Comparing Sustainable Value Approach, Data Envelopment Analysis and indicator approaches - An application on German dairy farms

Markus Ehrmann
Johann Heinrich von Thünen-Institut (vTI) / Institute of Farm Economics, Braunschweig, Germany

This document presents results obtained within the EU project SSPE-CT-2006-44215 on Sustainable Value Analysis of Policy and Performance in the Agricultural Sector (http://www.svappas.ugent.be). It does not necessary reflect the view of the European Union and in no way anticipates the Commission's future policy in this area

ABSTRACT

Abstract— **Objective of this paper is to compare different measurement concepts for sustainability at farm level in Germany: a) Sustainable Value Approach (SV), b) Data Envelopment Analysis (DEA) and c) indicator approaches close to KUL (Criteria for an Ecologically Compatible Land Management). The mathematical programming model FARMIS is extended wrt the underlying subject and applied for quantitative analysis. Indicators based on physical inputs are calculated based on monetary data of national FADN data. The methods are applied to a sample of about 4000 representative dairy farms. Results of SV are given in both absolute values and return-to-cost ratios which take farm size into account. Considering relationships between methods we found out that correlation between DEA and SV results are higher than 0.75. The indicator methods show correlations with the other approaches of more than 0.5 for economic indicators but a rather low correlation for ecological indicators. Further we identified characteristics of farms with high efficiency and sustainable performance. In order to show differences of used methods results are given by regions, size classes and orientation of production. Results indicate that bigger farms generate higher Sustainable Value. Farms in less favourable areas show a lower performance with regard to Sustainable Value and efficiency than farms located in other areas.**

Keywords— **Sustainable Value Approach, agriculture sustainability**

I INTRODUCTION

Sustainability is a multifunctional concept and thus not easy to assess or to evaluate. It includes the ecological, economic and social dimensions of sustainability [1]. Sustainability follows a normative approach; the Brundtland Commission [2] defines sustainability as a concept which meets the present needs without compromising the needs of future generations. The UAA of Germany covers about 17 million hectares, which amounts to almost half of the total area [3]. Therefore the agricultural sector affects the sustainable development significantly. An important aim of German agricultural policy is to measure and support sustainable development of farms [4]. Different approaches can be used to measure sustainability at farm level [5, 6, 7]. Moreover indicator sets were developed by the European Commission [8] or the OECD [9]. Another methodology, the Sustainable Value Approach (SV), follows an idea of financial economics that the return to costs has to cover the costs of capital [10]. Embedded in an EU research project this approach will be tested and applied for the agricultural sector. It compares efficient capital (resource) usage of a firm with a specific benchmark.

A Objective

The objective of this paper is to assess the sustainability performance of German dairy farms by using the Sustainable Value Approach, the Data

Envelopment Analysis (DEA) and indicator approaches and to compare the used methods.

Outcomes of mentioned methods will be shown and assessed by grouping the dairy farms into different size classes, intensities and other farm characteristics. Some extensions of the Sustainable Value approach, which are necessary for the adoption to the agriculture sector, will be shown.

II DATA

Farm accounting data of farms included in the German Farm Accountancy Network (FADN) were used. For calculations data of 4093 dairy farms from the financial year 2004/2005 were used. Results are projected by using weighting factors to achieve estimation for the total German dairy sector. In the calculations, almost none of the farms have missing values for the resources included in farm accounts. Farms with missing values for labour, UAA, capital or energy are excluded.

III METHODS AND MODIFICATIONS

A Description of included resources

Resources: For the calculations, physical inputs of seven resources were used:

- Total labour
- Energy
- Three nutrients (Nitrogen, Phosphorus, Potassium)
- Agricultural area (UAA)
- Capital

As some of the resources are only available in FADN as monetary accounts, physical inputs are derived with the farm group model FARMIS[1]

Output: Adjusted Farm Net Value Added

In a first step, profits are corrected by expenses and gains from other accounting periods [11]. Subsequently the FNVA of farms are calculated. Within FNVAs the costs for the expenditures of fertilizers and energy are already subtracted, whilst the costs for labour, UAA and the interest are not taken into account. In adjusted-FNVAs the amount of costs related to the included resources and accounted in the FNVA are added (expenditures for fertilizer and energy) All farms with a negatively adjusted-FNVA are not included, due to the fact that DEA calculations are not feasible with negative outputs and the SV calculation should be comparable with the DEA results. In this way a harmonised sample of farms is constructed, which is necessary for the comparison of methods.

B Sustainable Value Approach

The Sustainable Value approach is value based; the main objective is to measure farm sustainability by comparing value added of farms and with their bundles of resources with a benchmark. This benchmark can be defined as opportunity costs of considered resources. A positive Sustainable Value shows that a farm generates Sustainable Value, whereas a negative Sustainable Value indicates that other farms (benchmark) would provide higher values by using same resources. The Sustainable Value approach is also evaluating efficiency [12].

Calculation of the Sustainable Value

The Sustainable Value is calculated as described in Formula 1 and 2:

---

[1] For further information about FARMIS or methodological issues wrt to calculation of inputs and output, please contact the author

$$SV_{ir} = \left(\frac{y_i}{x_{ir}} - \frac{Y^*}{X_r^{\ *}} \right) * x_{ir} \qquad (1)$$

$$SV_i = \frac{1}{R} \sum_{r=1}^{R} SV_{ir} \qquad (2)$$

SV being the Sustainable Value, y stands for the Value Added of the farm i or the benchmark (*) and x for the amount of the used resources r of the farm i or the benchmark (*). In this calculation seven resources r are considered. In a first step the Sustainable Value SV_{ir} of each resource r is calculated. The value contribution of resource r of the benchmark * is subtracted from the value contribution of farm i of resource r. The total value contribution of resource r is calculated by multiplying total amounts of used resources with the value spread of the resource r. In a second step total Sustainable Value SV_i of each farm is calculated by summing up all SV_{ir} and dividing the sum by the number of included resources R. This step is necessary to avoid double counting of value creation [13]. To divide the resources by the number R of included resources doesn't mean that each resource has the same weighting. FIGGE and HAHN state that the weighting of the considered resources depend on their importance for value generation [10].

In Germany the size of the farms is very different and thus the level of the FNVA, too. The return to cost ratio takes the farm size into account and is calculated as described in formula 3. A return to cost ratio greater than one shows that the farm is more productive than the benchmark [14]

$$return\_to\_cost_i = \frac{y_i}{y_i - SV_i} \qquad (3)$$

In general benchmarks can be determined by e.g. a) value of best practice farms, b) the average or c) the values of the national economy. In this study the weighted average[2] of all included farms is taken for benchmark calculation. One main outcome of the Sustainable Value should be to rank farms and different farms or production systems wrt efficient resource use.

C Data Envelopment Analysis

To compare the results of the Sustainable Value Approach, the relative efficiency is calculated with Data Envelopment Analysis (DEA) [15]. The DEA is based on a linear programming approach and evaluates relative efficiencies of individual farms in comparison to the efficient farms. DEA is a non-parametric approach, thus it is not necessary to specify a functional relationship between inputs and outputs. For this calculation, an input oriented DEA model is used [16] as follows.

$$\min_{\lambda} \theta^0 \qquad (4)$$

$$\sum_{i=1}^{\pi} \lambda^i \ y^i >= y^0 \qquad (5)$$

$$\sum_{i=1}^{\pi} \lambda^i x_r^i \ <= x_r^0 \theta^0 \qquad \forall \ r = (1\ldots m) \qquad (6)$$

$$\sum_{i=1}^{\pi} \lambda^i = 1 \qquad (7)$$

For $\lambda^i \geq 0 \qquad \forall \ i = (1\ldots \pi)$

For the farm under consideration (farm 0) the input efficiency θ^0 should be minimized. Therefore, the outputs y of all farms (i = 1…π) should be at least as high as the output of the farm under consideration y0, where λ^i represents the level of

[2] For benchmark calculation all farms are weighted with the individual weighting factor and thus represent most parts of the German dairy sector (about 90000 farms)

each farm i and the sum of all λ^i must be one. Moreover, the total of inputs r of reference farms (x^i) must be less or equal to inputs r of the farm under consideration (x^0) multiplied by the farms efficiency factor θ^0. A farm is determined as relatively efficient if θ^0 achieves the value one, which means that no other farm can reach the output more efficiently than the farm under consideration (farm 0). The farms which achieve the value $\theta^0 = 1$ form the efficient frontier and are used for the other farms to measure their relative inefficiency. In the DEA analysis the same resources and same output as in the SV-calculations are included. In DEA and SV approach a ranking of farms is possible: a) with DEA by the relative efficiency, b) with SV by sustainable value contribution and the return-to-cost ratio. A comparison of different rankings will be shown later on.

D Indicator model KUL/USL

The assessment system KUL (Criteria for an Ecologically Compatible Land Management) has been developed by the Thueringer Landesanstalt fuer Landwirtschaft (TLL) since 1994. In an earlier stage, it aimed at recording and assessing ecological damage by agricultural enterprises. Since 2004, KUL has been extended with regard to a comprehensive assessment of sustainability (economic, ecological and social). The complete system is described as KSNL (Criteria for sustainable farming). A short overview of the system is given in Ehrmann and Kleinhanss [17]. In this study, indicators which can be derived from FADN data were used. Ecological and economic indicators are calculated with the same sample used by the other methodologies. Thereby the objective is not to describe each of the single indicators but to compare indicator approaches with DEA and SV.

Ecological indicators

In KUL, the indicators are transformed into a uniform scale (rating) ranging from one to eleven (Table 1). The optimum conditions get the rating one. Moreover, a tolerance range is defined by the greatest tolerable charges (rating 6). Deviations going beyond tolerances are classified as damage potential. Intermediate scales within tolerance ranges are based on linear deviations from the optimum, while those beyond are based on logarithmic deviations. A modification factor of each indicator is included to adjust the assessment function to special features of locations. These modification factors are not taken into account by using FADN data[3].

Economic indicators

To analyse the interaction between the Sustainable Value, DEA and economic indicators, eight indicators are calculated as shown in Table 2 by the methodology described in [11, 18]. The target values are based on criteria for economically sustainable farming (KWL) [19]. Assessment functions for the economic indicators were not available. Therefore, assessment is limited and exclusively shows whether indicator values of the farms are within a specific tolerance range or not. The percentage part of economic indicators inside the tolerance range can be calculated.

[3] For more detailed information about calculations of indicators, please contact the author.

Table 1: Tolerance range and target values of ecological indicators

Criteria	Dimension	Optimum (Rate 1)	Tolerable level	Modification factor
Mineral balances				
Nitrogen balance	kg N/ha·a	0 ... 20	-50 ... +50	Leakage water
Phosphorus balance	kg P/ha·a	0	-15 ... +15	P-class
Potassium balance	kg K/ha·a	0	-50 ... +50	K-class
Humus balance	kg C/ ha	0	-75 ... +300	Content class
Pesticides use				
Intensity of pesticides use	€/ha·a	< 70	< 120	Share of arable cops
Biodiversity/landscape				
Crop diversity	Index	> 2.2	> 1.25	Median of plot size
Plot size	ha	< 20	< 40	Location

Source: TLL (2002), http//www.tll.de/kul-old/use-02.htm and Umwelttestbetriebsnetz Thüringen 2003/04.

Table 2: Tolerance range and target values of economic indicators

		Rating		
Indicator	Unit	1	6	10
Income	1 000 €/AWU	> 50	> 25	< 10
Profit ratio	%	> 10	> 0	< -6
Remuneration of factors	%	> 130	> 90	< 75
Net debt service	%	< 33	< 100	> 100
Change of owner's equity	€/ha UAA	> 160	> 0	< -100
Change of owner's equity	1 000 €/AWU	> 10	> 0	< -6
Net investment	1 000 €/AWU	> 10	> 0	< -6
Farm net value added	€/ha UAA	> 1 200	> 700	< 400

Source: Bachmann (2006).

IV Results

Sustainable performance of the German dairy sector is described in the following chapter. On the one hand, the average Sustainable Value is given in absolute figures. On the other hand, the return-to-cost ratio, which takes the size of the farm into account, is shown. We focus on the comparison evaluation of various approaches. In a first step, the results of the Sustainable Value calculation, the DEA and the indicator approaches are shown. Subsequently the different approaches and their impact on conclusions will be described.

A Results of Sustainable Value (SV)

A positive SV figure indicates that the return of resource use of a farm exceeds a specific benchmark (opportunity costs) where a negative figure states that farms use their resources less efficient than the benchmark. As described above a weighted average of all farms serves as benchmark. From this follows that by calculating the weighted mean or by summing up the SVs of all farms the total becomes zero. While Sustainable Value presents an absolute figure, the return-to-cost ratio (SV_rc) is a relative measure. The return-to-cost ratio calculated with the weighted average SV of Germany is one.

… size class and intensity

Return-to-cost ratios of farms with more than 100 dairy cows are higher than of farms with less dairy cows. Also, farms with milk yield exceeding 10,000 kg/cow/year have a return-to-cost ratio of 1.32 which is almost twice as high as of farms with a milk yield lower than 4000 kg/cow/year (Table 3).

… by LFA/ non LFA regions and organic/ conventional production systems

The results of the Sustainable Value calculation indicate that performance of organic farms (return-to-cost ratio of 1.11) is higher compared to conventional farms (return-to-cost ratio of 0.995). Farms which are located in less favoured areas show a lower return to cost ratio than farms outside LFA regions (Table 4).

Table 3: Results of the different approaches by size classes and intensities

	SV €	SV_rc	DEA rel. eff.	Ecol_KUL[1)] rating	Econ_Crit[2)] %
<=25 Cows	-4,200	0.86	0.61	4.62	29
>25-50 Cows	-1,358	0.97	0.50	5.12	41
>50-100 Cows	6,918	1.08	0.54	5.67	56
>100-200 Cows	26,456	1.17	0.62	5.94	66
>200 Cows	65,860	1.10	0.75	5.27	69
<=4 T kg/cow	-10,216	0.68	0.60	4.72	23
>4-6 T kg/cow	-4,722	0.89	0.56	4.66	32
>6-8 T kg/cow	2,082	1.03	0.55	5.18	44
>8-10 T kg/cow	12,773	1.14	0.58	5.93	56
>10 T kg/cow	58,043	1.32	0.72	6.90	79
< 25 UAA	-1,790	0.93	0.68	4.79	30
25-<50 UAA	-2,063	0.95	0.52	4.95	36
50-<100 UAA	2,165	1.03	0.51	5.35	49
100-<150 UAA	6,358	1.05	0.53	5.38	57
150-<500 UAA	10,316	1.06	0.58	5.33	55
>=500 UAA	85,080	1.09	0.84	4.44	68

1) Rating with the assessment function of KUL; a low value describes a better performance.
2) Percent of criteria values inside the tolerance range; a higher value describes a better performance.

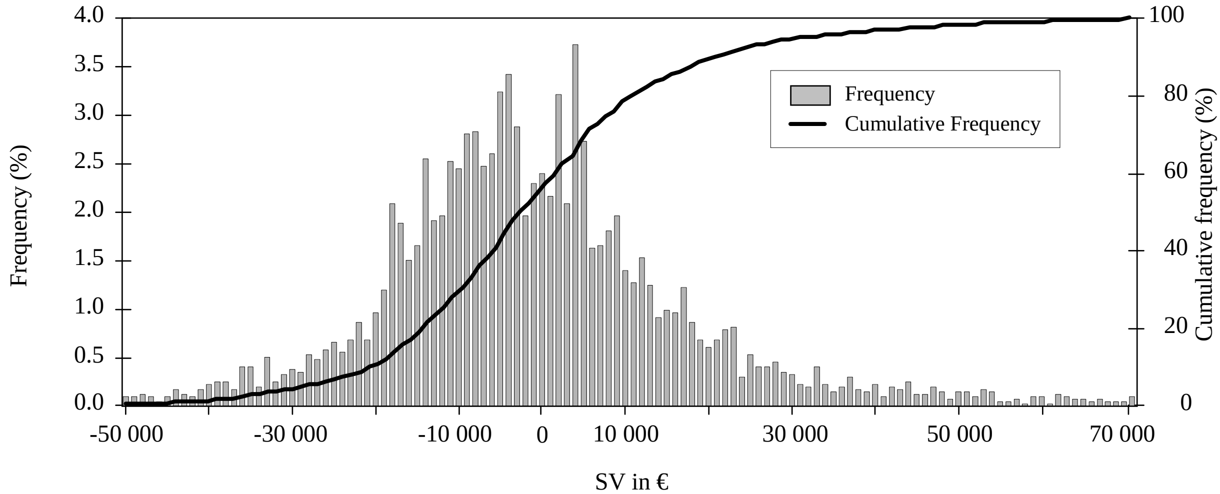

Figure 1: Frequency (%) and cumulative frequency (%) of Sustainable Value

Frequency of Sustainable Value

In Figure 1 an overview of the weighted frequency distributions of the Sustainable Value is shown. The 4093 dairy farms represent about 89,933 farms in Germany. The lowest SV is at -327,703 € and the highest value is at 987,575 €. The median is negative (-2,188), which shows that the majority of farms have a Sustainable Value lower than zero. The frequencies of Sustainable Values are calculated in classes with a range of 1,000 €. We can observe that 79 % of German farms have a SV between -20,000 € and 20,000 €, and about 49 % of the farms are within the range between -10,000 € and 10,000 €.

B Results of the Data Envelopment Analysis

In the following section results of an input oriented DEA model are shown. The calculation was done with all farms, included in the other approaches and the results were grouped later. The weighted average DEA efficiency of all included farms is 0.56.

Frequency of DEA results

In Figure 2 the weighted frequency of the DEA results, calculated with a range of 0.05, is shown. About 50 % of the farms show efficiency between 0.4 and 0.6. About 57 % achieve efficiency greater than 0.5 and 11 % show a relative efficiency greater than 0.8. Overall 85 of 4093 included farms are determined with an efficiency of “1”. As it is shown in Figure 2, these farms represent 5.9 %[4] of German dairy farms. On average the efficient farms have 299 ha were less efficient farms farm 71 ha. Also the efficient farms keep more dairy cows and achieve a higher milk yield. The return per hectare of the efficient farms is lower than the average of all farms because they employ more workers. But the group of efficient farms show the highest adjusted-FNVA per ha as well as per AWU.

[4] 2.1 % of farms show an efficiency of “1” without weighting farms with the aggregation factor.

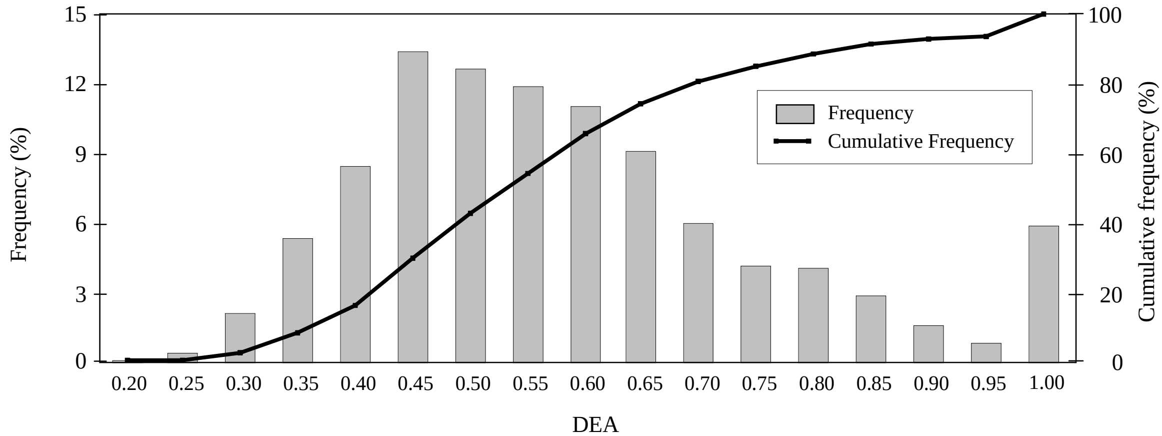

Figure 2: Frequency (%) and cumulative frequency (%) of Data Envelopment Analysis

… size class

According to DEA results the biggest farms achieve the highest efficiency, but small farms show better results than farms of median size classes (Table 3). One reason is, that farms with less than 25 hectares need a lower amount of nutrients and UAA per 1,000 € of output than medium size farms while the small farms need more of resources capital and labour[5].

… by LFA/ non LFA regions and organic/ conventional production systems

The DEA results record that organic farms show a efficiency of 0.66 in comparison to the conventional farms with an efficiency of 0.56 (Table 4). One reason is that the organic farms use a lower amount of nutrient per 1,000 € FNVA. The DEA results don't differ much between LFA and non LFA regions and thus indicate that the farms in LFA regions have the same efficiency than farms in non LFA regions wrt the considered inputs (Table 4).

C Results of the indicator approaches

Economic (Econ_Crit) and ecological (ECOL_KUL) indicators are calculated to compare the results of the other two approaches. Only six ecological indicators were calculated and therefore not every ecological issue is taken properly into account. Nevertheless the relative differences between the farms can be described with the indicators[6]. To compare the results of DEA and SV the percent share of economic indicators inside the tolerance range is given. It isn't the goal of this paper to describe the individual results of the indicators, but the main outcomes are shown in the following section.

… size class and intensity

The economic performance of size classes is similar; farms with more than 200 cows reach the target values in almost 70 % of indicators. The opposite effect can be observed for ecological indicators where farms with less than 25 cows show the best rating with an average of 4.62, and 79 % of these farms are inside the tolerance range (Table 3).

[5] For further information about DEA results and characteristics of efficient and less efficient farms contact the author

[6] The level of the rating might not be correct, e.g nutrient use in this calculation is lower than described by BMELV, 2006 [3].

Table 4: Results of used approaches for different shares of LFA and organic and conventional production systems

	SV €	SV_rc	DEA rel. eff.	Ecol_KUL[1] rating	Econ_Crit[2] %
Conventional farms	-274	0.995	0.56	5.13	39
Convert to organic	2,971	1.06	0.60	4.26	36
Organic farms	4,194	1.11	0.66	3.76	37
0 % LFA	5,116	1.08	0.57	5.78	45
0-50 % LFA	3,040	1.05	0.57	5.23	44
50-99 % LFA	-1,135	0.98	0.54	4.85	39
100 % LFA	-2,770	0.94	0.56	4.70	35

1) Rating with the assessment function of KUL; a low value describes a better performance.
2) Percent of criteria values inside the tolerance range; a higher value describes a better performance.

Farms with more than 500 hectares have the best rating in the ecological indicators (rating 4.4) and achieve the tolerance ranges of about 68 % of economic indicators. The second best rating of ecological indicators can be observed in farms with less than 25 hectares but these farms achieve only 30 % of ecological indicators. The most intensive farms with highest milk yields per cow show a high economic performance, but also the worst ecological rating, whereas farms with low milk yield show an inverse picture.

… LFA/non LFA regions and organic/conventional production systems

Ecological indicators indicate that organic farms have a higher performance. The conventional farms achieve the tolerance range of 39 % of the economic criteria, but the organic farms also achieve 37 % of economic target values (Table 4). Farms in less favoured areas show an ecological rating of 4.7, which is better than the farms in non LFA regions, but a lower share of economic targets can be observed in these regions, too.

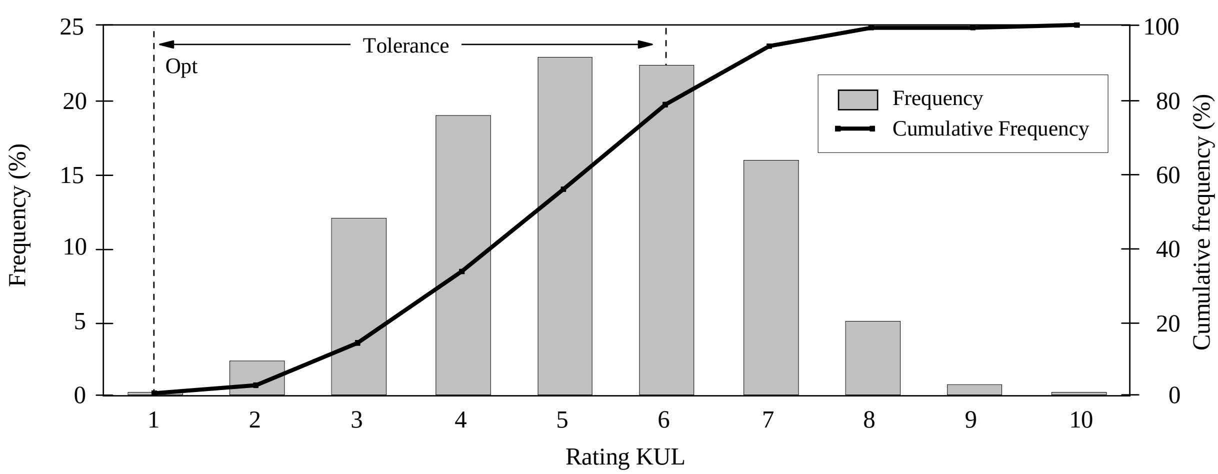

Figure 3: Frequency (%) and cumulative frequency (%) of ecological indicators (KUL)

Frequency of indicator approaches

In Figure 3 the frequency of the farms and their (KUL) classification is given. 68 % of farms are inside the tolerance range.

In Figure 4 the frequency of economic indicators being inside the tolerance range are given. It is conspicuous that about 13 % of the farms don't reach the target values of at least one economic indictor. On the other hand, almost 7 % of farms are able to reach the requirements of each economic indicator.

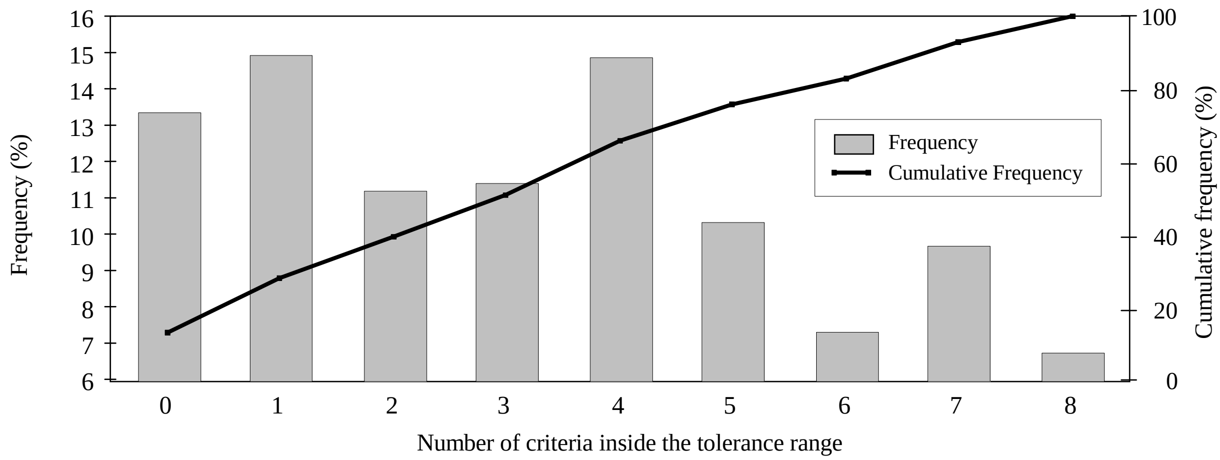

Figure 4: Frequency (%) and cumulative frequency (%) of the number of economic indicators inside tolerance ranges

D Comparison of the different approaches

In the following chapter it will be analysed if differences of assessments between methods exist. The objective is to evaluate if the different approaches indicate the similar results or if they indicate opposite results and thus lead to different conclusions.

Differences of the approaches…

… by farm size and intensity

Results of SV-calculation and economic indicators wrt size classes are similar; farms with 100 to 200 cows show a return-to-cost ratio of 1.17 and in farms with more than 200 cows target values in almost 70 % of economic indicators are reached. The opposite picture can be observed for ecological indicators where farms with less than 25 cows show the best rating with an average of 4.62 and 79 % of these farms achieve the tolerance range. The DEA doesn't give a clear picture; the biggest farms have the highest value but small farms achieve almost the same result as farms with 100 to 200 cows. The results of the SV-calculation, the DEA and economic indicators show that farms with a higher milk yield per cow have a higher performance. The ecological indicators give an inverse picture; with an average rating of 6.9, the intensive farms are outside the tolerance range (Table 3).

… by LFA/ non LFA regions and organic/ conventional production systems

The return-to-cost ratio, the DEA results and the ecological indicators indicate that organic farms have a higher performance than conventional farms (Table 4). The conventional farms achieve - with 39 % of the economic indicators - the tolerance range and thus show a better performance than the organic farms. The organic farms also achieve 37 % of economic target values. Farms with 100 % of less favoured areas show the lowest return-to-cost ratio and farms with less than 0 % of LFA have the highest value. The DEA results indicate that farms between 50 and 99 % LFA have the worst performance. But the DEA results don't differ much between LFA and non LFA regions and range between 0.54 and 0.57 (Table 4) Farms in less favoured areas show an ecological rating of 4.7 which is better than the farms in non LFA regions, thereby especially the Shannon index[7], the humus balance and the pesticide use are responsible for the better rating. The economic indicators show a clear ranking where farms with no LFA range at place one and farms with 100 % LFA at place four.

E Correlations between sustainability concepts

The Spearman[8] correlations between the different approaches are shown in the following.

For understanding of correlations it is necessary to take into account that a lower rating of ecological indicators indicates a better performance, compared to the other approaches where higher values are attached to a better performance. Therefore, if the correlation with ecological indicators is negative results show in a similar direction. The correlation of the DEA with the Sustainable Value is 0.789[9]. Also the correlation of DEA and SV with economic indicators is greater than 0.5[10]. Correlations of all approaches with ecological indicators (Ecol_KUL) are lower than 0.15, which indicates that almost no relationship between the results particularly with SV and DEA exist. The return-to-cost ratio and the absolute Sustainable Value show a high correlation (0.946) and thus correlations of return-to-cost ratio with other approaches are similar to SV (Table 5).

[7] Measurement figure for biodiversity

[8] The Spearman correlation takes the ranking of the farms into account.

[9] The Pearson correlations of DEA with SV is 0.551 and with return-to-cost ratio 0.734

[10] Note that the ranking of economic indicators is limited by the number of indicators inside the tolerance range.

Table 5: Spearman correlation between SV, return-to-cost ratio, DEA, economic and ecological indicators

	SV_tot	SV_rc	DEA	Ecol_KUL[1)]	Econ_Crit[2)]
SV_tot	1	0,946 ***	0,789 ***	0,012	0,656 ***
SV_rc		1	0,762 ***	0,008	0,658 ***
DEA			1	-0,049 ***	0,520 ***
Ecol_KUL[1)]				1	0,130 ***
Econ_Crit[2)]					1

* significant at 10 %; ** significant at 5 %; *** significant at 1 %

1) Rating with the assessment function of KUL; a low value describes a better performance.

2) Percentage of criteria values inside the tolerance range; a higher value describes a better performance.

V RECOMMENDATIONS AND CONCLUSIONS

The different approaches show different results. In the following section, the main results and some methodological aspects are described.

SV_tot

Farms with 100 to 200 cows show the highest return-to-cost ratio; intensive farms with a high milk yield per cow, too. Also the SV indicates that organic farms and farms in non-LFA regions have a better performance than conventional farms and farms in LFA regions.

DEA

The DEA results show that big farms are efficient but also farms with less than 25 cows are seen as more efficient than farms with 50 to 100 cows. Intensive farms as well as organic farms show a high efficiency whereas only a small difference between LFA and non LFA regions can be observed.

Economic and ecological indicators

The ecological and economic indicators point in an opposite direction wrt regional and farm characteristics. The analysis by size class and intensity shows that a high intensity and size is linked to a high economic performance. Organic farms and farms in LFA regions are seen as more ecologically compatible, but the conventional farms and farms in non-LFA regions reach the target values of more economic indicators.

Conclusions

Sustainability is an approach which mainly depends to national or global level. Nevertheless it is possible and necessary to assess aspects of sustainable performance on firm level. The used calculations don’t reflect all dimensions of sustainability properly; therefore the results of all the approaches are limited by the included resources. The value based assessment is a new approach and needs further research and development wrt the agriculture sector. To take farms size into account return-to-cost ratio as relative measurement figure is more useful particularly to compare different farms. The question of the appropriate benchmark can not be answered in this paper and depends on the individual research question. In addition to aggregated figures it is important to take the different resource SVs into account. The efficiency approach wrt assessment of sustainability issues is useful but efficiency is only part towards sustainable development but doesn't take all dimensions properly into account. The DEA result gives also one single figure and thus the identification of "problem areas" is difficult. The results of the indicator approaches depend on the chosen indicator set which was limited by data. Also the definition of the assessment function and the tolerance range has an important effect to the results. In comparison to the other approaches, which assess relative performance of farms, defined target values wrt sustainability exist. Overall the social dimension of sustainability is difficult to assess and none of the calculation in this paper takes social aspects properly into account. The results of DEA, Sustainable Value and economic indicators lead in most assessments to similar conclusions. In contrast to the high correlation between Sustainable Value and DEA rather low correlation with the ecological indicators can be observed. Moreover, results of SV and economic indicators are rather contrary to ecological indicators. In every case it seems to be reasonable to use more than one approach for the assessment, to get a more detailed and comprehensive picture of the individual dimensions and issues of sustainability.

VI REFERENCES

1. BARBIER E-B (1987): The concept of sustainable economic development. Environmental conservation: An international Journal of environmental sience 14:101-110
2. BUNDTLAND KOMMISSION (1987): Unsere gemeinsame Zukunft. Eggenkamp Verlag, Greven.
3. BMELV (2006): Statistisches Jahrbuch für Ernährung Landwirtschaft und Forsten. Münster.
4. BMELV (2008): Nachhaltige Land- Forst- und Fischereiwirtschaft. http://www.bmelv.de/cln_044/nn_749972/sid_21A8570A9B054D66904311B99C9BD5CF/DE/11-Forschung/Nachhaltigkeit/Nachhaltigkeit.html__nnn=true
5. HÜLSBERGEN KJ (2003): Entwicklung und Anwendung eines Bilanzierungsmodells zur Bewertung der Nachhaltigkeit landwirtschaftlicher Systeme. Shaker Verlag, Aachen.
6. SCHAFFNER A, HÖVELMANN L (2007): Der DLG-Nachhaltigkeitsstandard „Nachhaltige Landwirtschaft–zukunftsfähig. DLG Frankfurt.
7. TLL (2006b): Umwelt-Testbetriebsnetz Thüringen 3. und 4. Auswertejahr (2003/04) Ergebnisse und Schlussfolgerungen. USL-Projektstelle des VDLUFA beim Verband für Agrarforschung und -bildung (VAFB) Jena.
8. EUROPÄISCHE KOMMISSION (2000): Mitteilung der Kommission an den Rat und das Europäische Parlament: Indikatoren für die Integration von Umweltbelangen in die Gemeinsame Agrarpolitik, KOM(2000)20. Brüssel.
9. OECD (1997): Environmental indicators for agriculture. Paris: OECD.
10. FIGGE F, HAHN T (2005): The Cost of Sustainability Capital and the Creation of Sustainable Value by Companies. Journal of industrial ecology 9:47-58
11. DLG (2006): Effiziente Jahresabschlussanalyse: Einheitliche Erfolgskennzahlen für landwirtschaftliche Betriebe aller Rechtsformen. 2. vollständig überarbeitete Neuauflage. Arbeiten der DLG, Band 194. DLG-Verlag, Frankfurt am Main
12. FIGGE F, HAHN T (2004): Sustainable value added - measuring corporate contributions to sustainability beyond eco-efficiency. Ecological Economics 48(2), 173-187
13. VAN PASSELS S (2007): Assessing sustainability performance of farms: an efficiency approach. Ghent University, Ghent, Belgium.
14. HAHN T, LIESEN A, FIGGE F, BARKEMEYER R (2007): Nachhaltig erfolgreich Wirtschaften Eine Untersuchung der Nachhaltigkeitsleistung deutscher Unternehmen mit dem Sustainable-Value-Ansatz. Berlin. http://www.new-projekt.de/downloads/newstudiekurzfassung.pdf
15. CHARNES A, COOPER WW, LEVIN AY, SEIFORD LM (1994): Data Envelopment Analysis: Theroy, Methodology, and Application. AH Dordrecht.

16. DYCKHOFF H, ALLEN K (1997): Produktions- und entscheidungstheoretische Begründung der Effizienzmessung mittels Data Envelopment Analysis (DEA). Aachen.

17. EHRMANN M, KLEINHANSS W (2007): Concepts for the evaluation of sustainable agriculture in Germany. (unpublished), Braunschweig.

18. TLL (2006a): Kriterien einer Wirtschaftsverträglichen Landwirtschaft. http://www.tll.de/ainfo/ksnl/kwl10606.pdf

19. BACHMANN D (2006): Ökonomische Nachhaltigkeit. Kriterien, Toleranzbereiche und Ergebnisse. TLL-Schriftenreihe „Landwirtschaft und Landschaftspflege in Thüringen", Jena. Heft 8: 49-62.

- Author: Markus Ehrmann
- Institute: Johann Heinrich von Thünen-Institut (vTI)
- Street: Bundesallee 50
- City: Braunschweig
- Country: Germany
- Email: markus.ehrmann@vti.bund.de