Assessing Sustainability at Farm Level using RISE Tool: Results from Armenia

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Background Information and Problem Statement

Agriculture is one of the main economic sectors in Armenia, the main occupation and the biggest employer of the population (44.4%) in the rural areas. Due to the slower rates of growth of agriculture in the past decade compared with the nonagricultural sector of the economy, its share in the GDP gradually decreased, comprising 16.2% (the overall food and agriculture sector making 21.0%). However, the share of employment in agriculture remains relatively constant because of gradual decrease in the non-agricultural employment during all these years and corresponding absence of the labor outflow from agriculture to non-agricultural sectors.

Armenia is a land-poor country. The usable agricultural lands make 71.2% of the country's total land area, with arable lands making only 15.1%. Per capita, Armenia has 0.657 hectares of usable lands and 0.14 hectares of arable lands. According to the data of the RA National Statistics Service, around 33% of arable lands are not used on target. More than 80% of the gross crop produce in Armenia is produced on irrigated lands. Only 208,8 ths. hectares of agricultural land is irrigated. About 35,000 ha are out of use because of primary and secondary salinization and 15,000 ha because of water-logging (underground water at 1-2 m depth). In total about 200,000 ha of agricultural land across the country is out of use for a variety of reasons. The current structure of agricultural sector is as follows: crop production: 62.3%, livestock management: 37.7%, relatively 49.4% and 50.6% in 1990[1]. The contribution of peasant farms/household plots into the Gross Agricultural Output over past years remains prevailing compared with commercial organizations; and no major change and/or dynamics is registered.

After independence, various factors have caused a decrease in the area covered by gardens, the yield has dropped and the volumes of fruit processing have declined. In 1984, there were 54,000 ha of fruit orchards in the country (34,000 ha of which productive), while in 1999 the number was 22,500 ha (of which 21,600 ha productive). Currently there are about 35,000 ha (of which 30,000 ha productive) areas under cultivation[2].

Knowledge of farm management systems is fragmentary, and research in agricultural marketing and policy analysis is weak. Shortage of credit and high interest rates limit the ability of farmers to finance recovery through investment in capital stock, and the ability to re-establish agro-processing activity. As the internal capacity to finance investment is very weak, farmers and agro-processors will rely heavily on international assistance to support the recovery process.

In addition to abovementioned facts more alarming was the situation during the financial crisis and pot-crisis periods. The agricultural gross production decreased by 5.1% in the first quarter of 2009 (relative to 2008 first quarter). For the same time period, economic loss in processing industry was about 5.7%, where the production of cognac and canned food nearly halved. Moreover, the ratio of agricultural food imports to exports increased to 5.9/1 in the first four month of 2009 (the ratios for 2007 and 2008 are 2.6/1 and 3.6/1, respectively). In other words, exports of agricultural food products declined by about 45% in 2009 (first four months) relative to 2008. The level of imports of agricultural food products did not decrease greatly (5.3%), but the fact that it decreased already indicates reduced purchasing power of population (ICARE Country Report, 2010).

This situation continued in 2010 as terrible weather conditions joined to the financial crisis circumstances and the agriculture registered another 14.5% decline (NSS, 2010).

The resolution of these problems requires substantial investment within the framework of a long-term agricultural sector strategy. In the shorter term, private agriculture could be substantially strengthened through a process of institutional restructuring leading to increased client accountability and supporting government services, the promotion of private sector services and agricultural

[1] RA National Statistical Service, 2009, 2010.
[2] FREDA, Survey and Analysis of raw material base for processed fruits, Final report, Yerevan, 2010.

cooperatives, ministry staff and farmer training and reorientation to the market economy, and detailed sub-sector analysis.

In order to improve and develop a more efficient and sustainable agriculture, the Ministry of Agriculture, together with FAO, designed a "Strategy for Sustainable Agricultural Development" (MoA 2002, 2004, 2006, 2008). This document laid the ground for adopting the "2010-2020 Sustainable Strategy Program for Agricultural and Rural Development" by the Government of Armenia and the Ministry of Agriculture which is aimed at the restoration of the financial crisis circumstances and through formulation of anti-crisis mechanisms contribute to the modernization of the agri-food system and raise its competitiveness (GoA, 2010).

The adoption of this very important document probably is the most important achievement in view of current alarming state of agriculture. Nevertheless, the Strategy Program does not consider the integrated approach in consonant with 3 dimensions of sustainability: social, environmental and economic. Monitoring and Evaluation approach of the Strategy Paper is also vague and blurry.

In particular, a holistic assessment of agricultural production at farm level, which could provide baseline data facilitating the monitoring of progress, was not done so far. RISE was therefore considered a useful approach to analyzing and improving the situation of Armenian agriculture, and which could thus contribute to achieving the objectives of the national strategy. The application of RISE pursued the objectives of (1) identifying potentials and weaknesses of the sustainability of agricultural production in Armenia through an extensive, large-scale RISE assessment, (2) improving the situation through direct advice at farm level and (3) providing a sound basis for political decisions creating framework conditions that foster more sustainable production in Armenian agriculture.

This paper highlights the main findings of the joint research project entitled "Sustainability of Agricultural Production in Armenia – analysis of the current situation and improvements through farm advice and facilitation of policy action to adapt framework conditions using the RISE (Response Inducing Sustainability Evaluation)" of the Agribusiness Teaching Center (ICARE Foundation) and Swiss College of Agriculture, funded through the SCOPES program of SDC and SNSF (2005-2009).

RISE Methodology

The Response-Inducing Sustainability Evaluation (RISE, http://rise.shl.bfh.ch), developed at the Swiss College of Agriculture (SHL), aims at closing this gap by providing a farmer- and measure-oriented sustainability evaluation method. The assessment covers agricultural production on a farm within one year and starts with the collection of comprehensive information on ecological, economic and social aspects through a questionnaire-based interview with the farmer. A computer model uses this information to calculate 57 sustainability parameters, condensed into twelve indicators (Table 1). Indicator scores are displayed as a polygon showing farm sustainability at a glance. At parameter level, results are presented in tabular form, which allows for a differentiated appraisal and pinpointing of trade-offs in the concluding feedback discussion.

The approach builds on an intensive dialogue with the farmer (Thalmann et al., 2009). All indicators are composed of state (current situation of the system) and driving force (pressures on the system) parameters. The degree of sustainability of an indicator is calculated by subtracting the sum of driving force parameter values from that of the state parameters. All parameters are rated using a scale from 0 to 100, where 100 indicates the optimum situation in state and the worst situation in driving force parameters. Benchmark values used for normalization are derived from literature and statistics and can be regionally adapted where necessary (e.g. interest rates, minimum wages). An optimum situation is not achieved by maximizing single indicators, but through a balanced bandwidth of all indicators at the highest achievable level (Grenz. J et al, 2009).

Table 1. RISE Indicators and Parameters

Dimension	Indicator	State Parameter (SP)	Driving Force Parameter (DP)
Natural resources	**1 Energy**	SP1: Environmental effect of the used energy carrier	DP1: Energy-input per unit agricultural land DP2: Energy-input per unit work force
Natural resources	**2 Water**	SP1: Water quantity and availability SP2: Water quality and stability of the quality	DP1: Water quantity and productivity: DP2: Risk factors for the water quality
Natural resources	**3 Soil**	SP1: Soil pH, salinization, waterlogging, soil sampling. SP2: Erosion index	DP1: Pollution by pesticides, acidifying fertilisers & fertilisers containing heavy metals DP2: Tillage-related risks DP3: Salinization risk DP4: Nutrient mining on
Natural resources	**4 Bio-diversity**	SP1: Biodiversity promoting farming system	DP1: Proportion of intensely used agricultural land DP2: Plot size DP3: Weed control
Management	**5 N&P emission potential**	SP1: N & P balance SP2: Manure storage and application method	DP1: N & P from organic and inorganic fertilizers (imports / exports)
Management	**6 Plant protection**	SP1: Quality of the application SP2: Environmental and human-toxicological risks	DP1: Cropping systems DP2: Crop rotation
Management	**7 Waste**	SP1:Environmental hazard SP2: Methods of Waste disposal	DP1:Type and quantity of waste
Economy	**8 Economic stability**	SP1: Net debt service over change in owner's equity and interest paid SP2: Equity ratio SP3: Gross investment	DP1: Cash flow/raw performance rate DP2: Dynamic gearing DP3: Condition of the machines, buildings and permanent crops
Economy	**9 Economic efficiency**	SP1: Return on assets SP2: Return on equity SP3: Total earned income	DP1: Productivity
Economy/ Social situation	**10 Local economy**	SP1: Share of regional working forces and salaries SP2: Lowest salary on farm compared with the regional average gross wage	DP1: Raw performance per unit agricultural land
Social situation	**11 Working conditions**	SP1: Emergency/medical care on site SP2: Provision of potable water SP3: Accommodation and sanitary equipment SP4: Working hours SP5: Wage discrimination SP6: Child labor SP7: Forced labor SP8: Gender	DP1: Continuing education DP2: Encumbering work DP3: Assessment of the working conditions DP4: Disparity of income DP5: Working time for reaching minimum wage
Social situation	**12 Social security**	SP1: Social security SP2: Means of subsistence	DP1: Potentially payable salary DP2: Farm succession plan DP3: Legality and documentation of employment

RISE Armenia Project

The first RISE assessments in Armenia were completed on-site by Armenian researchers from Agribusiness Teaching Center, who had been trained at the Swiss College of Agriculture. For the pilot project dairy sector was selected and 13 dairy farms from 5 provinces of Armenia have been assessed by the trained researchers. The pre-study testified to the applicability of RISE under Armenian conditions and showed that farmers approved the assessment. A large-scale assessment covering 202 farms was done in the provinces of Armavir, Aragatsotn, Gegharkunik and Shirak (Figure 1).

The regions assessed represent typical production zones of Armenia that in sum should provide a generalizable picture of Armenian agriculture. The scale of the collected and analyzed data reaches from (1) "raw data" level providing basic information (e.g. water quantity and availability), (2) parameter level providing benchmarked information on specific topics (e.g. proportion of unstable water sources in relation to total water use), (3) state and driving force level providing aggregated information on the present state and relevant driving forces of each indicator, (4) the indicator level providing information on a subject area (e.g. biodiversity), to (5) the system level providing a global picture of farm sustainability (RISE sustainability polygon).

System level

The (arithmetic) mean degrees of sustainability across the 12 RISE sustainability indicators of the 202 farms displayed an unevenly distributed pattern with several substantially negative indicator values (Fig. 1b). Generally speaking, farming systems with such pronounced deficits are rated unsustainable. In the sections below, the rationale for this judgment is described.

Indicator level

At indicator level, major deficits affected the N&P Emission Potential, Economic Efficiency and Social Security indicators. A very positive score was registered for the Energy, Water, Waste, Local Economy and Plant Protection indicators. The indicators Soil, Biodiversity, Economic Stability and Working Conditions had values in the border area, i.e. they were acceptable, but with potential for improvement.

The patterns of the polygons in the four regions (mean value of all farms of a region) did not considerably differ from each other (Fig. 1c), 1d), 1e), 1f)). Statistical analysis, however, revealed[3] significant differences between the regions for all indicators with the exception of N&P Emission Potential, Local economy, Working Conditions (data not shown). For example in Armavir, indicator values for Economic Efficiency and Social Security were significantly higher[4] than in the other regions, indicating better economic performance. These two indicators are interlinked to a certain extent, since sufficient profitability of the operation is a prerequisite for social welfare. Armavir is the region with the most favorable agricultural conditions, allowing for the production of profitable agricultural goods. Farms of this region are often specialized in the production of high-value fruits and vegetables. Yields in fodder crop and cereal production are highest in Armavir. Beside favourable climatic conditions, there are structural factors: Armavir's median farm size of 2.7 ha exceeds that of other regions, e.g. Gegharkunik with 1.36 ha; hence more efficient production is possible in Armavir. Accordingly, production techniques in this region are the most intensive in terms of machinery and resource use.

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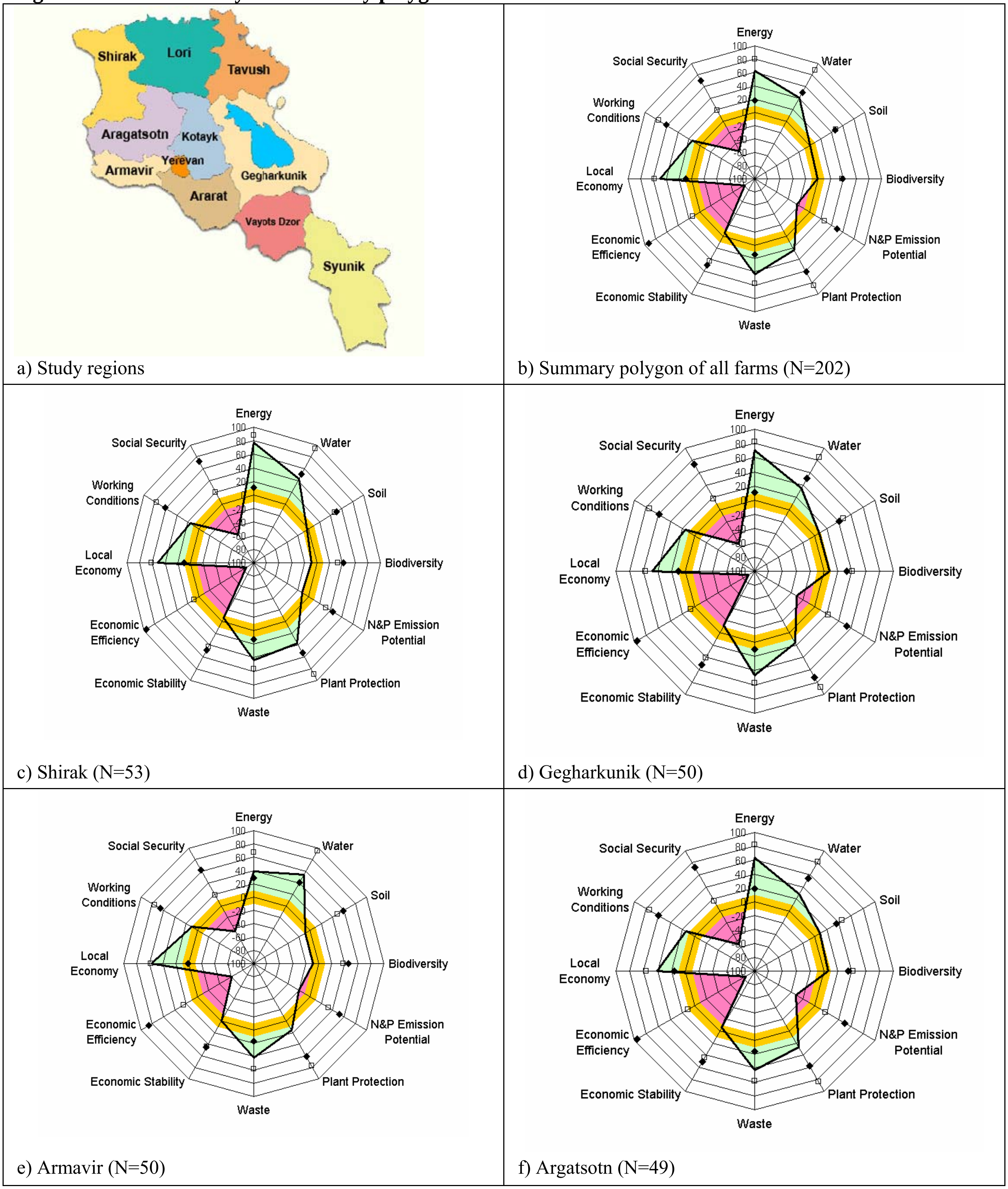
3 Kruskal Wallis Test

4 Mann Whitney Test

Figure 1: RISE summary sustainability polygons.



a) Study regions

b) Summary polygon of all farms (N=202)

c) Shirak (N=53)

d) Gegharkunik (N=50)

e) Armavir (N=50)

f) Argatsotn (N=49)

Legend: □ **State (S):** 0 pts = problematic situation; 100 pts = good situation. □ **Driving force (D):** 0 pts = low risk; 100 pts = high risk.
━ Degree of sustainability, DS = S – D: □ positive: 10 < x ≤ 100 pts; □ border area: -10 ≤ x ≤10 pts; □ negative: -100 ≤ x < -10 pts.

Parameter level

At parameter level of the N&P Emission Potential indicator, excessive nitrogen and phosphorus loads in animal manure, compared to the nutrient demand of crops, were found due to high livestock densities, particularly in Aragatsotn and Gegharkunik. However, high proportions of these nutrients do not reach crops due to inappropriate manure storage and application techniques, and considerable N&P emissions to soil, water and atmosphere occur. Manure is mostly stored on bare ground, which poses the risk of uncontrolled leaching of the liquid fraction. If liquid manure is applied at all, techniques are used that can cause high ammonia volatilization, e.g. broadcasting regardless of weather conditions. Another sustainability issue are the considerable amounts of nutrients leaving the farm nutrient cycle through the burning of dried dung during winter. Therefore, soils often suffer from severe nutrient depletion permitting only low yields of cultivated plants, despite the high levels of nutrient supply that would potentially be available. The elaboration of feasible solutions for reducing the need to burn dung for heating purposes, such as improved insulation of buildings or construction of small biogas fermenters, requires the involvement of different stakeholders. If the practice of burning dung could be discontinued, considerable amounts of nitrogen could be saved and used in crop production. In the strategy for sustainable agricultural production of the Armenian Ministry of Agriculture[5], it is suggested that farmers purchase mineral fertilizer using micro credits. However, the use of self-produced manure would reduce the need for a credit in the first place and thus avoid risks related to indebtedness. Many examples from other countries have proven the immanent risk e.g. of crop failure resulting in the inability to pay back credits used to buy consumables. Despite the generally problematic economic condition of most of the farms, the current low level of indebtedness positively stands out and should be preserved.

It is essential not only to pay attention to the results at indicator level, but also to the single parameters, since the aggregation process may mask detail information. This is particularly the case for the Water indicator which shows a generally positive degree of sustainability (Fig. 1b). However, at (sub-) parameter level several problematic issues were identified:

Several farmers rated their water availability for irrigation and livestock production as unstable and complained that water supply had become worse in the last years. Usually, water is sourced from an off-farm water supply. During the first phases of transition in the early 1990s, structures for maintenance of infrastructure were dissolved and maintenance neglected. Despite substantial programs for the renewal of basic infrastructure, the situation in many regions is still deteriorating. Limited water availability for irrigation may be one reason for the low yields of many of the crops cultivated (e.g. winter wheat 27 dt/ha; winter barley 17 dt/ha; potatoes 185 dt/ha) compared to other production systems. Any management practice that contributes to increased yields has positive effects on water productivity. Improved nutrient management (manure, composting), proper crop rotations, adapted varieties with reasonable yield potential, crop protection, and soil-water conservation measures may increase crop yields and thus water productivity. Although many of these options also exert positive effects on other sustainability aspects (e.g. on soil conservation and economic efficiency), trade-offs are to be expected: higher fertilizer inputs, for example, can increase pest and disease susceptibility of crops, contribute to further nutrient surplus, threaten water quality, or negatively affect biodiversity.

Water pollution by livestock feces, especially by livestock entering water bodies, is a serious issue, particularly in view of upstream-downstream relations and human and animal health. But also inadequate manure storage contributes to water pollution risks. Other risks for water bodies are related to waste water and its treatment and the lack of water protection measures. These issues need to be tackled at various levels. At farm level, agronomic skills and knowledge have to be improved. The most effective channels for dissemination of such information have to be developed in the upcoming

5 Armenian Ministry of Agriculture 2006. Agricultural Sustainable Development Strategy. Republic of Armenia (revised version).

process. Certainly, extension services will play a central role. The administration and regulatory level must provide a regulatory framework that improves the knowledge base and skills of the farmers and declare the protection of natural resources as a guiding principle.

Many farmers mainly produce for subsistence. The economic raw performance, including sales and external deliveries (self- and in-kind consumption), is frequently lower than the costs of production, resulting in a net loss for the agricultural enterprise. This reflects a low profitability of farms, which is compensated for by low earnings of the self-employed work force and low salaries of the employed work force. Earnings and salaries frequently are well below a minimum wage[6] that would enable e.g. to purchase adequate social securities, such as insurances (Social Security; SP1: Social securities; SP2: Means of subsistence). Almost inexistent investments (Economic Stability; SP3: Investments) can also be explained by low economic performance of the operations.

The reluctance to invest in replacement and maintenance of machinery and buildings is obvious. However, mainly the well-performing farmers stated that they were somehow blocked in their decisions by a general lack of agronomic and economic knowledge and information. It may be speculated that improved availability of up-to-date reliable information would foster higher rates of investment at least with less risk-averse farmers. It can be expected that with this low level of profitability, many farmers will quit agricultural production as soon as reliable and profitable income alternatives are available.

Conclusions and Way Forward

The RISE tool was successfully applied in differnet regions of Armenia and proved to be a suitable tool for the holistic evaluation of Armenian dairy farmers' sustainability. It has to be stressed that applying RISE not only targets a more rational use of the natural resources (energy, water, soil, biodiversity) and improved management practices (reduced emissions, proper crop protection and waste management). Through its holistic approach the tool also covers the most important economic and social aspects. Economic stability and efficiency of farming (including adequate income) and its effect on local economy (e.g. employment generation) as well as social security and working conditions in the agricultural sector are covered by the tool. These aspects are particularly important in a country like Armenia. A particular strength of the application of RISE is that it allows for the dual benefit of simultaneous research and development (i.e. improvements) on the ground. By establishing the basis for research (through sustainability assessments at farm level) improvements of farming practices are directly initiated in the feedback discussions between advisors or extension agents and farmers. The development and implementation of training modules by Armenian team members at the International Center for Agribusiness Research and Education and the Armenian State Agrarian University will raise awareness with students, scientists and extension services on the complexity and importance of sustainability issues in agriculture.

Results of the sustainability survey are now being communicated to farmers, extensionists, administration and donors through the **Armenian Platform for Sustainable Agriculture (www.apsa.am)** launched in January 2009 by the International Center for Agribusiness Research and Education and the Swiss College of Agriculture to contribute to the sustainable agricultural development of Armenia involving different stakeholders of the agri-food chain.

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6 Basic needs include food, energy, housekeeping, clothes, shoes, education, personal hygiene, rent, interests (mortgage), transportation, taxes and social securities (health care, old-age pension scheme, unemployment insurance, disability insurance).

References

FREDA 2010. Survey and Analysis of raw material base for processed fruits, Final report, Yerevan.

Government of Armenia, 2010. “2010-2020 Sustainable Strategy Program for Agricultural and Rural Development”.

J. Grenz, C. Thalmann, A. Stämpfli, C. Studer , F. Häni. 2009. RISE – a method for assessing the sustainability of agricultural production at farm level. Rural Development News 1/2009.

Ministry of Agriculture, 2002. A Strategy for Sustainable Agricultural Development. Prepared with the support of the Food and Agriculture Organization of the United Nations within the framework of TCP/ARM/0065.

Ministry of Agriculture, 2004 (updated in 2006). A Strategy for Sustainable Agricultural Development. Consistent with the Government program on “Poverty Reduction Strategy Paper.”

RA National Statistical Service Reports, 2009, 2010.

Thalmann, C, Porsche, H, Stämpfli, A, Häni, F, Studer, C. 2009 (submitted). RISE: a versatile tool for a quick and holistic sustainability evaluation of agricultural production at farm level. Submitted to European Journal of Agronomy.