Review of existing methodologies and tools for measuring sustainability in rural areas

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Abstract

The sustainability discourse clearly gives priority to the so-called 'three-pillar model, according to which sustainable development should equally try to reach ecological, economic, and social goals. An increasing variety of methods is being proposed to address the question of the measurement of sustainable development. This paper covers an overview of various methodologies that seek to deliver sustainable areas and tools which are practically implemented to measure sustainable development. More specifically, 16 studies that have attempted to measure sustainability have been reviewed and classified, according to their objectives and tools. The main finding of this review is that, there have been very few attempts to define social and economic sustainability as independent dimensions of sustainable development. There is limited literature that focuses on economic and social sustainability to the extent that a comprehensive study of this concept is still missing.

1. Introduction

There is a growing awareness that a more comprehensive and sustainable approach of agriculture is needed (Vereijken 1997). As a result, several new approaches have been proposed, such as sustainable (Allen and van Dusen 1998; Edwards et al. 1990) or integrated (Vereijken and Royle 1989). A sustainable agriculture should maintain basic natural resources such as healthy soil, clean water, and clean air. It should support fair treatment of all people involved in the food system, from farm workers to consumers (EC COM 2000).

Taking into account the issues raised by the Communication: the CAP towards 2020, one of the main recommended strategic aims is: to maintain viable rural communities, for whom farming is an important economic activity creating local employment; this delivers multiple economic, social, environmental and territorial benefits. (EC COM 672/5 2010)

While the idea of the 'three pillars' is not really in dispute, the same cannot always be said for key objectives, operationalization, and the definition of indicators within the three pillars. As a general requirement, indicators have to be policy-relevant. They must provide - at an appropriate spatial level – factual information, which can guide policy-makers in their decisions while reflecting tradeoffs between the ecological, economic and social dimensions of sustainability. Indicators should help to identify policy fields where action is needed. They must help to monitor the impact of policy action and make it visible to the broader public. (EC COM Agriculture Directorate 2001). Ecological objectives seem to be the least disputed, followed by economic goals, but there is clearly a lot more disagreement about the definition of the main social objectives of sustainable development (Omannn and Spangenberg 2002). In case of objectives and indicators, it seems to depend on who defined them. Often, they comprise a theoretically unfounded selection of assumptions, goals, and indicators of socio-political provenance (Littig and Griessler 2005).

Sustainable development and the definition of indicators to assess progress towards sustainability have become a high priority in scientific research and on policy agendas. At a practice level, tools, instruments and metrics to foster social and economic sustainability are biased toward environmental sustainability. All the attempts to identify the main elements of sustainable development highlight that a comprehensive theoretical framework to a fully integrated approach to sustainability is still lacking and it is unlikely that one could be developed in the near future. This is due to the multifaceted nature of the concept of sustainability.

There is a general agreement that the different dimensions of Sustainable Development have not been equally prioritized by policy makers within the sustainability discourse. The division of indicators along the lines of the sustainability dimensions emphasizes the multi-dimensional nature of Sustainable Development and reflects the importance of integrating its dimensions. While taking into account the complex way the three dimensions are linked, this study focuses on a literature review for methodologies that seek to deliver sustainable areas. Sixteen studies that try to measure sustainability have been reviewed, analyzed and classified, according to their objective and tools. The aim of this classification is to point out in what ways, and to what extend the three dimensions are incorporated within sustainable development; and to examine if the different dimensions of sustainability are equally prioritized within the concept of sustainability (Burton 2000; Drakakis-Smith 1995).

The structure of the paper is as follows: Section 2 describes the concept and the dimensions of Sustainable Development. A short history of the progress of Sustainable Development Strategy is presented. Finally, the Monitoring of Sustainable Development Strategy is also presented in this Section. In the next Section (Section 3) there is a literature review on methodologies that have attempted to measure sustainability. The reviewed studies have been classified, according to their objectives, methodologies and tools. Moreover, in this Section, is presented a review of the sustainability indicators that have been used, in order to assess and measure sustainability. The final section summarizes the paper and suggests potential future directions in the measurement of sustainability.

2. Sustainable Development

The concept of Sustainable Development (SD) can be interpreted in many different ways, but at its core is an approach to development that looks to balance different, and often competing, needs against an awareness of the environmental, social and economic limitations we face as a society. Sustainable development is about ensuring that a certain welfare level can be sustained over time. This requires that combinations of various forms of capital stocks are available for production and consumption (natural, human and man-made capital) (Pearce 1993) (Faucheux and O´Connor 1998) (OECD 1995).

"SD is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts(International Institute for Sustainable Development):

- *the concept of needs, in particular the essential needs of the world's poor, to which overriding priority should be given;*
- *the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs.*

Many, however, believe sustainability is solely an environmental issue or more narrowly, an effort to reduce greenhouse gas emissions. As important as these are, true sustainability is much more. Sustainability recognizes the connection between a healthy environment, a vibrant economy, and a socially equitable community, the three E''s of sustainability (CEC 2009b; EC COM 79 2012).

Some combination of development, environment and equity or economy, society, and environment are found in most attempts to describe it. However, proponents of sustainable development differ in their emphases on what is to be sustained, what is to be developed, how to link environment and development, and for how long a time (Parris and Kates 2003).

2.1 Sustainable Development Strategy

Sustainable development is a fundamental and overarching objective of the European Union, enshrined in the Treaty. In 1999, the European Commission presented a proposal for a long-term strategy dovetailing policies for economically, socially and ecologically sustainable development (European Council 1999). The Sustainable Development Strategy (SDS) was first proposed by the Commission in May 2001, singled out a number of objectives and measures for future policy development in four priority areas': climate change, transport, public health and natural resources (EC COM 264 2001). is a framework for a long-term vision of sustainability in which economic growth, social cohesion and environmental protection go hand in hand and are mutually supporting (EC COM 400 2009).

The EU Sustainable Development Strategy (EU SDS), launched by the European Council in Gothenburg in 2001 and renewed in June 2006, aimed for the continuous improvement of quality of life for current and future generations.

In 2006 the European Council adopted a renewed SDS that sets out a single, coherent plan on how the EU will more effectively live up to these principles and the overarching objective of sustainable development enshrined in the Treaty. The plan consists of seven key challenges which must be tackled if Europe is to move along a sustainable development path and maintain current levels of prosperity and welfare (Council of the European Union 2006).

In recent years, the European Union has mainstreamed the objective of sustainable development (SD) into a broad range of policies. The Sustainable Development Strategy of the European Union (EU SDS), as revised in 2006, is a framework for a long-term vision of sustainability in which economic growth, social cohesion and environmental protection go hand in hand and are mutually supporting (EC COM 400 2009)

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At EU level, the SDS itself plays a central role in promoting the overall objective of sustainable development which is primarily promoted and monitored in the context of individual EU policies, The EU SDS has also been instrumental in developing sustainable development strategies at national and regional levels. Today, almost all EU Member States have their own national sustainable development strategies (NSDS) in place, in line with international recommendations of best practice (ESDN website).

2.2 *Monitoring Sustainable Development Strategy*

Measuring progress towards sustainable development is an integral part of the EU SDS, and it is Eurostat's task to produce a monitoring report every two years based on the EU set of sustainable development indicators (EU SDIs).

When it first adopted the SDS in 2001, the Commission was invited to 'evaluate implementation of the Sustainable Development Strategy. This report was a task first given to the Commission by the Lisbon European Council in 2000 as part of the monitoring and review process of the Lisbon Strategy. When the renewed strategy was adopted in 2006, the Commission was mandated to draw up a progress report on the implementation of the SDS, covering both the EU level and the member states, every two years. The 2006 SDS specifies that "to ensure an in-depth coverage of the complexity of sustainable development, the indicators are to be developed at the appropriate level of detail to ensure proper assessment of the situation with regard to each particular challenge." (Council of the European Union 2006). Eurostat has played a key role in developing and reviewing a set of sustainable development indicators for this purpose (EC COM 642 2007). In order to contribute to these progress reports, Eurostat has developed a set of Sustainable Development Indicators (SDIs). A first set of indicators was adopted by the Commission in 2005 (CEC 2005). Eurostat has so far published four monitoring reports, in 2005, 2007, 2009 and 2011. All these reports chart progress in the implementation of the strategy's objectives and key challenges (CEC 2007a),(CEC 2007b),(CEC 2009a),(CEC 2009b),(CEC 2011).

Sustainable development still remains a fundamental objective of the European Union. The strategy will continue to provide a long-term vision and constitute the overarching policy framework for all Union policies and strategies.

3. Review of methodologies and tools which seek to deliver sustainable areas

In this Section 16 methods were selected from a literature research. These methods all try to deliver sustainable areas. Most of them use a set of indicators to evaluate or measure sustainability. Only methods that were sufficiently different from each other, well documented and showing proof of having been actually used:

1. Paracchini et al. 2011 proposed a further advancement in integrated assessment procedures by setting up an operational multi-scale and transparent framework, which comprises the assessment of European regions in terms of sustainability, and the identification of the impact that policy options might have on the sustainability of these regions. The framework is designed for use in ex ante sustainability impact assessment of policy scenarios on multifunctionality of land use and integrates economic, environmental and social issues across a variety of sectors (agriculture, forestry, transport, tourism and energy).
2. Gomez-Limon and Sanchez-Fernandez 2010 developed a practical methodology for evaluating the sustainability of farms by means of composite indicators. This methodology was based on calculating 16 sustainability indicators that cover the three components of the sustainability concept (economic, social and environmental). The methodological proposal implemented in this paper allowed an integrated vision of agricultural sustainability and a careful selection of sustainability indicators, carried out on the basis of reliability criteria and applicability. The evaluation of farm sustainability using the methods suggested is a potentially useful tool for public decision-makers who are tasked with designing and implementing agricultural policy. The results demonstrated the usefulness of analyzing several sustainability indicators in conjunction, in order to obtain more robust results. They also enabled a visualization of farm heterogeneity within a single agricultural system with respect to sustainability. Such information could help to improve current agricultural policies (such as income policy, agricultural structure policy and rural development policy), with the aim of improving the sustainability of the sector.
3. Zahm et al. 2008 based on 41 sustainability indicators covering the three dimensions of sustainability, tried to design a self-assessment tool not only for farmers but also for policy makers to support sustainable agriculture. They used the IDEA method (Indicateurs de Durabilité des Exploitations Agricoles or Farm Sustainability Indicators) (Vilain 1999). The scientific approach is based on identifying three different scales of sustainability. The method is capable

of observing differences in sustainability between production systems. The proposed system of indicators does not claim to be final or to establish a model of sustainability that must never be changed. The conclusion is that there is not just one farm sustainability model, and therefore the indicators must be adapted to local farming before using the IDEA method.

4. Van Cauwenbergh et al. 2007 proposed a framework for sustainability assessment of agricultural systems, (Sustainability Assessment of Farming and the Environment - SAFE). The SAFE framework is composed of principles, criteria, indicators and reference values in a structured way. Principles are related to the multiple functions of the agro-ecosystem. In addition, in this study, they formulate consistent and objective approaches for indicator identification and selection. The multifunctional character of the agro-ecosystem encompasses the three pillars of sustainability: the environmental, economic and social pillars. Indicators and reference values are the end-products of the framework. They are the operational tools that are used for evaluating the sustainability of the agro ecosystems. The proposed framework is intended to serve as an assessment tool for the identification, the development and the evaluation of agricultural production systems, techniques and policies.

5. Abildtrup et al. 2006 presented an integrated approach to the construction of socio-economic scenarios required for the analysis of climate change impacts on European agricultural land use. The chosen scenarios ensured internal consistency between the evolution of socio-economics and climate change. This approach provides a useful tool for the quantification of scenario drivers and model parameters. Moreover, these tools are helpful at each step to facilitate the discussion and communication of the resulting scenarios.

6. Halberg et al. 2005 selected ten input–output accounting systems (IOA) systems covering the topics of the farm's use of nutrients, pesticides and energy, from a survey of 55 systems and compared them. The approaches and indicators used vary from systems based on good agricultural practices (GAP) to accounts based systems that use physical input–output units. IOA systems should be linked with production planning tools used by the advisory services. It is concluded that IOA systems could become effective tools for agri-environmental improvement of European farms given further development and standardization.

7. Rasul and Thapa 2004 examined the sustainability of two production systems in terms of their environmental soundness, economic viability and social acceptability. Twelve indicators were selected to evaluate sustainability. The study was based on empirical data collected through a household survey, soil sample analysis, observations and discussions. The findings

suggest that ecological agriculture has a tendency towards becoming ecologically, economically and socially more sound than conventional agriculture. Broad-policy measures are outlined for the promotion of ecological agriculture.

8. Glaser and Diele 2004 presented some central aspects of a sustainability assessment for a North Brazilian mangrove crab fishery. It was based upon a number of classical criteria from biology, economics and sociology. They intended to contribute to future resource management plans to improve the living conditions of current and future generations while ensuring the health and productivity of the crab population and the mangrove ecosystem they depend on. They also intended to advance the practice of sustainability assessment. Their results revealed that social and economic sustainability are being eroded while no threats to biological sustainability are currently apparent.

9. Lundin and Morrison 2002 presented a procedure for the selection of indicators, which reflects the environmental sustainability of urban water system. The chosen indicators were evaluated in Case Studies in a developed and a developing region. This procedure combined empirical results with a theoretical framework based on LCA methodology. Case Studies provided results which empirically defined the most important indicators for the system being studied and emphasized site-specific issues. They also helped to reveal information gaps and problems concerning availability and quality of information.

10. Girardin et al. 2000 have adopted an interaction matrix to evaluate the effects of farmer production practices on the agro-ecosystem. Evaluation models can be aggregated to yield two types of indicators: Agro-Ecological Indicators (AEI) reflect the impact of one production practice on all environmental components; Indicators of Environmental Impact (IEI) reflect the impact of all production practices. The evaluation matrix provided the raw material both for the development of indicators (AEI or IEI) and for the use of multicriteria methods for sorting, selecting, or classifying cropping or farming systems. Using an evaluation matrix, it is possible to develop tools that could help decision-makers (farmers, extension services, administrative) to make rational decisions concerning environmental as well as economic and social criteria. Moreover, agro-ecological indicators may be used to establish an agro-environmental control panel for the farm, to provide the basic information for a final indicator to synthesize knowledge about environmental conservation, and possibly to sort cropping systems according to their sustainability.

11. Onate et al. 2000 tried to evaluate the potential effects of Agri-environmental Regulation EC 2078/92 on European agricultural landscapes through the use of agri-environmental indicators (AEIs) on policy effects. The main effects may be catalogued as improvement effects or protection effects since they represent a change in participant over non-participant farmers' decisions. Finally, the importance of this type of policy evaluation approach is discussed in the light of the likely future development of AEP in the European Union. AEIs are an important tool for feeding information into the decision-making process. The approach presented in this paper shows clear signs of being operational even when applied to completely different agricultural landscapes with very different AEP measures being applied.

12. Pannell and Glenn 2000 presented a conceptual framework for the economic valuation and prioritization of sustainability indicators. The framework was based on Bayesian decision theory, particularly its use to calculate the value of information under conditions of uncertainty. They tried to fill the gap of a conceptual framework as basis for evaluation and sustainable development. The framework has revealed a number of important insights which should influence the choice of indicators for any given resource management problem.

13. The objective of the method proposed by Rossing et al. 1997 is the design of environmentally friendly flower bulb production systems. This study was carried out to bring together the fragmented agronomic information and to assess agrotechnical options (Audsley et al. 1997). Subjective components, one economic, two environmental objectives and various socio-economic constraints, were identified in interaction with the stakeholders. Interactive multiple goal linear programming was used to optimize the objectives at the farm level and determine the exchange value of the economic objective. The results revealed that the negative impact of environment-oriented production systems on farm gross margin is importantly mitigated by strategic choices at the farm level.

14. Biewinga and van der Bijl 1996 presented a method to assess ecological and economic sustainability of growing and conversion of crops to energy. This method was based on Life Cycle Assessment (LCA), which is a method that can be used to assess the environmental impact of agriculture (Hanegraaf et al. 1998), but in this case it considered additional indicators specific for agricultural production systems.

15. Haas et al. 2001 used the framework of a LCA in 18 grassland dairy farms covering three farming intensity levels. In this study, the selection of appropriate impact categories and functional units are emphasized, to fit specific agricultural and regional requirements in order to

compare the impact of farms (Haas et al. 2000)(Haas et al. 2000)(Haas et al. 2000). The objective of this study was to adapt the LCA method, developed for assessing the environmental impact of production processes, to agriculture on the whole farm level, efficiently and feasibly assessing all relevant environmental impacts.

16. Taylor et al. 1993 took into account 33 farmer production practices for producing cabbage. Each practice yields a positive or negative score. These scores are summed to a Farmer Sustainability Index (FSI), a single value reflecting ecological sustainability. FSI considers recent changes in practices, thus a farmer whose practices have been moving towards greater sustainability obtains a higher FSI than one who uses the same practices, but has not modified them.

The next tables present a classification of the reviewed studies. As a preliminary classification, in Table 1 we can see that the studies are divided in three groups, according to their objectives. Table 2 presents a classification of the reviewed studies, according to the methodologies and tools which they have used or adopted. As we can observe, about the half of the studies (43.75%) have presented a procedure which measures environmental sustainability, or have adopted a methodology, for assessing the environmental impact of production processes. All of them have used as tools indicators which best reflect environmental sustainability, such as Agro-Ecological Indicators (AEI) or Indicators of Environmental Impact (IEI).

On the other hand, the 37.5% of the analyzed studies attempted to examine all the three dimensions of sustainability: They set up a multi-scale framework, which comprises the assessment in the three dimensions of sustainability, or tried to evaluate the three dimensions sustainability by means of composite indicators. Additionally, other studies attempted to support sustainable agriculture by measuring environmental economic and social indicators covering the three dimensions of sustainability.

The last group of the studies, that covers the 18.75%, refers to different approaches to measure or assess sustainability. Abildtrup et al. have developed scenarios, for the analysis of climate change trying to ensure internal consistency between the evolution of socio-economics and climate change. Moreover, Biewinga and van der Bijl tried to assess ecological and economic sustainability, using environmental and additional economic indicators. Finally, Pannell and Glenn presented a conceptual framework for the economic valuation and prioritization of sustainability indicators.

Table 1. Classification of the studies according to their objectives

Objective of the Studies	Number of Studies	Percentage
Attempts to assess or measure all three dimensions of sustainability (economic, environmental, social)	6	37.50%
Focus only on environmental sustainability, or assessing environmental impacts	7	43.75%
Different approaches to measure or assess sustainability. (Consistency between socio-economic indicators and climate change, assessment of ecological and economic sustainability or economic valuation of sustainability indicators.	3	18.75%
Total	**16**	**100%**

Table 2. Classification of the studies according to the methodologies and tools

Environmental, Economic and Social Sustainability		
Author	**Objective**	**Methodologies and Tools**
Paracchini et al. 2011	integrated economic, environmental and social issues across a variety of sectors	operational multi-scale framework, which comprises the assessment in the three dimensions of sustainability
Gomez-Limon and Sanchez-Fernandez 2010	evaluated the three dimensions sustainability of farms by means of composite indicators	16 indicators that cover the three components of the sustainability concept
Zahm et al. 2008	designed a self-assessment tool based on the IDEA method to support sustainable agriculture	41 sustainability indicators covering the three dimensions of sustainability
Van Cauwenbergh et al. 2007	proposed a framework for sustainability assessment of agricultural systems, encompassed the three dimensions of sustainability	the framework is composed of principles, criteria, indicators and reference values in a structured way
Rasul and Thapa 2004	examined the sustainability in terms of environmental soundness, economic viability and social acceptability	12 indicators covering the three dimensions of sustainability
Glaser and Diele 2004	presented some central aspects for the assessment of the three dimensions of sustainability	criteria from biology, economics and sociology
Environmental Sustainability		
Halberg et al. 2005	selected ten input–output IOA systems as effective tools for Agri-environmental improvement	environmental indicators based on good agricultural practices (GAP)
Lundin and Morrison 2002	presented a procedure which measures environmental sustainability of urban water system, based on LCA methodology	indicators, which best reflect environmental sustainability
Girardin et al. 2000	adopted an interaction matrix to evaluate the effects of farmer production practices on the agro-ecosystem.	Agro-Ecological Indicators (AEI) and Indicators of Environmental Impact (IEI)
Onate et al. 2000	tried to evaluate the potential effects of Agri-environmental Regulation	Agri-environmental indicators (AEIs)
Haas et al. 2000	adapted the LCA method, for assessing the environmental impact of production processes	the whole farm level, efficiently and feasibly assessing all relevant environmental impacts
Taylor et al. 1993	tried to measure ecological sustainability taking into account recent changes in	Farmer Sustainability Index (FSI), a single value reflecting ecological sustainability.

	practices in the farm	
Rossing et al. 1997.	designed a framework for environmentally friendly flower bulb production systems	1 economic, 2 environmental objectives and various socio-economic constraints
Additional Studies		
Abildtrup et al. 2006	presented an approach for the construction of socio-economic scenarios required for the analysis of climate change impacts	scenarios that ensured internal consistency between the evolution of socio-economics and climate change
Pannell and Glenn 2000.	presented a conceptual framework for the economic valuation and prioritization of sustainability indicators	the framework was based on Bayesian decision theory calculate the value of information under conditions of uncertainty
Biewinga and van der Bijl 1996	tried to assess ecological and economic sustainability of growing and conversion of crops to energy	environmental and additional economic indicators specific for agricultural production systems.

The next Tables content the results of a more extensive review, focusing on studies applying sustainability indicators in order to assess or measure sustainability. Table 3 focuses on the studies that have used indicators which best reflect environmental sustainability, such as Agro-Ecological Indicators (AEI) or Indicators of Environmental Impact (IEI). As we can observe, all the studies focus on soil and water resource protection, energy use, pesticide use, water consumption and use of irrigation water and biodiversity. Table 4 is dedicated to a review of approaches that have tried to assess the three dimensions of sustainability, or tried to evaluate the three dimensions sustainability by means of composite indicators. The indicators that refer to environmental sustainability are similar to the ones mentioned above. The focus here is also on agro-environmental subsidy areas, animal well-being and diversity. Regarding the economic dimension of sustainability, the used indicators cover the fields of land productivity, of income of agricultural producers and the contribution of agriculture to GDP, they examine the dependency on direct or indirect subsidies and on external finance and they analyze farmer's agricultural and other market activities. Finally, regarding the social dimension of sustainability, the focus is on indicators that measure the well-being and the quality of life, such as culture, health, recreation, food security and safety. The used indicators examine also agricultural employment and the risk of abandonment of agricultural activities or risks and uncertainties involved in crop cultivation.

Table 3. List of Indicators for the assessment of environmental sustainability

Author	Indicators
Halberg et al. 2005	1. Nutrient use (Surplus N and P, Efficiency % output input 2. Energy use (Direct energy, MJ or MJ, Total energy Use) 3. Pesticide use (Treatment frequency index, Environmental impact points)
Lundin and Morrison 2002	1. Withdrawal - Annual freshwater withdrawal/annual available volume 2. Water consumption - Use per capita per day 3. Treatment - Chemical and energy use for water supply 4. Distribution - Leakage (unaccounted water/produced water) 5. Reuse of water - Reused water 6. Production - Wastewater production per day 7. Treatment -performance Removal of BOD5, P, N 8. Loads to receiving water - Loads of BOD5, P and N 9. Resource use - Chemical and energy use for wastewater treatment 10. Recycling of nutrients - Amount of P and N recycled 11. Quality of sludge - Cadmium content in sludge 12. Energy recovery -Energy recovered, heating and power
Onate et al. 2000	**Land-use level** 1. Scrubs - Area of scrub 2. Barren - land Area of barren land 3. Grassland - Area of grassland 4. Crops - (Arable area–Fallow area) 5. Fallow land - Area of fallow land 6. Irrigated land - Area of irrigated crops 7. Tree plantations - Area of tree plantations 8. Crop boundaries - Area (length) of boundaries 9. Hedgerows Area - (length) of hedgerows 10. Crops to fallow - Area converted 11. Fallow to crops - Area converted 12. Arable to tree plantations - Area converted 13. Arable to abandoned - Area converted **Management level** 14. Grain legume crops - Area of grain legume 15. Crops diversity - No. of crops with >5% of FA or GA 16. Fertilizers use Kg 17. Sprayers use Kg 18. Grazing stock density 19. Date of harvest
Haas et al. 2000	1. Resource consumption - Use of primary energy, Use of P- & K- fertiliser 2. Global warming potential - CO, CH,, N20-emission 3. Soil function/strain Accumulation of heavy metals, NH~, NO x, SO2-emission 4. Water quality - N-fertilising, N-farmgate-balance, potential of nitrate leaching, 5. P-fertilising, P-balance, % of drained area 6. Human and ecotoxicity - Application of herbicides and antibiotics, potential of nitrate leaching, NH3 emission 7. Biodiversity - Grassland (number of species, date of first cut), hedges & field margins (density, diversity, state, care) 8. Landscape image Grassland, hedges & field margins, grazing animals (period, breed, alpine cattle keeping), layout of farmstead (regional type, buildings) 9. Animal husbandry - Housing system & conditions, herd management (e.g. lightness, spacing, grazing season, care)

Table 4. List of Indicators for the assessment of the three dimensions of sustainability

Author	Indicators		
	Economic	**Environmental**	**Social**
Paracchini et al. 2011	1. Residential Ind. Services 2. Land based Production 3. Infrastructure	4. Abiotic Resources 5. Provision Habitat 6. Ecosystem Processes	7. Work 8. Health & Recreation 9. Culture
Gomez-Limon and Sanchez-Fernandez 2010	1. Income of agricultural producers 2. Contribution of agriculture to GDP 3. Insured area	4. Economic dependence on agricultural activity 5. Specialisation 6. Mean area per plot 7. Soil cover 8. Nitrogen balance 9. Phosphorus balance 10. Pesticide risk 11. Use of irrigation water 12. Energy balance 13. Agro-environmental subsidy areas	14. Agricultural employment 15. Stability of work-force 16. Risk of abandonment of agricultural activity
Zahm et al. 2008	1. Available income per worker compared with the national legal minimum wage 2. Economic specialization rate 3. Financial autonomy 4. Reliance on direct subsidies from CAP and indirect economic impact of milk and sugar quotas 5. Total assets minus lands value by non salaried worker unit 6. Operating expenses as a proportion of total production value	7. Diversity of annual or temporary crops 8. Diversity of perennial crops 9. Diversity of associated vegetation 10. Animal diversity 11. Enhancement and conservation of genetic heritage 12. Cropping patterns 13. Dimension of fields 14. Organic matter management 15. Ecological buffer zones 16. Measures to protect the natural heritage 17. Stocking rate 18. Fodder area management 19. Fertilization 20. Effluent processing 21. Pesticides and veterinary products 22. Animal well-being 23. Soil resource protection 24. Water resource protection 25. Energy dependence	26. Quality of foodstuffs produced 27. Enhancement of buildings and landscape heritage 28. Processing of non-organic waste 29. Accessibility of space 30. Social involvement Short trade 31. Services, multi-activities 32. Contribution to employment 33. Collective work 34. Organisation of space 35. Probable farm sustainability 36. Contribution to world food balance 37. Training 38. Labour intensity 39. Quality of life 40. Isolation 41. Reception, hygiene and safety
Van Cauwenbergh et al. 2007	1. Farm income 2. Dependency on direct and indirect subsidies 3. Dependency on external finance 4. Agricultural activities 5. Market activities 6. Farmer's professional training 7. Inter-generational continuation of farming activity 8. Land tenure arrangements 9. Adaptability of the farm	10. Supply (flow) of quality air function 11. Supply (stock) of soil function 12. Supply (flow) of water function 13. Water flow buffering function 14. Supply (flow) of energy function 15. Supply (stock) of biotic resources 16. Supply (stock) of habitat function 17. Biotic resource flow buffering function	18. Food security and safety 19. Physical well-being of the farming community function 20. Psychological well-being of the farming 21. community function 22. Well-being of the society
Rasul and Thapa 2004	1. land productivity 2. yield stability and profitability	3. land-use pattern 4. cropping pattern 5. soil fertility management, 6. pest and disease management 7. soil fertility status	8. input self-sufficiency 9. equity 10. food security 11. risks and uncertainties involved in crop cultivation

4. Discussion

This paper covers an overview of various methodologies that seek to deliver sustainable areas and tools which are practically implemented to measure sustainable development. In previous Section 16 studies that seek to deliver sustainable areas were selected from a literature research. These studies have been reviewed, analyzed and classified, according to their objective and tools. Although there are various international efforts on measuring sustainability, only few of them have an integral approach taking into account environmental, economic and social aspects, or attempted to support sustainable agriculture by measuring indicators covering the three dimensions of sustainability. In most cases the focus is on one of the three aspects (Singh et al. 2009). More specifically, most of the studies adopted a methodology, for assessing the impacts of environmental sustainability, or presented a procedure which measures environmental sustainability. The last group of the studies refers to different approaches to measure or assess sustainability, such as developing a conceptual framework for the economic valuation and prioritization of sustainability indicators or attempting to ensure internal consistency between the evolution of socio-economics and climate change.

The results outline the fact that a conceptual approach to economic and social sustainable development is still missing from the literature (Pearce and Atkinson 1992; Pearce and Atkinson 1993). Scientists and policy researchers have developed a plethora of objectives, strategies and measurement instruments, but with little regard for the economic and social sustainability perspective.

The concept of sustainability tends to be rather nebulous and confusing in the context of rural social and economic sustainability. It is becoming increasingly important, when attempting to assess the socioeconomic sustainability of a region, to take full account of the dependence dimension, as well as the more obvious "direct" structure and performance indicators (Copus and Crabtree 1996). There is a need for an integrated concept which will incorporate the approaches of both socioeconomic sustainability and multifunctionality (Wiggering et al. 2006). The attempts to identify the main elements of sustainability highlight that a comprehensive theoretical framework to a fully integrated approach to sustainability is still lacking and it is unlikely that one could be developed in the near future. This is due to the multifaceted nature of the concept of sustainability.

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