Chapter 2
Life Cycle and Supply Chain Information in Environmental Management Accounting: A Coffee Case Study

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Abstract This case study illustrates the application of environmental management accounting in a medium-sized coffee refining and exporting enterprise in Southern Vietnam, with the example of the Neumann Gruppe Vietnam Ltd. It examines the relevance of environment-related supply chain information derived from life cycle assessments for environmental management accounting and reveals possibilities to improve eco-efficiency at the site level and for its supply chain.

All company-related information provided in this case study has been disclosed by Neumann Gruppe Vietnam Ltd. and cross-checked by the authors. The information is partly simplified to ensure both confidentiality and a better understanding of the case.

Keywords Coffee • Supply chain • Environmental management accounting • Vietnam • Eco-efficiency • Supply chain costing • Supply chain management • Life cycle assessment

1 Introduction

This paper presents a case study on environmental management accounting, which has been conducted under the InWEnt-funded capacity development project 'Environmental Management Accounting for small and medium-sized enterprises

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in South-East Asia' (InWEnt 2008). The study was conducted at Neumann Kaffee Vietnam Ltd, a coffee refining and exporting company. To understand better the case study setting, the paper provides an overview of the economic and environmental situation of the Vietnamese coffee business and reveals relevant results of life cycle assessments on coffee. Combined with specific information on the company's environmental and business performance, the environmental decision-making situation and potential consequences are discussed. Special attention is paid to the relevance of supply chain information and life cycle assessment results for environmental management accounting.

2 Environmental Management Accounting and Life Cycle Information

The basic task of management accounting is to provide information to managers and other internal stakeholders for their decision-making, e.g. product and production cost, budgets, investment appraisals or benchmarks. In contrast with financial accounting, which discloses mainly standardised and often mandatory information to external stakeholders such as shareholders, stockholders, creditors or tax authorities; management accounting is a voluntary function used to improve business performance (Atkinson et al. 2007, Hansen and Mowen 2006, Horngren et al. 2008).

Environmental accounting has evolved because of insufficient consideration of environmental impacts and their financial consequences in conventional accounting (Schaltegger and Burritt 2000). In accordance with general accounting, environmental accounting can be categorised into financial and management accounting, with environmental management accounting (EMA) primarily supporting decision-making by internal stakeholders (Burritt et al. 2002). This being the case, EMA has potential application in various business decision-making situations and therefore comprises different tools and measures. Indeed, various academic papers deal with different decision-making situations and contribute to their further exploration. For instance, Burritt (2005) examines EMA in a risk management context and Figge et al. (2003) and Dyllick and Schaltegger (2001) propose a Sustainability Balanced Scorecard (SBSC) to link EMA and strategic management. Burritt et al. (2002) propose a framework which allows classifying EMA decision settings systematically depending on the type of information required by the decision maker. They distinguish monetary or physical, long term or short term-focussed, ad hoc or routinely generated, and past or future-oriented information (Burritt et al. 2002).

Most papers dealing with the actual implementation of environmental management accounting, however, focus mainly on environmental cost accounting applications, i.e. the provision of short-term focussed, routinely generated, past-orientated, monetary environment-related information for decision-making (see the ensemble of contributions in Bennett et al. 2002, 2003, Rikhardsson et al. 2005 and Schaltegger et al. 2006). Likewise, international guidelines on EMA published by

International Federation of Accountants (IFAC) mention the range of EMA decision settings, but concentrate on an environmental costing approach (IFAC 2005).

Restricting EMA to internal environmental cost accounting seems to be inappropriate from a supply chain perspective. If companies aim at improving their supply chains toward sustainable development, environmental and economic information on supply chain steps external to the company is required. As a consequence, life cycle assessment (LCA) and environmental life cycle costing become crucial EMA tools to improve the supply chains. These EMA tools provide the adequate information for supply chain-specific decision settings (Burritt et al. 2002; for an introduction to LCA and environmental life cycle costing see Guinée 2002, Hunkeler et al. 2008). Therefore, this case study pays special attention to life cycle aspects relevant for managerial decision-making.

3 Case Study Background: The Coffee Market

Coffee is one of the most valuable traded commodities in the world. Until the late 1990s it was even the second most valuable commodity after oil (Ponte 2004). Vietnam is a newcomer on the international coffee market and has experienced a rapid growth of coffee farming for the last two decades. This rise has not only made Vietnam the second biggest coffee exporter after Brazil, but it has also contributed to shrinking prices and ever-increasing competition in the world market. Since 1970, the average annual price decline has been 3% for Arabica and 5% for Robusta coffees (Lewin et al. 2004).

Globally, the declining prices are associated with rising unemployment and poverty in some of the coffee exporting countries. At the same time, the profits made in the coffee importing countries have remained stable or even increased due to the introduction of new brands and blends and other value-adding activities (Lewin et al. 2004). Thus Ponte (2004) characterises the coffee supply chain as a buyer-driven or more specifically as a ‘roaster-driven’ one.

Vietnam is a mass producer of coffee, not a quality leader. Robusta, the main type of coffee produced in the country, is considered less valuable than Arabica, which is the main type of coffee produced in most other countries. Robusta achieves lower prices in the world market and is mostly used as admixture to downmarket coffee products. Many consumers prefer the taste of Arabica, except for certain types of espresso. Hence, Vietnam’s current competitive situation is a purely price-driven one; it needs to produce a cheap type of coffee for the mass market at lowest possible costs. It should be noted, though, that there are initiatives to change this situation, for instance, the Vietnamese Ministry of Agriculture is planning to increase the production of Arabica coffee, to improve the quality of coffee processing and to participate more actively in international coffee trading (People’s Daily Online, 9th May 2006). This might lead to the development of higher-quality grades in the future, which are less dependent on the fluctuating world market prices. At present, the world market prices have risen, relieving news for Vietnamese coffee production (Flexnews, 26th March 2007).

Coffee is a typical example of a global commodity. Mainly produced in developing nations in tropical areas, however, the majority of consumers can be found in industrialised countries. Highly efficient consumer markets and the large corporate wholesalers, roasters, and traders buy coffee from agricultural smallholders and middlemen. The widely spread perception of the global value chain of coffee is one where profits are made in industrialised countries at the expense of environmental and social problems in the developing world. This has lead to initiatives promoting fair trade and sustainable coffee farming including organic, shade-grown and bird-friendly coffee products. The market share of organic and fair trade coffee is continuously increasing; however, it is still less than 2% of the world market (Ponte 2004).

Doubtlessly, the cultivation and processing of coffee has severe environmental consequences. Deforestation, loss of biodiversity, eutrophication, depletion of water and energy resources, and erosion are examples of environmental impacts associated with the first steps of the coffee supply chain. Plentiful measures to reduce these impacts are available, for instance, shade grown and organic cultivation, diversification and alternating vegetation, fallowing, planting of grass under the coffee plants, recycling of wastewater, composting of other waste, etc. These measures are perceived as costly and therefore, the fierce price competition drives harmful practices (Clay 2004).

Admittedly, it cannot be concluded that less intense competition would automatically lead to less harmful practices. On the contrary, high world market prices and profit margins encouraged Vietnamese authorities to promote coffee farming since the late 1980s and stimulated the interest of many Vietnamese to take their chance in coffee farming. Without knowing much about coffee cultivation, harvesting and processing, this boost lead to deforestation, soil degradation, over-fertilisation and further environmental impacts (Johnston 2001).

The stages of the coffee supply chain and the associated environmental issues will be elaborated further. Improvement options will be derived from a review of life cycle assessments on coffee.

3.1 Environmental Issues in the Coffee Supply Chain

The coffee supply chain starts with agricultural processes in tropical countries and ends with the consumption and disposal stages, predominantly in industrialised countries in cooler latitudes. The main stages and environmental impacts are highlighted in Fig. 2.1 and comprise (ICO 2001):

- *Coffee cultivation*: Coffee farmers and hired workers plant coffee trees, apply fertiliser, pesticides and herbicides, irrigate the plants and finally harvest coffee cherries. These activities are associated with soil erosion and loss of biodiversity

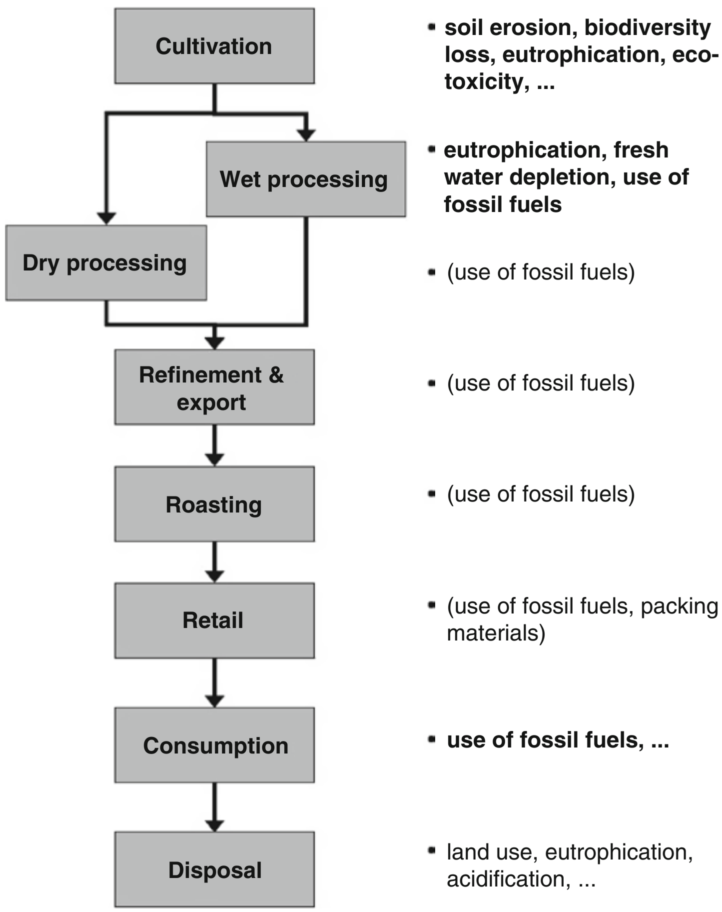

Fig. 2.1 Coffee supply chain stages and environmental issues

due to the extension of agricultural land use; eutrophication, eco-toxicity and greenhouse effect due to fertilisation; mammal and aquatic life toxicity due to pesticide use; and resource depletion due to the fuel and water consumption required for farming.

- *Dry/wet processing*: The coffee cherries have to be processed to release the green coffee beans. Robusta coffee cherries are usually treated by using the dry processing method; most Arabica coffees are wet processed. Dry processing can be achieved by solar power (sun-drying) or by the use of fuels; the latter one is more common in Vietnam. After drying, the coffee cherries are hulled and ground to release the green coffee bean. The waste of this process, dried pulp and parchment skin, can be composted. Wet processing is more harmful from an environmental point of view, but gains higher selling prices for the coffee beans.

The traditional wet processing method requires 40,000–70,000 l of water input per tonne (ton) of green bean; the mechanical removal of mucilage (coffee fibre) reduces this demand down to 1,000 l. The organic pollutant load of the generated waste water is similar in both cases. BOD and COD of wet processing waste-water are extremely high, while the pH is low. Untreated waste-water of wet processing is therefore a major driver of environmental problems caused by the production of coffee.

- *Coffee refinement and export*: Coffee beans are not homogeneous, e.g. they vary in size, shape, colour and/or moisture content. To separate and to improve quality grades, a variety of measures are applied in the refining step: polishing, sorting, washing and drying. The coffee-producing countries export most of their coffee to industrialised countries. Both, the refinement process and coffee export require energy, either in the form of electricity or fuel input.
- *Coffee roasting and retail*: To roast the green coffee beans, thermal energy is required. This thermal energy can cause air emissions including greenhouse gases. Decaffeinated and soluble coffee in particular require water in the roasting process as well. After roasting, coffee needs to be packed. Polyethylene foil (PET) is used for packing to ensure that no oxygen reacts with the coffee to avoid ageing. Other packaging types are glasses with screw caps for soluble coffees. Roasting does not necessarily happen after export, it is also common to export roasted coffee.
- *Consumption*: Energy consumption is the most important environmental issue of this step of the coffee life cycle. The making of coffee requires energy, mainly electricity, for the percolator. The habit of leaving coffee on the hot plate of the percolator to keep it warm increases the energy demand further. Of course, coffee-making involves a certain amount of water input as well.
- *Disposal*: Consumers need to dispose coffee grounds and filters as well as the packaging. Coffee grounds and filters are often composted, but have a comparably long and irregular rotting process. Packaging as well as jute and plastic bags from previous supply chain steps is recycled, incinerated or dumped. The common environmental problems related to waste treatment like energy consumption, acidification and greenhouse gas emissions are therefore present.
- *Transportation*: Transportation is not depicted in Fig. 2.1, as it occurs between almost all steps of the coffee life cycle. The biggest transportation distance concerns the shipping of green beans or roasted coffee from the producing to the consuming countries. Transportation is associated with the depletion of natural resources, in particular fossil fuels, and the environmental impacts of combusting the fuels, most prominently global warming.
- While coffee farming, the supply chain's first step, is often in the spotlight of environmental attention, later steps of the value chain tend to be disregarded. However, life cycle analyses (LCA) of coffee production conducted by Diers et al. (1999) and Salomone (2003) show that another crucial step of coffee production is coffee consumption.

3.2 Environmental Supply Chain Improvements – Conclusions from Life Cycle Assessments on Coffee

An LCA can be used to highlight the environmental importance of different steps of a product's life cycle. Two LCAs have been conducted for coffee production (Diers et al. 1999, Salomone 2003). Looking for the highest overall improvement potential of the coffee life cycle, the conclusion of both LCAs is similar: the first and the last steps of the life cycle matter most.

Salomone (2003) identifies consumption as the single most important step followed by cultivation. Cultivation accounts for more than 97% of coffee's total eco-toxicity and eutrophication, while consumption, comprising mainly the water use and energy demand for preparing coffee, accounts for more than two thirds of total air acidification, greenhouse effects, photochemical oxidant formation, depletion of ozone layer, human toxicity, and aquatic eco-toxicity. The importance of the consumption step for the overall environmental performance of coffee production is supported by the results of a sensitivity analysis. It reveals that in terms of overall environmental impact, the impact of changing the coffee-making process, e.g. gas stove coffee-making instead of an electric coffee machine, is substantially higher than the impact of avoiding pesticides or applying organic fertilisers in cultivation (Salomone 2003).

In the analysis of Diers et al. (1999), coffee cultivation and processing account for 49%, and consumption and disposal for 41% of the environmental impacts. Furthermore, a comparison of best case, worst case and the current situation places the current situation near to the worst case scenario, meaning that the improvement potential of the coffee life cycle is rather high (Diers et al. 1999). The coffee processing step has a higher impact in this analysis due to the fact that wet and dry processing have been considered, while Salomone considers dry processing only. Similarly, the analysis of Diers et al. is stressing the waste disposal issue more than Salomone does which leads to a slightly higher importance of the disposal stage. Both LCAs do not explicitly consider loss of biodiversity, which is likely to increase the environmental importance of the cultivation step even further.

The results of the two LCAs help decision makers to prioritise options for environmental improvements of the supply chain (Diers et al. 1999, Salomone 2003):

- In *cultivation*, avoidance or reduction of fertiliser use is the most important concern followed by measures to avoid erosion. Preservation of biodiversity has not been considered in the LCAs, but is likely to be of importance in the Vietnamese coffee farming context as well.
- The impacts of *wet processing* can be substantially reduced by proper waste-water treatment and reduction of water consumption. In wet and dry processing, fuels are consumed for drying. Energy-efficiency measures could reduce environmental impacts like global warming and resource depletion.

- *Refinement*, export, roasting, retail and transportation are not the highest priority for environmental improvements of the coffee life cycle.
- In *consumption* eco-efficiency can be improved by using electricity from renewable resources or by substituting the coffee machines run by electric energy with different devices, e.g. plunger pots, which can use other less polluting energy sources like gas. A big improvement potential is the change of consumer habits which includes, for instance, the use of thermos cans or bottles instead of leaving the coffee on the hot plate for several minutes or the reduction of wastage caused by non-consumed coffee poured to the drainage.
- Coffee ground and coffee filters are the biggest contributors to environmental impacts of the *disposal* stage. Measures to ensure proper composting are likely to reduce these impacts substantially.

4 The EMA Case of a Vietnamese Coffee Exporter

Neumann Kaffee Gruppe (NKG) is one of the biggest coffee exporter and importer companies in the world. The group steers 47 companies in 28 countries from its headquarter in Hamburg, Germany. Besides its export business including quality milling and grading and its import and trade of industrial volumes, specialities and instant coffees, the NKG is also doing business in coffee farming, logistics, risk management and finance (Neumann Kaffee Gruppe 2008).

One of the group's subsidiaries, Neumann Gruppe Vietnam Ltd, is refining and exporting coffee to overseas roasters. The company has been subject to an EMA case study carried out by the authors of this paper as part of InWEnt's capacity development project 'Environmental Management Accounting for small and medium-sized enterprises in South-East Asia' (InWEnt 2008). The case study is part of a series of case studies that aim at identifying and analysing environment-related management decision settings in various South-East Asian businesses (Herzig et al. 2006).

4.1 Initial Situation

Neumann Gruppe Vietnam Ltd (called Neumann in the following) refines green Robusta coffee beans and exports to customers in several industrialised countries. Its customers expect a coffee quality which is above average and pay premiums for certain quality grades. Eighty employees work at Neumann's plant in Binh Doung Province, near to Ho Chi Minh City. The annual volume of sales is €12 million which correlates to the high value of the raw material; about 95% of the sales value comprises raw material purchasing costs. Competitors of Neumann are various Vietnam-based international, private and state-owned coffee exporters.

4.1.1 The Refinement Process

Neumann exports coffee beans of different quality grades. To produce these grades, the coffee beans are processed once or twice through the following refinement steps:

- *Coffee cleaning*: This basic cleaning step produces the lowest exportable quality grade of Robusta coffee beans. The step ensures that no kind of foreign matter is included in the exported products which could harm the customers' roasting devices.
- *Gravity sorting*: Neumann's customers pay a premium for deliveries of homogeneous coffee beans. This step allows Neumann to produce export coffee beans within a determined range of size.
- *Colour sorting*: Further value is added to the coffee beans if they consist of the same size and the same colour. Too dark beans are sorted out as they would otherwise deteriorate the quality of the roasted coffee at the customer's site.
- *Wet polishing*: This final step produces the highest quality of Robusta coffee beans by improving and harmonising the bean's surface.

The selling price for the different qualities of Robusta and the purchasing price for Robusta beans depend on the world market and the local supply. It varies from season to season or even shorter time scales due to international commodity trading. Assuming a rather high purchasing price of €1,000 per metric ton, the premium for refinement ranges from less than €5 per ton for cleaned beans to €60 per ton for wet polished Robusta.

4.1.2 Supply Chain Setting

Neumann is situated at the interface of smallholders and local companies on one side and multinationals and global competition for commodities on the other. Neumann's sales follow the demand and supply rules of international markets, while their procurement depends on the availability and quality of the local supply. The same appears for environmental and social issues: international requirements for more sustainable coffee production meet the local, not necessarily congruent, perception of environmental importance.

For several commodities Blowfield (2004) observed a gap between the sustainability or ethical standards of parts of the demand side and the values and priorities of producers in the chain. This is particularly true for the Vietnamese coffee chain. Neumann's customers, international coffee roasters and traders, are exposed to environmental and sustainability concerns in the coffee consuming countries. Many of the international roasters and traders have responded by establishing corporate social responsibility (CSR) departments, launching of codes of conduct, and offering fair trade and sustainable coffees. Neumann's suppliers, in contrast, face almost no direct pressure and get little incentive to change their current way of coffee mass production.

4.1.3 EMA Motivation and Decision Setting

Neumann's motivation for using EMA is to identify if and how environmental aspects are relevant for the business's success. The company's options to increase its business performance are related to the margin between the purchase price and the selling price of coffee. Three basic options to increase the value added can be distinguished and are linked to environmental issues:

1. *Gain premiums for better qualities of coffee*: Neumann is already refining Robusta coffee to benefit from premiums. The export of sustainable coffees might be a further option to receive premiums.: however, the supply and demand for sustainable, organic or fair trade Robusta coffee from Vietnam is negligible. Thus Neumann would have to stimulate the demand and the supply at the same time. Alternatively, Neumann could also try to export sustainable Arabica coffee from Vietnam.
2. *Reduce company-internal costs*: Considering the purchasing and selling price of coffee as fixed, Neumann could increase profits by reducing the costs of refining and exporting coffee. This includes measures to increase energy- and material-efficiency.
3. *Purchase price reduction*: Assuming unchanged selling prices, lower purchase prices add value to Neumann's operations. Eco-efficiency improvements in the supply chain might enable suppliers to reduce their production costs and prices.

Option 1 has not been considered further as the company is considering itself not to be in a strong enough position to foster the development of a market for sustainable coffee from Vietnam. Neumann's interest in analysing the relevance of environmental aspects on the production costs (option 2), can be characterised as an ad-hoc, short-term focussed analysis of available information. Referring to the EMA framework of Burritt et al. (2002) (Fig. 2.2) this decision-making situation is found in Box 3, supported by some related physical information (Box 11). Option 3 requires external, supply chain-related information. Influencing the

		Enviromental Management Accounting (EMA)			
		Monetary EMA (MEMA)		Physical EMA (PEMA)	
		Short Term Focus	Long Term Focus	Short Term Focus	Long Term Focus
Past Oriented	Routinely generated information	e.g. environmental cost accounting 1	e.g. environmental induced capital expenditure and revenues 2	e.g. material and energy flow accounting 9	e.g. natural capital impact accounting 10
Past Oriented	Ad hoc information	**e.g. ex post assessment of environmental costing decisions 3**	**e.g. environmental life cycle (and target) costing 4**	**e.g. ex post assessment of short term environmental impacts 11**	**e.g. life cycle inventories 12**
Future Oriented	Routinely generated information	e.g. monetary environmental operational and capital budgeting 5	e.g. environmental long term financial planning 6	e.g. physical environmental budgeting 13	e.g. long term physical environmental planning 14
Future Oriented	Ad hoc information	e.g. environmental job costing, environmental pricing 7	e.g. monetary environmental investment appraisal 8	e.g. short run environmental impacts 15	e.g. life cycle analysis of specific project 16

Fig. 2.2 EMA decision situation at Neumann Coffee Group (EMA framework adapted from Burritt et al. 2002)

eco-efficiency of the suppliers requires a rather strategic, long-term focussed approach. The environmental management accounting approach to provide adequate information for this decision-making situation refers to Boxes 4 and 12 of Fig. 2.2.

4.2 EMA Application

As detailed above, the EMA application at Neumann is expected to support two different decision-making situations: environment-related cost information on the refinement processes and eco-efficiency potentials within the supply chain (options 2 and 3 in Sect. 4.1.3).

4.2.1 Material- and Energy Flow-Based Cost Accounting of the Refinement Processes

The business of refining and exporting coffee is not known for environmental problems like air and water pollution or intensive energy and resource consumption. A rough analysis of Neumann's operations validated this presumption. Perceivable environmental issues at Neumann's site are energy consumption (electricity), solid waste and water consumption. Transportation has not been considered as it is outsourced to suppliers. The low impacts of the on-site environmental issues are highlighted by the following comparisons: for refining and exporting a metric tonne of green beans, Neumann uses 40 kWh of electric energy, while a Vietnamese company that cultivates and processes coffee consumes roughly 50 times more per t (Doan et al. 2003). Neumann's water demand for refining and exporting one tonne of green bean is 35 litres on average, while the upstream water demand for traditional wet processing of coffee can amount up to 70,000 l per tonne (ICO 2001). An overview of material and energy inputs and outputs can be found in Table 2.1 (please note that for confidentiality reasons, grade A, B, C and D is used instead of the actual product names for different qualities).

Table 2.1 Physical input/output table for 1 ton of green bean input (simplified)

Input		Output	
Item	Physical amount	Item	Physical amount
Green beans	1,000 kg	Green beans grade A	430 kg
Water	0.035 m^3	Green beans grade B	370 kg
Electric energy	40 kWh	Green beans grade C	60 kg
		Green beans grade D	55 kg
		Green beans for local market	75 kg
		Dust	2 kg
		Weight loss	8 kg
		Waste water	0.035 m^3

Table 2.2 Physical and monetary flows of green beans grade B (simplified)

		Current situation		Best case scenario	
		Physical amount	Monetary equivalent (€)	Physical amount	Monetary equivalent (€)
Wanted product	Green beans grade B	1,000 kg	1,040	1,000 kg	1,040
Unwanted product	Green beans grade D	60 kg	60	0 kg	0
	Beans for local market	10 kg	10	0 kg	0
Waste	Dust and weight loss	10 kg	0	0 kg	0
Raw material input	Green beans	1,080 kg	−1,080	1,000 kg	−1,000
Further input	Electric energy	25 kWh	−1.50	23 kWh	−1.40
Profit/loss[a]			28.50		39

[a]Not including depreciation, labour costs, and overhead costs like general administration costs, management salaries, etc.

The consideration of inputs and outputs shows rather low raw material losses; dust and weight losses due to further drying of the beans account for 1% of the total output only. Nevertheless, the financial relevance of these losses is not to be neglected. One percent loss equals one percent of the purchasing costs of green beans, which account for more than 95% of the total production costs. Furthermore, according to Neumann green beans grade D and green beans for local market need to be considered as unwanted products, as the selling price for these products is neither higher nor lower than the purchasing price. There is no value added for these products, therefore Neumann should aim at reducing the amount of these products as far as possible. To better understand the refinement process for the different grades, a product-specific material and energy flow-related cost accounting has been carried out to trace energy consumption as well as material losses to the different quality grades. As an example, Table 2.2 displays the material and energy flows and losses as well as the related revenues and expenses for grade B coffee beans.

In contrast to the very low and therefore insignificant energy costs (0.14% of total expenses), material losses and the production of lower-quality grades have financial implications. Assuming that it would be possible to produce grade B without producing lower-quality grades and wastes, the profit would increase by 37% or €10.50 per ton of final product (best case scenario in Table 2.2). These figures are fictive as it is not possible to fully eliminate lower-quality grades and waste. The quality of beans as well as the waste-generating moisture and dust content vary and depend largely on the supplier. Nevertheless, the results imply that paying premiums for high-quality supplies, which lead to less unwanted products and wastes, is profitable within a certain margin.

The material and energy flow-based cost accounting has proven most of Neumann's assumptions, in particular that the financial importance of energy and water consumption is rather low, while the quality of the purchased coffee affects the profitability of the business. Eco-efficiency improvements in the supply chain, however, seem to be of higher importance for Neumann's performance.

4.2.2 Environmental Supply Chain Costing and Management

From a decision-making point of view it is important to know at which steps of the coffee life cycle environmental improvements are most promising. Neumann operates in a highly competitive market, thus financial implications of environmental supply chain improvements are of great interest. Gathering, analysing and using supply chain cost information for managerial decision-making is not widely covered in the general management accounting literature. At least some authors have elaborated this topic in detail in particular in the context of logistics (Cullen et al. 1999, LaLonde and Pohlen 1996).

Supply chain costing provides information to determine the overall effectiveness of the supply chain, identify improvement opportunities, evaluate alternative supply chain structures and select supply chain partners. The implementation of supply chain costing is a difficult task as its benefits do not necessarily occur evenly throughout the chain (LaLonde and Pohlen 1996). 'The sharing of cost information may give away a hard-earned competitive advantage or provide negotiating leverage to their supply chain partners' (LaLonde and Pohlen 1996:4).

The environmental improvement priorities elaborated in Sect. 3.2 can be used to analyse supply chain costs. As Neumann is not considering itself in a position to affect the consumer behaviour or the disposal stage of the coffee life cycle, the environmental supply chain costing focuses on upstream stages, namely cultivation and processing. Figure 2.3 exemplifies the supply chain costing approach. It depicts hypothetical production costs and gross profits for the three supply chain stages: cultivation, processing and refining. The composition of production costs in cultivation, though, corresponds to an average Robusta coffee farm in Dak Lak Province of Vietnam as investigated by one of the authors (E.D.E. Consulting for Coffee 2003).

In cultivation, the use of fertilisers is costly and harmful for the environment. Figure 2.3 shows that fertilisers account for 38% of total cultivation production costs. Moreover, the majority of farmers have been found to use fertilisers inefficiently. Many farmers use more than twice as much fertiliser as necessary (E.D.E. Consulting for Coffee 2003). Hence, if farmers manage to use fertilisers in the best possible way, they could halve the costs for purchasing fertiliser and the related environmental impacts. This would reduce their total production costs by roughly 20%.

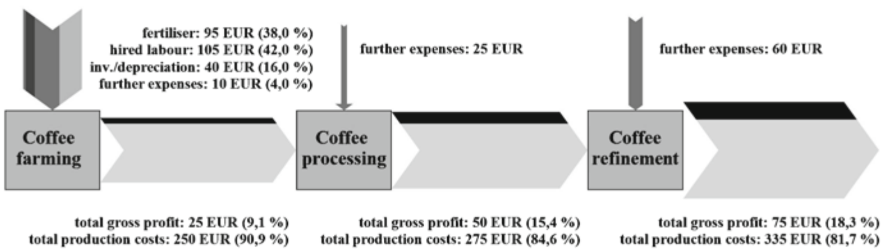

Fig. 2.3 Supply chain costing, current situation (hypothetical)

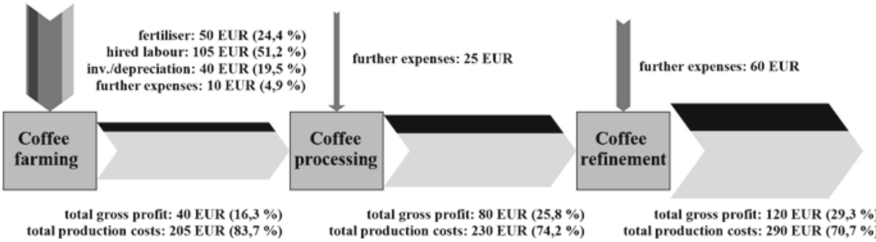

Fig. 2.4 Supply chain costing, adequate fertiliser use (hypothetical)

Figure 2.4 assumes that a supply chain management approach has been applied to increase eco-efficiency by using appropriate quantities of fertiliser, and that this eco-efficiency gain is shared among the three supply chain actors. At constant sales (€700), all three actors would increase their profits substantially due to the more eco-efficient use of fertilisers.

An environmental supply chain costing can also be used to reveal the additional benefits and costs of alternative, less damaging cultivation methods, for instance, by comparing the premiums paid for organic, shade-grown coffee and the consequent reduction of production costs with the reduced yields. In processing, the saving potential of more energy-efficient drying devices could be of interest, too.

The availability of supply chain cost information does not solve one major problem, though: 'restructuring the supply chain to exploit efficiencies or seize competitive advantages requires a mechanism capable of equitable allocating cost benefits and burdens between supply chain partners' (LaLonde and Pohlen 1996:8). Obviously, most Vietnamese farmers have not adapted methods for efficient fertiliser use by themselves. If one supply chain actor, like Neumann, starts to train farmers on more efficient use, it is not necessarily Neumann who benefits. The farmers may as well sell their coffee to other middlemen and exporters or just keep the farm gate price on the same level to make more profit. At first glance, the incentive for Neumann to facilitate eco-efficiency improvements within the supply chain is rather low.

A potential solution to overcome this dilemma is the application of environmental supply chain management. For Cooper et al. (1997a:68) supply chain management is 'an integrative philosophy to manage the total flow of a channel from earliest supplier of raw materials to the ultimate customer, and beyond, including the disposal process'. When taking the perspective of one company within the chain, the challenge is slightly different, though. In this perspective the supply chain looks not like a chain, but rather like an uprooted tree. The company needs to decide how many of the roots and branches it wants to manage (Cooper et al. 1997b:9). Seuring (2004) has compared different concepts of environmental management that address the flow of material and information along life cycles or supply chains. He concludes that out of all approaches assessed, environmental supply chain management is the most management-oriented approach.

For Neumann, the supply chain management challenge is to foster eco-efficiency improvements, in particular, reduced use of fertilisers at the coffee farming stage and to ensure participation in the financial benefits. According to Williamson (1975, 1985) the three basic options for co-ordinating supply chains are price (market arrangement), command and control (hierarchical arrangement) and negotiation (co-operative arrangement):

- Neumann could use *market arrangements to provide incentives*, or more precisely premiums to its supplier to receive higher qualities or special types of coffee, for instance, organic, fair trade coffees if there is a customer demand for it. Actually, this type of market arrangement is already used to ensure a certain quality level of the coffee bean supply. For the reduction of fertiliser use or other eco-efficiency measures in the upstream supply chain, market arrangements are not a promising option though. These measures benefit the farmer or middlemen only, but not Neumann.
- *Establishing hierarchical arrangements* is nearest to the original understanding of supply chain management, where rather large enterprises purchase key suppliers and own or control distribution channels. However, Neumann does not intend to acquire suppliers and is also not in a position to dominate the chain.
- *Cooperative arrangements* are the most promising option for Neumann. For instance, the company can offer its suppliers training and support on implementing eco-efficiency measures. In return, the suppliers need to agree to either pay Neumann for these services or to share their financial benefits. This kind of vertical co-operation is difficult to achieve as it requires monitoring the success of eco-efficiency measures and the adherence to contracts for all partners involved. Middlemen or farmers might take the opportunity to underestimate the savings or to sell parts of the harvest to other traders and exporters without Neumann Coffee's knowledge. Thus, horizontal cooperation, e.g. a joint initiative of all Vietnamese coffee exporters, seems to be the best available option. Higher energy-efficiency in dry processing and appropriate use of fertilisers lead to higher profitability and/or competitiveness of the Vietnamese coffee industry as a whole. Vietnamese coffee exporters, traders and related organisations like the Vietnam Coffee and Cocoa Association (VICOFA) could share the costs of training programmes for coffee farmers and companies of the processing step. Neumann Kaffee could try to initialise and lobby such an eco-efficiency programme. To date, Neumann has been involved in various projects that aim at increasing eco-efficiency in the supply chain. Most of these projects have been co-funded externally and supported by consultancy services including E.D.E. Consulting owned by the Neumann Foundation. Co-operative arrangements of Neumann and competing Vietnamese coffee exporters to improve the supply chain are not recorded.

The findings above are in line with the results of a comprehensive analysis of sustainable cotton supply chains. Goldbach et al. (2003) observed that the initial phase of environmental and sustainability supply chain management is characterised by cooperative or even hierarchical arrangements, while at later stages, market arrangements gain importance. Furthermore, they conclude that environmental supply chain management cannot be viewed as a technical matter only. It is rather an inter-organisational concept (Goldbach et al. 2003). It implies a 'change from managing supply chains based on serial dependence and power to recognising and managing the reciprocal dependence' (Cullen et al. 1999:31).

5 Conclusions

Neumann is one of many actors in the Vietnamese coffee industry and supply chain. Neumann's own business, the refinement and export of green Robusta coffee beans, is not causing huge environmental impacts. EMA has been used to confirm this, but it has also ascertained the financial relevance of even small raw material losses like dust and weight loss due to evaporation.

In contrast to the rather low environmental importance of its refinement and export operations, the supply chain in which Neumann operates is exposed to substantial environmental concerns. Using LCA information in the context of EMA has helped to identify those steps within the coffee supply chain that have highest environmental impacts and highest options for environmental improvement measures. Cultivation and consumption are the most important steps from an environmental perspective. Some of the environmental concerns in the supply chain have direct financial consequences. Energy inefficiencies and the overuse of fertiliser diminish the overall supply chain profits or lead to less competitive market prices. Neumann can get better understanding of these interdependencies by applying supply chain costing. Measures to increase the supply chain eco-efficiency need supply chain management efforts, in particular horizontal cooperation, for instance a joint initiative of coffee exporting companies to train farmers.

Besides Neumann, further actors within the supply chain can contribute to environmental and related financial improvements. Coffee consumers have an even bigger role in this than expected. By demanding alternative types of coffees like organic, fair trade or sustainable coffee, consumers influence the supply chain indirectly, in particular the cultivation step. But consumers can also directly reduce the environmental burdens of the coffee life cycle, for instance, by not making more coffee than is consumed, by using insulated coffee pots rather than leaving coffee on the percolator stove, by purchasing electricity from renewable sources or by substituting their electrical coffee machine.

This case study reveals the importance of environment-related supply chain information for corporate decision-making. EMA can make use of tools like LCA to satisfy this demand. In combination with concepts like supply chain costing this analysis leads to the identification and prioritisation of eco-efficiency improvements along the chain. In contrast to still growing niche market solutions like fair trade or organic coffee farming, supply chain eco-efficiency measures show a potential to directly enter the mass market of Vietnamese coffee production.

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