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Ph.D. School of Management and Business Administration

Thesis of the PhD dissertation



**THE CRITICAL ANALYSIS OF AGRICULTURAL ADAPTATION
OF SUSTAINABLE VALUE ASSESSMENT**

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Background of the research

From the very beginning of human history agriculture has to meet several – although ever changing – expectations. The amount and the structure of the required food, feed, fibre – and nowadays even fuel – are influenced by the amount of disposable income and the preferences of households.

The agrifood sector and the land use in general is still one of the production activities has the closest interrelationship with the natural resources and the environment in general. This relationship shows peculiar duality, since at the same time it tries to shape to be in line with the actual human needs (which is certainly possible to a certain point) and on the other hand to adapt to the law of nature. The previous one might be linked to certain critical barriers of the system, which led to several environmental problems of today. As a spillover effect, the outcome of these is detectable in the socio-economical processes as well. The close imbeddedness of the agriculture into the ecosystem requires special emphasis on the role of time (the possible change of system elements is different) and the spatial dimension (the subsystems related to agriculture have different spatial range).

Nowadays several disciplines play greater attention to sustainability research. The widespread headway is feeded upon on the one hand the critics of the orthodox view of economic growth as accounted through the national accounts. On the other hand the growing importance of social and environmental aspect which affect economic processes.

There are several reasons that justify the actuality of the subject-matter. Every important international organization – ENSZ, OECD, EU – contains sustainability on its agenda with high importance. In case of agriculture, in a European context, considering the new challenges related to natural resources any method would gain attention that could use existing data sources and feed policy process in order to increase sustainability. There is a large number of existing research both Hungarian and international, which study sustainability in different context from general economic activity to the case of agriculture or land use in general. This large number of international research until now has reached significant results, however these are applied in Hungary to a limited extent.

The starting point of the dissertation is the research activity done between 2007-2010 under an EU 6th framework project called SVAPPAS (Sustainable Value Analysis of Policy and Performance in the Agricultural Sector). The core objective of the project is the development and adaptation of a methodology for the assessment of sustainability performance and policies in agriculture. The sustainable value (SV) methodology is an existing framework in other sectors not related to natural resources directly. The SV method access the performance

of farms of certain type, in relation to the resource (natural, capital, social) use in the production process. The project aims to adapt the methodology for application at farm, sector, regional and cross-national level, by combining it with efficiency analysis methods for benchmarking and with policy models. Application on different cases and countries will allow to test the method under different farming and local conditions and to link this method with FADN (Farm Accountancy Data Network) data.

Objectives of the research

The main objective of the research is to develop such a general economic framework that could serve as a tool for sustainability assessment of agriculture production. The chosen method is not used in the agriculture sector and the adaptation is still under development.

My goal is to present - through critical analysis - the possibilities and limitations of the method. While the methods currently used most often are trying to evaluate different aspects of the damage, the new method tries a different prospective. Its starting point is the ability of value creation.

The method wishes to provide guidance on sustainable future through the quantifying the "sustainable value" produced. It should be emphasized that the method is not to give answers whether some of the examined enterprises are sustainable or not. The method would like to answer whether a production activity used the resources more efficiently compared to a benchmark reflecting any particular approach.

The final goal of the dissertation is the introduction, critical assessment and application of such a framework that is based on micro decision makers – e.g. farms – and capable of performing a single index based sustainability assessment at different level of aggregation and finally explore its influencing factors.

I determined the following goals of my research work:

1. Exploring and structuring the theoretical basis of sustainability

I intend to establish the sound foundations of sustainable value method thorough synthesizing the extensive literature of sustainability. This necessarily requires a kind of historical overview of existing sustainability, sustainable development, starting from the conceptual and interpretation difficulties (weak vs. strong sustainability) through the possibility for practical application. Considering the "value added" philosophy of the sustainable value approach a separate section deals with the issue of efficiency and productivity.

2. *Critical assessment of the sustainable value approach, its possible application and development for policy applications*

During the adaptation of the method it is important to take into account the specific properties of agriculture and the critical elements of the initial approach. Within this framework, I would like to focus on the characteristics of agricultural production, its closer relationship to biophysical systems. In order to access the possible benefits of the method it is necessary to obtain its policy usability, considering the existing institutional and functional framework. It is also useful to compare the method with other existing approaches, mainly with indicator based ones in particular.

3. *Summary of existing international experience regarding the application of sustainable value method and its possible usability at Hungary*

As the sustainable value approach has not been used in Hungary until now, it is particularly useful to gather and synthesize international experience. The analysis primarily focuses on the applicability within national conditions, highlighting the features that may affect the results in Hungary.

4. *Detailed analysis of specialized dairy farms based on FADN data*

The application of the method is presented through the case study of specialized dairy farms. It was chosen based upon the fact that it is one of the most complex sector; therefore it is suitable to present several challenges. This case study also serves as practical applications capable to present the barriers and hint needed future development. Moreover, several hypotheses can be formulated:

- Economic efficiency (profitability) significantly affects the sustainability performance.
- The legal form does not significantly affect the sustainability performance.
- The manager's (agricultural) qualification significantly affects the sustainability performance.
- The economic size of the farm significantly affects the sustainability performance.
- The share of own land does not significantly affect the sustainability performance.
- The order of all farms and the difference between the individual farms – their relative sustainability performance – is steady, while the individual performance is changing.
- Sustainable performance at the farm level shows progress through time.
- The (agricultural) subsidies significantly affect (increase) the sustainability performance.

The sustainable value assessment

The sustainable value (SV) method was first developed by Figge and Hahn (2004a, 2004b), which they used different economic principles and theories. The SV (Figge 2001; Figge and Hahn 2004a; 2004b; 2005a; 2005b) is capable to assess the contribution to achieve sustainability of a given region considering given economic units (e.g. farms or even sector, or the entire agriculture). The value oriented approach assesses and aggregates economic, social and environmental impacts according to their effect on value creation rather than according to their relative harmfulness (Figge and Hahn, 2004b). While burden-oriented approaches argue *how* resources should be substituted by each other (Pretty et al., 2000; Tegtmeier and Duffy, 2004), the sustainable value focuses more on the question *where* resources should be allocated in order to have the highest value creation with the resources available (Figge and Hahn, 2004b). In other words the method assesses whether a reallocation of resources between firms within a sector or region could increase the efficiency of resource use. The method rests upon the concept of opportunity costs, which refer to the value forgone by applying one option and not an alternative one. In the sustainable value method a financial economics perspective is applied, by defining opportunity costs as the value created by the market, which is an appropriate alternative for a risk averse investor. Firms creating positive sustainable value contribute to the economy's sustainable value creation while firms with negative sustainable value reduce the economy's sustainable value creation. The outcome of the method can be used to support decision makers in their aim for more sustainable production practices. Moreover, SV should be seen as a complement tool to existing ones.

SV is not by any mean a method designed to assess what is (e.g. at farm level) sustainable and what is not. Rather it is capable of calculating an economic unit's relative contribution, with a given benchmark in hand. The opportunity cost of the firm capital is the value created by the foregone market alternative. As the Sustainable Value method considers social and natural capital, market prices are often not available or ill-defined. The opportunity cost principle is used to overcome this. Given the financial perspective, opportunity costs are defined at the level of the economy as a whole. The underlying idea is that a risk averse investor considers the market as the best available investment alternative for a firm. When the productivity of the farm exceeds the benchmark productivity¹, the farm creates sustainable value and the farm contributes to sustainability. In the other case the farm destroys sustainable value. Most often the output figure is expressed in monetary terms; however it is also possible to use physical indicators. The resources considered in the assessment have to be

¹ The alternative must be feasible and comparable.

scarce and necessary for the production (e.g. in case of dairy, cows are always required). The SV method was first applied in case of agriculture by Van Passel et. al (2006 and 2007), was further investigated and improved by the SVAPPAS project.

Factors contributing to sustainable efficiency (or in other words Return-to-Cost), which is the normalized version of SV, considering the size of the economic unit assessed, were performed according to Van Passel et al. (2007). First the results based on sustainable efficiency results of different years were compared, using Spearman's rank correlation. As a second step, based on indicators of three different category – structural, managerial, strategic – the average of these indicators were compared between the best (forrunner farms, with the best [10%] sustainable efficiency score) and worse (laggard farms, with the worse [10%] sustainable efficiency score) farms. As a final step, econometric investigation took place: a stepwise panel regression analysis was performed.

Indicators used in the assessment

In order to perform any sustainable value assessment, several indicators have to be considered. The basic source of these indicators is the financial-economic indicators of the FADN system. Two complementing datasets should be identified: on the one hand, there are national variables defined at national level and on the other hand there is an EU harmonized (between member states) dataset, the so called Standard Results (or SE variables). These latter indicators are often used in policy and sector analysis done by the Commission (European Commission, 2007).

In order to evaluate the sensitivity of data used, the SV assessment was performed using two different data model. The first one is based on the practice applied by SVAPPAS partners in their case study analysis, published in different peer reviewed journals hence can serve as a reliable starting point. However, it is not based on any detailed analysis of the farm type assessed. This weakness is overcome by the data model of the European Commission developed for the economic analysis of the dairy farms. This is a detailed model, which uses established protocols to account for own resource use, through estimation. This is highly important from the opportunity cost perspective. The fundamental approach of the model is to allocate cost based on certain allocation keys (European Commission, 2009).

Own land was valued based on the weighted regional rent rate of utilized agricultural area. In the FADN, among the different land use categories only arable land could be taken into consideration separately. However, except from

one or two cases, regional differences are negligible²; therefore the average regional rent rate is used.

When “pricing” family labour use, it is possible to distinguish between different activities or operations. In line with our expectations, the highest wage rate is found among the managerial staff, while other operations show little variation, except seasonal work, which has significantly lower rates in all cases. Within a given year and operation, regional differences are also negligible, except for the Central Hungarian regions, which usually shows higher rates.

There are four main groups of indicators used for assessing the influence on sustainable efficiency: structural farm specific indicators (legal form [family/individual vs. corporate], age of farm manager [year], qualification of farm manager [yes/no]), production related indicators (quantity of milk produced [tonne], stocking density [LU/ha], share of own land [%], share of grassland [%]), the subsidy related indicators (investment subsidy [1000 Ft], share of total subsidy in gross income [%]) and finally economic/income related indicators (share of own capital [%], output to NVA ratio [%]). Profitability or in other words “economic efficiency” is captured through the use of farm net value added [FNVA] indicator.

Methods

According to quantitative analysis standards, data screening (outlier detection, basic summary description) was performed before the assessment. The benchmark was estimated using the non-parametric Data Envelopment Analysis approach (VRS Model, Output oriented). The benchmark used is the firm’s peer on the frontier (Option 1 in Mondelaers et al., 2009). Therefore the opportunity cost of the firm is the best available alternative for this firm in the market. The justification for this benchmark was that from a firm perspective optimal reallocation with respect to maximizing sustainable performance occurs when resources are allocated to efficient peer firms on the frontier.

Assuming that there are n decision making units (DMUs), each producing single output by using m different inputs and the i -th DMU produces y_i units of output using x_{ri} units of the r -th inputs, the variable returns to scale (VRS) output-oriented DEA model for the i -th DMU is expressed as follows:

$$\begin{aligned} & \text{Max } \theta_i \\ & \theta_i \lambda_j \\ & \sum_{j=1}^n \lambda_j y_j - \theta_i y_i - s = 0 \\ & \sum_{j=1}^n \lambda_j x_{rj} + e_r = x_{ri} \end{aligned}$$

² In case of Northern Hungary, the relative high presence of permanent crops (fruits and grape) „pul” the average compare to arable land.

$$\sum_{j=1}^n \lambda_j = 1$$

$$\lambda_j \geq 0; s \geq 0; e_r \geq 0$$

$k = 1, \dots, m$ (inputs); $j = 1, \dots, n$ (DMUs)

where θ_i is the proportional increase in output possible for the i -th DMU; s is the output slack; e_k is the k -th input slack; λ_j is the weight of the j -th DMU.

In case of panel data, there are two basis effect models: fixed effect (1) and random effect (2) models (Green, 2008).

$$Y_{it} = \beta X_{it} + \alpha + u_{it} \quad (1)$$

$$Y_{it} = \beta X_{it} + \alpha + u_{it} + \varepsilon_{it} \quad (2)$$

Fixed-effects (FE) model is used whenever one is interested in analysing the impact of variables that vary over time. When using FE we assume that something within the individual (e.g. farm) may impact or bias the predictor or outcome variables and we need to control for this. This is the rationale behind the assumption of the correlation between entity's error term and predictor variables. FE models remove the effect of those time-invariant characteristics from the predictor variables so we can assess the predictors' net effect.

Another important assumption of the FE model is that those time-invariant characteristics are unique to the individual and should not be correlated with other individual characteristics. Each entity is different, therefore the entity's error term and the constant (which captures individual characteristics) should not be correlated with the others. If the error terms are correlated then FE is no suitable since inferences may not be correct and we need to model that relationship (e.g. using random-effects), this is the main rationale for the Hausman test. In summary, fixed-effects models are designed to study the causes of changes within an entity (e.g. farm) or in other words to reveal the causes of change of the individuals.

Random-effects models are added with an error term in order to capture the changes within the entity. Random effects assume that the entity's error term is not correlated with the predictors which allows for time-invariant variables to play the explanatory variables' role. An advantage of random effects is that one can include time invariant variables (e.g. gender). In the fixed effects model these variables are absorbed by the intercept.

In random-effects one needs to specify those individual characteristics that may or may not influence the predictor variables. The problem with this is that some variables may not be available therefore leading to omitted variable bias in the model.

Beyond the already mentioned Hausman test, the followings should be considered:

- In case of fixed-effect model it is important to check the role or importance of time.
- The Breusch-Pagan Lagrange multiplier (LM) test helps to decide between a random effects regression and a simple OLS regression.
- Cross-sectional dependence may cause problem in macro panels with long time series (over 20-30 years). This is not much of a problem in micro panels (few years and large number of cases).
- Pasaran CD (cross-sectional dependence) test may be used to test whether the residuals are correlated across entities. Cross-sectional dependence can lead to bias in tests results (also called contemporaneous correlation).
- Test for the presence of heteroskedasticity (using Wald test).
- Testing for the presence of unit roots/stationary.

Software environment

Explorative data analysis was performed using STATA 11.2 and SPSS 19.0 softwares. The DEA benchmark values were calculated using General Algebraic Modelling System (GAMS). The panel effect models and related test were performed with STATA as well.

Results

Suitability of the FADN data, data requirements

There are several reasons for doubting the suitability of FADN data for all capital forms during SV assessment. According to its primary goal the FADN system contains mainly monetary indicators and limited to natural ones. This is certainly not in line with the property of SV covering all capital forms; for certain capital forms FADN variables could serve as proxy at best. Because the overall goal of sustainability is to maintain the necessary systems, it is better focus to the entire effect of resource use than any intermediate stage. From this perspective the FADN shows a “double twist” both in case of natural and social capital. On the one hand the necessary physical quantities are not recorded and only possible to estimate with the distortion of prices and taxes. On the other hand even knowing the physical quantities only the function of magnitude is. It is very well possible that lower specific use lead to smaller effect (e.g. depending the way of use).

In case of most environmental related issues and resource use only indirect indicators (e.g. not use but only cost data) are available. These should be treated merely as indicative, however in worse case they possibly lead to false conclusion. For example, there are no data available at farm level in the FADN about the nitrogen balance, therefore the ecosystem related cost-benefit analysis

of nitrate use can not be estimated (Barg, Swanson, és Venema, 2005).

The following steps are elaborated to select the required indicators:

1. Based on the research question, the followings have to be set:
 - Production process/function (inputs/outputs).
 - Time horizon (one or more production cycle).
 - Spatial level (farm level, regional, national, EU).
2. Typology of production system (technology):
 - Defining related systems.
 - Defining/setting the system barriers (internal/external).
 - Identifying inputs/outputs based on the production system identified:
 - Aggregation/disaggregation.
 - Quantifying qualitative information (e.g. setting categories³).

In the light of all these, in the framework defined by the FADN system, farms with the most homogenous production system possible should be chosen. This is attained by using the four digit farm type in all cases. At the same time, as provided by the FADN manual⁴, the classification of farms is determined by their economic results. Therefore, it is very well possible, that even though farms are well defined in an economic sense, but some “marginal” activity cause significant differences in the environmental or social outcomes. So one have to conclude, that in case of sustainability assessment, the economics centred FADN typology only might serves ass a starting point. In order to define a well suited typology, a much more diversified approach has to be followed.

Another possible approach could be, if one accepts, that specialized dairy farms might have other activities on the side. In this case, special attention has to be paid to the inputs and outputs considered or selected. In both cases, assessment of marketed and own consumption has to be done advisedly.

In case of the inputs, it has to be clarified what should be treated as input use and what as the result of input use, which could be seen as indirect use. Based on the value oriented approach of the SV method to the sustainability of production, it is important to distinguish between decisions driven and non influenced consequences. To provide an example in case of dairy farms the use of physical capital (e.g. stall) depends on the decisions of the manager. On the other hand the amount of manure is only partly affected by the technology

³ In case of DEA certain categorical groups are not comparable, efficiency results are only comparable in a given group (Fried, Lovell, & Schmidt, 2008).

⁴ http://ec.europa.eu/agriculture/rca/pdf/site_en.pdf, page 7.

applied. Its amount and quality depends on the feeding and other circumstances, however it is a necessary, unavoidable outcome of milk production. Finally, once the manure enters to the groundwater, there is hardly any decision of the farmer has affect on the environmental consequences.

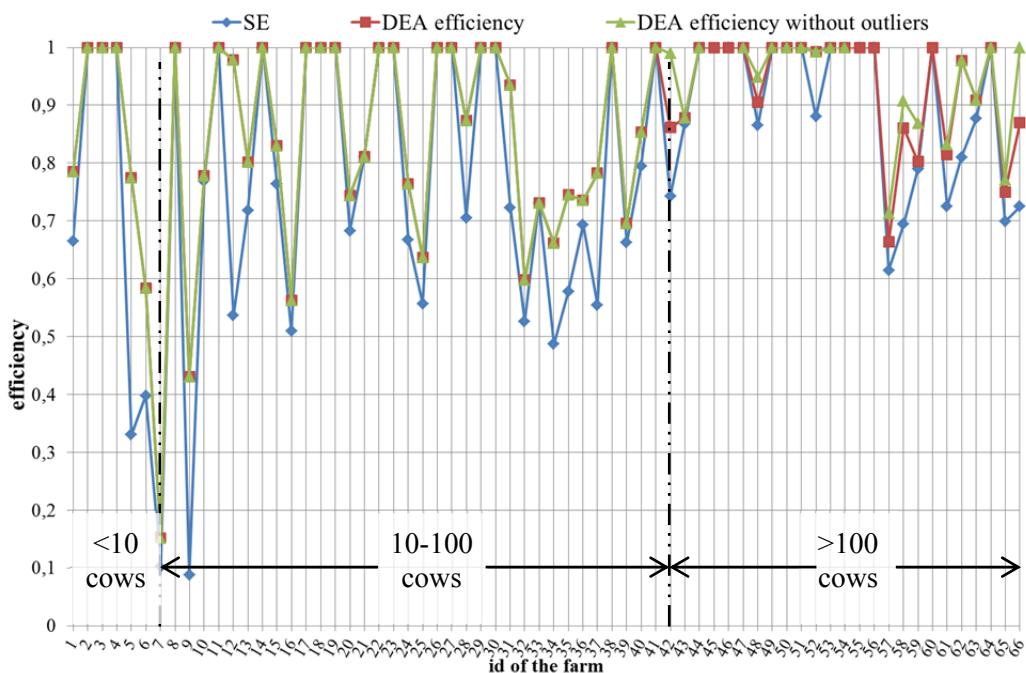
Summing up it can be concluded, that from the data acquisition point of view there are three top priority issues require special attention: (1) what kind of resources/inputs are used, (2) with what kind of result/output and (3) how are the used resources combined.

According to the extensive assessment results, proxy variables derived from the FADN are not necessary suitable for assessing the environmental efficiency, might provide misleading conclusion. FADN indicators should be used only in case of proven quality and suitability. This step must be performed before the assessment and compulsory includes each and every capital forms represented by the chosen indicators. In line with the conventions, the proxy variables are only acceptable in case the results with the different indicators are strongly related to each other (e.g. the correlation is at least 0,9).

Results of the farm level assessment

According to the section about the used data, the sustainable efficiency of the farms – specialized dairy farms – are calculated using two different indicator models. Accepting its limits, basically the „B” model should be seen as the better elaborated and the professionally more established. Outliers are identified using box-plot figures. The result of this shows, that almost all of the identified outliers are extremely large farms. However, regardless of there small number their share in the output is substantial and similar farms are also present in the population as well. Therefore, their inclusion in the analysis is reasonable. This decision is further confirmed by the fact, that DEA efficiency results are almost identical with and without the outliers (Figure 1). The outliers are situated on the peer of the frontier and can be considered as efficient.

Therefore the analysis is performed using the entire panel dataset.



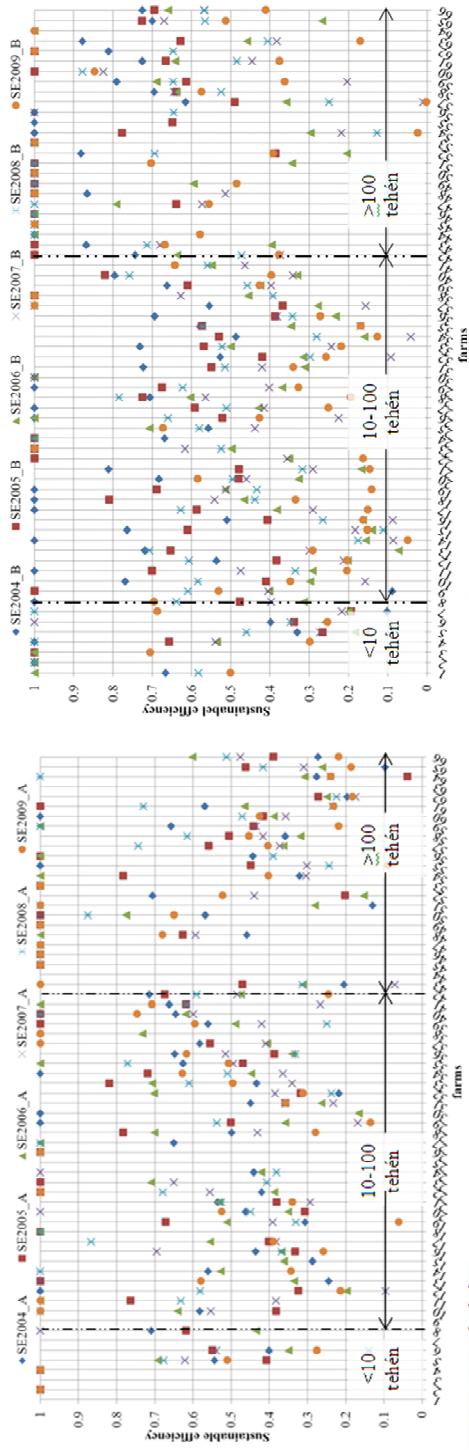
Source: own calculation

Figure 1.: Comparison of SE and DEA efficiency results (with and without outliers), based on 2004 FADN data

Figure 1. compares the result of three different approaches based on the herd size identified by the structural analysis of the Hungarian diary sector. Most farms have better than 0,5 efficiency and fall between 1 and 0,5. The largest farms have the least scattered results and at the same time the different approaches have the least divergence.

Based on the distribution results of both data models, SE results do not have not normal distribution and differ year by year. It can be concluded, that the frequency of better SE results are decreasing through time, while the worse are increasing.

According to Figure 2., that while some farms experience relatively stable results between the years, others have significant variation. The overall tendency is more visible if the results are plotted in ascending order (Figure 3.). This reveals, that the line representing the different years is slowly shifted towards lower values, meaning that on average the sustainability performance is decreasing. Comparing the results of the two models unfolds similar patterns. However, in case of model „B” more decided difference is observable both in case of specific farm variation and between relative rank differences.



Source: own calculation

Source: own calculation

Figure 2.: The variation of SE values between farms according to „A” (left) and „B” (right) data models, 2004-2009

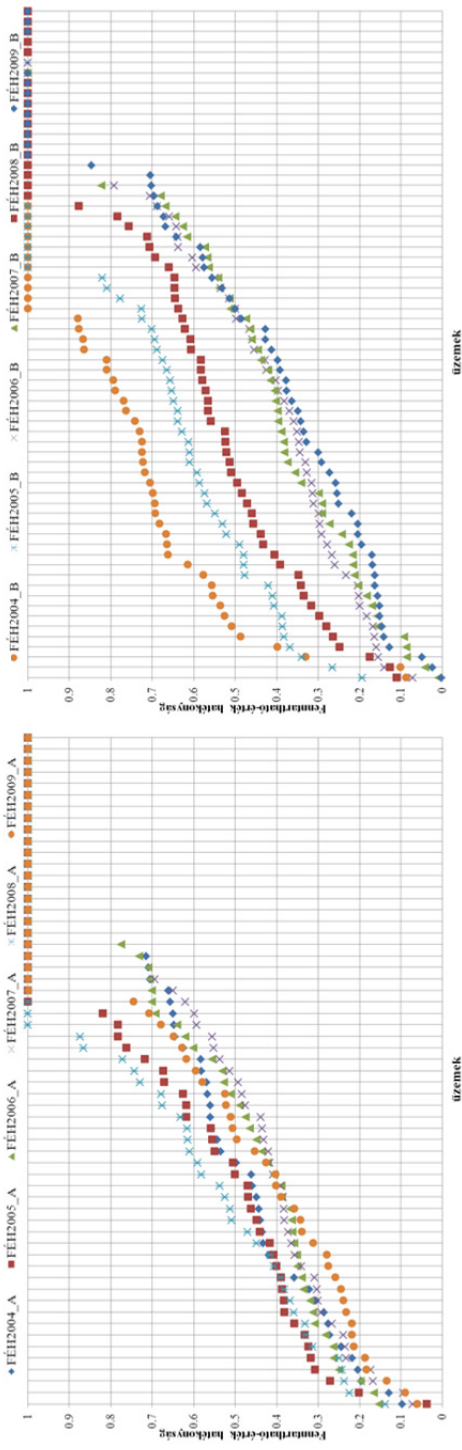


Figure 3.: The variation of SE values between years according to „A” és „B” data models, 2004-2009

Causes of SV difference

The correlations between the SE values⁵ are all – except one – significant and show weak or moderate positive correlation (Table 1.). Based on this we can conclude, that on average the same farm have better sustainability performance. Moreover, the results of the earlier years are less related to the latest ones. This might indicate the EU accession or other general structural change and even at this point call the attention to a more detailed analysis of the issue of heteroskedasticity.

Table 1.: Correlation between the SE values, based on FADN panel data, 2004-2009

	SE2004	SE2005	SE2006	SE2007	SE2008	SE2009
SE2004	1,000	,449**	,412**	,373**	,331**	,226*
SE2005		1,000	,617**	,647**	,383**	,493**
SE2006			1,000	,714**	,540**	,648**
SE2007				1,000	,521**	,690**
SE2008					1,000	,668**
SE2009						1,000

** significant at 0,01, * significant at 0,05

Source: own calculation

Based on the average values presented in Table 2. the best SE values are attained by individual or family farms and have better agricultural qualifications. The age of the farm manager shows no difference. Farms with better sustainability performance produce less milk and have higher share of grassland. The worse performing farms have higher share of own land and capital and compare to the best ones receive two times larger investment subsidy. Finally, there is difference between the best and worse performer farms regarding their Net Value Added (NVA) and specific indicators based on it (better farms have lower values).

⁵ Considering, that the „B” data model is considered as a better basis for assessing sustainability performance in this case, the influencing variables are analysed only for the SE values attained using that model only.

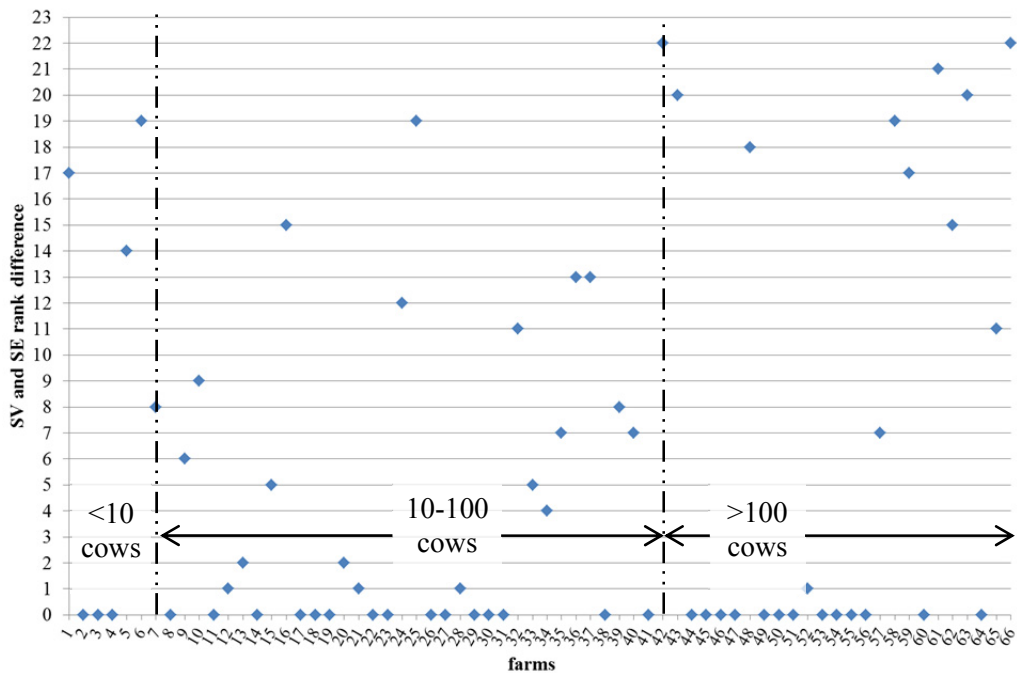
	All farms (avg.)	Best 10% (avg.)	Worst 10% (avg.)
Sustainable efficiency	0,63	1,00	0,14
Legal form (0=individual, 1=corporate)	0,32	0,25	0,28
Agricultural qualification [manager] (0=non, 1=any)	0,71	0,78	0,75
Age of the manager (year)	52,21	52,13	53,95
Produced milk (ton)	1494,46	1084,44	1130,47
Stocking density (LU/UAA ha)	1,44	1,30	1,29
Share of pasture (%)	26,83	30,17	24,37
Share of own land (%)	40,60	42,52	51,66
Share of all subsidies in gross income [SE605/SE410] (%)	0,53	0,54	0,52
Investment subsidies [SE406] (€)	3492,64	1113,05	2899,00
Share of own capital (%)	76,18	77,16	80,64
Net value added (1000 Ft)	63 434	52 748	47 083
Specific net value added (Ft/kg)	55,54	50,82	55,91
Proportion of income relative to the production value	16,66	16,77	17,56

Correlations between the indicators – which are useful selecting possible dummy variables – are presented in Table 3.

[illegible]

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It is observable, that rank obtained using sustainable value versus sustainable efficiency is significantly different, which confirms the importance of size necessary to consider in the assessment (Figure 4.).



Source: own calculation

Figure 4.: Difference between SV and SE ranking, 2004

A stepwise strategy using several tests was used in order to select the best effect-model. Moreover, during model selection several alternative independent variables were tested. Due to length limits, the thesis only presents the summary of the different model results (Table 4.).

Table 4.: Comparing different effect-model results

Model	Independent variables	coefficient	significance (p value)
Baseline	age	-0,0140934	0,709
	square of age	0,0001336	0,689
	produced milk	0,0000272	0,339
	share of subsidy	0,0072091	0,645
	specific FNVA	-0,0000766	0,877
Version 1. (robust, random-effect, GLS estimation)	legal form	-0,0866449	0,137
	qualification	-0,0144211	0,757
	age	0,0353366	0,008
	square of age	0,0003337	0,012
	produced milk	0,0000161	0,092
	share of subsidy	0,0174162	0,152
	specific FNVA	-0,0002028	0,622
Version 2. (robust, random-effect, GLS estimation)	legal form	-0,0880112	0,172
	qualification	-0,0327412	0,509
	produced milk	0,0000276	0,000
	share of subsidy	0,0176189	0,162
	specific net value added	-0,0005308	0,172
	stocking density	0,0232667	0,197
	share of grassland	0,0024675	0,010
	investment subsidy (lagging)	-0,0000043	0,048
Version 3. (robust, random-effect, FGLS estimation)	legal form	-0,113995	0,018
	qualification	-0,0358638	0,254
	produced milk	0,0000289	0,000
	share of subsidy	0,0308978	0,012
	specific net value added	-0,0008042	0,010
	stocking density	0,0406685	0,003
	share of grassland	0,0028033	0,000
	investment subsidy (lagging)	-0,0000053	0,003
Version 4. (robust, random-effect, PCSE estimation)	legal form	-0,0934534	0,103
	qualification	-0,0314243	0,423
	produced milk	0,0000283	0,001
	share of subsidy	0,0218031	0,107
	specific net value added	-0,0005452	0,154
	stocking density	0,0287561	0,070
	share of grassland	0,0025051	0,003
	investment subsidy (lagging)	-0,0000045	0,020

Source: own calculation

Although several significant influencing variables are identified, the explanatory power (between R^2) – even for the best model – is rather low. The best model is only capable to explain around one fifth of the variation between the SE values with the variables used.

After selecting the best effect-model, the hypothesis defined in the objectives can be answered:

- The legal form of the farm has significant effect on the sustainability performance in case of the best effect-model. Individual or family farms perform better compare to corporate farms. However, considering the fact that the variable is not significant in all cases, it should be treated as an unstable influencing factor.
- The agricultural qualification of the farm manager has no significant effect on the sustainability results.
- The economic size has significant effect on the sustainability performance; the larger the farm the better the SE value.
- Both the share of grassland and the stocking density are significant influencing variables; the larger the share of grassland and/or the stocking density the better the SE value.
- The (agricultural) subsidies have significant effect on the sustainability performance; the share of income related subsidies positively, while the investment subsidies negatively affect the SE value.
- The economic performance (profitability) shows significant correlation with the sustainability performance; the increase of economic efficiency decreases the SE value.

Comparison with the international results

Results of the German assessment based on the herd size of the farm shows, that both the smaller (less than 25 cows) and the larger (more than 100 cows) farms are having better sustainability performance than medium size (50-100 cows) ones. The weighted DEA score of farms is 0,56, while about half of the farms have efficiency score between 0,4 and 0,6. The most efficient farms have 300 ha on average and at the mean time have more than average number of cows with better individual production. However, there absolute economic performance is worse, as a result of more labour use⁶. The following table (Table 5.) provides an overall summary about the farm level results and conclusions of different SVAPPAS project partners.

Table 5.: Farm level results of SVAPPAS project partners⁷ for dairy farms⁸

⁶ Their specific FNVA or AWU performance is better.

⁷ The Hungarian results were not available at the moment the referenced papare was pulished.

Switzerland	<p>Factors Contributing to SE (Sustainable Efficiency):</p> <p>→ Positively: Proportion of para-agriculture in total farm output, Organic Farming, Farm Size</p> <p>→ Negatively: Part-time farming, Age, Borrowing Rate, Intensity of Conc. Use Organic farms exhibit High Sustainable Efficiency.</p>
Germany	<p>High Intensity & Large farms → Better Economic Performance.</p> <p>Conventional & non-LFA farms → Better Economic Performance.</p> <p>Organic & LFA farms → Better Ecological Performance.</p>
Italy	Farms with ecological practices attain better sustainability performance.
Belgium (pig farms)	<p>Specialised Farms → Higher fluctuation in output.</p> <p>Land Productivity → Initially higher on specialised farms, differences declining.</p> <p>Energy and Capital Productivity → Declining.</p> <p>SV discounting risk: no differences between specialized and mixed farms</p> <p>SV accounting for risk: mixed farms performed better than specialized farms.</p>
Belgium (specialized dairy farms)	<p>Using different benchmarks results different resource re-allocation. Therefore different conclusions can be made.</p> <p>Farms using ecological practices outperform farms with standard practices. Ecological farms are situated closer to the meta-frontier.</p>
Finland	Sustainability Values depend on benchmark estimating method. No broad conclusions on farm performance, efficiency, or sustainability. No superior method, situation contingent.

Source: Srinivasan, M. and Jan, P. (2010)

Results of the sector level analysis

While previously individual farms and their sustainable efficiency and the influencing variables were assessed, the next part assesses the sustainability performance at sector level using the aggregation methodology presented before.

The goal of the sectoral/regional level analysis is to provide support for policy decision making. In this way different sectors or regions might be compared. The results presented in this section are not easy to interpret. In order to limit this shortfall, the results are compared with the output of the sector and also with results of other project partners.

The results are negative by construction, since in the DEA model, the frontier envelopes the observed data from above and only farms with $SV = 0$ are diagnosed as efficient. The aggregate SV of the Finnish dairy sector resulted in

⁸ Except one – indicated – belgian analysis, which is conducted about pig farms.

about -16.5 million Euros (-16,521,842 €) for the year 2004, with efficiency score of the representative farm equal to 0,649.

The Hungarian results are questionable and ambiguous in many ways. The representative („average”) farm in 2004 has a sustainable-value efficiency value of 0,71, which only slightly differs from the Finish result. However, between 2005 and 2008, the representative farm is situated on the peer of the frontier, meaning it is efficient and therefore the entire sector is also efficient. This contradicts with the results attained at the farm level, where it was evident, that the share of inefficient farms is about the same compare to 2004 or 2009. An important aspect might explain part of the results is the fact, that the weights have been changed from 2004 to 2009. The average weight was 24,2 in 2004, while 35,8 in 2009, which explains about a 30% increase of the SV. Considering the output of the sector, in 2004 the sector level laggard is around 40% and 15% in 2009, which later is a much better improvement results from the SE progress of the representative farm.

Conclusions and proposals

Conclusions

The refined sustainable value approach keeping the core ideas of the original method – opportunity cost thinking, market efficiency –, eliminating the critiques being drawn provides new possibilities to put sustainability in practice. However it is important to emphasize, that the approach should not be seen as an ultimate and sole method to be used, but rather as a complement, auxiliary one to the existing approaches whose results should be always considered.

The FADN is only capable to provide information to SV assessment to a limited extent. Therefore sustainable value assessment based solely on FADN data should be considered with reservations and should be confronted with results of different approaches with the same goal.

Based on the panel regression results – in line with the hypotheses set in the objectives – the legal form of the farm, its economic size, the economic efficiency significantly affect the sustainability performance and reject that the agricultural qualification of the manager affect the sustainability performance. Moreover, because of strong correlation with the other variables no definite conclusion is presented regarding the share of own land. Both the share of grassland and the stocking density are significant influencing variables. The larger the share of grassland and/or the stocking density the better the SE is. In addition, agricultural subsidies significantly affect SE, the share of subsidy in the income positively, while the investment subsidies negatively affect the

sustainability performance. Finally, the increase of economic efficiency decreases the sustainability performance.

Proposals

Considering the revealed incompleteness of the FADN system, further research work is needed to detect at farm level the missing or underrepresented capital forms. This should cover a wide range of possible solutions and data acquisition inside and outside the FADN. This later should also study the possibility of joining existing data sources. Altogether, the solution should be always based on a cost-benefit analysis to find the most suitable and affordable alternative.

The sustainable value method holds further possibilities providing policy decision making support. For example it would be also possible to assess the consequences of introducing some kind of an efficiency target or resource use barrier.

Based on the detailed review of the underlining concepts and their relation to the FADN (Molnár, 2010), the following recommendations can be made:

- Use of table about capital stock and flow pairs.
 - *Help to clarify confusions and to avoid double-counting.*
- Table should be created about complements/substitutes⁹ on the input side.
 - *This should be in line with the production function for a given production activity.*
- Table should be created about inputs used in a given production and their second best alternative.
 - *Help to verify scarcity.*
- Recommended to construct fact sheets for all variable/indicator used. A good example is provided by the SEAMLESS project practice (Olsson et al., 2009).

Beyond FADN, the use of other data sources is highly recommended. The most challenging task to this regard is to arrive to a homogenous unit of measurement and system boundaries.

⁹ Note, that in most cases only a certain degree of substitution/complementarity exists and there are - however in a limited number of - cases when perfect complementarity takes place.

New scientific results

1. I analysed the suitability of the FADN system to provide the necessary indicators in order to implement sustainable values assessment. Based on this investigation I found that the FADN system – in line with its primary goal – is mostly suitable to provide information about economic processes. However, social and environmental issues might be studied based on FADN data to only a limited extent. I developed processes, which support the indicator selection for sustainable value assessment. These auxiliary tables facilitate the basic underlining assumptions of the sustainable value approach. This includes helping to identify possible double-counting issues (through the use of stock-flow pairs), to grasp the appropriate production relationships (through the substitutability and complementary of resources) and finally to confirm resource scarcity and opportunity cost (through identifying alternative resource uses).
2. Using FADN panel data with different data models, the sustainability performance of Hungarian specialized dairy farms was assessed for the period of 2004-2009. Based on the results I determined that the use of different data models has no effect on the results assessing sustainability performance. However, in case of time series analysis, the results slightly differ. Moreover, I found that the farms experience different rate of change in terms of their sustainability performance; while there are farms having relatively stable results, others face with significant fluctuation or instability.
3. The assessment of the sustainability performance of specialized dairy sector – represented by the 66 farms analysed before – was carried out using FADN panel data for the period 2004-2009. According to the results of this investigation, I determined, that in 2004, the dairy sector had very similar performance – on average 0,71 – compared with the Finish results (0,65) performed with the exact same methodology. However, between 2005 and 2008, as opposed to the farm level results, the sector performed at maximum sustainability, which certainly requires further investigations, which is beyond the scope of the PhD dissertation. The result attained for 2009 is again comparable with the 2004 one, and shows progress as the average sustainable efficiency increased to 0,87. However, the results are worth considering the fact that the experienced change in the weights used in the calculations are significantly affect the overall outcome of the assessment. This fact makes it much more difficult to compare the results. The “output” – or in other words the sustainability performance – of the sector lag behind by some 40% in 2004 and due to the improvement mentioned before it has been dropped to 15% by 2009.

4. Based on existing results about the possible variables that have influence on sustainability performance, the best effect-model was attained for the period of 2004-2009 using panel data of 66 specialized dairy farms. The best model was found comparing different regression estimation methods – least square, GLS, FGLS – and by using different tests to reveal certain important properties – such as heteroskedasticity – of the farms described by the data. Based on the best effect model, I found the following results:
- a. The economic size, the share of grassland, the stocking density, the agricultural subsidies and the specific income potential are found to have significant affect on sustainability performance (as expressed by the SE value). The corporate legal form, the economic efficiency (profitability) and the investment subsidies reduce, while the economic size, the share of grassland, the stocking density and the income subsidies increase the farm level sustainability performance (or in other words SE value).
 - b. The agricultural qualification of the farm manager does not affect significantly the sustainable efficiency.
 - c. Regarding the legal form of the farm, due to the ambiguous results, it cannot be taken as a stable influencing variable.

Related publications

Academic book, book chapter published in Hungarian

1. Biró, Sz., Dorgai, L.(szerk.), **Molnár, A.** (2009): Ártermelő állattartásunk és a 'kölcsonös megfeleltetés' alkalmazása”. Agrárgazdasági Tanulmányok, Agrárgazdasági Kutató Intézet, Budapest, HU ISSN 1418 2122, p. 170.
2. Dorgai, L., Ludvig, K., Márkus P., **Molnár, A.**, Pesti, Cs., Székely, E., Tóth, E., Udovecz, G. (2008): A közvetlen támogatások feltételezett csökkentésének társadalmi-, gazdasági- és környezeti hatásai (első megközelítés). Agrárgazdasági Tanulmányok, Agrárgazdasági Kutató Intézet, Budapest, HU ISSN 1418 2122, p. 134.

Peer reviewed articles, published in foreign languages

3. Sarah C. Davis, Joanna I. House, Rocio A. Diaz-Chavez, **A. Molnar**, Hugo Valin and Evan H. DeLucia How can land-use modelling tools inform bioenergy policies?. Interface Focus 2011 (1), doi: 10.1098/rsfs.2010.0023, pp. 212-223.
4. **Molnár, A.**, Vandenbroucke, P. (2010): Structural and land use change of farm sin the periurban area of Budapest – Case study of Veresegyház subregion. Studies in Agricultural Economics, Issue 112., ISSN: 1418-2106, pp. 83-97.
5. Edelman, M., Hueth, B., **Molnár, A.**, Otto, D. (2003): „Economic and Environmental Impacts of Biomass Energy Utilization in Rural Communities: A Case Study of the Chariton Valley Biomass Project”, working paper, Iowa State University, Department of Economics, p. 50.

Peer reviewed articles, published in Hungarian

6. Popp, J., **Molnár, A.** (2010): Közös Agrárpolitika 2013 után: kihívások és lehetséges válaszok. Gazdálkodás, 54. évf., 1. sz., pp. 2-25
7. Biró, Sz., Dorgai, L., **Molnár, A.** (2010): A kölcsönös megfeleltetés (cross compliance) jogi háttere és lehetséges gazdasági következményei ártermelő állattartó gazdaságokban. Gazdaság és Jog, 18. évf., 1. sz., pp. 21-25.
8. **Molnár, A.** (2009): A mezőgazdaságban keletkező biomassza energetikai hasznosításának agrár-közgazdasági összefüggései. Gazdálkodás, 53. évf., 6. sz., pp. 620-626.
9. **Molnár, A.** (2008): Gondolatok a mezőgazdaság és a környezet kapcsolatáról, A Falu, 2008. XXIII. Évf. 3. sz., pp.61-72.

Published scientific conference presentation or paper, in foreign language

10. Markó, B., **Molnár, A.**, Popp, J. (2010): Environmental security. Növénytermelés, 59. évf., Suppl. pp.609-612.
11. **Molnár, A.** (2008): Applying Sustainable Value Methodology for Hungarian Agriculture. XII.th Congress of European Association of Agricultural Economics, Ghent, Belgium, 26-29 August 2008, <http://ageconsearch.umn.edu/bitstream/44139/2/234.pdf>
12. **Molnár, A.** (2008): Bioenergy - with or without rural development?. Central European Biomass Conference 2008, Graz, pp. 107
13. **Molnár, A.**, Singh M. K. (2006): The environmental effects of the energy utilization of agriculture produced biomass considering economies of size and scope. Ecological problems of our days - from global to local scale – nemzetközi tudományos konferencia, 2006. November 30. – December 1., Keszthely, ISBN-10: 963-9639-14-1
14. **Molnár, A.** (2006): The role of biomass in the context of rural development. Az alternative energiaforrások hasznosításának gazdasági kérdései – nemzetközi tudományos konferencia, 2006. November 8-9., Sopron, ISBN: 978-9364-82-0
15. **Molnár, A.** (2006): New aspects in the cost-benefit analysis of agriculture based biomass energy production. 2nd International Conference on Business, Management and Economics, Yasar, 2006. június 15-18., p. 6.
16. **Molnár, A.** (2004): Economic Impacts of Biomass Energy Utilization in Rural Communities: A Case Study of the Chariton Valley Biomass Project. IX. Nemzetközi Agrárökonómiai Tudományos Napok, Gyöngyös, 2004. március 25-26., ISBN 963 214 313 2 CD kiadvány, p. 6.
17. **Molnár, A.** (1998): Cutting height and timeliness losses of *Miscanthusxgiganteus*. 4th Seminar on Energy and Environment, Szent István University, Gödöllő, 1998, pp. 14.

Published scientific conference presentation or paper, in Hungarian

18. **Molnár, A.** (2010): Számszerűsített fenntarthatósági teljesítmény. Az Élhető Vidékért 2010 környezetgazdálkodási konferencia Siófok, 2010. szeptember 22-24. ISBN 978-963-229-871-9 pp. 308-317
19. **Molnár, A.** (2010): Vidékfejlesztési támogatások területi aspektusai. Geográfia – 2010 – Pécs, 2010. november 4-6.
20. **Molnár, A.** (2007): A Nemzeti Vidékfejlesztési Terv környezetgazdálkodási intézkedéseinek tapasztalatai – különös tekintettel a térbeli megoszlásra. Földminőség, Földértékelés és Földhasználati Információ – A Környezetbarát Gazdálkodás Versenyképességének Javításáért Országos Konferencia és Tanácskozás, Keszthely, 2007. November 22-23., pp. 203-211.

21. **Molnár, A.** (2006): A megújuló energiaforrások szerepe és lehetősége a vidékfejlesztésben. Sapientia Erdélyi Magyar Tudományegyetem, Cork +10 Konferencia, Csíkszereda, 2006. október 13-14., p. 8.
22. **Molnár, A.** (2006): A mezőgazdaságban keletkező biomassza energetikai hasznosításának szerepe és lehetőségei, különös tekintettel az elméleti közgazdasági összefüggésekre. X. Nemzetközi Agrárökonómiai Tudományos Napok, Gyöngyös, 2006. március 30-31., ISBN 963 229 623 0 CD kiadvány, p. 5.

Scientific report

23. Farkasné dr. Fekete, M., Hustiné Béres, K., **Molnár, A.**, Naárné Tóth, Zs., Vas, J. (2010): A fenntartható fejlődés, a klímaváltozás és a földhasználat változása társadalmi-gazdasági tényezőinek összefüggése. Project Report. A T 048531 számú OTKA kutatás zárójelentése. In: Holl András (szerk.) Repository of the Academy's Library: REAL-OTKA. Budapest: OTKA, 2010. pp. 1-8.
24. Popp, J., Potori, N., **Molnar, A.**, Garay, R., Varga, E. (2008): Expert report for EnerCap; 2008. Project evaluation: BHD Biomass Project – 49.9MW, Szerencs, Hungary Request for Fuel Supply Due Diligence Assistance
25. **Molnár, A.** (2010): Final dataset description. SVAPPAS WP3 D5.4., AKI, Budapest p. 35.
26. **Molnár, A.** (2010): Recommendations on a data collection. SVAPPAS WP3 D5.3., AKI, Budapest, p. 50.
27. Duffy, M., Chung, K., Edelman, M., Hueth, B., **Molnár, A.**, Otto, D. (2002): Economic Impacts of Renewable Generation Technology on Rural Economies: Literature Review and Proposed Methodology. working paper, Iowa State University, Department of Economics, 2002, p. 27.

Other periodical

28. **Molnár A.**, Cruse, R. M. (2007): A bioüzemanyagok jelenlegi és jövőbeni szerepe az USA-ban. Mag. kutatás, fejlesztés és környezet, 21. évf., 2. sz., pp. 12-16.
29. **Molnár, A.**, Singh, M. K., Nagy, H., Percze A. (2007): Barriers and opportunities of sustainable bioenergy production in Hungary. Cereal Research Communications, 35. évf. 2.(2)., pp. 793-796.

Other publication

30. **Molnár, A.** (szerk.), Hamza, E., Székely, E., Varga, E. (2010): Az EU társfinanszírozásával megvalósuló főbb vidékfejlesztési intézkedések átfogó értékelése. Agrárgazdasági Információk, Agrárgazdasági Kutató Intézet, Budapest, HU ISSN 1418 2130, p. 111.
31. Tanító, D., Felkai, B. O., Fogarasi, J., Tóth, K., Kemény, G., **Molnár, A.**, Papp, G., Popp, J., Potrori, N., Tóth, O., Varga, T. (2010): Tények és szempontok a 2014-2020 közötti KAP reformjához. Agrárgazdasági Információk, Agrárgazdasági Kutató Intézet, Budapest, HU ISSN 1418 2130, p. 117.