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Evaluation of sustainable agriculture in Hungary

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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. This paper further intends to prove the strong relationship between the indicators of sustainable agriculture and the influences on food exports, with the use of Principal Component Analysis (PCA).

KEYWORDS
sustainable agriculture, environment, economic, social, profit, indicator, data analysis

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 [5]. 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 centers around expanding awareness on crop variation [26]. The most critical achievement elements to accomplish the sustainable, genuine execution of economic and organic farming requires instruction, cooperation localization, and limit building [26].

Sustainable agriculture and development shared to achieve a healthy and productive life in collaboration and harmony with nature. Sustainability today must be a basis to progress to achieve environmental availability, which is needed for the present and future generations by using natural resources without degradation, damage, or with the precautionary approach to protect [25]. In addition to saving the resources and the environment, encourage public awareness to make information about sustainability widely available[25]. Scientific understanding, full participation of women, and the interdependence of economics, environment, and society at large was needed [25].

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 [30].

Hungary's agriculture lost it is status twenty-five years ago; the rapid growth of the global population means that food production needs to increase because, as it stands, one-seventh the population is still hungry, and the development of agricultural production and food industry is the cornerstone of rural development. In Hungary, which is far from potential, two percent of EU agricultural products are produced. Food and agriculture can only be improved and developed together. Food production is a key element of the supply chain; the success of European countries lags behind and resources are not enough. Also, long-term cooperation between farmers and manufacturers is insufficient, with minimum specific market organizations. The intensity of environmental protection and natural protection is increasingly underlined and appreciated at the same time by sustainable development. The agriculture and forestry industries can also replenish the natural resources and have beneficial effects on the environment, not only in food and other raw materials[23].

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 [9]. 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 financing 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 [18].

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 which until the beginning of the 21st century, had not happened [20]. 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[11)

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 productive agricultural operations, 5. progress the quality of life of farmers and society both together [27].

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 [13].

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 are makes the most efficient 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[17].

The requirement of sustainable agriculture

Agriculture produces healthy fiber products and of functional 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[2],[19].

Making sustainability measurable

How is it possible to estimate farm sustainability? The Response-Inducing Sustainableness Evaluation (RISE) method has been developed in Bern by the Swiss School of Agriculture, Forest, and Food Sciences to evaluate sustainability as universally as possible. Since 2000 RISE has been used for several hundred farms of different sizes by a variety of organizations. The RISE method has been used by the German Society for International Cooperation (GIZ) GmbH since 2012. The objective of RISE is to make farm sustainability and operations communicable and measurable. They work on one farm through interviews and data collection to collect information on sustainable indicators such as soil use and livestock farming in order to evaluate cultural, environmental, and social aspects. RISE provides farmers with advice on agricultural habits. Farms receive a sustainability assessment, so that farm managers can either improve or develop their sustainability instantly. The use of the increasing number of GIZ farmers in one zone has shown that farms in a single area are often patterned by analyzing a few development samples, representative groups, development cooperation programs, to identify and recognize the shortcomings and advisory improved strategies. Although development cooperation typically involves family-run companies, sustainability often is not especially good. Special development is also required in economic terms such as profitability, competitiveness, operational management, and ecological aspects (such as nutrient management and carbon footprint). Therefore, family-run small-holder farms are not necessarily more durable than massive farms. RISE can provide valuable insight into policy advice, in addition to helping counseling farmers because certain sustainability deficiencies are the consequences of the structural framework rather than farm management[8].

Sustainable agriculture is a multifunctional concept, so it is not easy to measure and make an evaluation[31]. Numerous studies[3][7][14[16] used to evaluate and measure sustainability at the level of the farm. [9]. (2006), mention that some researchers like (Keatt, 2015) used regression analysis to find a 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.

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 [6][23].

The indicators were chosen separately for the three dimensions and collected in conjunction with the indicators' attachments: importance, trust, precision, comparability, ease of analysis, and good quality basic data. There are two choices for selecting a metric for a particular topic such as raw data usage (e.g. agricultural consumption and energy production), use of a ratio (e.g. agriculture ratio in energy consumption), and using a quantitative measure (e.g. gross value added energy consumption). Pure raw data is the most suited indicator for making a time comparison since other data do not distort or deform information. If we are to compare space or locations, raw data can be misleading because the various countries in the area and in the production style are very different. For example, an energy use indicator that uses a relative indicator such as (energy per gross added value) can not accurately and correctly display the pressure on the environment. For some years, however, energy consumption can decrease as the gross added value increases due to the correct weather for cropped products. The same case with the ratio of 71 type indicators, albeit less likely. The truth to compare indicators of variable countries with raw data can also be misleading and will not tell the story. Without the use of a proportion or a relative indicator that is incomprehensible, Hungary's environmental performance in relation to energy consumption is a decision needed in collecting a set of indicators. As our main objective is time comparison, raw data and ratio style indicators are usually used for the compilation. This set or group of indicators should be used in future research as a basis for developing composite indicators for sustainable agriculture availability of data is an important factor when selecting indicators. The quality of the data encounter as waste originating from farming, for example, is ten times higher in 4 years, whereas the number of time series was too short. For instance, only 2010 soil cover and tillage techniques or some other indicators. Data are not valid for most Member States with respect to environmental spending. The results of this collection of indicators are 26 environment-related indicators, 15 economic-related indicators, and seventeen social-related indicators. They were losing data usually processed by Excel 's trend function [24].

Economic dimension

Fifteen metrics **Social dimension**

Information was available and utilized in the context 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 employed in agriculture. Also selected were rural development indicators on the ratio of rural population over 65 years to population change study and unemployment rate. Included in the program were extra data from income statistics relevant to densely populated regions. Data were not available for infrastructural supply or subsidies and its quality and on food security and safety as well.

have covering efficiency, gross value-added, and farm income. The indicator is also based on foreign trade, production structures, subsidies, research, and development. Prices have been omitted because it is not applicable to sustainability from the collection of indicators. Price volatility may be a potential sustainability issue; correct methodologies for this indicator should be improved. Data on equipment, buildings, and land prices were only partly available to the richness and wealth of the farming sector.

Table 1: Indicators of sustainable agriculture for Hungary, the 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: [24].

Environmental dimension

According to the pressure-state response system established by the OECD, environmental information or data may be collected. The pressures which harm the environment are provided with a wide field and a variety of data. The domains include air pollutant emissions, energy consumption, fertilizer and manure, pesticide sales, irrigation, and production (living density, arable land share) selling pesticides. Far less environmental data is available (nutrient balance and farmland bird index). Data are given on the response to agri-environmental and organic farming participation and sharing. The twenty-six indicators offer a broad range of details and data but certain areas (tillage, vegetation, waste production, pollutant quality of water and soil, vegetation) may not be enveloped in the indicator collection.

Social dimension

Information was available and utilized in the context 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 employed in agriculture. Also selected were rural development indicators on the ratio of rural population over 65 years to population change study and unemployment rate. Included in the program were extra data from income statistics

relevant to densely populated regions. Data were not available for infrastructural supply or subsidies and its quality and on food security and safety as well.

Table 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: [24].

Table 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 standared output of farm managers over 65years	%
SO_3	Share of standared output of farm manager under 35 years	%
SO_4	Share of standared 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: [24].

According to [28], in 2014, on the individual farm, sustainable agricultural indicators briefly listed economic indicators, which include productivity, production costs, farm income, product quality, product price stability, marketing network, and the relationship between producer and buyer.

Hypothesis
H1 – in Hungary, there are many indicators of sustainable agriculture.
H2 – sustainable agriculture has a positive relationship with food export in Hungary.

METHODOLOGY

1. Study area

The study will be conducted in Hungary, emphasizing Agriculture, which accounts for 4.3% of the GDP, with the food industry occupying roughly 7.7% of the labor force. Those two figures reflect only the primary agricultural production: Agriculture accounts for around 13 percent of GDP along with related businesses. Hungarian agriculture is self-sufficient and export-oriented for traditional reasons. Agricultural exports make up 20-25 percent of the total. About half the total land area in Hungary is the agricultural area under cultivation. This ratio is noteworthy among other EU members. This is due to favorable conditions in the country, including plains that make up about half of the Hungarian landscape and the continental climate.

The research problem is that because of its geographical location, Hungary is a country with essential areas in Eastern Europe. The research issue is that because of its geographical location, i.e., as an intermediate between Eastern Europe and Western Europe and its agricultural importance, Hungary is a country with essential areas in Eastern Europe. Therefore, we should ask ourselves that, given the massive expansion, Hungary's agricultural land suffers from a lack of development. Issues would restrict the sustainability of agriculture in which private problems related to agricultural production usually reduce water, irrigation and prevention methods, and the availability of farmers' equipment and expertise in the field of crop selection or mode of action throughout the year.

2. Data Source

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

3. Data analysis technique

The empirical research used Principal Components Analysis (PCA) in this study. PCA is a multivariate statistical approach used to study large data sets. By using a small number of new variables called main components (PCs), this approach reproduces a large proportion of variance among a large number of variables.

Components were extracted to facilitate interpretation and rotated using the varimax method. High absolute loading values for the variables on the PCs imply that the indicator has a large bearing on that component's creation. So we considered all variables which scored more than 0.50 to be related to the component definition [10][15].

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 hypothesizes, 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 of Hungary. The established system of indicators is shown in Table 4.

Table 4: Indicators used to evaluate the sustainable agriculture

Code	**Indicator**	**Unit**	**Goal**
1	**Environmental dimensions**		
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 sulfur oxides in agriculture	Tonnes	_
EN_5	Emission of nitrogen oxides in agriculture	Tonnes	_
EN_6	Emission of non-methane volatile organic compounds in agriculture	Tonnes	_
EN_7	Emission of methane 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 hectare of UAA	Tonnes	_
EN_{12}	Phosphorus balance per hectare of UAA	Tonnes	_
EN_{13}	Use of manure per hectare of UAA	Kg /ha	+
EN_{15}	The 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 utilized 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 dimensions**		
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 dimensions		
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: 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 emission	**-.953**	.048	.135	.134	.145
Emission of ammonia in agriculture	**.888**	.396	-.142	-.030	-.003
Emission of sulfur oxides in agriculture	**.823**	.106	-.417	.147	.228
Emission of nitrogen oxides in agriculture	.218	**.917**	-.111	.016	-.105
Emission of non-methane volatile organic compounds in agriculture	**.917**	.228	-.220	.074	.158
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 balance per hectare of UAA	-.219	.178	**.933**	.044	.035
Phosphorus balance per hectare of UAA	-.241	.162	**.933**	.048	.025
Use of manure per hectare of UAA	.049	-.116	.072	-.048	**.925**
Irrigable area in UAA	.206	**.528**	-.232	**.745**	.109
Biomass production in agriculture	.251	**.898**	.041	.311	.026
Share of mixed crops –livestock farms	.291	**.826**	.096	.306	-.036
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 of organic farming	-.208	.079	.368	**.691**	-.285
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 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).

Table 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.		

Table (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 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 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.		

To check the second hypothesis that the relationship between sustainable agriculture and food exports in Hungary is positive. A regression analysis was applied to determine the impact of independent variables on the respective dependent variable.

Table 4 indicates that food exports have a major effect on environmental indices (R=0.996, $p < 0.00$). Table 5 shows that all of the coefficients have a significant positive relationship with food exports.

Table 8: A regression analysis of environmental indicators

Adjusted R	R-squared	S.E. of regression	S.D. dependent Var	P-value
0.995	0.996	0.130	0.0749	0.000

Table 9: Environmental indicators coefficients

	Coefficient	Std. Error	t-Ratio	P-Value
Water use in agriculture	0.198	0.556	2.15	0.005
Livestock density	0.135	0.041	3.26	0.008
Bird index of farmland species	0.432	0.225	1.92	0.008
Share of organic farming	0.143	0.072	0.193	0.002
grazing	0.621	0.042	1.47	0.001

Dependent variable: agriculture export

Table 10 shows that economic indicators have a significant impact on food export (R=0.999, $p < 0.00$). All the economic indicators coefficients in table 7 are significantly positively related to food export.

Table 10: A regression analysis of economic indicators

Adjusted R	R-squared	S.E. of regression	S.D. dependent var	P-value
0.999	0.999	0.075	0.074	0.000

Table 11: An economic indicators coefficients

	Coefficient	Std. Error	t-Ratio	P-value
Gross value added	0.280	0.234	9.71	0.004
Gross fixed capital formation	0.328	0.145	2.25	0.004
Agricultural income	0.248	0.118	2.10	0.04
Research and development in agriculture	0.117	0.213	5.23	0.002

The results in table 12 confirm that there is a significant positive relationship between social indicators and food export (R=0.905, $p < 0.00$). Furthermore, all social indicators coefficients in (Table 9) have a significant positive impact on food export.

Table 12: A regression analysis of social indicators

Adjusted R	R-squared	S.E. of regression	S.D. dependent var	P-value
0.876	0.905	0.102	0.073	0.000

Table 13: A social indicators coefficients

	Coefficient	Std. Error	t-Ratio	P-value
Rate of net migration of rural population	0.152	0.194	5.23	0.001
Labor force in agriculture	0.651	0.206		0.001

DISCUSSION

Principal component analysis (PCA) is a multivariate method that tests and analyses the observed data table in which are described by various inter-correlated quantitative dependent variables. Its aim to extricate the significant input from the observed statistical data to represent it as a group of new rectangular and orthogonal variables, which called principal components, furthermore to show the pattern of likeness between the observations and of the variables as points in spot and points maps [29].

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. Thus, the goal was defined for each indicator with the effect of an increase or decrease on 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 powerfully demonstrating the presence of indicators with high or high impact after entering data and obtaining results through the PCA model [32].

Principal components of PCA for the environmental indicators have a total 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), the 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 have composed three social indicators, of which two 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. Table 4 shows that environmental indicators are significantly impacted by food export (R=0.996, $p < 0.00$).

Table 5 presents that all the coefficients have a significant positive relationship with food export and Table 10 shows that economic indicators have a significant impact on food export (R=0.999, $p < 0.00$). All the economic indicators coefficients in Table 7 are significantly positively related to food export, the results in Table 12 confirm that there is a significant positive relationship between social indicators and food export (R=0.905, $p < 0.00$). Furthermore, all social indicators coefficients in Table 9 have a significant positive impact on food export.

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[1].

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 the total variation, respectively.

The economic aspect were presented two significant factors thatcan explain (72.22%, 95.64%) of total variation, respectively. Finally, the social demission represents two significant factors that can explain (46.88%, 90.15%) of the total variation , respectively. A regression model was employed to examine the relationship between sustainable agriculture and food export. The empirical results show that sustainable agriculture dimensions have a significant positive impact on food export. 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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