Agricultura 2: 7-11 (2003)

Sustainability assessment of farms with the model RISE[1]

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Sustainable production is the most important leading principle for the world markets where liberalisation exerts the greatest pressure on development. Numerous studies have been conducted to evaluate the degree of sustainability on a national and local level. However, only little information for single farm assessment is available at this time.
The present paper introduces a tool called "Response-Inducing Sustainability Evaluation" (RISE), which allows an easy assessment at the farm level. It is system-oriented and offers a holistic approach for advice, education and planning. The model covers ecological, economic and social aspects by defining 12 indicators for Energy, Water, Soil, Biodiversity, Emission Potential, Plant Protection, Waste and Residues, Cash Flow, Farm Income, Investments, Local Economy and Social Situation. For each indicator the "Driving force" (D) and the "State" (S) are determined. D stands for the estimated pressure on the farming system and reflects the tendency of development, S stands for the measured or estimated actual situation. For D and S is used a scale between 0 and 100. For D is the best case 0 (lowest pressure), for S it is 100 (highest performance). The degree of sustainability (DS) is S minus D (values between –100 and +100). The results are summarized and displayed in a sustainability polygon. In addition to this polygon the situational framework is rated for 1) stability of the social, economic and ecological framework, 2) farmer's risk awareness and precautions against risks, 3) grey energy (machines, buildings, external inputs), 4) animal health and welfare.
The tool RISE was tested and used to evaluate very different farms in Brazil, China and Switzerland. The results are considered relevant with regard to the objective stated. Further testing, adaptation and fine-tuning is under way. It is envisioned to develop a similar methodology for the sustainability assessment of the entire supply chain. Agricultura 2: 7-11 (2003)

Key words: sustainability assessment; sustainability at the farm and crop level; indicators of sustainability; driving force - State - Response (DSR) – model

BACKGROUND AND AIMS

Whereas the liberalisation of the world markets today seems to exert the greatest pressure on development, sustainable production is the most important leading principle (Stückelberger 1999). According to the Brundtland Commission (WCED 1987), "sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs". The three key factors of sustainable development are environmental protection, economic efficiency and solidarity in society.

Numerous studies have been conducted to evaluate the degree of sustainability on a national and local level and broadly accepted indicators have also been recommended (e.g. Meadows 1998, OECD 2000, UNO 2001). However, only little information for the precise assessment of a single farm is available. To fill this gap and to provide a simple and robust tool for the holistic assessment of the sustainability of an individual farm and the sustainable optimisation of farms, we developed RISE, a model for the Response-Inducing Sustainability Evaluation at the farm level. Our work is based on the mentioned publications of OECD and UNO, on earlier research work on farming systems (Häni 1990, 1993, Häni et al. 1998) and we have also been considering approaches for life cycle assessments – FAL 2002 – and for the determination of indicators at the farm level (Briquel et al. 2001, Girardin et al. 1994, 1999).

The goals set for the RISE model were:

• A holistic approach, using relevant indicators for individual aspects as well as for the whole farming system. The choice and the determination of relevant parameters consider the principles of ISO-14040 norms for life cycle assessment.

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[1]The present publication is partly based on two earlier papers (Häni et al. 2002 and 2003) and on a seminar of the international workshop „Sustainable Food Production in Central and Eastern Europe in the 21 st Century", 3 - 5 October 2002, Subotica, Serbia.

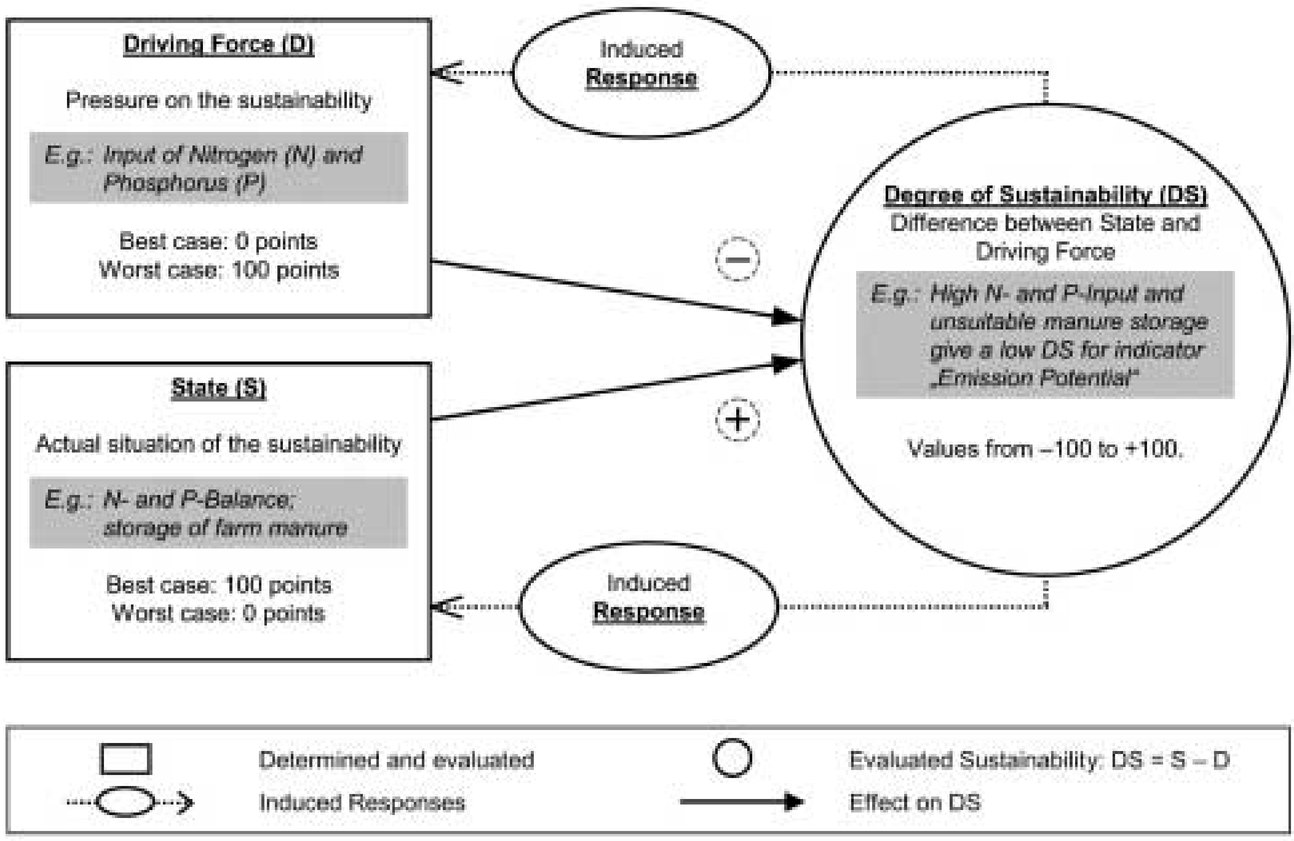

Fig. 1. Schematic approach of the response-inducing sustainability evaluation (RISE). The "degree of sustainability" (DS) is calculated as "state" (S) – "driving force" (D). For single indicators values above +10 are considered sustainable; the whole system is sustainable if no values of DS are below –10.

• An easy instrument for the comparative evaluation of the sustainability degree of different farms and a planning tool for the improvement of the sustainability of individual farms.

• An instrument applicable for different farm types and conditions as well as throughout different countries.

• Indicators, data procurement and interpretation of the results must be verifiable and understandable for farmers and a wider public.

• The effect of individual measures on the whole system must be easy to visualise.

• The farmer should be able to see both the strengths and the weaknesses of his farm to be able to optimise the farm accordingly (response-inducing approach).

PRINCIPLES AND METHODS

RISE is based on twelve indicators for the economic, ecological and social situation: Energy usage, water consumption, the situation of the soil, biodiversity, emission potential, plant protection measures, wastes and residues produced, cash flow, farm income, investments, impact on the local economy, social situation of farmer family and employees. For each indicator the "Driving force" (D) and the "State" (S) are assessed (Figure 1 and Table 1). The "driving force" quantifies the "pressure" on the economic, social or ecological situation on a scale of 0 (best case) to 100 (worst case). The "state" quantifies the present situation on a scale of 0 (worst case) to 100 (ideal situation). The degree of sustainability (DS) is calculated as S-D. Single indicators are considered sustainable if DS is above +10, the whole system of farm is considered sustainable if no indicator has a DS below –10. To visualise the results and allow an easy interpretation, D, S and DS of all the indicators are shown in the form of a sustainability polygon (Figure 2 - 6). In an ideal situation the polygon does not show maximum values for individual indicators but rather a regular band of positive values for DS. The interpretation of the results will identify weak aspects of the farm and can thus induce steps to improve the situation. In addition to the sustainability polygon a strength and weakness profile to further evaluate the situational framework has to be determined for 1) stability of the social, economic and ecological situation, 2) farmer's risk awareness and precautions against risks 3) grey energy (machines, buildings, external inputs), 4) animal health and welfare. Every farm is rated for each of these four points with A (best rating: strong point of the farm), B (medium rating: acceptable) or C (worst rating: weak point of the farm; not favourable for sustainable development).

RESULTS AND DISCUSSION

Figure 2 shows the example of the sustainability assessment for a typical mixed Swiss farm producing livestock and cash crops. The result of the evaluation of the actual situation (a) can be considered as rather typical for many farms working along the lines of the Swiss agricultur-

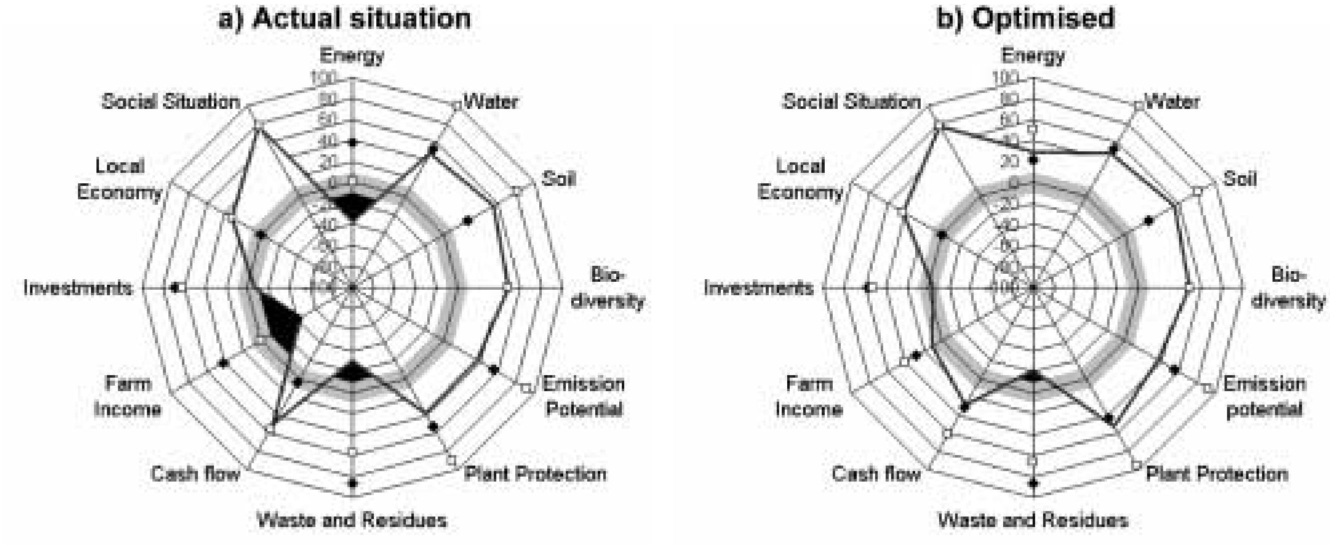

Fig. 2. Swiss mixed livestock and crop farm: 19 ha; 1.5 Large animal units/ha; 2.5 Workforces.

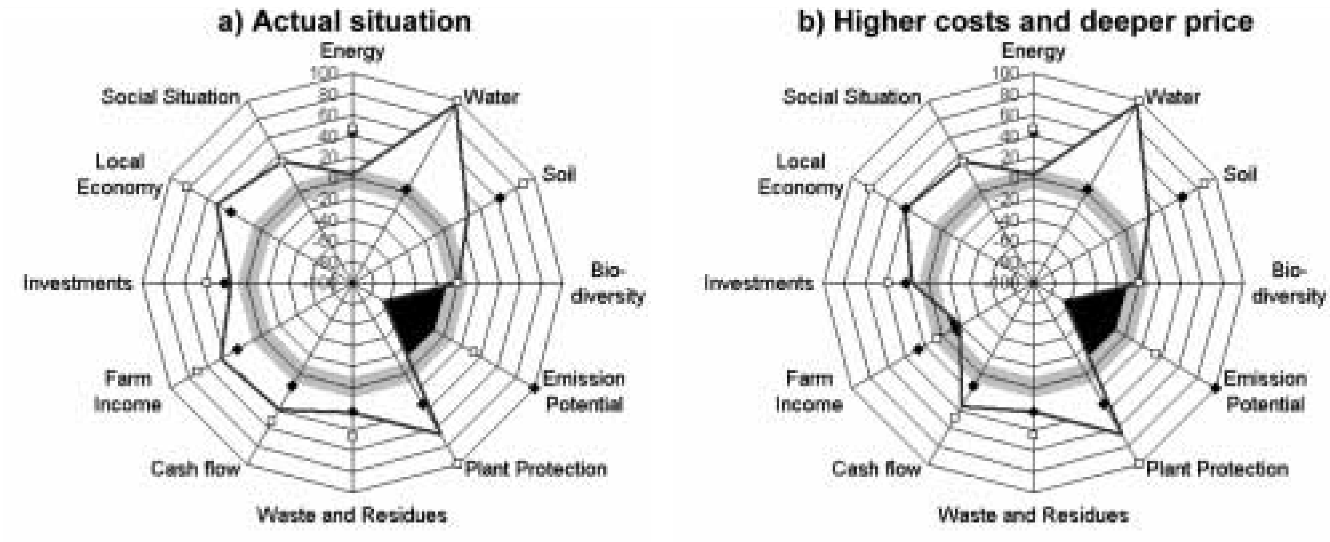

Fig. 3. Dairy cattle farm in China: 0.7 ha; 4.3 Large animal units/ha; 2.0 Workforces.

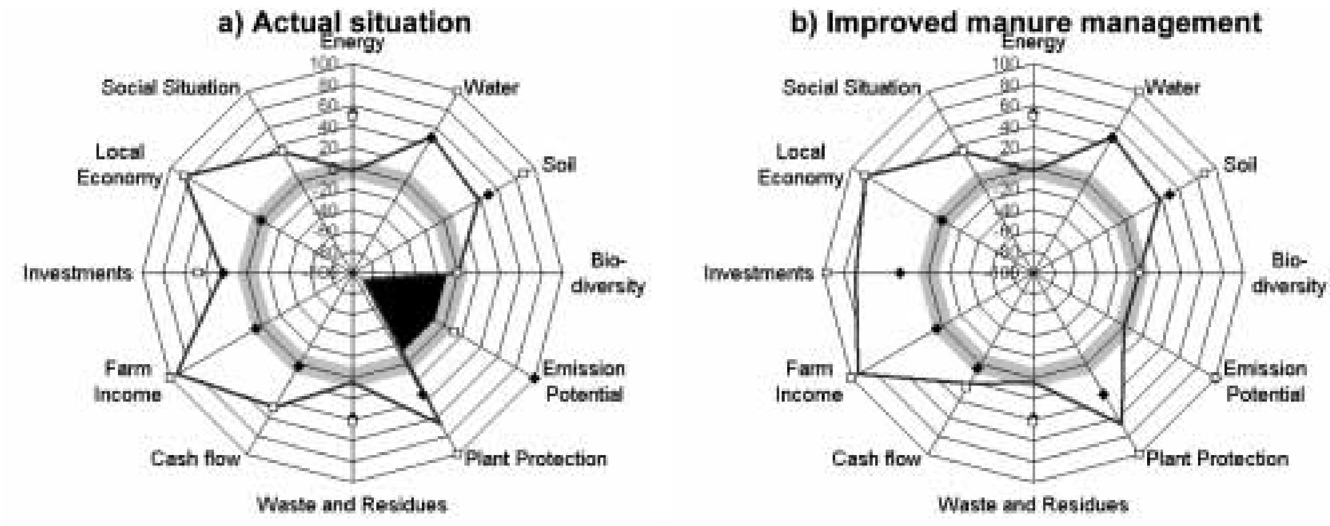

Fig. 4. Dairy cattle farm in China: 1.4 ha; 25 Large animal units/ha; 6 Workforces.

◆ Driving force (D) □ State (S) — Degree of sustainability (DS) positive Border Area negative

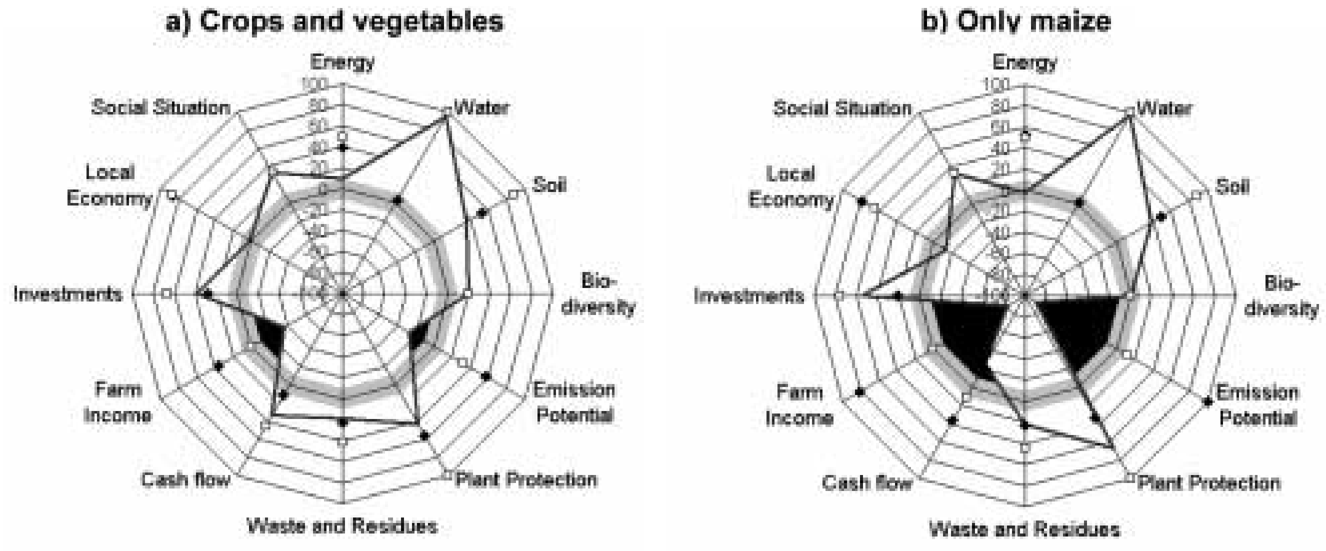

Fig. 5. China; a): 5.4 ha; maize, flax, cabbage, spinach; 5 Workforces. b): 0.6 ha, 1.8 Workforces.

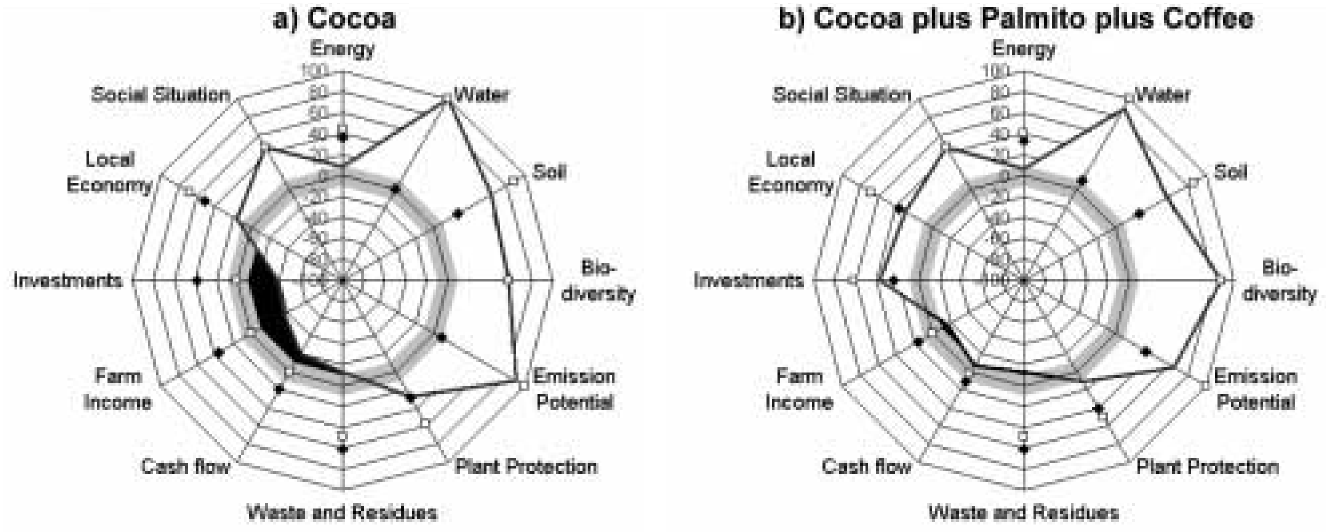

Fig. 6. Farm in Brazil: 1'940 ha; 1'459 ha Cocoa, 359 ha Palmito, 122 ha Coffee; 682 Workforces.

al policy with direct payments for ecologically beneficial farming systems. The most serious handicap is the farm income; energy consumption and wastes are other weak aspects. The farm could clearly improve its situation by optimising (b) the cattle housing system and investing into renewable energy systems (biogas, canola oil driven tractor).

Figures 3 – 5 show the results of farms from the district of Shuangcheng, near Harbin in Northern China, Province of Heilongjiang.

Figure 3 shows an example of a milk supplier to the Nestle factory in Shuangcheng: The actual economic and social situation is good, but there is a very serious problem concerning the emission potential (a). This problem is due to a surplus of organic manure (high animal density) as well as mineral fertilizer and to a missing or unsuitable storage of manure. Scenario b) was calculated with a supposed price increase of soybean (used as feed) by 30% and a decrease of the milk price by 10% (not unrealistic assumptions). The result shows that the farm income is highly dependable on these external factors and the economic situation can be considered as rather fragile.

Figure 4a) shows another typical example of a Nestle milk supplier. This farm with a livestock density of 25 Large animal units (LU)/ ha (most of the fodder comes from outside the farm) is economically sound but has a very high emission potential. Scenario b) shows that by recycling the manure as fertiliser, the situation can be improved considerably. Investments are required in the areas of manure storage, transport and spreading and 85% of the manure have to be exported to local cash cropping farms.

Despite its relatively big surface, the cropping farm in Figure 5a) achieves a less favourable economic result than the Chinese dairy farms, but it has also a lower emission potential. Farm 5b) is a very small farm, even under the regional conditions. It grows only maize and the resulting economic result is very unsatisfactory. Striking is the fact that also this small farm has a very high emission potential, which is due to a high input of fertilizer.

Table 1: Six examples of indicators of sustainability. D = driving force; S = state; FL = farmland; WF = workforce(s); MRI = minimum regional income

Indicator	Para-meter	Basis of data (determination per year)	Units of reference
Energy	D	∑ Energy usage	∑ ha FL
		∑ Environmental impact (global warming, air pollution etc.)	∑ Farm
	S	∑ Energy consumption per WF unit	∑ Farm
		∑ Degree of self sufficiency for energy consumption	∑ Farm
Water	D	∑ Water consumption	∑ ha FL
	S	∑ Stability of water source	∑ Farm
Soil	D	∑ Soil contamination through fertilizers and pesticides	∑ ha FL
		∑ Effect on the soil by farm machinery	∑ ha FL
	S	∑ State of the soil (a): Nutrients, carbon, pH, wetness, salinity	∑ ha FL
		∑ State of the soil (b): Erosion	∑ ha FL
Emission	D	∑ Input of nitrogen (N) and phosphorus (P)	∑ ha FL
Potential	S	∑ N & P-balance (supply and demand)	∑ Farm
		∑ Storage of farm manure	∑ Farm
Farm Income	D	∑ Number of workforces multiplied by MRI, as % of sales	∑ Farm
	S	∑ Farm income, as % of previous measure (absolute value)	∑ Farm
Local	D	∑ Sales in relation to a regional benchmark	∑ ha FL
Economy	S	∑ Relative size and compensation level of local workforce	∑ Farm
		∑ Lowest salary paid as % of MRI	∑ Farm

The farm in Figure 6 was the second biggest cocoa producer of the world, but ran into serious economic problems due to price decrease and a disastrous cocoa disease (*Crinipellis perniciosa*). Compared to the exclusive production of cocoa (Figure 6a), the additional diversification in to the production of palm hearts and coffee improves the economic situation considerably (Figure 6b). This example shows, that the RISE-model can also be used to analyse the impact of individual commodities on the whole farm.

CONCLUSIONS AND OUTLOOK

• The model RISE was successfully tested on very different farm types under variable conditions in Brazil, China and Switzerland.
• The results show that RISE can achieve the stated objectives and it can be a valuable instrument for the easy assessment of the sustainability of farms.
• The model is at present further validated in different countries.
• It is envisioned to extend the model in order to include the entire supply chain up to the factory gate.

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Received June 24, 2003; Accepted in final form September, 2003