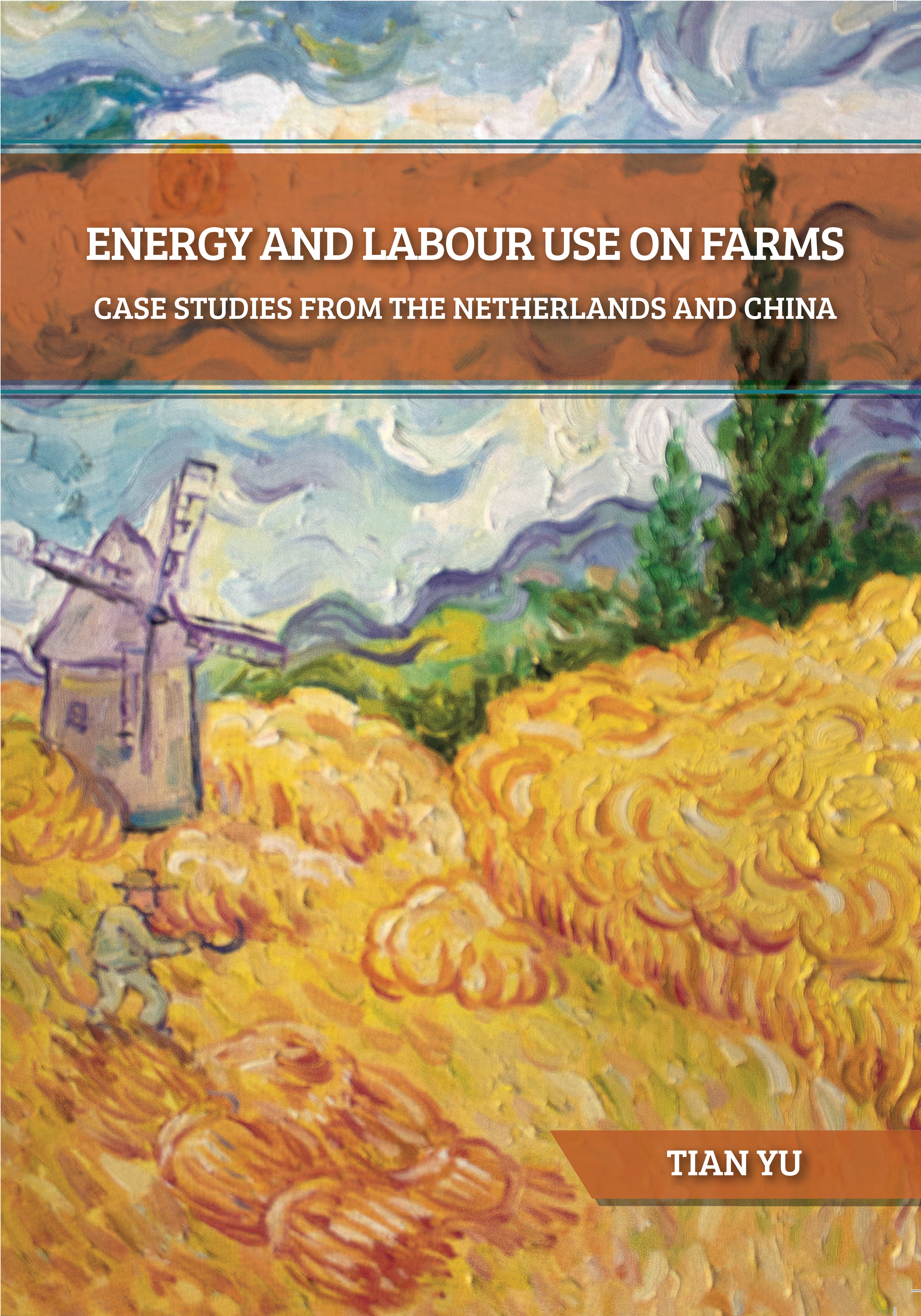

ENERGY AND LABOUR USE ON FARMS

CASE STUDIES FROM THE NETHERLANDS AND CHINA

TIAN YU

Propositions

1. Organic farms have great potential in achieving sustainability through the reduction of fossil energy use.
   (this thesis)

2. Quantity and quality of peasant labour is key to sustainability on organic farms.
   (this thesis)

3. Technological innovation increases efficiency but reduces equality in the utilization of resources.

4. Renewable energy is limited in mitigating climate change.

5. Inter-country competition leads to irrational behaviour.

6. Human beings challenge nature because of fear.

Propositions belonging to the thesis, entitled

Energy and labour use on farms: case studies from the Netherlands and China

Tian Yu

Wageningen, 20 November 2019

Energy and Labour Use on Farms:

Case Studies from the Netherlands and China

Tian Yu

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Energy and Labour Use on Farms:

Case Studies from the Netherlands and China

Tian Yu

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To my late grandmother,
a hardworking and resilient peasant.

Table of contents

Chapter 1

Introduction

1.1 The transition to sustainable food production

On the basis of widespread discussions regarding how the current food production system is burdening our planet, it follows that sustainable food production should be promoted in order to best feed a growing population with increasingly limited resources. A report published by InterAcademy Partnership (IAP, 2018) points out that the global food system is failing humanity, and both agricultural production and food consumption should be blamed for driving disastrous climate change. Focusing on agriculture alone, it contributes about 20%-25% of global annual emissions, making it one of the major climate change drivers. Conversely, the increasingly frequent climate extremes and variability threaten agricultural productivity and food accessibility. Apart from emissions, the so-called industrial agricultural production, featured with high mechanisation and large-scale monoculture, has also been proved to be responsible for more environmental problems, including soil degradation, biodiversity loss, water and air pollution, etc. (Liu et al., 2006; Frison et al., 2011). Another aspect of the unsustainability of the industrial agricultural production is that it depends on high input to achieve high output. Even though increasing agricultural yield has indeed provided more food for the growing population in the last decades, the high demand of inputs like synthetic fertiliser and pesticides consumes a great number of resources, such as minerals, fossil energy, etc. Realising that most of these resources are limited and unrenewable on the planet, it is doubtful that the continuously-expanding population can be fed with current food production system. Against the background of climate change, environmental damage, and resources depletion, it is necessary to discuss the transition to sustainable food production.

Organic agriculture, rising in the 1970s, has been gradually entering mainstream awareness and consumption, especially in the developed countries. Nowadays it is a fast-growing sector not only in the Global North but also in some developing economies. Regulated by organic principles and certification, organic agriculture is generally believed to be of more value in reducing environmental damage and mitigating climate change compared with conventional agriculture (Pimentel et al., 2005; Scialabba & Müller-Lindenlauf, 2010; Reganold & Wachter, 2016). However, after years of development, it has been criticised for being less productive and more labour intensive, making it controversial whether it is a more sustainable way of food production.

1.2 Energy and labour as two fundamental resources on farm

As one of the most important issues related to sustainability, energy use in agricultural production is of great interest due to its direct connection to both climate change and resource depletion. For looking at the structure of energy use on farms, all energy sources might be divided into two types: fossil energy and non-fossil energy. Alongside the direct use of electricity and gas, on-farm fossil energy use also includes energy used for producing fertiliser, pesticides and other inputs on the farm. Human and animal power were gradually replaced by machine power from the end of 18th century onward, and more and more fossil energy was used to increase productivity in the world economy (Gever et al., 1991). Non-fossil energy usually enters agricultural production as solar energy, which needs to be combined with human labour and other energy forms to become effective. It also enters as animal traction, which is gradually being replaced nowadays by machinery. Finally, renewable energy is produced by solar panels, wind turbines and biogas, also increasingly being used in agricultural production nowadays.

Apparently the direct fossil energy used on farms should be replaced by renewable energy for sustainable reasons, but it may not happen soon due to the high cost for producing new energy and the manipulated low price of fossil fuels. Moreover, the indirect fossil energy used on farm may not be replaced under the current agro-technology and economic conditions, especially the part used for producing fertiliser and pesticides, and powering heavy machinery and information & communication technologies used in the agriculture sector (Li, 2007; Gellings & Parmenter, 2016). Research shows that the production and distribution of synthetic fertilisers are considered to comprise 37% of the total fossil energy inputs in agricultural production, while pesticides account for almost 5% (Deike et al., 2008). To sum up, energy used in agricultural production nowadays is still composed in great measure by fossil energy, and the situation may not be any different in the near future.

However, fossil energy is a non-renewable resource, and it is closely affiliated with climate change and other environmental problems due to the greenhouse gas emission it causes (Olivier et al., 1998). In the agriculture sector, the statistic of fossil energy consumption seems small, but when indirect energy use is included, the proportion goes up (Pervanchon, F. et al., 2002). Therefore, it is vital to reduce agriculture's dependency on fossil energy use for achieving sustainable food production.

Labour can be regarded as a kind of non-fossil energy, another basic resource used on farm. It is believed that the more fossil-energy-powered machinery, fertilisers, and pesticides are used, the more labour is replaced. This means that labour input on farm can be substituted by fossil energy use in general, while it can in turn also substitute fossil energy consumption (de Wit, 1975). However, the labour input is deeply embedded in the social and economic contexts, and if that labour input is replaced by fossil energy input on farm, that could lead to social issues like unemployment in rural areas; conversely, using labour to substitute fossil energy on farms could be limited by labour shortage and rising labour prices in the agricultural sector. It is likely that when the issues related to fossil energy use are tackled, labour issues in the agriculture sector will rise accordingly. Thus, it is important to consider the balance of fossil energy and labour input in sustainable food production, and deal with not only the environmental aspect but also social and economic aspects.

In the context of the transition to sustainable food production and the development of organic agriculture, this thesis is going to discuss the sustainability of agricultural production in terms of fossil energy and labour use at farm level. It is an exploratory study focusing on comparing the balance of fossil energy and labour input among different farms.

1.3 Triple comparison on fossil energy and labour input at the farm level

a. Comparing organic and conventional farming systems

As an alternative method of agricultural production, organic farming has been proved by many studies to be efficient in reducing fossil energy use, even though the result is sometimes inconsistent (Thomassen, M. A. et al., 2008; Bos, J. F. et al., 2014). Forbidding the use of synthetic chemicals, organic farming could potentially decrease the indirect use of fossil energy, but it increases labour use on farm at the same time due to the work of weeding, harvesting, etc. (Bukman, 1992; Bondt et al., 1997; Jansen, 2000). Increasing labour use while decreasing fossil energy use on farm, organic farming seems to have a special input balance that is in contrast to that of conventional farming. It is therefore interesting to explore the questions of how differently the inputs of energy and labour are balanced on organic farms from on conventional farms, and how that balance can influence the sustainability of agricultural production.

b. Comparing different farming activities and farm sizes

Besides different farming principles (organic or conventional), other characteristics like farming activity (crop or livestock types) and farm size could possibly make a difference in the balance of fossil energy and labour input on farms. As presented in the studies of Jansen (2000) and Lobley et al. (2009), farming activity, farm size, social connection and other factors could influence the socioeconomic character of different farms, including the fossil energy and labour input practices. On dairy, arable, and (open-field) vegetable farms, the fossil energy and labour input intensity can be highly variable due to the different processes of farming practices. Usually dairy and arable farms use more and larger machines than vegetable farms, while vegetable farms are more labour-intensive. Different farm size could also change the input balance, as they may have different methods for organising the inputs for agricultural production. As Foster and Rosenzweig (2017) point out, big farms use more productive machines while small farms use less productive machines, and this results in a difference in yield: the bigger the farm, the more profitable it is. Even though this point of view can be challenged, it still anyhow shows that there is a different balance of resource use according to the size of the farm. Therefore, it is crucial to consider the variables of farming activity and farm size when comparing the fossil energy and labour input balance at farm level.

c. Comparing farms in the Netherlands and China

Due to the different social contexts, the fossil energy and labour input balance at farm level can also differ according to country. It is therefore necessary to include the cross-regional level in the comparative study. In this study we have calculated the energy and labour balance on farms in China and the Netherlands.

In the Netherlands, technology-driven intensification plays an important role in its agricultural growth (Hayami & Ruttan, 1985). Inventing the windmill in the 15th century for draining off water in agricultural land, perfecting the engineering for land reclamation, and leading the way in the 20th century with state-of-the-art chemical fertiliser, pesticides, fodder concentrate, improved machinery and farm management, the Dutch have made their agricultural system one of the most productive in the world. The high output in agriculture was built upon high input. Taking fertiliser use as an example, the amount of nitrogenous fertiliser used per ha of agricultural land in the Netherlands was double how much was used in Germany in 1980, and 3.5 times how much was used in the UK (Harms *et al.*, 1987). In terms of labour, the technology of mechanisation reduces human labour on farms by a large percentage. The high input levels and wide application of machinery undoubtedly increase the dependency on fossil energy use in the agriculture sector.

Different from in the Netherlands, China's agriculture growth is mainly accomplished through labour-driven intensification (Ploeg et al., 2013). Traditionally, a peasant family works on a small piece of land with cattle or a horse, using a labour-intensive method of production. But the situation is changing as China's agriculture is undergoing a rapid industrialisation that is increasing the use of fossil energy on farms (in the form of fertilisers, pesticides, machinery, etc.) (Renpu, B., 2014; Wang et al., 2016). Labour input is partly replaced by fossil energy use, but it is still relatively high compared to developed countries due to the large percentage of peasant households in the agricultural sector that have limited land size and resources.

Representing two different trajectories of the agricultural development, the Netherlands and China may present different balances of fossil energy and labour input for agricultural production. As a developed country, the Netherlands is leading in the use of advanced technologies in the agricultural sector, and they depend on high fossil energy input. However, China, as a developing country under rapid industrialisation, is possibly following the trajectory to increase its fossil energy dependency as more and more technologies are applied to the agricultural sector. How will the Netherlands, or the developed countries in general, reduce fossil energy use towards achieving sustainability? How will China, or the rising developing countries, balance the use of resources for food production? These are the important questions to be answered in comparing these two countries' fossil energy and labour input balance in farming. The comparison between the Netherlands and China might also be valuable for understanding the sustainable agricultural development in other regions.

1.4 Theoretical notions

a. Input balance and substitution of fossil energy and labour

The input balance of fossil energy and labour on farms refers to the resources consumed in the production of agricultural products, from raw materials to the farm gate, in the form of fossil energy and labour. The fossil energy flows into the farming practices not only as direct energy like gasoline, electricity, coal, etc. but also as indirect energy consumed by the production of fertiliser, crop protection, seeds, machinery, buildings, etc. The fossil energy input on farms can be computed by analysing both the direct and indirect energy consumption in a carefully defined farming system. The labour input on the farm refers to the work involving human beings in the process of agricultural production. This includes the work of farmers, permanent and temporary hired workers, etc. The labour input on a farm can be calculated by counting the hours that human beings put into producing agricultural products. The fossil energy consumption of farm workers is not only related to production but also to private purposes. As it is difficult to distinguish the different purposes of fossil energy use, and this study only focuses on the fossil energy consumed for agricultural production, the fossil energy consumed by human beings is not included in the total fossil energy use on the farm. Once the input of fossil energy and labour is determined, the input balance of these two basic resources can be captured on each farm.

In addition to the input balance of fossil energy and labour on farms, the substitution is also considered in this study. De Wit (1975) put forward the concepts of added energy and added labour, and discussed the substitution between the two basic resources for achieving a certain yield on farms. Added energy and added labour refers to the total amount of fossil energy or labour used on a farm, used in the production of all agricultural inputs (off-farm) and used for transportation. This means that both the fossil energy and labour used on-farm and off-farm for agricultural production are included. Based on de Wit (1975)'s theory, the substitution of fossil energy and labour can be visualised as isoquant, or equal product curve. It represents a set of points at which the same quantity of output is produced while changing the quantities of fossil energy and labour (see Fig. 1-1).

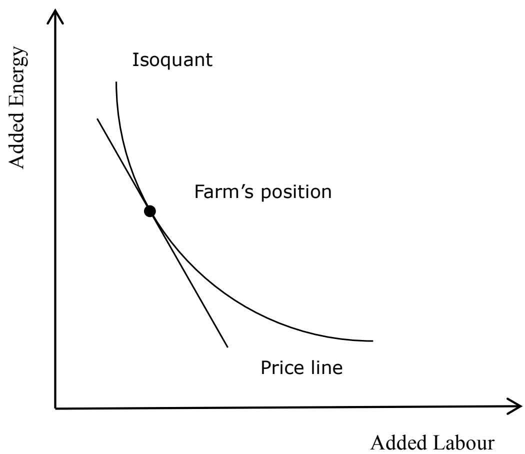


Fig. 1-1 The substitution of added energy and added labour for producing certain amount of agricultural output

When farms with different characteristics are considered, (i.e. organic or conventional, Chinese farm or Dutch farm, big or small farm), they would hypothetically move along the curve based on the price line of fossil energy and labour. The price line is determined by the price of fossil energy and labour, which may be variable among different farms. The slope of the price line is equal to the marginal substitution ratio (MSR) of added energy and added labour. The MSR shows to which level the fossil energy and labour can be substituted by each other for producing a certain amount of agricultural output.

For organic and conventional farms, the input balance and substitution of fossil energy could be different. As discussed above, organic farming has been proved to use less fossil energy and more labour on farms than conventional farming due to the application of organic principles. It shows different ways to structure the on-farm processes of production and development. Therefore, it is possible that organic farming is located on the curve differently from conventional farming. The differences in the position would perhaps explain how organic and conventional farms would choose to balance the fossil energy and labour use at the farm level. The different positions on the substitution curve would also apply to big and small farms, and farms producing different products, since the on-farm practices of using fossil energy and labour could be varied among different farm size and farming activity.

When farms in the Netherlands and China are compared, they may have different positions on the curve as well because of their different resource endowments and resource accumulation over time. Hayami and Ruttan (1985) have proved in development economics that the successful achievement in agricultural growth of a specific country over time depends on its ability to adjust to the original endowments and its change in response to institutions (political, economic and cultural systems). Obliviously the Netherlands and China represent different trajectories of agricultural development in terms of making use of fossil energy and labour. Even though the situation is changing, the different social contexts should still be taken into account.

Even though farms with different characteristics could possibly shift their location on the curve, there might also be lock-ins that hinder this movement. This could relate to the historical investments of fossil energy and labour on farms, or the original resource endowments and economic/political institutions in the relevant country.

b. Further complications: labour constraints and conventionalisation of organic agriculture

Is it possible in practice to use labour to replace the fossil energy input on farms for achieving sustainable food production? Taking the Netherlands and China as examples, both countries are facing the potential constraints of labour shortage and increasing labour prices in the agricultural sector. How farmers, especially organic farmers who tend to reduce fossil energy while increasing labour use on farm, respond to these constraints is then an important question to explore. Facing the labour constraints, organic farmers have to adapt to the changes so that they can secure their livelihood. Referring to the ability to adapt to change or keep the main functions regardless of the changes, resilience has been widely discussed in the rural development studies (Perrings, 2006, Wilson, 2012). Therefore, in this study we aim to look at how organic farmers would respond to the changes, and how the responses from different organic farmers would influence their resilience.

Furthermore, inasmuch as organic agriculture is considered to be a more sustainable method of food production than conventional agriculture, especially as regards reducing fossil energy use, its tendency towards conventionalisation should also be noted. To understand organic and conventional agriculture as two different methods of organising resources for agricultural production, the modes of farming and styles of farming should be introduced to the discussion. As Ploeg (2018) explains in his study, there are three modes of farming: capitalist agriculture, entrepreneurial agriculture, and peasant agriculture. The modes of farming are distinguished according to the nature and magnitude of the resource base, however, for each mode, there are different ways to use and develop the resource base. Based on the different use and development of the resource base, there are different farming styles among farmers. When it comes to the differences between organic and conventional agriculture, the essential difference is the choice whether or not to put ecological principles and cycles on centre stage. It is believed that after years of development and practices, organic agriculture is losing its ecological principles and cycles, and moving towards the nature of conventional agriculture. This is called the conventionalisation of organic agriculture. When comparing the qualities of different modes of farming with the organic principles, the countertendency of conventionalisation is the development of organic peasant agriculture, which has gradually been put into practice as agroecology.

1.5 Objectives and research questions

The overarching objective of this thesis is to discuss the balance of fossil energy and labour input at farm level by comparing conventional and organic farming systems, and to explore the possibility to optimise sustainability in agricultural production. In detail, the following research questions and sub-questions were generated regarding these objectives:

(Q1) To what degree does the balance of fossil energy and labour input on organic farms differ from that of conventional farms?

(Q2) To what degree do such balances coincide or differ in the comparison between the Netherlands and China?

(Q3) How could organic farming in the two countries use more farm labour considering the constraints of labour shortage and increasing labour prices?

(Q4) How to understand farmers' different input strategies and what is the conventionalisation of organic agriculture in terms of resource use?

(Q5) As a countertendency of conventionalisation, what are the values of organic peasant agriculture?

1.6 Methodology

a. Comparative case study

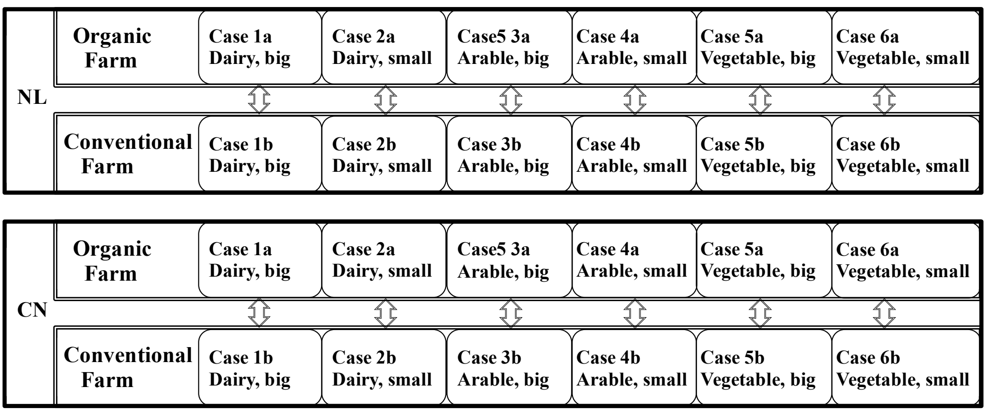


Fig. 1-2 Comparative case study design

A comparative case study is used in this research. For each country, six organic farms and six conventional farms were selected to obtain a wide spectrum of different farming activities and farm sizes (see Fig. 1-2). The conventional and organic cases are treated as two independent systems to be compared, and only fossil energy and labour used within the whole system are computed.

b. Sampling

As this study mainly focusses on discussing the sustainability of organic farming, it starts to select organic cases by using purposive sampling strategy. Basically there are three steps for selecting organic cases. First, all organic farms were divided into three types according to their products: dairy farm, arable farm (mainly producing grains) and vegetable farm. Second, for each type, one big farm and one small farm were selected. To identify big and small farms, professionals were consulted. Third, other criteria were also considered in selecting the cases, including the possibility for farmers to share data, farmers' language level, etc.

After the selection of organic cases, snowballing strategy was used to select conventional cases. Usually the selected conventional farm, with similar size and producing similar products as the organic farm, was also close in proximity to the organic farm to make sure both farms had the same soil type and climatic conditions. Fig. 1-3 lists the sampling procedures.

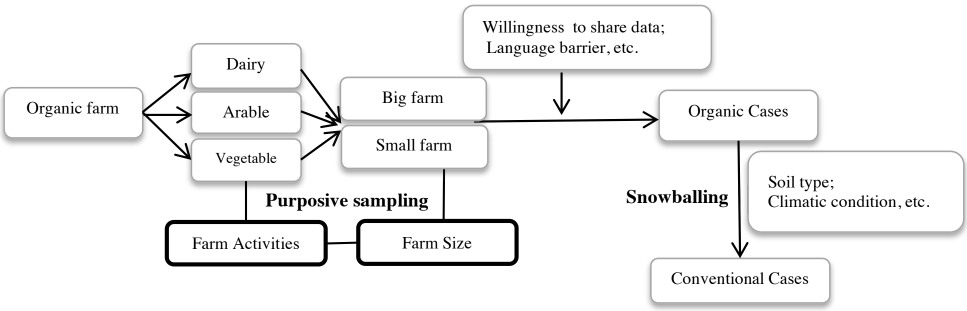


Fig. 1-3 Sampling Design

c. Data Collection and Analysis

The data of this study was collected according to the research objectives and questions, and both quantitative and qualitative data have been included (see Table 1-1). Quantitative data is mainly extracted from financial reports on the farm, or interviews with a farmer who could not provide financial reports. Based on the quantitative data, fossil energy and labour use at the farm level are calculated. Additionally, farm-level data derived from databases in the Netherlands and national annual statistic data in China are also used to test the representativeness of the cases selected in these two countries. Qualitative data is collected via semi-structured interviews with farmers, and content analysis is used to treat the qualitative data.

1.7 Outline

The main body of this thesis is organised as follows: In Chapter 2 and Chapter 3, the balance and substitution of fossil energy and labour on farms is compared between organic and conventional farming systems in the Netherlands and China separately. Chapter 4 compares the results of the balance and substitution of fossil energy and labour between the Netherlands and China in further detail. Chapter 5 studies organic farmer's responses to the constraints of labour shortage and increasing labour prices and the potential for increased resilience on organic farms. Chapter 6 explores the conventionalisation of organic agriculture through the lens of farming modes and farming styles. Chapter 7 discusses the value of organic peasant agriculture, the countertendency of the conventionalised organic agriculture, in achieving sustainability in agricultural production.

Table 1-1 Strategies of data collection and analysis

RQ	Data Collecting Methods	Content of Data	Data Type	Data Analysing Methods
Q1&Q2	• Collect raw data Collect basic information of farms Collect data of inputs on farm • Database and source Agramatie China rural household data Literature	• Basic information includes land size(ha), crops(cows), yield, soil type, farm location, rotation; • Direct fossil energy use: gasoline, electricity, etc. • Indirect fossil energy use: amount of purchased inputs/ services, depreciation of building and machinery; • Working hours on farm: family members and hired labour; • Data of energy input and working hours on all farms from Agramatie (NL), China Yearbook of Rural Household Survey, Compile Data of Cost and Profit of Agriculture Products in China, and China Yearbook of Rural Statistic; • Energy coefficient of all kinds of on-farm inputs (Literature).	Quantitative Data	• Frequency description in terms of basic information of farms; • Calculate energy input of each case, present data with bar chat; add up all working hours on each case, show data with bar chat; • Compare the results between organic and conventional farm in each country; • Compare the results in the Netherlands and the results in China.
Q3	• Interview Semi-structured interview with organic farmers.	• Interview organic farmers about their perception and response to labour constraints.	Qualitative Data	• Content analysis to analyse qualitative data using Atlas.ti ➢ Transcription of the interviews ➢ Coding ➢ Compare codes from organic farmers in the Netherlands and China ➢ Cases interpretation
Q4	• Interview Semi-structured interview with both organic and conventional farmers • On-farm observations	• Interview all farmers about input strategy decision (energy-labour), influence factors in this decision, intended improvement on farm towards sustainability; • Observe the on-farm practices related to resource use.	Qualitative Data	• Content analysis to analyse qualitative data using Atlas.ti ➢ Transcription of the interviews ➢ Coding ➢ Cases interpretation
Q5	• Interview data from farmers and professionals	• Interview questions about how organic farmers deal with the issues of planet, people and profit.	Qualitative Data	• Content analysis to analyse qualitative data using Atlas.ti ➢ Transcription of the interviews ➢ Coding ➢ Cases interpretation

Chapter 2

Energy and Labour Input Balance on Farms in the Netherlands

2.1 Introduction

The concern of the depletion of natural resources was brought into the public eye in the 1970s, and since then, the western world has been aware of the importance of conserving fossil energy. However, in the most recent decades environmental effects related to fossil energy use (i.e. greenhouse effect, acid rain, etc.) revealed that much more effort had gone into exploiting this unrenewable resource than had gone to achieving sustainability. In the agriculture sector, fossil energy has been widely used directly or indirectly to replace human labour, and the increasing use of these inputs has been widely criticised to be unsustainable.

Fossil energy is manifest on farms not only as fuels, electricity, and gas to power machines, but also as fertiliser, pesticides, and other inputs to increase productivity. The high productivity on modern farms usually goes along with high levels of external inputs. The use of these inputs in the Netherlands increased mainly from 1950s to 1980s with the development of industrial agriculture, leading not only to heavy environmental burden, but also high fossil energy dependency. In 2015, the agriculture sector in the Netherlands accounted for about 6.8% of the total national fossil energy use according to official statistics (CBS Statline, 2015). It seems that farming is not a main consumer of fossil energy, however, the figure only reflects direct fossil energy use (fuels, electricity and nature gas used on farm), while the indirect fossil energy, mainly consumed by other on-farm inputs, contributes to larger amount of fossil energy consumption; energy used for producing, storing, and transporting, as well as fertiliser, pesticides, buildings, machines, etc., is not included (Bos et al., 2014). With such energy-intensive inputs being used on farms, industrial agriculture actually consumes large quantities of fossil energy, which challenges the goal of transitioning to clean production and pursuing sustainability (Horrigan et al., 2002).

As the public became aware of the environmental and social impact of high external input farming systems, regulations were put forward under the pressure of the environmental movement. Around the same time, alternative farming systems were discussed and brought into practice as well, organic farming being one of them. Without using synthetic fertilisers and pesticides, organic agriculture is believed to be environmentally friendly, and potentially sustainable in terms of reducing fossil energy use (hereafter written as energy use) (Ziesemer, 2007), even though the conclusion is not always consistent. The literature shows that the result varies accordingly to different calculating methods and units: normally, energy use per ha on organic farms is considerably lower than that on conventional farms due to its lower input per ha (Cederberg et al., 2000; Grönroos et al., 2006; Thomassen et al., 2008; Gomiero et al., 2008; Nemecek et al., 2011). It bears mentioning that the result of comparing energy use per unit of output between these two farming systems is not quite certain due to the possible yield gap. Current studies show that the energy used for producing one unit of milk on a Dutch organic dairy farm is definitely lower than that on a conventional dairy farm (Thomassen et al., 2008; Bos et al., 2014), but the results are inconsistent for crop farms (vegetable and arable farms) (Dalgaard et al., 2001; Shepherd et al., 2003; Hoeppner et al., 2006; Loges et al., 2006; Deike et al., 2008; Bos et al., 2014). Considering the inconsistent conclusions on organic farming's potential for reducing energy use, more practical studies on comparing energy use between organic farms and conventional farms are necessary. This study is going to validate the conclusion that organic farming reduces energy use when compared with conventional farming in certain methods.

Despite its reduced fossil energy use, organic farming has been proved to require more human labour for weeding, pest control, and harvesting compared with conventional farming (Jansen, 2000). Is it that organic farming uses more human labour to *replace* (fossil) energy? To clarify this, we need to compare the labour input, specifically the energy and labour input balance, between the two farming systems. As energy and labour input on farms could vary according to farming activities (dairy, arable or vegetable) or farm size, it is important to include these variables when making that comparison.

This chapter first presents an energy analysis of different Dutch farms. The comparison of energy input between organic and conventional farming is presented in the following part. Then labour input on different farms is calculated, and the result between organic and conventional farm is also compared. Finally, combining the results of energy and labour input analysis, the input balance and substitution between energy and labour on different Dutch farms is discussed.

2.2 Methodology

A case study is used in this research to calculate energy and labour input, and discuss the input balance between energy and labour on Dutch farms. Based on the assumption that farming system (organic or conventional), farm size (big or small) and different farming activities (dairy, arable, or vegetable) could influence energy and labour input for on-farm production, 12 cases are selected (see Fig. 2-1) under certain criteria.

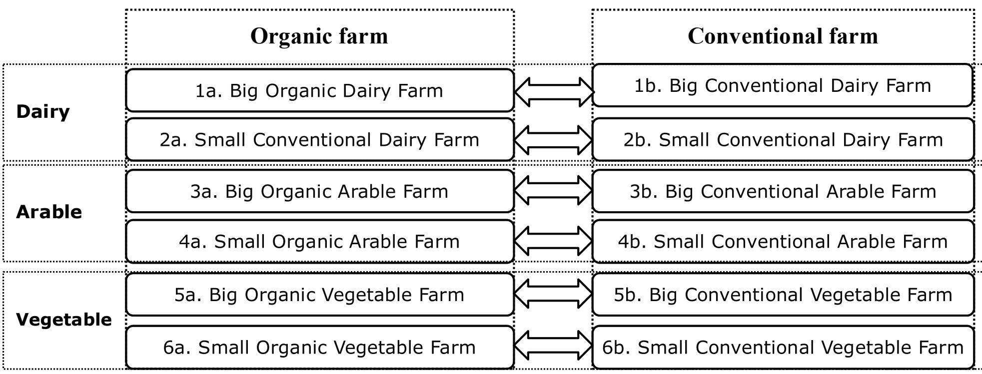


Fig. 2-1 Selected cases among Dutch farms

The sampling starts with identifying organic cases by using purposive strategy. First, organic farms certified either by EU or EKO[1] are divided into three types according to the products they produce, namely dairy farm, arable farm and vegetable farm. Then one big and one small farm are selected in each type. To identify big and small farm, experts working on each specific area are consulted. Other criteria are also considered, such as the possibility for farmers to share data or farmers' skill level in English, to finalise the six organic samples. Once the organic cases are determined, snowballing strategy is used to select conventional farms, mostly in close

[1] EKO is an organic certification given by authorities in the Netherlands.

proximity to the corresponding organic cases to make sure that the two cases are comparable in terms of the same type of soil, climatic condition, and similar planting scheme.

Quantitative data are collected from selected cases including accountancy data on farms (monetary cost and amount of inputs and outputs), and total working hours calculated from recorded wages from 2013 to 2015. Data from Agrimatie database[2] in the same period is also used to test the representativeness of the selected cases.

Under the sampling strategies, 12 farms are selected across the Netherlands. The characteristics of these cases are listed in Table 2-1 (average data over three years).

Table 2-1 Characteristics of selected Dutch farms

Farm type	Soil type	Milk cows	Area (ha) Grass	Area (ha) Arable	Yield/ha (kg)	Yield/cow (kg)
1a. Big Organic Dairy Farm	80%Peat	121	133[1]	0	4,937	4,642
1b. Big Conventional Dairy Farm	73%Peat	149	120	3	9,730	8,250
2a. Small Organic Dairy Farm	100%Clay	55	52	0	6,968	6,560
2b. Small Conventional Dairy Farm	100%Clay	67	38	6	12,169	8,127

Farm type	Main crops[2]	Area (ha)	Yield (ton/ha)	Farm information	Main crops	Area (ha)	Yield (ton/ha)
3a. Big	**Total**	**102.0**	**20.6**	**3b. Big**	**Total**	**113.0**	**33.8**
Organic	1 Consume potato	34.7	33.2	**Conventional**	1 Consume potato	41.5	40.7
Arable	2 Onion	14.5	59.2	**Arable**	2 Onion	11.9	87.1
Clay Soil	3 Wheat	21.9	5.3	**Clay soil**	3 Wheat	32.0	9.0
4a. Small	**Total**	**62.0**	**17.3**	**4b. Small**	**Total**	**47.0**	**34.7**
Organic	1 Consume potato	9.4	40.2	**Conventional**	1 Consume potato	12.2	54.5
Arable	2 Onion	7.9	50.5	**Arable**	2 Onion	8.8	53.9
Clay soil	3 Wheat	11.0	4.8	**Clay soil**	3 Wheat	9.5	8.1
5a. Big	**Total**	**75.0**	**24.5**	**5b. Big**	**Total**	**50.0**	**56.5**
Organic	1 White Cabbage	6.4	39.7	**Conventional**	1 White Cabbage	5.0	72.3
Vegetable	2 Spinach	13.4	15.9	**Vegetable**	2 Spinach	11.0	47.3
Clay soil	3 Kale	3.0	10.2	**Clay soil**	3 Kale	5.1	28.3
6a. Small	**Total**	**9.0**	**15.6**	**6b. Small**	**Total**	**14.0**	**27.8**
Organic	1 White Cabbage	0.2	17.3	**Conventional**	1 White Cabbage	0.3	53.3
Vegetable	2 Spinach	1.3	6.4	**Vegetable**	2 Spinach	2.8	17.1
Clay soil	3 Kale	1.1	7.7	**Clay soil**	3 Kale	1.8	16.1

1. 70 ha out of total 120 ha grassland is nature reserve land leased from the government.
2. Main crops refer to the crops selected as typical products of different farms to be compared between organic and conventional farming systems. This does not include all crops growing on each farm.

2.3 Energy input on farms in the Netherlands

a. Energy analysis

Energy analysis (also known as gross energy requirement) is a method to quantify the fossil energy requirements in the whole production process that allow a system to produce a given output. It concerns both the direct and indirect energy requirements for manufacturing a product, while the indirect energy use usually includes the energy requirement of production, transportation of the inputs, and the energy use of capital goods (Wilting, 1996). To calculate

[2] The Agrimatie database is financed by the Dutch Ministry of Economic Affairs, and it is administered by Wageningen Economic Research. The database combines the best available data sources and presents long-term developments on hundreds of indicators on themes like agricultural trade, farm income, environmental impacts, employment and prices. Most of the data are farm level data, of both organic farms and conventional farms.

energy requirements, appropriate energy equivalents of different types of inputs are adopted to examine the accumulated fossil energy used along the production chain. Normally, the energy equivalent of fossil fuel is regarded as the sum of its heating value and the fossil energy used to make it available in the production. For others, the energy equivalent is calculated by the amount of fossil energy consumed for making them available (Markussen & Østergård, 2013). In this study, the energy analysis offers an approach to compare the energy requirements of organic farming and conventional farming for food production.

b. System boundaries

The aim is to compare organic and conventional farming systems vis-à-vis energy use for production (from raw materials to farm-gate) so that the system boundaries of farming are limited to the production activities on farms. Energy use during this stage can be categorised as direct energy use like the input of diesel, electricity (gas is not included because it is usually only used for home heating in the Netherlands, not for production), indirect energy use for producing seeds, fertiliser (synthetic fertiliser used on conventional farms, while organic fertiliser on organic farms), crop protection (pesticides used on conventional farm while others used on organic farms), machines, and buildings, as shown in the flowchart of Fig. 2-2.

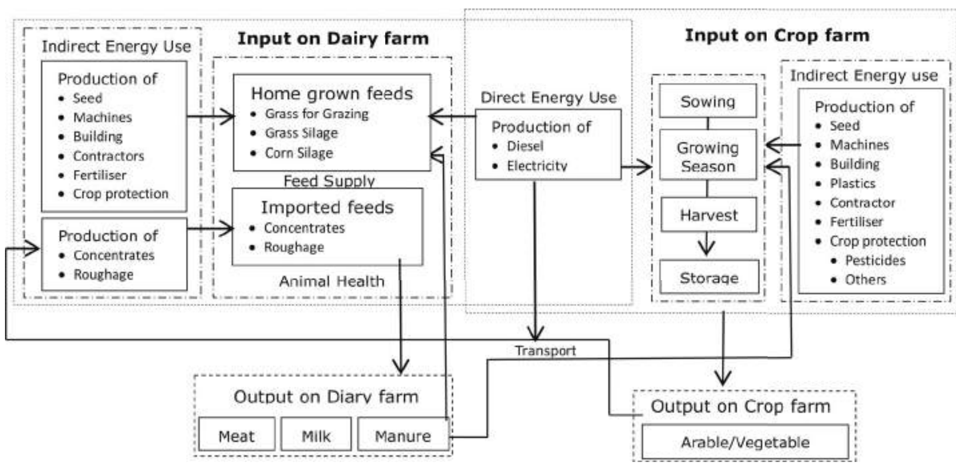


Fig. 2-2 Flowchart of energy use on farm in the Netherlands

Labour work could be a source of energy use on farms, however it is not included in the system. During the production process, farmers have to be fed, dressed, and housed, etc. and hired workers have to consume food and other services as well. However, it's very difficult to divide the purchase for work and for private consumption. While in this study, as production and consumption are strictly separate processes, energy analysis only concerns production, thus energy used by labour concerning both production and consumption is not included.

Some on-farm processes are not listed because the inputs can usually be regarded as other forms of energy flow into farm, for example, irrigation. Considering that water usually comes from canals nearby the field in the Netherlands, only a pump is needed for watering. Hence, the energy consumption of irrigation only concerns diesel for the production and operation of the machine. Other inputs that have a minor influence on the total energy use are also excluded, for example, bedding materials for cows, washing detergents, disinfectants for stables, etc.

Buildings and machines are also important sources of energy consumption on farms, even though they are not easy to be quantified. Normally the depreciation data is accessible for calculating in this case, but the situation varies from different farms as buildings and machines may not be depreciated in the same period, making it incomparable among different farms. In this study, the depreciation data of buildings and machines on each farm is collected, and it is corrected using the standard cost data from Kwantitatieve Informatie veehouderijand and Kwantitatieve Informatie Akkerbouw en Vollegrondsgroenteteelt[3], in order to close the gap between accountancy data and the reality on the farms, and finally, to make the data from each farm comparable.

The function unit in the production system is important in an energy analysis, especially in this study focusing on comparing energy use between organic and conventional farms. In this study, energy input per ha is computed at first on arable and vegetable farms. As the land size of different dairy farms could be incomparable in reality, energy input per ha is not calculated for dairy farms. Other than that, a unit based on yield is also used, especially considering the yield gap between conventional and organic farming systems (Bos et al. 2014; De Ponti et al., 2012; Gomiero et al., 2008; Stockdale et al., 2001). In this study, '*one tonne of fat and protein corrected milk*'[4] is selected as a unit for dairy farms (Blok & Spek, 2016), while for arable and vegetable farms, *one' tonne of crops produced during one annual growing season*' is applied.

c. Quantification of energy use

With each process of on-farm production being analysed and key factors being identified, the input and output data collected on farms are processed further in preparation for calculation. To obtain the final result, energy equivalents referenced from the literature are used, as it is almost impossible to conduct a separate energy analysis for each input. In this study, the energy equivalents of different inputs are collected either from the literature or related experts in the Netherlands (see Table 2-2).

As there are usually by-products of the output on farms, for example, meat and manure on dairy farms, input-output analysis should be used technically to allocate the energy use according to the economic values of different outputs. Usually the allocation among all output products is based on their shares in the total farm income (Thomassen, 2008).

d. Results and discussions

As shown in Fig. 2-3, energy use per ha land on organic arable and vegetable farms is generally lower than that on corresponding conventional farms. Specifically, energy consumed by fertiliser and crop protection is much higher on conventional farms than on organic farms, which can mostly explain the great gap in energy input per ha between these two farming systems. For different farm size, energy input per ha on big organic farms is generally lower than that on small organic farms.

[3] Kwantitatieve Informatie Veehouderij is statistical information of livestock farming in the Netherlands, published annually. The costs listed in the book are the average or standardized data of the country. Kwantitatieve Informatie Akkerbouw en Vollegrondsgroenteteelt is the statistical book for arable and vegetable farming.

[4] FPCM (kg) = raw milk (kg) * (0.337 + 0.116 * Fat content (%) + 0.06 * Protein content (%))

Table 2-2 Energy equivalents of inputs on Dutch farms (based on Bos et al. 2007, Bos et al., 2014)

Energy Carrier	Energy equivalent	Unit	References
Dairy farm			
Diesel	48.2	MJ/kg	Corré et al., 2003
Electricity	9.5	MJ/kWh	Corré et al., 2003
Fertiliser-N	41.8	MJ/kg	Cederberg & Flysjö, 2004
Fertiliser-P	12	MJ/kg	Dalgaard et al., 2001
Fertiliser-K	7	MJ/kg	Dalgaard et al., 2001
Concentrates[1]			
Standard protein-	6.3	MJ/kg	Hageman et al., 1994
Rich protein-	5.2	MJ/kg	Hageman et al., 1994
Extra rich protein-	3.9	MJ/kg	Hageman et al., 1994
Imported Roughage	2.7	MJ/kg	Hageman et al., 1994
Animal health	19.2	MJ/€	Hageman et al., 1994
Seeds	19.6	MJ/€	Hageman et al., 1994
Crop protection	19.2	MJ/€	Hageman et al., 1994
Contractor services	10.6	MJ/€	Hageman et al., 1994
Machines, depreciation	7.9	MJ/€	Hageman et al., 1994
Building, depreciation	9.7	MJ/€	Hageman et al., 1994
Crop farm			
Diesel	48.2	MJ/kg	Corré et al., 2003
Electricity	9.5	MJ/kWh	Corré et al., 2003
Fertiliser-N[2]	41.8	MJ/kg	Cederberg & Flysjö, 2004
Fertiliser-P[2]	5.2	MJ/kg	Dalgaard et al., 2001; Cederberg & Flysjö, 2004
Fertiliser-K[2]	5.8	MJ/kg	Dalgaard et al., 2001; Cederberg & Flysjö, 2004
Seeds	7.5	MJ/kg	Mombarg et al., 2004
Pesticides			
Herbicides	267.5	MJ/kg	Mombarg et al., 2004
Fungicides	176.0	MJ/kg	Mombarg et al., 2004
Insecticides	217.4	MJ/kg	Mombarg et al., 2004
Plastics	87	MJ/kg	Mombarg et al., 2004
Contractor services	2.2	MJ/€	Mombarg et al., 2004
Machines, depreciation	7.9	MJ/€	Hageman et al., 1994
Building, depreciation	9.7	MJ/€	Hageman et al., 1994

Diesel use for transporting manure[3]

Type of manure	Energy Equivalents	Unit	Distance of transportation	References
Semi-liquid manure	0.02	$L/km/m^3$	15 km	Mombarg et al., 2004
Solid manure	0.02	L/km/ton	20 km	Mombarg et al., 2004
Compost manure	0.0075	L/km/ton	100 km	Mombarg et al., 2004

1. Concentrates are categorised into three types on dairy farms according to different DVE content. Standard protein concentrates: 90<DVE<120; Rich protein concentrates: 120<DVE<180; Extra protein concentrates: DVE>180 (Hageman et al., 1994).

2. The energy equivalents of fertiliser on crop farm is different from that on dairy farm. this is referenced from Bos et al. 2007, as the references provided by Bos et al., 2014 cannot by verified.

3.Manure is generally not calculated as a source of energy consumption on farms, only its transportation and application, which consume diesel. As the application of manure is usually done by self-owned machines or hired contract services, the energy consumption of used diesel in this part has been calculated in the total diesel input or contract service part. So only diesel use for the transportation of manure is computed here.

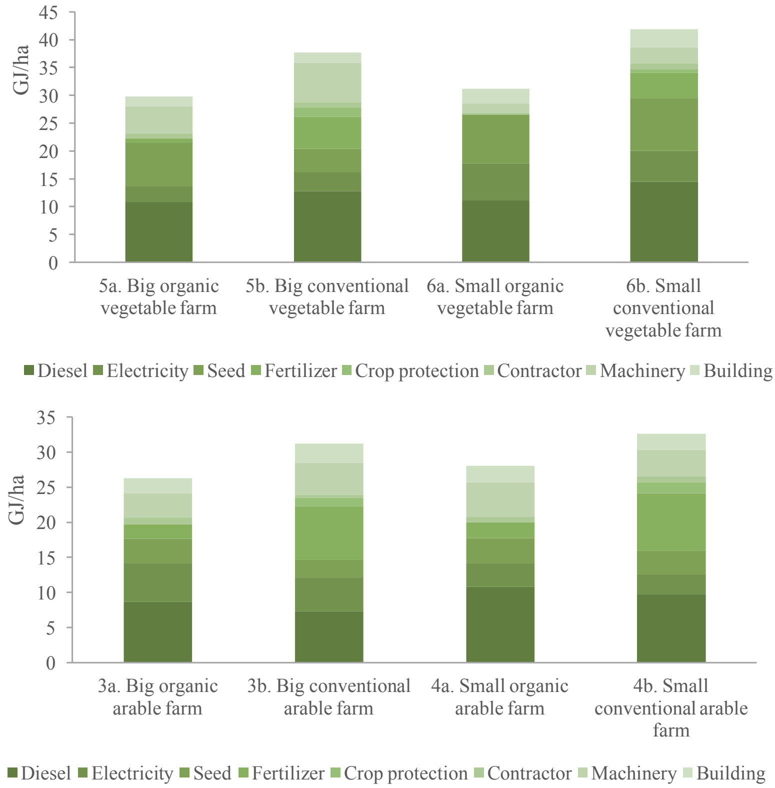


Fig. 2-3 Energy input (GJ/ha) on farm in the Netherlands

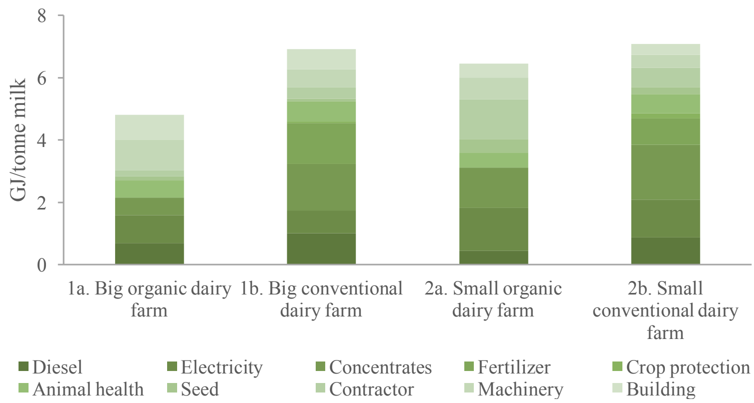


Fig. 2-4 Energy input (GJ/tonne milk) on dairy farms in the Netherlands

Fig. 2-4 shows that energy use per tonne FPCM (hereafter denoted as per tonne milk) on organic dairy farms is generally lower than on the corresponding conventional farms, while energy input on small organic dairy farms is higher than on big organic dairy farms for producing a certain amount of milk. On big dairy farms, the energy use is 4.8 GJ per tonne milk on organic farms, and 6.9 GJ per tonne milk on conventional farms, and for small dairy farms, the energy use is 6.4 GJ per tonne milk on organic farms, while 7.1 GJ per tonne milk on conventional farms.

When comparing the result with other studies, it shows consistency. Bos et al. (2014) reports energy use ranged from 4.4 to 5.5 GJ per tonne milk on organic farms, while from 5.9 to 7.6 GJ per tonne milk on conventional farms, increasing with the farm intensity. The slight difference between this study's result and that of Bos' study could be attributed to the dissimilar calculation of energy requirements of buildings and machines. Another study shows that energy use on Dutch dairy farms is 3.1 GJ per tonne milk for the organic and 5.0 for the conventional (Thomassen et al., 2008), but in which the energy use of producing seed, machines, and buildings is excluded. If these are included in the total energy use, the result could be close to that in this study.

For arable and vegetable production, energy use per tonne product on organic farms is generally higher than on conventional farms, but the gap between organic and conventional farming for producing vegetables is relatively small (see Fig. 2-5).

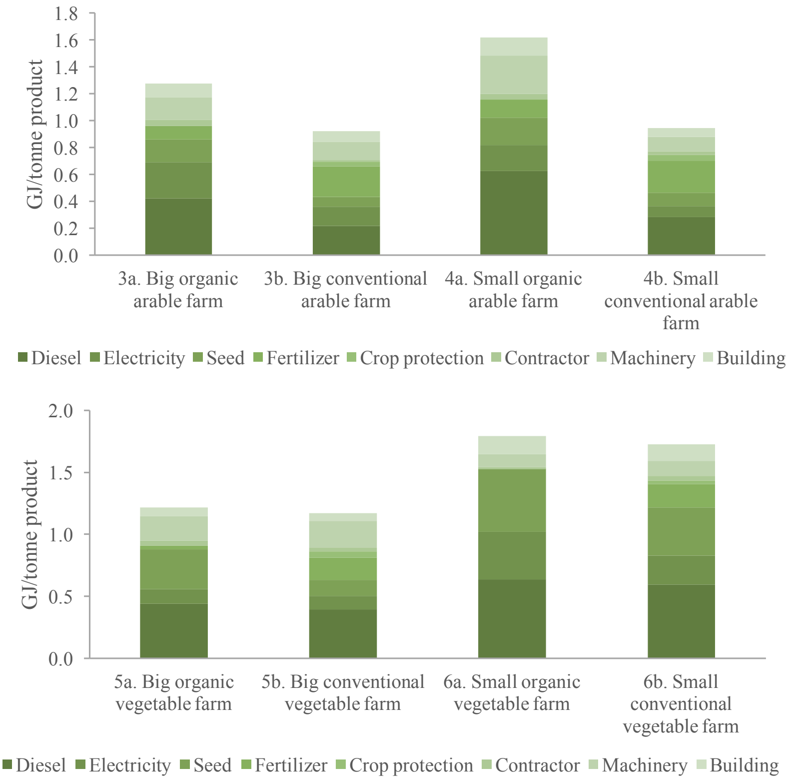


Fig. 2-5 Energy input (GJ/tonne product) on arable and vegetable farm in the Netherlands

Comparing the result of energy use per unit yield presented above with that from the literature, they are highly consistent. Bos et al. (2014) reports that energy use per unit product for growing organic sugar beets and peas was lower than conventional crops, but for other organic crops the energy use is higher. The high intensity level of the organic cropping system, and the large yield gap between organic and conventional crop production are the reasons for higher energy use per unit yield in Dutch organic crop production. Other studies, focusing on comparing organic and conventional crop production systems outside of the Netherlands, report that energy use per unit yield on organic farms is close or even lower to that on conventional farms (Deike et al., 2008; Loges et al., 2006; Hoeppner et al., 2006; Shepherd et al., 2003; Dalgaard et al., 2001).

As the results calculated under the two different function units show high degrees of inconsistency in energy use at farm level, it is necessary to discuss what kind of unit is more appropriate for comparing energy use between organic and conventional farming systems. Even though the result of energy use per ha on farms seems decent, some researchers point out that it is inappropriate to compare energy use between organic and conventional farming by land area, as organic farming has a much lower input as well as lower output per ha (De Ponti et al., 2012). It seems that the unit of output is better than that of land size. Apparently using energy input per tonne product as a unit is economically reasonable when the yield is regarded as the only output on the farm. However, as agriculture is not only about food production from a post-modern perspective (Ploeg and Renting, 2000), the environmental and social benefits contributed by organic farming should also be considered as part of the organic farming output in a rural-development model (Darnhofer, 2005). To quantify the real farm output, it is more appropriate to use monetary value, as the benefits of organic farming are normally compensated by the higher prices of the product. Thus, with the data of total energy input and monetary output of the products on farms (only output of milk is considered on dairy farms), the energy use per Gross Value of Product (GVP) on each farm should be computed.

Fig. 2-6 shows that the energy use for producing €1000 on organic farms is generally lower than that on conventional farms, except that the result on small organic arable farms is slightly higher. The energy consumed by the inputs of concentrates (on dairy farms), fertiliser, crop protection (including pesticides), and animal health (on dairy farm) contributes the most to the gap in energy use between organic and conventional farming systems. For farms with different activities, the energy use gap between organic and conventional arable farming is much smaller than that of dairy and vegetable farming. When considering farm size, energy use per GVP on small organic dairy farms is higher than on big organic dairy farms, while both the result between big and small organic arable farms, and the result between big and small organic vegetable farms changes to the opposite.

Evidently, the inconsistent results among farms with different activities and sizes require further discussion. Questions remain requiring further exploration: why is the gap of energy input between organic and conventional farming different among farms with different activities and sizes? Why is energy use on the small organic arable farm slightly higher than that on the small conventional arable farm? Is it the feature of different farming activities and farm sizes or the heterogeneity among individual farms that can explain the changeable results in energy gap? In Chapter 5, an exploratory study will be conducted to tackle these questions.

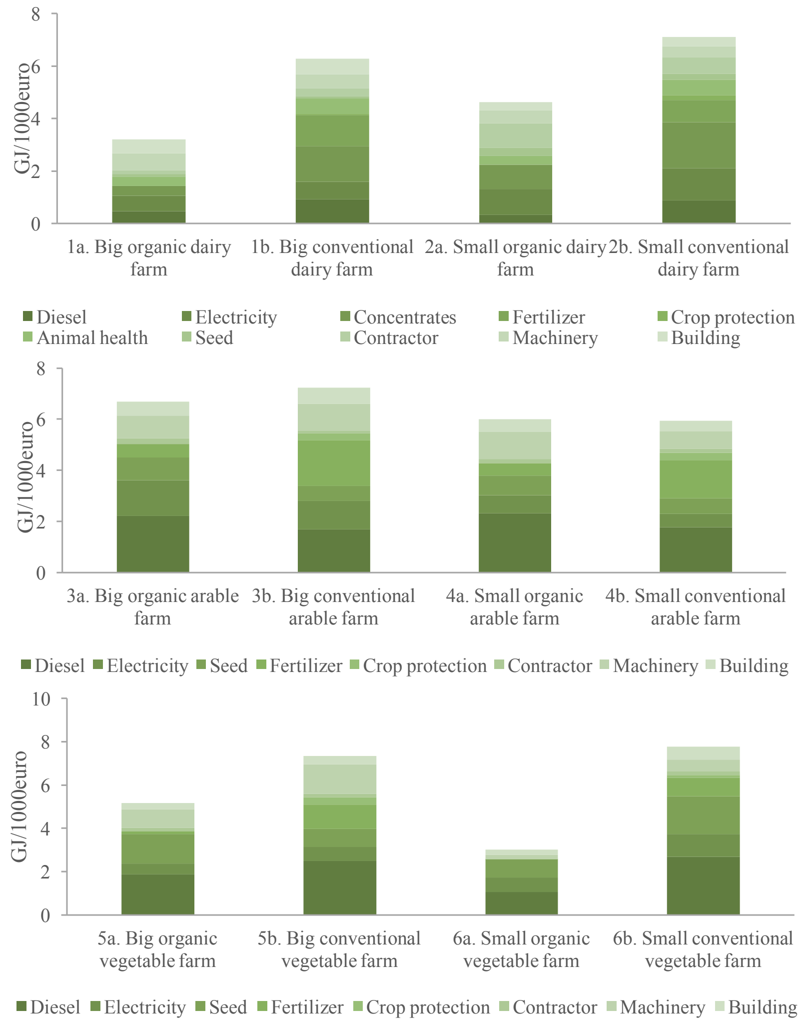


Fig. 2-6 Energy input (GJ/GVP) on Dutch farms

2.4 Labour input on farms in the Netherlands

Labour input on farms is defined as the work, manual or administrative, directly related to the cultivation or husbandry of animals and plants (Whatmore, 2016). To calculate the labour input on farms in the Netherlands, quantitative data is collected from accountancy of selected cases from 2013 to 2015. In order to make it accurate, qualitative data generated from interviews with farmers has also been taken into consideration. The labour input is ultimately quantified by the unit of hour, and categorised as four types, the working hours of family labour, permanent labour, temporary labour, and volunteer. Family labour normally refers to managers working in the farming enterprises or family members (husband, wife, and offspring) on family farms (which account for about 87% of the total number of Dutch farms[5]). Permanent labour usually

[5] FAO, 2013. http://www.fao.org/family-farming/countries/nld/en/ (accessed June 13, 2017).

refers to workers who are hired full time on a farm, while temporary labour refers to seasonal workers hired temporarily during busy periods. Volunteer work on a farm is usually unpaid or paid informally (e.g. with food or accommodation).

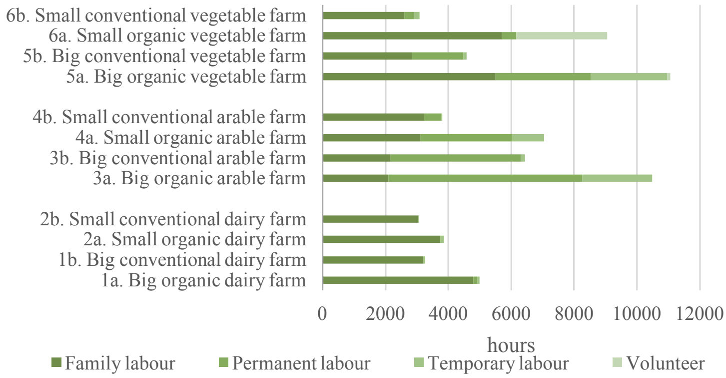


Fig. 2-7 Labour input (hours) on Dutch farms

Fig. 2-7 shows that labour input on organic farms is generally higher per year than on conventional farms, however, the gap varies among different farming activities. In the dairy sector, the labour input on organic farms is close to that on conventional farms, while for producing crops, the labour input on organic farms is seen to be much higher than that on conventional ones. Comparing labour input between organic farms of different sizes, the labour input on big dairy farms is similar to small organic ones, and on big arable farms it is higher than that on small ones, while on big vegetable farms it is lower than on small organic vegetable farms.

For the structure of labour input on farms, the working hours of family labour comprises more than 50% of the total input working hours on most of the selected farms, which means most of the selected cases are family farms according to FAO's definition[6]. However, arable farms, especially big conventional and big organic farms, have relatively low family labour input. According to qualitative data, these farms are managed as enterprises by managers other than family farmers. If the whole agriculture system is categorised into three modes, the big farms are entrepreneur agriculture or capitalist agriculture other than peasant agriculture (Ploeg, 2018), which may potentially affect the labour input on farms. The differences among different modes of agriculture in energy and labour use at farm level will be discussed further in Chapter 6. In addition, temporary labour input on organic arable and vegetable farms is much higher than that on the corresponding conventional farms, noting that on small organic vegetable farms volunteer labour replaces temporary labour.

Using the data of total labour input on farms, labour input per unit product, and per GVP can also be computed among all cases accordingly. As shown in Fig. 2-8 and Fig. 2-9, labour input on organic farms is always higher than on conventional farms, no matter which unit is used. For different farm sizes, small farms usually have a higher labour intensity than the corresponding big farms. For different farm activities, labour input on vegetable farms is generally higher than

[6] According to FAO, 'A farm is considered to be a family farm when at least 50% of total labour used at the farm originates from family labour'. http://www.fao.org/family-farming/countries/nld/en/ (accessed June 13, 2017)

on the other two types of farms. Thus, not surprisingly, the labour input on small organic vegetable farms is the highest, making it the most labour intensive farm of all.

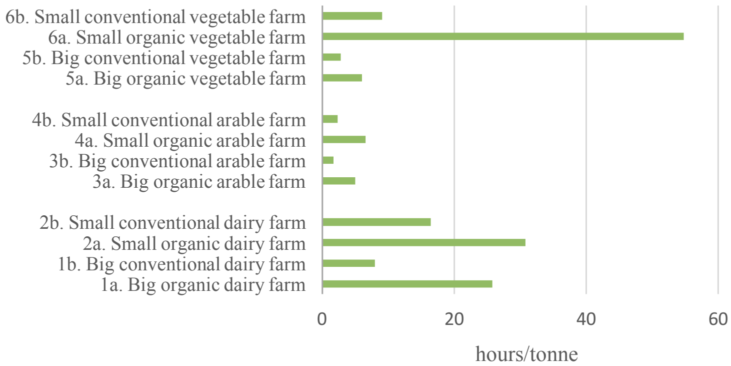


Fig. 2-8 Labour input (hours/tonne product) on Dutch farms

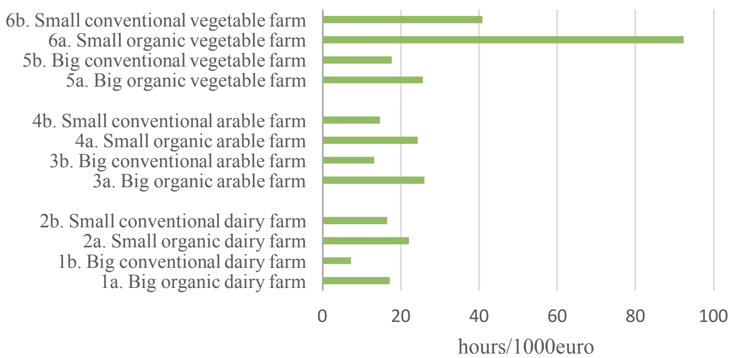


Fig. 2-9 Labour input (hours/GVP) on Dutch farms

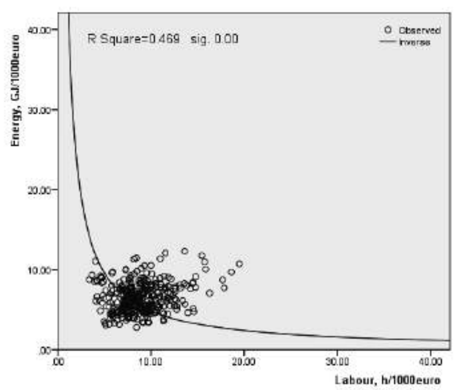
2.5 Representativeness of the selected cases

To test the representativeness of the selected cases in this study, farm-level data from Agramatie database[7] is used to calculate the energy and labour input per GVP (€1000) on each farm. Based on the variables of farming activity and farm size in both organic and conventional farming systems, all the samples are categorised into 12 groups to correspond to the 12 selected cases in the Netherlands. Finally, non-linear regression curves of the 12 different categories are estimated on IBM SPSS Statistics 23 by using the inverse model.

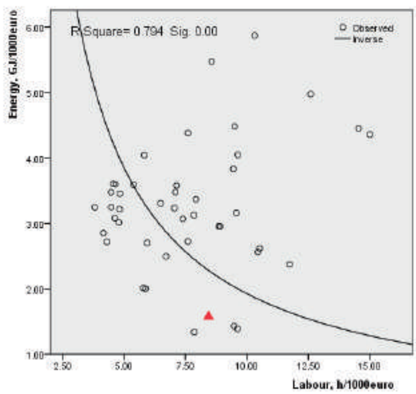
The results of curve estimation are shown in Fig. 2-10. All the 12 curves can explain more than (or close to) 50% of the sample, and the results are significant. It can be seen that the triangles, representing the selected cases in this study, are all close to the corresponding estimated curves, which means the selected cases are positive in representing their sample.

[7] The Agrimatie database is financed by the Dutch Ministry of Economic Affairs, and is administered by Wageningen Economic Research. The database combines the best available data sources and presents long-term developments on hundreds of indicators on themes like agricultural trade, farm income, environmental impacts, employment and prices. Most of the data are farm-level data from both organic farms and conventional farms.

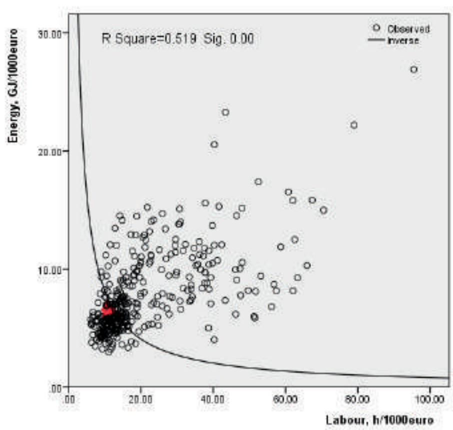
Energy and Labour input per GVP on Big Conventional Dairy farm



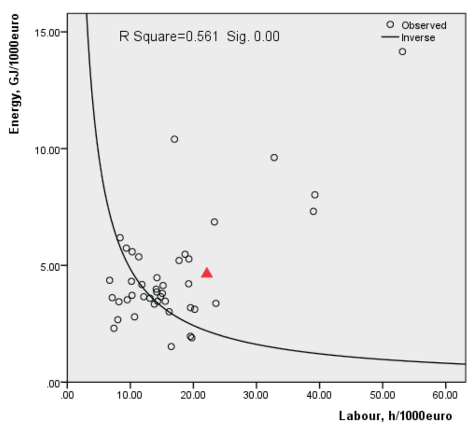
Energy and labour input per GVP on Big Organic Dairy farm



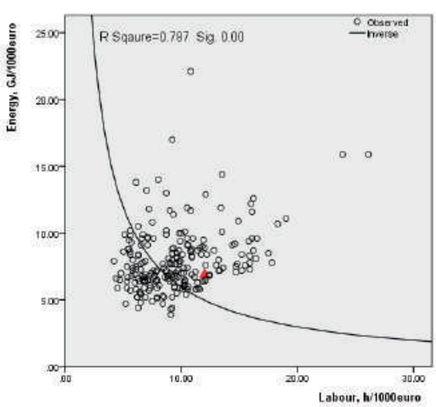
Energy and labour input per GVP on Small Conventional Dairy farm



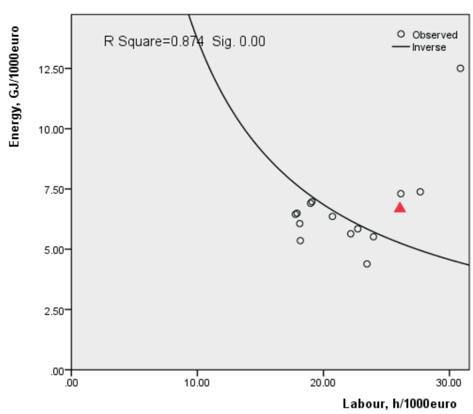
Energy and Labour Input per GVP on Small Organic Dairy farm



Energy and Labour input per GVP on Big Conventional Arable farm



Energy and Labour input per GVP on Big Oragnic Arable farm



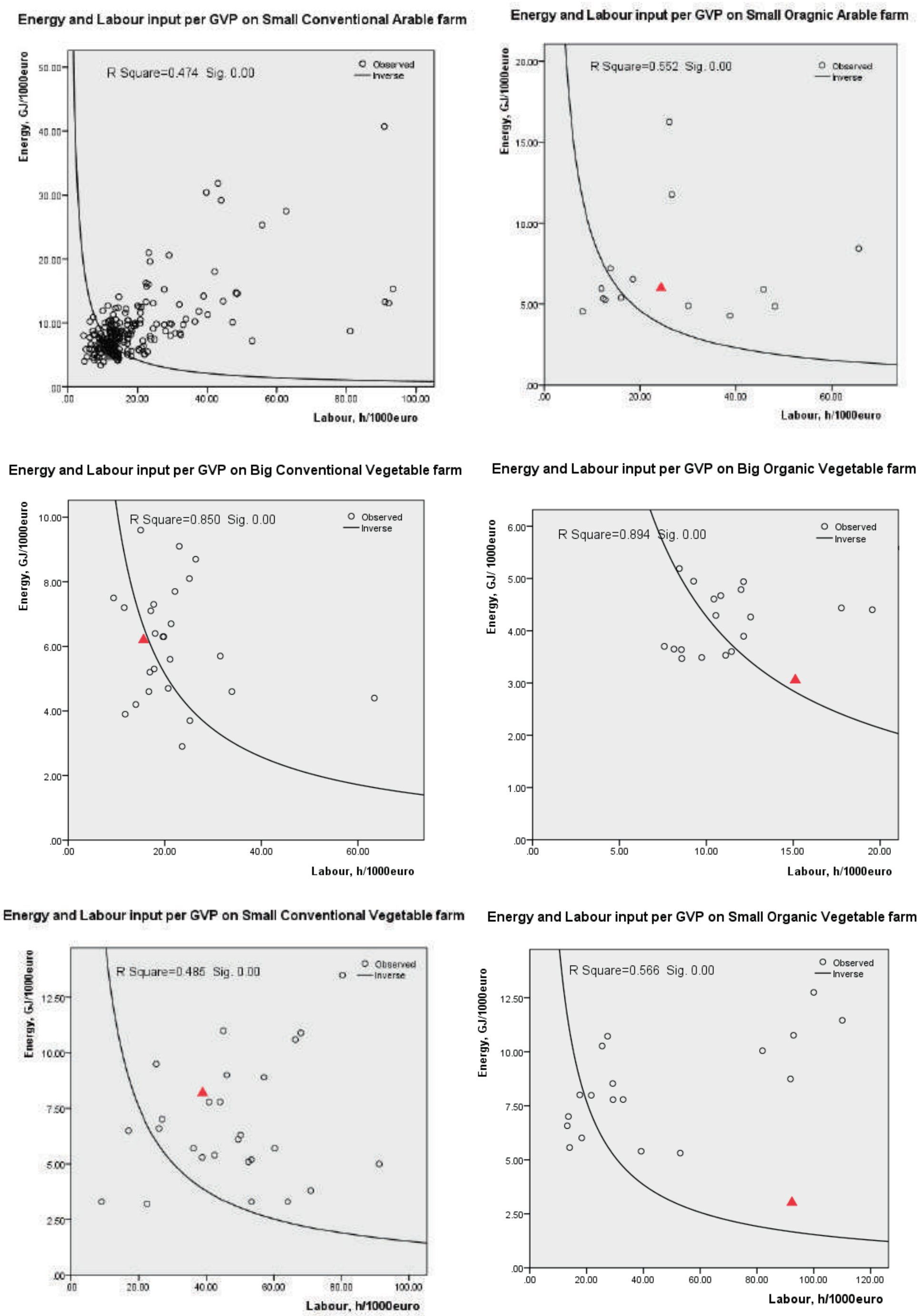


Fig. 2-10 Representativeness of the selected cases in the Netherlands

2.6 Balance and substitution of energy and labour input on Dutch farms

After analysing energy and labour input on Dutch farms separately, it can be summed up that organic farming uses less energy and more labour than conventional farming in general for producing one unit GVP (see Fig. 2-11). However, the question of how the increased labour input on organic farms substitutes the decreased energy use still needs to be answered.

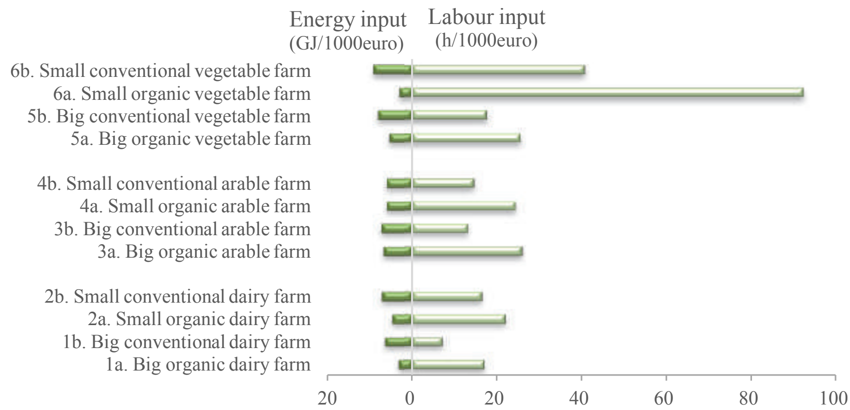


Fig. 2-11 Energy and labour input balance on Dutch farms

When energy and labour are regarded as two basic resources, it is possible to compute the requirement of energy and labour for agricultural production from raw material to product at farm gate, and they are then defined as 'added energy' and 'added labour' (de Wit, 1975). Added energy (AE), or added labour (AL) includes the total amount of energy or labour used on the farm, the energy or labour used in the production of all inputs (off-farm) and transportation. As the calculation of energy input on the farms above basically covers all these three parts of energy consumption, the result from the energy analysis can be determined as 'added energy'. However, the on-farm labour input calculated above excludes the labour used for the production of all inputs (off-farm labour input). To calculate added labour, de Wit (1975) assumes that the indirect (off-farm) labour use is the same as the direct (on-farm) labour use, which, however, may not be applicable for this study, as the structure of factor (labour, rent of capital) and non-factor (products and services input) costs on organic farms is different from that on conventional farms. In order to calculate added labour, the indirect labour use on farms is estimated according to the proportion of the non-factor cost within in the total cost with respect to each farm in this study[8].

Usually different input mixed with varied added energy and added labour combinations would lead to different yields on farms, which is crucial for the substitution analysis between energy and labour. However, in reality, agricultural production can be influenced by almost every single process and condition on the farm, for example, seed quality, elements of ploughing, application of fertiliser, control of water and pH in soil, control of disease, handling after harvest, etc. Hence, different growth factors within the production process should be discussed to determine their effect on the yield, so that different input functions can be generated to characterise various

[8] As the accuracy is limited in the data of added labour, especially in the off-farm labour input, there could be issues of uncertainty in the results. This is also why de Wit's theory has not been widely applied in other researches (Stanhill, 1984).

input bundles and the substitution between those inputs. For further analysis, I examine two extreme situations to include to what extent energy and labour cannot be substituted for each other. One is the minimum amount of added energy required for a given yield when labour is abundantly available ($AE_{L>}$), and the other is the minimum amount of added labour input for a given yield when energy is abundantly available ($AL_{E>}$).

Theoretically, it is possible to harvest something with only labour input on farm, but it is almost impossible to get output if there were no labour input. This means that the input function curve of $AE_{L>}$ does not pass through the origin, while that of $AL_{E>}$ does. However, to get higher yield, the resources from outside should be used to improve the soil fertility. These could be fertiliser or machinery, which are rich in added energy. But after obtaining a median yield, the inputs used for higher output level become less energy intensive. Thus, the input function of $AE_{L>}$ steepens first and then levels off toward the end. For the other perspective, other than the necessary labour input on the farm, the development and use of other inputs require labour input as well. That is why the input function of $AL_{E>}$ gets steep as the yield increases.

When looking back to the energy input data presented previously in this chapter, on one hand, the energy use of mechanised operation (machines, contractor) occupied a big part of the total energy input on farms, especially on organic ones. On the other hand, the yield increasing inputs like fertiliser and concentrates (on dairy farm) consume most of the energy on conventional farms. Hence, $AE_{L>}$ on different farming systems can be estimated according to the percentage of yield-increasing energy consumption in different cases. As it is impossible to automatise farm work to the fullest, the required minimum amount of added labour with unlimited access to added energy for a certain yield is estimated to reduce half of the total added labour.

As the minimum amount of added energy and labour are substitutable with unit elasticity, the production function can be written as,

$$(AE-AE_{L>})\ (AL-AL_{E>})=\text{Constant} \qquad (1)$$

in which AE and AL represent all input bundles of added energy and added labour required for a given yield, and $AE_{L>}$ and $AL_{E>}$ are the minimum amounts of added energy and added labour when there is unlimited access to the other one.

With function (1), the marginal rate of substitution (MRS), or the slope of the function can be written as,

$$\frac{dAE}{dAL}=\frac{AE-AE_{L>}}{AL-AL_{E>}} \qquad (2)$$

so MRS of each farm selected in this study can be computed.

Even though a unit based on GVP is more appropriate than yield (tonne) for comparing organic and conventional farming systems as discussed previously, the calculation of the MRS does not change no matter which unit is used. This is because in function 2 the unit per tonne cancels out both in the numerator and the denominator, making the calculation of MRS irrelevant to the yield.

If the results of the MSR are visualised on the Isoquant curve which represents the same level of agricultural output, all the farms would be located at different points on the curve. Fig. 2-12 illustrates the position of each farms on the equal product curve. The results of calculation and visualisation show that the MRS on organic farms is generally lower than that on conventional farms, and it is lower on small farms than that on big farms. This means that there is a great difference in the slope of the substitution curve between added energy and added labour input: at the decreasing labour input (due to increasing labour prices for instance), the degree of energy input on conventional farms increases much faster than that on organic farms. When looking at organic farms of different sizes, if the labour input reduces, the degree of energy input on big farms increases much faster than that on small farm. Specifically, one unit labour input change could replace 198.2 GJ energy on a big organic dairy farm, while it could replace 477.0 GJ energy on a big conventional dairy farm. On a small organic dairy farm, one unit labour input change could substitute 190.2 GJ energy, which is lower than that (198.2 GJ) on a big organic dairy farm.

Comparing different farming activities, the MRS on vegetable farms is generally lower than on the other farms, and a small organic vegetable farm has the lowest MRS. This means that for labour intensive farming activities like vegetable cultivation, decreasing one unit labour input results in the lowest increase of energy input for achieving the same level of output, compared with dairy and arable farming.

In practice, the result of MSR means that when labour input has to decrease for reasons like high labour prices or low labour availability, organic farms would need much less energy input to substitute the declining labour use than conventional farms. Small, organic vegetable farms would require the least energy use to replace the same amount of labour use, possibly making them the most sustainable in terms of fossil energy consumption.

Table 2-3 Marginal substitution ratio (MSR) between energy and labour input on Dutch farms

Cases	AE MJ/ton	AL h/ton	$AE_{L>}$ MJ/ton	$AL_{E>}$ h/ton	MSR MJ/h
1a. Big organic dairy farm	4,809.7	35.9	1,250.3	18.0	198.2
1b. Big conventional dairy farm	6,906.9	13.9	3,582.0	7.0	477.0
2a. Small organic dairy farm	6,447.4	44.6	2,207.0	22.3	190.2
2b. Small conventional dairy farm	7,081.3	26.4	3,590.7	13.2	264.4
3a. Big organic arable farm	1,277.0	7.2	270.9	3.6	279.8
3b. Big conventional arable farm	923.1	2.7	336.4	1.4	428.6
4a. Small organic arable farm	1,620.2	9.5	337.7	4.7	270.4
4b. Small conventional arable farm	946.1	3.8	381.0	1.9	299.0
5a. Big organic vegetable farm	1,217.9	8.8	350.8	4.4	196.4
5b. Big conventional vegetable farm	1,168.8	4.5	361.9	2.2	362.5
6a. Small organic vegetable farm	1,792.8	68.5	504.3	34.2	37.6
6b. Small conventional vegetable farm	1,724.9	12.2	605.2	6.1	183.2

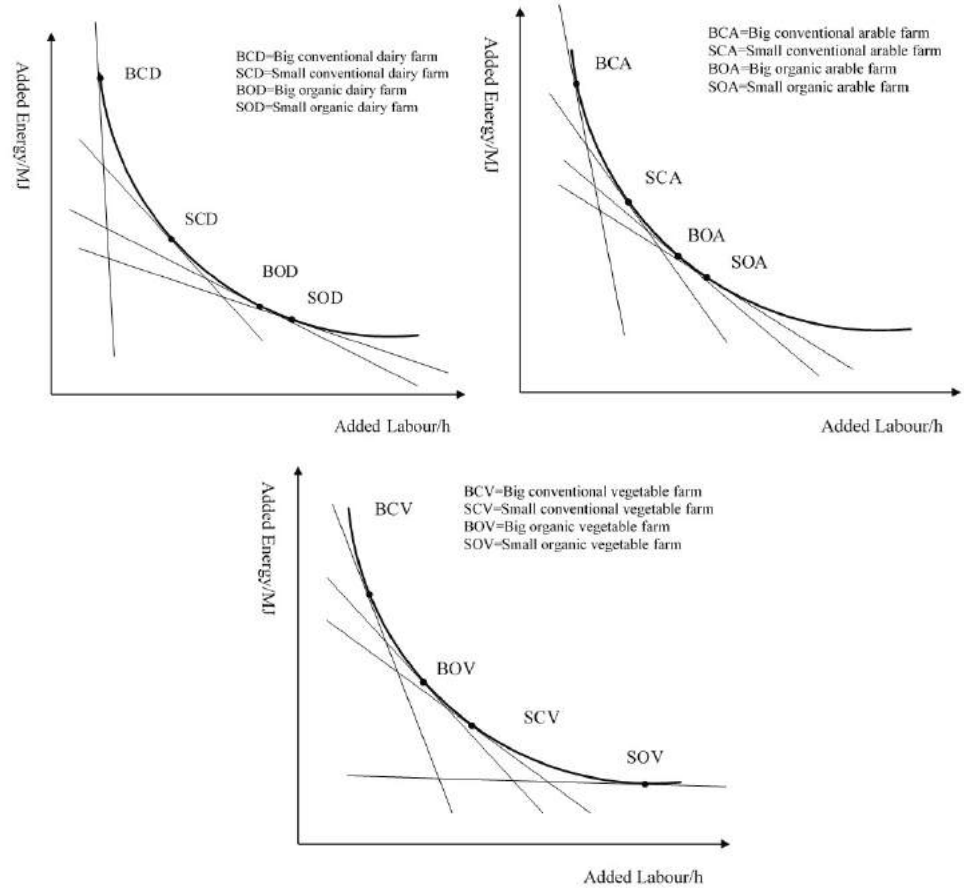


Fig. 2-12 Dutch farms' position on an isoquant curve for producing certain amount of outputs

2.7 Conclusions

This chapter first calculates the energy and labour input on Dutch farm independently. The energy analysis on Dutch farms shows that energy input per ha on organic farms is generally much lower than that on conventional farms, while energy use per tonne product on organic farms is much higher than on conventional farms. This result is consistent with what is reported in the literature. However, this chapter argues that neither the unit of land size nor the unit of yield is appropriate for comparing energy use between organic and conventional systems. Thus, the unit *gross value of product* (GVP) is introduced, and with it we can conclude that for producing a certain GVP, energy use on organic farms is lower than that on conventional farms. When considering farms with different activities and sizes, the results of energy use among different farms do not show consistency. This will be discussed further in Chapter 5. The calculation of labour input on Dutch farms shows that organic farms use more labour than conventional farms no matter the unit of yield nor the unit of value. When analysing the structure of labour input, most farms use more family labour than hired labour, but the result changes when it comes to arable farms. The reason behind this would also be discussed further in Chapter 5 with qualitative data.

When combining the results of energy analysis and labour input calculation, the input balance and substitution between energy and labour among different farms are presented. It can conclude that organic farms generally use more labour and less energy than conventional farms for producing a certain GVP. When introducing the analysis of farms' added energy and added labour, the results of the marginal substitution ratio between energy and labour use show that decreasing labour use on organic farms can possibly result in less increase of energy use compared with conventional farms. This means that organic farms have great potential in achieving sustainability through the reduction of fossil energy use in agricultural production.

Chapter 3

Energy and Labour Input Balance on Farms in China

3.1 Introduction

Since China's opening and reform of the early 1980s, its economy has been growing steadily for decades. In the agricultural sector, production increased rapidly during the past years due to the wide application of synthetic fertiliser and pesticides (Yu & Zhao, 2009). According to statistical data, synthetic fertiliser input increased from 1.27 million tonnes in 1980 to 6.02 million tonnes in 2015, while pesticides input went up from 0.73 to 1.78 million tonnes from 1990 to 2015, making China the biggest consumer of both fertiliser and pesticides in the world (China Rural Statistical Yearbook, 2016).

The elevated use of chemicals in China has brought negative externalities. According to the literature, the efficiency of using chemical fertiliser in China is only about 33% (Cheng et al., 2010; Wu, 2011), while the number for pesticides is estimated to be 35% (Ministry of Agriculture, 2015), and they are believed to be the major sources of non-point pollution in rural areas. The eutrophication of water, acidification of farmland, and contamination of farm products have been proved to be closely related to the chemical overuse in the agricultural sector (Le et al., 2010; Guo et al., 2010; Qu et al., 2011; Sun et al., 2012).

As the production of fertiliser and pesticides consumes mainly coal, natural gas, and oil, agriculture production in China has a high dependency on fossil energy nowadays, making it vulnerable to an energy crisis (Li, 2007a). In 2006, the production of nitrogen fertiliser in China consumed about 18.7%, 22.1% and 2.3% of the nation's total consumption of natural gas, coal, and electricity, and the data show a rising trend (Cheng et al., 2010). The fossil energy use for nitrogen production in the industry accounted for about 3.9% of the total fossil energy production in 2008, and 3.5% of the total consumption[9] (Li, 2007b; Cheng et al., 2010). According to the research of China-UK Sustainable Agriculture Innovation Network (SAIN), agriculture and agro-chemical industries in China account for about 15% of its total fossil energy consumption and 20% of total greenhouse gas emissions[10].

With the exposure of environmental issues and the development of international movements, organic farming has been promoted since the last decade of the 20th century in China, and it is believed to be environmentally friendly because pesticides and synthetic fertilisers are forbidden on organic farms. However, the production of organic food in China has mostly been oriented to export since then (Bekele et al., 2017). At the beginning of the 21st century, several food safety crises occurred as another consequence of the rapid development of China's economy. One example is the melamine-tainted milk scandal of 2008. Fearing unsafe food, people – especially the rising middle class in China – started to seek safe and healthy organic food (Shi et al., 2011). With the decrease of consumers' trust in the conventional food system, different alternative food networks (AFNs) emerged in 2008, including community supported agriculture, organic farmers' markets, and so on (Shi et al., 2011; Wang et al.,, 2015; Si et al., 2015). Organic farming within these AFNs has become popular nowadays in China for its environmental benefits and value of producing healthy food.

[9] Fossil energy production and consumption are calculated by total production of primary energy (2.6 billion tonnes of standard coal) and total consumption of primary energy (2.85 billion tonnes of standard coal) in 2008, in which 1 kg of standard coal equals 29.3 MJ.
[10] See the website of SAIN http://www.sainonline.org/pages/projects/lowcarbonc.html (accessed June 20, 2018)

The application of organic principles in agricultural production could potentially reduce the dependency on fossil energy, however, it simultaneously increases labour input for weeding and other on-farm work. This raises questions about the energy and labour input balance on organic farms, and how it is different from conventional farms. This question is crucial for achieving sustainability in agricultural production. In addition, how variables like farming activity and farm size can influence the energy and labour input balance on farms could also be important in the transition to sustainable food production.

To answer these questions, this chapter first analyses energy and labour input on organic and conventional farms in China independently. These farms include different farming activities, dairy, arable and vegetable farm, and different size – big or small in either livestock or land area, in order to find out how farming activity and farm size could affect energy and labour input. Then the results of energy and labour input analysis are combined to discuss the input balance of these two resources used on different farms.

3.2 Methodology

A case study is used to compare energy and labour input between conventional and organic farms, and 12 cases with different farming activities (dairy, arable or vegetable), and farm size (big or small size in livestock or land area) are sampled in North China (see Fig. 3-1).

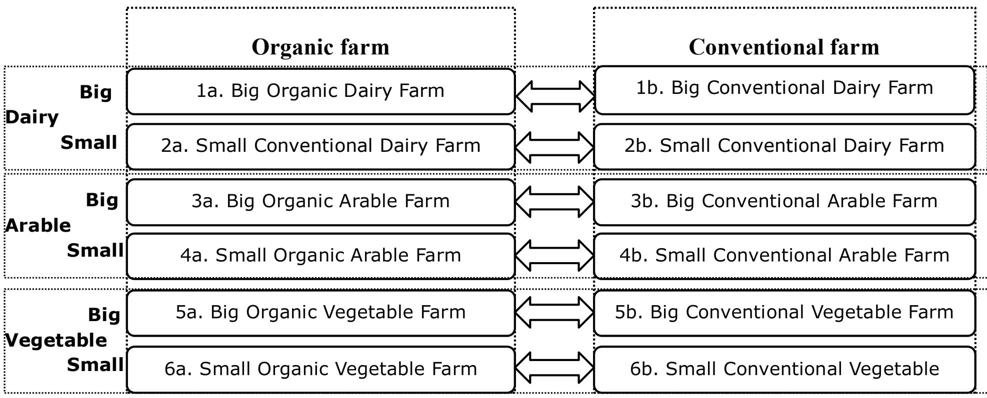


Fig. 3-1 Selected cases among Chinese farms

The sampling began by identifying organic farms. Besides farms certified by authorities, farms under Participatory Guarantee Systems (PGS) were also considered because they incorporate organic principles into their farming practices . A purposive sampling strategy was used to select the six organic cases under the criteria of farm activities (dairy, arable and vegetable), farm size (consulting professionals), farm location (mainly North China plain), farmer's availability and willingness to support the research, and so on. After the organic cases were selected, the snowballing strategy was used to choose the corresponding conventional cases which were usually the neighbouring farms.

The 12 cases selected in this study are located in the North China plain and include Henan, Beijing, Hebei, and the southern part of Inner Mongolia (see the map in Fig. 3-2). The characteristics of these farms are listed in Table 3-1.

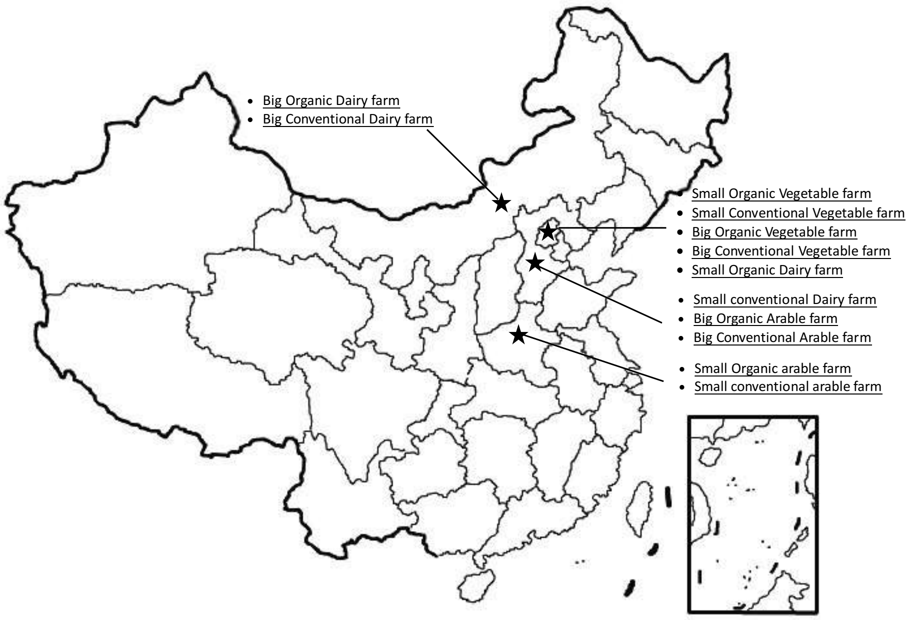


Fig. 3-2 Map of the selected cases in China

To make the organic and conventional cases comparable, the farm size of the selected conventional cases is close to that of organic cases. This is why the conventional farm size, especially the size of small farms, is much larger than the average Chinese farms. For organic farms, there is no statistical data available for identifying the average farm size. In this study the big and small organic farms were selected by consulting experts in China. The farm size of the selected organic cases is relatively big, because most of the organic farms were built and certified with the support of the government. Moreover, as the certification fee is high, only large farms or companies with capital could afford it. For organic farms under PGS, the farm size is also growing due to the increasing demand for organic food.

Data collected from the selected cases include both quantitative and qualitative data. The quantitative data basically covers the accountancy data, including all the costs and amount of input and output on the farm, or data acquired from interviews when there was no accountancy data available. The qualitative data was collected through semi-structured interviews with farmers in which questions related to farming practices and input strategies were asked. In addition, data from the annual publication *Compilation of Data on Costs and Profits of Agricultural Products 2016* was used to calculate the average energy and labour input on both national and provincial levels to compare with the results achieved from the selected cases in this study, in order to test if the selected cases are outliers or not.

Table 3-1 Characteristics of selected cases in China

Farm information	Soil	Milk cows[1]	Area: Grassland	Area: Arable land	Yield/cow (kg)
1a. Big organic dairy farm (CERTIFIED)	Clay	600	258	209	8,000
1b. Big conventional dairy farm	Clay	680	0[2]	130	8,500
2a. Small organic dairy farm (CERTIFIED)	Clay	350	666[3]	128	8,400
2b. Small conventional dairy farm	Clay	300	0[2]	67	8,700

Farm information	Main crops	Area (ha)	Yield (ton/ha)	Farm information	Main crops	Area (ha)	Yield (ton/ha)
3a. Big organic arable farm (PGS) Clay soil	**Total**	**20.0**	**4.5**	**3b. Big conventional arable farm Clay soil**	**Total**	**20.0**	**6.0**
	1 Wheat	7.0	6.0		1 Wheat	6.5	7.5
	2 Maize	3.0	4.5		2 Maize	7.0	6.7
	3 Soybean	5.3	2.2		3 Soybean	6.0	3.0
4a. Small organic arable farm (PGS) Clay soil	**Total**	**6.0**	**3.9**	**4b. Small conventional arable farm Clay soil**	**Total**	**3.3**	**5.6**
	1 Wheat	2.6	5.2		1 Wheat	1.0	6.3
	2 Maize	0.8	4.3		2 Maize	0.7	6.0
	3 Soybean	1.7	2.6		3 Soybean	1.3	3.7
5a. Big organic vegetable farm (CERTIFIED) Clay soil	**Total**	**26.7**	**86.1**	**5b. Big conventional vegetable farm Clay soil**	**Total**	**20.0**	**127.5**
	1 Tomato	6.6	150		1 Tomato	5.2	187.5
	2 Cucumber	5.4	112.5		2 Cucumber	4.0	202.5
	3 Pepper	5.6	82.5		3 Pepper	5.0	112.5
6a. Small organic vegetable farm (PGS) Clay soil	**Total**	**6.7**	**47.8**	**6b. Small conventional vegetable farm Clay soil**	**Total**	**4.0**	**77.5**
	1 Tomato	0.9	120.0		1 Tomato	1.2	145.0
	2 Cucumber	0.5	97.0		2 Cucumber	0.6	120.0
	3 Pepper	0.4	64.0		3 Pepper	0.7	90.0

1. The dairy farm size in China is changing due to governmental regulations implemented after the milk scandal happened in 2008. According to statistics from China Dairy Statistical Summary 2017, less than 20% of dairy farms in China had over 100 cows in 2008, but the number reached 53% in 2017, and in 2015 dairy farms with more than 1000 cows comprised nearly 15% of the total dairy farms in China.
2. Most of dairy farms in China don't have self-owned grassland for grazing. They usually buy grass silage from farmers who own grassland, or import from overseas.
3. This is the size of a piece of natural grassland in Inner Mongolia which provides silage to the small dairy farms directly.

3.3 Energy input on farms in China

a. Energy analysis

To quantify the fossil energy requirement for agricultural production, energy analysis is used to include both direct and indirect energy flow into the process of on-farm activities (from raw material to farm gate) (Wilting, 1996). Usually system boundaries of on-farm production should be determined first so that different inputs can be identified and clarified for energy calculation. Once the boundaries have been established, the energy equivalent, a coefficient of accumulated fossil energy use per unit of on-farm input, is developed to quantify the total energy use of all inputs within the farming system.

b. System boundaries and function units

The purpose of this study is to find out the energy use of on-farm production so that the system boundaries can be demarcated from the import of raw materials to the export of the agricultural product. The flowchart in Fig. 3-3 can basically cover all the energy that flows in the production process on dairy, arable and vegetable farms. The energy is categorised into direct energy use like diesel, electricity, coal, and indirect energy use for producing various inputs like fertiliser, pesticides, machines, and buildings. It is necessary to explain in detail why some farm inputs are included while others are not.

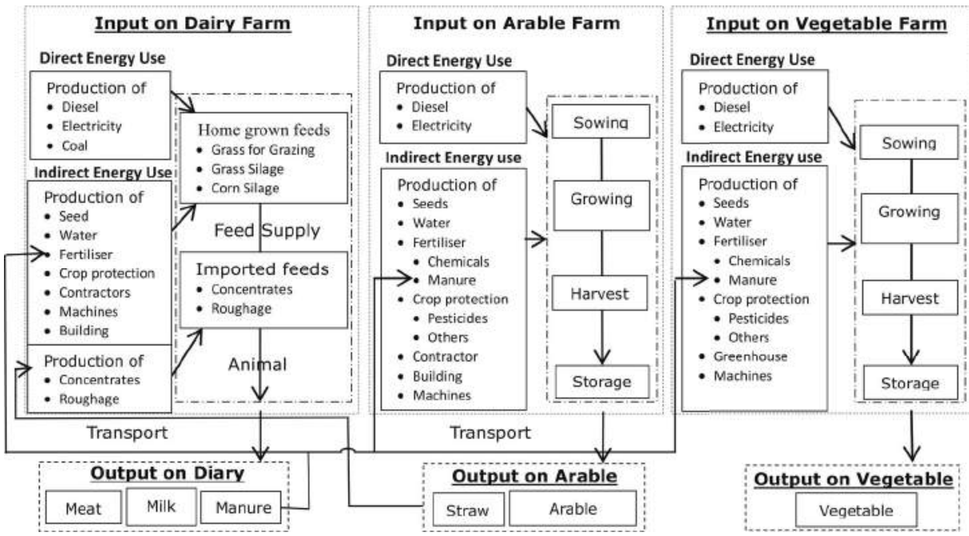


Fig. 3-3 Flowchart of energy use on farms in China

For direct energy consumption, coal is included in the flowchart of dairy farms because most dairy farms in northern China consume coal to heat the stables in winter. Arable and vegetable farms normally use no coal during their production process.

When analysing indirect energy consumption, it is important to include water irrigation in all farming systems; agriculture production in northern China uses a large amount of underground water, which could mean significant energy use in water exploitation. However, some other inputs are excluded, such as stable bedding used on dairy farms and plastic used on arable and vegetable farms, due to their minor influence on total energy input in the farming system.

Differences in inputs between organic and conventional farms are also captured on the flowchart, especially inputs for fertility and crop protection. Usually no synthetic fertiliser and pesticides are used on organic farms. Instead, manure and compost could be applied for soil fertilising, and physical or biological methods could be used for pest control. As manure and compost contribute lower nitrogen levels compared with chemical fertilisers (also lower P and K assumed), they are usually regarded as by-products without value (Van Zeijts et al., 1999; Hulsbergen et al., 2001; Ji et al., 2012). Therefore, the production of manure and compost is usually not recorded as energy use, only its transportation (Dalgaard et al., 2001). For pest control on organic farms, small equipment like pest control light is included in the energy flowchart, while other natural bio-based products like fermenting vinegar or tobacco leaf aqueous solution are excluded due to their minor energy use.

Other than the transportation of manure and compost, the transportation of feed on dairy farm is also calculated in the system because most dairy farms import concentrates and roughage from far away, sometimes even overseas from the U.S., Australia, and New Zealand, according to the report of the Ministry of Agriculture of China (2017).

When analysing a farm's output, there are usually by-products produced on farm, for example meat and manure on a dairy farm, and straw on an arable farm. Thus, input-output analysis should be used to allocate the total energy use to the main product. Usually the allocation among all outputs on farm is conducted by each output's share in the total income (Thomassen et al., 2008). However, as straw usually has no or minor economic value (farmers normally burn it down after harvesting), no allocation is necessary among outputs on crop farms.

A function unit is crucial in doing an energy analysis. Units based on land size and yield are the most commonly used ones in the literature, namely energy use per ha and per tonne product. When it comes to the cases selected in this study, it is not possible to apply energy use per ha on dairy farms, as the sources of feed, internal or imported, on each farm are different, which makes their land size vary greatly. Hence, only the energy use for producing one tonne of fat and protein corrected milk (FPCM)[11] per year is computed on a dairy farm, while the energy use for cultivating on one ha land and for producing one tonne of agricultural products in one growing year are conducted on both arable and vegetable farms. As there is a yield gap between organic and conventional farming, using the unit yield for comparing energy use in these two systems could be unfair for organic farming. Considering organic's extra benefits beyond yield, a monetary unit, gross value of product (GVP) is also introduced in comparing energy use on different farms, particularly as the benefits may be compensated by the higher prices of agricultural products. In this study, energy use for making 1000 RMB of agricultural products is computed on all the selected farms.

c. Energy equivalent

It is almost impossible to analyse the energy consumption of every single on-farm input. Energy equivalents from different sources are usually used for convenience. Table 3-2 lists the energy equivalents of the main agricultural inputs in China, and all the data are sourced from the literature. According to the availability of data collected on farms for practical reasons, different farms choose different units of energy equivalents. For instance, the unit of energy equivalents used for buildings and machines on dairy farms is based on the depreciation data, because most dairy farms use similar buildings and machines; whereas the unit of energy equivalents used for buildings and machines on arable and vegetable farms is based on the analysis of different types of greenhouses and the weight of different machines, both of which can vary widely on different farms.

Due to the limited data and references, the unit of some energy equivalents for certain on-farm inputs are sourced from energy study in the Netherlands, for example the energy equivalent of animal health, crop protection, contractor services, buildings and machines on dairy farms, and contractor services on arable farms. That is why the unit MJ/euro is used here. In practical calculation, the related monetary data collected from Chinese farms are recomputed according to Purchasing Power Parity (PPP) between the two different currencies.

When comparing the energy equivalents of some inputs between China and the Netherlands, there are some differences. For example, the energy equivalent of electricity and nitrogen fertiliser is relatively higher in China than in the Netherlands. This is because the method and technology for producing electricity and nitrogen fertiliser in the two countries are different,

[11] According to Blok & Spek, 2016, FPCM (kg) = raw milk (kg) * (0.337 + 0.116 * Fat content (%) + 0.06 * protein content (%))

which results in different amounts of fossil energy consumption in making those inputs available.

Table 3-2 Energy equivalents of agricultural inputs in China (based on Liu et al., 2010, Bos et al., 2014)

Energy Carrier	Energy equivalent	Unit	References
Dairy farm			
Diesel	47.79	MJ/L	Cervinka, 1980
Electricity	12.5	MJ/kWh	Chen, 2002
Coal	29.27	MJ/kg	Dong, 2007
Concentrates[1]			
Standard protein-	6.3	MJ/kg	Hageman et al., 1994
Rich protein-	5.2	MJ/kg	Hageman et al., 1994
Extra rich protein-	3.9	MJ/kg	Hageman et al., 1994
Imported Roughage	2.7	MJ/kg	Hageman et al., 1994
Animal health	19.2	MJ/€	Hageman et al., 1994
Seeds	19.6	MJ/€	Hageman et al., 1994
Fertiliser-N	50	MJ/kg	Yin, 1998
Fertiliser-P	12	MJ/kg	Yin, 1998
Fertiliser-K	4.22	MJ/kg	Yin, 1998
Crop protection	19.2	MJ/€	Hageman et al., 1994
Water	4.95	m^3	Yin, 1998
Contractor services	10.6	MJ/€	Hageman et al., 1994
Building, depreciation	9.7	MJ/€	Hageman et al., 1994
Machines, depreciation	7.9	MJ/€	Hageman et al., 1994
Crop farm			
Diesel	47.79	MJ/L	Cervinka, 1980
Electricity	12.5	MJ/kWh	Chen, 2002
Seeds	7.5	MJ/kg	Mombarg et al., 2004
Planting material			
Heated greenhouse	640	MJ/1000	Mombarg et al., 2004
Non-heated greenhouse	145	MJ/1000	Mombarg et al., 2004
Fertiliser-N	50	MJ/kg	Yin, 1998
Fertiliser-P	12	MJ/kg	Yin, 1998
Fertiliser-K	4.22	MJ/kg	Yin, 1998
Pesticides			
Herbicides	288	MJ/kg	Green, 1987
Fungicides	196	MJ/kg	Green, 1987
Insecticides	237	MJ/kg	Green, 1987
Contractor services	2.2	MJ/€	Mombarg et al., 2004
Water	4.95	m^3	Yin, 1998
Machines	210	MJ/kg	Chen, 2002
Buildings, depreciation	7.9	MJ/€	Hageman et al., 1994
Greenhouses			
Heated	959.9	MJ/ton yield	Wang et al., 2014b
Non-heated	563.8	MJ/ton yield	Wang et al., 2014b

Energy use for transporting				
Type of manure[2]	Energy Equivalents	Unit	Distance of transportation	References
Semi-liquid manure	0.02	L/km/m^3	15 km	Mombarg et al., 2004
Solid manure	0.02	L/km/ton	20 km	Mombarg et al., 2004
Compost manure	0.0075	L/km/ton	100 km	Mombarg et al., 2004
Other transportation[3]	0.005	kg · km	/	Pimentel, 2008

1. Concentrates are categorized into three types on dairy farms according to different DVE content. Standard protein concentrates: 90<DVE<120; Rich protein concentrates: 120<DVE<180; Extra protein concentrates: DVE>180 (Hageman et al., 1994).
2. Manure is generally not calculated as a source of energy consumption on farms, as only its transportation and application consume diesel. As application of manure is usually done by self-owned machines or hired contract services, the energy consumption of used diesel in this part has been calculated in the total diesel input or contract service part. Thus, only diesel use for transportation of manure is computed here.
3. Other transportation mainly includes the transport of feed, including concentrates and roughage, on dairy farms.

d. Results and discussion

As shown in Fig. 3-4 and Fig. 3-5, energy use per ha is much higher on conventional farms than on organic farms for arable and vegetable farming. The gap can be explained mainly by much higher energy consumption for producing crop protection materials and fertiliser on conventional farms, namely pesticides and synthetic fertiliser, than on organic farms (energy consumed mainly by the transportation of manure and compost is regarded as the energy use of fertiliser on organic farms). Concerning farm size, energy use per ha on small organic farms is lower than on big organic farms, which means cultivating per unit of land on small organic farms is more efficient in energy use. This can be explained by the lower levels of energy-consuming inputs like big machines, irrigation water and organic fertiliser on the small organic farms in China.

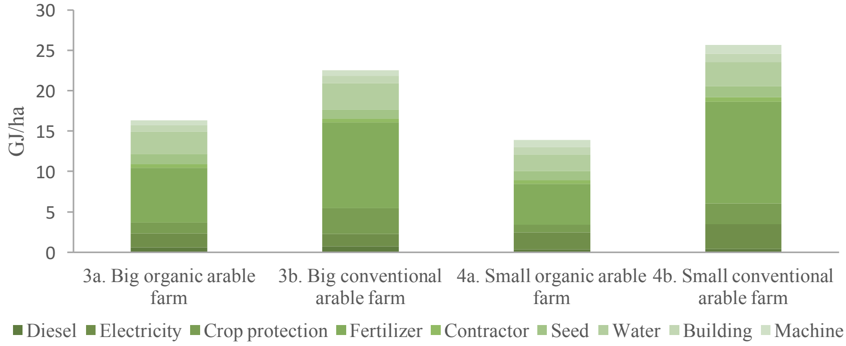


Fig. 3-4 Energy input (GJ/ha) on arable farms in China

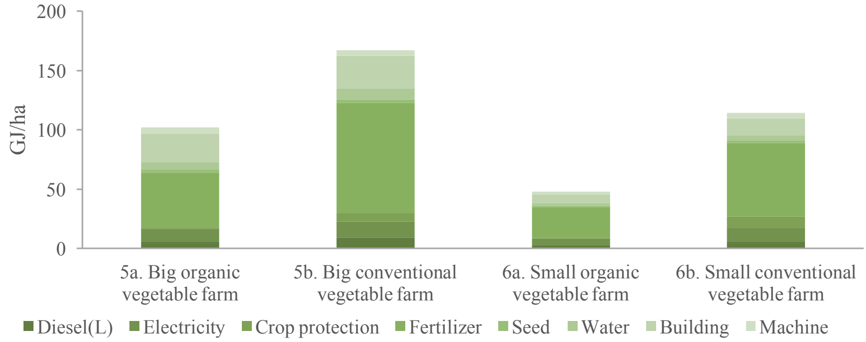


Fig. 3-5 Energy input (GJ/ha) on vegetable farms in China

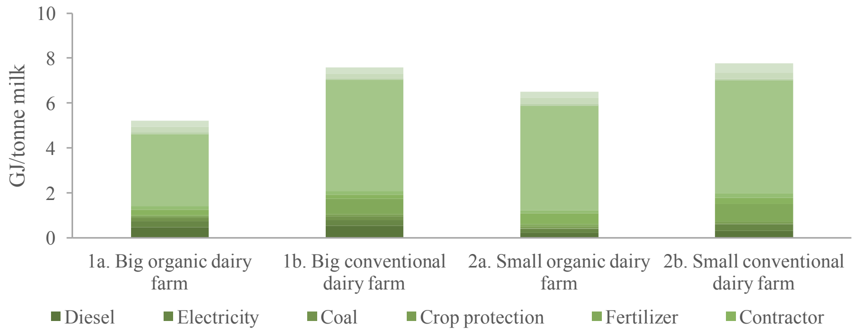


Fig. 3-6 Energy input (GJ/tonne milk) on dairy farms in China

Chapter 3

The result of energy use per tonne of product on dairy farms in China is shown in Fig. 3-6. For producing one tonne of FPCM (here after denoted as per tonne milk), the energy use is 7.5 GJ on big conventional dairy farms, which is higher than 5.2 GJ on big organic ones. On small conventional farms, the number is 7.8 GJ, also higher than 6.5 GJ on small organic ones. The higher energy use per tonne milk on conventional dairy farms can mainly be attributed to their higher energy consumption for importing feed, including concentrates and roughage overseas. When considering farm size, energy use per tonne milk is higher on small organic dairy farms than on big organic ones. The gap can mostly be explained by the higher energy use for feed per unit of milk produced on small organic farms.

In the literature, a study about energy use on dairy farms in China shows that energy use per tonne of milk[12] is about 2.2 GJ on organic farms, and 8.5 GJ on conventional farms (with an average output of 8.5 tonnes per cow) (Dong, 2007). The result of energy use on organic farms is quite low compared with the result shown above, while the result on conventional farms is close. As Dong presents, the organic case he chose in the study uses only local feed, including soybean, maize grown on the farm itself or in villages nearby, and grass planted on its own land. The manure is produced on its own farm for fertilising soil. But the conventional farm imports great amounts of feed from overseas and uses much more synthetic fertiliser other than manure on the farm. This is why the energy input on this organic farm is much lower it is on the conventional farm. The explanation is tested to be right in this study as well. Furthermore, as both the big and small organic dairy cases in this study import part of their feed from other regions of the country, their energy use per tonne of milk is higher than that of the organic case studied by Dong.

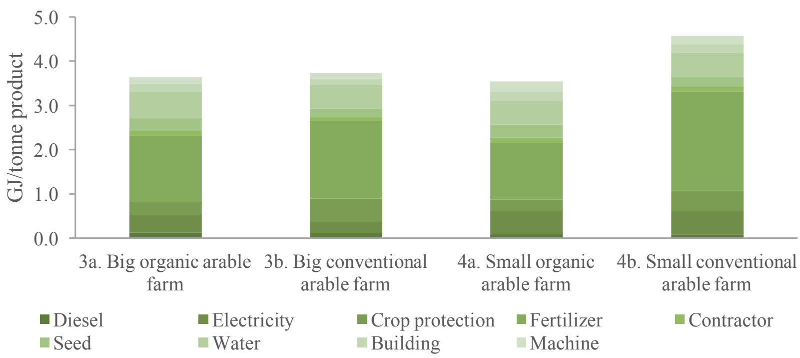


Fig. 3-7 Energy input (GJ/tonne product) on arable farms in China

On arable farms in China, energy use for producing one tonne of product is about 3.6 GJ on big organic farms and 3.5 GJ on small organic farms, while it is about 3.7 GJ and 4.6 GJ on big conventional farms and small conventional farms respectively (see Fig. 3-7). The energy use per tonne of product on organic farms is generally lower than on the conventional farms, but the gap is not as big as that of energy use for cultivating per ha land between the two farming systems, especially between big organic and big conventional farms. The reason behind that is that the yield from organic farms is generally lower than that of conventional farms. For the

[12] The function unit used in this study is one tonne of Fat Corrected Milk (4%).

arable cases, the yield of wheat on big and small organic farms is under 400 kg per mu, while that of conventional farms is around 500 kg per mu.

According to life cycle assessment studies on wheat and maize production in northern China, the energy use for producing one tonne of winter wheat can reach to 6.3 GJ, while it is 3.5 GJ for producing one tonne of summer maize (Liang et al., 2009). Liang's study focuses on the conventional grain production, and it is close to the result of energy use calculated from the selected conventional case in this study. To analyse energy input for grain production, most studies believe that chemicals with extremely high fossil energy consumption in the production process contribute the most to the total energy use on the farm (Wang et al., 2006; Wang et al., 2017). One study even reports that energy consumed by the production of synthetic fertiliser accounts for more than 70% of the total energy use in grain production in China (Yang et al., 2015).

Energy use for producing one tonne of vegetable product is about 1.2 GJ on big organic farms, and 1.3 GJ on big conventional farms. On small farms, energy use is about 1.0 GJ for organic and 1.5 GJ for conventional farms (See Fig. 3-8). In general, energy use per tonne of product on organic vegetable farms is lower than that of conventional farms, but the gap, especially between the big ones, is quite small. The input of pesticides and synthetic fertiliser on conventional farms is the reason for the higher energy use.

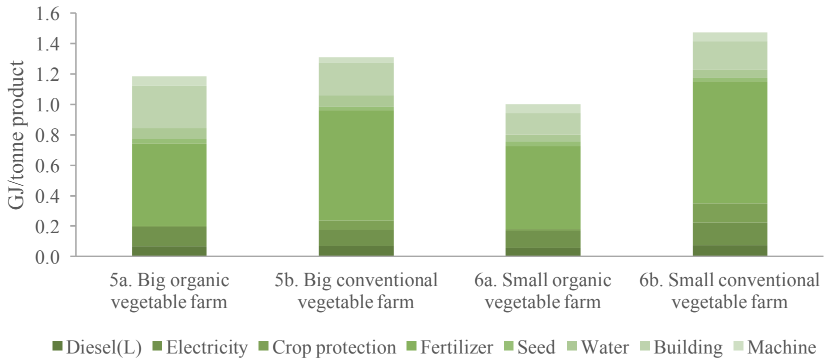


Fig. 3-8 Energy input (GJ/tonne product) on vegetable farms in China

Another study related to energy use for greenhouse vegetable production in China shows that for producing one tonne of vegetables, including tomato, cucumber, pepper and eggplant, an organic farm needs 1.11 GJ energy, while a conventional farm needs 1.14 GJ (Xu et al., 2018). For producing one tonne of tomatoes, energy use on a conventional farm is about 1.5 GJ (Wang et al., 2014b). The results from the literature are close to the results shown above in this study. In discussion, Xu (2018) points out that energy consumed by the production of synthetic fertilisers comprises about 74% of the total energy use on conventional greenhouse vegetable farms, however, energy used for manure transportation and production only accounts for about 16% on organic farms. 'Synthetic nitrogen in China consumes a large amount of coal in its production process, which increases fossil energy consumption greatly' (Xu et al., 2018).

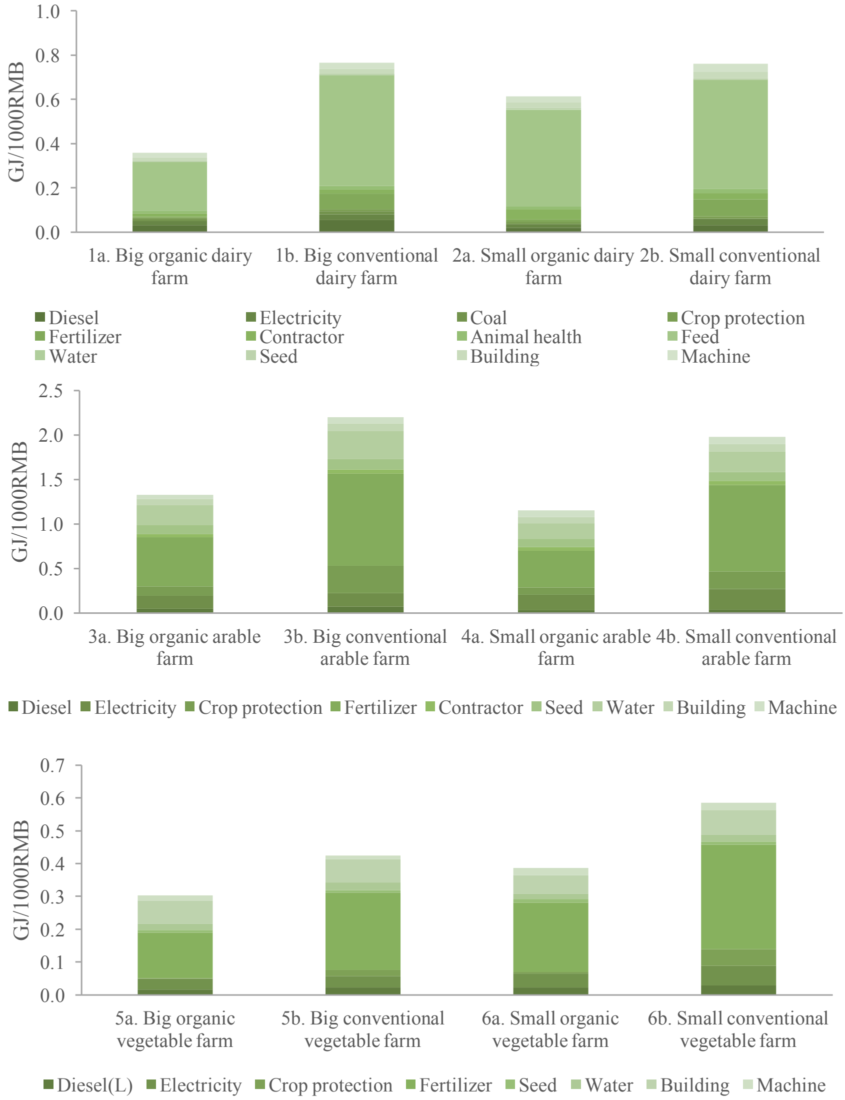


Fig. 3-9 Energy input (GJ/1000RMB) on Chinese farms

When using GVP as a function unit, energy use on an organic farm, whether it is a dairy, arable or vegetable farm, is much lower than that on a conventional farm (see Fig. 3-9). For making a gross value of 1000 RMB, a small organic farm usually uses more energy than a conventional farm, except that a small organic arable farm uses less than a big organic one.

To sum up, energy input on an organic farm, be it a dairy, arable, or vegetable farm, is lower than that of a conventional farm in China, no matter what function unit (land size, yield, or GVP) is used, and the gap can be explained generally by a higher input of imported overseas feed for dairy farms, and a higher input of chemicals on crop farms, which both lead to higher energy consumption on conventional farms. When considering the difference in energy use among farming activities and farm size, no consistent results show up in the study.

3.4 Labour input on farms in China

Labour input on farm is defined as the work, manual or administrative, directly related to the cultivation or husbandry of animals and plants (Whatmore, 2016), and it is categorised as family labour, permanent labour, temporary labour, and volunteer. Family labour is usually a member of the farm family, or a manager in a farming enterprise. Permanent labour is staff hired full-time on the farm, while temporary labour refers to seasonal workers hired during peak periods of farming activities, for example, weeding, and harvesting. Volunteer is people who work on the farm without payment for certain reasons, for instance, getting farming or rural life experience. The data on labour input on the farm is mainly collected from farmers via interviews.

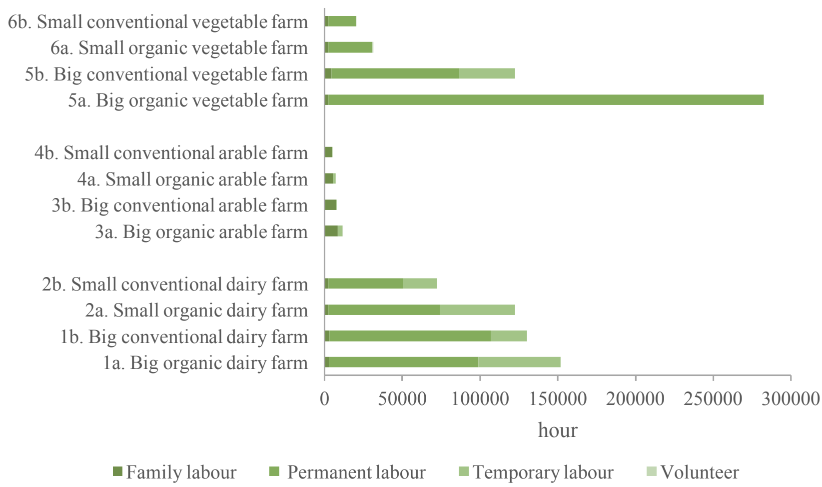


Fig. 3-10 Labour input (hours) on Chinese farms

As shown in Fig. 3-10, labour input on organic farms is generally higher than that on conventional farms, and it is higher on big organic farms than on small ones. The big organic vegetable farm has the highest labour input, as much more permanent labour is hired in this farming enterprise. On arable farms, labour input is generally lower than the other two types of farms. This is because all the arable farms selected in this study are family farms. On dairy farm, the gap of labour input between organic and conventional farms is relatively small compared to the difference between the big organic and big conventional vegetable farms.

For labour input per unit yield and gross value of product, organic farms generally use more labour than conventional farms (see Fig. 3-11). For producing one tonne of product and making 1000 RMB, labour input on organic arable farms is the highest, and this can be explained by its lower yield and GVP compared with vegetable and dairy farms.

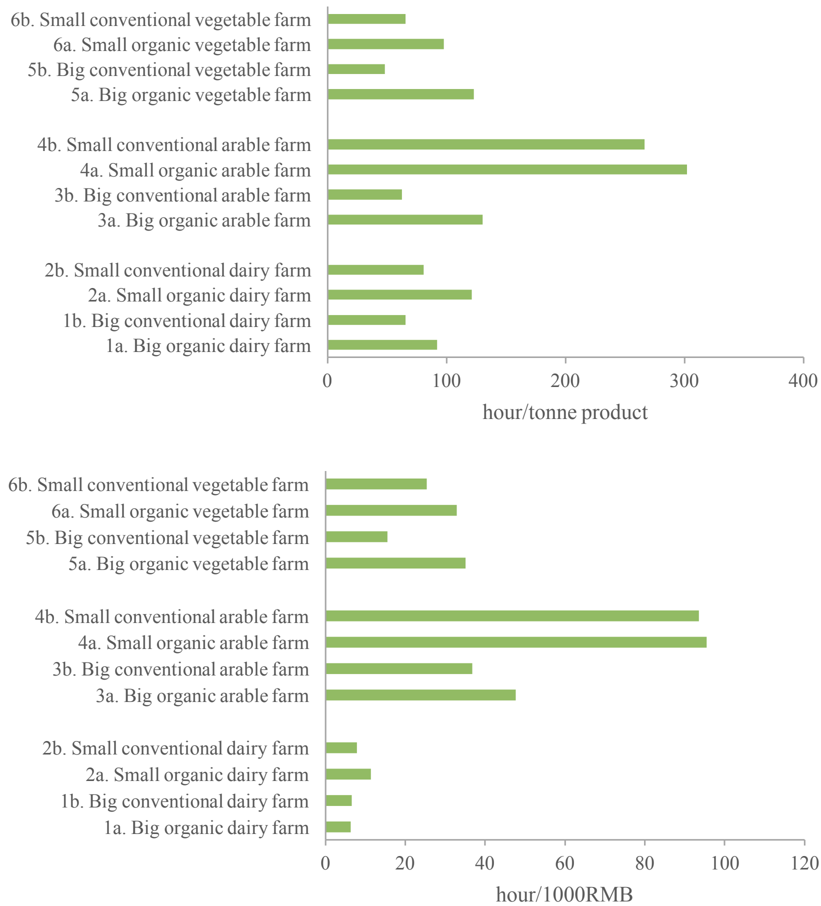


Fig. 3-11 Farm labour input per unit in China

3.5 Representativeness of the sample

To make sure that the cases selected in this study are not outliers in their categories, the representativeness of the sample is tested by introducing the average energy and labour data at national and provincial level. As the yearbook *Compilation of Data on Costs and Profits of Agricultural Products 2016* provides the average cost data of major on-farm inputs for agricultural products in China, energy and labour input on farms with different sizes for producing milk, grain, and vegetables can be computed.

Fig. 3-12 presents the average energy use on farms at national and provincial levels (bar in dark green) and the energy use on sample farms (bar in light green). As the data extracted from the yearbook do not distinguish organic from conventional farms, only the results based on the general dataset of all farms are presented. It can be seen that energy use on most conventional farms is close to that of average levels, while energy use on organic farms is lower than that of average levels.

Fig. 3-12 Compare average energy input on farms with energy input on the sample farms in China

For farm labour input, the average result calculated from cost data of agricultural products on national and provincial levels is compared with the result of sample farms in this study (see Fig. 3-13). No big gap is identified among all the categories, except that on small arable farms the labour input for producing one tonne of products is relatively higher than the average number.

Fig. 3-13 Compare average farm labour input with labour input on the sample farms in China

3.6 Balance and substitution between energy and labour use on farms in China

When combing the results of energy and labour input analysis on farms in China, it is clear that organic farms in China use less energy but more labour for producing a unit gross value compared with the corresponding conventional farms (see Fig. 3-14). To explore the relation between energy and labour use on farm, substitution effects between these two resources will be discussed in further detail.

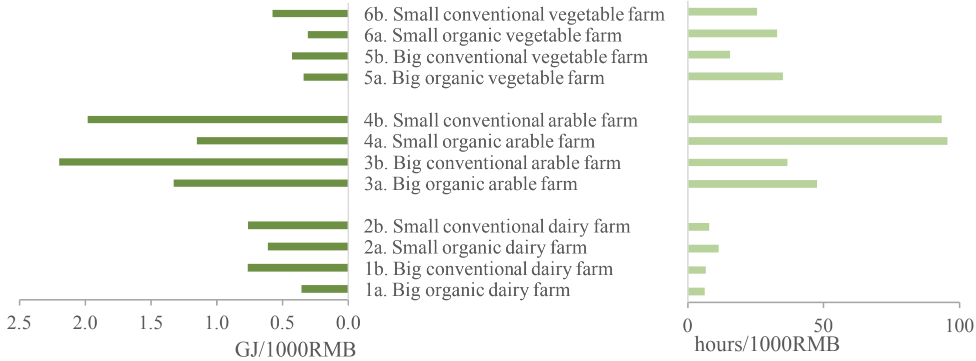


Fig. 3-14 Balance of energy and labour input on Chinese farms

Applying the economic analysis already discussed in Chapter 2, the marginal substitution ratio of added energy and added labour can be calculated on each Chinese farm as well. As shown in Table 3-3, MSR on organic farms in China is generally lower than on conventional farms. MSR equals the slope of the price line for each farm on the isoquant curve (as illustrated by Fig. 3-15), and the result means that at decreasing labour use on farm (under the circumstance of increasing labour price for instance), the added energy used on conventional farms could increase sharply compared with that on the corresponding organic farm. If labour input declines on big farms, the degree of energy input increases much faster than that on small farms. When using the numbers in the table to explain the differences, for example, one unit of labour change on a big organic dairy farm could replace 36.12 MJ energy, while it can replace 49.39 MJ energy on a big conventional dairy farm. On a small organic dairy farm, one unit of labour change could replace 24 MJ energy which is much smaller than that on a big organic dairy farm. For different farming activities, the MRS on organic vegetable farms is relatively low, while it is very high on dairy farms, which means that one unit of labour change could replace less energy use on vegetable farms, while more on dairy farms.

The analysis of substitution between added energy and added labour shows that organic farms, especially small vegetable ones, are potentially more sustainable in terms of energy use when labour input decreases for certain reasons.

Table 3-3 Marginal substitution ratio of added energy and added labour on farms in China

Cases	AE MJ/ton	AL h/ton	$AE_{L>}$ MJ/ton	$AL_{E>}$ h/ton	MSR MJ/h
1a. Big organic dairy farm	5,219.77	92.13	3,555.78	46.06	**36.12**
1b. Big conventional dairy farm	7,585.48	65.53	5,967.24	32.76	**49.39**
2a. Small organic dairy farm	6,509.30	121.12	5,055.58	60.56	**24.00**
2b. Small conventional dairy farm	7,759.43	80.69	6,158.69	40.35	**39.67**
3a. Big organic arable farm	3,634.07	130.22	2,090.00	65.11	**23.71**
3b. Big conventional arable farm	3,733.80	62.33	2,473.22	31.17	**40.45**
4a. Small organic arable farm	3,542.24	302.13	1,829.79	151.06	**11.34**
4b. Small conventional arable farm	4,571.08	266.49	2,934.40	133.24	**12.28**
5a. Big organic vegetable farm	1,185.12	122.78	579.83	61.39	**10.04**
5b. Big conventional vegetable farm	1,310.38	48.04	807.93	24.02	**21.13**
6a. Small organic vegetable farm	1,001.43	97.81	590.63	48.91	**9.74**
6b. Small conventional vegetable farm	1,472.52	65.48	952.60	32.74	**19.36**

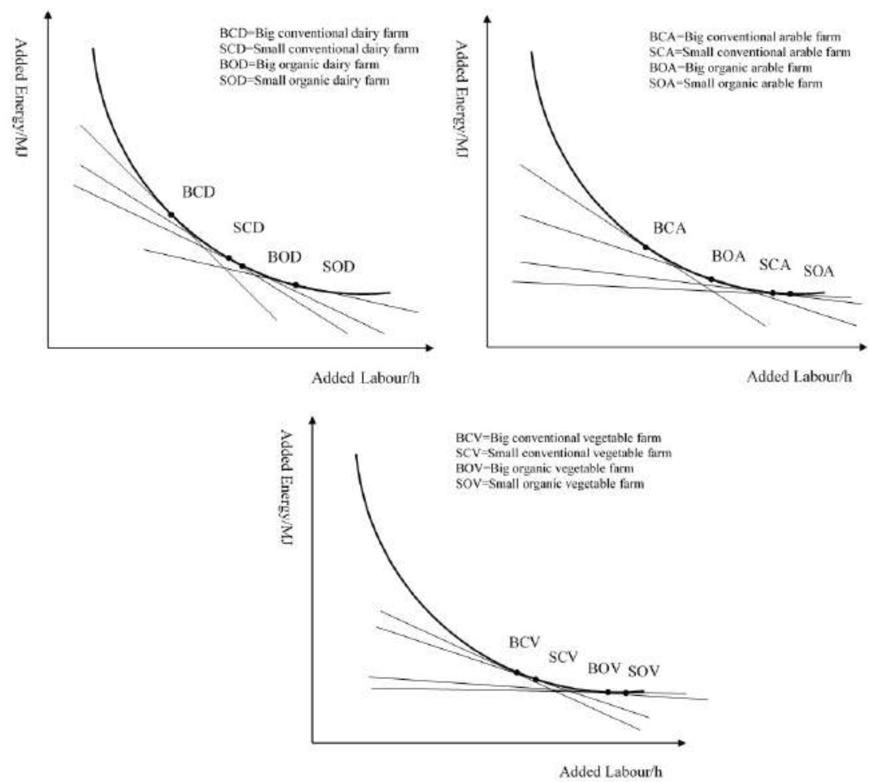


Fig. 3-15 Chinese farms' position on isoquant curve for producing certain amount of outputs

3.7 Conclusions

With high fossil energy dependency, conventional farming in China is vulnerable in energy conservation, emission reduction, and environmental protection. Rising in the 1990s, organic farming provides an alternative method of agricultural production in the country. The results show that organic farming in China uses less energy but more labour for on-farm production than conventional farms under different comparing units. When considering the differences in energy and labour use among organic farms with different farming activities and farm sizes, the results are not consistent. The analysis of substitution effects between energy and labour use on farms in China shows that organic farms would require less energy input than conventional farms when reducing unit labour input. This means that organic farming may present less dependency on energy use compared with conventional farming.

Reducing energy consumption, organic farming seems to be more sustainable for agricultural production. Apparently, reducing the use of high energy-consuming inputs like pesticides and synthetic fertiliser would be helpful for not only restoring the soil and reducing the pollution, but also for mitigating the greenhouse gas emissions. In the face of the challenges of climate change and environmental degradation, organic farming could be one sustainable option for agricultural production in China.

Chapter 4

Compare Energy and Labour Input on Farms in the Netherlands and China

4.1 Introduction

Be it conventional or organic, in the pre-industrial era or in contemporary society, agricultural production always depends upon resource input. In this study, energy - in both its direct and indirect form - and labour are regarded as the two basic resources required for achieving agricultural outputs. The input balance of these two basic resources has been calculated separately in the Netherlands and China in previous chapters based on the hypothesis that the energy and labour input on farms could be variable in different social contexts. But the questions of what the different social contexts are and how they would influence the energy and labour input on farms are still unanswered. Therefore, it is necessary to compare the results of energy and labour input balance between the Netherlands and China, and interpret the meanings behind the results.

It is widely believed in the domain of development economics that regional agricultural productivity and growth connect closely to the resource endowment in the agricultural section. As Hayami and Ruttan (1985) point out, one country's successful achievement in agricultural growth over time is highly determined by its ability to adjust to the original resource endowments and resource accumulation in the process of historical development. It also changes according to its response to the cultural, political, and economical institutions so that it can realise the growth potential. The resource endowments and institutions then bring useful perspectives to the discussion about the influencing social contexts behind the resource input on farms in the Netherlands and China. When it comes to organic agriculture, it concerns not only productivity but also sustainability. Even though the energy and labour input on organic farms has been proved to be different from that on conventional farms, the transition from conventional to organic for achieving both productivity and sustainability in agricultural production still involves these dimensions. It is thus important to figure out how they would influence the development of organic agriculture in both the countries as well.

This chapter will first compare the energy and labour input balance between the Netherlands and China based on the results from Chapter 2 and Chapter 3. The differences of farm resource input between these two countries are then captured and explained within the framework of resource endowments and economical institutions in changing agricultural growth. Finally, the substitution possibilities between added energy and added labour in these two countries are compared in order to discuss the possible changes of resource use in the two countries towards achieving sustainability in agricultural production.

4.2 Comparing energy and labour input balance on farms

Before comparing the energy and labour input balance between the Netherlands and China, there is a technical problem that should be considered: the unit. Chapter 2 and Chapter 3 have presented the results of energy and labour input on farms in the Netherlands and China under various function units. I have argued that the unit *gross value of product* (GVP) is appropriate for comparing the input balance between organic and conventional agriculture. However, when it comes to comparing the input balance between Dutch farms and Chinese farms, the monetary unit should be unified first to close the gap between the currency values.

Normally, there are two indicators to convert one currency to another: normal currency exchange rate or Purchasing Power Parity (PPP) exchange rate. The normal currency exchange rate is defined as the value of one currency in terms of another, and it is rather changeable, which may distort the comparison between the two economies. However, the PPP exchange rate refers to 'the rate of currency conversion that equalises the purchasing power of different currencies by eliminating the differences in price levels between countries' (OECD, 2019). It is useful for comparing between countries as it stays fairly constant over time. According to OECD (2019), the PPP of the euro and RMB (Chinese currency) per US dollar (USD) from 2013 to 2015 is listed in Table 4-1. Using this data, the average PPP currency exchange rate between the euro and RMB is computed and shown in the last column.

Table 4-1 PPP exchange rate between RMB and euro

PPP	2013	2014	2015	Average
China (RMB/USD)	3.55	3.51	3.48	3.51
The Netherlands (euro/USD)	0.80	0.81	0.81	0.81
RMB/euro	4.44	4.34	4.29	4.36

Source: OECD (2019), Purchasing power parities (PPP) (indicator). doi: 10.1787/1290ee5a-en (Accessed 15-04-2019)

Using the average PPP exchange rate, the energy and labour input per gross value of product on farms in China and the Netherlands can be unified as GJ/1000euro and hour/1000euro. Fig. 4-1 shows the results of energy and labour input balance on dairy, arable and vegetable farms in the Netherlands and China. The black dots represent the energy and labour input balance on Dutch farms, while the light grey dots represent the same on Chinese farms. It thus becomes visible that the Dutch farms are generally located on the top left corner on the graph (except for the small organic vegetable farms) while Chinese farms are located on the bottom right corner (except for the big and small conventional arable farms). This means that for producing 1000 euro of agricultural products, in general Dutch farms use more energy while Chinese farms use more labour.

When looking at different farming activities, the resource use pattern that Dutch farms use more energy while Chinese farms use more labour is relatively obvious for dairy and vegetable production. For arable production, the big and small conventional arable farms in China maintain not only higher labour input but also higher energy consumption than on arable farms in the Netherlands. The organic arable farms in China maintain higher labour input, and a level of energy input that is very close to the one of organic arable farms in the Netherlands. This makes the Chinese arable farms less competitive in terms of resources use for producing grains. This will be discussed later.

When looking specifically at organic agriculture, Chinese organic farms use far more labour and less energy than Dutch organic farms. There is one exception: the small organic vegetable farm in the Netherlands located at the bottom right corner on the graph is close to the Chinese vegetable farms in its levels of energy and labour use.

The findings on energy and labour input on farms in the Netherlands and China generally support the hypothesis made by development economists that one country's achievement in agricultural growth depends on its adaptive response to its original resource endowments in the historical development.

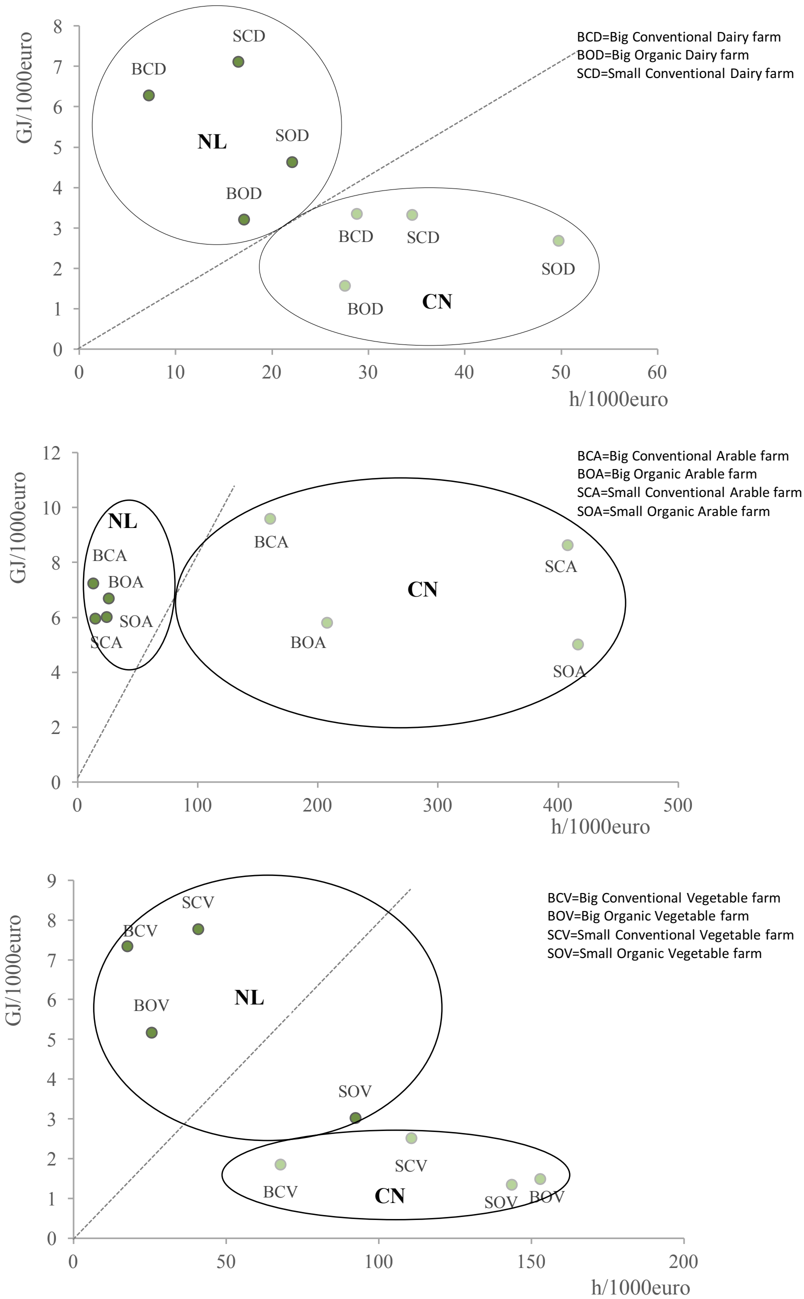


Fig. 4-1 Energy and labour input balance on farms in the Netherlands and China

The agricultural growth in the Netherlands has been proved to be technology-driven, and it connects closely to the development of the non-agriculture sector (Hayami & Ruttan, 1985). In a developed country like the Netherlands, its non-agriculture sector attracts labour from agriculture, and provides the technical inputs to substitute labour use on farms. These technical inputs produced in the non-agricultural sector are transmitted to the agriculture sector in the form of so-called efficient and cheaper sources of power and nutrients like machines and synthetic fertilisers. These external inputs occupy the majority of the total fossil energy consumption in agricultural production, which relies heavily on the industrial technology of fossil fuel exploitation. Even though claimed to be less dependent on fossil energy consumption, organic agriculture in the Netherlands cannot do without the influence from the energy-intensive resource endowments.

However, on the one hand, China's industries are producing sophisticated technologies to be applied in agriculture that are possibly less developed than that in Europe insofar as China is still a developing country. On the other hand, China still has much more labour working in the agricultural sector, even though the situation is changing in the recent decades. Identified as a form of labour-driven growth, agriculture in China mainly depends on intensive labour input (Ploeg et al., 2013). This has been the case for thousands of years (King, 2013). Even though there were several agricultural technology innovations (not necessarily transmitted from the modern industrial sector), intensive labour input plays the key role in agricultural growth. With the large population especially in the countryside, labour, rather than the energy-based industrial inputs, is easily available for the agriculture sector. In organic agriculture, the labour input on farms is even higher, as most energy-based inputs are forbidden. That's why both conventional farms and organic farms are located on the far right section of the graph's horizontal axis.

The different resource endowments of the Netherlands and China basically explain the different balance of energy and labour input balance on Dutch and Chinese farms. However, the resource accumulation and institutional adjustment of the last decades is slowly changing this pattern, and this change may explain the abnormal resource input of arable farming in China.

With the development of industrialisation in China, the advanced technologies in the industrial sector are transformed to the agriculture sector in the form of machineries, synthetic fertilisers, and pesticides to replace labour input, which leads to a considerable drop in the rural population from 95% in 1978 to 65% in 2010 (Yang *et al.*, 2013). In the meantime, both the small and large machine stocks in the agriculture sector have developed fast. Taking tractors as an example, the small tractor stock rose from 1 to 18 million from 1978 to 2010. However, the number of large/medium tractors were only about 800,000 in 1978, and the number remained low till 2005 when it increased from 1 million to 4 million by 2010 (Yang *et al.*, 2013). The sharp increase in the number of large/medium tractors is concurrent with increases in the subsidies for purchasing agricultural machinery. In 2004, the central government promulgated the *Law of the People's Republic of China on Promotion of Agricultural Mechanisation,* and since then the total financial expenditure on the subsidy rose from 70 million yuan to 23.75 billion yuan by 2016. In the years from 2004 to 2017, a total number of 187 billion yuan (about 25 billion euro under current exchange rate) was expended for supporting farmers to purchase machinery in the agriculture sector (Ministry of Agriculture of China, 2018). This led to the rise of the comprehensive level of mechanisation in agricultural production. In 2008, the levels of mechanisation for wheat, rice, and maize production were about 86.5%, 51.2% and 51.8% respectively, and the numbers went up to 93.7%, 78.1%, and 81.2% in 2016 (Gao, 2009; Xu *et al.*, 2019) [13]. However, the mechanisation level is unbalanced among different crops. For cash crops, the number was 20.9% for potato production, 23% for rape seeds production, and less than 10% for vegetable and fruit production (Gao, 2009). It is possible that the relatively high level of mechanisation in arable farming (for producing grains) in China, which is in line with the increasing subsidies, accounts for the abnormally high energy input on Chinese arable farms.

It is obvious that the combination of industrial technologies and supportive policy is transforming the agriculture sector in China. The agricultural growth shows a trend of following the path of the developed countries like the Netherlands that use energy-based technologies to substitute labour input in agriculture. Even though most Chinese farms, no matter whether organic or conventional, are still located at the bottom right part of the graph (low energy and high labour input), they are in transition. With the availability of rural labour decreasing and the price of labour increasing, it will possibly see a decrease in the labour input on farms in the near future. But the current situation in arable agriculture that combines high energy and high labour input at the same time seems to be too challenging to continue. It may be interpreted as the contradiction between the original resource endowment (rich in labour resource) and institutional interventions (increase agricultural mechanisation level with tendentious policies).

The resource accumulation and institutions in the Netherlands are also changing. Aware of the energy crisis, the western world has started to explore the substitution of fossil energy since the 1970s. Aware of the threat of climate change and various problems caused by industrial agriculture, it works positively to seek and practice alternative farming principles for achieving sustainability in agricultural production. Organic agriculture is one of them. It has proved that organic farms in the Netherlands show better performance in reducing energy use. However, there are lock-ins in the balance of energy and labour input on Dutch farms due to their resource endowments and accumulation. This means that the decrease of energy use on Dutch organic farms is limited.

Even though the balance of energy and labour on organic farms in the Netherlands cannot escape the trajectory of high fossil energy use, there are exceptions. The small organic vegetable farm in the Netherlands, maintaining relatively high labour and low energy input, represents those exceptions which present a different pattern of organising energy and labour use at farm level in the developed countries.

It is true that the energy and labour input balance on Chinese farms is undergoing a transition, and it is highly possible that more energy-intensive inputs would flow into the process of agricultural production to replace labour input in the near future, but the case of the small organic vegetable farm in the Netherlands may provide another direction for the transition of Chinese agriculture sector in resource use. Located in the bottom right part on the graph, the small organic vegetable farm shows a totally different energy and labour input balance from the other Dutch farms. Reducing energy input while keeping much higher labour use on farm,

[13] The level of mechanization refers to the integrated mechanization rate. It represents the percentage of land area using large/medium machines for ploughing, sowing and harvesting in the total area of farming land. The integrated mechanization rate is usually calculated and published by the Ministry of Agriculture of China.

it seems inconsistent with the rules of resource endowment in the Netherlands. Compared with Chinese vegetable farms, the small organic vegetable farm in the Netherlands shows slightly higher energy input and a moderate level of labour input. The special pattern of energy and labour input balance shows that it is unnecessary for Chinese farms, especially organic farms, to convert high labour input mode into high energy input mode. It is meaningful for the transition of the Chinese agriculture sector in the era of focusing not only on productivity but also on sustainability. Nevertheless, this brings up another question regarding how the small organic vegetable farm in the Netherlands manages its special energy and labour input balance. The next chapter will explore this question further.

4.3 Comparing the substitution between added energy and added labour

The reason for discussing the substitution effect between energy and labour, the two basic resources for agricultural production, is that the contexts of resource usage could be uncertain in the future. Energy, mainly referring to fossil energy here, is a non-renewable resource, and it contributes directly to climate change. Labour, mainly rural labour, faces a trend of decrease in the most industrial countries, and the price of hired labour on farms keeps increasing as well. It is therefore important to discuss the question of how different farms in different countries reduce their dependency on fossil energy to deal with climate change and also survive the labour challenges.

Chapter 2 and 3 have introduced the concept of added energy and added labour, and have calculated the marginal substitution ratio of added energy and added labour among conventional and organic farms with different farming activities and sizes in the Netherlands and China separately. It is necessary to compare the substitution of energy and labour between the two countries, considering their different original resource endowments and the possible changes in the resource usage in the future.

Combing the data presented in the previous chapters, Table 4-2 compares the marginal substitution ratio of added energy and added labour on farms between the Netherlands and China. It shows both the marginal ratio of the added energy to substitute one unit of added labour (MJ/h), and the marginal ratio of the added labour to substitute one unit of added energy (h/GJ)[14]. The results show that the marginal ratio of energy to substitute labour (the light grey columns) is much higher on Dutch farms than on Chinese farms, while the marginal ratio of labour to substitute energy (the white columns) is much lower on Dutch farms than on Chinese farms. When the MSR of each case is illustrated on an isoquant curve – assuming that all cases produce the same amount of output (see Fig. 4-2) – it turns out that Dutch farms are generally located on the upper left of the curve while Chinese farms are at the lower right of the curve, or Chinese farms are located below the Dutch farms on the curve. This means that with one unit less of labour, Dutch farms require much more energy use than the Chinese farms to achieve the same level of agricultural output, however, with one unit less of energy, Dutch farms need an additional increased in labour input that is lower than the one of Chinese farms. When considering the original resource endowments, or specifically the relative price of energy and

[14] To make the number of MSR greater than 1 for the convenience of comparison, different units of energy, MJ and GJ, are used here.

labour in the two countries, it is economically rational to use energy to substitute labour input in the Netherlands and to use labour to substitute energy input in China.

Table 4-2 Comparing marginal substitution ratio (MSR) of added energy and added labour between the Netherlands and China

Cases	MSR-NL (MJ/h)	MSR-CN (MJ/h)	MSR-NL (h/GJ)	MSR-CN (h/GJ)
1a. Big organic dairy farm	198.2	36.1	5.0	27.7
1b. Big conventional dairy farm	477.0	49.4	2.1	20.2
2a. Small organic dairy farm	190.2	24.0	5.3	41.7
2b. Small conventional dairy farm	264.4	39.7	3.8	25.2
3a. Big organic arable farm	279.8	23.7	3.6	42.2
3b. Big conventional arable farm	428.6	40.4	2.3	24.7
4a. Small organic arable farm	270.4	11.3	3.7	88.2
4b. Small conventional arable farm	299.0	12.3	3.3	81.4
5a. Big organic vegetable farm	196.4	10.0	5.1	99.6
5b. Big conventional vegetable farm	362.5	21.1	2.8	47.3
6a. Small organic vegetable farm	37.6	9.7	26.6	102.7
6b. Small conventional vegetable farm	183.2	19.4	5.5	51.7

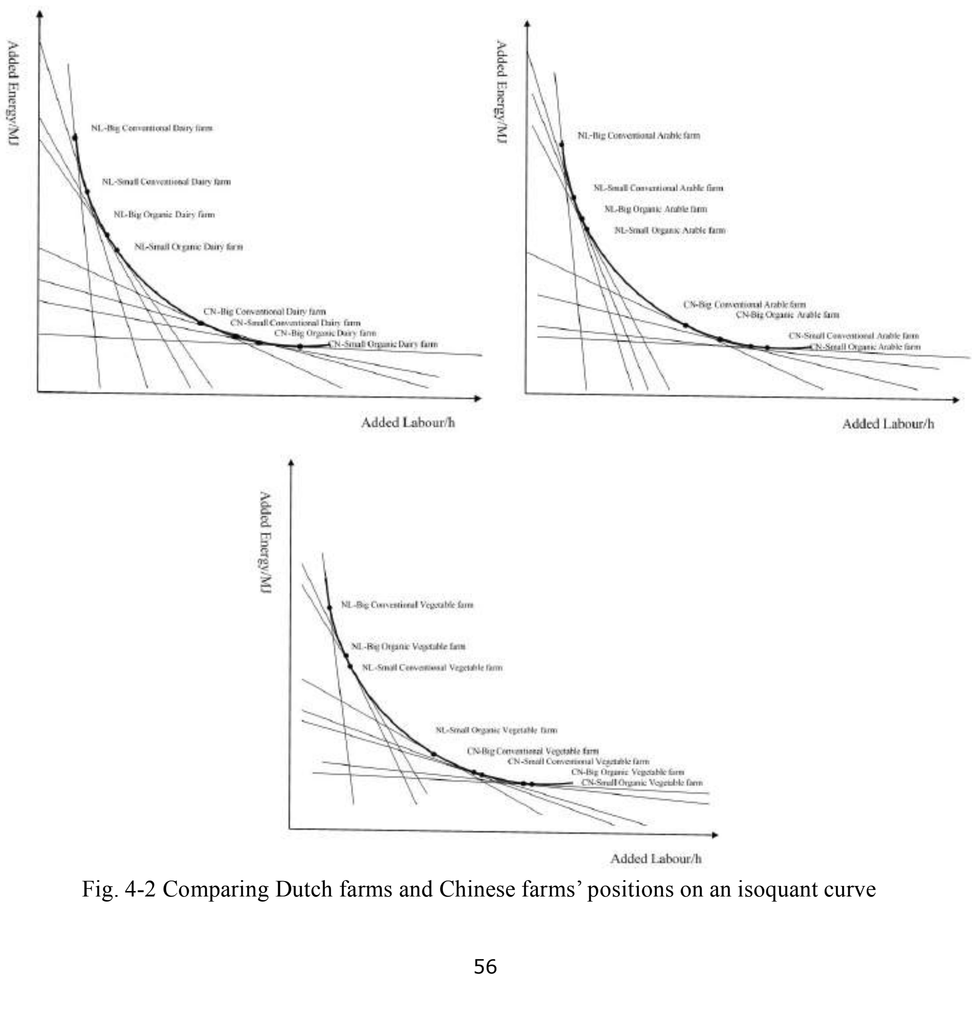


Fig. 4-2 Comparing Dutch farms and Chinese farms' positions on an isoquant curve

However, to deal with climate change and other environmental problems caused by fossil energy use and to achieve sustainability in food production, energy use should be reduced in general, especially in the developed countries like the Netherlands where the agriculture sector has a high dependency on fossil energy consumption. This means that when looking at the resources used in the Dutch agriculture sector, not only economic rationality, but also environmental benefits need to be kept in mind. When decreasing the energy use on Dutch farms, especially on organic farms, the required extra labour input is much lower than on Chinese farms. Thus, it is environmentally rational to decrease the fossil energy use on Dutch farms in terms of using labour input to substitute energy use, and the organic farms show higher possibilities for doing so.

In the developing and fast-growing economies like China, even though the energy input on farms is relatively low, it is experiencing a rapid increase, especially under the policy interventions. However, the labour input on farms is still high at present. Eventually, the increasing energy input and high labour input would make the Chinese farms less competitive in the agricultural production. To avoid the negative externalities resulting from the high energy input and the uncompetitive situation, Chinese farms should therefore maintain a dynamic equilibrium between the energy and labour input. To be specific, they should make full use of the current labour resource while stabilising or even reducing the energy input, and there seems to be more potential for this being successfully accomplished on the organic farms, as they currently keep relatively lower energy and higher labour input than the conventional farms.

4.4 Conclusions

Based on the hypothesis that energy and labour input balance on farms could be different in different social contexts, this chapter compared the input balance of resource use between the Netherlands and China by using the framework that agricultural growth is determined by the adjustments to one country's resource endowments and economical institutions. It concludes that as the developed and developing country respectively, the Netherlands and China have different resource endowments in terms of energy and labour input for agricultural production, and the differences thus determine that Dutch farms maintain intensive energy input while Chinese farms maintain intensive labour input on their farms. However, due to the changes over time, different patterns of energy and labour input balance are captured in both countries. In China, the advanced technologies from the industrial sector have been transmitted to the agriculture sector, and influential policies have been implemented to promote the energy-intensive inputs in agricultural production. These may result in both unsustainable and uncompetitive situations in the Chinese agricultural sector. In the Netherlands, the awareness of climate change and environmental problems has led to the practices of pursuing sustainability in the agriculture sector. Some organic farms that represent exceptions to the energy-intensive pattern of resource use try to reduce energy dependency and seek a reversed energy labour input balance on their farms. These exceptions are meaningful for exploring the sustainability in resource use balance in agricultural production, and also for providing examples of another direction of agricultural growth for the developing and rising economies like China.

Considering the possible challenges in the resource use for agricultural production, the substitution between the two basic resources, energy and labour is discussed in this chapter in detail. The result shows that it is economically rational to use energy to substitute labour use in the Netherlands while using labour to substitute energy use in China. However, in dealing with the climate change related to energy use, it is environmentally rational to reduce energy use on Dutch farms. In China, considering the increasing energy use and relatively high labour input on farm, it is important to maintain a dynamic equilibrium between the use of the two basic resources. As organic farming has been proved to have potential in reducing energy use while keeping relatively high labour input on farm, it represents a promising pathway to achieve sustainability goals in both countries.

Chapter 5

Organic Farmers' Responses to Labour Constraints: Case Studies from the Netherlands and China

5.1 Introduction

As discussed in previous chapters, organic agriculture, forbidding the use of chemicals, requires more labour input on farms than conventional agriculture in the Netherlands and China, and this has also been proved by other studies. On reviewing studies from different European countries, Jansen (2000) reports that 5% to 10% greater labour use is estimated on organic dairy, vegetable, livestock, and arable farming compared to the corresponding conventional farming. Morison et al. (2005) finds out that the organic agriculture in the UK and Ireland employed nearly twice as much labour per ha than conventional agriculture. In the United States, organic agriculture has also been proved to use from 7% to 75% more labour than conventional agriculture (Santos and Escalante, 2010; Beach, 2011; Finley et al., 2018). The reason for more labour use on organic farms is often attributed to the human jobs of weeding and managing rotation cycles, since organic agriculture makes use of complex agroecosystems (Jansen, 2000; VanderMeer and Perfecto, 2017).

The additional requirement of labour on organic farms on the one hand can be interpreted in a positive way to increase rural employment and promote rural economic development (Darnhofer 2005; Maynard and Green, 2006; Lobley et al., 2009; Finley et al., 2018); on the other hand, it can also be criticised as problematic, considering that labour input on organic farms is constrained by the increasing labour price and decreasing labour availability in the agriculture sector of most industrialised countries (Schneeberger et al., 2002; Pimentel et al., 2005; Acs et al., 2007). These constraints not only concern the conventional farmers who are thinking about converting to organic farming, but also put organic farmers in a difficult position due to the high labour demand on farms. Therefore, how organic farmers deal with the constraints to secure their livelihoods becomes an important question to explore.

Moreover, the question of how organic farmers in different contexts react differently to the constrains will broaden the discussion. As presented in the studies of Jansen (2000) and Lobley et al. (2009), farming activities (crop or livestock types), farm size, social connections and other factors could influence the socio-economic character of different kinds of farms, including labour input. It is important therefore to include organic farms from different countries with different farming activities and sizes in the discussion.

To respond to the critics on the high quantity of labour use on organic farms, this chapter starts with clarifying the labour constraints in the Netherlands and China, and then discusses organic farmers' different responses to the constraints. Finally, two cases from each country are introduced in detail to present organic farmers' resilience to the constraints. The findings show that organic farmers in both countries show three different patterns in response to labour constraints. The first pattern is the conventional solution of using machines to replace manual labour. The second pattern is to break the boundaries of the commodified labour market and build an alternative economy on the farm. The third is a pattern of civil society-driven development by building local networks to secure organic farmers' livelihoods. This chapter argues that the conventional response, which requires external dependence on technology and the market, would reduce organic farms' resilience, but the second pattern, mainly encountered on big and small organic vegetable farms in the Netherlands, and the third pattern, mainly seen on small organic arable and vegetable farm in China, could increase organic farms' resilience in dealing with labour constraints. In the following sections, the different patterns of response to labour constraints among Dutch and Chinese organic farmers are discussed within the distinct social contexts of the two countries.

5.2 Potential labour constraints in the Netherlands and China

In the Netherlands, the employment in the agriculture sector keeps decreasing, as does the labour force. The number of regular-employed workers in the primary agriculture and horticulture sector declined annually by 2.7% on average since 2000, comprising 2.1% of the total national employment in 2015. Among employment in agriculture, family labour accounts for 70.3%, whereas the number declined annually by 2.4% on average since 2000. What is worse, the growing aging population, now at 18.8% and estimated to be as much as 26.1% in 2040, exacerbates the labour reduction (CBS, 2017). It has already affirmed that there is an insufficient labour force in the agriculture sector of the country.

To supplement the shortage of labour, migrants from eastern and central Europe are attracted. According to a report published recently (ABU, 2018), there was a total of 371,000 migrants working in the Netherlands in 2016, 183,000 of whom worked as temporary workers (49%), and they often commit to simple and primary production work, for which it is extremely difficult to hire Dutch employees. In total, these migrants fill in 514,000 different jobs, amounting to 4.7% of the total number of jobs available in the Netherlands. As 26.4% of these migrants are hired in the agricultural sector, in some agricultural production regions in the south and west the share of their employment can be as high as 25%. However, the living condition, especially the housing of these migrant workers is not sufficient in the Netherlands, making the country less attractive to the migrants. Besides, the price of migrant labour increases quickly due to the growing economy and intense competition over labour force among the countries in Western Europe.

On organic farms, a study reported that labour input is 20% higher for livestock breeding, and 50% higher in arable and horticulture farms in the Netherlands (Bukman, 1992). The higher requirement of labour on Dutch organic farms is normally satisfied by non-family workers, especially temporary hired workers (Linden & Heezen, 1998). Acs et al. (2007) explained that due to the low skill requirements and boring, mainly manual work on organic farms, the willingness of people to do this farm work is very low, which means that labour availability could be a problem faced by organic farms in the Netherlands. Another aspect to mention is that the total wage cost of hired temporary workers is high, as Acs et al. (2007) reported that the total expenditure on hiring workers on organic farms is seven times higher than that on conventional farms.

As calculated in previous chapters, the labour input on organic farms is generally higher than that on conventional farms. The data of the total cost of labour[15] on each selected farm is presented in Fig. 5-1. It is clear that the total labour cost on organic farms is higher than that on conventional farms, and the gap is even larger between organic and conventional arable/vegetable farms. For the cost of hiring labour, the disparity between organic and

[15] The original data is collected from the farms' accounting, and the accounting data usually includes the standard labour cost of the farmers themselves based on the tax policy. To show the labour cost in reality, the data presented here removes the standard labour cost of the farmers from the accounting data.

conventional farms, especially for arable and vegetable farming, could be overwhelming. There is an exception that the cost of hiring labour on small organic vegetable farms is smaller than on the corresponding conventional farms, and this will be explained in a later part of this chapter.

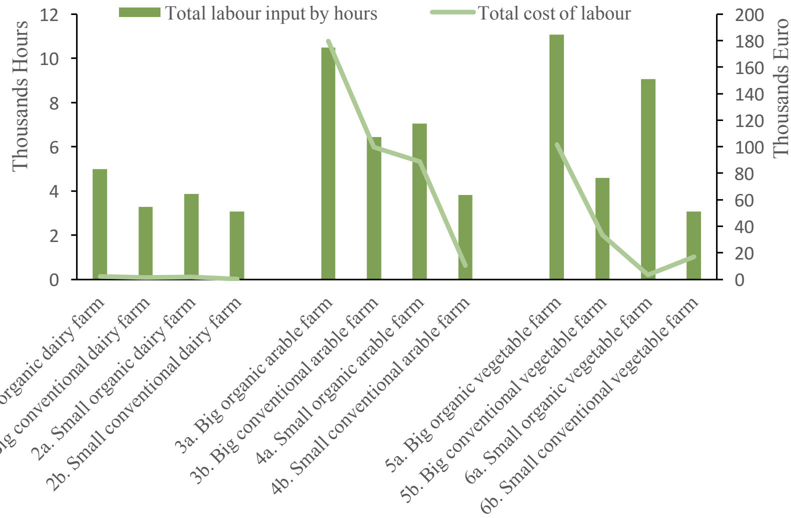


Fig. 5-1 Labour input and cost on farms in the Netherlands

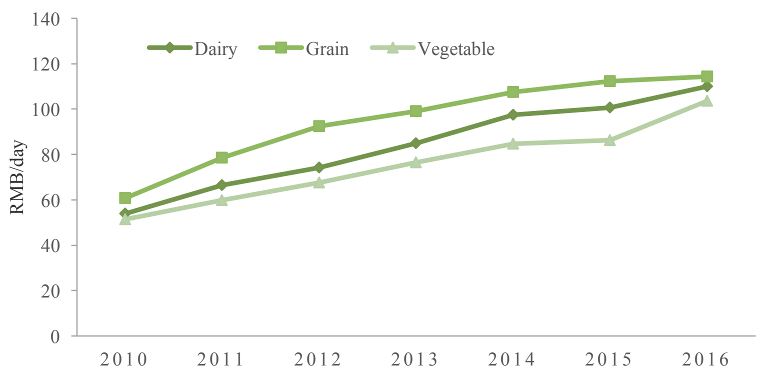


Fig. 5-2. Average wage of hired labour on farms in China between 2010-2016

In China, the agriculture sector also faces the problems of labour shortage and increasing labour price, even though the context is different from that in the Netherlands. With the rapid industrialisation and urbanisation happening in China, millions of people in rural areas, regarded as surplus rural labour, are moving to cities: about 170 million rural migrant workers in 2016 alone left their home (Liu & Li, 2017). Most of the out-migrating labourers are young and fit men, leaving behind about 60 million children, 47 million women, and 50 million elderly people in 2015, which in turn led to a severe labour shortage for agricultural production (Yang, 2013;Liu & Li, 2017). Each year around 2 million hectares of agricultural land are left uncultivated due to the labour migration in China. Apart from labour shortage, the price of hired temporary labour on farm has increased rapidly in last decade. According to the yearbook Compilation of Data on Costs and Profits of Agricultural Products, the average wage of hired labour increases continually on dairy, grain and vegetable farms. The price of hired labour on farms in 2016 was nearly double what it had been in 2010 (see Fig. 5-2). The increasing labour price is no doubt a causal factor in the growing cost of farming.

As organic agriculture is still a relatively new topic in China, the study about labour issues on organic farms is limited. The comparative analysis of labour input between organic and conventional farms in China in the previous chapter has proved that organic farms use more labour, and the data collected from organic farmers also show that labour costs on organic farms are higher than on conventional farms (see Fig. 5-3). The labour cost gap is extremely large between organic and conventional vegetable farms. The increase in labour price would bring great cost pressure to organic vegetable farms.

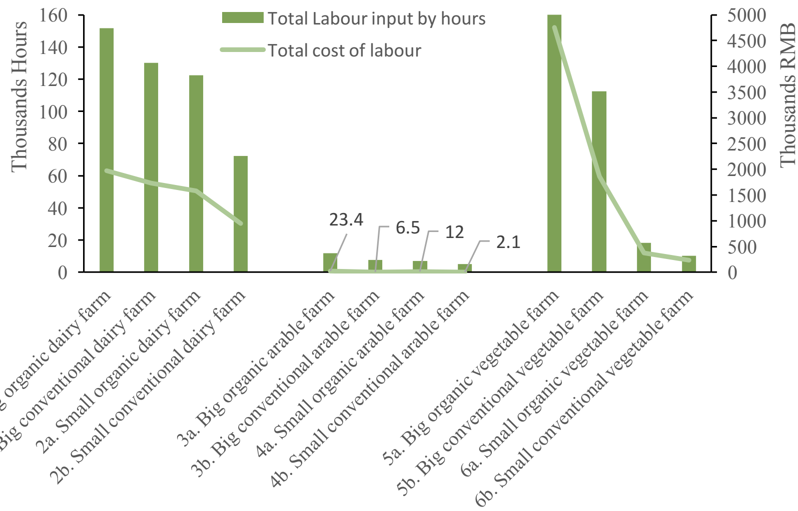


Fig. 5-3 Labour input and cost on farms in China

Comparing the labour input and cost between the Netherlands and China reveals that the labour input and cost on dairy farms in China is relatively high while the same in the Netherlands is low. The situation for arable farms in the two countries shows the reverse, because the average size of dairy farms in China is much larger than it is in the Netherlands, while the average size of arable farms in China is much smaller than it is in the Netherlands. Another reason for the different labour input and cost in the dairy sector could be that the mechanisation level on dairy farms in China is lower than that in the Netherlands.

5.3 Organic farmers' perception of and response to labour constraints

Even though the potential labour constraints have been presented at a theoretical level, organic farmers' perceptions on the issue remain unclear. In the interviews with organic farmers in both the Netherlands and China, questions about the possible constrains related to labour use in organic farming, and how they would respond to the constrains were asked. The responses revealed that organic farmers have different perceptions of labour constrains, and that they also responded differently to the constrains (see Table 5-1).

Table 5-1 Organic farmers' perceptions of and responses towards labour constraints in the Netherlands and China

	The Netherlands		China	
	Perception of labour constraints	Response to labour constraints	Perception of labour constraints	Response to labour constraints
1a. Big Organic Dairy farm	No concern	/	High labour cost	Increase mechanisation
2a. Small Organic Diary farm	No concern	/	High labour cost; Aging problem	Increase mechanisation
3a. Big Organic Arable farm	High labour cost; Labour shortage	Increase mechanisation	High Labour cost;	Build cooperative and organic farmers' market
4a. Small Organic Arable farm	High labour cost; Labour shortage	Increase mechanisation	High labour cost;	Rural reconstruction; Build organic farmers' market
5a. Big Organic Vegetable farm	High labour cost; Labour shortage	Hire underage labour	High labour cost; Ageing problem	Increase mechanisation
6a. Small Organic Vegetable farm	High labour cost; Labour shortage	Work with volunteers	High labour cost;	Build organic farmers' market;

Except for the dairy farmers in the Netherlands expressing no concern regarding labour constrains, others in both countries see the labour challenges of high labour cost and labour shortage. As the labour input and cost on organic dairy farms are not much different from that on conventional dairy farms in the Netherlands, organic dairy farmers do not see constrains related to labour use on their farms. For other organic farmers in the Netherlands, high labour cost and labour shortage are the two main concerns. The high labour cost is usually connected to increasing labour price and high labour demand by farmers, while labour shortage is connected to the difficulties and worries in hiring temporary labour in the busy season. In China, all organic farmers show concern regarding the high labour cost due to the increasing labour price and high labour demand, but no one worries about the issue of labour shortage, as they can still hire enough labour. Another concern, the ageing problem, is also mentioned by some organic farmers because most of the workers hired on organic farms are over 50 years old. As they normally have no or only basic health insurance, the employers worry about the accidents that may happen to them during work.

Closer analysis of the responses of organic farmers to the labour constraints reveal different patterns. The first one is to increase mechanisation on the farm. This means that the organic farmer would like to use bigger machinery or new technologies, for example artificial intelligence, to replace human labour on farm. The second pattern is that the organic farmer explores unconventional forms of labour and thereby reduces labour costs. This is mainly seen in the Netherlands, with organic farmers trying to either hire underage labourers or use volunteers to get the manual labour accomplished on the farm. To reduce labour costs and secure their livelihood, some organic farmers, especially in China, choose to build networks not only with other organic farmers but also with consumers, for example by forming a young organic farmers' network, or an organic farmers' market. These networks would be helpful to ensure that organic farmers get enough support from both their peers and their clients when they face labour constraints. The support could be training and recruiting workers or getting a relatively high return for the product to compensate the high labour cost on the farm.

The first pattern is obviously a conventional way to possibly increase the other resources input on organic farms, however, it would decrease organic farms' resilience. Using high levels of mechanisation on organic farms, for example using robots to replace human work, could reduce farmers' autonomy in organising agricultural production and reproduction. It is a large investment which may bring debts to farmers. Due to the financial pressures, farmers are increasingly forced to change their farming practices. Moreover, the high technology would be exclusive to small organic farmers and organic farmers in the developing countries, as they have limited access to commodified resources. This would squeeze them out of the market further and lead to them losing their livelihoods (Altieri *et al*, 2008).

However, the second and third patterns would increase the organic farms' resilience and ability to deal with the constraints, which are of great interest to be discussed further. The following part of this chapter will present four cases (two from each country) to explain how some organic farmers have been dealing with the labour constraints.

5.4 Cases of organic farmers' resilient responses to labour constraints

a. A pattern of moving beyond the boundaries of the commodified labour market

As part of the complete organic production chain, farm workers, especially the temporary workers employed by organic farms in the Netherlands, usually come from Eastern and Central Europe. These migrant workers are recruited by local agencies and then sent to work in the Netherlands. They are usually classified into different categories based on the proficiency of their skills and attached with different prices. Organic farmers can create a combination of workers with different proficiency levels in order to maximise the labour efficiency while minimising the cost. Workers on these organic farms are thus completely commodified on the labour market.

Concerning the high labour cost and difficulties in recruiting enough migrant workers, some organic farms seek alternative ways to hire temporary labourers to work on their farms in the Netherlands, and the big organic vegetable farm selected in this study is one of them. Located in Flevoland province, the land reclaimed from the sea in the Netherlands, the farm shifted to organic in the 1990s. Now there are about seven varieties of vegetables planted on a total of 75 ha land, which is larger than the average organic vegetable farm according to the farmer. With his decades of experience in organic farming, the farmer pointed out that one of the biggest challenges is the increasing labour cost. It occupies the largest percentage of the total farm costs. To reduce the labour cost, in recent years the farm began to hire the local youths, pupils, and students rather than migrant labourers during busy agricultural season.

According to the regulation of the Dutch government, young people from 13 to 16 years of age are allowed to work outside of school hours and in the holidays, and people over 16 are free to work without restrictions. Usually people older than 22 should be paid regular minimum wage, while people from 15 to 21 have irregular minimum wage, which is lower. For example, 15-

year-old students are allowed to be paid 40% of the minimum wage (Agri-info, 2007). As the busy season on the farm is normally the summer holiday for students, it is possible for the farmer to hire students under 22 at a lower wage than other workers.

However, sometimes it is not easy for the farmer to get enough young workers, as the farm job is not that attractive on the one hand, and on the other, hiring information does not spread as easily as on the regular labour market. The son of one such farmer, working as a partner on the farm, fixed the problem based on his knowledge about the popular online social network among the youth. With the development of mobile Internet, young students spend a lot of time on social network, sharing their life in words, photos and videos. Using this situation as an opportunity, he posted some specially edited words, photos, and videos about working on the farm, spreading the message 'working on farm is cool' throughout local students' communities. Eventually, the farm was able to hire enough students to work during the summer.

The post on social network about hiring students working on the organic

Usually the youth hired on the farm only undertake unskilled jobs, for example, harvesting, cleaning, and sorting vegetables, and they are only hired at school holiday times. For doing work at non-school holiday times, the organic farmer also tries to hire the unemployed locals and housewives who work flexible schedules for lower payment. The strategy of hiring the youth and housewives to work on the farm reduces the labour input cost effectively, according to the farmer.

Actually hiring the youth to work on the farm is not unique to the agricultural sector, as supermarkets and stores selling fast-moving consumer goods have been hiring the youth for a long time to work part time. But what that organic farmer is doing now moves beyond the normality of organic farming's dependence on migrant workers.

If the case discussed above can be regarded as stretch the boundaries of the commodified labour market, the labour use practice on the small organic vegetable farm then departs from the market entirely. Located in the central part of the Netherlands, the small organic vegetable farm started in 2006 by three young women who owned no land but all had a passion for farming. They rent land from a big organic arable farm, and plant dozens of varieties of vegetables on that land throughout the whole year. With its limited land size and capital investment at the beginning, the vegetable farm started with intensive labour input to keep its cost as low as possible. To get enough people working on the farm within a very limited budget, the new farmers decided to follow a different course. At first, they tried to involve as many volunteers as possible to work on farm, and it worked. Now there are about 10, sometimes even more, volunteers working for them. These volunteers are usually retired, unemployed or half-employed locals living close by, and they come to work on the farm for one or two days per week according to their schedule. As volunteers, they do the work on farm without payment, only sometimes taking vegetable home as a reward. Now the working hours contributed by volunteers accounts for about 30% of the total labour input on farm, which successfully keeps the labour cost as low as possible.

It is surprising that some volunteers have been working on the farm for more than 10 years. When asked why they chose to work on the organic vegetable farm, the volunteers answered that it is the lifestyle of organic farming that attracts them and makes them enjoy working together for a long time, namely working with the earth, eating healthily, and living as a community. According to the participatory observation, the labour work on the farm is not intense, as volunteers and farmers joke and chat together like friends while working. Normally there are two breaks from their work per day, during which refreshments like tea, coffee and home-baked cakes are served, and local news is shared. The volunteers interviewed usually used the words 'happy' and 'satisfying' to describe their experience of working on the farm. In fact, the relationship among the volunteers and farmers is not limited to the farm. They often organise activities and spend time together in the weekends as friends. On one Friday movie night, one volunteer invited everyone working on the farm to his house close by the farm, and food produced by themselves was cooked together and shared.

Different from the capitalist labour hiring activity, the practice of organising volunteers to work on the farm is a form of 'alternative economies'. According to Healy (2009), the term 'alternative economies' refers to an array of processes that differ from the mainstream economy, and the process of labour is one of them. Neoliberalism assumes that as rational people, organic farmers would always try to extract the most value out of the hired labour while minimising the cost. However, the small organic vegetable farm chooses not to use 'the rational way' of hiring commodified labour, but rather to build a local community among people who are marginalised by the mainstream labour market. These people working on the farm are not treated merely as labour but as humans who have their own values and feelings. In the interview with the farmer, she made a comparison between people working on her farm and the migrant labour hired on her neighbouring organic farm.

> *'Even though farming job is not easy, I always feel a relaxing and pleasant atmosphere during our work on farm. I also noticed the Polish workers hired by our neighbour farm. Their job is very tough. Last summer they even had a strike when they harvested pumpkins on farm because they had no enough time for rest. I feel sorry for them. I definitely don't want that happens on my farm.'*

Even having the same perception of potential labour challenges, the farmers of the big and small organic vegetable farms respond differently from other organic farmers. If what the big organic vegetable farmer is doing can be interpreted as expanding the boundary of the commodified labour market, the small organic vegetable farmer's practices abandon the whole neoliberalist system. This response to the challenges defined by neoliberalism represents the organic farmer's resilience to the pressures of the mainstream economy.

b. A pattern of civil society-driven development

In China, due to different social contexts, organic farmers mainly show another pattern of response to the labour constraints. It is a pattern of development driven by the whole civil society. Two cases, one small organic arable farm and one small organic vegetable farm, are taken up in this study.

Witnessing rural declines that resulted from industrialisation and urbanisation in China, various parts of civil society, scholars, NGOs, and grassroots, started to explore the possibility for revitalising the countryside. Aiming at resolving 'sannong issues' (issues involving agriculture, the rural area and the peasants)[16], the New Rural Reconstruction Movement (NRRM), led by Liang Shuming Rural Reconstruction Centre (LSRRC), has been working on sustainable agriculture and rural development in China since 2003. It promotes alternative farming systems by supporting peasant cooperatives, local knowledge, and agroecology (Guo, 2013). One of the important activities organised since then is to inspire the youth (mainly college students) to go back to the village to help peasants build stronger social networks and gain knowledge on sustainable agricultural development. By practical training and education, hundreds of young people started their career back in the village according to an unofficial statistic[17]. On the second network meeting of the youth organised in Henan province in 2016, about 36 people participated, from 20 to 50 years old. According to a survey conducted during the meeting, over half of them started their family farm, 30% organised a peasant cooperation for agro-ecological production in the local village, while others worked on agricultural and local services[18].

In fact, returning to the village is not an accidental event occurring in one single province. Other than the returning youth who have been included in the network in Henan, Guangxi, Fujian, and Jiangxi provinces, millions of migrant workers who lost their jobs in cities, especially during the global financial crisis in 2008, went back to their hometown (Liang et al., 2014). A study conducted in a traditional agricultural province shows that half of these returning workers planned stay in village for various reasons (Wang et al., 2014a). When asked what jobs they would choose, about half of them intended to become self-employed individuals, and 20% of them planned to go into agricultural production (Wang et al., 2014a). With the shifting of the industrial structure and new norms of economy in China, it is possible for the returning youth and migrant workers to revitalise the countryside in different directions (Démurger & Xu, 2011). The labour intensive organic farming could be one of them.

Located in Henan province, a traditional agricultural area in North China plain with a large population of migrant peasant workers, an organic arable farm was started by a new and young peasant in 2012. In his 20s, rather than finding a job in the city like the other youth normally do, the young man chose to stay in the village and start an organic farm together with his parents who had been working in the fields for their whole life. This was quite a bold decision

[16] Also known as 'Three Dimensional Rural Problems' or '三农问题' in Chinese, sannong issues include the problems of agriculture (high cost and low profit, abandoned farm), peasant (low income, migrant worker with low welfare), and the rural (hollowing village, labour shortage, left-behind children and elderly people) happened in the process of industrialization and urbanization.

[17] According to the organizer of the youth camp, every year there are about 15 to 20 college students joining in the camp. In 2017, the 13th camp was organized successfully. After the training in camp, these students usually go start their own career either in countryside or for serving rural society.

[18] Based on an article 'Group image of the returned youth in Henan province'(in Chinese) posted on social media of Liang Shuming Rural Reconstruction Centre.

considering almost no peers lived in the village any more, especially no one who had studied in college in Beijing like he had, and thus had a much higher education than the other villagers. In the first few months after his return, villagers gossip about him, and some even wondering if this young man was a criminal in the outside world. These rumours naturally brought great pressure to his parents, however, if the villagers had known more about his experience studying in college, his decision would have seemed totally understandable.

In 2009 when first left the village to study business management in a college in Beijing, the young man never imagined that one day he would return to live in the village. Only after the New Rural Reconstruction Movement piqued his interest did he change his mind. During his involvement in the NGO, he received training sessions on organising peasant cooperatives and converting to organic farming. With that knowledge, he constructed his own awareness about rural development and farming, which formed the basis for him to be a successful young farmer.

At the beginning, together with his parents on 40 mu land (about 2.7 ha), he cultivated cereals and beans organically. Due to the expanding demand, they rented another 50 mu (about 3.3 ha) land from other villagers two years ago. Just as on other small organic farms, both the amount and cost of labour input on this small organic arable farm is high. Weeding is the most labour intensive activity on the farm: at least five workers need to be hired for five days of weeding, and this happens about eight times a year. The farm hires mostly women over 50 who have either just lost their jobs in the city or are the left-behind ones in the village. These women usually have their own small piece of land, but normally it is not the main source of their household income. Working on the organic farm temporarily has somehow become popular among them since they have an otherwise very limited income.

Even though most villagers do not think that returning home and doing farm work is acceptable for a young man, the benefits to this alternative soon became visible. In recent years, as some labour intensive factories moved out of China due to increasing costs, more young people are returning to the village. According to the young farmer, some of these fellows he grew up with who had been working in electronic factories in coastal cities consulted him about starting their own organic farm. The new farmer said he is planning to build a local network in the village to help them.

> *'We already have a network including most of the new farmers in the province. We visit each other's farms frequently, and gather together to share knowledge and to support each other. There is even a national network and we meet once a year to discuss the challenges we all face and possible solutions. I benefit a lot from these networks, and I also want to help the fellow young people who want to do organic farming in my village. Hopefully we can build a small but stronger network. This could be a cooperative, or something else.'*

This example case of young people returning to their village and being successful in their enterprises is not the only one of its kind, which shows the promise of new blood in the rising organic agriculture in China. The network is being built up by these new and young farmers who express enthusiasm for expanding the network in the future. Even though they still face various barriers, it is a good start to tackle not only labour challenges on organic farms but also the future of agriculture in China.

Another aspect of the labour challenges is the financial pressure of the increasing labour price on organic farm. To secure organic farmers' livelihoods, different civil activities provide alternative food systems in the context of the rising middle class in China. With the booming urban economy, people's average income is increasing rapidly in China, and a Chinese middle class is taking shape. The reference to 'middle class' here has nothing to do with the Marxist concept, but simply indicates the share of people with mid-level income (Wu & Yang, 2006). The number of this group could soon reach up to 300 million, exceeding the average population of most developed countries in the Western world (Ma, 2006). According to research from China Academy of Social Sciences, this middle class in China is estimated to comprise about 23% of the whole population in 2010 (Lu, 2010). Over the last decade, the middle class might have mostly been distributed in municipalities like Beijing, Shanghai, or other coastal cities, either in the delta of Yangtze or Pearl River where advanced industry is concentrated. But today the group is expanding to smaller towns more inland (Shi et al., 2011). The characteristics of the middle class in China are summed up as people who are wealthy with a high level of education, pursuing a quality life (Chen & Yi, 2004). As consumers, the middle class prefers products with higher quality when it comes to food (Veeck & Burns, 2005; Gale & Huang, 2007). Especially with the frequent food safety scandals and environmental hazards, the demand for food safety and sustainability among the middle class has increased sharply (Yin et al., 2010; Bekele et al., 2017). Evidence shows that they are willing to pay a premium for organic or green products (Wang et al., 2008; Yu et al., 2014).

To promote quality food, different food labels with quality standards were issued at the national level in China (Scott et al., 2014). The first organic certification was granted to a farm producing tea in 1990, and by 2016, there were about 2.3 million hectares agricultural land certified as organic ranking China the third in the world for organic production (Willer et al., 2018) even though it still comprised less than one per cent of the total agricultural land area in the country. The production of organic food is mainly for exporting (with foreign certification), and only in recent years has the production for the domestic market (with domestic certification) increased due to growing demand. However, according to some researchers, consumers do not have a high level of trust in the organic certification in China (Yin et al., 2010; Sirieix et al., 2011; Chen, 2013), and this distrust in turn provides opportunities for the development of alternative food networks (AFNs).

Against the background of the food safety crisis and the growing middle class, various AFNs have been established in civil society since 2008: community supported agriculture (CSA), organic farmers' markets, buying clubs, and recreational garden plot rentals (Si et al., 2015). There are different dimensions of alternativeness within AFNs, and the redistribution of value to smallholders on the value chain is one of them. To promote ecological production, farmers included in the networks produce organically, even though most of them have no third-party certificates. Out of food safety anxiety and the pursuit of healthy foods, the consumers, on the other end of the value chain, are seeking organic products via alternative channels (Shi et al., 2011; Scott, et al., 2014). Aiming at booming local farms by maintaining local markets and a shortening food supply chain, AFNs thus provide farmers with profound sale channels that are different from the conventional ones. Furthermore, they ensure that organic farms, especially small ones, get a fair return for their work. In this way, the increasingly high labour cost on organic farms is somewhat compensated by the premium that the middle class is willing to pay for safe and healthy food.

The Beijing farmers' market is one of the AFNs. Claimed to be a social enterprise, it provides not only a market for farmers to sell their products, but also a Participatory Guarantee System (PGS) to make sure these farmers follow organic principles in their production. Initiated by the farmer's market, the PGS also involves the fellow farmers, consumers' organisations, and NGOs to participate in the activities. It works as a peer certification process among roughly 40 small farms. The organisers of the market are responsible for organising on-farm inspections before as well as during a farm's participation in the market. A monthly booth fee is charged for the participation in the market, ranging from 200 to 1000 RMB (from €25 to €125 according to the 2018 currency rate) based on farm size.

The customers of the farmers' market are mainly white collar workers, especially mothers with children, or the elderly with poor health. They have great demand for healthy food, as well as concern for the environment. On the market, the price of products is normally determined by the producer based on the cost of all inputs on the farm, including the cost of the farmer's work. According to interviews and observation, the price on the market is generally several times higher than that of conventional food, but the products, mainly fresh vegetables and prepared food, are still sold out quickly.

Located northeast of Beijing, the small organic vegetable farm is a member of the farmers' market. The farmer started his organic farm in 2013. It has less than 100 mu land (6 ha), on which he has placed 12 plastic greenhouses and 3 unheated greenhouses (covered with thermal insulation material). Despite being run strictly on organic principles, the farm has not been certified by any certification bodies. One reason is that the cost for certification is high, reaching to 20,000 RMB per year per category of vegetable products. As there are usually about 70 different varieties of vegetables growing on a relatively small plot of land, more than five certificates are potentially needed to cover all these products with the official certification system, and this would cost a good fortune of this small farm. Thus, joining Beijing organic farmers' market and its PGS is a better choice.

According to the farmer, he tries to reduce the input on the farm as much as possible, for example avoiding the overuse of nitrogen from manure or compost, using natural resources to make repellent liquid for pest control, and even experimenting with no-tillage cultivation for saving labour, but the labour cost on the farm is still high, being the largest part of the total cost. Now the farm is mainly managed by the farmer and his wife, and they have to hire another six farmers working full time on the farm. After joining the farmers' market, the farm developed enough loyal customers who order the vegetable weekly, and it provides home delivery services as well. The farmer said he could cover the high labour cost and support his family with the income now, thanks to the market that provides a valuable channel for his products.

As an AFN, the farmers' market in fact realises the value of the small organic vegetable farm to the fullest by connecting it directly with customers. It helps the middle class find the safe food that they demand, and makes sure small organic farmers get fair return to support their livelihood. When talking about the high price of products at the market, one of the organisers pointed out, *'When you buy vegetables at the market, you seemingly pay for the products, but actually the price you pay includes much more than that, for example, the labour work of farmers, the environmental benefits contributed by organic farming. Your consumption can support a small organic farmer's livelihood. This is different than buying vegetables in the supermarket. The price of those products does not include the real value of the farmer's work, and it neglects the value of protecting the environment as well.'*

With the high price of vegetables, the farmers' valuable labour work is apparently compensated to some extent.

With the participation of the entire civil society, organic farmers in China have found positive ways to deal with the labour constraints. The movement of rural reconstruction initiated by scholars and NGOs provides training and support to build wide networks among young organic farmers, and the organic farmers' market and PGS constructed by both consumers and organic farmers make sure that the producers can get equal return from their work. These grassroots activities have increased organic farmers' resilience greatly by increasing their capacity to adapt to either external or internal changes.

5.5 Explaining the different patterns between the Netherlands and China

The organic farmers in China, not worrying much about labour shortage but about ageing problems and increasing labour cost, show a different pattern of resilient response from that in the Netherlands. The differences between the two countries can be explained mainly by their different social contexts, specifically the distinct development of organic farming.

When it comes to organic producers in the Netherlands, Miele (2001) pointed out that three different generations should be distinguished. The first generation of organic producers were the motivated pioneers who had no agricultural background and thus mostly failed in their business, while the second generation who had agricultural education applied economic farm management and eventually built an increasingly attractive image of organic agriculture. Over many years, a mature organic food supply chain has been built up in the Netherlands, and it is profitable under the growing demand of organic food. Thus, the third generation of organic producers is mainly motivated by the economics of it, and the organic production is generally export-orientated. Within the highly commodified and marketed organic industry, almost all inputs, including workers, and outputs on organic farms are circulated under the market disciplines. This gives less space for the involvement of civil society, and that is also the reason why organic farms in the Netherlands basically try to break through the boundaries of the commodified labour market as a response to the labour constraints.

Even though both organic systems are challenging the mainstream economy, the organic farmers' practices in China shows stronger contradictions or even resistance to the formal organic sector compared with that in the Netherlands[19]. Organic farming has been part of Chinese agriculture for less than 30 years, and it was introduced and promoted mainly by the government. At first, it was export-oriented as well, however, with the increase of people's income and the exposure of food scandals in China, the demand of organic food increased

[19] Here the organic farmers refer to those who are not certified by official certification bodies but by the Participatory Guarantee System (PGS). The formal organic sector refers to the production and circulation of organic products, which is supervised by the official certification bodies.

quickly. The other consequence of the food scandals is that consumers lost their trust to the food systems, including the state-driven organic sector (Scott, 2014). Both the rural reconstruction promoted by NGOs and the organic farmers' market organised by both producers and consumers are trying to challenge not only the conventional food systems, but also the official organic sector. This allows civil societies to participate in the organic movements in various ways, exploring different solutions to their problems. In terms of the labour constraints, civil society is capable of activating the resources in not only the rural but also the urban areas to deal with the challenges innovatively.

5.6 Conclusions

To respond to the critique that organic farming requires more labour, which is problematic considering the labour constraints, this chapter argues that organic farmers have different perceptions and responses to the labour constraints. The findings show that organic farmers in the Netherlands and China present three different patterns in response to labour constraints. The first pattern is the conventional way of increasing mechanisation on the farm to replace manual labour. The second pattern is to break through the boundaries of the commodified labour market and build alternative economies on the farm. The third pattern is to increase the involvement of the motivated civil society in the organic movement. The second pattern, mainly discovered on big and small organic vegetable farms in the Netherlands, and the third pattern, mainly witnessed on small organic arable and vegetable farms in China, would increase organic farms' resilience to the challenges they face. In the subsequent sections, the different patterns of response in the two countries were explained by their different developments of organic agriculture. When considering other variables, both farm activity and farm size show inconsistent influence on organic farmers' responses to labour constraints. Except for organic dairy farmers, both organic arable and vegetable farmers show resilient patterns of response to the labour constraints in China, while in the Netherlands, only organic vegetable farmers show that quality. For different farm sizes, both big and small farms have shown resilient patterns.

These findings could be meaningful to organic farmers who are seeking resilience in conserving the organic production in both developed and developing countries. In developed countries like the Netherlands, building alternative economies to break through the commodified market could be helpful for farmers who would like to convert to organic farming but are concerned about the high labour cost. In the rising developing countries whose organic food supply chain is still immature and still has potentially rich human resources in the countryside, the wide involvement of civil society in developing alternative food networks could provide a solid perspective for organic farmers, especially small households, to secure their livelihoods.

Chapter 6

Farming Style and Mode: to Understand Farmers' Strategy vis-à-vis Energy and Labour Input in the Netherlands and China

6.1 Introduction

Even though it has been concluded in previous chapters that organic farms use less energy and more labour compared with conventional farms in the Netherlands and China, there are still some unanswered questions. As shown in Fig. 6-1, a small organic arable farm in the Netherlands tends to use more energy than the corresponding conventional farm for producing the same amount of gross value while keeping a relatively high labour input on the farm (see the dark green bar). Farming activities and farm sizes do not show consistent influence on organic farming's potential in reducing energy use in both China and the Netherlands, as the energy gap between organic and conventional farming is rather changeable among farms with different activities and sizes. For example, Fig. 6-1 shows that the energy gap between organic and conventional arable farms in the Netherlands is smaller (the dark green bars) than between organic and conventional dairy/vegetable farms (the light green bars). Fig. 6-2 shows that the energy gaps between small organic and conventional dairy farms and between big organic and conventional vegetable farms in China are relatively small (the dark green bars) compared to that between other organic and conventional farms (the light green bars). In terms of labour use, the percentage of family labour use on organic arable farms in the Netherlands and on organic dairy and arable farms in China is smaller than that on other organic farms in each country. The differences of energy and labour input on different organic farms will be discussed in this chapter in order to understand farmers' strategy on resource use at the farm level.

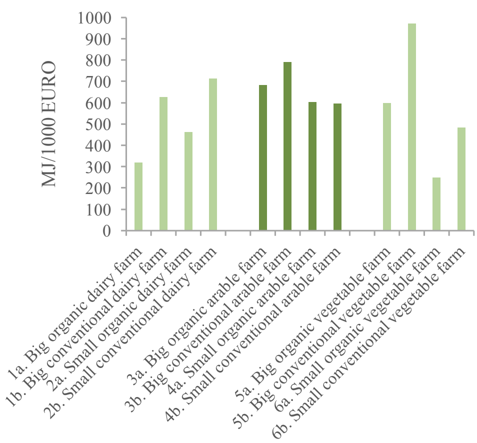


Fig. 6-1 Energy use per Gross Value of Product on farms in the Netherlands

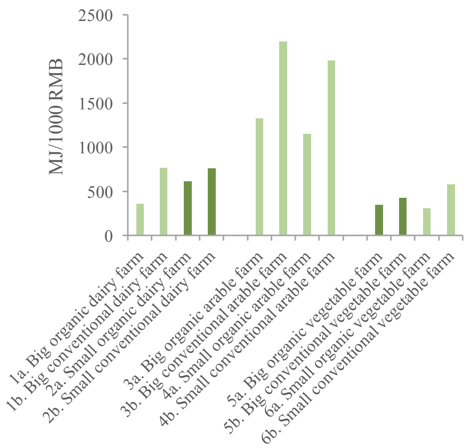


Fig. 6-2 Energy use per Gross Value of Product on farms in China

To define the differences among farms described above, they could be group differences, like the differences in energy use between the dairy and the arable sectors, or individual differences which present individual heterogeneity on farm. As discussed by Harms et al. (1987), the intensification of arable farming in the Netherlands resulted in the specialisation of crop production especially on potato, beet and maize, and land enlargement to satisfy the capacity of machines working on farms. These historical contexts could limit the potential of organic arable farming in the Netherlands in reducing both the direct and indirect energy use. Therefore, the differences between the arable sector and other sectors could explain the smaller energy gap between organic and conventional arable farms. However, if the individual differences are considered, many more exceptions in this study could be understood better.

If energy and labour are considered as two main inputs on farms, farmers as individuals would decide how to organise these resources subjectively. In agricultural economics, the best input bundle on farms is believed to be at the optimal point on the substitution curve, and the 'optimum' is defined by the price relation of input resources, namely energy and labour in this study. However, the price relation is not necessary to be objective, as subjective valuations can be highly relevant as well: farmers valorise energy and labour input based on their own situation. Thus, the input strategy on organic farms is rather changeable, which may affect its potential for reducing energy use.

How do farmers decide their input strategy? This probably links to the resource base they build and develop on the farm. It determines at which point one farm can organise its production and reproduction independently. According to the distinct resource base and how farmers would organise it, different modes and styles of farming can be distinguished. They are the keys to understanding the heterogeneity of farmers' input strategy.

With years of development, organic farming has been criticised to be conventionalised now, as it builds increasing dependency on the external inputs (De Wit & Verhoog, 2007). This means that the resource input pattern on organic farms is changing at the risk of losing its advantage in sustainability. It is important therefore to discuss what the conventionalisation of organic farming is and what the countertendency in the development of organic farming is that would enable it to achieve sustainable food production.

In this chapter, the resource base on the farm is discussed first to distinguish modes and styles of farming in order to understand the heterogeneity of farmers' input strategy on farm. In this part, farming styles of selected cases in the Netherlands and China are identified based on the qualitative data collected from interviews and participatory observation. Then the trend of conventionalisation in organic farming is discussed combining the perspective of farming styles, and two cases are presented to illustrate this process in both the Netherlands and China. At last, a hypothesis is elaborated that organic farming's potential in reducing energy use for achieving sustainability can only be maximised when combined with peasant agriculture, and organic peasant agriculture should be the countertendency of conventionalised organic agriculture.

6.2 Modes of farming, styles of farming and farmers' input strategy

When considering what might influence farmers' input strategy on farm, the accessibility to various resources and the organisation of the flow of resources to agricultural production could be the logical factors. These two factors are closely related to another concept: resource base. It represents the resources that are accessible to farmers naturally, and farmers can develop it without building dependency on external resources. As Ploeg (2018) points out, resource base includes not only the tangible resources like land and livestock, but also the intangible resources, for example social relations of production and distribution. It distinguishes farms that have different modes and styles of farming.

According to the nature and magnitude of the resource base, three constellations of world agriculture are mapped by Ploeg (2018) to describe different modes of farming: capitalist agriculture, entrepreneurial agriculture, and peasant agriculture. As shown in Table 6-1, these different modes of agriculture have different orientations, methods of production, and way of organising basic production factors on farm. When looking into the function of resource base in their farming activities, capitalist agriculture has the least resource base as it is grounded on the capital-wage labour relation. Due to its mostly large size, capitalist agriculture depends on large amounts of capital to organise its production. It moves all over the world to chase profit by making use of the resources from the international market. Thus, the resource input is basically determined by the market environment rather than its own resource base. Entrepreneurial agriculture and peasant agriculture usually consist of family farms, but the former has a limited resource base while the latter has an autonomous resource base. Even though their production is organised at a family scale, the entrepreneurial agriculture has a much higher market dependency than peasant agriculture. This means that resources used on an entrepreneurial farm are mainly the externals of its resource base. However, peasant agriculture has a much more independent resource base, which allows it make the most use of internal resources. These includes the ecological capital, family labour, local market, etc.

Table 6-1 Features of different farming modes (based on Ploeg, 2018)

	Orientations	Methods	Land	Labour	Capital	Interconnections with society
Peasant Agriculture	Peasant livelihoods; Market orientated, and reproduction of farm and family.	Multifunctionality	Owned by family	Family labour or labour within rural community	Sustained use of ecological capital	Decentralised circuits; Peasant markets.
Entrepreneurial Agriculture	Scale-enlargement; Completely market oriented.	Highly specialised; Highly market dependent.	Owned by family, rent or bought.	Family labour, hired temporary or permanent worker.	Financial and industrial capital.	Highly centralised with large food processing and trading company.
Capitalist Agriculture	Profit maximisation; Large segments of food and agriculture markets.	Agro-export model; Mobile farm enterprise.	Land grabbing	Salaried workers	International large capital.	Highly centralised with large food processing and trading company.

Modes of farming therefore categorises farms who have different accessibilities to resource base, and it determines fundamentally what kinds of input strategies farmers would use their on farm. However, if how farmers apply the input strategies needs to be explored in further, styles of farming which distinguish the use and development of resource base on farm should be discussed.

Farming style, first put forward by Ploeg in the early 1990s, is a theoretical method for describing the diversity of farming in the Dutch province of Friesland (Ploeg, 1990, 1994, 1995a, 1995b). It assumes that almost every farm commits to some certain systematic and continuous operations which identify its farming style, and 'every farming style contains a systematic pattern of style-specific valuations of scarcity and price relations'. In other words, farmers with different farming styles would attribute different 'prices' to energy and labour, which eventually results in different input strategy and farming practices. With contributions from other researchers, it has been proven to be ideal for understanding different farming practices, strategies, and socio-technical networks on farm (Leeuwis, 1993; Commandeur, 2003; Noe and Alroe, 2003; Ploeg, 2000, 2003).

To explore farmers' input strategy regarding energy and labour, the cases selected in this study can be distinguished from each other according to their featured practices and development opportunities related to technology and market, which are regarded as two coordinates for determining the possible farming style of a farm. The decision whether or not to apply technology on the farm could lead the conversion process to two opposite directions, just as the degree of one's market dependency could make a big difference in how resources are mobilised on farm. In other words, skill-orientated versus technology orientated, and strengthening own resource base versus increasing market dependency for development, are the two pairs of scales to position a farm on the map of farming styles.

a. Identify farming styles of Dutch farms

As various questions related to on-farm practice (technology appliance and market independence) were asked in interviews with Dutch farmers, farming styles among Dutch farms can be identified according to two dimensions, technology and market. The qualitative data collected from the interviews was coded in six categories, and the codes are sorted and listed in Table 6-2.

The codes listed under the category 'use of machines and new technology' are supposed to reflect farmer's choice on conversion process between technology orientation and skill orientation, while the categories use of feed (on dairy farm), fertiliser, pesticides, and labour are regarded as an index with which to detect the mobilisation of resources on farm. Codes about concentrates, fertiliser, crop protection, permanent workers, contract workers, and temporary workers are supposed to relate to a high degree of market dependency, while grazing, internal manure, and family members are seen as internal resources related to low degree of market dependency (high degree of autonomy) on the farm. Under the categories of development on farm and sustainability on farm, the farmer's vision about reducing energy cost, labour cost, monetary cost, and environmentally-friendly farming is regarded as a high degree of autonomy on the farm as well, whereas expanding farm size, increasing input and output, and lack of concern about sustainability go the opposite direction, towards dependency. Thus, based on all the codes in the table, we can locate each farm's position on the farming style map[20] (see Fig. 6-3).

[20] The map is sourced from Page 116 of the book from Ploeg (2003).

Table 6-2 Practices of production and reproduction on farms in the Netherlands

Farm type	Use of machines/new technology	Use of feed (Dairy)	Use of fertiliser/crop protection	Use of labour	Development on farm	Sustainability on farm
Big conventional dairy farm (B.C.D.)	Careful with big machines/new technology;	Grow more maize; Use more concentrates;	Reduce fertiliser and pesticides;	Family member;	Expand farm size;	Intend to convert to organic
Big organic dairy farm (B.O.D)	Careful with big machines/new technology;	Grazing as much as possible; Reduce concentrates;	No fertiliser and pesticides; Limited manure use;	Family member; partner;	Reduce energy cost;	Environmentally friendly;
Small conventional dairy farm (S.C.D.)	Use new machines; Try new technology;	Use more high protein concentrates;	Apply fertiliser and pesticides;	Family member;	Expand farm size;	Do not concern;
Small organic dairy farm (S.O.D.)	Not into machines/new technology; Believe in farmer's intelligence	Grazing as much as possible; Reduce concentrates;	No fertiliser and pesticides; Apply internal manure;	Family member;	Reduce energy cost;	Environmentally friendly; Animal welfare
Big conventional arable farm (B.C.A.)	Use big machines; Try new technology;	/	Apply fertiliser and pesticides;	Staff; Contract worker;	Increase input and output;	Do not concern;
Big organic arable farm (B.O.A.)	Use big machines;	/	No fertiliser and pesticides; Use external manure;	Seasonal worker; Contract worker;	Expand farm size;	Environmentally friendly;
Small conventional arable farm (S.C.A.)	Use big machines;	/	Apply fertiliser and pesticides;	Family member;	Expand farm size;	Do not concern;
Small organic arable farm (S.O.A.)	Use big machines; Try new technology;	/	Use organic fertiliser and pesticides;	Seasonal worker;	Reduce labour cost[5]; Expand farm size;	Not a big problem;
Big conventional vegetable farm (B.C.V)	Use big machines; Try new technology;	/	Apply fertiliser and pesticides;	Staff; Contract worker;	Expand farm size;	Do not concern;
Big organic vegetable farm (B.O.V)	Use big machines;	/	No fertiliser and pesticides; Use both internal and external manure[1];	The youth[3]; The local[4];	Reduce labour cost[6];	Environmentally friendly;
Small conventional vegetable farm (S.C.V.)	Careful with big machines;	/	Apply fertiliser and pesticides;	Contract worker;	Expand farm size;	Do not concern;
Small organic vegetable farm (S.O.V.)	Use second-hand machines;	/	No fertiliser and pesticides; Use related internal manure[2];	Volunteers;	Reduce monetary cost;	Environmentally friendly;

1. Uses waste or under-market-standard vegetables trading for organic manure from dairy farm; Collects organic waste to make fermented fertiliser on farm.
2. Collaborates with neighbour organic dairy farm for exchanging manure and labour work.
3. Hires high school students working on farm during summer season.
4. Hires local unemployed or half-employed people working on farm, especially women.
5. Intends to replace labour with machines working on farm.
6. Intends to hire more low-price workers working on farm

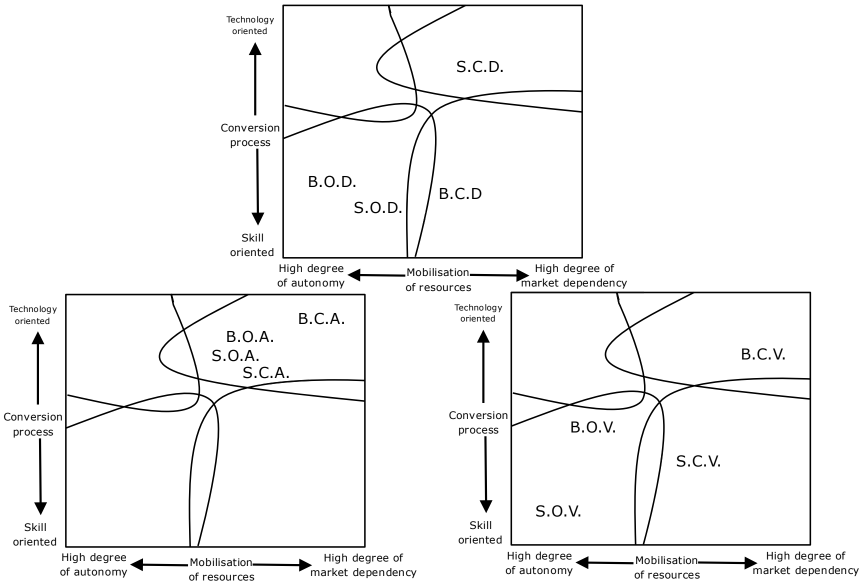


Fig. 6-3 Farming styles of selected farms in the Netherlands

If the bottom-left area on the map is defined as the zone of economical farms (skill oriented and high degree of autonomy), then most selected organic farms belong to this area. However, the two organic arable farms (B.O.A and S.O.A.), together with other two conventional ones, are all located in the upper-right zone, identified as intensive farms (technology oriented and high degree of market dependency). Considering the exceptions mentioned at the beginning of this chapter that the small organic arable farm (S.O.A) uses lightly more energy compared with the small conventional arable farm, and the energy gap between organic arable and conventional farms is relatively smaller than that between other organic and conventional farms, the intensive farming style of both the big and small organic arable farms (B.O.A. and S.O.A) could be the explanation to the exceptions.

Therefore, it is remarkable to realise that farming styles vary even among organic farms. As shown in Fig. 6-3, both big and small organic arable farms, categorised as intensive farms, are different from other organic farms. This result shows consistency with the analysis of energy and labour input on farms in Chapter 2, which presents the finding that energy use on these two organic arable farms is close to or even higher than that on the corresponding conventional farms, while their labour input is still much higher than the latter ones. It proves at some point that it is farming style that determines the organic farmers' input strategies of energy and labour on farms rather than the method of organic production itself.

b. Farming styles of Chinese farms

The analysis of energy and labour input on Chinese farms has shown great differences between the organic and conventional systems, while the input bundle is still varied within the organic farming system. The question whether farming style can explain the diversities among Chinese organic farms, just as it did on Dutch farms, is worth exploring.

As farming style is socially constructed, the context it embedded in, tangible or intangible, is important for identifying the styles. Apparently, China is different from the Netherlands in nearly all respects, also in styles of farming. However, when we talk about energy and labour as basic input resources on farms, there are similarities at the macro-level between these two contexts as well. Thus, technology and market, as two universal perspectives in modern agricultural production, can still be used as two poles for mapping the farming styles of Chinese farms regarding input strategy -- but other perspectives are also considered.

When analysing the qualitative data collected via interviews and participatory observation on Chinese farms, different codes are generated with respect to production and reproduction (see Table 6-3). The codes are divided into two dimensions: market and technology, representing the way of mobilising resources and conversion processes on farm respectively. If we use the farming style map in Figure 6-3, the position of each Chinese farm can be located on the map according to the codes.

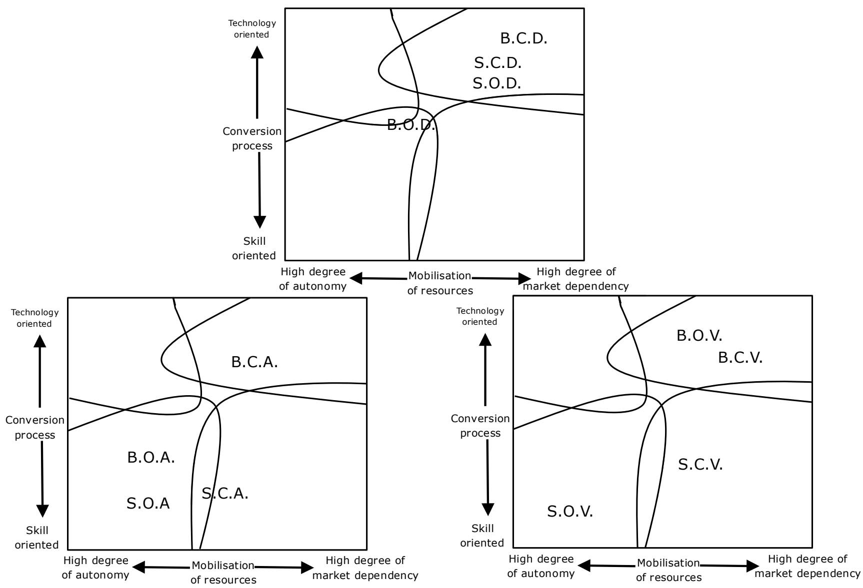


Fig. 6-4 Farming styles of selected farms in China

As shown in Figure 6-4, most organic farms are located at the bottom-left area on the map, identified as the economical farming style, which has low technology orientation for conversion and low market orientation for organising resources on farm. The farms located in this area generally show relatively high potential in reducing energy use if we go back to the analysis of energy and labour input in Chapter 3. However, the small organic dairy farm and big organic vegetable farm (S.O.D. and B.O.V.), located in the intensive farming style section, with their relatively high technology and market orientation, show lower potential than other organic farms in terms of reducing energy use. This result is consistent with the findings from Figure 6-2 that the energy gap between the small organic and the conventional dairy farms and between the big organic and the conventional vegetable farms is smaller than that between other organic and conventional farms in China.

Table 6-3 Practices of production and reproduction on farm in China

Farm type	Use of machines/new technology	Use of feed/animal health (Dairy)	Use of fertiliser/crop protection	Use of labour	Development on farm	Sustainability on farm
Big conventional dairy farm (B.C.D.)	Use big machines; Use new technology	Import concentrates; Import silage overseas; No control of antibiotic use	Not applicable[3]	Professional farm manager; permanent professional worker	Increase yield per cow; Enlarge cattle number	Profitable
Big organic dairy farm (B.O.D)	Use big machines; Use new technology	Grow maize; Grazing; Control antibiotic use;	No chemicals; Use manure (maize); Natural grassland	Professional farm manager; permanent professional worker	Enlarge cattle number	Environmentally friendly; Animal welfare; Profitable
Small conventional dairy farm (S.C.D.)	Use big machines; Use new technology	Import concentrates; Import silage overseas; No control of antibiotic use	Not applicable	Professional farm manager; permanent professional worker	Increase yield per cow; Enlarge cattle number	Profitable
Small organic dairy farm (S.O.D.)	Use big machines; Use new technology	Import concentrates partly[1]; Transport silage from the North[2]; Use herbs for prevention disease	No chemicals; Use manure (maize); Natural grassland	Professional farm manager; permanent professional worker	Increase yield per cow; Enlarge cattle number	Profitable; Environmentally friendly
Big conventional arable farm (B.C.A.)	Use big machines; Use new technology	/	Use fertiliser and pesticides;	Family member; temporary worker	Increase land size;	Profitable
Big organic arable farm (B.O.A.)	Hire small machines; Careful with new technology	/	Use manure and compost; Use biological pesticides[4]	Family member; Family member; local villagers at busy season	Reduce labour cost; Increase the value of products	Soil fertility; Environmentally friendly; Input and output balance;
Small conventional arable farm (S.C.A.)	Hire small machines; No new technology	/	Use fertiliser and pesticides;	Family member;	Reduce labour input[6]	Not concern
Small organic arable farm (S.O.A.)	Hire small machines; No new technology	/	Use manure, compost, and biological pesticides[4]	Family member; local villagers at busy season	Reduce labour cost; Increase the value of products	Soil fertility; Environmental friendly
Big conventional vegetable farm (B.C.V)	Use small machines; Use new technology (big greenhouses)	/	Use fertiliser and pesticides	Partnership[5]; permanent workers;	Seek new market; Technology oriented	Profitable
Big organic vegetable farm (B.O.V)	Use small machines; Use new technology (big greenhouses)	/	Use organic fertiliser, manure, compost, and physical pest control	Professional farm manager; permanent workers	Seek new market; Reduce labour cost; Technology oriented	Profitable; Environmentally friendly
Small conventional vegetable farm (S.C.V.)	Use small machines; No new technology	/	Use fertiliser and pesticides	Family member; permanent workers	Increase yield per ha; Seek new market	Profitable
Small organic vegetable farm (S.O.V.)	Use small machines; No new technology	/	Control the use of compost; Use biological pesticides[4]	Family member; limited local workers	Reduce imported inputs; Reduce labour input	Soil fertility; Environmentally friendly

1. Imports mainly soybean, while growing maize on farm, and then mixes them together on farm to feed cows.
2. The cows are located in Beijing, but the farm's grassland is located in Inner Mongolia (about 500km).
3. As almost all feeds are bought outside of the farm, there is no fertiliser nor pesticide use within the farm.
4. Biological pesticides are usually made by farmers themselves on organic farms. Tobacco leaf liquid, vinegar, Chinese liquor, and fermented liquid are normally included in the ingredients.
5. Two people who are related to each other, for example cousins, own the farm together, and they manage the farm together as well.
6. The farmer has other jobs in city close by. He tries to plant crops which need less human labour input.

To sum up, identified by farming practices and the farmer's vision, farming styles can be featured as a decision-making model to explain the differentiation of energy and labour input balance on different farms in the Netherlands, as well as in China. Specifically, trying to reduce farming costs by applying less technology and making the most use of internal resources, organic farms with an economical farming style shows higher potential in reducing energy use in the agricultural production than the farms identified as intensive farming style.

6.3 The conventionalisation of organic agriculture

Even though organic principles or values can be introduced and identified from different perspectives, for example, the history of organic movement, regulations of certification, and empirical studies, the four principles summarised by IFOAM construct a value base rooted in almost every perspective (Padel et al., 2007; Luttikholt, 2007; de Wit & Verhoog, 2007). Specifically, the four principles include health, ecology, fairness, and care. Organic agriculture should enhance the health of not only humans, but also animals and the planet. It should also work with, emulate and sustain the ecological system and cycles, which means chemicals should be forbidden, non-renewable resource consumption should be reduced, closed input and output cycle and recycling should be used, and biodiversity should be protected. The principle of fairness demands equality and respect of life opportunities and animal welfare, while care covers the values of precaution, transparency, and participation, in general to be responsible for the well-being of the environment and all its inhabitants, both now and in the future. These principles are what distinguish organic agriculture from conventional agriculture.

However, the current organic farms could possibly go against the value-base of organic agriculture when they increase the intensification and specialisation on their farms, just as conventional farms are doing. This can be seen on the farming styles chart – that some organic farms are located in the area of intensive farming styles rather than the economical farming style. Both the big and small organic arable farm in the Netherlands use as much machinery and high technology as possible on farm in order to reduce labour input and increase dependency on fossil energy. This is in conflict with the principle of ecology. Moreover, the big organic arable farm, to make it more convenient for machinery operation, plants limited varieties of crops (about six varieties) in the rotation scheme on hundreds of ha of land, which neglects the value of diversity protection. Even though it has more than 300 milking cows, the small organic dairy farm in China uses massive amounts of soybeans, which are possibility imported overseas and could therefore be sourced from genetically modified (GM) products; it also uses silage, which needs long-distance transportation. This goes against the organic principles of health and ecology. Furthermore, all the cows on the farm are kept inside stalls with limited space, and no grazing is possible, as there is no grassland close by. Even though the practice conforms to the regulations of organic agriculture in China, it violates animal welfare. On the big organic vegetable farm, hundreds of greenhouses equipped with different technologies cover the land permanently. The so-called organic fertiliser and biological pesticides produced in factories are applied on the farm, even though the source of these inputs is questionable. High off-farm inputs on this organic vegetable farm are in great conflict with the value of minimising resource use and closing the production cycle, not to mention the possible pollution from the inputs with conventional sources.

Two cases, one in the Netherlands and one in China, are presented in detail below to illustrate the conventionalisation of organic agriculture in the two countries.

a. Machine man: the case of a small organic arable farm in the Netherlands

The small organic arable farm in the Netherlands has about 60 ha land, of which 40 ha is owned by the farmer, and 20 ha is rented from another farmer. It is managed by the family where the father is the main worker on the farm and the son helps occasionally. About seven different varieties of arable crops are planted on the farm with a rotation scheme. There are quite a lot machines on this farm: they fill about two large barns, and most of the machines are large. The farmer reportedly preferring machine labour over human labour:

> *'If it's possible, I want to replace all of the human work on the farm with machines. I am very much looking forward to the development of the working robot'.*

With all these machines, the farm needs almost 20,000 L of gasoline every year. There is a big gasoline tank beside the field, and it needs to be refilled 5 times a year. When asked if he was concerned about the issue of fossil energy use on farm, the farmer said it was not a problem for him. He believes that the use of machinery is a positive trend for farming since the cost of labour is getting high.

Even though there are many different kinds of farm machines, contract workers with machines still need to be hired for harvesting. With high input on machines, the cost of labour on this small organic arable farm is still high, especially as some parts of the work cannot be done completely by machines yet, for example weeding. That's why the farmer said he welcomes the technology of robots to replace human work: he prioritises the reduction of the labour cost over the high cost of robots and the ensuing high dependency of the farm on the consumption of non-renewable energy seeing as stable, safe, and clean energy is still not yet abundantly available. These priorities lead this organic farm to position itself against the organic principle of ecology, specifically the value of reducing non-renewable resources.

b. Questionable Organic Dairy: the case of small organic dairy farm in China

The small organic dairy farm, certified by China Quality Certification Centre, is located at the northwest Beijing. It was converted to organic in 2013 with the support of the local government, as it wanted to promote the construction of ecological civilisation as a response to the national strategy. The cost of organic certification on this dairy farm was covered by the local government.

Keeping about 350 milking cows currently, the farmer called her farm a dairy cooperative because all the land, about 2000 mu (128 ha), had been bought from other villagers for a relatively low price. All this land is used for planting maize to feed the cows. As there is no grassland in the village, all the silage used for cow feed is harvested and transported from natural grassland in Inner Mongolia (about 666 ha of grassland producing about 2000 tonnes of grass per year), about 500 km north of the farm, and all cows thus stay inside the barn without grazing at all. Besides, about 1500 tonnes of soybeans are imported to the farm per year. When asked the source of these soybeans, the farmer said it could not be guaranteed 100% organic. China has become the biggest soybean importer in the world since 2000, importing over 70 million tonnes of mostly GM soybeans in 2014, which accounted for about 80% of China's soybean consumption (BBC, 2015; Yan et al., 2016). It is therefore highly possible that the soybeans used on the organic dairy farm are genetically modified soybeans imported from overseas.

Even though the number of machines and technology used on the dairy farm is not significant, the farmer expressed that she prefers to apply more. Considering the 30 full-time hired labourers are mostly over 50 years old, 'it is risky to keep them on farm because they can easily get injured during their work.' Another reason for applying big machines and technologies on the farm is that they can reduce the high cost of labour.

Another strange aspect about the organic farm is that the organic milk collected by Yili, one of the biggest dairy companies in China, is processed together with conventional milk from other farms, as Yili has no organic milk production line in Beijing area. This means the 'organic milk' produced by the farm is sold at the same price as conventional milk, which makes the inputs on the farm more suspicious. If all the inputs are produced under organic principles, which normally cost more than those on conventional farms, how can the farm survive when they sell the organic milk at the same price as conventional milk?

In the future, the farmer would like to get more milking cows (about 600) to make sure that her farm is financially sustainable, according to her words.

We cannot jump to the conclusion that the conventionalisation of organic farms is a predominant phenomenon in the Netherlands or in China, but some general characteristics can be summarised from the trends in both countries. It is very likely that energy use on the conventionalised organic farm is relatively close to or even higher than that on conventional farms, however, at the same time, its labour input is higher. This means that the conventionalised organic farm has less or no advantage at all over conventional farms in terms of sustainability. The two cases presented above show that in both the Netherlands and in China, the conventionalised organic farm shares almost the same qualities – high energy and high labour input at the same time, as well as high dependency on off-farm inputs. It could be worse in China, as more inputs with conventional sources are used due to untruthful certification (Nie et al., 2018).

The conventionalised organic farms encountered in the Netherlands and China may just show parts of organic agriculture's tendency toward change, but they nonetheless offer the picture that organic farms are moving towards conventional principles by reducing the organic principles. When considering the discussion before that organic farms moving from economical farming style to intensive farming style, it is just consistent with the conventionalisation of organic agriculture.

6.4 The countertendency: organic agriculture and peasant qualities

It seems that conventionalisation would reduce organic agriculture's performance vis-à-vis moving towards sustainability in agricultural production. It is important to explore the countertendency of conventionalisation in order to guide the development of organic agriculture into the future. If comparing the value-base of organic agriculture with the features of different farming modes, a hypothesis can be sustained that peasant agriculture could make the best match with the organic principles mentioned above, and this can also be proved by the practices on farms with economical farming style among the organic cases selected in this study.

As peasant agriculture orientates itself towards a peasant's livelihood and to the reproduction of the farm unit and family, it has to maintain the farming process carefully: the farmer must take good care of the animals to reduce the risk of disease, and pay close attention to soil health to guarantee the output on the farm. Using ecological capital sustainably, rather than financial or industrial capital, peasant agriculture could possibly make a closed input and output cycle of production by making the most use of manure – and other resources within the farming system – for fertilising and pest controlling. As peasant agriculture interconnects with society in forms of decentralised circuits, for example, peasant markets, other than highly centralised food supply chains manipulated by large food processing and trading companies, there are more chances for building relationships based on fairness to respect different life opportunities. Moreover, a short and fair supply chain on a peasant market usually makes direct interaction between farmers and consumers possible, which could involve the participation of both parties in discussing the issues that they both care about, for example, enhancing people's eating habits, reducing food waste, protecting the environment, etc.. The participation and discussion show great responsibilities in protect the well-being of both the current and future generations.

Here below, four different farms – on which peasant qualities and organic principles are applied – are introduced in detail to give a more vivid illustration of the linkage between peasant agriculture and organic values.

a. *Taking care of the cows' health: the small organic dairy farm in the Netherlands treats milking robots with caution.*

The small dairy farm, located in a village of Friesland, was converted to organic in 1989. At that time, the newly married couple, owners of the farm, decided to make some changes after joining in a debate about organic farming and thereby determining that organic agriculture was the farming style or life-style that they preferred. After decades of development, there are not many changes on the farm – only a new tractor and a new milking machine have been introduced. With fewer than 60 milking cows, the farmer of the small organic farm milks the cows twice a day, in the early morning and in the late afternoon, with a pipeline milking machine.

The neighbour of the farm is a conventional dairy farmer also owning about 60 cows. Other than applying conventional inputs on farm, the neighbour dairy farm also uses an automated milking system, or milking robot in the farmer's language. According to the neighbour farmer, the robot works almost 24 hours per day to milk all the cows at least 3 times. Close to the milking machine, there is a small office room equipped with a computer recording the data of each cow's milk quantity, moving activities, etc. The conventional farmer said that the data is helpful for monitoring the health status of each cow, and ultimately makes it easier to manage the production process on the farm.

> *'I can judge if the cow is ill or about to become ill based on the data in the computer, and then I can do something to prevent the disease. By doing so I can reduce the loss of yield'.*

However, when asked why he doesn't use a milking robot on farm for the convenience of management, the organic farmer said,

> *'I can make my judgment on the health of cows by observing their movements in the barn. I don't need a machine to tell me. The robot just makes a farmer lazy and stupid rather than smart...when a cow gets ill, that may be a signal to tell me she needs rest. I would put her in a different barn to make her comfortable. Of course she couldn't produce milk for days, but it doesn't matter. When you get ill you need rest, it is not good to give you pills and keep you working. This is the same for cows. We treat the cows just like our friends, our children. That's maybe why the cow's average age on my farm is higher.'*

Moreover, the organic farmer explained that the robot uses too much electricity and also 'costs too much time and money for repair when there are problems'.

It is obvious that the two farmers have different views on the health management of the animals. The conventional farmer thought the milking robot is good for helping him maintain the yield on farm, while the organic farmer thought that the animal's health status and its right to get rest should be the focus rather than the yield, and that it is not necessary to worry about the yield, as the short-term loss would be compensated in the long run. The conventional farmer is output-oriented, while the organic farmer, by taking good care of animal health and welfare, is reproduction oriented. As a peasant quality, reproduction orientation on the small organic dairy farm ensures that the organic values of enhancing animal health and respecting animal welfare are applied on the farm.

b. Low input on farm: the case of a small organic vegetable farm in China

The small organic vegetable farm located at the suburbs of Beijing was started in 2013. There are about 5 ha of land covered with 12 plastic greenhouses, and 3 unheated greenhouses (covered with thermal insulation material)[21], growing about 70 varieties of vegetables throughout the whole year. When it comes to farming practice, the farmer believes that low input is good for the production on the farm. Most of the inputs on his farm are made by himself based on his knowledge and experiments. For example, he usually makes insect repellent liquid – to control the pests on farm – with different natural ingredients like Chinese liquor, white vinegar, and brown sugar. Besides, intercropping and crop rotation have also been implemented to reduce pests in different growing seasons. Compost made from fallen leaves, kitchen waste from hotel and restaurants, and left-over vegetables from the farm, is mainly used on his farm as fertiliser. The farmer thinks that nitrogen, especially sourced from animal manure, is helpful for plants' growth, but overuse of it would increase the risk of plant disease and pests, let alone the excessive nitrites in the vegetables themselves.

> *'The plant is just like a human being, if you get too many nutrients, you can get diseases of affluence'.*

Based on this belief, there is a strict implementation of low input on his farm.

The farmer tries to reduce not only material inputs on the farm, but also in the labour. He said he focuses not only on lower energy flow, but also lower labour use.

[21] All the greenhouses can be opened during summer time.

'The ageing problem in the agriculture sector is happening now, and we can try to face this issue in different directions, not just by the replacement of manpower.'

There are usually seven persons working on the farm including the farmer himself, and the six hired full-time workers are villagers living close by. Most of the time, the farmer and other workers have to work inside the greenhouse, seeding, spraying, irrigating, and harvesting. To reduce work on the farm, he did some experiments. For example, after harvesting, he does not uproot tomato vines, nor does he plough the soil, but plants Chinese cabbage directly onto the same piece of land.

'This is labour-saving, and also provides some green manure for the cabbage after the vines rot in the field.'

When asked about his view on the development of his farm, he said there is still a lot to learn about the soil and the plants.

'We don't know much about the soil and plants actually. If we can build a healthier soil environment for the plants to release their growing potential, the output on the farm could be better, and we can all eat more healthily.'

This is also his opinion on sustainability: 'study as much as we can to get a long-term solution'.

Apparently the farmer believes that knowledge, especially knowledge on elements within the farm like soil and plants, is important for farming. He prefers to understand farming within the ecological system and work with it by building up his own resource base. Even though this might be less 'efficient' in other farmers' views, it benefits not only the environment, but also human beings who are a part of the ecosystem and the primary consumers of farming output. On his farm, the peasant quality of sustained use of ecological capital is combined together with the organic value of ecology which promotes the use of closed cycles and reduction of input consumption.

c. Fairness on peasant market: the case of a big organic arable farm in China

The big arable farm, located about 160 km south of Beijing, was converted to organic in 2010 with the help of a NGO in China. As there are no big machines on the farm, contract workers are hired for planting seedling and for harvesting. For fertilising, a compost of mixed horse and cow manure is applied in the field. The manure is transported from other animal farms nearby for a very low price. The farmer sprays liquids extracted from tobacco leaf on plants to prevent pests. He said this was an old method for protecting crops before pesticide became commonly used.

There are about four persons working on the farm: the farmer, his wife, his son, and his daughter-in-law. During the busy time, especially for weeding, there are about ten workers hired on the farm to work for about two weeks. These workers are villagers living close by, and most of them are farmers over 50 years old who have their own land in the village. The farmer is happy that his son chose to return home and become his work partner after college, as living and working together with his son's family makes the farming work easier.

'The young generation has their own thoughts on farming, and they have more ideas about the market channel, and I respect that.'

The farm did not obtain an organic certificate from a certification body; instead it participates in the Participatory Guarantee System (PGS) of the Beijing Organic Farmer's Market, which allows the farm's products to be sold as organic food there. The farmers' market is organised by a group of consumers who care about food safety, environmental issues, and farmers' livelihoods. It formed a PGS free of charge in order to include qualified small-scale peasants who farm according to organic principles. To make sure a peasant who sells his/her products directly on the market follow the principles completely, a group consumers and peer peasants organise frequent visits to his/her farm. Eventually the three parties -- the peasants, the market organisers, and the consumers – form a strong connection: peasants can sell their products on the market at higher prices, which is seen as a reasonable reward for the peasant's hard work, while the consumers can get organic food from trustworthy sources.

The arable farm has been a member of the farmers' market for five years, and mostly sells grain flour, and beans there. After years of hard work of both the parents and son's generation, they expanded the farm size, now cultivating on about 20 ha of land, mostly transferred from other villagers. The yield of wheat on the farm is generally lower than on other conventional farms in the village. However, as the price of wheat flour produced on his farm is a third higher than the price on the conventional market, the total income is on average about a third higher than other conventional farms. Last year, as their wheat flour got popular, and the family got enough savings, they invested in a new, larger wheat-processing machine, and they built a small wheat flour processing factory in the village. As more and more consumers living in cities have a great demand for organic products, some villagers started thinking about converting to organic farming as well. The farmer has initiated a cooperative in his village to help and also work together with these villagers.

Even though the land scale of the organic arable farm is relatively large now, it still has clear features of peasant agriculture; for example, focusing on the reproduction of the farm and the big family, using decentralised circuits to interconnect with society. More importantly, by connecting with consumers directly, the farmer makes decisions on the price of his products based on the real cost, and that is usually considered fair by consumers on the market. The market gives the farmer and his family the opportunity to secure a livelihood different from the other villagers. But of course he earns the opportunity himself, and it is respected by the farmers' market and the consumers shopping there. This means that a decentralised circuit, as a peasant's method to interconnect with society, could bring the organic value of fairness to the life of the farmer.

d. The returned spinach: the case of a big organic vegetable farm in the Netherlands

The vegetable farm was converted to organic in 1989. Located on the polder of the Netherlands, it cultivates seven varieties of vegetable with a yearly rotation scheme on about 75 ha land. The farmer is getting close to the age of retirement, and his son joined him as a work partner a few years ago. Along with another farmer, the three men manage the farm together.

The inputs like fertilisers usually comes from the farm itself or other farms. There is a big methane tank fermenting abandoned vegetables and kitchen waste, which produces a natural fertiliser. Another fertiliser comes from organic dairy farms nearby: the organic farm exchanges its damaged vegetables for the dairy farm's manure. Leaves and old, rotten branches are also collected from the surrounding nature and mixed into the compost to become fertiliser.

According to the interview with a farm manager, about 70% of the farm products are distributed in three main sale channels through a sales enterprise founded together by the partners of the farm: wholesales to supermarkets/vegetable stores, sales to open markets/restaurants, and home delivery to consumers[22]. Each channel accounts for about 30% of the total sales. After doing market research, the partners decided to start home delivery to consumers in 2012, and the sales enterprise was built at that time. There were about 70 families who live in cities organised in groups by neighbourhood, and they order fresh food from the sales enterprise through a web shop. Due to the diversified daily food demand of the families, the sales enterprise not only provides the vegetables produced on its farm, but also collects different agricultural products (like fruit, mushrooms, eggs, dairy products, etc.) from other organic farms nearby, and then delivers them to a pick-up point where volunteers from the consumers work in turns to sort out the products for different families and wait them to pick up their food package. As the average price of the vegetable products for home delivery is almost two times that of wholesales, even though the cost for home delivery is much higher due to the higher labour cost, the partners of the farm are thinking about expanding the home delivery system.

> *'Our home delivery customers are very satisfied with our products, and it is also nice and more comfortable to work with them.'*

An event that happened last year may explain why they want to expand the home delivery sales. About 900 kg of organic spinach were ordered wholesale from the farm at harvest time, however, they were soon returned for the reason that the length of stem, the size of leaves, and the cleanliness did not meet the required standards. In this case, normally farmers have to throw away the products; it is not easy to keep them fresh for several days while they try to find the next buyer. Rather than wasting this top quality spinach, the farmer of the organic vegetable farm quickly turned to social media to ask for help. Ultimately, through a web shop selling food for local farmers, all the spinach was sold to consumers directly in just one day.

The post on the farm's social media reports the returned spinach event

Wholesale returns of agricultural products to farmers due to failing the standards seem to be common, but this may result in wasting a huge amount of food. As the farmer said,

[22] The other 30% of the products is distributed by the other partner of the farming enterprise.

'We don't worry that much about losing money. We don't want to waste the good quality food'.

Furthermore, the wholesale product standards could also be related to consumers' consumption habits, yet the consumers have no idea about the consequences of their food tastes. As one consumer commented,

'Anyone who returns the spinach is stupid, but consumers are also to blame for this. They choose to buy chemically processed products, they even fear things coming from nature, and think these are dirty... This is sad. Human beings are losing our roots (from nature).'

Although the big organic vegetable farm may not be identified exactly as peasant agriculture (at best, we can locate it in the overlap area between peasant agriculture and entrepreneurial agriculture), it is trying to rebuild its interconnection with society. Just as what happened in the event of the returned spinach, the direct connection between the farmer and consumers not only reduces the farmer's loss, but also avoids food waste. Moreover, it increases the transparency of food system when both farmers and consumers participate in the discussion of issues on food waste. The discussion and rethinking show great responsibility to the well-being of humankind and its relation with the environment. This relates directly to the organic value of care.

To sum up, organic agriculture with peasant qualities, or 'organic peasant agriculture' could be the ideal countertendency of the development of organic agriculture. In practice, agroecology, which applies ecological principles to agricultural production systems and cares about the social impacts of farming activities, is close to this conceptual tendency.

6.5 Conclusions

As the variables farming activity and farm size do not show consistent influence on organic farms' potential to balance energy and labour use, an exploratory study was conducted to better understand the heterogeneity of organic farmers' input strategies. The theory of farming modes and farming styles are explained based on distinctive resource bases. This study argues that in both the Netherlands and China, organic farms with an economical farming style who try to reduce both technology and market dependency on farm present better potential for reducing energy use and balancing energy-labour input. However, organic farms with an intensive style of farming who build relatively high energy and labour dependency at the same time, lose their potential for maintaining the energy and labour input balance on the farm. With detailed case studies, the conventionalisation of organic agriculture is then discussed correspondingly with the changing tendency of farming styles (from economical farming style to intensive farming style). With regards to organic agriculture maintaining sustainability in its production and marketing styles, the countertendency of the conventionalisation is discussed, which reveals that peasant agriculture shows better performance in this respect, when combined with organic principles. Thus, even though a follow up research may be required to test it, this exploratory study supports the hypothesis that organic agriculture combined with peasant qualities shows great potential for achieving sustainability in resource use in agricultural production.

Those who critique conventionalised organic agriculture do not seek to abandon the organic principles, but rather to improve the application of the principles. Understanding the heterogeneity of farmers' input strategy provides an important way to respond to the critique and inspire more sustainable resource use in agricultural production. The discussion in this chapter shows that whether in developed countries like the Netherlands or in developing countries like China, diversified farming modes and farming styles are essential in understanding the transition to sustainability.

Chapter 7

The Value of Organic Peasant Agriculture: Planet, People and Profit

7.1 Introduction

Even though a hypothesis has been made that organic agriculture with peasant qualities could not only apply organic values perfectly, but also show better performance in dealing with challenges such as an energy crisis, labour shortage and increasing labour cost, it is still necessary to explore its value specifically on sustainable food production.

With the development of industrialisation and urbanisation all over the world in the last decades, food systems, including all processes involved for feeding human beings, have undergone profound changes. As an important part of the systems, the industrial agriculture, a chemically intensive system of food production, faces great challenges in terms of sustainability, even though it has made great contributions to increasing agricultural productivity (Rosin et al., 2013). These challenges include environmental issues, feeding the growing population, and securing farmers' livelihoods. Industrial agriculture depends on off-farm inputs such as chemical fertilisers, pesticides, machineries, greenhouse technologies, etc. for achieving high output. These inputs are also the main sources of fossil energy consumption and greenhouse gas emission (GHE) in agricultural production, which are unsustainable under the depletion of unrenewable fossil energy and the urgency of climate change (Reganold & Wachter, 2016). Moreover, operating intensively with large machines, monoculture in industrial agriculture has been widely adopted, which has been proved by research to be negative for both biodiversity and soil health (Liu et al., 2006; Frison et al., 2011). Even though industrial agriculture claims to increase productivity, millions of people still go hungry under the conventional food systems. Meanwhile, the global population is growing at a fast rate, and by 2050, there will be an estimated 9 billion mouths to feed (Godfray et al., 2010). It is doubtful that industrial agriculture can provide enough food in the future by increasing off-farm inputs under the situations of resource depletion and climate change. Finally, with the concentration of farmland involved in large capital food production, small-scale farmers are squeezed out of the market, millions of them all over the world thereby losing their livelihood. Obviously the current path of food production needs a transition to achieve sustainability.

Organic agriculture has been widely discussed and practiced by pioneers as an alternative for pursuing sustainable food production since the 1970s, but it has been showing a trend towards conventionalisation in recent years. Organic agriculture is supposed to not only reduce the environmental burden of agricultural production, but also increase fairness and care within the food system. However, these principles are trampled by the increasing use of off-farm inputs, and the dominance of industrial capital. Chapter 6 has discussed how peasant qualities could correspond to organic principles, nevertheless, the sustainability of organic peasant agriculture as regards food production should be evaluated further.

Triple Bottom Line (TBL) is a practical framework consisting of three dimensions – planet, people and profit -- for the purpose of assessing sustainability. Originally used to measure the sustainability of corporations in the business sector in the mid-1990s, TBL goes beyond the measurement of profit, and includes environmental and social dimensions as well. With this extension of its application, it is now also used to address broad issues on sustainability by non-profit organisations and even governments (Slaper & Hall, 2011). As there is no common unit of measurement, it is not easy to quantify the TBL of complex issues, for example the sustainability of alternative food production. But the framework still provides a systematic method to analyse the impact of agro-activities. If a food production activity shows better performance on all three dimensions – planet (environmental dimension), people (social dimension) and profit (economical dimension) – it is possibly more sustainable for agricultural production.

In this chapter, the characteristics of organic peasant agriculture are first explained, and then evidence is provided either from collected empirical data in this study or from the literature to discuss how organic peasant agriculture can address environmental (planet), social (people), and economical (profit) issues in agricultural production. It argues that, different from conventional agriculture and conventionalised organic agriculture, organic peasant agriculture is valuable in the transition to a sustainable food system.

7.2 What is organic peasant agriculture

Organic agriculture with peasant qualities, or 'organic peasant agriculture' as we are calling it, combines organic values with peasant agriculture. Defined by International Federation of Organic Agriculture Movements (IFOAM), there are four basic principles for organic agriculture: health, ecology, fairness and care. Peasant agriculture is usually oriented to peasants' livelihood and the reproduction of farm and family, with multifunctional characteristics (Ploeg, 2008; 2018). It makes optimal use of ecological capital (which differs from industrial or financial capital), and interconnects with society in the form of decentred circuits, which differ from large food processing and trade companies. Therefore, as discussed in Chapter 6, peasant agriculture is better able to integrate its characteristics into organic principles than other farming modes.

Table 7-1 summarises the characteristics of organic peasant agriculture (OPA), and distinguishes it from conventionalised organic agriculture (COA) and conventional agriculture (CA). All are market-oriented, but COA and CA put much more attention on profit and enlargement of the business, while OPA focuses on peasants' livelihood and the reproduction of farm and family. If the orientations of OPA are explained as focusing on internal development (through internal resources like family-owned land, family or community labour, and ecological capital), those of COA and CA are always depending on external opportunities for expanding, either through the external input of production factors (land, capital and labour) or centralised connections with society. In terms of production method, both OPA and COA operate according to organic standards, but COA operates in the logic of CA, depending on mass production and off-farm inputs, to pursue so-called efficiency. Thus, the environmental burden of COA is higher than OPA even though organic standards are applied.

Even though organic peasant agriculture shares the features of peasant agriculture, it is not necessarily limited to small farms. As Ploeg discussed in his book (2018), the size is not what distinguishes peasant agriculture from other farming modes; it is rather the resource or path that the organic peasant uses to increase the farm size that differentiates it. Take expanding land size as an example: a conventionalised organic farm or a conventional farm usually rents or buys land directly from the land market, while an organic peasant would make use of or develop natural, unclaimed land with their labour force (especially in developing countries) or make full use of its social capital by seeking labourers among relatives or local community members. In this way, the path chosen by organic peasants would increase the farmland size and labour input at the same time, while it is purely land enlargement on the other farms.

It has distinguished the characteristics of organic peasant agriculture from conventionalised organic agriculture and conventional agriculture, but organic peasant agriculture is still a theoretical term used in this thesis to refer to farms who combine organic principles with peasant qualities. In practice, it is usually interpreted as agroecology. It is a method to farming using natural resources and applying ecological principles as much as possible. It depends on the value of labour and knowledge to develop natural resources so that the farm can achieve a high level of autonomy, which can be translated to resilience (Ploeg *et al.*, 2019). Although the development of agroecology in reality may follow very different or even contrasting trajectories (Cayre *et al.*, 2018), there are still some common points in the practices. These include reducing the external inputs and maximising the efficient use of internal inputs, involving in the improvement of transition to make agriculture more sustainable and more resilient, and helping to improve farming income and rural economy. These points are highly consistent with the characteristics of organic peasant agriculture if they are compared with the lists in Table 7-1.

Table 7-1 Distinguishing characteristics of organic peasant agriculture, conventionalised organic agriculture and conventional agriculture

	Organic peasant agriculture (OPA)	Conventionalised organic agriculture (COA)	Conventional agriculture (CA)[23]
Orientations	Peasant's livelihood; Market orientated; Reproduction of the farm and family; Sustainability	Market and profit orientated; Scale-enlargement.	Market and profit orientated; Scale-enlargement.
Methods	Forbidden chemicals and GMOs; Polyculture; Multifunctionality.	Forbidden chemicals and GMOs; Questionable resource; Specialised farming.	Use chemicals and GMOs; Specialised farming; Monoculture.
Land	Owned by family; Partly rented.	Mostly rented or bought; Land enlargement.	Mostly rented or bought; Land enlargement.
Labour	Mainly family labour; Partly hired from local community.	Hired permanent or temporary labour.	Hired permanent or temporary labour.
Capital	Sustained use of ecological capital; Low cost.	Industrial or financial capital; International large capital.	Industrial or financial capital; International large capital.
Interconnections with society	Decentralised circuits, like farmer's market, CSA, etc.	Centralised with large wholesale, food processing and trading companies.	Centralised with large wholesale, food processing and trading companies.

Therefore, it can be confirmed that the concept of organic peasant agriculture is being practiced all over the world now as agroecology.

With this understanding of organic peasant agriculture, it is necessary to measure its performance with respect to sustainability under the TBL framework. Hereafter in this chapter

[23] Conventional agriculture here refers to industrial agriculture, corresponding to entrepreneurial agriculture and capitalist agriculture in Ploeg's classification, since peasant agriculture can also be attributed to conventional in general when organic and conventional are distinguished.

the potential of organic peasant agriculture in addressing environmental (planet), social (people) and economic (profit) issues of food systems will be discussed in detail based on the experiences from both developed countries like the Netherlands and developing countries like China. As it is not possible to include every aspect of the three dimension, only the key issues are included specifically to contribute to the most controversial discussions.

7.3 Planet: climate change and environmental issues

According to a report published by the Intergovernmental Panel on Climate Change (IPCC) in 2018, only 12 years remain to make changes in global energy consumption to limit global warming to moderate levels, and climate change is happening faster than we expected (IPCC, 2018). Traditionally we believe that industry is the main contributor to massive fossil energy consumption and GHG emission, which are closely related to climate change. However, if the indirect fossil energy use and GHG emission caused by the production of various inputs on farms are considered, the contribution of agriculture to climate change cannot be neglected. Moreover, reducing soil's carbon sequestration capacity, deforesting and livestock breeding make it worse.

As an alternative to industrial agriculture, organic agriculture has been proved by many studies to be energy efficient, even though the results are not always consistent. According to a review paper, organic farming shows higher energy efficiency compared with conventional farming for producing almost all crops when energy use is calculated based on per unit of land; the result is changeable per unit of product due to lower yield on organic farms (Smith et al., 2015). The same conclusion is made by other researchers as well: Gattinger et al. (2012) study organic farms in Germany, Italy, Sweden, and Switzerland, and show that 70% of organic farms use significantly lower energy per unit of output. Another meta-analysis of European research presents in detail that organic farms use 21% lower energy per unit of product, and only three organic cases out of 34 are found to be negative on reducing energy consumption (Tuomisto et al., 2012). When looking into energy efficiency on organic farm worldwide (except for cases in Africa), a meta-analysis based on 165 studies illustrates that 67.3% of the observations presented positive results and 32.3% presented neutral or negative results (Lee et al., 2015). As there are no studies discussing the reasons behind the contradictory results of energy efficiency among different organic farms, the empirical analysis presented in Chapter 4 may provide a possibility to understand the inconsistency. That is, organic farming with economic farming style, which shares important qualities of peasant agriculture, or as we are calling it, 'organic peasant agriculture', shows better performance than conventionalised organic agriculture (with intensive farming style) in reducing energy consumption on farm. This can be explained by the strictly applied closed-cycle of resourse use on the organic peasant farm. To test this hypothesis, a follow up study is required.

Agriculture is considered to be a major contributor to GHG emission, a crucial cause of climate change (Rockström *et al.*, 2009; Godfray *et al.*, 2010; Amundson *et al.*, 2015). It is important to evaluate organic peasant agriculture's performance vis-à-vis reducing emission in the context of intense global warming. The literature shows no clear results with respect to the GHG emissions of organic farms compared with conventional farms: is the emissions remain changeable according to the varied products, cropping pattern and measurement unit, but in general the meta-analysis based on 195 worldwide studies concluded that organic farming is favoured over conventional farming in terms of GHG emission (Tuomisto et al., 2006; Mondelaers et al., 2009; Skinner et al., 2014; Lee et al., 2015). Moreover, due to lower energy use and higher organic matter in the soil on organic farms, it is ideal for limiting GHG emission and building the soil's carbon sequestration capacity, which are important for mitigating climate change (Kaspercyk & Knickel, 2006; Mondelaes *et al.*, 2009; Gattinger *et al.*, 2012; Tuomisto *et al.*, 2012; Reganold &Wachter, 2016). Making the best possible use of ecological capital and taking good care of the soil as a way of maintaining reproduction on farm, organic peasant agriculture could be ideal for reducing GHG emission to cope with climate change.

Other than reducing fossil energy use and GHG emission, organic peasant agriculture brings more benefits to the environment. Different from conventional farming, it has been proved that there is much more plant diversity, faunal diversity, and landscape diversity on organic farms (Lotter, 2003; Crowder et al., 2010; Gomiero et al., 2011; Lynch et al., 2012; Kennedy et al., 2013; Tuck et al., 2014). However, if the differences between organic peasant farming and conventionalised organic farming are considered, we can conclude that the benefits of diversity of the former must be greater, as the organic peasant always chooses to diversify the crop/animal varieties on the farm to reduce risks while most conventionalised organic farms focus on specialised farming. Besides, organic farming has also been proved to show better performance in general in reducing pollution to water (synthetic pesticide pollution of ground water (Alföldi *et al.*, 2002), and excessive use of nitrogen and phosphorus leading to the degradation of freshwater and the marine ecosystem (Rockström et al., 2009)), air (agricultural emission sourced from synthetic fertiliser is closely related to PM 2.5 levels in the air (Pozzer et al., 2017)), and soil (nitrate leaching (Tuomisto *et al.*, 2012)). These are also the environmental benefits that could be contributed by organic peasant agriculture.

To sum up, the qualities, including using closed-cycle resources, forbidding chemicals, and applying polyculture farming on farm, make organic peasant agriculture more sustainable for addressing climate change and environmental challenges faced by current food production (see Figure 7-1).

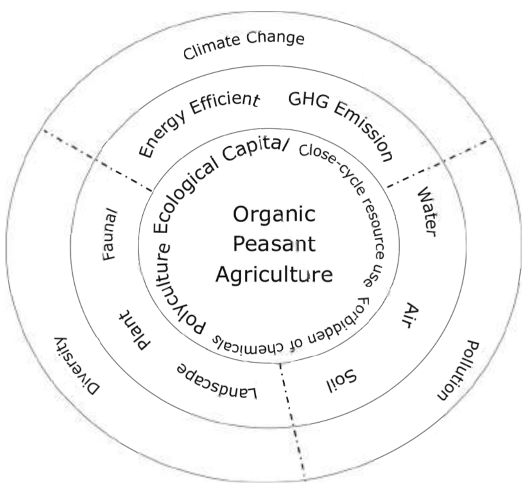


Figure 7-1 How does organic peasant agriculture address the challenges of our planet?

7.4 People: to feed a growing world population

It is estimated that there will be about 9 billion people on the planet in 2050. How to feed this large population with sufficient agricultural production is a hotly debated topic not only in academia but also in governmental organisations. Obviously the wide use of chemical fertiliser and pesticides after WWII has increased the productivity per unit of land. However, the increase in yield has shown a trend of slowdown in recent years due to the reasons of soil erosion, damage to biodiversity and environment, pest resistance, and degradation of water resources (Rosegrant et al., 2006). Moreover, the production of chemical inputs and the use of big machines and high technologies have led to great dependency on non-renewable resources. The monoculture farming and overuse of chemicals have stimulated the outbreak of pests and diseases, which has in turn required more chemicals to maintain the output at a stable level. It seems that conventional industrial agriculture has failed to deliver food security at present and in future in terms of providing sufficient, safe and nutritious food[24].

As an alternative style of food production, organic agriculture is believed to have lower yield than conventional agriculture per unit of land. The yield gap between these two farming systems leads to the main doubt whether organic agriculture can produce enough food to feed the increasing population. According to a meta-analysis of 362 published comparative studies between organic and conventional farming on crop yield, the average organic yields of single crops are about 80% of conventional yields, but the result varies according to region (De Ponti et al., 2012). The yield gap is relatively high in North European countries, or countries with intensive agricultural systems like the Netherlands and Denmark, while it is lower in Asian and tropical areas. Another experiment reveals that, even if the yield in the organic farming system is lower initially, after 10-13 years it gets close to that in conventional farming system, and in the meantime requires lower nitrogen inputs (Schrama et al., 2018). It concludes that 'closure of the yield gap between organic and conventional farming can be a matter of time and that organic farming may result in greater spatial stability of soil biotic and abiotic properties and soil process'.

Since the yield gap is the most critical point for the transition towards organic agriculture, many studies focus on exploring the method for closing the gap between organic and conventional farming systems. It has been proved that the gap can be narrowed down through more effective on-farm management, for example, agricultural diversification practices. When the methods of multi-cropping and crop rotations are applied only on organic systems, the yield gap can be reduced from 19.2% to 9% and 8% respectively (Ponisio et al., 2015). Thus, it is possible that the yield gap for some crops and regions could be reduced by investing in improving research of the organic management system. As multi-cropping and crop rotation are used frequently on organic peasant farms, it follows that organic peasant agriculture has better potential for increasing yield compared with conventionalised organic agriculture, which shows an obvious trend of monoculture and short rotation scheme in practice.

[24] Food security, according to World Food Summit (1996), 'exists when all people, at all times, have physical and economic access to sufficient, safe and notorious food to meet their dietary needs and food preferences for an active and healthy life'.

The case of the experiment on closing the yield gap between organic and conventional maize and wheat production in China

Jiang Gaoming is a senior researcher working in State Key Laboratory of Vegetation and Environment Change in Chinese Academy of Sciences. He has been working together with his team on the experiment of closing the yield gap between organic and conventional maize and wheat production since 2006. The experiment site is located at North China Plain, the major grain producing area in China. After three years of transition (using manure/compost to replace chemical fertilisers), they conducted the experiment, planting mainly organic maize and wheat, on an area of 17 mu (about 1.13 ha) rehabilitation land, which are separated into plots with different size. The result of the five-year experiment shows that, with using manure compost, the yield of organic maize is actually even about 14.5% higher than that of conventional maize (see Table 7-2). According to Jiang, the first two years in transition was hard because they only got 50-60% of the conventional yield, but after three years' restoration of soil, the yield of organic maize eventually increased.

'It takes time to rehabilitate the soil environment. It could take about three years'.

Table 7-2 The yield of organic and conventional maize in a five-year experiment (Jiang, 2017)

Farming methods	Plot size	Fertiliser	Yield (kg/mu)
Conventional maize	Regular crop field	Chemicals	478.7
Conventional maize	Regular crop field	50% chemicals + 50% manure compost	536.1
Maize in transition	Regular crop field	Manure compost	455.8
Organic maize	Small (about 0.01 ha)	Cattle manure compost	746.4
		Earthworm manure	731.5
Organic maize	Big (about 0.05 ha)	100% manure compost	547.9

As the consumption of meat in China is increasing, Jiang's team also tried to experiment with using grain straw to feed beef cattle. In North China, farmers usually burn out straw after harvesting grains. However, due to the newly implemented strict air pollution regulation, the burning has been forbidden. In the farm experiment, all the straw is chopped and mixed together with grain to feed the cattle. The data shows that one head of beef cattle can consume about 2.1 tonnes straw and 300 kg grains per year, and in turn produces 150 kg beef, which equals the calories of 750 kg grain. This means that raising one steer can produce 450 kg grains in calorie, and the total yield would increase about 45% if using 2 mu land to feed that one animal. Moreover, with this cattle-grain mode of circular agriculture, bioenergy can be produced: in the village affiliated with the experiment site, Jiang's team built a biogas pit to heat 130 rural households. The biogas produced per year equals about 65.9 tonnes standard coal, and using this bio-gas to replace fossil fuel consumption could reduce 177.9 tonnes CO_2 emission.

When Jiang presented his ideas about the transition to organic agriculture in China, people doubted that it would be able to feed the large population. After years of experimenting, the result clarifies that organic agriculture would not necessarily lead to famine.

'If we make the full use of straw, weed, and even pests, the edible calories produced by 1 mu land can satisfy 2.5-2.8 people's requirements. Considering that we have 1.8 billion mu cultivable land in China (if we assume that 50% of this land has medium to high yield), organic agriculture can feed a population of 2.2-2.5 billion.'

'With the change in human's working and living style, the decrease of manual labour reduces the calorie consumption of our body...In 2009, the amount of grain per capita in China was 398.7 kg, exceeding 128% of the actual requirements if calculated by calories...Currently the food issue in China is not about quantity, but quality. There are about 160 million people suffering from high blood pressure, more than 80 million suffering from diabetes, at least 160 million suffering from dyslipidemia, and about 400 million with diseases related to over-nutrition. These are caused by the decrease in food quality.'

In Jiang's opinion, if there is more support for the research of organic agriculture, its yield performance could be better. 'If the budget used for supporting food production can really benefit farmers, and organic circular agriculture is applied in practice, we can not only feed the population with good quality food, but also solve the problems of non-point pollution caused by agricultural production.'

Even though agricultural productivity is closely related to food security, it is not sufficient to solve the problem of hunger. Evidence shows that the global calorie production has greatly exceeded the world population's need, while other social or political issues deter people from getting sufficient food (Smil, 2005; McIntyre, 2009; Holt-Giménez *et al.*, 2012; Tomlinson 2013). The fact is that poor peasants in developing countries comprise the largest part of hungry people in the world (Pretty & Hine, 2001; Kremen & Miles, 2012; Holt-Giménez *et al.*, 2012). Compared with high-input agro-technology that claims to increase productivity, organic peasant agriculture allows them to increase yield with low cost, and fulfil their economic needs by providing fair access to local markets.

7.5 Profit: the farmer's livelihood and reproduction on the farm

When talking about sustainability, profit is an important aspect to be noticed as almost no one can live without it in the modern economy. Apart from how agricultural production makes profit, being a vital part of the whole economic chain, profit relates closely both to investment at the upstream and to distribution at the downstream as well. To discuss the economic sustainability of organic peasant agriculture, questions about the cost, investment sources, making income and distributing income should be considered. This study argues that reducing cost while increasing income on farm, organic peasant agriculture is believed to be profitable and economically sustainable in practice.

Whereas conventional agriculture and conventionalised organic agriculture mostly use industrial or financial capital as their main investment source, organic peasant agriculture makes the most use of ecological capital, or nature capital. This means that external inputs like synthetic fertiliser and chemicals are replaced by manure, compost, and ecological pest management based on local knowledge; practical small machines or tools are preferred over big machines and high technologies; family labour or labour from the rural community is preferred over hired temporary or permanent migrant workers. Thus, the cost of input on an organic peasant farm is usually much lower, making it easier for poor people to get access to food -- 75% of whom live in rural areas in developing countries without financial and resource support according to FAO. Moreover, low cost on organic peasant farm would reduce financial risk by avoiding the need for credit and reducing subsequent debt.

Normally farmers make a profit by selling their products in the markets, either directly or indirectly. As most conventional agriculture or conventionalised organic agriculture gets connected with consumers through dealers or other third parties like the food processing companies that play a dominant role in the market, farmers have limited power in determining the price of their products. With great dependency on off-farm inputs, which consume a large amount of fossil fuel, the rise of the fossil fuel price would result in the increase of the total cost on farm. Therefore, conventional agriculture has relatively low economic stability, especially in terms of making a profit. However, by depending on decentred circuits like the farmers' market or Community Supported Agriculture (CSA), organic peasant agriculture builds a short supply chain with consumers. Connected with local communities, an organic peasant farm could potentially increase its income by producing premium priced organic products for the demand driven market. An organic peasant thereby acquires the pricing power on the local market so that its livelihood can be secured in the long run.

For organic peasant agriculture, the income of agricultural production is used to support not only the farmers' livelihood, but also the reproduction on the farm. Usually the reproduction is organised through the accumulation of income for years. However, the organic peasant also keeps exploring new approaches for increasing income to promote reproduction. Distinguished from conventional agriculture, or conventionalised agriculture, a key feature of organic peasant agriculture is multifunctionality. Food production is not the only function of organic peasant farm anymore. The reinvented agricultural activities on farm – including product processing, rural tourism, and agricultural education – offer sufficient possibilities for farming's added value (Ploeg & Ye, 2016).

It has been widely discussed in the literature that organic peasant agriculture or agroecology is positive in its economic performance. In Europe, various studies have provided evidence in different countries. In the Netherlands, the economical style of farming (with low cost) in the dairy sector maintains a higher level of income than conventional farming, and the economic benefits of the agroecological style of farming over conventional farming was much better during the milk price crisis in 2008 (Dirksen et al, 2013; Oostindie et al., 2103). Similar effects of agroecology in the dairy sector have been encountered in Denmark, France and Germany as well (Hamerlinck et al., 2014; Devienne et al., 2016; Jürgens *et al.*, 2016; Bijttebier et al., 2018). In Switzerland, organic farms have proved to be economically better than conventional farms and they employ more people to sustain the rural economy (Hoop et al. 2016).

In addition, developing a new market is also a positive way for organic peasant agriculture to achieve better off-farm prices (Ploeg *et al.*, 2012). A case study here below illustrates how organic peasants can get access to a local market with low cost and high returns to secure their livelihood and reproduction on the farm at the same time.

The case of a Participatory Guarantee System (PGS) to support organic peasant agriculture

The Participatory Guarantee System (PGS), defined as 'locally focused quality assurance systems'[25], was first adopted during an International workshop about Alternative Certification in 2004. Due to the issues of third party certification in organic agriculture, for example that it is dominated by big organic food companies and exclusive of smallholders, that it is export oriented and expensive, , PGS was formed based on the analysis of dozens of alternative certifications and CSAs all over the world. It aims to reduce the cost of access to market for smallholders, and to promote a just and fair food production chain. By involving different stakeholders, consumers, farmers, NGOs, and even governmental organisations into the process of organic certification, PGS not only assures the quality of products, but also links the producers to alternative markets (home delivery, CSA, etc.) and even helps to educate consumers about food systems and organic values (Källander, 2008).

In terms of connecting smallholders to the market, PGS helps to promote Short Food Supply Chains (SFSCs) between producer and consumer. As alternative food supply systems, SFSCs is built based on local food. It conducts sustainable agriculture by making use of local resources to produce local, sustainable and alternative foods, and thus promote local economy and employment (Renting *et al.*, 2013). By shortening the distance between producer and consumer, SFSCs not only reduce energy consumption of food processing and transportation, but also cut down intermediate links of food systems to make sure that consumers can get transparent information about the food production process. By assuring the product quality, PGS provides more convenience for organic peasants to get into the market at a low cost, and promotes a short supply chain of organic food.

As estimated by IFOAM (2017), 66 countries all over the world have PGS initiatives, and at least 43 among them have practical operations. Data shows that there are at least 307,872 farmers involved worldwide in PGS and at least 76,229 producers certified, with most of them being small-scale farmers and processors. The number keeps increasing. From 2016 to 2017, the annual growth rate of certified PGS producers all over the world was 34%. Currently three countries, Bolivia, Brazil, and India, have recognised PGS in their national organic legislation, and the annual growth rate of certified producers in these countries is significant.

PGS is ideal to support the sustainability of organic peasant agriculture from three perspectives: low cost, local market, and livelihood. The cost of participatory certification is relatively low, especially compared with the cost of third party certification used by most conventionalised organic agriculture. The characteristic of low-cost makes it easier for poor peasants in developing countries who want to start organic farming to certify their products. Normally the certified products are aimed for local markets that offer a direct connection between the organic farmers and consumers. This can ensure that organic farmers have a market channel to sell their products and thereby get a fair income. With the low cost of certification and access to a local market, the livelihood of the famer and his family can be secured, which makes reproduction on the farm possible. The mode of PGS assures organic peasant agriculture to be economically

[25] See the definition on the website of IFOAM https://www.ifoam.bio/en/organic-policy-guarantee/participatory-guarantee-systems-pgs (accessed February 25, 2019).

sustainable, especially in developing countries where organic farmers have fewer economic resources.

7.6 Conclusions

Considering the concerns of resource exhaustion and increasing environmental issues, the conventional agricultural production, as an important part of food systems, should reorient itself towards achieving sustainability. In the context of the systemic assessment on organic farming's performance regarding planet, people, and profit, this chapter argues that organic peasant agriculture, or agroecology in practice, is believed to be valuable in the transition to sustainable food system. Due to the application of organic principles, organic peasant agriculture shows great performance in alleviating climate change and reducing environmental burdens throughout the food production process. Even though there is a yield gap between the organic and conventional farming systems, that gap can be narrowed down in the long term by improving the management on organic peasant farms. However, increasing yield is apparently not the only solution to the need to feed the growing world population. Organic peasant agriculture provides hungry people living in developing countries who have limited resources a method of farming to increase yield and get access to the local market. Moreover, low cost on farm and access to local markets assure organic peasants enough income to support their livelihood and organise reproduction on farm. By reducing costs and increasing income, organic peasant agriculture is profitable and economically sustainable.

Chapter 8

Conclusions and Discussions

8.1 A review of the conclusions from the empirical chapters

Agricultural production is a process of activities conducted by human beings that achieve output by making use of various resources. Labour and energy are two fundamental inputs in this process, with energy being either from the sun or other sources. The resources used by human beings change according to the progress of technology. Entering the era of industrial civilisation, fossil energy was widely adopted directly or indirectly in organising the resources to advance agricultural production. This industrialised agricultural production has increased the yield of food to feed the booming population in the last century, but it achieved the greater yield in an inefficient way. When the input of fossil energy and output of agricultural products are calculated, an increase of 619% of energy input per ha from 1950 to 2015 results in an only small rise of output by 12% in energetic values (Smit, 2018). This has resulted in a sharp decline in the sustainability of agriculture in the last decades. In addition to the inefficient use of energy, the industrial approach of agricultural production has resulted in various environmental and social problems. These problems, including greenhouse gas emission, environmental pollution, resource depletion, and rural decay, threaten the sustainability of food production.

Aware of the problems caused by the industrial agricultural production, organic agriculture has been widely practiced as an approach to sustainable food production. Rising mainly in the developed economies from the 1970s onwards, it has been proved to be positive for the ecosystem, environment, and also rural economies. Nowadays it is growing fast not only in the developed countries but also in the developing countries, even though they share very different contexts vis-à-vis the development of organic farming.

Although organic agriculture is an alternative method of food production, labour and energy are still main resources involved in the process. This thesis focuses on discussing the energy and labour use at the farm level for achieving sustainability in food production. It first demonstrates the sustainability of organic agriculture as a whole system by comparing its energy and labour input with that of conventional agriculture. Then the labour constraints faced by organic farmers are interpreted, as well as how they respond to the constraints. Thereafter, the heterogeneity of organic farmers' input strategies is discussed and both the conventionalisation of organic agriculture and its countertendency are elaborated. The conclusions of the six empirical chapters in this thesis are reviewed as follows.

Chapter 2 and Chapter 3 calculate the energy and labour input balance in the Netherlands and China separately. Selecting 12 cases with different farming systems (organic and conventional), farming activities (dairy, arable and vegetable) and farm sizes (big and small size) in each country, energy and labour use for producing a certain gross value are computed and compared among different cases. The general conclusion of these two chapters is that organic farming uses less energy and more labour compared with conventional farming in both countries, but there is great variation among all the farms in the size and farming activity. When the added energy and added labour between organic farm and conventional farm are compared, the substitution rate of the two resources is much lower on organic farms than that on conventional farms, which means organic farms would require less energy input to replace the decreased labour use than conventional farms would. Thus, organic farming is more sustainable in reducing its dependency on energy use, compared with conventional farming in both the Netherlands and China.

Chapter 4 compares the energy and labour input balance between Dutch farms and Chinese farms. It concludes that Dutch farms use more energy while Chinese farms use more labour due to their different resource endowments. However, the situation is changing in both countries. In China, energy input is increasing because of the policy incentive for promoting the development of industrial agriculture. This could result in high energy and high labour input on farms at the same time, which may not sustain the development of agriculture. In the Netherlands, there are also farms following a different path of development using more labour and less energy on farms. This means that the so-called industrial agriculture, which consumes much more energy, is not the only trajectory for agricultural development. Developing countries should not necessarily choose the conventional trajectory but rationally consider their resource endowments when making policy of agricultural development.

Chapter 5 responds to the critique that organic farming requires more labour input and this makes it vulnerable to the potential labour constraints. Analysing organic farmers' perceptions and responses to the labour constraints in both the Netherlands and China, it concludes that there are three patterns of responses to deal with the constraints, and specifically two patterns witnessed in the two countries would increase organic farmers' resilience in dealing with the difficult situations. These two different patterns can be further explained by the different social contexts of the Netherlands and China. This shows that organic farmers could respond to the labour constraints in more resilient ways, and these responses are usually embedded in their local social contexts. Organic farmers should be encouraged to explore their local and diversified solutions to increase the farm resilience when dealing with labour constraints.

Chapter 6 discusses farmers' input strategies by clarifying the heterogeneity within organic farms, and tries to understand the trend of conventionalisation in the development of organic agriculture. Applying the theories of farming mode and farming style concerning the resource base on the farms, this chapter explains how an organic farm with an economical farming style shows better performance in achieving sustainability vis-à-vis resource use compared with an organic farm with an intensive farming style. The move from economical to intensive farming is then interpreted as the conventionalisation of organic agriculture. To optimise organic agriculture's potential in sustainable food production, the countertendency of conventionalisation is then identified as organic peasant agriculture. The exploratory study ultimately supports the hypothesis that organic agriculture with peasant qualities shows better potential in applying organic principles to optimise the sustainability on an organic farm.

Chapter 7 discusses the theoretical concept 'organic peasant agriculture', and tries to distinguish it from conventional agriculture and conventionalised organic agriculture. Within the framework of triple bottom line, it makes a general discussion on the sustainability of organic peasant agriculture in the perspective of planet, people, and profit. It concludes that organic peasant agriculture is valuable in the transition to sustainable food production.

8.2 Industrial technology, organic peasant agriculture, and the sustainable future of agricultural production

It is estimated that there will be about 10 billion people on earth in 2050, 3 billion more mouths to feed than in 2010 (Searchinger *et al.*, 2014). Moreover, the increasing income in the rising economies would increase people's desire for consuming resource-intensive animal-based food. At the same time, the urgent climate change timetable would ask to cut greenhouse gas emission in agricultural production. How to feed the growing population with limited resources while lowering emissions is the worldwide challenge confronting the current food system.

In terms of providing enough food, the solution provided by industrial agriculture seems uncomplicated: increasing efficiency, namely using fewer resources like land and water to produce the highest yield. To achieve this goal, different industrial technologies have been – and are still being – developed. The revolutionary innovations of agro-mechanisation, fertilising, pest controlling, and many more, have changed agricultural production completely in the past century. They have increased the productivity but also brought challenges, and to deal with these challenges, new technologies supported by industrial capital must be innovated at the expense of vast direct and indirect energy consumption. This is the typical way of thinking of industrial civilisation, which controls the whole food system. Under the umbrella of technological innovation, farmers are either involved passively and follow the tide, or are cruelly squeezed out of the game. Thus, the power of food production in the world concentrates gradually on industrial capital. Claiming to be highly efficient and productive and depending on intensive energy use, the empires of food production are changing the food system, yet are still questionable in their purpose and ability to feed the whole world sustainably.

Organic peasant agriculture, being criticised as inefficient in feeding the growing population, may provide an alternative way to deal with the challenges. Unlike industrialised agriculture, which seeks to expand based on high energy consumption, organic peasant agriculture attaches great importance to internal resources like family labour and ecological capital. Rather than emphasizing the values of expansion and yield, it stresses the values of human labour, protecting the local ecological environment and the livelihood of peasants. Focusing on increasing the internal efficiency by making the most use of low-cost resources, organic peasants have shown great resilience not only in balancing the energy and labour input on the farm but also in securing their livelihood. This is extremely important in the Global South where the peasants have limited access to industrial technologies, and where the largest population growth is expected.

The point of the argument is not to blame the innovation of technology, but to rethink its inclusiveness. Agricultural production has benefited greatly from various industrial technologies, and has built unstoppable dependency on them. This is especially the case in the developed countries. However, in the era where technological progress is becoming a universal value, the question how progress would influence peasants' livelihoods in the developing countries could easily be neglected. Just like the development of artificial intelligence, a popular technology which could possibly replace human labour in agricultural production in the future, it relies on the great amount of investment of both capital and energy, which could potentially exclude most peasants and deprive them of their livelihoods. Other agro-technologies, usually requiring large investment as well, are hardly convincing methods to deal with the challenge of growing populations and climate change, especially in the developing countries.

However, human labour, valued by peasant agriculture, provides a basic line of fairness to peasants in both developed and developing countries. Combined with the inclusive technologies, like natural breeding, ecosystem designing, crop rotation, composting, etc., labour contributed by organic peasants could achieve higher productivity to feed the growing population in a more sustainable way. But the development of organic peasant agriculture then requires support from different parts of the society, policy support from the government, research support from the university, and action support from the consumer.

In China, where peasant households cultivate about 71.4% of the total arable land and produce the majority of food, peasant agriculture is still regarded as a traditional or backward way of agricultural production. After years of agriculture being dominated by values of industrialisation, a policy document published in 2019 is one of the first to point out that peasant households should be supported as part of modern agriculture (The state council of China, 2019)[26]. In addition to stressing the importance of peasant agriculture in ensuring food security and promoting green production, the document also values the peasant qualities in employment stabilisation, cultural inheritance, social structure shaping and environmental protection in rural area. As one big developing country, China is changing its policy on peasant agriculture. Against the background of protecting the ecological environment and mitigating climate change, the development of organic peasant agriculture seems promising.

8.3 Contributions, limitations and future research

With six empirical chapters, this thesis has tackled the question of sustainable food production from different perspectives. It contributes to the discussion of this issue in different ways. However, due to the constraints of time and other subjective factors, there are limitations as well. These limitations thus call for future research.

a. Energy and labour as two factors of agricultural production

In classical economics, land, labour, and capital stock are treated as the factors of production as they are the primary resources to facilitate production. Based on the theory of classical economics, neoclassical economics puts forward more factors of production, for example capital, including fixed capital and financial capital, and technological progress. Knowing that capital and labour cannot account for all economic growth, neoclassical economists use technological progress to refer to the unexplained contributors besides capital and labour in the production functions, like total factor productivity and Solow residual. However, as an alternative to neoclassical economics, ecological economics values the factor of energy when it integrates the laws of thermodynamics with the economic systems in reality. Capital and energy, both applied as secondary resources in the production process, could possibly change places under different circumstances. In agricultural production, De Wit (1975) discussed the substitution between energy and labour when they are technically regarded as two fundamental resources for agricultural production. Using the concepts of added energy and added labour, it is possible to discuss the substitution between energy and labour used in the production process

[26] http://www.gov.cn/zhengce/2019-02/21/content_5367487.htm (accessed May 15, 2019).

from raw material to the product at the farm gate. Based on De Wit's theory, this thesis adopts energy and labour as two factors of agricultural production, specifically organic and conventional farming.

Considering the current challenges faced by most industrial countries, climate change and reduced agricultural labour, the comparison of energy and labour use between organic and conventional agricultural production in this study is of great value. On one hand, reducing the dependency on energy use is essential in achieving sustainable food production. On the other, understanding how farmers, especially organic farmers adjust their on-farm practices to balance the energy and labour input under different contexts is useful to not only deepen the exploration of sustainability but also inspire the transitioning actions.

Besides inputs, the output of agricultural production is important in the study of efficient resource use. Usually the yield valuable for humans is regarded as the output on farm. However, other 'useless' outputs going into environment could reduce one's yield. Thus, in the calculation of the farm's input efficiency, output should include more than yield only. In this study, the gross value of products are considered to deal with the gap of yield and also differing environmental effects between organic and conventional farming. This is a relatively new perspective in comparing the resource use efficiency between organic and conventional farming systems.

However, this thesis has limitations on comparing energy and labour use between organic and conventional farming systems. First, there are still some unavoidable differences which may affect the results of the comparative study, even though most variables of the selected cases from the two farming systems are controlled to make them comparable. For example, the crop varieties and the rotation scheme could vary greatly among different farming systems, and the differences could yield uncertain results when comparing the two parts on energy use. To increase the scientific accuracy of the results in the comparative study, in the future experimental farms should be built for the purpose of utmost control of the variables. Second, the results of comparison between the organic and conventional farming systems could change over time: an organic farm usually has a more complex ecological system than a conventional farm, and it may take years to see the benefits that an organic farm brings to the yield. However, only the data of the last three years are collected in this study, which may underestimate organic farming's potentials in the long run. The time schedule of the comparison should be prolonged in future studies. Third, the sample size selected in this thesis is limited. There is only one case selected for each category of farms, and it is questionable if the case can represent the category completely, despite this study having tested the representativeness of the samples. In the future, data from more farms should be considered to compare energy and labour input balance so that the results can be more stable and convincing.

b. Resource use on farm in different countries

It has been proved in development economics that one country's agricultural growth can be decided by its ability to adjust to the resource endowments, accumulation of resources, and institutions of politics, economics and culture. The finding of this thesis has provided more empirical evidence to support this theory by comparing energy and labour use on farms in the Netherlands and China. Moreover, it advances the discussion further to compare the different trajectories of agricultural development between developed and developing countries. This is why the cases from the Netherlands and China are selected, and why the input balance of fossil energy and labour input are analysed twice in these two countries separately.

Possessing different resource endowments in energy and labour, the Netherlands and China have chosen different trajectories of development in their agricultural sector. However, due to the fast process of industrialisation in China, the trajectory of Chinese agricultural development is changing under the influence of policy incentives. To catch up to, or even compete with the developed countries like the Netherlands, much has been invested in the study and application of the high level of mechanisation on farms that could be possibly mismatched with the agricultural sector at the moment, especially considering that there are still a large number of small-household peasants that have limited demand for large machines and other advanced agro-technology. This could make the development of agriculture in China unsustainable. Therefore, it is rational for the policy makers to rethink the resource endowments of agricultural production in China at present and apply sustainable incentives to promote the development of agriculture in the country. In the Netherlands, even though most farms including organic farms have built a great dependency on fossil energy use in agricultural production, there are exceptions that stand out of the conventional trajectories of development. They represent the exploration of sustainability in the developed countries under the challenges of environment, economy, and society.

Both the experiences from China and the exploration in the Netherlands are meaningful to other regions, especially for the countries from the Global South whose agricultural sector faces both the challenges of climate change and the influence of intense industrialisation at present. It is not necessary for them to follow the Dutch trajectory of agricultural development, which is built on high fossil energy consumption and has proved to be unsustainable. Moreover, the experience from China indicates that development should be promoted by considering internal conditions in the agricultural sector. This is important for agricultural development in developing countries, especially as it faces the impacts of industrialisation.

However, when it comes to the methodology used in the comparison study between the Netherlands and China, the results could be distorted. This thesis argues that *gross value of products (GVP),* other than yield, is a better unit to measure the output at farm level, as the price of agricultural products produced on organic farms is much higher than that on conventional farm, which can be regarded as a compensation to organic farming's benefits to environment. But GVP is related to the price of agricultural products, and the price is changeable, especially when it comes to compare that in two different countries like the Netherlands and China. Even though Purchasing Power Parity (PPP) is introduced in the comparison study in Chapter 4, the results could be unstable due to the changeable agricultural products' price and other issues in calculating PPP. To minimize the influence of the changeable price, this studies has collected the data from the past years, and it only considered the average number when calculating the GVP on the farms selected in both countries. The other factors that could affect the results cannot be taken into consideration due to methodological difficulties. These difficulties may need studies in future so that the results of the comparing study is more accurate.

Moreover, this study has discussed the trajectories of agricultural development in different countries, but more empirical evidence is still required to elaborate the discussion. In future, the research about the sustainable resource use strategy at farm level and comparison of trajectories of agricultural development should be conducted in different social-economic contexts.

c. Organic farmers' responses to the labour constraints in different contexts

It has been proved by many studies that organic farming is labour intensive, and the high labour requirements could stop farmers from converting to organic farming and also bring challenges to farmers who are applying organic principles on their farms. This is especially the case in the countries experiencing the decrease of the availability of agricultural labourers and the increase of labour price. However, almost no studies have looked into organic farmers' responses to the constraints related to labour input on farms. This thesis first puts its focus on organic farmers' response to the labour constraints and provides valuable on-farm experiences of resilience from the Netherlands and China in dealing with the constraints.

This thesis not only focuses on the innovation and robustness of organic farmers in dealing with challenges, but also pays attention to the different patterns of responses in different social-economic contexts. As two different countries, the Netherlands and China are also different in their paths of agricultural growth, specifically in their development level of organic farming. As regards the availability and price of rural labour, organic farmers in both countries are potentially in the same difficult position even though their labour issues are embedded in different contexts. Depending heavily on the migrants from Eastern European countries, most organic farmers in the Netherlands are concerned about the labour issues, just like the organic farmers in other developed countries. In China, with a potential large labour resource pool in the countryside, organic farmers put more attention on the increasing labour price and ageing problems of the agricultural labour. When the two countries' development of organic agriculture is compared, the different orientation and balance of civil society and state power in their organic sector is vital in determining how organic farmers would respond resiliently to the challenges they face. These distinctive contexts thus result in different patterns of response in the two different countries.

It is important to realise the different patterns of resilient responses in different social-economic contexts because it shows that organic agriculture presents complexity and diversity not only in its ecological system but also in its social-economic system. By summarising the experiences from the Netherlands and China, this thesis would like to encourage the discussion on exploring resilience of organic farming at the local level.

Even though the thesis has shown that it is possible for the organic farmers in the Netherlands and China to provide helpful experience to both the developed and developing countries, the understanding is limited. The Netherlands may share common features of the developed societies, and China may share those of the developing societies, but their local experiences cannot be universally applicable. Thus, research about organic farmers' resilient responses to the labour constraints should be conducted in various countries in order to help organic farmers in different contexts to achieve local solutions.

d. Discussion on the conventionalisation of organic agriculture

The organic sector keeps growing worldwide in the last decade. According to the report published by the Research Institute of Organic Agriculture, and IFOAM (Willer et al., 2018), 69.8 million hectares of land were being farmed organically at the end of 2017, and the organic farmland increased about 20% in the same year. Among the world's organic agricultural land, a quarter of them were in the developing countries and emerging markets, and the organic producers in these regions covered more than 87% of the total number worldwide. In the meantime, the consumption of organic food and beverage in the global market continues to grow, and it reached 90 billion euros in 2017. The U.S. is the leading market with 40 billion euros, followed by Germany (10 billion euros), France (7.9 billion euros), and China (7.6 billion euros).

However, the booming of the organic sector worldwide does not always seem promising as it shows a trend of conventionalisation compared with how it started. How to understand the conventionalisation? There are many perspectives that should be included in the discussion, but this thesis chooses that of the resource use on organic farms. Linking to the theory of farming modes and farming styles, it elaborates the conventionalisation as a change in the style of farming, from economical to intensive style, and it further identifies the countertendency, 'organic peasant agriculture'. This distinguishes the different characteristics of farming modes and also broadens the critical thinking on the current development trend of organic agriculture. Emphasising peasant qualities and organic principles, organic peasant agriculture, or agroecology in practice, is discussed as an approach to optimising the sustainability of agricultural production.

Even though the sustainability of organic peasant agriculture has been discussed via a review of both the literature and empirical cases, the hypothesis that organic peasant agriculture could deal with the challenges faced by agricultural production sustainably better than conventionalised organic agriculture or conventional agriculture, should be tested empirically with more solid evidence.

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Summary

As one of the major contributors to greenhouse gas emission, agricultural production is responsible for climate change. In the most industrial countries, agricultural production has built a great dependency on fossil energy consumption by replacing most human labour with agro-technologies on the farm. This is unsustainable in the context of climate change and resource depletion. Therefore, in order to mitigate climate change, the transition to sustainable food production is necessary and urgent.

A movement rising in the 1970s, organic agriculture is believed to be a sustainable approach for agricultural production. It has been proved to use less fossil energy due to a commitment not to use any synthetic substances, but at the same time it uses more labour. When labour and fossil energy are regarded as two basic resource inputs on a farm, it seems that organic farms use more labour to compensate for the reduced fossil energy consumption. However, it is still unknown how the input balance of fossil energy and labour on organic farms is different from that on conventional farms, and how the different input balance would influence the sustainability of agricultural production. It is valuable to explore these questions against the backdrop of climate change.

When considering other issues, the differences between the Netherlands and China in their trajectories of agricultural development in their different social contexts may influence the input balance of fossil energy and labour use between organic and conventional agriculture as well. Moreover, different farming activities and farm sizes are also supposed to make a difference in resource use on a farm. It is thus necessary to include these variables in comparing the resource input balance between organic and conventional farming systems.

As the issue of fossil energy and labour input balance on farms has not been studied thoroughly, this thesis is written based on an exploratory research. The main objective is to explore the balance of fossil energy and labour input at farm level by comparing conventional and organic farming systems, and to explore the possibility to optimise sustainability of resource use in agricultural production. Five research questions were generated with respect to the objective:

(Q1) To what degree does the balance of fossil energy and labour input on organic farms differ from the balance on conventional farms?

(Q2) To what degree do such balances coincide or differ when the Netherlands and China are compared?

(Q3) How could organic farms in the two countries use more labour on the farm facing the constraints of labour shortage and increasing labour price?

(Q4) How to understand farmers' different input strategies and what is the conventionalisation of organic agriculture in terms of resource use?

(Q5) As a countertendency of conventionalisation, what are the values of organic peasant agriculture?

To answer these questions, this thesis uses a comparative case study to collect and analyse both quantitative and qualitative data. In total six empirical chapters are organised to answer the five research questions accordingly.

Chapter 2 and Chapter 3 tackle the first research question by calculating the energy and labour input balance separately for the Netherlands and for China. Selecting 12 cases with different farming systems (organic and conventional), farming activities (dairy, arable and vegetable) and farm sizes (big and small size) in each country, energy and labour use for producing a certain gross value are computed and compared among different cases. The general conclusion of these two chapters is that organic farming uses less energy and more labour compared with conventional farming in both countries, but there is great variation among all the farms in the size and farming activity of this gap. When the added energy and added labour between organic farming and conventional farming are compared, the substitution rate of the two resources is much lower on organic farms than on conventional farms, which means organic farming would require less energy input than conventional farming to replace the decreased labour use. Thus, organic farming is more sustainable in reducing its dependency on energy use, compared with conventional farming in both the Netherlands and China.

Chapter 4 compares the energy and labour input balance between Dutch farms and Chinese farms to respond to the second research question. It concludes that Dutch farms use more energy while Chinese farms use more labour due to their different resource endowments. However, the situation is changing in both countries. In China, energy input is increasing because of the policy incentive for promoting the development of industrial agriculture. This could result in high energy and high labour input at the same time, which may not sustain the development of agriculture. In the Netherlands, there are also farms following a different path of development using more labour and less energy on the farm. This means that the so-called industrial agriculture – which consumes much more energy – is not the only nor the best trajectory for agricultural development. The rising developing countries should not necessarily choose the conventional trajectory but rationally consider their resource endowments when making policies for agricultural development.

Chapter 5 responds to the critique that organic farming requires more labour input and this makes it vulnerable to the potential labour constraints. Analysing organic farmers' perceptions and responses to the labour constraints in both the Netherlands and China, it concludes that there are three patterns of responses to deal with the constraints, and specifically two patterns witnessed in the two countries would increase organic farmers' resilience in dealing with the difficult situations. These two different patterns can be further explained by the different social contexts of the Netherlands and China, which show that organic farmers could respond to the labour constraints in more resilient ways, and these responses are usually embedded in and shaped by their local social contexts. Organic farmers should be encouraged to explore their diverse local solutions to increase the resilience of their farm when dealing with labour constraints.

Chapter 6 tackles the fourth research question, discussing farmers' input strategies by clarifying the heterogeneity within organic farms, and highlighting the trend of conventionalisation in the development of organic agriculture. Applying the theories of farming mode and farming style concerning the resource base on farm, this chapter reveals that organic farms with economical farming style perform better with respect to achieving sustainability in resource use compared with organic farms with an intensive farming style. Changing styles from economical to intensive farming is interpreted as the conventionalisation of organic agriculture. To optimise organic agriculture's potential in sustainable food production, the countertendency of conventionalisation is then identified as 'organic peasant agriculture'. The exploratory study ultimately supports the hypothesis that organic agriculture with peasant qualities shows better potential in applying organic principles to optimise the sustainability of an organic farm.

Chapter 7 discusses the theoretical concept of organic peasant agriculture, and tries to distinguish it from conventional agriculture and conventionalised organic agriculture. Within the framework of triple bottom line, it discusses the sustainability of organic peasant agriculture from the perspective of planet, people, and profit. It concludes that organic peasant agriculture is valuable in the transition to sustainable food production.

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Tian Yu

September, 2019

Tian Yu
Wageningen School of Social Sciences (WASS)
Completed Training and Supervision Plan

Name of the learning activity	Department/Institute	Year	ECTS*
A) Project related competences			
Research Methodology-From topic to proposal	WASS	2015	4
Writing research Proposal	WUR	2015	6
Qualitative Data Analysis: Procedures and Strategies	YRM-60806	2016	3
B) General research related competences			
WASS introduction Course	WASS	2015	1
Data Management Planning	WUR Library	2016	0.4
Scientific Writing	Wageningen in' to Languages	2016	1.8
Information Literacy for PhD including EndNote introduction	WUR Library	2016	0.6
Systematic approaches to reviewing literature	WGS	2016	4
Towards a Global One Health: an interdisciplinary lens to explore synergies, trade-offs and pathways for food systems transitions	WIAS	2018	1.5
Efficient Writing Strategies	Wageningen in' to Languages	2018	1.2
Scientific Publishing	WGS	2018	0.3
Academic Publication and Presentation in the Social Sciences	WASS	2019	4
C) Career related competences/personal development			
'The Youth Going Back: A case study of the intergenerational conflict confronted by new peasant in China'	4th KU-WUR International Graduate Workshop on Food, Farm and Rural Development	2018	1
Career Perspectives	WGS	2018	1.6
'Energy and labour use on farms: case studies from the Netherlands and China'	5th WUR-KU International Graduate Workshop on Food and Development Studies	2019	1
Total			**31.4**

*One credit according to ECTS is on average equivalent to 28 hours of study load

Colophon

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