The International Scientific Conference INPROFORUM 2015, *November 5 - 6, 2015, České Budějovice*, 47-53, ISBN 978-80-7394-536-7.

Quest for Sustainable Food Production: Social and Financial Metabolism of a Local Food System

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Abstract: *The question of how to feed the global population not only sufficiently, but also sustainably has become a significant problem for both academics and activists all around the world. However, there is not any shared methodology how to assess the sustainability of agricultural production. Local food systems (LFS) are often suggested as a more sustainable alternative to the large-scale mechanized mode of agriculture but there are still many gaps in our knowledge of their social, environmental and economic impacts. This paper introduces the concept of social metabolism as a useful tool for assessing the LFS' sustainability; looking at energy and material stocks and flows of a defined system, it enables one to inspect the functioning of a food system in detail, both on global, national and local scale. Applied to three case studies of Czech and Slovak organic farms, the social metabolism study can provide information on energy and material demands per unit of production, on land-use, labour time and the level of self-sufficiency of the farm system. The data on material and energy flows are suggested to be complemented by a local multiplier, an indicator of local monetary flows related to the farms. Although not providing the final verdict about the farms' sustainability, the concept of social metabolism provides a very useful framework to structure such a debate.*

Key words: Social metabolism · Local Multiplier · Sustainable Food Production · Organic Agriculture

JEL Classification: Q15 · Q18 · Q57 · R11

1 Introduction

Food production is one of the most important fields of human activity, together with energy production one of the unavoidable ones, if we, as human beings, are to sustain our lives on the Earth. During the last century, we have witnessed an unprecedented growth of the volume of food production on a global scale, but also a growing amount of data suggesting that there are many environmental, social, and also economic problems connected to the current industrialized and globalised food production system. In this context, rising academic attention has been devoted, among others, to so-called local food systems (LFS), which are rooted in a broader concept of economic localisation. At the same time, new conceptual frameworks have been developed for studying complex socio-economic systems and their interactions with the environment, including the concepts of social metabolism and the local multiplier (see section 2 for more details).

The issues of food security, food sovereignty and more generally sustainable food production is gaining increasing attention and importance on all levels of the national (MZV ČR, 2011: 6, 10, 15-16), European (EU Focus, 2010) and global (UN, 2010) political agenda. The question of how to feed the global population not only sufficiently, but also sustainably in a long term, has become a significant part of a vivid academic debate (see e.g. Pretty et al., 2006; Ranganathan & Hanson, 2011 or GOS, 2011). Though often perceived as a global problem, sustainable food production has the inevitable local dimension of agricultural, environmental, economic, social, institutional and other context of particular countries, where the food is produced, processed, transported, traded, and consumed or wasted. Hence, understanding of the particular food production practices and their impacts on the local level is crucial for any understanding and change on the higher levels.

The concept of economic localisation can be seen as an attempt to develop a potential alternative trajectory to economic globalisation.[8] There is a wide stream of localisation proponents who consider economic localisation to be

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[8] Economic localisation can be defined as "both the process and the result of moral, political and practical support of as many localised aspects of production and consumption as possible and desirable. More specifically, it includes preferring local factors of production, their local ownership, local capital flows, and orientation primarily on satisfaction of local needs. Other integral aspects include emphasis on and support for sustainability of production and consumption, the development of local communities, democratic decision-making, strengthening local economies and self-reliance, and building relationships to place. Economic localisation does *not* mean (attempts at) absolute autarky or any other type of isolation from the outside world." (Fraňková & Johanisová, 2012)

one of the most important strategies for developing sustainable ways of satisfying human needs (see e.g. Douthwaite, 1996; Shuman, 1998; Hines, 2000). Especially the current system of food production, distribution and consumption has become both a focus of localisation activists' practice, and a distinct subject of academic interest. (Winter 2003; Watts et al., 2005; Maye et al., 2007) According to the proponents of economic localisation (see their analysis by Fraňková & Johanisová, 2012: Table 2), the concept entails, besides others, the following environmental and economic aspects:

- preference for locally sourced factors of production (natural resources, labour and capital);
- the most feasible closed circulation of matter and energy, including management of waste as a resource;
- emphasis on sustainability of production and consumption;
- attempts to shorten distances between production and consumption;
- preference for local ownership of factors of production;
- emphasis on local circulation of money and local financial capital.

By putting these aspects into practice, localised food production is supposed to bring social, environmental and economic benefits such as: lower transport dependence resulting in less consumption of fossil fuels, lower CO_2 emissions, less waste from packaging, higher levels or local recycling, more closed cycles of matter and energy within the production system, and also stronger local economies showing a higher level of local circulation of money, lower dependence on foreign investments, and less dependency on, and more resilience towards fluctuations of the global economy. (Douthwaite 1996; Norberg-Hodge et al., 2002; Desai & Riddlestone, 2002) However, there are still significant gaps in our knowledge of the social, environmental and economic impacts of food system localisation (Martinez et al., 2010) and thus more contextualised material data is needed, critically investigating the potential localisation benefits indicated above.

There are some case studies of particular localisation schemes targeted on the social and community aspects of localisation (e.g. Seyfang, 2007), and a growing body of literature focused on its environmental impacts, mostly on the connections between the local food systems and climate change (e.g. Kramer et al., 1999; Weber & Matthews, 2008; MLFW, 2010 and others, for the literature review see Edwards, 2008 or Brodt, 2007). Some of these studies combine carbon emissions/carbon footprint studies with energy use analyses, often using the life-cycle methodology or input-output analysis (see Carlsson-Kanyama et al., 2003; van Hauvermeiren et al., 2007). However, no study so far seems to have made use of the intellectual framework of social metabolism as introduced below, although they may share much of the methodological background. Besides this, there is a limited number of studies available, trying to measure the economic impact of localised food systems, using mostly the concept of local multiplier (see Martinez et al., 2010).

In spite of the growing body of foreign literature regarding local food systems and the concept of economic localisation, and also a significant mass of literature on the social metabolism and local multiplier methodology, which can be very effectively employed in the study of local food systems (see also further), there are still some crucial missing links. Thus, this papers aims to 1. introduce the concepts of social metabolism and local multiplier (section 2), 2. and demonstrate and discuss their usability for studies of local food systems (section 3) and more broadly for the debate on (more) sustainable forms of agriculture (section 4).

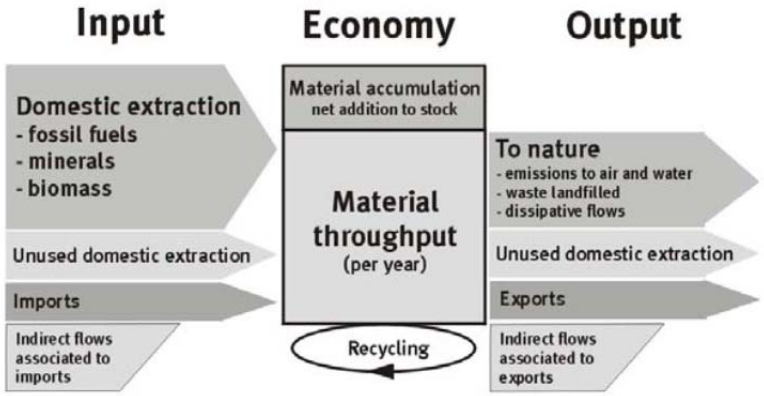
2 Methodological framework

During the last two decades, social metabolism has become a recognized field of research. Rooted in the intellectual background of ecological economics (see Martinez-Alier 2009), its purpose is to study complex socio-economic systems and their interactions with the environment. For the intellectual history and basis of the social metabolism concept see Fischer-Kowalski (1998a; 1998b) and Fischer-Kowalski et al. (1999). The social metabolism approach is "based on the premise that any social system not only reproduces itself culturally but also biophysically through a constant flow of materials and energy with its natural environment as well as with other social systems." (Singh et al, 2010: 5) To study these exchange relations of material and energy flows, the conceptual framework of the Material and Energy Flow Accounting (MEFA) is used (Singh et al, 2010: 6). For its general outline and analytical categories (in terms of the Material Flow Analysis, MFA) see Picture 1.

Most of the social metabolism studies are conducted on a national level. There is a unified methodology approved for the EU countries by Eurostat (EUROSTAT, 2007), and comparable data are already available for the EU countries (e.g. Weisz et al., 2005), and also on a global scale (Dittrich et al., 2012). For the Czech Republic, a comprehensive study of the country's social metabolism and land-use was done by Kušková et al. (2008) for the period between 1830 and 2000. For the regional and local level, there is a limited number of social metabolism studies (for their overview see Hammer et al., 2003). Most are focused either on developing countries or, in industrialised countries, on cities and their

hinterlands. As regards local food system studies, only a few pilot studies conducted in the context or industrialized rural areas are available (Krausmann, 2001; Krausmann et al., 2003; Haberl & Krausmann, 2007; Haas 2002). There thus remains the challenge of piloting another study of social metabolism on a local level focusing on local food systems, and thus contribute to integrating the expertise of the two fields of research, social metabolism and local food system studies.

Figure 1 General scheme for economy-wide material flow accounting and analysis (MFA), excluding water and air flows



Source: EUROSTAT (2001:16)

One of the important features of the localisation concept is its complexity and the interconnectedness of its particular aspects. For this reason, it is important to complement the assessment of environmental impacts studied via the social metabolism concept with economic analysis. Within the localisation studies, the methodology of the local multiplier is suggested to be highly relevant. The multiplier effect was described already by J. M. Keynes, who studied the impacts of government spending on national economies. In the Keynesian sense, a multiplication effect occurs when a change in spending induces a more than proportional cumulative change in demand. In other words, "Increased spending causes firms to hire more workers, those workers go out and consume more, and a virtuous circle ensues." (Mendel, 2012, in prep.) By the same principle, the *local* multiplier can be calculated, expressing the "added value", i.e. the cumulative positive change in demand and related potential of job creation on a local level – the assumed positive outcomes of economic localisation indicated above. The British New Economics Foundation (NEF) has developed a simple tool, the Local Multiplier, to calculate the local multiplication effect for individual actors (be it a government body, local shop, a farm, or other) within a local economy. NEF recommends tracking the spending of the investigated actor up to the third round of circulation of the money within the local economy, and hence they call the tool LM3 (Local Multiplier, 3rd round). LM3 can be interpreted as an indicator of how much the particular actor contributes to the local economy, and also of the strength of the local economy, expressed by the proportion of money staying circulating within the local economy before "leaking" outside. For a more detailed explanation of the logic and interpretation of the LM3 see NEF (2002).

There have been a number of LM3 case studies performed in the UK, mostly for the spending of the public sector and its impacts on local economies (see NEF, 2002). Specifically for the local food sector, a few studies exist using (not only) the local multiplier tool (Magnusson et al., 2010; Matinez et al., 2010). However, the methodology is not settled yet and the results are comparable only to a limited extent. In the Czech Republic, there are a few pilot studies using the LM3 tool also for investigating the effect of local governmental spending and its impacts on local economies (e.g. Ježková, 2009; Novotná, 2011), none, however, have been targeted on local food systems' impacts on local economies.

3 Social metabolism and metabolic transitions in agriculture

Using the approach of social metabolism, particular facts and consequences are revealed which might escape our attention otherwise, if we rely solely on monetary-based indicators. One of the most important of such insights is the energy inefficiency of the industrialized agriculture compared to other forms of cultivation and food production. Despite the different methodologies and thus somewhat limited comparability of the results of particular metabolic studies (see e.g. Pelletier et al. 2011 for their review), it has been made clear that the industrialized forms of agricultural

production typically require more energy inputs than they produce as outputs. Ulčák (2003:74) provides an overview of various forms of agricultural production and their energy efficiency; ranging from the ratio of 65-70:1 (energy output : energy input) of the tropical small-scale production of cassava, 38:1 ratio of non-mechanized rice production in Thailand and 10:1 ratio of pastoralist production of meat and milk in Africa, through 1,3:1 energy ratio of kitchen gardens in the UK, the world average represents already the inverse ratio of 1 energy unit of output to approximately 10 units of input. The mechanized production of strawberries in the US (1:5), the broiler production in the UK (1:10) and the marine fisheries of the Mediterranean region (1:100) then all represents the same trend of more inputs than outputs, typical for the industrial, high-external-input (as characterized by Giampietro et al., 2014:41) agriculture.

If we complement the data on energy return on energy invested (EROI) with other metabolic indicators such as the annual material throughput, number of people working in agriculture and the volume of stocks of man-made artefacts, one can distinguish three general metabolic patterns, so called metabolic regimes (Fisher-Kowalski & Haberl, 2007); whereas the first type, hunter-gatherer society is characterized by an average per capita annual flow of approximately 1t of biomass (food, wood) and < 0,1t of minerals (stones, metals), and the second, agrarian society by an annual average of 4t of biomass (food, fodder, wood) and 0,2-2t minerals (stones, metals), the industrial society's flows represent a magnitude-bigger flows of approximately 20t of materials in total, consisting of 5t of biomass (food, fodder, wood), 5t of fossil fuel energy carriers, 8t of construction minerals and 2t of metals. (Fischer-Kowalski et al. 2011) The historical process of change and transformation from one metabolic pattern to another is then called metabolic transition. (Fischer-Kowalski & Haberl 2007) This transition is highly interconnected with the big-scale processes of industrialization and globalization with significant impacts not only on the whole economies and societies but also on their lower levels.

Thus also the agricultural sector was subject to change; the transition from more subsistence based models of the hunter-gatherer and agrarian societies to the industrial agriculture is characterized above all by diminishing importance of human and animal labour, by growing dependency on fossil fuels and more generally on external inputs, and by higher levels of overall material and energy throughput. Also the Czech (and Czechoslovak) agriculture has undergone such transformation from the agrarian to the industrial model of production during the last two or three centuries, as both qualitatively and quantitatively demonstrated by Kušková et al. (2008) and Grešlová Kušková (2013). Between 1920 and 2000, the number of workers in agriculture dropped from 1 474 000 to 181 000 and the energy use of animal and human labour was dwarfed by energy inputs from fossil energy and industrial fertilizers. (Grešlová Kušková 2013:594,596) Symbolic for this trend is the point when tractors in the Czechoslovak agriculture outnumbered the horses which happened between 1965 and 1970. In accordance with other data on energy efficiency (see above), within the same period (1960-1970) the energy efficiency of Czechoslovak agriculture lowered significantly from 5,1:1 to 2:1; after some fluctuations, very similar result is typical also for the current state – in 2005 the ratio was 2,1:1. (Grešlová Kušková 2013:594,598)

If we are to reverse this trend (growing energy inefficiency and numerous related negative environmental impacts of agriculture), we have to look for models which show better results regarding their metabolic profile. It is very useful to compare the current metabolic parameters with the historical ones, however, we need models viable in current both social, environmental and economic conditions. Exactly for this reason, a project looking at three case studies of Czech and Slovak organic farms takes place;[9] this study of the farms' social metabolism will provide information on energy and material demands per unit of production, on land-use, labour time and the level of self-sufficiency of the farm systems. The analysis is complemented by the local multiplier investigation, as described above. The data will contribute to the debate on sustainability in agriculture, both on the methodological and material level.

4 Discussion and Conclusions

As already noted above, sustainability in agriculture is a complex issue. Ulčák & Pall (2003) formulate three basic areas of its meaning; 1. Sustainability as sufficient food production to feed the world population;[10] 2. Environmental sustainability – preserving ecosystem functions and biodiversity, and minimizing negative impacts of agriculture on biota, and 3. Sustainability of related cultures and human relationships. All these aspects are combined in the term of *food sovereignty* as defined by farmers, social initiatives and NGOs both from the global South and North, together with the democratic right to participate and decide on the conditions and consequences of food production: *"Food sovereignty is the right of peoples, communities, and countries to define their own agricultural, labour, fishing, food*

[9] A project called *Quest for sustainable food production: Social and financial metabolism of selected local food systems* (grant no. 13-38994P) supported by the Czech Science Foundation (GAČR).

[10] It is the meaning of *food security* as defined by FAO (Food and Agriculture Organisation of the UN): *„Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life."* (FAO 2006:1)

and land policies, which are ecologically, socially, economically and culturally appropriate to their unique circumstances. It includes the true right to food and to produce food, which means that all people have the right to safe, nutritious and culturally appropriate food and to food-producing resources and the ability to sustain themselves and their societies." (Nyéléni 2015). It resonates with the insight of one of the most influential writers on sustainability in agriculture, Wendell Berry, who argues that every truly responsible food consumer is, at least to some extent, also a food producer (Berry 1977).

In this line of thought it is important to remind that not only agriculture as a specialized profession and an economic sector is a source of alimentation. Also subsistence cultivation (as mentioned above) and food production in the form of gardening provides substantial amounts of food, both South, North, East and West. As showed e.g. by Sovová (2015) on the case of allotment gardens in Brno, CZ, the amount of food produced in this area is remarkable and thus deserves, together with other forms of local food production (see e.g. Ulčák 2006 for pork), more research attention. Though far from being framed in terms of sustainability practice or in the food security context by its practitioners (see Smith & Jehlička 2007 for one of the very few studies of this phenomenon), the Czech practice of local subsistence gardening has significant pro-environmental impacts, and many features comparable to the western movements of urban gardening, community gardens, and home-grown food campaigns now gaining ground in the UK and other western countries. The Czech Republic as a post-communist country, still in the process of transformation, is a very interesting area for studies of local food models as it provides a combination of existing "native" food practices partly persisting from the communist and pre-communist times with the concepts such as farmers' markets, organic box-schemes, and community supported agriculture initiatives imported as part of the local food agenda from the West (esp. UK and USA).

Although there has been only little theoretical reflection of these phenomena (see the exceptional study by Smith & Jehlička 2007) the situation is changing and the topic gains more attraction both within practice and academia. This paper tried to contribute to this trend and aimed at enriching the methodological tools available for studying (not only) Czech local food practices and sustainable agricultural initiatives. Thus, this paper introduced the concept of social metabolism as a valuable tool to capture the complexity of issues related to the sustainability debate in food production, possibly complemented by another tool to capture the local economic flows, the local multiplier. Especially on the issue of energy efficiency in agriculture it was shown that social metabolism does provide crucial material insights that are not revealed by prevalent monetary-based indicators. Although not providing the final verdict about the agricultural practices' sustainability, the concept of social metabolism is a very useful framework to structure the necessary debate.

Acknowledgement

The work on this paper was supported by the Czech Science Foundation, grant no. 13-38994P: Quest for sustainable food production: Social and financial metabolism of selected local food systems.

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