /animal output	
EC_8	Factor income	Million Euro
EC_9	Output of non-agricultural activities	Million Euro
EC_{10}	Number of holdings with other gainful activities	Number of holdings
EC_{11}	Research and development in agriculture	Million Euro
EC_{12}	Subsidies in percentage of entrepreneurial income	%
EC_{13}	The total area under 20 ha /total area over 100 ha	
EC_{14}	GDP of rural territories	Euro per capita
EC_{15}	Entrepreneurial income /UAA	Euro per ha

Source: (Tóth et al., 2011)

5.7.2 Environmental dimension

Environmental information or data can be gathered according to the Pressures-State Response framework which developed by OECD. A wide domain and range of data are available for the pressures that are hurtful to the environment. These domains include emission of air pollutants, energy consumption, use of fertilizers and manure, sale of pesticides, irrigation and production patterns (livestock density, the share of arable land) sale of pesticides. Much fewer data are obtainable on the environment state (nutrient balances and bird index of farmland species). About the responses, data only occur on the participation and sharing in agro-environmental schemes and on organic farming. The twenty-six indicators afford a wide selection of information and data however some areas (tillage, landscape, waste generation, pollutant content of water and soil, landscape,) could not be enveloped in the indicator set.

Table 5.2 Indicators of sustainable agriculture for Hungary, environmental dimension.

code	indicator	Unit

EN_1	Final energy consumption in agriculture	1000 tonnes of oil equivalent
EN_2	Emission of greenhouse gases in agriculture	1000 tonnes of CO_2 equivalent
EN_3	Emission of ammonia in agriculture	Tonnes
EN_4	Emission of sulfur oxides in agriculture	Tonnes
EN_5	Emission of nitrogen oxides in agriculture	Tonnes
EN_6	Emission of non-methan volatile organi compounds in agriculture	Tonnes
EN_7	Emission of methan in organic	1000 tonnes
EN_8	Emission of nitrous oxide in agriculture	Tonnes
EN_9	Use of inorganic fertilizers –nitrogen	Kg /ha
EN_{10}	Use of inorganic fertilizers –phosphorus	Kg /ha
EN_{11}	Nitrogen balance per hectar of UAA	Kg /ha
EN_{12}	Phosporus balance per hectare of UAA	Kg /ha
EN_{13}	Use of manure per hectare of UAA	Kg /ha
EN_{14}	Sales of pestisides	Tonnes of active ingredients
EN_{15}	Irrigable area in UAA	%
EN_{16}	Water use in agriculture per UAA	M^3/ha
EN_{17}	Biomass production in agriculture	1000 tonnes
EN_{18}	Ratio low input farms	%
EN_{19}	Share of mixed crops –livestock farms	%
EN_{20}	Share of not utilised area in the agricultural area	%
EN_{21}	Share of arable land in UAA	%
EN_{22}	Livestock density (livestock unit /UAA)	Livestock unit /ha
EN_{23}	Grazing rate (livestock unit /fodder area)	Livestock unit /ha
EN_{24}	Bird index of farmland species	2000 =1000
EN_{25}	Share of UAA under agro-environmental measures	%
EN_{26}	Share of organic farming in percentage of UAA	%

Source: (TÓTH et al., 2011).

5.7.3 Social dimension

Data were available and utilized in the framework of indicators on farm managers with the observance of their age, education, and gender. Data were also used on agricultural education and the labor force used in agriculture. The indicators of rural development on the ratio of rural population over 65 years to study changes in population and the unemployment rate were selected as well. Extra data from income statistics in connection with thinly populated areas were inclusive in the system. Data were not available for infrastructural supply or subsidies and its quality and on food security and safety as well.

Table 5.3 Indicators of sustainable agriculture for Hungary – Social dimension.

code	**indicator**	**Unit**
SO_1	Share of farm managers with full agriculture training	%
SO_2	Share of standard output of farm managers over 65years	%
SO_3	Share of standard output of farm manager under 35 years	%
SO_4	Share of standard output of female farm manager	%
SO_5	Labor force in agriculture	1000 annual working units
SO_6	Share of graduated in agriculture and veterinary field as % of all fields	%
SO_7	Ratio of rural population over 65 years	%
SO_8	Rate of natural change of rural population	%
SO_9	Rate of net migration of rural population	%
SO_{10}	Share of households with the risk of poverty or social exclusion in the thinly populated areas	%
SO_{11}	Share of households with very low working intensity in the tiny population areas	%
SO_{12}	Share of household below 60% of the medium equalized income in the tiny populated areas	%

SO_{13}	Share of households with the housing cost overburden in the tiny populated areas	%
SO_{14}	Severe material deprivation rate in the thinly populated areas	%
SO_{15}	Severe housing deprivation rate in the thinly populated areas	%
SO_{16}	Rate of unemployment in the thinly populated areas	%

source:(Tóth et al., 2011).

According to (Waney et al., 2014), sustainable agriculture indicators in the individual farm briefly mentioned economic indicators which include productivity, cost of production, farm income, product quality, product price stability, marketing network and producer-buyer relationship. Also, the environment indicators which includes land preparation, erosion control, nutrient and soil fertility management, the use of fertilizers, intensity of land occupy, cropping system, weed control and pest disease control and the social indicators which includes local community engagement, resources availability and accessibility, supporting system accessibility, knowledge about resources conservation and stakeholders supporting.

Hypothesis

H1 – Indicators of sustainable agriculture effect has increased in Hungary.

5.8 Methodology

Study area

The study will be conducted in Hungary emphasizing on Agriculture which accounts for 4.3% of the GDP with the food industry occupying roughly 7.7% of the labor force. These two figures represent only the primary agricultural production: along with related businesses, agriculture makes up about 13% of the GDP. Hungarian agriculture is self-sufficient and because of the traditional reasons export-oriented. Exports related to agriculture make up 20-25% of the total. Almost half of Hungary’s total land area is the agricultural area under cultivation. This ratio is notable among other EU members; this is due to the country's favorable conditions including plains that make up about half of Hungary’s landscape and the continental climate. The problem of research is that Hungary is a country of important areas in Eastern Europe due to its geographical location i.e. as an intermediate between Eastern Europe and Western Europe and its agricultural importance. So, we should ask ourselves whether the agricultural land in Hungary suffers from a lack of exploitation despite the vast extension. Will problems limit the sustainability of agriculture in which throughout the year, reduces private problems related to agricultural production typically water, irrigation and methods of prevention and the availability of equipment and expertise of the peasants in the area of crop selection or mode of action.

2. Data Source

The study employs observations for the period of 1998 to 2016 for eleven variables used. All variables are expressed in logs. The data sets were obtained from International Finance Statistics (IFS), Food and Agriculture Organization (FAO) and the Statistics, Hungarian Central Statistical Office (HCSO) and World Bank (WB).

3. Data analysis technique

In this study, the empirical investigation used Principal Components Analysis (PCA). PCA is a statistical multivariate methodology used to study large sets of data. This method reproduces a great proportion of variance among a big number of variables by using a small number of new variables called principal components (PCs). Components were extracted and rotated using the varimax method in order to facilitate the interpretation. High absolute values of loadings of the variables on the PCs imply that the indicator has a large bearing on the creation of that component. Thus, we considered all the variables that scored more than 0.50 as being related to the definition of the component (Li & Wang, 2014; Jolliffe, 2002).

5.9 Results

As a result of the research in the theoretical part, the definition of sustainable agriculture was collected and combined, which was kept in mind during the implementation of the research objectives and the hypothesis which served as a theoretical framework for the established system of indicators. The indicator system of sustainable agriculture was gathered, and filled with data for the years 2000-2016 in Hungary. The established system of indicators is shown in Table 5.4.

Table 5.4: Indicators which used to evaluate the sustainable agriculture

Code	**indicator**	**Unit**	**Goal**
1	**Environmental diemention**		
EN_2	Emission of greenhouse gases in agriculture	1000 tonnes of CO_2 equivalent	_
EN_3	Emission of ammonia in agriculture	Mg/L	_
EN_4	Emission of sulphur oxides in agriculture	Tonnes	_
EN_5	Emission of nitrogen oxides in agriculture	Tonnes	_
EN_6	Emission of non-methan volatile organi compounds in agriculture	Tonnes	_
EN_7	Emission of methan in organic	1000 tonnes	_

EN_8	Emission of nitrous oxide in agriculture	Tonnes	_
EN_9	Use of inorganic fertilizers – nitrogen	Tonnes	_
EN_{10}	Use of inorganic fertilizers – Potassium	Mg/L	_
EN_{11}	Nitrogen balance per hectar of UAA	Tonnes	_
EN_{12}	Phosporus balance per hectare of UAA	Tonnes	_
EN_{13}	Use of manure per hectare of UAA	Kg /ha	+
EN_{15}	Irrigable area in UAA	%	_
EN_{16}	Water use in agriculture per UAA	M^3/ha	_
EN_{17}	Biomass production in agriculture	%	+
EN_{19}	Share of mixed crops –livestock farms	%	+
EN_{20}	Share of not utilised area in the agricultural area	%	+
EN_{21}	Share of arable land in UAA	ha	+
EN_{22}	Livestock density (livestock unit /UAA)	Livestock unit /ha	+
EN_{23}	Grazing rate (fodder area)	ha	_
EN_{24}	Bird index of farmland species	2000 =1000	+
EN_{26}	Share of organic farming	Tonnes	+
2	**Economic diemention**		
EC_2	Gross value added	Million HUF	+
EC_3	Gross fixed capital formation	Million HUF	+
EC_6	Agricultural income	Million HUF	+
EC_7	Crop output /animal output	Million	+

		HUF	
EC_8	Factor income	Million HUF	+
EC_{11}	Research and development in agriculture	Million HUF	+
3	Social dimension		
SO_5	Labor force in agriculture	1000 annual working units	+
$S0_9$	Rate of net migration of rural population	Million	+
SO_{16}	Rate of unemployment in the thinly populated areas	%	–

* "+" means a maximization goal, "-" means a minimization goal, Source: own research

Table 5.5 Principal components of the PCA on the environmental indicators

Variables	Components				
	1	2	3	4	5
Emission of greenhouse gases in agriculture	-.081	**.858**	.385	.274	.079
Water use in agriculture per UAA	.202	.463	-.328	**.733**	.075
Co2 emissi	**-.953**	.048	.135	.134	.145

on					
Emission of ammonia in agriculture	**.888**	.396	-.142	-.030	-.003
Emission of sulphur oxides in agriculture	**.823**	.106	-.417	.147	.228
Emission of nitrogen oxides in agriculture	.218	**.917**	-.111	.016	-.105
Emission of non-methan volatile organi compounds	**.917**	.228	-.220	.074	.158

in agriculture					
Emission of methan in organic	**.723**	**.541**	-.143	.277	.195
Emission of nitrous oxide in agriculture	.218	**.917**	-.111	.016	-.105
Use of inorganic fertilizers – nitrogen	**-.585**	**.744**	.130	.043	-.103-
Use of inorganic fertilizers – Potassium	**.803**	.447	-.056	.061	.016
Nitrogen balanc	-.219	.178	**.933**	.044	.035

e per hectar of UAA					
Phosp orus balanc e per hectare of UAA	-.241	.162	**.933**	.048	.025
Use of manur e per hectare of UAA	.049	-.116	.072	-.048	**.925**
Irrigab le area in UAA	.206	**.528**	-.232	**.745**	.109
Bioma ss produc tion in agricul ture	.251	**.898**	.041	.311	.026
Share of mixed crops – livesto	.291	**.826**	.096	.306	-.036

ck farms					
Share of not utilized area in the agricultural area	-.061	.283	**-.891**	.178	-.027
Share of arable land in UAA	**.848**	.192	.059	.135	-.114
Livestock density (livestock unit /UAA)	**.938**	-.011	.118	-.066	-.003
Grazing rate (fodder area)	**.676**	-.109	-.375	-.353	-.236
Bird index of farmland species	**-.927**	-.001	.160	-.139	-.184
Share	-.208	.079	.368	**.691**	-.285

of organic farming					
Eigenvalues	42.992	24.983	12.051	6.157	4.763
Cumulative explained variance	35.35	67.97	80.02	86.18	90.94
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.					

Source: own research

The economic indicators, the PCA carried on 6 variables of the economic dimensions of which 2 principal components with eigenvalues greater than 1 were retained for further analysis (Table 5.2). The first principal component (PC1) explains 72.22% of the total variance associated indicators: gross value added (.985), gross fixed capital formation (.743), crop output /animal output (.961), factor income (.961), and research and development in agriculture (.980). The values of the economic indicators of sustainable agriculture when relied on the results of the components with have more than 0.5 indicates the most important indicators. These important indicators have the most contribution, relevance, impact and importance to link sustainable agriculture to other variables in future studies.

Table 5.6 Principal components of the PCA on the economic indicators

Variables	Components	
	1	2
Gross value added	**.985**	-.020
Gross fixed capital formation	**.743**	**.579**
Agricultural income	.056	**.986**
Crop output /animal output	**.961**	.200
Factor income	**.961**	.200

Research and development in agriculture	**.980**	.131
Eigenvalues	77.17	18.46
Cumulative explained variance	72.22	95.64
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.		

Source: own research

Table (5.7) shows the Principal components of the PCA on 3 social indicators of which 2 principal components with eigenvalues greater than 1 were retained for further analysis (Table 5.7). The first principal component (PC 1) explains 46.88 % of the total variance associated indicators: labor force in agriculture (.928) and the rate of unemployment in the thinly populated areas (.732). The second principal component (PC2) explains 90.15% of the total variance associated indicators: rate of net migration of rural population (.955) and with opposed indicators: rate of unemployment in the thinly populated areas (-.584).

Table 5.7. Principal components of the PCA on the social indicators

Variables	Components	
	1	2
Rate of net migration of rural population	.095	**.955**
Labor force in agriculture	**.928**	.214
Rate of unemployment in the thinly populated areas	**.732**	**-.584**
Eigenvalues	50.05	40.09
Cumulative explained variance	46.88	90.15
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.		

Source: own research

5.10 Discussion

Principal component analysis (PCA) is a multivariate method that tests and analyses the observed data table which are described by various inter-correlated quantitative dependent variables. It aims to extricate the significant input from the statistically observed data to represent it as a group of new rectangular and orthogonal variables which called principal components. Furthermore, it also shows the pattern of likeness between the observations and the variables as points in spot and points maps (Wang et al., 2017).In this study, the indicators of the evaluation of sustainable agriculture were divided into three groups as they are divided into many studies and scientifically approved into environmental, economic and social indicators as well. Based on that, these indicators were chosen according to the availability of statistical data for each of them and thus the goal was defined for each indicator with the effect of an increase or decrease in sustainable agriculture as shown in Table (4). The PCA model is a distinct model in reducing a large number of indicators to be limited and strongly demonstrating the presence of indicators with high or high impact after entering data and obtaining results through the PCA model (Yu & Chang, 2000).

Principal components of the PCA on the environmental indicators totals of 22 variables. Five principal components with eigenvalues greater than 1 were retained for further analysis (Table 5). The rotated factor (Varimax) matrix of independent variables is also given in (Table5). The first principal component (PC 1) explains 35.35% of the total variance associated indictors emission of ammonia in agriculture (.888), emission of sulfur oxides in agriculture (.823), emission of non-methane volatile organic compounds in agriculture (.917), emission of methane in organic (.723), use of inorganic fertilizers –Potassium (.803), share of arable land in UAA (.848), livestock density (livestock unit /UAA) (.938), and grazing rate (fodder area) (.676). Its opposed indictors CO_2 emission (-.953), use of inorganic fertilizers –nitrogen (-.585), bird index of farmland species (-.927).

The second principal component (PC2) explains 67.97% of the total variance associated indicators: emission of greenhouse gases in agriculture (.858), emission of nitrogen oxides in agriculture (.917), emission of methane in organic (.541), emission of nitrous oxide in agriculture (.917), use of inorganic fertilizers –nitrogen (.744), irrigable area in UAA (.528), biomass production in agriculture (.898), and share of mixed crops –livestock farms (.826). The third principal component (PC3) explains 80.02% associated indicators: nitrogen balance per hectare of UAA (.933), Phosphorus balance per hectare of UAA (.933). Its opposed indicator share of a not-utilized area in the agricultural area (-.891). The fourth third principal component (PC4) explains 86.18% associated indicators: water use in agriculture per UAA (.733), the irrigable area in UAA (.745), and share of organic farming (.691). The fifth principal component (PC5) explains 90.94% of total variance associated indicators use of manure per hectare of UAA (.925).

The economic indicators, the PCA carried on 6 variables of the economic dimension of which 2 principal components with eigenvalues greater than 1 were retained for further analysis (Table2). The first principal component (PC1) explains 72.22% of the total variance associated indicators: gross value added (.985), gross fixed capital formation (.743), crop output /animal output (.961), factor income (.961), and research and development in agriculture (.980). The second principal component (PC2) explains 95.64% of the total variance associated indicators: gross fixed capital formation (.579), agricultural income (.986).

Principal components of the PCA on 3 social indicators of which 2 principal components with eigenvalues greater than 1 were retained for further analysis (Table 7). The first principal component (PC 1) explains 46.88 % of the total variance associated indicators: labor force in agriculture (.928) and the rate of unemployment in the thinly populated areas (.732). The second principal component (PC2) explains 90.15% of the total variance associated indicators: rate of net migration of rural population (.955) and with opposed indicators: rate of unemployment in the thinly populated areas (-.584).

Testing the second hypothesis shows that there is a positive relationship between sustainable agriculture and food export in Hungary. A regression analysis was applied to determine the impact of the independent variables on the corresponding dependent variable. This study was limited to identifying sustainable agriculture in Hungary by analyzing indicators only, and there is not any comparison between Hungary with other countries with regard to this field, which is distinct from the study of (Birovljev & Kleut , 2016).

5.11 Conclusions

The main aim of this paper is to evaluate the sustainable agriculture in Hungry and examine its impact on food export. Principal Components Analysis (PCA) was used to evaluate sustainable agriculture dimensions. The results of this study showed the significance of certain dimensions (environmental, economic and social) of sustainability of agriculture. In this paper, the environmental aspect within the model of sustainable agriculture represents five significant factors that can explain (35.35%, 67.97%, 80.02%, 86.18%, 90.94%) of total variation respectively. While the economic aspect presents two significant factorsthat can explain (72.22%, 95.64%) of total variation respectively. Finally, the social dimension represents two significant factors that can explain (46.88%, 90.15%) of total variation respectively. The findings of this study are limited to Hungary and cannot be generalized to other countries. Future research may include more countries.

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CHAPTER VI.

Sustainable Agriculture, Food production and Export: A Case of Hungary

6.1 Abstract

Nowadays, the sustainability of agriculture is an essential issue for many society components, starting from farming tools or practices that all farmers apply to be sustainable until the producers reaching to the consumers all over the world. But in many cases, sustainable agriculture is studied by focusing on the impact of its application only on the society with all its components and its environmental and economic impact, without examining the relationship between the basic components of the sustainability process that begins with farmers through the producer and the exporter to reach the consumer. Relevant issues to address involve understanding the factors that make sustainable agriculture an essential engine for the production and export processes and how each step affects the other. It also addresses the main points for sustainable agriculture to be a successful base for the food production and export. The purpose of the study is to examine the existence of sustainable agriculture, and the effect of sustainable agriculture on food production and food export in Hungary. This study is quantitative, which is based on data collection and information that helps to accurately describe the problem and analyze. The study thus adopted the survey method to collect the primary data. Findings suggested that sustainable agriculture largely (with the exception of tools) influence food production and export.

Keywords: Hungary, sustainable agriculture, food production, food export.

6.2 Introduction

For thousands of years, agriculture was the primary source of subsistence for human communities and still provides subsistence for half the world's population. Food and Agriculture Organization, 2007 estimates that the quantity of food produced per capita has decreased since 1984, as the unprecedented rate of population is growing. In 1960, when the world population was only 3 billion, about 0.5 ha of cropland per capita was available and considered the minimum area essential to the development of a diverse, stable, nutritious plant and animal diet (Mamolos et al. 2011;Keyzer et al. 2005)

With ever-increase population levels combined with the decline in per-capita availability of natural resources, the related negative environmental effects and subsequent unplanted construction activities, the natural resources and socio-economic structures have grown to a point of disaster resilience. The pressure to produce more has further exacerbated the problems which lead to the unsustainability of agriculture production systems worldwide and, in particular, the developing countries, which require the paradigm shift to integrated, sustainable agriculture growth and renovation management for a holistic agroecosystem (Kiers et al., 2008).

Depending on Kiers et al. 2008,that research and technology have made an important historical contribution to growing production, nutrition, and overall income, and acknowledges that improvements have been inconsistent and that achievements have had environmental and social effects. The increases in production have not increased access to the world's poor to food consistently, in the case of intensification of production, the costs of widespread fertilizer- eutrophication, pesticide pollution and depletion of locally cultivated landraces have generally followed it (Tilman et al. 2001). The evaluation found that institutional improvements in science and research governance, production and distribution are needed in order to distribute benefits more equally and to reduce environmental impacts.

FAO's Plant Protection Service focused on the success of integrated Pest Management (IPM) from an ecological point of view, showing that farmers can produce high profitability with the right training, keep the pesticide inputs minimal and strengthen management. With the right training, farmers can produce high profitability. "Farmers Field Schools"-training models initially developed within the Indonesian National IPM system starting in 1989 and expanded to the rest of Asia and other crops during the 1990s-were also introduced, FAO's goal is to concentrate on the low-income farmers, who, given their often high production and profit potential, are typically food insecure. Specific emphasis is being placed on vulnerable rural communities and the FAO Specific Program for Food Security has started to combine IPPM (Integrated Production and Pest Management) and livelihood guidance, The incorporation of genetics and agricultural technology and mechanization to approach to ecosystems for greater production efficiency, and the use of resources, as well as the safeguarding and even improvement of the environment is important to sustainable agriculture and production intensification as parallel lines(FAO, 2014).

6.3 Sustainable Agriculture, Management, Practices, and Model

Across several ways environmental, social and economic dimensions, sustainability is researched and controlled over a variety of time and space levels. Sustainability assessment is often a daunting challenge. Literature offers only a few metrics for assessing the sustainability of the farm system, including the yield patterns, productivity, biodiversity, soil safety, nutrient balance, runoff quality, and groundwater quality, pollutant concentration in the productive system, soil and nutrient production and limited resource coefficient (Hayati et al. 2001;Senapati et al. 2015).

Different productive methods of management that promote a balanced production system with minimal environmental impact may achieve a sustainable agriculture system. The effect on agriculture and the environment of the various managerial activities differs in time and space, as soil, climate and cultivation systems vary, field experiments to assess management effects on different temporal and spatial scales may not be feasible. Therefore, it could be a simple and cost-effective way to research the effects of various agricultural management practices on sustainable production systems. simulated management practices through process models (Senapati et al. 2015).

The nutrient balance in many agricultural systems with offtake higher than input is counterproductive in current commercial and subsistence practices. The depletion of soil nutrients without sufficient replacement would lead to a significant decrease in crop yields over time, and external intervention or replacement would become a "must" activity, creating a vicious cycle. According to the current trend, more land is subject to intensive cultivation/husbandry practices in order to sustain production levels, where farmers have to cultivate more marginal areas.

In animal husbandry, municipal pasture lands have decreased and livestock has become increasingly dependent on crop field drilling, especially in areas that have had more dry weeds in the past. To sustain agricultural productivity, the cycling of nutrients among rangelands, croplands, ruminant animals and soil. But farmers have no knowledge of the nutrient distribution mechanisms. Sustaining the sustainability of an ecosystem that is increasingly fragile requires an enhanced understanding of nutrient cycles and the development of new and innovative management strategies to make full use of integrated systems.

The biomass cycling from crop components that animals (manure or urine) to excreta fertilizes the soil in the integrated systems is well known to connect animal productivity with soil productivity. In the integrated farming systems, where the connection between the planting and animal agriculture could be used for the benefit of sustainability, soil health, i.e. organic soil, the availability of nutrients, nutrient exchange and water holding capacity, is preserved. If nutrients excreted by animals are not collected, processed and distributed on cropland, nutrient losses may increase in stall feeding to animals.

While several approaches to agriculture have claims for sustainability, organic agriculture is the only well-defined farm management system, including suggested and restricted environmental and food production practices. In protected areas, however, the main challenge is to conserve biodiversity while providing a base for local people's social and economic development (Marambe & Silva, 2012).

It can not be maintained if a globalized food system encourages competition, devalues personal relationships, discourages relationships with nature and food producers and imposes significant environmental, social and health costs. The price of food for the user shall not include any of the environmental costs resulting from food production and distribution. The secret externalities of our current 'effective' farming practices would be compensated for by future generations. In order to avoid exacerbating the current injustice, strategies need to ensure that the poor in our societies are the most vulnerable to such pressure.

Farmers are driven by many reasons to join local food systems, not least to combat the influence of the dominant globalized food system and to form a viable alternative food system in the City. Certain factors include increasing agricultural diversity, growing new and mostly organic nutritious food, reducing 'food miles.' In their turn, consumer engagement in local food processing systems is encouraged to purchase new, organic and seasonal goods, help and establish trustworthy relationships with the farmers and enjoy social interactions (O'Kane, 2014).

Alternative food systems can, through an environmentally sound embedding process and through the application of a standard, recommended or contractual practice in industrial supply chain management offer farmers the chance to develop or conserve specific farmed systems, in brief, the challenge for farmers to manage the "nexus of food / non-food / natural resources" (including ecosystem services) in an integrated landscape approach is for developing sustainable local/regional agriculture that contributes to sustainable development as a whole, ranging from local to global. The implementation of circular economies is an important means of addressing the local or regional bioenergy production challenge (Kline et al., 2016), Conceptual and methodological frameworks that help stakeholders in developing a local or regional agro-ecological transition to managing this relation. They stress the need to take into account priorities, constraints and interactions between farming practices, supply chains and the management of natural resources (Therond et al. 2017).

6.4 Methodology

This study used a survey approach for collecting primary data. Questionnaires were distributed to farm owners in Hungary. The questionnaire is divided into five sections, namely; respondent and firm information, sustainable agriculture tools, sustainable agriculture dimensions (economic, environment, social, and political), agriculture export sector, and agriculture production sector. The measurements were developed based on an extensive review of the literature (Valko, 2015; Rovira, et al., 2015; Muema et al., 2018; Dong, et al., 2015; Fami et al., 2007; Gaviglio et al., 2017; Mavrogiannis et al., 2008). All measurements used a five-point Likert scale. The sample was selected randomly from the complete list of farm owners, Hungarian food exporters and producers. An online survey took place during February -April 2020 and yielded 106 usable responses. The respondent profile information is presented in Table 6.1.

Table 6.1. Respondent profile information

Characteristics	Categories	Frequency	Percentage（%）
Gender	Male	85	0.80
	Female	21	0.20
	20-30	16	0.15

Age	31-40	31	0.29
	41-50	45	0.42
	More than 51	14	0.13
Education level	Postgraduate	34	0.32
	Graduate	57	0.54
	Other qualifications	16	0.15
Type of firm	Self-owned	78	0.74
	Rented	28	0.26
Size (Employees)	Less than 100	12	0.11
	100-300	23	0.22
	301-500	26	0.25
	501-1000	25	0.24
	More than 1000	20	0.19
Motivation for cultivation	For income	98	0.92
	for hobby	0	0.00
	Inheritance	8	0.08

6.5 Results

Descriptive statistics

Table 6.2 shows descriptive statistics such as (mean, standard deviation, and correlation). The results indicate that the means score for all the constructs is located between (2.684-3.957) and standard deviation (0.496-1.357). Also, the results show that each of the constructs is positively and significantly correlated with each other.

Table 6.2. Descriptive statistics

	Mean	S.D.	SAT	ED	END	SD	PD	E	P
SAT	3.696	0.727	1						
ED	3.823	0.496	.609**	1					

END	3.957	0.869	.475**	.443**	1				
SD	3.689	0.930	.534**	.316**	.362**	1			
PD	3.510	1.294	.354**	0.147**	0.236**	0.154**	1		
E	2.684	1.357	0.144**	0.146**	0.244**	0.125**	0.340**	1	
P	3.746	0.703	.369**	0.213**	.400**	0.257**	.306**	.345**	1

**. Correlation is significant at the 0.01 level (2-tailed).
SAT= Sustainable Agriculture Tools, ED= Economic Dimension ,END= Environmental dimension, SD= Social dimension ,PD= Political dimension E= Agricultural Export , P= Agricultural Production.

Reliability and Validity

The confirmatory factor analysis (CFA), and AMOS 24 was used to assess the reliability and validity of measurement scales. The reliability of the scales was evaluated using Cronbach's alpha coefficient as it is seen in (Table 3), Cronbach's alpha coefficient for all constructs ranges between 0.930and 0.756 which are above the threshold value of 0.50which indicates that all the items are internally consistent (Hair et al., 2010). The convergent validity was determined in three important indicators which are factor loadings (standardized estimates), Average Variance Extracted (AVE) and Composite Reliability (CR). Hair et al.,

(2006) suggests that the items with loadings between 0.50 to 0.70 can be maintained. Table 3 shows that the item loadings all exceeded the threshold value and statistically significant (p<0.05). Composite reliability (CR) for all constructs ranges between 0.891and 0.792which are above 0.50 that indicates that all the constructs demonstrate a good level of composite reliability (CR) as recommended by (Hair et al., 2012). The average variance extracted (AVE) value for all the constructs is located between 0.701 to 0.771which is above the threshold value .50 which is suggested by (Hair et al., 2010).

Table 6.3. CFA results: reliability and validity.

Constructs	Measurement Items	Factor Loading	a	CR	AVE	P.V
Sustainable Agriculture Tools	SAT1	0.786				0.0
	SAT2	0.968				0.0
	SAT3	0.871				0.0
	SAT4	0.628				0.0
	SAT5	0.688	0.788	0.821	0.720	0.0
	SAT6	0.804				0.0
	SAT7	0.967				0.0
Economic Dimension	ED1	0.971				0.0
	ED2	0.88				0.0
	ED3	0.657	0.794	0.792	0.701	0.0
	ED4	0.878				0.0
	ED5	0.864				0.0
	ED6	0.843				0.0
Environmental dimension	END1	0.796	0.867	0.810	0.710	0.0
	END2	0.92				0.0
	END3	0.921				0.0
	END4	0.939				0.0
	END5	0.961				0.0
Social dimension	SD1	0.977				0.0
	SD2	0.954	0.756	0.841	0.730	0.0
	SD3	0.937				0.0
	SD4	0.923				0.0
	SD5	0.773				0.0
Political dimension	PD1	0.968				0.0
	PD2	0.909		0.891	0.751	0.0
	PD3	0.938	0.930			0.0
	PD4	0.928				0.0
Export	E1	0.841				0.0
	E2	0.851				0.0
	E3	0.927				0.0
	E4	0.926				0.0
	E5	0.931			0.771	0.0

	E6	0.942	0.917	0.886		0.0
	E7	0.92				0.0
Production	P1	0.947	0.811	0.832	0.733	0.0
	P2	0.911				0.0
	P3	0.865				0.0
	P4	0.847				0.0
	P5	0.746				0.0
	P6	0.947				0.0
	P7	0.929				0.0

a= Cronbach's alpha ,CR =Composite Reliability and Average, AVE=Variance Extracted

Discriminant validity was assessed by using (Fornell & Larcker, 1981) method. They suggested that if the square root of the AVE for a latent construct is greater than the correlation values among all the latent variables that means discriminant validity is supported. Table (4) indicates that the square root of the AVE values of all the constructs is greater than the inter-construct correlations which confirms discriminant validity. The goodness-of-fit measures were used to assess the fitness of a measurement model. The results confirm an adequatemodel fit (CMIN/df= 2.214, GFI=0.8821, TLI= 0.860, CFI=0.881, RMSEA=0.031). Thus, the measurement model indicates good construct validity and reliability.

Table 6.4. Discriminant validity

	SAT	ED	END	SD	PD	E	P
SAT	**0.849**						
ED	0.431	**0.837**					
END	0.231	0.421	**0.843**				
SD	0.512	0.201	0.331	**0.854**			

PD	0.501	0.531	0.610	0.309	**0.867**		
E	0.391	0.561	0.509	0.612	0.583	**0.878**	
P	0.520	0.613	0.712	0.301	0.591	0.322	**0.856**

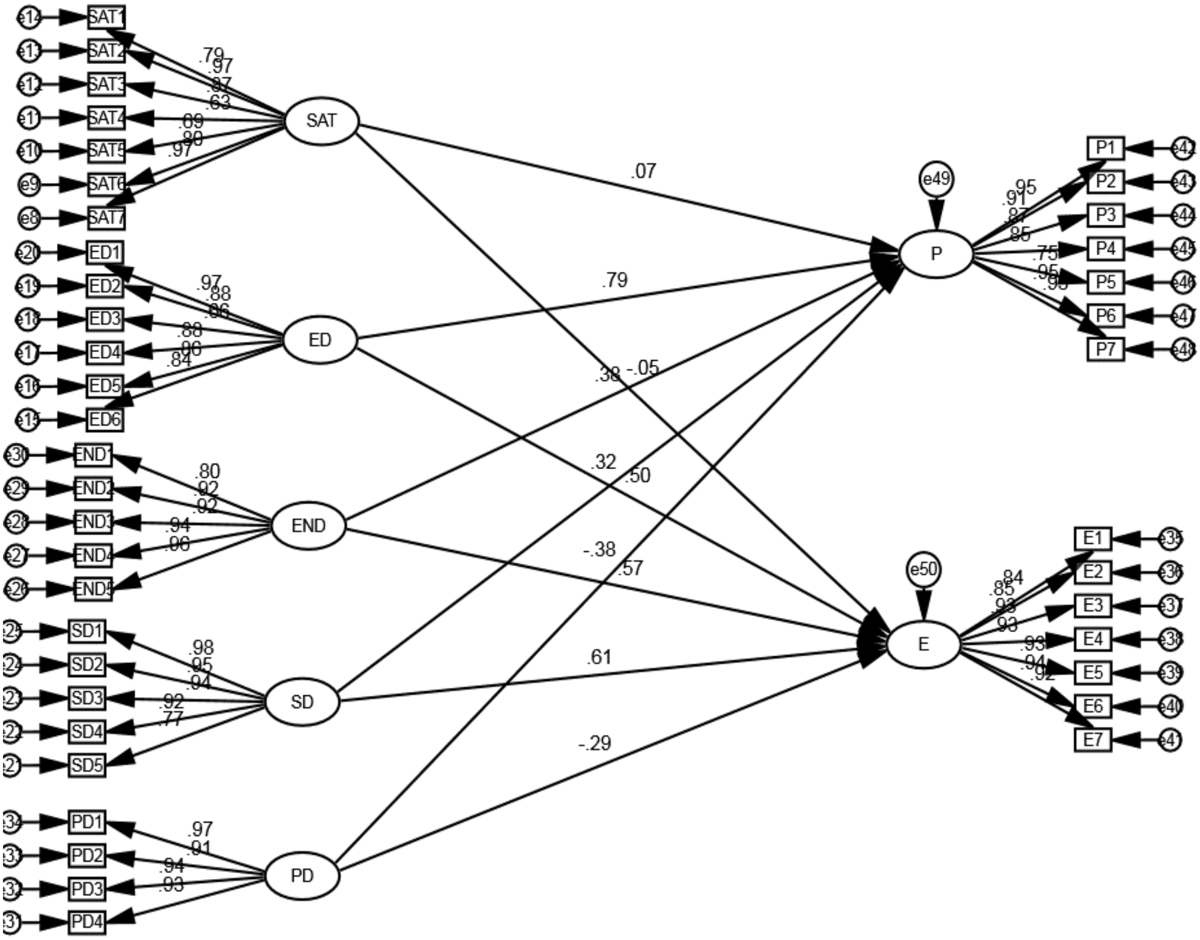
Notes: Bold values in diagonal represent the squared root estimate of AVE.

Test of hypotheses

The structural equation modeling (SEM) was used to test the proposed hypotheses. The results of the hypothesis test are shown in Table 5 and Fig. 1. The results show that sustainable agriculture tools (B=0.066, p<0.213) have no significant impact on agricultural production. Thus H1 is not supported. Likewise, there was an insignificant relationship between sustainable agriculture tools and agricultural production (B=-0.052, p<0.071) therefor; H6 is rejected. Also, the results indicate that the economic dimension (B=0.791, p<.0.000), environmental dimension (B=0.379, p<.0.000), and social dimension (B=0.322, p<.0.000)are significantly and positively impact on agricultural production, which lends strongly support H2, H3, and H4. While the Political dimension has a significant negative impact on agricultural production (B=-0.378, p<.0.000), and agricultural export (B=-0.287, p<.0.000), that supports H5 and H10. Finally, the results confirm that the economic dimension (B=0.501, p<.0.000), environmental dimension (B=0.571, p<.0.000), and social dimension (B=0.606, p<.0.000)are significantly and positively impact on agricultural export, thus H7, H8, and H9 are supported.

Table 6.5 Result of hypothesis Test

NO.	Hypotheses	Beta Coefficient	P Value	Result
H1	Sustainable Agriculture Tools → Agricultural Production	0.066	0.213	Not Supported
H2	Economic Dimension→ Agricultural Production	0.791	0.000	Supported
H3	Environmental Dimension→ Agricultural Production	0.379	0.000	Supported
H4	Social dimension→ Agricultural Production	0.322	0.000	Supported
H5	Political dimension→ Agricultural Production	-0.378	0.000	Supported
H6	Sustainable Agriculture Tools → Agricultural Export	-0.052	0.071	Not Supported
H7	Economic Dimension→ Agricultural Export	0.501	0.000	Supported
H8	Environmental Dimension→ Agricultural Export	0.571	0.000	Supported
H9	Social dimension→ Agricultural Export	0.606	0.000	Supported
H10	Political Dimension→ Agricultural Export	-0.287	0.000	Supported



6.6 Discussion

The objective of the study was to understand the importance sustainable agriculture and its resulting influences on food production and food export. Sustainable agriculture here is operationalize to include sustainable agriculture tools as well as dimensions (economic, environmental, social and political). The researcher believes that these factors all together influence food production and food export. Findings of the study indicated that sustainable agriculture tools have no influence on agricultural production. In the same wave length sustainable agriculture has been proven to have no significant impact on agricultural production. The results suggest that sustainable agriculture in its current form does not really contribute to the increase in agricultural production as well as food export. Benefits of the food production and its corresponding export are not associated with the sustainable agriculture tools. It could be that even though the tools are being applied, they may be ineffective in their applications. Another reason could be that the farmers do not do a holistic application of the tools.

In respect of the dimensions of sustainable agriculture, the economic, environment as well as social dimensions all have significant and positive impact on agricultural production in the country and food export. They are significant perhaps because they represent very important factors when a country considers sustainable agriculture. It is safe to assume that the monetary, cost-benefit analysis and all other economic considerations are widely influencing factors in the decision to enhance sustainable agriculture. It is also not surprising to know that the environment plays an active role in positively influencing agriculture production. The environment represents the field of play where agricultural activities take effect. In this case there is the need to ensure appropriate maintenance of the environment to enhance its longevity to serve other generations beyond the current one. On the environmental effect of agricultural production and export, Reganold, Papendick and Parr (1990) acknowledge the damaging effects of soil erosion and the need for its prevention. This could have a lasting effect on agricultural production.

Social dimension has also been seen to positively influence food production and food export. This indicates that the social activities of the farmers are necessary catalysts for sustainable agriculture. The findings here indicates that farmers see themselves as modern ones and as such would likely want to adopt sustainable agricultural practices and to also ensure that the workers on the farm work in a safer environment. It also suggests that farmers are ready to approve the use of a more convincing sustainable agricultural practice since sustainable agriculture methods improve the credibility of the farmers in the society. This is supported by the view expressed by Pharm & Road (1987) that economic viability, environmental soundness as well as social acceptance of agricultural production all have the hallmark of ensuring food production.

However, the political dimension has a negative influence on food production and export. This means that the agency does not either provide adequate information on how to apply sustainable agricultural practices or encourage farmers to adopt same. Encouragement could come in the form of subsidies or loans, in which case are absent. From the results, it is safe to assume that the continuous use of any agency to help in providing information or encourage farmers on sustainable agriculture in its current form brings about a detrimental effect. It is therefore vital to overhaul the activities of any agency responsible in this regard.

6.7 Conclusion

The purpose of the study was to unearth the importance of sustainable agriculture on food production and food export. Findings indicate that there is, largely, an influence of sustainable agriculture on food production and food export. However, political dimension, as a sustainable agriculture element has been found to negatively influence food production and export. Again, sustainable agriculture tools were also found not to influence food production and export. This could perhaps mean that the tools used in sustainable agriculture are not properly applied or are not applied in their right context. Again, the researcher could argue that, there is no holistic approach in the usage of the sustainable agriculture tools.

CHAPTER VII. DISCUSSION AND CONCLUSIONS

7.1. Overall conclusions

Sustainable agriculture has a positive influence on food security so when we work to improve sustainable agriculture we are at the same time working to improve on food security. This is in line with the assertion made by Hinchcliffe, Thompson and Pretty (1996) that sustainable agriculture is known to offer significant opportunities to improve food production. Improvement in food production would in the long run ensure food security. Food security can therefore be achieved where sustainable agriculture becomes effective. Sustainable agriculture includes the investment of available natural resources, the employment of all potential opportunities for the rural population, and agricultural raw materials to increase agricultural exports in order to reduce the balance of payments deficit. There are many indicators which affect sustainable agriculture in Hungary. However, it is found that the economic, social and environmental indicators have proven to be effective in sustainable agriculture in Hungary. Sustainable agriculture is the necessary means to achieve comprehensive development because it is an important source for improving agricultural production by quantity and quality as well as maintaining the natural resource base.

The study further revealed sustainability of agriculture is a vital aspect of many societies in the world, and Hungary is not an exception. In many studies, the concept of sustainable agriculture is looked at in respect of the impact of its application on the society, without examining the relationship between the basic components of the sustainability process that begins with farmers through the producer and the exporter to reach the consumer. The purpose of the study is to examine the existence of sustainable agriculture, and the effect of sustainable agriculture on food production and food export in Hungary. Findings suggested that sustainable agriculture largely (with the exception of tools) influence food production and export

7.2. Theoretical implications

The study contributes to theory in some important ways. In the first place the research was conducted in order to address the gap in the literature. The identified gap was on the importance of sustainable agriculture and food production and export. This study therefore contributes to the literature by stating that sustainable agriculture has an influence on food production and food export. With respect to sustainable agriculture tools, not much can be said to influence food production and export. This could be due to the fact that the tools that are identified with the farmers are not either fully utilized or not holistically implemented. Thus, the presence of sustainable agriculture tools does not in itself render improvement in food production and food export but the effective use of those available tools.

In essence, the study supports the literature with respect to the importance of sustainability on food production and food export. This is also expected to improve food security. From the literature, several studies were focusing on three (3) main dimensions of sustainability. However, this study added another dimension which is political dimension. The idea was to find out if at all the political aspect of the agriculture sector has any influence on sustainable agriculture and by far, food production and export. Moreover, consistent evaluations of sustainable agriculture indicators are essential in the improvement of sustainable agriculture as a part of sustainable development. It is at the same time necessary to continually know the current state of sustainable agriculture at specific periodic times. Mention can also be made about food security in the context of sharing similar goal with sustainable agriculture. Whiles countries spend time and other resources in ensuring food security, much time can also be given to sustainable agriculture. This is because sustainable agriculture, whilst important for the future, does not leave the current generation behind.

7.3. Managerial implications and Recommendation

The potential importance of the study on the agriculture sector in Hungary cannot be underestimated. The results present some vital implications for managers or stakeholders in the agriculture industry. Firstly, farm managers must be in constant contact with researchers (research agencies) in agriculture to enable them appreciate the whole picture regarding agriculture in the country. Farm managers must also be able to do somewhat assessment of their capabilities with respect to the information they get from research bodies. Also, of important mention is that this study has tested the possibility of the influence of a political dimension on sustainable agriculture. Even though it has no desired outcome, it is important for stakeholders to find out how they can rope in that dimension to the overall benefit of the agriculture in the country.

The study recommends the following.

1. There should be a national consensus on how sustainable agriculture tools can be implemented to maximize the overall benefit.
2. Increase the cooperative efforts of farmers, food suppliers and food exporters in order to effectively achieve sustainable agriculture.
3. Ministry of agriculture and rural development provide some greater level of assistance to farmers

for sustainable agricultural practices. This assistance could come in a form of loans, subsidies etc.

4. Farmers should be in contact with the universities for research and development in sustainable agriculture.

5. The opinions of Hungarian farmers on importance of keeping up farming trends in relation to sustainable agriculture must be taken into consideration.

6. Information must be sought from Hungarian farmers on the importance of sustainable agricultural trend as a reflection on export performance and food production, with environmental protection in mind as well as profit.

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APPENDIX

Kutatási kérdőív

Tisztelt Válaszadó!

Ola Jaafreh vagyok, a Kaposvári Egyetem Gazdaságtudományi Karának PhD-hallgatója. Jelen kérdőívvel azt kísérlem meg felmérni, hogy a magyarországi élelmiszergyártás és – export milyen mértékben alapozható a fenntartható mezőgazdaságra.
A válaszadás önkéntes, anonim, és körülbelül 15-20 percet vesz igénybe. A válaszait bizalmasan kezelem, azok kizárólag a kutatás keretein belül kerülnek felhasználásra.

Köszönöm, hogy időt szán a kérdőívem kitöltésére!

Első rész: A válaszadóra vonatkozó információk

1. Neme

☐ Férfi N☐

2. Életkora

☐ 20-30 éves ☐ 40 éves 41-50☐ s 50 év felet☐

3. Munkával töltött évek száma

☐ 0-5 év 6☐ év 11-20☐ 20 év fele☐

4. Iskolai végzettsége

☐ Főiskola/Alapszak Eg☐em/Mesterszak PhD-fok☐t Egyéb: ....

5. Milyen méretű a termőföldje?

____

6. Mióta gazdálkodik a területen?

____

7. A jövőben is folytatni kívánja a termesztést?

i☐n nem ☐

8. A farmod távol van a helyi piactól?

☐ol nincs t☐l ha távol, milyen messze: __________ km

9. A terület saját tulajdona vagy bérli?

☐át tulajdonom bérlem ☐

10. Hány személyt foglalkoztat teljes munkaidőben?

____________ személyt

11. Hány személyt foglalkoztat részmunkaidőben?

____________ személyt

12. Nehézséget okoz a mezőgazdasági dolgozók felvétele?

i☐n nem ☐

13. Főként milyen növényt termeszt?

1: ____________ 2: ____________ 3: ____________

14. Átlagosan mekkora az éves hozam (tonna/év)?

____

15. Mennyi az élelmezési kultúrák átlagos költsége évente?

____(Ft/év)

16. Mekkora tőkével rendelkezik?

____(Ft/év)

17. Milyen célból foglalkozik növénytermesztéssel?

☐Fő bevételi forrás Hob☐ól Örök☐ miatt

Második rész: a fenntartható mezőgazdaság eszközei

Véleménye szerint az alábbi tényezők mennyire fontosak a fenntartható mezőgazdaság szempontjából Magyarországon? **(5=Nagyon fontos, 1=Egyáltalán nem fontos, 0=Nem tudja)**

	5	4	3	2	1	0
Megőrzési talajművelés						
Kontúr ültetés						
Inter- cropping						
vetésforgó (Crop rotation)						
Fedjük le növényeket (Cover crops / mulches)						
Szerves műtrágyák (Organic fertilizers)						
Környezetbarát kémiai műtrágyák (Eco friendly chemical fertilizers)						
Újrahasznosított víz (Recycled water)						
Kezelt víz (Treated water)						

Permetező öntözés (Sprinkler irrigation)						
Biológiai ellenőrzés (Biological control)						
Mechanikai és fizikai ellenőrzés (Mechanical and physical control)						
A kultúra ellenőrzése (Culture control)						
Környezetbarát kémiai peszticidek (Eco friendly chemical pesticides)						

Harmadik rész: a fenntartható mezőgazdaság tényezői

1. Gazdasági tényezők

Véleménye szerint az alábbi tényezők mennyire fontosak a fenntartható mezőgazdaság szempontjából Magyarországon? **(5=Nagyon fontos, 1=Egyáltalán nem fontos, 0=Nem tudja)**

	5	4	3	2	1	0
A termesztés magas bekerülési költségei.						
A termesztés nyereséges legyen.						
Információs forrásom a fenntartható mezőgazdaságról az alapanyagok beszállítóitól (My source of information about sustainable agriculture from input suppliers)						
A fenntartható mezőgazdaság növeli a termesztés bekerülési költségeit.						
A fenntartható mezőgazdaság növeli a termesztés profitját.						
Kapcsolattartás agráregyetemmel kutatás-fejlesztési célokból.						

2. Környezetvédelmi tényezők

Véleménye szerint az alábbi tényezők mennyire fontosak a fenntartható mezőgazdaság szempontjából Magyarországon? **(5=Nagyon fontos, 1=Egyáltalán nem fontos, 0=Nem tudja)**

	5	4	3	2	1	0
A fenntartható mezőgazdaság csökkenti az eróziót a területemen.						
A fenntartható mezőgazdaság javítja a talaj és a talajvíz minőségét a területemen.						
A fenntartható mezőgazdaság csökkenti az energiafelhasználásomat.						
A fenntartható mezőgazdaság csökkenti a vízfelhasználásomat.						
A fenntartható mezőgazdaságnak köszönhetően csökken a rovar- és egyéb						

kártevőirtószer használata.						
A fenntartható mezőgazdaságnak köszönhetően csökken a műtrágya használata.						

3. Társadalmi tényezők

Véleménye szerint az alábbi tényezők mennyire fontosak a fenntartható mezőgazdaság szempontjából Magyarországon? **(5=Nagyon fontos, 1=Egyáltalán nem fontos, 0=Nem tudja)**

	5	4	3	2	1	0
Modern farmerként fenntartható elvek mentén szeretnék földet művelni.						
A beosztottjaim biztonsága.						
A fenntartható mezőgazdaságnak köszönhetően javul a beosztottjaim munkavédelmi biztonsága.						
A beosztottjaim elfogadnák a fenntartható mezőgazdaság eszközeinek a használatát.						
A családtagjaim elfogadnák a fenntartható mezőgazdaság eszközeinek a használatát.						
A termelőszövetkezet/agrárkamara elfogadná a fenntartható mezőgazdaság eszközeinek a használatát.						
A fenntartható mezőgazdaságnak köszönhetően az átlagember számára a földművelést végzők hitelesebbek/elismertebbek lesznek.						

4. Politikai tényezők

Véleménye szerint az alábbi tényezők mennyire fontosak a fenntartható mezőgazdaság szempontjából Magyarországon? **(5=Nagyon fontos, 1=Egyáltalán nem fontos, 0=Nem tudja)**

	5	4	3	2	1	0
Az agrárminisztérium és a helyi szervezetek kellő információval szolgálnak a fenntartható mezőgazdasággal kapcsolatban.						
Az agrárminisztérium és a helyi szervezetek ösztönzik a fenntartható mezőgazdasági művelés						

megvalósulását.						
Az agrárminisztérium és a helyi szervezetek pénzügyi támogatásokkal ösztönzik a fenntartható mezőgazdasági művelést.						
Az agrárminisztérium és a helyi szervezetek könnyen hozzáférhető hiteleket tesznek elérhetővé a fenntartható mezőgazdasági művelés megvalósulása érdekében.						

Negyedik rész: Exportpiac

Milyennek értékeli a fenntartható mezőgazdaság hatását az alábbi területeken? **(5= Nagyon fontos 1= Egyáltalán nem fontos, 0= Nem tudja)**

	5	4	3	2	1	0
A területem exportpiacra történő termelése.						
A külföldi vásárlók bioélelmiszert részesítenek előnyben.						
A területem exportpiacra történő termelése növekedni fog a jövőben.						
A területem exportpiacra történő termelése nyereséges.						
A területem exportpiacra történő termelése a közeljövőben lesz nyereséges.						
A területem exportpiacra történő termelése költséges.						
A területem exportra történő termelésének költsége a jövőben a fenntartható mezőgazdaságnak köszönhetően csökkenni fog.						
Az új környezetvédelmi szabályozásoknak köszönhetően a külföldi élelmiszerkereslet növekedni fog.						
Exportpiacra termelőként ösztönözzük a fenntartható élelmiszertermelésre történő áttérést.						
Fenntartható élelmiszergyártók vagyunk.						

Ötödik rész: Agrártermelés

Milyennek értékeli a fenntartható mezőgazdaság hatását az alábbi területeken? **(5= Nagyon fontos, 1= Egyáltalán nem fontos, 0= Nem tudja)**

	5	4	3	2	1	0
A fenntartható mezőgazdaság növeli a területemen a termelést/hozamot.						

A fenntartható mezőgazdaság növeli a bevételemet.						
A fenntartható mezőgazdaság módszerei összeegyeztethetők a már megszokott módszereimmel.						
A fenntartható mezőgazdaság módszerei összeegyeztethetők a mezőgazdasági koncepciómmal.						
A fenntartható mezőgazdaság módszerei összeegyeztethetők a szakmai tapasztalatommal.						
A fenntartható mezőgazdaság módszereinek az alkalmazása kivitelezhető a területemen.						
A fenntartható mezőgazdaság módszerei összeegyeztethetők a mezőgazdasági szükségleteimmel.						
A fenntartható mezőgazdaság módszerei összeegyeztethetők a megrendelő/vevő elvárásaival.						
A fenntartható mezőgazdaság módszerei műszakilag egyszerűek.						
A fenntartható mezőgazdaság módszerei kihívásokkal teliek.						
A fenntartható mezőgazdaság módszereinek elsajátítása oktatást/továbbképzést tesz szükségessé.						
A fenntartható mezőgazdaság módszerei kis területen kipróbálhatók bizonyos helyeken.						
A fenntartható mezőgazdaság módszerei kipróbálhatók bizonyos időszakokban.						
A fenntartható mezőgazdaság módszerei kipróbálhatók bizonyos fajtákkal.						
A fenntartható mezőgazdaság módszereinek az alkalmazása tápláló terményt eredményez.						
A fenntartható mezőgazdaság módszereinek az alkalmazása szennyeződésmentes terményt eredményez.						
A fenntartható mezőgazdaság módszereinek az alkalmazása táplálja a talajt.						
A fenntartható mezőgazdaság módszereinek az alkalmazása eladhatóbbá teszi az élelmiszert.						
A fenntartható módon előállított élelmiszerek magasabb áron értékesíthetők.						
A fenntartható mezőgazdaság csökkenti a kártevők megjelenését.						
A fenntartható mezőgazdaság módszereinek alkalmazása további befektetést követel meg.						
A fenntartható mezőgazdaság módszereinek alkalmazása további munkaerőt követel meg.						

A fenntartható mezőgazdaság módszereinek alkalmazása hosszabb munkaidőt eredményez.						
A fenntartható mezőgazdaság alkalmazásával időt lehet nyerni.						
Vannak e a farmjának a termékeinek vevői						
Termény értékesítése városi vagy falusi piacon.						
Termény értékesítése hipermarketeknek.						
A jövőben nagyobb mennyiségben szeretnék értékesíteni városi vagy falusi piacon.						
A jövőben nagyobb mennyiségben szeretnék értékesíteni hipermarketeknek.						