Evaluation of sustainability performance of Transforum projects -Greenport Shanghai-

Anton Kool

Hans Blonk

November 2010

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giving shape to sustainability

Blonk Milieu Advies BV
Kattensingel 3
2801 CA Gouda
Telefoon: 0182 579970
Email: info@blonkmilieuadvies.nl
Internet: www.blonkmilieuadvies.nl

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1. Introduction

1.1 Sustainability mapping approach

This document evaluates the sustainability performance of the TransForum project "*Greenport Shanghai*" (also referred as: *the initiative)* according to the approach that is described by Blonk et al. (2010).

A full description of the approach that is used to evaluate the sustainability performance of TransForum projects can be found in the methodology report by Blonk et al. (2010). A short introduction to the applied methodology is described in chapter 2.

Paragraph 1.2 gives a short description of the TransForum project "Greenport Shanghai". Chapter 3 describes which baseline scenario is used to determine the sustainability performance of Greenport Shanghai. Chapter 4 evaluates the total sustainability performance of Greenport Shanghai. Chapter 5 closes with the discussion and conclusions.

1.2 The initiative: Greenport Shanghai

Greenport Shanghai is part of Dongtan Ecocity; an example for ecological urbanisation situated near the Chinese metro pole Shanghai[1]. At Greenport Shanghai large scale and modern agro production is planned to supply the growing demand for sufficient and save food products in China in general and Shanghai in particular. Besides the production function, Greenport Shanghai is designed as a showcase for efficient and ecological agro production and as a centre for communication, education and trade. The initiative Greenport Shanghai is still under development. Different scenarios are designed (see masterplan: Smeets et al., 2007).
In this study the scenario 'Large scale' (Table 1.1) has been chosen for the evaluation of the sustainability.
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Table 1.1 the characteristics of the studied plan of Greenport Shanghai (based on Smeets et al., 2007)[a].

			External product
Animal production	Pigs	120,000 sows and 1 million fattening pigs	240,000 ton pork
	Poultry	2 million laying hens, 66,600 rearing hens and 10,000 parent animals	500 million eggs
		5 million broilers, 265,000 parent animals and 135,000 rearing parent animals	60,000 ton poultry meat
Vegetable production	vegetables	400 ha greenhouses	24,000 ton vegetables
	mushrooms	38 ha mushrooms	87,000 ton mushrooms
			260,000 ton champost
CPU	Co-fermentation	3.8 Mton manure and municipal waste	3.5 million ton digestate
			115 gWh electricity (During winter)
	composting	141,000 ton solid poultry manure and straw	

[a] It is assumed that the production animals will be reared in the park as much as possible. (for instance parent chickens for the production of broilers). This leads to an increase in numbers of livestock , digestate and compost compared to the figures mentioned in the masterplan (Smeets et al, 2007) The production volumes of mushroom are corrected compared to the figures in the masterplan, analogue to reasonable western (Dutch) production figures (mushroom cultivation is increased from 31 kton to 87 kton).

[1] Dongtan Ecocity is planned on the east head of Chongming Island located in the estuary of the Yangtze river. This island is recently connected with Shanghai by a new bridge which makes the area very interesting for development.

Greenport Shanghai includes several agro-production units as described in Table 1.1. A specific feature of Greenport Shanghais is that the flows of in- and outputs of the different production units are connected as most as possible by the so called 'Central Processing Unit' (CPU). The idea behind the CPU is that 'wastes' from one production unit can be transferred into a raw material for another production unit. For instance the manure from broilers is composted in the CPU and the compost can be used as growing substrate for mushrooms. In figure 1.1 an overview is given of the in- and out coming flows of products and energy for GPS as a whole and the flows between production units driven.

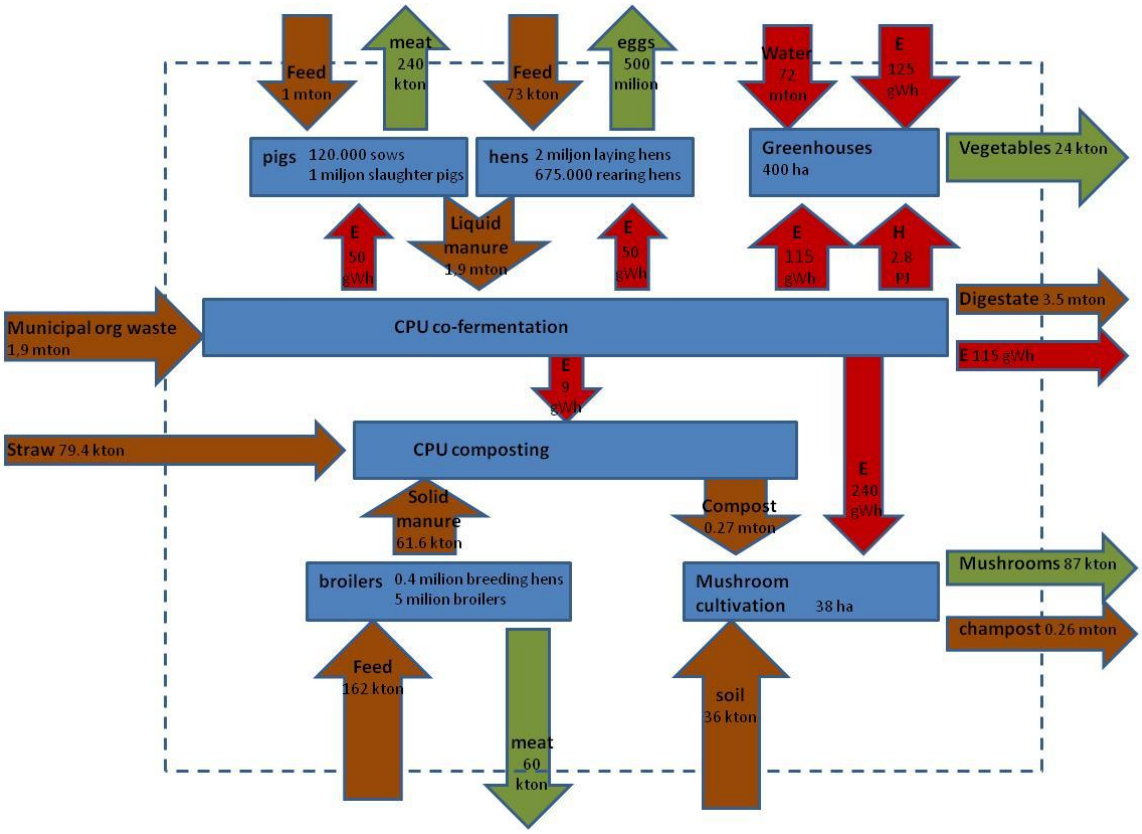


Figure 1.1. A schematic overview of the internal product and energy flows of Greenport Shanghai, the input needed for the different processes (brown arrows aimed inside) and output of food products (green arrows aimed outside) and non food products (brown arrows aimed outside) E = electricity, H = heat.

For the assessment of sustainability of the project Greenport Shanghai (GPS) the added value of the infrastructure and the separate production units plus the combination of those two is evaluated.

The masterplan defines the framework for development of GPS. However, for the assessment of the sustainability of several elements more specific information is needed. For instance in the masterplan no specific pig housing system was defined in relation to animal welfare or ammonia emissions. In general the focus of GPS is to meet the highest production standards resulting in optimal performance of sustainability (welfare, environment etc). This is described in the masterplan (Smeets et al. 2007) and the businessplan (Anonymus 2009). The involvement of Transforum was based on facilitating the 'orgware' to create essential conditions for a sustainable production. Furthermore the entrepreneurs involved realized very well that any activity at GPS which could be interpret as non sustainable would harm the perspectives of the initiative very much. For this analysis we presume that the above described factors are all preconditions for a certain level of sustainable agro production at GPS. Concerning the level of sustainability we assume that this is conform the Dutch standards. Meaning air washers with the highest reduction rates are used in animal houses, management is at Dutch level of knowledge and skills meaning

high efficiency rates are obtained, output from the CPU is sold in a proper way and animal welfare is maximized in the Chinese context.

1.3 System definition: Added value through integration

Greenport Shanghai includes several agro-production units connected by the CPU. The connections created by the CPU between multiple enterprises are so complex that the whole system can be seen as one initiative. Besides that the CPU and other central parts like trade facilities, education centre are part of the infrastructure and contributes on specific points to sustainability. Also the separate production units (pig, poultry and vegetable production) can be evaluated separately.

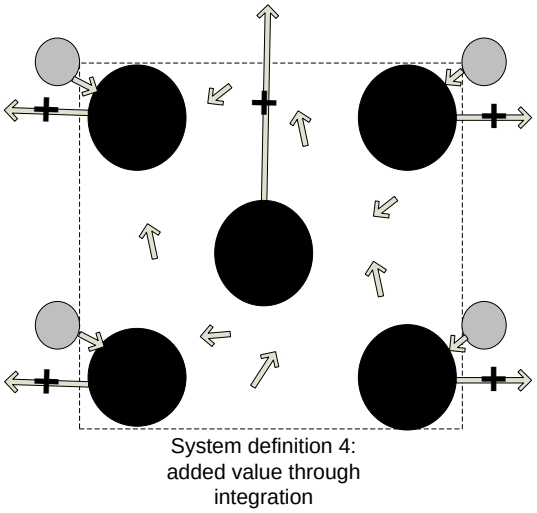


Figure 1.2 System definition of Greenport Shanghai as described in Blonk et al. (2010)

2. Methodology

This chapter gives a brief overview of the methodology used to evaluate the sustainability performance of initiatives. More information about this methodology can be found in Blonk et al. (2010).

2.1 Evaluating initiatives on sustainable performance

Sustainability is a very broad concept dealing with ecological, social and economic consequences of our actions. Absolute sustainability doesn't exist or at least very hard to define. A more workable concept is sustainable development which implies that we are able to define more sustainable directions and thus be able to measure a more sustainable performance. Sustainable development includes nature and environmental aspects (planet), social aspects (people) and economic aspects (profit). It refers to a an ongoing process of finding balance between these aspects.

It is often not easy to evaluate the performance at a glance because the implications of an initiative do often not result in an improvement on all different sustainability aspects. Moreover there are many effects and actors involved on different locations and with different timeframes.

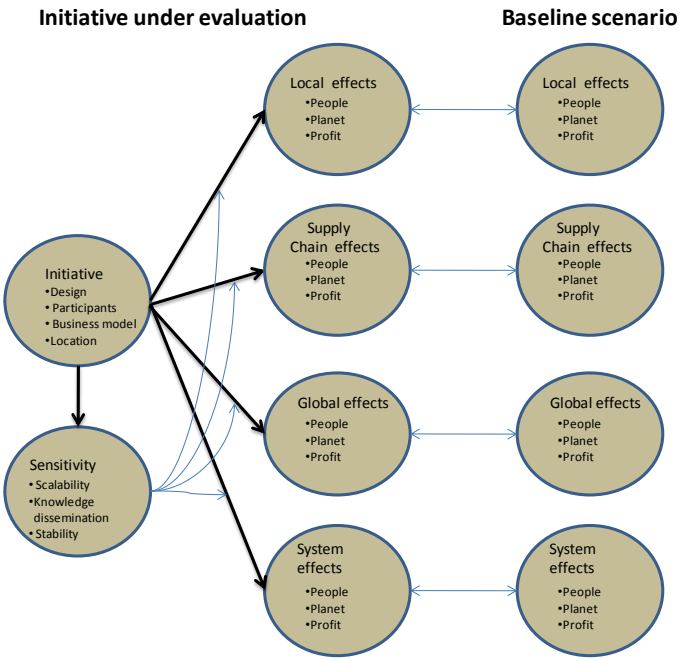


Figure 2.1. Outline of applied evaluation methodology

For evaluating the TransForum initiatives a specific evaluation methodology needed to be developed because existing methods do not cover the total spectrum of effects related to a new initiative. Each initiative generates people, planet and profit effects for different actors and different scales These effects are divided in this methodology in local effects at the initiative, local effects in the supply chain, global effects, and system effects. The ultimate impact of an initiative is also the result of the resilience of the deigns, the potential for upscaling and the knowledge spreading mechanisms involved. Scoring the sustainability performance is only possible in relation to a baseline scenario (figure 2.1).

Our method for measuring sustainable development performance of initiatives is based on a combination of three existing approaches of :

- Lifecycle assessment (Guinee, 2002)(ISO14040, 2006)(ISO 14044, 2006) (ILCD 2010) (SLCA guide 2009)
- Environmental Impact Assessment *(a.o. EU directive 85/337/EEC amended in 1997)*
- Supply chain and company Reporting of Sustainability (Global Reporting Initiative)(ISO 14064, 2006) (Poverty footprint of Oxfam Novib draft 2010)

LCA methodology gives the framework for making a sound evaluation of environmental and (partly) societal impacts over a production chain of products and gives directions how to evaluate the consequences of changes or improvements in lifecycles. EIA methodology is primarily involved with local effects and provides different working methods for evaluating a combination of qualitative and

quantitative information. Furthermore a sound definition of the baseline and alternative scenario's is one of the most important aspects of EIA. A third approach can be qualified as reporting sustainable performance of companies and their supply chain. The Global Reporting Initiative and the poverty footprint methodology of Oxfam Novib set the framework. All these basic methodologies are under continuous development which means that our sustainability mapping methodology is also

The evaluation is preferable carried out in a iterative and interactive way, using a sequence of five steps per round:

1. Define the initiative.
2. Define the baseline scenario.
3. Score local, supply chain, global and system effects.
4. Visualize the scores within the sustainability map *(for an example see figure 4.1)*.
5. Evaluate the results of the evaluation with the main stakeholders.

These steps are explained in the next paragraphs.

2.2 Defining the initiative

Before an initiative can be evaluated on sustainability a clear understanding of the initiative is needed. Which parties are involved? What are the boundaries of the initiative? What are the sustainability propositions (aims)? What's the location of the initiative? Some initiatives must be defined further to come to a business case that can be evaluated. This can be the case when an initiative is still in a preliminary stage of design.

2.3 Defining the baseline scenario

To evaluate the sustainability of an initiative it is necessary to define a baseline scenario. The baseline scenario differs for each initiative and is based on the business as usual for the initiative and the participants. Leading question is what would have been the situation, in a couple of years, if the initiative does not take place?

There are several types of developments relevant for defining the baseline scenario:

- What would the entrepreneurs do if the initiative does not take place?
- What would happen at the location if the initiative does not take place?
- What happens to other locations because of the initiative?
- How would the (environmental) performance of the product autonomous develop if the initiative does not take place?

Which developments are important to include and to what extent depends on the initiative. Sometimes the local aspects are very important and sometimes it is a minor issue.

2.4 Definition of effect categories

This paragraph briefly describes the different sustainability aspects (3P's) with the corresponding sustainability indicators of local, supply chain, global and system effects. A description of all sustainability indicators, and how these indicators are scored, can be found in Blonk et al. (2010).

2.4.1 Local effects of the initiative

Local effects are divided into scales: The first scale is the initiative. The second scale is a regional scale, referring to the surroundings of the initiative. Sometimes a third scale is involved, for instance a national scale when specific themes are interrelated with national governance. Regional and national scales are

relative terms and depend on the type and extension of each specific initiative. These scales have to be defined for each individual initiative.

Initiative
A part of the effects of the initiative are located within the physical borders of the initiative. On the initiative scale there are people, planet and profit effects defined:

- People effects for employees, entrepreneurs and animals (e.g. work conditions and animal welfare).
- Planet effects at the initiative site (e.g. landscape, physical environmental quality and biodiversity)
- Profit effects of the initiative (e.g. balance, investment costs and value creation).

Regional
An initiative also influences the direct surroundings and can have people, planet and profit effects on a regional scale. It can affect residents, companies or employees nearby the initiative. People effects are for example changes in opportunities for recreation and community involvement towards the initiative. Planet effects are related to physical or chemical emissions to the surroundings and changes in landscape and biodiversity. Profit effects on a regional scale are considered as a positive contribution to the community.

National (when appropriate)
For some of the local effects it is necessary to take the national perspective into account. On national scale planet effects are important because they have a strong national dimension based on regulations (e.g. regulations on eutrophication). People and profit effects are not evaluated on a national scale because of difficulties in making these effects operational unambiguously.

2.4.2 Local supply chain effects

Besides local effects at the site of the initiative an initiative can also have comparable local effects at the supplying companies. This can be initiated by selective sourcing, setting sustainability criteria for suppliers, developing sustainability improvements with suppliers, etc. The same thematic framework is used as a starting point for evaluating local effects in the supply chain.

In some cases local effects of downstream business (customers) need to be included in the evaluation, for instance in case of forwarded chain integrations.

2.4.3 Global effects of the product(s) of the initiative

A specific category of effects are those effects not depending on the location of operation and/or emissions. These effects include some specific planet effects and major environmental themes like global warming and land use.

The global effects which are scored are:

- Land use. This indicator is related to land conversion, loss of biodiversity, increasing greenhouse gas emissions, increasing competition between agro functions such as food, bio-based materials and biofuels.
- Climate change.
- Depletion of fossil resources, such as use of fossil fuels and phosphate rock.

These global effects are determined on product level so upstream and downstream processes are also included in the calculations. It must be noted that changes in quality or quantity of land do also have an impact on social or economic viability. The effects on local changes in land quality are evaluated under local people effects of the initiative or the supply chain.

2.4.4 System effects

An initiative ultimately generates products or services that may have an impact on other systems related to the usage of the product. For instance the usage of LED lamps reduces costs of energy of the consumer while at the same time it will reduce the environmental impact per unit light and per unit money.

A change in environmental impact (planet effect) per expended unit money (eco-efficiency) is relevant from a sustainable consumption perspective. A consumer can only use its money once and it is assumed that a lower impact per euro is better. A change in the amount of money expended per function is relevant for determining rebound effects related to the change in costs and behavioural adaptations. System effects of products related to health and improving knowledge of agricultural and/or sustainable production are also scored.

2.4.5 Potential of the initiative

The potential of an initiative refers to the scalability, stability and spreading of knowledge of an initiative. A first question to be answered is whether it is possible for an initiative to be copied at other locations and by other entrepreneurs or is it a one time operation or a specific niche market? The main question to be answered for evaluating "*Spreading of knowledge*" is whether the initiative aims to spread knowledge and/or includes mechanisms to do so?

2.4.6 Critical success factors

Finally, the evaluation gives information on specific parameters in the design or the surroundings of the initiative which are determinant for the realization and up scaling potential. These critical success factors give the actor(s) involved with the initiative essential information on risks and opportunities and can be used for strengthening the design or defining the conditions for (further) investments and making the initiative operational.

2.5 Visualizing the effect scores: "mapping of sustainability performance"

To make interpretation of the results easier we developed two visualizations.

1. A dashboard where the effects are categorized along the following qualification:
   - positive in relation to the baseline scenario
   - neutral in relation to the baseline scenario
   - negative in relation to the baseline scenario
   - not relevant for this initiative
   - relevant, but lack of data

2. A circle diagram which shows the relative amount of scoring positive, neutral, negative or relevant but lack of data.

3. Description of the baseline scenario

The Chinese agro production sector is developing strongly. Because of increasing wealth the consumers needs for food quality, food safety, and processed food increases rapidly. This increasing demand is mainly concentrated in the strongly urbanised cities.
The agro production sector in China is facing various problems to comply with these developments. The primary agriculture is mainly based on small scale farming. This primary sector is characterised by a low level of investments in technology, a low knowledge level and as a result a low productivity. Besides that only 13% of the Chinese surface is suitable for agriculture which is declining because of urbanisation, industrialization and erosion. Concerning the Chinese strategy to cope with these developments, three main aspects can be distinguished. First of all reforming the traditional agriculture to increase productivity, cooperation between primary sector and food processing and increase wealth in rural areas. Secondly China in general stimulates modern efficient production and especially very innovative and sustainable projects as a global showcase. The third aspect is that China focuses abroad to ensure the import of raw materials from agriculture. Trade with for instance sub-Saharan African countries has increased rapidly the past years, facilitated by, for instance strategic partnerships with those countries (Fan, e.a., 2010) .

Starting point for definition of the baseline is that both GPS and the alternative production provides food products for the growing demand of sufficient and save food in China and especially the urbanised region of Shanghai. To define the baseline the question 'if GPS is not realized what would be the replacing agro food production?' has to be answered. A balanced answer for such theoretical questions especially in a complicated situation as the Chinese food market is impossible. The most reasonable is that concerning the baseline the alternative food production is provided by modern large scale companies within China nearby highly populated regions. We expect that the majority of growing demand, especially from cities like Shanghai will be provided by newly created large scale modern facilities. This increase in production is mostly vertically driven in the production chain. Meaning that growth in production is developed by large companies down- or upstream in the production chain. For instance by feed companies or slaughterhouses that create new animal production. The driving force for establishing this primary production is guaranteed purchase of products (feed) or supply (living animals for slaughter). On horizontal level integration or cooperation between different agro-food production units is hardly present (Enting & Verstappen 2009, Enting 2010, Mingtian 2010). The production units are 'mono functional' designed, meaning all effort is aimed at producing the main product (eggs, vegetables, mushrooms, pigs etc.). No widening of activities takes place like demonstration, tourism, trade etc. The agricultural activities aim to increase productivity and by doing so reduce costs and consumption of natural resources and energy. The production units in the baseline are relatively extended (for instance pig farms have 2500 sows and 21000 fattening pigs) and we assume for each production sector about 50 farms spread over Jiangsu, the province where Shanghai is located and several adjacent provinces.

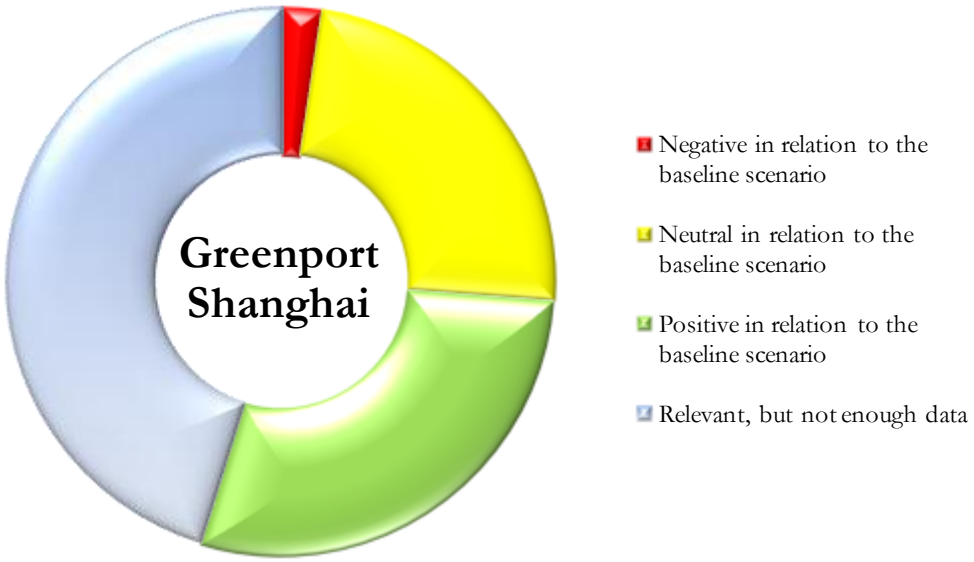
Unlike in Europe legislation concerning animal welfare and environmental protection in China is missing or stands at a much lower level. However this does not automatically result in inferior production circumstances. For instance the area available per fattening pig is on average the same as the area prescribed by actual Dutch welfare regulation (0.8 m^2, Enting, 2010). Legislation with regard to application of manure is determined on local level and can be either very minimal or very complex For instance manure has to placed at an arable farm. On the other hand arable farmers mostly prefer chemical fertilizer above animal manure because of costs and effectiveness (Mingtian, 2010).
Details of the baseline scenario if relevant, will be further described in the explanation of each sustainability indicator described in chapter 4.

4. Sustainability of Greenport Shanghai

In this chapter the sustainability of Greenport Shanghai is evaluated through a top-down design. In paragraph 4.1 the overall figure, the sustainability map, is shown which is assembled out of a more comprehensive table, the sustainability table, from paragraph 4.2. This sustainability table contains 50 scored sustainability indicators and the critical success factors. The arguing of the scored sustainability indicators is described in paragraphs 4.3 till 4.7. The critical success factors are described in paragraph 4.8.

4.1 Sustainability map

Figure 4.1 shows the sustainability map for Greenport Shanghai compared to the baseline scenario as described in chapter 3. A comprehensive description of all scored sustainability indicators can be found in the following paragraphs of this chapter. Figure 4.1 is assembled out of the relevant sustainability indicators from table 4.1. We did not apply a weighting of relative importance of each indicator.



Critical succes factors
- involving entrepreneurs
- management for sustainable development of GPS
- creating surplus value food products
- minimizing risks infectious animal diseases
- market for organic wastes
- managing high local emissions

Figure 4.1. Sustainability map of Greenport Shanghai

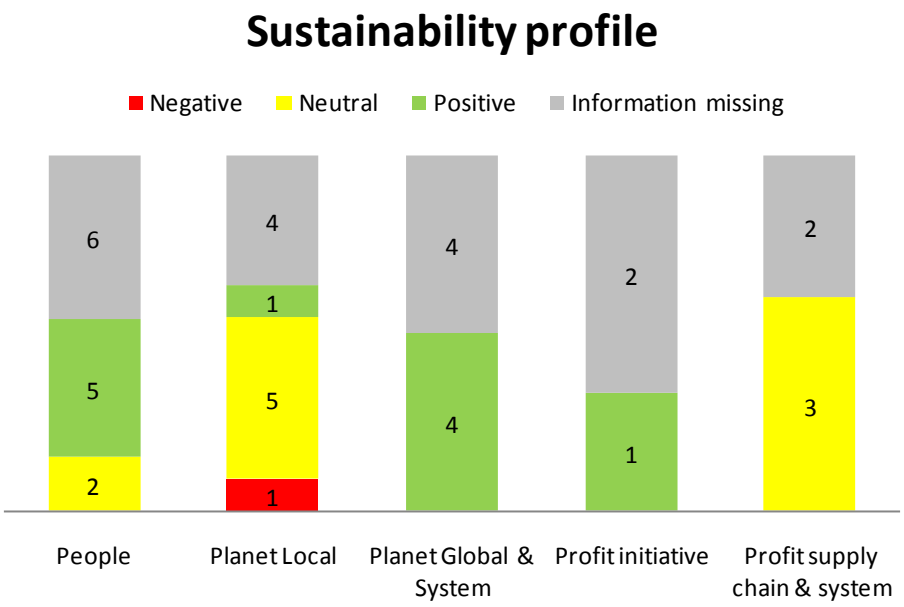


Figure 4.2. Sustainability profile of Greenport Shanghai.

Figure 4.2 is assembled out of the relevant sustainability indicators from table 4.1. A weighting of importance of each indicator has not been applied.
A red score can refer to many different situations of which three are of special importance:

- Red (negative) for economic indicators of the initiative (column 4)
- Red for global planet indicators (column 3)
- Red for system effects (column 3)

If the green scored area in the donut is relatively low, one may wonder if the initiative must be qualified as a sustainability initiative. It depends, however, greatly on what the relative weight of the green area is. A well thought initiative is aware of these hot spots of sensitive sustainability issues. The relative contribution of the "grey area" (relevant, but not enough information) gives information about the extent of issues that could not be evaluated. In this area there may be possible threats as well as opportunities. (For further explanation see Blonk et al. 2010).

4.2 Sustainability table

Table 4.1 shows the sustainability map of Greenport Shanghai compared to the baseline scenario as described in chapter 3. A detailed explanation about this format and the selection of the specific sustainability indicators can be found in the methodology report (Blonk et al., 2010). The explanation of the scored sustainability indicators is described in paragraphs 4.3 up to 4.7. The critical success factors are described in paragraph 4.8.

1 .Local(ized) impacts of the production system				
Theme			Initiative	Supply chain
People	In Company	1.01 Human rights		
		1.02 Labor conditions		
		1.03 Animal welfare & health		
	Community	1.04 Human health (other than emissions)		
		1.05 Animal desease risks		
	Community posiitive	1.06 Development		
		1.07 Involvement		
Planet	In Company	1.08 Environmental quality		
		1.09 Biodiversity		
		1.10 Landscape		
	Surroundings	1.11a Emissions to air: *local*		
		1.11b Emissions minerals and metals: *local*		
		1.11c Emissions: *regional*		
		1.12 Environmental quality		
		1.13 Biodiversity		
		1.14 Landscape		
Profit	In Company	1.15 Balance		
		1.16 Investment		
		1.17 Value creation		

Legend
Positive in relation to the baseline scenario
Neutral in relation to the baseline scenario
Negative in relation to the baseline scenario
Not relevant for this initiative
Relevant, but not enough data

2. Global (non localized) impacts of the production system per functional unit		
Planet	2.01 Land use	
	2.02 Greenhouse gas effect	
	2.03 Depletion: fossile energy use	
	2.04 Depletion: phosphate rock	

3. Functional (system) effects related to product consumption and use		
People	3.01 Health	
	3.02 Other welfare aspects (individual)	
	3.03 Welfare of the community	
Planet	3.04 Land use	
	3.05 Greenhouse gas effect	
	3.06 Depletion: fossile energy use	
	3.07 Depletion: phosphate rock	
Profit	3.08 Money budget	
	3.09 Time budget	
	3.10 Prosperity community	

4. Potential of initiative	
Scalability	
Knowledge spreading	

5. Critical succes factors
1 involving entrepreneurs
2 management for sustainable development of GPS
3 creating surplus value food products
4 minimizing risks infectious animal diseases
5 market for organic wastes
6 managing high local emissions

Table 4.1. Sustainability table of Greenport Shanghai

4.3 Local impacts of production chain - Initiative

This paragraph describes the local sustainability indicators 1.01 to 1.17 of the initiative which are scored in Table 4.1. Sustainability indicators which are not relevant (blanc in table 4.1) are not addressed.

1.01 Human rights

In all available documentation about GPS no information is available about human rights although this is a relevant indicator in China. The aim of the initiative to become an (international) showcase of sustainable production and the potential risk for foreign entrepreneurs of naming and shaming (if the initiative seems to be not as sustainable as promised) seems to be pre-conditions for improvements on this aspect compared to the baseline. Nevertheless this indicator is scored grey because to less (quantitative) information is available.

1.02 Labour conditions

Smeets (2009) describes that no Human Resource Management (HRM) aspects are being worked out. This means that no information is available to score labour conditions. We think that this aspect needs special attention in relation to dust, ammonia and other substances affecting air q uality. Besides that the same argumentation concerning the pre-conditions for sustainability level as described for human rights (see above, 1.01) applies for this indicator. In China the new "Labour Contract Law is in force which implies a maximum of 40 hours labour per week and extra labour has to be compensated (Enting, 2010). GPS will have to obey this law, but this is not different from the baseline. This indicator is scored grey because to less (quantitative) information is available.

1.03 Animal welfare and health

Animal housing and transport are important aspects determining animal welfare[2]. Animal transport is being reduced substantially because animal growing and slaughtering is combined at one location in GPS. In the baseline these elements are on separate locations which imply transport of living animals.

With regard to the animal housing it is assumed that the design and management is according to Dutch standards (for design according to legislation). This implies a positive change compared to the Chinese animal production in the base line where no legislation is operative concerning animal welfare and management has insufficient attention for animal welfare.

The total score on animal welfare and health is positive because a positive score for as well transport as animal housing.

1.04 Human health (other than through emissions)

GPS will strongly reduce animal transport between farms and slaughterhouse(s). This reduction of transport may be evaluated positively but the uncertainty in which degree this reduction will improve safety in Chinese traffic is high. Food safety is another important aspect concerning Human Health in China. Recently several health incidents occurred in relation with food (for instance melanine containing milk). In GPS production of save food is one of the main goals and this will be realized by an integrated food production system, high quality logistics (for instance cooled storage) and good management. Another aspect is the risk of contamination with zoonoses (like chicken flu) or that people get infected with antibiotic resistant bacteria like MRSA (Methilicine Resistant Staphylococcus Aureus)[3]. In modern

[2] Satisfaction with feed is another main aspect determing animal welfare. Using compound feed may give nutritional satisfaction but the mechanical satisfaction may not be enough. The mechanical satisfaction is determined by the degree of filling of the gastric. Not meeting the satisfactional needs will lead to declined behaviour (Enting, 2010). Concerning this aspect we expect no difference between GPS and the baseline.

[3] MRSA (Methilicine Resistant Staphylococcus Aureus) is a resistant variant of the Staphylococcus Aureus bacteria. MRSA occurs in pig and veal calves husbandry and only people that work in these husbandry farms and are in direct

animal husbandry systems contact between people and animals is much lower than in traditional Chinese animal husbandry. In the baseline animal husbandry is organised in a modern way where contacts between animals and employees are already minimized (Enting, 2010). In GPS contacts can be reduced further because of the large scale of the initiative. The aspect of food safety and zoonoses and risks for contamination with resistant bacteria has probably more importance for the indicator human health than the share of animal transport in safety of Chinese traffic. Therefore this indicator is being evaluated as positive compared to the baseline.

1.05 Animal disease risk

In China highly infectious animal diseases like foot and mouth disease and swine-fever occur and underreporting of outbreaks persists. The chance to get infected as a farm with these diseases is much higher than in Europe. This is one of the main reasons why expansion in animal numbers initiated by slaughterhouses or feed companies is always divided in relatively small units of for instance 2500 sows (Enting, 2010). If a unit is infected by a high infectious animal disease the production of only that unit will fall out. The more animals being kept on one farm the bigger the impact will be on production if that farm is being infected.

Greenport Shanghai implies a much bigger concentration of animals (pigs and poultry) than in the base line. Therefore it can be expected that if the animals are being infected with a highly infectious animal disease the impact is much higher than in the baseline. The main question however is to what extent the chance of getting infected will be reduced at GPS. The chance of getting infected can be reduced by management measurements and housing adaptations. Nevertheless a reduction to zero chance of infection seems not to be feasible (Enting 2010). In all available documentation about GPS no attention is paid about this aspect and how the risk of getting infected with a large impact is being managed.

The indicator is relevant but there is no information available about a strategy to lower the chance for animals getting infected with highly infectious animal diseases. If however GPS does not take adequate precautions, this indicator must be scored negative due to the high impact if animals get infected (which is indicated by the red line).

1.07 Involvement

Greenport Shanghai is strongly focused on demonstration and communication with citizens which is facilitated in the infrastructure. Demonstration and communication only, however, does not automatically result in a positive involvement of the community as intended in the sustainability mapping framework. For a positive evaluation of this indicator a well based strategy for enhancing involvement is needed, including educational targets for specific target groups to increase knowledge of sustainable agro-production. It may also include participation in the production process, which gives inhabitants of the community a certain amount of responsibility for agricultural production.

For now we cannot determine whether the demonstration and communication activities of GPS changes the involvement of citizens in agro-production positively compared to the baseline, so this indicator is scored grey.

1.11a Emissions affecting ecosystems and human health *to air local*

No specific details concerning reducing emissions to air (ammonia, particulate matter and odour) are being mentioned in the documentation about GPS. In the masterplan (Smeets et al., 2007) the only relevant remark is that 'zero emission' is a starting point for GPS. Although it is not clear whether this is a starting point for emissions to air, soil and/or water and more specific for ammonia, particulate matter

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contact can be infected with this resistant bacteria. Carrying this bacteria is not dangerous at first, but may induce complications for patients on the intensive care department in hospitals or for people with skin problems.

and/or odour. Nevertheless zero emissions to air for ammonia, particulate matter and odour is not feasible in animal husbandry.
We assume that the best available and applied techniques for reduction of emissions to air will be used. This means an air washer with a 80% - 90% reduction of ammonia emission and 70% - 80 % reduction of particulate matter and odour emissions for the different animals in GPS.
Using these assumptions the emissions of ammonia, odour and particular matter are calculated as resp. 752 ton NH3, 9000 thousand OU and 259 ton PM10. Compared to Nieuw Gemengd Bedrijf (one of the biggest Dutch planned agro production site) this is 12 times more ammonia emission from one site. So although the relative high level of reduction the absolute local emissions from one site are high. For particulate matter and odour the relative reduction is also less because due to animal welfare reasons no laying battery but a system with litter is applied for laying hens.
The main difference with the baseline is that at GPS these emissions are concentrated on one spot, as in the baseline these emissions will be scattered among a region because of the dispersed location of different husbandries.

In the baseline on the local level of Dongtang we assume the introduction of one pig, one broiler and one laying hen farm. Compared to these farms (see Table 4.2), the emissions to air of GPS, including the best available techniques for reduction of emissions to air, gives a 8 – 25 fold (for resp. ammonia and particulate matter) higher emission to the air than the baseline. So, we think this aspect is of major importance and we evaluate this negative.

Table 4.2 Emissions to air (ammonia, particulate matter and odour) for the local and Dutch case scenario of GPS compared to the separate farms in the baseline. Note that there are approximately 50 farms per animal category needed to obtain the same production as GPS.

	Greenport Shanghai	Base line (emission per farm)		
		Pig farm (app. 50 farms)	Broilers (app. 50 farms)	Laying hens (app. 50 farms)
Ammonia (ton NH3)	752	73	12	5
Odour (1000 ou[a])	9000	612	16	29
Particulate matter (ton PM10)	259	7.6	2.5	0.2

[a] ou = odour unit per second

1.11b Emissions affecting ecosystems and human health *minerals and metals: local*
GPS produces 3,500 kilotons digestate and 260 kilotons champost which are applicable as fertilizer. If we assume an application of 15 ton digestate per ha, an area of 233,000 ha can be provided with digestate. This is comparable to the total area of maize silage grown in the Netherlands. This implies that the digestate and also the champost have to be transported before proper application.
In the documentation about GPS nothing is mentioned about the disposal of these organic fertilizers. So there are no *no regret* specifications for this topic. In the perspective of the Chinese circumstances where detailed legislation about proper application of manure is lacking, there is a big chance that organic waste available in such big amounts, is not treated in a proper way but dumped.
Nevertheless, we assume that all the organic wastes are distributed to areas where it is applied properly combined with eventually a further processing on GPS. This result in a positive ranking compared to the baseline.

1.11c Emissions affecting ecosystems and human health *regional*
Seen on regional level the emissions to air on several locations (about 150) in the base line are concentrated on one location. To evaluate the difference in emissions and especially the impact on local

and regional environment and people living in the surroundings detailed information is needed either about local circumstances in the baseline and the initiative. For a sound comparison information is needed of the actual presence of vulnerable nature (and possible impact of emissions) and people close to the farms in the baseline and for the initiative. This information is not available in this study so this indicator is marked grey.

1.12 Environmental quality, 1.13 Biodiversity and 1.14 Landscape

On regional level the animal and vegetable production is concentrated on one site in one initiative and production on several locations is avoided. This concentration might have a significant impact on the indicators environmental quality, biodiversity and landscape. Note that the Chongming Island on which GPS is planned does have a high value for biodiversity. Although impacts of GPS on biodiversity and landscape are minimized as described in the masterplan, there will always be an impact. Nevertheless there is not enough information available to compare the concentrated impact of GPS on one specific location to the spread impacts in the region. The indicators are marked grey.

1.15 Balance sheet

Concentration of production on one location results in significant costs reductions as described in the recent published business plan of GPS (Anonymus 2009). Moreover integrated production will increase efficiency (fewer losses due to transport or storage) over the production chain. Both aspects will have a positive effect on the balance compared to the baseline.

1.16 Investment

The investment costs per unit production are relatively high for GPS due to the needed investments for the infrastructure including CPU, trade centre, education centre etc. These investments in infrastructure have to be seen separately from operating GPS. The investments for infrastructure etc. will be carried out by financial parties supported by the fact that the return on investment calculated in the business plan (Anonymus 2009) is positive. Seen from this perspective the economic tress hold for entrepreneurs to join GPS is kept relatively small. Nevertheless there is not enough quantitative information to score this indicator.

1.17 Value creation

An advantage of GPS compared to the baseline is the guaranteed supply of save food products at one location. The latest is a strong advantage for buying parties like retailers (Anonymus 2009). It remains uncertain however, to what extent this will generate added value in economic terms compared to the products of the baseline. Another positive aspect is producing energy out of waste and manure which can be considered as new economic products and hence can be regarded as value creation. The business plan, however is not very specific about the market for these products (Anonymus 2009). Because of the uncertainty to what extent surplus value can be realized this indicator is marked grey, with the opportunity to create value with energy production and save food (indicated with the green line).

4.4 Local impacts of production chain - Supply chain

This paragraph describes the local sustainability indicators 1.01 to 1.17 of the supply chain which are scored in table 4.1. Sustainability indicators which were not relevant are not addressed. Although GPS is an example of chain integration on one location there is still need of supply. The main supply flows for GPS in quantity are feed and breeding animals for animal production and municipal waste. For those flows the relevant indicators are evaluated. This means that indicators concerning animal health are only

relevant for the supply chain of breeding animals and planet aspects are only relevant for the supply of feed and municipal waste. If more supply chain affect an indicator an analysis is made of a total score.

1.01 Human rights and 1.02 Labour conditions
For these indicators no specific changes are expected in the supply chain of feed, breeding animals and municipal waste compared to the baseline.

1.03 Animal welfare and health
This indicator is only relevant for the supply of breeding animals which is integrated in GPS. This implies that the positive score is also applicable for the supply chain.

1.04 Human health (other than emissions)
The most relevant supply chain involved in GPS for human health is probably municipal waste. With realization of GPS a strong demand for municipal waste will stimulate the collecting of waste at the municipality. This is evaluated as positive compared to the baseline.

1.05 Animal disease risks
This indicator is only relevant for the supply of breeding animals which is integrated in GPS. This implies that the grey score (see explanation at 1.05 in § 4.3) is also applicable for the supply chain.

1.08 to 1.10 and 1.13 to 1.17 Planet and profit indicators
The most relevant supply chain for these indicators is animal feed. For the initiative GPS there is no information available if standards on sustainability aspects (environment, social, economic) of production are considered for the production of feed. Besides that the aim of the initiative is to become an (international) showcase of sustainable production and it aims at production at a high level of quality. This will lead to a higher level of tracking and tracing and pre conditions for supply than in the baseline. Nevertheless it is uncertain to what degree extra attention for tracking and tracing will give improvements on these indicators. Therefore these indicators are scored neutral (yellow).

4.5 Global Effects

This paragraph describes the global sustainability indicators 2.01 to 2.04 which are scored in Table 4.1. The global sustainability indicators (land use, greenhouse gas effect fossil energy use and depletion of phosphate rock) are calculated from feed production until retail (including breeding of lay hens).

2.01 Land use
Land use is mainly determined by the feed used in the animal production units. In GPS documentation no additional standards are set for feed composition. Nevertheless we assume the feed conversion rate (FCR) to be lower (less feed is used for the same amount of animal product produced) than the base line. This assumption is based on improved management practices compared to the Chinese standard in the baseline. Based on information from Chinese feed producers (Enting, 2010) a FCR of 3.0[4] is assumable for modern pig husbandry. The average FCR in the Netherlands is about 2.75 (InterPIG/LEI, 2009).This implies less feed and therefore less land is used for the same amount of products in GPS compared to the baseline.

[4] A FCR of 3 means that 3,0 kg of feed was needed per kg liveweight produced from piglet production by sows to fattening pigs at slaughter weight (110 kg)

2.02 Greenhouse gas effect

The production of energy from animal manure and municipal waste replaces energy produced from fossil resources[5] and thereby avoids emissions of greenhouse gas. Besides that fermentation of pig manure in the CPU avoids storage of manure including methane emissions.

2.03 Depletion: fossil energy use

The production of energy from animal manure and municipal waste replaces energy produced from fossil resources and avoids depletion of fossil energy resources.

The greenhouses in GPS use a relative large share of the energy produced at the CPU (75%). The energy used is mainly allocated to cool the greenhouses during summer. To give an impression; the total energy demand for greenhouses in GPS for mainly cooling is 12 million MJ/ha where the energy demand in Dutch greenhouses for tomato production is about 15 million MJ/ha which is mainly used for heating. Although the energy used is renewable the use must always be minimized. To evaluate this point the question raises what the energy input would be for modern greenhouses in the baseline. In the baseline we assume that such greenhouses will be build in the region of big cities like Shanghai or Beijing. Beijing is even hotter in summer than Shanghai so we do not expect a considerable difference in energy use. In the latter aspects GPS scores neutral, but the production of energy from renewable sources makes the score positive.

2.04 Depletion: phosphate rock

A lower VC combined with proper application of manure results in more efficient use of phosphate.

4.6 System effects

This paragraph describes the sustainability indicators (the system effects) 3.04 till 3.07 which are scored in table 4.1. Sustainability indicators which are not relevant (blanc in table 4.1) are not addressed. Some of these indicators are related to the community. The community is defined as the society, civilians living and working in the neighbourhood of GPS but not directly involved.

3.01 Health

Food production in GPS is completely controlled and combined with adequate facilities like cooling resulting in a healthier product for the consumer. Therefore GPS is scored positive on this theme

3.03 Welfare of the community

Although a lot of effort is put on knowledge spreading and communication about agro-food production it is uncertain what the effect will be on welfare and involvement of the community.

3.04 to 3.07 Planet indicators

No information is available on financial aspects of the products from GPS so these aspects cannot be evaluated.

3.08 and 3.09 Money and time budget

No information is available on financial aspects of the products from GPS so these aspects cannot be evaluated.

[5] Electricity in China is mainly produced from coal resulting in relatively high greenhouse gas emissions

3.10 Prosperity community

About prosperity of the community it is assumable that the trade function will result in more spin off for local economy which is evaluated as positive. Nevertheless there is not enough information to evaluate this adequately

4.7 Potential

This paragraph describes the sustainability indicators scalability and spreading of knowledge which are scored in table 4.1. These indicators show the potential of the initiative.

Upscaling potential

In theory it will be possible to upscale the concept of GPS to other regions, although the implementation of each agropark may differ depending on local circumstances. Near the Chinese city Changzhou and in India comparable initiatives for agropark are initiated. Nevertheless the initiative GPS has not been realized until now and it is fairly impossible to evaluate scalability of an initiative that has not been realized by itself.

Knowledge dissemination

There is an active policy in the dissemination of knowledge or in making the gained experiences available for other entrepreneurs. This indicator is evaluated as positive

4.8 Critical success factors

In this paragraph the factors are described that are crucial for a successful operation of Greenport Shanghai. First, factors are described which can be distinguished as crucial for realization of GPS itself. Next the critical success factors that are crucial for a sustainable development of Greenport Shanghai will be determined.

Concerning the realization of GPS we do not pretend to be able to give a complete list of success factors. We aim at the critical success factors that determine the realization of GPS according to sustainability principles.

Involving entrepreneurs

Having entrepreneurs to invest are crucial for realization of GPS. A potential obstacle for the first investors is that the surplus value of cooperation, for instance expressed in the operation of the CPU is not available in the beginning although high investments to obtain the no regret values are needed right from the beginning. The surplus value of the connection between the different production units is only maximized at the end stage of realization of the initiative. Moreover the involvement of entrepreneurs from different agro production can be a threshold. Stallen *et al.,* 2007 mention that vertical integration on agroparks has proven to be more successful than horizontal.

Management for sustainable development of GPS

The concept of a sustainable agro production park as GPS needs a strong and independent management that fully initiates, supports and maintains the desired level of sustainability of the initiative. It needs to watch over the goals set for sustainable agro production over the long term and during day by day management. Complying these goals for sustainable agro production is necessary to realize the positive impacts and to avoid as much as possible the possible negative impacts as described in this assessment. Organizations involved until now are not automatically the most suitable for this management position.

For instance Alterra from Wageningen UR as a knowledge provider or consultant can only give advice, managing such an initiative would be beyond Alterra's knowhow. On the other hand giving the Shanghai Industrial Investment Corporation (SIIC) the responsibility for management of GPS will include the risk that creating the sustainable concept of GPS will become of minor importance than creating maximum value for the land property. Until now no organization has been found which is suitable and willing to take this responsibility, which is one of the main reasons why GPS is not realized until now.

Creating surplus value

Anonymous (2009) states in the business plan that the investments needed for GPS are relatively high. To earn back this investment, a surplus value on the product is needed. According to the business plan this can be realized by the earnings of food products with high and guaranteed quality generating more added value. The realization of this can be seen as a critical success factor.

Minimizing chance off and impact from infection with infectious animal diseases

Infectious animal diseases like swine fever and mouth and food disease occur in China. It is not the question whether a farm will be infected but rather when. Because a large amount of animals (more than 1 million pigs and about 7 million chickens) are being held on GPS the impact of infection with such a disease will be enormous. The impact is several times larger than the baseline where impacts due to these infections are lowered by spreading animal production over several locations. This separation in the baseline is deliberate to lower the amount of production loss when a production units get infected.

So, a critical success factor is to what extent GPS succeeds to minimize the chance of infection and or reduce to impact (for instance by partitioning the animal husbandry) of animal diseases and especially the infectious diseases.

Market for organic wastes

There is no destination defined yet for the organic material from GPS (digestate and champost). If applied as fertilizer in the near region it will induce the risk for inefficient use. The amount of supply is to such an extent that the region needed for outlet is that large that costs for transport will be very high. This results in a high risk for excessive use in a small region near to GPS.

Nevertheless a balanced application of these products is needed to stay within the ecological standards. Therefore a balanced destination (application in the region or other place or further processing) is also a critical success factor for GPS.

Managing high local emissions

Greenport Shanghai accommodates a large amount of farm animals which, even if the most advanced emission reduction techniques are used, emits a large amount of ammonia, particulate matter and odour. This can be harmful to nearby nature and also be a disadvantage for the human living conditions in the eco-city which is developed next to the agropark. It is also doubtful whether these emissions are a disadvantage of the eco-image of GPS itself.

A critical success factor is how these inevitable emissions will be managed taking into account the possible effects on the environment, the eco-city and the image of the agropark itself.

5. Discussion and conclusions

This study evaluates the sustainability performance of the initiative Greenport Shanghai divided in four impact categories (local, supply chain, global and system effects), based on the methodology that is described in Blonk et al. (2010). Within this differentiation different sustainability indicators, which are ordered in the three categories people planet and profit, are evaluated. The total evaluation of the sustainability performance depends on each sustainability indicator and the importance (relative weight) of each indicator. A weighting of importance of each indicator has not been applied in this study.

The results of this study are based on the intentions and plans of Greenport Shanghai. If the implementation deviates from those intentions, this could have consequences for the sustainability performance evaluation. This can have either positive or negative effects on the final evaluation. If such deviations from the original plan and intentions occur, this needs to be evaluated before conclusions can be drawn about sustainability.

Strengths

- Integration of production chain on one location, avoiding transport costs
- Production energy from waste
- The strong willingness and aim of involved (Dutch) organisations and entrepreneurs to develop and manage Greenport Shanghai in a sustainable direction

Weaknesses

- High local emissions to air
- High investments
- No market defined for waste products from GPS (digestate and champost)
- No specific measurements mentioned to prevent import of infectious animal diseases

Opportunities

- Value creation due to deliverance of save product and concentrated supply for retailers etc.

Threat

- High impact if infected with infectious animal disease
- Difficult to find an organization which is capable and suitable to manage Green Port Shanghai including the goals set for sustainability

References

Anonymus, 2009. Businessplan Agropark China. Merapeak BV and Headventure, Delft/Pijnacker.

Blonk H., Kool A., Luske B. 2008, Milieueffect van Nederlandse consumptie van eiwitrijke producten, Blonk Milieu Advies, Gouda.

Blonk H., Scholten J.J.J., Broekema R., Kool A. 2010. Evaluation of sustainability performance of TransForum projects – Methodology proposal - Blonk Milieu Advies, Gouda.

Enting, I. 2010. Personal communication. Wageningen University – Animal Sciences Group, Beijing, China.

Enting, I., J. Han & J. Verstappen 2009. An overview of Trade opportunities in China's pork chain. Ministery of Agriculture Nature and Food Quality, Den Haag.

Fan, S., B. Nestorova and T. Olofinbiyi, 2010. China's Agricultural and Rural Development: Implications for Africa. China-DAC Study Group on Agriculture, Food Security and Rural Development, Bamako.

Guinee 2002. Handbook on Life Cycle Assessment Operational Guide to the ISO Standards Series: Eco-Efficiency in Industry and Science , Vol. 7 Guinée, Jeroen B. (Ed.) 2002, 708 p., ISBN: 978-1-4020-0557-2

Hoogland C., 2006. Transparency of Meat and Fish Production as a Determinant of Sustainability in Food Choices.

Infomill, 2009. Emissiefactoren voor de emissie van ammoniak, geur en fijn stof. www.infomill.nl.

InterPIG/LEI, 2009. Interpig is an international network of pig production economists collecting data and comparing cost of production.

ISO14040, 2006. Environmental management - Life cycle assessment- Principles and framework.

ISO14044, 2006. Environmental management - Life cycle assessment- Requirements and guidelines.

ISO14064, 2006. Greenhouse gases – Part 1: Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals.

Kool, A., I. Eijck & H. Blonk 2008. Nieuw Gemengd Bedrijf Duurzaam en Innovatief? Blonk Milieu Advies, Gouda.

Mingtian, Yao 2010 Personal communication. Wageningen University – Alterra, Beijing, China.

Poon, C. 2006. An overview of China's pork industry. Embassy of The Kingdom of the Netherlands Department of Agriculture, Nature and Food Quality, Beijing, China.

Smeets, P.J.A.M., M. van Mansfeld, Z. Chonghua, R. Olde Loohuis, J. Broeze, S. Buijs, E. Moens, H. van Latensteijn, M. van Steekelenburg, L. Stumpel, W. Bruinsma, T. van Megen, S. Mager, P. Christiaens en H. Heijer 2007. Masterplan Greenport Shanghai Agropark. Shanghai Industrial Investment Corporation & Alterra Wageningen University and Research Centre, Shanghai / Wageningen.

Smeets, P.J.A.M. 2009. Expeditie agroparken. Proefschrift Wageningen Universiteit, Wageningen.

Smith, Rowan and Sullivan 2002. Technology of mushroom cultivation. In: Medicinal Mushrooms: Their therapeutic properties and current medical usage with special emphasis on cancer treatments. University of Strathclyde, Glasgow.

Stallen, M., C. Ooms & W. Kokkeel 2008. Sustainable Agricultural Clusters (Greenports) China. From concept to a feasible design (phase 1) Organizing the trade function. Draft report. Fresh Studio Innovations, Haarlem/Poeldijk.

Wang, R. 2006. China – Pork Powerhouse of the World. In: Advances in Pork Production, volume 17, pg 33-46.

Wijst, J. van der. 2005. Notitie: Doelbereik reconstructieplannen in relatie tot het Rijkstoetsingskader. Provinciale Staten Provincie Noord-Brabant, Den Bosch.