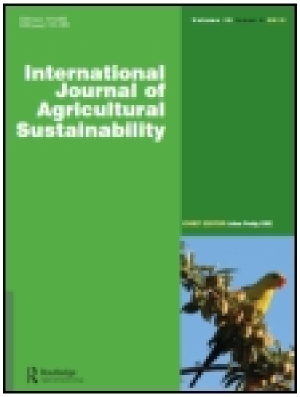


International Journal of Agricultural Sustainability
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/tags20

# A participatory assessment of agro-ecosystem sustainability in Abesard, Iran

Hadi Veisi [a] , Korous Khoshbakht [a] & Hossain Sabahi [b]

[a] Department of Agroecology , Environmental Sciences Research Institute, Shahid Beheshti University , G.C., Evin, Tehran , 1983963113 , Iran

[b] Department of Life Science Engineering, Faculty of New Science and Technology , University of Tehran , Iran

Published online: 10 Apr 2012.

*International Journal of Agricultural Sustainability*, 2013
Vol. 11, No. 1, 52–68, http://dx.doi.org/10.1080/14735903.2012.676797

Routledge
Taylor & Francis Group

# A participatory assessment of agro-ecosystem sustainability in Abesard, Iran

Hadi Veisi[a]*, Korous Khoshbakht[a] and Hossain Sabahi[b]

[a]*Department of Agroecology, Environmental Sciences Research Institute, Shahid Beheshti University, G.C., Evin, Tehran, 1983963113, Iran;* [b]*Department of Life Science Engineering, Faculty of New Science and Technology, University of Tehran, Iran*



Participatory approaches have emerged in developing countries as an integrated and holistic system approach for assessing the agro-ecosystem sustainability. The aim is to integrate and apply knowledge about natural and social aspects of agro-ecosystems, taking into account their long-term, uncertain and non-linear relationships. The purpose of the study described in this paper was to assess the sustainability of the agro-ecosystem of Abesard in Tehran Province. A participatory landscape/lifescape appraisal (PLLA) method was used within an agro-ecological framework to assess the farmers' sense of agricultural sustainability based on different categories of sustainability (better-off, average and poor). Results indicated that a majority of farmers think of sustainability solely as an economic issue, followed by sustainability being a combination of ecological and social concerns. Regarding the indicators of sustainability, results revealed that for farmers in the poor group, resilience and stability were critical criteria, whereas for better-off farmers, stability, reliability and resilience were generally important. However, the average group of the farmers was placed between the two groups. Overall, it was concluded that the economic status of households has an influence on the sustainability of their agro-ecosystems and that improvement of their economic situation promotes agricultural sustainability. It could also be concluded that PLLA has the potential to integrate socio-economic (lifescape) and environmental (landscape) dimensions for analysing the sustainability of agro-ecosystems.

**Keywords:** Abesard; agriculture; agro-ecosystem; participatory approaches; sustainability

## Introduction

Sustainability as a whole system, an interdisciplinary concept and the highest-order emergent quality of an agro-ecosystem (Gliessman 2007) is extraordinarily complex (Andreoli and Tellarini 2000). Operationalizing sustainability of an agricultural system on the ground involves considering numerous aspects including physical, environmental, social, cultural and/or economic dimensions and their interactions. It focuses on a 'set of strategies' (Bachev 2007), the ability to satisfy an adverse set of goals through time (Darnhofer *et al*. 2010), the 'ability (potential) of the system to maintain or improve its functions' (VanLoon *et al*. 2005) and the 'process of learning about changes and adapting to these changes' (Raman 2006). This complexity leads to the need for an integrated and interdisciplinary framework and assessment methodology that can consider the varied facets in a holistic fashion and see the whole that is greater than the sum of its parts (Sulser *et al*. 2001, Wang *et al*. 2009). With regard to this fact, Gliessman (2007) has suggested

*Corresponding author. Email: hveisi@gmail.com

using an agro-ecological framework to determine (1) if a particular agricultural practice, input or management decision is sustainable, and (2) what is the ecological basis for the functioning of the chosen management strategy over the long term. This framework recognizes agro-ecosystems as socio-ecological systems in order to understand agriculture within its social context, the effects of different input/output strategies, the importance of the human element for production and the relationship between the economic and ecological components. Thus, in terms of methodology, 'the assessment of agricultural sustainability has to consider the dynamic interactions between socio-economic and bio-physical elements in the system' (Herrmann *et al*. 2011). Eksvärd *et al*. (2009) and Wang *et al*. (2009) have asserted that 'within farming systems contexts, where there is a need for a holistic approach' participatory research could be used to recognize the central importance of the socio-economic and socio-cultural dimensions of sustainability (Glaser 2006), and also to understand and research complex situations. These approaches have been evolving over the last 40 years and have also been firmly based on the ideas of hard and soft systems thinking (Checkland and Scholes 1990), later on developed and applied by other researchers (e.g. Bawden 2003, Eksvärd *et al*. 2009). Given this background, the purpose of this paper was to provide an answer to one of the top 100 most important questions concerning the future of global agriculture; that is, the question of how can interdisciplinary frameworks integrating scientific innovation and multi-stakeholder perspectives be designed and effectively applied to the assessment of farming systems within developing countries (Pretty *et al*. 2010). We have done this by illustrating the development and application of participatory landscape/lifescape appraisal (PLLA) to assess the sustainability of the agro-ecosystem of Abesard as a case study of participatory sustainability science research.

### ***Sustainability of the agro-ecosystem***

Agricultural sustainability has been defined and characterized in vastly differing ways. Each definition has been devised from a different perspective and also for a different purpose (Winograd 1994), and little headway has been made to come up with a comprehensive and concise definition (Pearce *et al*. 1990). The various definitions can be categorized into one or more of three main perspectives: the agro-ecological concept, the resource concept and the growth concept (Conway 1986, Harrington 1992, Gitau *et al*. 2008). Definitions using the growth concept focus on the need for continued growth in agricultural productivity while maintaining the quality and quantity of the resources devoted to agriculture. This requires that the renewable resources be used at a rate lower than that at which they can be regenerated, the wastes be emitted at a rate lower than that at which they are absorbed by the environment and optimization of non-renewable resources (Gitau *et al*. 2008).

The second category of definitions places an emphasis on stewardship or the proper care and protection of resources (Barker and Chapman 1988). According to this perspective, agricultural sustainability can best be enhanced by slowing economic development, stabilizing human population levels and discouraging the exploitation of natural resources (Durning 1990).

The third category, agro-ecological perspective, focuses on sustainability in terms of system productivity and stability based on factors that enter the system, on its reliability and on resilience and adaptability based on factors that leave the system (Rao and Rogers 2006). Productivity is the capacity of the system to produce specific outputs to realize objectives (such as yield and profitability), whereas stability is the ability of the system to reproduce processes needed to attain specified outputs (e.g. input use efficiency). In this sense, stability is derived from ecology and refers to the preservation of the natural resources base. This is different from the conventional statistical sense (variance) in which it has been often used. Resilience is the capability of the system to return to a stable equilibrium after facing shocks or disturbances (such as drought, flood and instability of markets). To be able to cope with any inevitable change, a farmer needs to retain diversity and redundancy to ensure adaptability (Darnhofer *et al*. 2010). Reliability is a measure of the extent to which the system can remain close to stable equilibrium when facing 'normal' perturbations (such as yield variability). Adaptability refers to the ability of the system to adapt its functioning to an entirely new set of conditions (e.g. climate change and the WTO regime).

In this sense, a central question involves how a system's ecological parameters are changing over time. An agro-ecosystem that becomes unproductive gives numerous hints at its future. Despite producing acceptable yields, its underlying foundations are being destroyed. Its topsoil may be gradually eroding year by year, salts may be accumulating and the diversity of its soil biota may be declining. Inputs of fertilizers and pesticides may mask these signs of degradation. In contrast, a sustainable agro-ecosystem will show no signs of underlying degradation; its topsoil depth will hold steady or increase, and the diversity of its soil biota will remain consistently high. Equally important is the question of the maintenance of farmer, farm family and farm community livelihoods. Are the elements of social health and welfare being maintained so that farm families are able to enjoy a dignified, healthy life with opportunities for education, personal growth and food security? Even if economic returns hold steady in a region, individual farmers may have to leave farming, children may be taken out of school to work on the farm or local opportunities for employment may be reduced. Reducing the number of crops to meet market requirements or hiring undocumented labour at lower salaries and with fewer benefits may mask these signs, so an integrated analysis is necessary to detect them (Gliessman 2007). A sustainable agro-ecosystem, therefore, indicates health and happiness in all segments of the social fabric of the food system (Gliessman 2007), and has socio-economic health, as well as environmental dimensions (Waltner-Toews 1996).

Accordingly, to promote agro-ecosystem sustainability, farmers or households follow two types of strategies; that is, natural resource-based and non-natural resource-based. Agricultural intensification, extensification and diversification are components of a natural resource-based strategy that focuses on internal factors to improve agro-ecosystem productivity and stability. Livelihood diversification (e.g. off-farm jobs) and migration which are based on external factors are non-natural resource-based strategies for enhancing reliability, resilience and adaptability (Cramb *et al*. 2004). These are options for creating a stable equilibrium after facing disturbances, perturbations, and for setting new conditions.

Following this line, sustainability of an agro-ecosystem is interpreted as a capability (potential) of the system to maintain or improve its functions. Accordingly, the main agro-ecosystem characteristics that influence sustainability have been specified as resilience, stability, profitability, productivity and adaptability.



### *Participatory methodology of sustainability agro-ecosystem assessment*

The inclusion of stakeholders' interests in the process of agro-ecosystem sustainability assessment is part of the process with which conventional scientists have the most trouble (Eksvärd *et al*. 2009). Generally, most searches for indicators of sustainability appear to have deliberately excluded stakeholder negotiations (Waltner-Toews 1996). Consequently, sustainability assessment in the form of participatory approaches is a useful contribution to the ongoing debate. In this paradigm, social learning among people with common interests is critical (Blackstock *et al*. 2007, Bohlen and House 2009, Binder *et al*. 2010) and stakeholders participate and benefit jointly from the outcomes (Goma *et al*. 2001).

PLLA has been developed as a research method to aid the understanding of the human–environment (causal) relationships within the landscape as well as the constraints on sustainable agriculture (SANREM CRSP – West Africa 1999, Willigen 2002). It is also the most appropriate scale for applied research aimed at the conservation of biodiversity and for identifying and enhancing sustainable strategies of livelihood for the populations that interact within the environments defined (Hargrove and Hoffman 1999). PLLA is based on tools, strategies and experiences of participatory rural appraisal, rapid rural appraisal (RRA) and farming systems researches for visualizing and detecting where changes in a given system can be made for increasing sustainability (Binder *et al.* 2010). Similar to RRA (which is a systematic but semi-structured activity carried out in the field by a multidisciplinary team with the objectives of obtaining new information and formulating new hypotheses about rural life (Chambers 2002, Veisi and Rezvanfar 2010)), PLLA is a rapid research method that helps us as a transdisciplinary team to comprehend local knowledge, understandings and perspectives of the landscape by inter-institutional collaboration. In PLLA, the information is owned by local people but shared with the research team as outsiders during a participatory process. It differs, however, (1) in scale, as it moves the description (baseline data) from the farm scale to the landscape, and (2) a shift from identification of problems toward the relationships on a landscape scale, on the interaction of human activity with the biophysical environment and on the long-term sustainability of the landscape/lifescape (Hargrov *et al.* 2000). The objectives of PLLA are:

- To gain an understanding of interrelationships in the agro-ecosystem.
- To identify and gain a collective understanding of constraints on natural resources and agricultural sustainability from the local community's perspective.
- To initiate and establish a community–scientist dialogue.
- To facilitate the community to identify their natural resources and become more aware of linkages in the landscape.
- To gain 'real-time' experience for diverse partners (international scientists, national scientists, NGOs, local communities, etc.) working together and how to enhance skills in listening, negotiating and visioning.
- To develop a participatory research agenda.

Based on the above characteristics, as Earl and Kodio (2005) have asserted, PLLA is based on four philosophical and methodological cornerstones: participatory research, interdisciplinary teams, inter-institutional collaboration and a landscape scale analysis. It provides a snapshot of the landscape at a particular time (Willigen 2002) by bringing scientific and local knowledge systems together with the thoughts of ecological, agricultural and social scientists, and development practitioners. Landscape refers to a complex mosaic of biological and physical processes, while lifescape refers to the social or human factors that influence the landscape. PLLAs also incorporate any other data that may be available regarding the local issues. The PLLA process consists of four phases as described below:

(1) Preparatory phase

During this phase and prior to undertaking the field phase of the PLLA, measures that consist of identifying a research site, user groups, building a research team and a literature review were carried out. For the identification of a site, a set of criteria should be considered that includes the presence of a variety of agricultural or livelihood activities, receptivity and willingness to participate from rural partners, and availability of secondary data related to the site. After the identification of the research site, local partners including researchers and development experts, and target farmers were identified as key to understanding the rich and dynamic social and natural resource complexities found in the study site (Binder *et al*. 2010). In the next step, working agreements were established as communication ground rules to improve interaction during research (Heckathorn 2002). At the end, a literature review was conducted on the issues of agriculture and natural resources based on personal interviews with researchers and development experts across the research area, grey literature and formally published documents.

(2) Establishing the research protocol outline: indicator selection

Following the preparatory phase, the research team members worked together to design the research protocol and to determine indicators. All members of the research team consisting of local partners (here the local reference groups) and the interdisciplinary research team worked together to provide area-based indicators in which they can address key environmental, economic and social processes, and in order to account specifically for multifunctionality of the agricultural system. PLLA allows researchers more choice in the selection of indicators, as there is no predefined indicator list at all, and it only provides a tentative list, which is supposed to be adapted to each specific case. Finally, PLLA is a bottom-up study approach as the choice of indicators not only depends on the researchers, but on the goals, principles and the general contributions the stakeholders bring to the assessment process. Given its transdisciplinary approach, PLLA has no predetermined indicators.

(3) Fieldwork and measurement phase

The measurement phase is related to the portrayal of indicators and processes. Regarding this, the PLLA research team will collect data pertaining to indicators using a variety of participatory tools. These tools include (1) informal, open-ended interviews with individuals or small groups, (2) resource mapping, (3) resource flow diagrams, (4) preference ranking, (5) seasonal calendars, (6) Venn diagrams, etc. (Hargrove and Hoffman 1999). A variety of information can be collected, depending on the indicators selected for the appraisal. The specific information to be collected dictates the appropriate tools to be used. In PLLA, stakeholder assessment is employed to explain the status of agricultural management practices concerning indicators (Binder *et al*. 2010).

(4) Application and follow-up

Application and follow-up are related to the possibility of using the assessment results by the user groups (Binder *et al*. 2010). Following data collection, the PLLA team will be regrouped to share preliminary results, triangulate findings and identify gaps in data requiring further investigation. The teams will then return to pose the remaining research questions and to share their results at village-wide meetings. Information sharing is a key tenet of participatory research, because it demonstrates respect and equality between the outside researchers and local partners. It also provides an opportunity for local participants to respond to any key findings, clarify misunderstandings and ask the research team questions (Earl and Kodio 2005). The results from this phase allow farmers to situate themselves within a benchmark and provide the basis for identifying successful farm management practices (Binder *et al*. 2010). In addition to these meetings, the team meets once again in site and began documenting their work.

## Methods

The sequence of steps in the PLLA approach that were adopted in the present study have been depicted in Figure 1. In the preparatory phase, first, the Abesard region was selected as the study site. The region is located in the far eastern part of Tehran Province (Figure 1a), about 5 km away from Damavand (the county capital) and 35 km away from Tehran (the capital of Iran) (Figure 2). It lies between latitude 35°20′N to 35°55′N, and longitude 51°53′E to 53°51′E in the north-central part of Iran. Abesard covers an area of about 19,000 ha and is one of the most agriculturally productive areas in Iran, with favourable soil and climatic conditions. At present, about 260 households live in the region comprising people of numerous ethnic groups. The dominant ethnic groups are Fars, Tati and Arab. The soil is classified as Alfisol. The soil texture is clay loam at the A-horizon having the soil pH ranges from 6.5 to 7.3 containing 1.3 per cent organic carbon. Agriculture is the main economic sector, and it includes both crop and livestock production. Potato is the main staple crop (25–36 per cent), but a wide variety of other subsistence (wheat, 4 per cent, barley, 2 per cent) and cash products (e.g. apple, 15–20 per cent) are found according to changes in topography and soil type. Ranching of cattle, sheep and goats is the major livestock production system. However, the bulk of agricultural production in Abesard is oriented towards cash sales in regional and, to some extent,

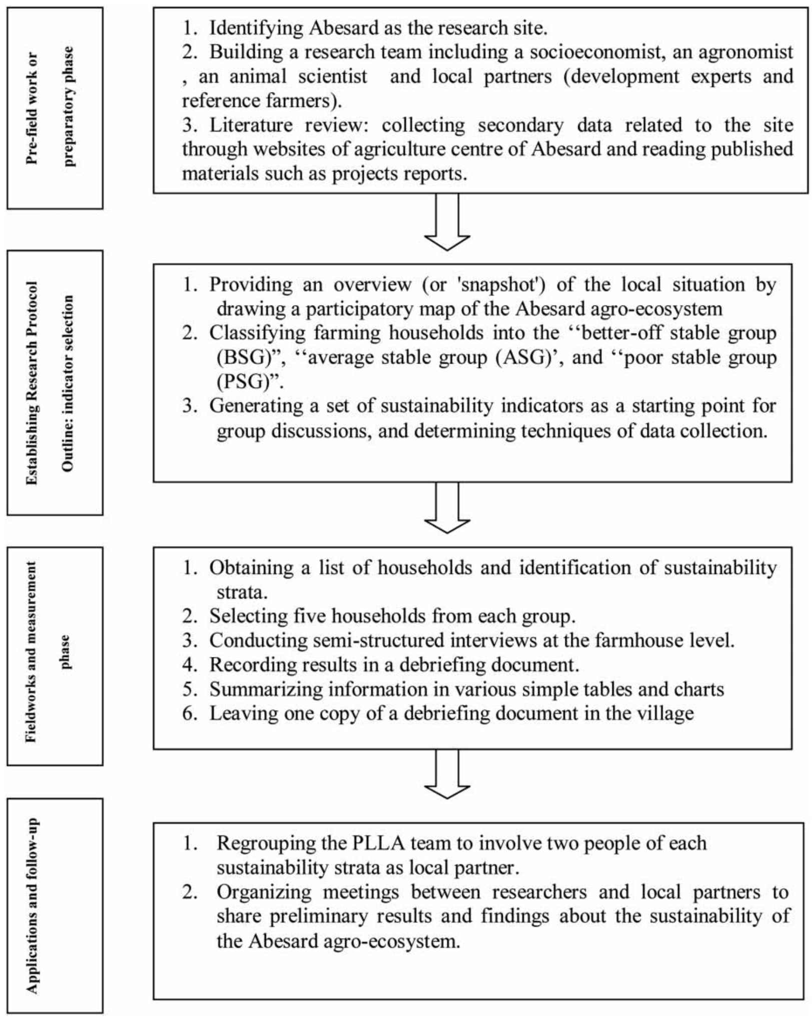


Figure 1. Sequence of steps in the PLLA approach adopted in the present study.

national and international markets. Over the last decade, agriculture in Abesard has undergone changes in response to the social, economic and environmental conditions in the region. As shown in Figure 1b, orchards are dominant in the northern part of Abesard, while in the southern part, arable and agro-forestry are seen. It is notable that the presence of several villas, a town and a factory in landfields reveals landuse change due to the pressure from the urban population. As a result, agricultural intensification has shifted production, for example, from wheat to potato and greenhouse cultivation. It has also led to a decrease in the number of farmers, as there are only 260 farmers in Abesard now.

In the next step, a research team consisting of a socio-economist, a anagronomist and an animal scientist was formed that was accompanied by local partners, namely development experts and reference farmers. In this regard, a snowball sampling method was used to find people with a specific range of skills and characteristics such as age, farming experience, education and farm size as key informants. During sampling we chose people to track the

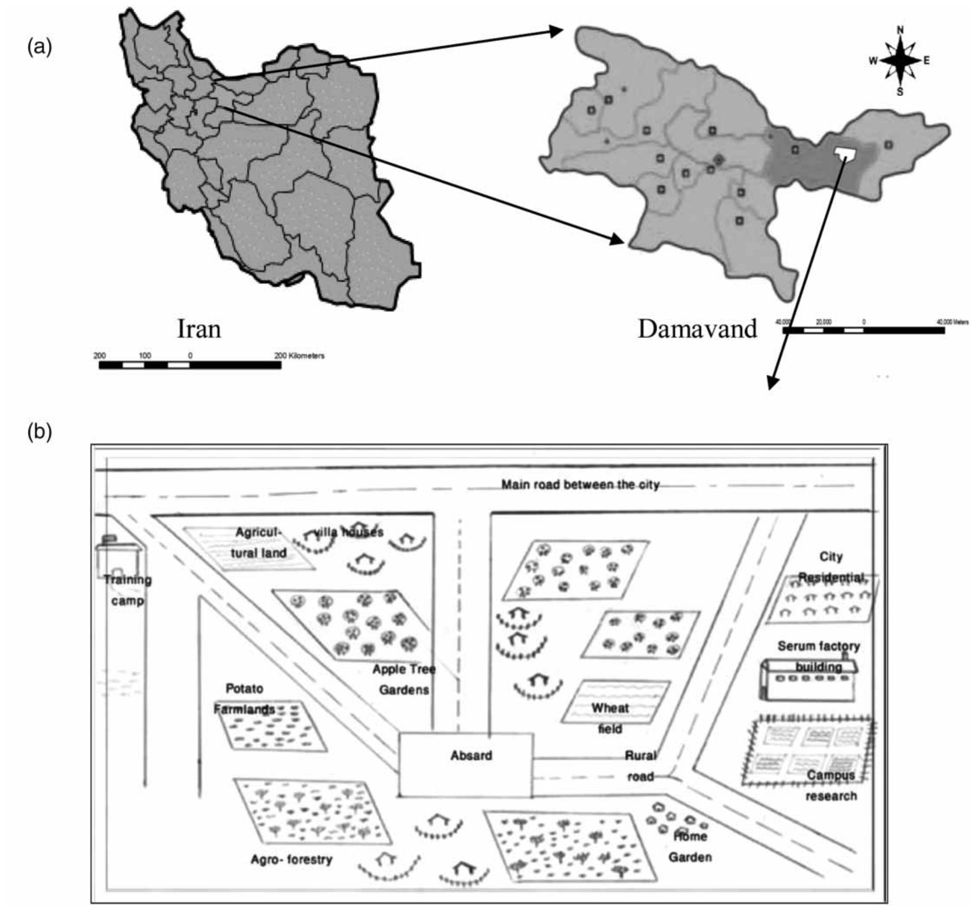


Figure 2. Geographical location of Abesard in the Tehran province, Iran (a) and the Abesard participatory map (b). Map (b) has been made by the farmers and shows the transboundary situation and the resources of the location such as gardens, infrastructures, farms, etc.

recommendations of local leaders. We then asked them to refer to us other people who fit our study requirements and then we followed up with these new people and repeated this method of requesting referrals until we had studied enough people (10 people) (Heckathorn 2002). Following this, they were trained in the PLLA process and participatory tools, and established a working agreement for achieving the aims of the study. To get some background information (population, geographic information and livelihood sources), secondary data related to the site of study were collected through the website of the agricultural centre of Abesard and published materials such as projects reports.

In the second phase, the research team persuaded their local partners to draw a map of the Abesard agro-ecosystem (Figure 2b) to obtain an overview (or ’snapshot’) of the local situation. A semi-structured interview tool was then employed to explore the reference farmers’ sense of agricultural sustainability. Subsequently, livelihood conditions of farmer’s households were analysed via participatory well-being ranking. As a result, farming households were classified into the ‘better-off’, ‘average’ and ‘poor’ groups (Table 1). Then, the approach and technique of participatory well-being ranking were modified in collaboration with local partners to develop sustainability categories, while it measured the farmers’ sense of agricultural sustainability instead of

Table 1. Criteria for wealth categories as identified by the referenced group.

| Poor group | Average group | Better-off group |
|---|---|---|
| Small plot: <1 ha of potato-land | 1–3 ha of potato-land and garden (>3) | Plenty of land: >3 ha of potato-land and garden (>3) |
| Household labour | Household labour, and a few workers | Many workers |
| Not enough to eat | Enough to eat | Cash surplus and investment |
| No cattle or sheep | Not many cattle and sheep (<15) | Many cattle (>15) |
| Credit from private lenders on a short-term basis with a high interest rate | Credit from private providers and the government sector if necessary | Credit from the government sector on a longer-term basis with a low interest rate |
| Have no tools, machinery and implements | Own a few suitable farm tools and machinery, e.g. a tractor | Own basic tools and machinery, e.g. a tractor, a few hoes and an axe. |
| Number of family members >5 | Number of family members =3–5 | Number of family members <4 |
| 60% of the total households in Abesard | 25% of the total households in Abesard | 15% of the total households in Abesard |

well-being. There are three categories to capture the important differences within the farming community, that is, better-off stable group, average stable group and poor stable group. These categories could be used to map actual changes in sustainability.

In the next phase, local partners and the research team together (as a discussion group) ascribed farm families to a particular group and this formed the basis for a focus group discussion about variables that farmers themselves use to assess agricultural sustainability. The aim was to generate a set of sustainability indicators which could be used as a starting point for discussions and to determine techniques which would be most appropriate for facilitating discussions at the community level. As a result, 23 sustainability indicators were identified and used as indicators by which information was sought in Abesard during the study.

During fieldwork, the participatory tools of natural resource mapping, transect walk, trend line, structured brain storming, sustainability matrix and scoring matrix were applied to collect information. The study team spent four days in Abesard, starting with a series of household interviews with randomly selected farmers in each of the groups. A list of households was obtained from the community mapping exercises. Following the identification of sustainability strata, five households from each group were randomly selected, resulting in 15 households in total. For each household, the research team conducted semi-structured interviews at the farmhouse. The interviews were carried out over a period of four days, with each interview lasting about 2–3 hours. As a complementary action (triangulation), the transect walk and group discussion were undertaken to generate a list of farming practices considered to be indicators of sustainable agriculture for each group. Descriptions were done of how to distinguish 'better- off', 'average' and 'poor' sustainability for each practice. Then, the team spent time experimenting with different participatory exercises (institutional mappings, history timelines, a flow diagram, trend analyses, etc.) in different formats (open meetings, reference group, focus group discussions, etc.) to assess the indicators. For instance, institutional mappings were employed to assess accessibility to government services. Using a flow diagram, the type of available marketplace for each group was determined and trend analyses were adopted to explain the response to innovation. Finally, the results were recorded in a debriefing document, one copy of which was left in the village and the other copy was kept by the study team. The information in the debriefing document was then summarized in simple tables and charts, which allowed comparisons between groups regarding region trends and patterns.

As a follow-up study, the PLLA team was regrouped to involve two people of each group as local partners. As a result, six people from the sustainability groups were added to the research team. Several meetings were then held between researchers and local partners to share preliminary results and findings about the sustainability of the Abesard agro-ecosystem (Table 2).

Table 2. Farmers' indicators for sustainable agriculture in Abesard.

| Sustainability indicator | Poor group | Average group | Better-off group |
|---|---|---|---|
| Crop diversification | Farmers grow only one or two crops (potato and/ or cucumber) | Farmers grow 3–5 crops (e.g. potato, cucumber, wheat and warm season vegetable) | Farmers grow a number of varieties of several crops (e.g. potato (agria and marfona), cucumber, wheat, warm season vegetable, marrow) |
| Application of chemicals (fertilizer and pesticide) | Farmers are not able to buy fertilizers to apply on all farmland, and rely on the government as a source of fertilizers | Farmers are able to buy macro-fertilizers to apply on farmland, but rely on the government for micro-fertilizers | Farmers are able to buy macro- and micro-fertilizers to apply on all farmland, thus ensuring production and allowing them to buy more fertilizers in subsequent years |
| Crop rotation and fallow | Farmers cultivate the same types of crops on the same pieces of land every year | Farmers practice rotation between two crops such as cucumber and potato, with legume and Lucerne planted on fallow land | Farmers practice proper rotation and fallow |
| Application of organic manure (animal and compost) | Farmers do not access manure because they usually do not own any animals and may not be able to purchase manure | Farmers put manure on each plant station to economize. They usually just apply 1–2 ha of farm plots near homesteads for limited access to animal manure | Farmers apply animal manure and buy organic fertilizers. They have no limitation in access to animal manure and organic fertilizers |
| Soil fertility | Water retention is low because soil is compact | Water retention is good, but the nutrient-holding capacity is low | Very fine clay with appropriate water-retention and nutrient-holding capacity |
| Water availability | 4 hours per week | 10–12 hours per week | More than 20 hours per a week |
| Tilling or weeding by retaining weeds and crop residues in soil | Farmers usually gather weeds in piles and burn them and potato leaves and stalks, retain in soil | Farmers in this group mostly retain potato leaves and stalks, in soil and burn weeds | Farmers burn residues immediately after harvesting of potato |
| Yield (per hector yield of indicator crops) | Apple: 0<br>Potato: <20,000 kg/ha | Apple: >50,000 kg/ha<br>Potato: 20,000–25,000 kg/ha | Apple: >60,000 kg/ha<br>Potato: 25,000–35,000 kg/ha |
| | First year: high yield, second year: average and after third year: low yield | First 1–2 years: high yield, 3–4 years: average and after fifth year: low yield | High yield because of using organic matter, manure and leaving the land fallow for three or more years |

(*Continued*)

Table 2. Continued.

| Sustainability indicator | Poor group | Average group | Better-off group |
|---|---|---|---|
| Non-farm income | Farmers work as bricklayer and labour for others | Farmers work as members of staff, shopkeepers, labour force for others | Farmers work as shopkeepers, and rent agricultural tools |
| Availability to marketplace | Farmers have access to the local market | Farmers have access to the local, regional and, rarely, international markets | Farmers have access to the local, regional and, rarely, international markets |
| Pests, diseases and disasters | Farmers apply harmful chemicals to fields | Farmers apply recommended measures and types of chemicals to their fields | Farmers conduct recommended measures and types of chemicals to their fields<br>Farmers practice integrated pest management |
| Access to government services and supports | Farmers do not have access to extension services and advice | Farmers receive some credit, often from within the village, not outside institutions. To some extent, they also have access to extension services and advice | Farmers have access to a range of credit sources for the purchase of inputs. They always have access to extension services and even agricultural specialists from outside of Abesard |
| Age and education | 20% young people, 45% middle aged, 35% elder. 60% head of the family (secondary school), 65% women (illiterate) and 80% (child) other members of the family (primary school) | 40% young people, 30% middle aged, 30% elder. 85% head of the family (diploma and bachelor degree), 60% women (higher education) and 60% (child) other members of the family (higher education) | 50% young people, 30% middle aged, 20% elder. 55% head of the family (diploma), 40% women (higher education) and 90% (child) other members of the family (higher education and bachelor) |
| Participation in decision making and membership in CBOs | Farmers are members of the local cooperative and participate only in decisions regarding water management | Farmers are members of the local cooperative and receive some extension advice<br>They participate in decisions regarding water management and marketing | Farmers are members of local and regional cooperatives for both cash and food crops. They have access and are able to act on good extension advice. They make decisions regarding marketing and control it |
| Response to innovation | Farmers usually accept only new seed and variety | Farmers accept new seed and variety and even new crop | Farmers accept every technology relating to the production process in agriculture |
| Women's status | Women have active participation in all of the farming practices like production processing, harvesting and even selling products, because their husbands are working for other farmers and sometimes do non-farm work | Women have participation only in some farming practices like harvesting of potato | Women have no participation in the farming practices |

(Continued)

Table 2. Continued.

| Sustainability indicator | Poor group | Average group | Better-off group |
|---|---|---|---|
| Family health | Farmers pay attention to health issues; do not go to health centre for check-up | Farmers pay attention to health issues, and go to health centre 2–3 times for check-up | Farmers do not pay attention to health issues; They do not go to health centre for check-up |
| Access to seed | Farmers usually use last year's seed and they cannot provide new seed. They may not always follow recommended planting methods | Farmers usually change seed every two years and plant new seed. They usually follow recommended planting methods | Farmers access enough new seed for all crops and can also buy seed. They are able to follow recommended planting methods per plant station and spacing |
| Mixed cropping | Farmers overload the garden with many crops beyond capacity | Farmers mix crops better by making sure that the crops grown in the same garden relate well by mixing nitrogen fixing like marrow and potato. However, there are some complementary crops in the garden such as pumpkins | Farmers tend not to mix crops but may divide plots within the farmland for different mixtures |



## Results

### *Farmers' perceptions of sustainable agriculture*

We asked the farmers (reference people) to provide a definition of what sustainability meant to them and to their farm operation. The definitions ranged from very brief ('low stress', 'having a warranty in support of production', 'no chemical fertilizer' and 'we grow what we can sell in market and need – potato, apple, etc.') to detailed, well-thought-out statements (such as 'ability to survive in today's economic markets', 'Sustainable agriculture (SA) means to me: the ability to have a viable insurance to protect me from the market stresses when I cannot sell my production', 'To me, sustainable agriculture means decreasing financial risks associated with farming and adequacy of the returns of investment and labour', 'To me, SA means an agriculture that is supported by government policies favouring agriculture in attendance of community support, and farmer has awareness and information about suitable technologies', 'To me, SA is about stewardship of the land and environment through implementing environmentally conscious and economically profitable farming practices that result in the preservation of natural resources' and 'SA is a farming system of crop rotation and reducing or rational use of inputs through good agricultural practices to maintain excellent soil health and nutrition'). Deeper analysis through classifying the farmers definitions using the three dimensions of sustainability (social, economic and environmental) showed that a majority of farmers thought of sustainability solely as an economic issue, followed by sustainability being a combination of economic/social concerns. Environmental concerns were less important among farmers, both alone and in various combinations with economic and social aspects. In total, farmers included some environmental components in their definitions concerning crop rotation and the reduction in or rational use of inputs.

***Sustainability conditions in the agriculture of Abesard***

The participants in the focus groups were asked to identify the wealth categories and to allocate each household in Abesard to one of the categories 'better-off', 'average' and 'poor', and to specify the defining characteristics or criteria in each category. As indicated in Table 1, family size was bigger for the poor group (>5) and smaller for the average (3–5) and better-off groups (<4). In general, 15 per cent of households were assigned to the better-off category, 25 per cent to the average category and 60 per cent to the poor category.

An analysis of the findings of timeline use of workforce in farms indicated that the poor group has only used household labour while the average group has employed seasonal labour for some activities (e.g. weeding) and the better-off group has hired full-time workers for all agricultural activities. The average land area owned by each household in the better-off group was almost more than 5 ha, while households of the average and poor groups owned 1–3 ha and ≤1 ha, respectively. The difference in the number of cattle kept by the groups was the most striking finding. While households in the poor group had no cattle or sheep, those in the average and better-off groups had ≤15 and >15 cattle and sheep, respectively. There was also a difference in sources of credit between the groups. Whereas the poor and average groups obtained credit from private lenders on a short-term basis at a high rate of interest, the better-off group obtained credit from the government sector on a longer-term basis at a low interest rate. Hence, poor households suffered an overall disadvantage in financial terms. Households in the poor group had no tools or implements, while those in the average group had electricity, a motorbike or a tractor. Households in the better-off group owned all the tools that were required for agriculture while hiring them out some time.

After the identification of the wealth strata, five households were selected from each group according to wealth criteria. At the end, 15 households were selected for interviews regarding the indicators of sustainability of agriculture in each group. Table 1 represents the results of these interviews. Findings showed that farmers in the poor group face limitations in their access to inputs, so that they usually use last year's seeds. They were also not able to provide new seeds, to apply fertilizers to their whole farmland and to access extension services and advice. They only applied harmful chemicals for their fields and had insufficient manure to spread on the whole farmland and with only four hours of water usage per week. So, these farmers grow only one or two types of crop, plant the same types of crops on the same pieces of land every year, are unable to leave any land fallow and usually accept only new seeds and varieties. Regarding farm characteristics, they own small farmland and have to overload their gardens with many crops more than their capacity. The water retention capacity of their farms is also low because the soil is compacted. In addition, they do not track sustainable agricultural practices.

Findings of the farmers' self-assessment in the average group indicated that although water retention of their soil is good, nutrient holding capacity is low. They practice two years fallow, use organic fertilizer (manure) to the extent it is available and use macro- and micro-chemical fertilizers relying on the government for micro-fertilizers. They also improve seeds they use every two years and follow the recommended planting methods.

Regarding their access to resources and inputs, they own 1–3 ha of apple orchards, livestock (<15), some basic tools (e.g. a tractor and axes) and inadequate land. However, some farmers can afford to rent to expand their farm area. They also have access to local, regional and, rarely, international markets, to water for about 10–12 hours per week and to some credit, mostly from within the village institutions. In relation to other indicators, a majority of the farmers are young (<40 years old) and educated, and participate in decisions regarding water management and marketing through local cooperatives. They also receive some extension advice.

According to the findings of on-field observations and transect walk, the farmers of the better-off group own all tools and implements required (e.g. ploughs, ridgers, oxcarts, plus hoes, sickles, axes and tractors), large apple orchards (>10 ha), diverse types of livestock (e.g. chickens, sheep and cattle) and enough land to plant all crops. The soil of the farms is characterized by very fine clay soil with appropriate water-retention and nutrient-holding capacities. They also use mixed cropping, practice proper rotation and fallow, grow different crops, accept new technologies, act on good extension advice, impact markets and involve in decision making. The majority of the farmers are young and educated. As non-farm jobs, they work as shopkeepers and rent agricultural tools to supplement their income. Their wives do not work on the farm; instead they hire full-time labourers for agricultural activities. As the findings in Table 2 show, the farmers of the average group have better status in terms of health (as a social indicator) as they attend health check-up 2–3 times a year. In contrast, the farmers of the better-off group do not go to the health centre for check-up and the farmers of the poor group do not go to the health centre and care about their health issues themselves. In this regard, the farmers in the better-off group can afford to treat disease if it happens, while the farmers in the poor group focus on local methods of treatment. The farmers in the average group usually follow the strategy of prevention against diseases, because of the high cost of treatment. Findings also showed that the farmers of the better-off group have more control over community-based organizations (CBOs) of marketing and productive cooperatives (non-profit agencies created by communities to address local needs) compared to other groups of farmers (Chechetto-Salles and Geyer 2006).

## Conclusion and discussion

This paper has illustrated the development and application of PLLA in a case study regarding participatory sustainability science. The aim was to indicate how an interdisciplinary framework integrates scientific innovation and multi-stakeholder perspectives in assessing farming ecosystems.

Based on the findings relating to the farmers' definitions of SA, it can be concluded that the respondents accorded a different weight to the three aspects of social, economic and environmental sustainability. It goes almost without saying that agriculture is not going to be sustainable if it is not economically viable and profitable. Following this line, all respondents included economic considerations into their definitions. The low concern about the social and ecological aspects within respondents' definitions about sustainability is probably due to the volatility of external (e.g. fuel prices, farm policy and markets) and internal (e.g. management decisions) factors affecting agriculture in Abesard that make short-term economic concerns paramount for farmers (Sassenrath *et al*. 2009). On the other hand, it may be due to the fact that Abesard is one of the most agriculturally productive areas in Iran, with excellent soil and climatic conditions and a long-term record of agriculture in support of food production and food security. Our results are consistent with findings of Tyrchniewicz and Ragone (1997) and Ikerd (1996) who found a low level of social concern among producers through surveys of farmers in the Great Plains and Missouri, respectively.

Regarding the indicators of sustainability in Abesard, our findings show that limited accessibility to natural capital (e.g. land, water, etc.), physical capital (equipments, seed, etc.) and financial capital (assets, credit and income) acted as the driving and pressure forces on the farmers of the poor group and decreased their farms' productivity and reliability (due to yield variability). In response, they operated a combined set of natural and non-natural resource-based strategies to promote resilience and stability of their farms. They achieved the above goal through using household labour (women and children) for agricultural practices, doing off-farm jobs (labour force) and planting trees such as apple, peach and walnut around their farmlands to be served as a support to family food production and food security.

In contrast, for better-off farmers, weaknesses in human capital (i.e. the low number of family workforce, dependence on hired labour for agricultural practices and illiteracy of the hired labour), social capital (e.g. low family support as women do not participate in agricultural practices) and to some extent natural capital (high cost of renting the land) seemed to act as pressure forces on better-off farmers, which ultimately reduce productivity (profitability). In response to these limitations, these farmers largely focus on sustainability in terms of system stability, reliability and resilience using the natural resource-based strategy. To promote resilience and system stability, they mix crops, practice correct crop rotation and fallow and grow different crops. To support farmland reliability, they accept new technologies and act on good extension advice. These measures contribute to how the farmers employ potential internal and external capacities of agro-ecosystems to achieve sustainability.

The average group of the farmers is placed between the above two groups. Physical capital, that is, soil quality, and small land size are factors of unsustainability. To overcome these challenges, farmers in this group responded through a complex set of natural and non-natural resource-based strategies such as agricultural intensification/extensification and livelihood diversification to promote productivity, resilience and stability. These farmers practice fallow, apply organic fertilizer (manure), retain weeds and crop residues on the soil and use mixed cropping to conserve natural resources (Woodhouse *et al*. 2000, Rao and Rogers 2006). They also vary factors that enter the system such as changing seeds every two years and following recommended planting methods for higher productivity. To extend farmlands, the farmers of this group hire land. As mentioned earlier, the farmlands of the average group are characterized to some extent by reliability and resilience, because they have access to resources and inputs, to some basic tools, to local, regional and occasionally international markets. These characteristics make the farmers ready when faced with shocks or disturbances (e.g. drought, flood and markets) and yield variability. However, they sometimes have low adaptability (as a criterion for agro-ecosystem sustainability) because they have to sell off farmlands due to the lack of supportive institutions and changes in climate and market mechanisms. Instead, they start working as shopkeepers.

Given the nature of the information obtained about the agro-ecosystem of Abesard using participatory approaches, it can be concluded that (1) the agro-ecosystem of Abesard is oriented towards unsuitability because the majority of farmlands are owned by the poor group (60 per cent) and their agricultural practices are not socially acceptable, environmentally responsible or economically viable; (2) that the economic status of households has an influence on the sustainability of their agro-ecosystems and with improvement in their economic situation, agricultural sustainability will be promoted; (3) PLLA is able to offer a comprehensive framework for the assessment of sustainability of the agro-ecosystem and to integrate socio-economic (lifescape) and environmental (landscape) dimensions when analysing the sustainability of agro-ecosystems.

On the basis of these results, the following suggestions could be proposed for achieving agricultural sustainability in Abesard:

- As shown, the main reason for not achieving agricultural sustainability in the poor group was the inadequacy of organic inputs and resources. In accordance with what Zhu *et al*. (2012) affirmed, government supervision assures the implementation of the agro-ecosystem health management. Thus, we recommend a ‘targeted policy approach’ to these farmers in the form of appropriate policies and strategies to ensure their access to extension services, land resources, credit and subsidized inputs. As Elizabeth (2006) asserted, assistance and programmes should also include more income-generating activities and training for improved production.

- Since women play a key role in the farms of poor households and, to some extent, in those of average households, especially during harvesting, this study recommends planning and holding agricultural workshops for women and also involving them in grassroot organizations so that they can influence the decision-making process.
- Given the adequacy of inputs and resources in the better-off group, it is suggested that they be encouraged to apply practices regarding sustainable agriculture such as integrated pest management.
- Farms of the better-off group mostly use full-time labours for agricultural practices. So, it is recommended to strengthen them to apply organic inputs and resources in a sustainable manner.

Overall, it can be argued that by following the process identified here, the differences between the outputs of different methods and investigators could be demonstrated to identify more appropriate stakeholders, to formulate more relevant sustainability indicators and thus to develop practical measures for bridging the gaps towards sustainability.

## Acknowledgements

We express our sincere thanks to Shahid Beheshti University for funding this research. We also thank Dr Janet Blake and Dr Sofizadeh for editing the English text. Furthermore, we express our sincere gratitude to Mrs Bagheri Tolabi, Mr Ahrani, Mr Zohari and Mr Abdi for their help in conducting the field survey.



## References

Andreoli, M. and Tellarini, V., 2000. Farm sustainability evaluation: methodology and practices. *Agriculture, ecosystems & environment*, 77, 43–52.

Bachev, H., 2007. Governing of agrarian sustainability. *ICFAI Journal of environmental law*, VI (2), 7–25.

Barker, R. and Chapman, D., 1988. *The economics of sustainable agricultural systems in developing countries*. Working Paper 88-13. Ithaca, NY: Cornell University.

Bawden, R., 2003. Systemic discourse, development, and the engaged academy, *Proceedings of 47th meeting of the international society for the systems sciences*, Crete, Greece: Heraklion.

Binder, C.R., Feola, G., and Steinberger, J.K., 2010. Considering the normative, systemic and procedural dimensions in indicator-based sustainability assessments in agriculture. *Environmental impact assessment review*, 30, 71–81.

Blackstock, K.L., Kelly, G.J., and Horsey, B.L., 2007. Developing and applying a framework to evaluate participatory research for sustainability. *Ecological economics*, 60 (7), 26–74.

Bohlen, P.J. and House, G., 2009. Agro-ecosystem management for the twenty-first century: sustaining ecosystems, economies, and communities in a time of global change. *In*: P.J. Bohlen and G. House, eds. *Sustainable agroecosystem management: integrating ecology, economics, and society*. Boca Raton, FL: CRC Press, 1–13.

Chambers, R., 2002. *Relaxed and participatory appraisal: notes on practical approaches and methods for participants in PRA/PLA-related workshops*. UK: The Participation Resource Centre, Institute for Development Studies.

Chechetto-Salles, M. and Geyer, Y., 2006. *Handbook series for community-based organizations*. The Institute for Democracy in South Africa (IDASA). South Africa: Pretoria, 27.

Checkland, P. and Scholes, J., 1990. *Soft systems methodology in action*. Chichester: Wiley.

Conway, G., 1986. *Agroecosystem analysis for research and development*. Bangkok: Winrock International Institute for Agricultural Development.

Cramb, R.A., Purcell, T., and Ho, T.C.S., 2004. Participatory assessment of rural livelihoods in the Central Highlands of Vietnam. *Agricultural systems*, 81, 255–272.

Darnhofer, I., Fairweather, J., and Moller, H., 2010. Assessing a farm's sustainability: insights from resilience thinking. *International journal of agricultural sustainability*, 8 (3), 186–198.

Durning, A., 1990. How much is enough? *World watch*, 3, 12–19.

Earl, J. and Kodio, A., 2005. Conflict, social capital and managing natural resources. *In*: K.M. Moore, ed. *Participatory landscape/lifescape appraisal*. Trowbridge: Cromwell Press, 77–87.

Eksvärd, K., *et al.*, 2009. Participatory approaches and stakeholder involvement in sustainable agriculture research. *In*: P.J. Bohlen and G. House, eds. *Sustainable agro-ecosystem management: integrating ecology, economics, and society*. Boca Raton, FL: CRC Press, 271–282.

Elizabeth, S., 2006. Participatory assessment of the impact of Women in Agriculture Programme of Borno State, Nigeria. *The journal of tropical agriculture*, 44 (1–2), 52–56.

Gitau, T., Margaret, W., and Waltner-Toews, G.D., 2008. Development of health and sustainability indicators for a tropical highlands agroecosystem. *In*: T. Gitau, W. Margaret, and G.D. Waltner-Toews, eds. *Integrated assessment of health and sustainability of agroecosystems* (Chapter 6). New York: CRC Press, 147–196.

Glaser, M., 2006. The social dimension in ecosystem management: strengths and weaknesses of human-nature mind maps. *Human ecology review*, 13 (2), 122–141.

Gliessman, S.R., 2007. *Agroecology: the ecology of in sustainable food systems*. 2nd ed. Boca Raton, FL: CRC/Taylor & Francis Group.

Goma, H.C., Rahim, K., Nangendo, G., Riley, J., and Stein, A., 2001. Participatory studies for agro-ecosystem evaluation. *Agriculture, ecosystems & environment*, 87, 179–190.

Hargrove, W.W. and Hoffman, F.M., 1999. Using multivariate clustering to characterize Ecoregion borders. *Computing in science & engineering*, 1 (4), 18–25.

Harrington, L.W., 1992. Measuring sustainability: issues and alternatives. *In*: W. Hiemstra, C. Reijntjes and E. van der Werf, eds. *Farmers judge: experiences in assessing the sustainability of agriculture*. London: Intermediate Technology, 26–41.

Heckathorn, D.D., 2002. Respondent-driven sampling II: deriving valid estimates from chain-referral samples of hidden populations. *Social problems*, 49, 11–34.

Herrmann, S., Van de Fliert, E., and Alkan-Olsson, J., 2011. Editorial: integrated assessment of agricultural sustainability: exploring the use of models in stakeholder processes. *International journal of agricultural sustainability*, 9 (2), 293–296.

Ikerd, J.E., 1996. *Evaluating relative impacts of conventional and sustainable farming system on rural communities*, Final Report to NCR-SARE (LNC92-48).

Hargrov, W.L., Garrity, D.P., Rhoades, R.E., and Neely, C.L., 2000. A landscape/lifescape approach to sustainability in the tropics: the experience of the SANREM CRSP at three sites. *In*: R. Lal, ed. *Integrated watershed management in the global ecosystem*. Boca Raton, Florida: CRC Press, 209–222.

Pearce, D., Barbier, E., and Markandya, A., 1990. *Sustainable development: economics and environment in the Third World*. London: Edward Elgar.

Pretty, *et al.*, 2010. The top 100 questions of importance to the future of global agriculture. *International journal of agricultural sustainability*, 8 (4), 219–236.

Raman, S., 2006. *Agricultural sustainability. Principles, processes and prospect*. New York: The Haworth Press Inc.

Rao, N.H. and Rogers, P.P., 2006. Assessment of agricultural sustainability. *Current science*, 91 (4), 439–449.

SANREM CRSP – West Africa, 1999. *Participatory landscape/lifescape appraisal*: *Synthese du diagnostic participatif réalisé à Madiama, Nérékoro, et Tombonkan du 1er au 14 février 1999*. Sustainable Agriculture and Natural Resource Management Collaborative Research Support Program – West Africa Site, Working Paper No. 99-02. Blacksburg, Virginia: Office of International Research, Education, and Development, Virginia Tech.

Sassenrath, G.F., *et al.*, 2009. Principles of dynamic integrated agricultural systems: lessons learned from an examination of southeast production systems. Agro-ecosystem management for ecological, social, economic sustainability. *Advances in agro-ecology series*, 56, 259–269.

Sulser, T.B., *et al.*, 2001. A field practical approach for assessing biophysical sustainability of alternative agricultural systems. *Agricultural systems*, 8, 113–135.

Tyrchniewicz, A. and Ragone, S., 1997. *Defining sustainability concerns and issues for the North American Great Plains: challenges and opportunities*. Available from: http://iisd.ca/agri/nebraska/tyrch1.htm.

VanLoon, G., Patil, S., and Hugar, L., 2005. *Agricultural sustainability: strategies for assessment*. London: SAGE Publications.

Veisi, H. and Rezvanfar, A., 2010. *Participatory rural appraisal*. Tehran: Shhid Beheshti University-Iran.

Waltner-Toews, D., 1996. Ecosystem health: a framework for implementing sustainability in Agriculture. *BioScience*, 46 (9), 686–689.

Wang, X., Liu, W., and Wu, W., 2009. A holistic approach to the development of sustainable agriculture: application of the ecosystem health model. *International journal of sustainable development & world, ecology*, 16 (5), 339–345.

Willigen, J.V., 2002. *Applied anthropology: an introduction*. 3rd ed. Oklahoma City: Paperback/Greenwood Press, Society for Applied Anthropology.
Winograd, M., 1994. *Environmental indicators for Latin America and the Caribbean: toward land use sustainability*. Washington, DC: World Resources Institute (WRI), IICA/GTZ Project, 83.
Woodhouse, P., Howlett, D., and Rigby, D., 2000. *A framework for research on sustainability indicators for agriculture and rural livelihoods*. Working Paper 2. Department for International Development Research Project No. R7076CA.
Zhu, W., Wang, S., and Caldwell, C.D., 2012. Pathways of assessing agroecosystem health and agroecosystem management. *Acta ecologica sinica*, 32, 9–17.