



SUPPLY CHAIN PARTICIPANTS IN THE MUSHROOM SECTOR AND THEIR ROLE IN THE ADDED VALUE CREATION IN SUSTAINABLE WAY BASED ON A HUNGARIAN CASE STUDY

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Annotation

With the world's growing population the significance of the food producing sector as well as mushroom growing is constantly increasing. Great improvement is waiting for the mushroom sector in Hungary based on the expected development efforts and trends during the period until 2020.

Experts often mention the fact that nowadays neither products nor enterprises but supply chains are competing in the market. This is also true for mushrooms, namely those companies and participants will be the winners who can satisfy customers' dynamically changing needs faster and more exactly, or can provide the customers with their needs regularly and in a reliable way. The goal of the study is to present the supply chain in the Hungarian mushroom (primarily *agaricus*) sector, to determine the most important participants of the supply chain and their fundamental role in the added value creation according to the end product's sustainable production and quality.

KEY WORDS: mushroom growing; sustainable agriculture; supply chain; added value; sustainable production.

Introduction

The organization and planning of supply chains have become such a strategic area which requires an international overview. (Bowen, 2011; Csáki et al., 2010; Goodman, 2004) Concerning the supply chain efficiency of foods and their values provided to consumers the attention centres around how the product reaches the costumers. There are various needs and habits, cultural differences should be considered in individual countries and in different markets, however, the protein consumption of the developing markets or a great del of wasting in developed markets have brought important changes (Kearney, 2010).

In the supply chain of foods economy, environment and society are expressively connected and they give a mutually related complex system (Pálvölgyi et al., 2012). The questions of sustainability, environment consciousness and thriftiness cannot be separated from each other, they should only be seen in a strategic and systematic way. National governments have already realized that economy developing and environment protection should be managed together, and they have described national strategic programmes. It is important that methods must be real as specific solutions at the level of farmers as well as at the level of connections among farmers. Studying supply chains is considered as a good example of thinking in this system. According to classic value chain models of economics value comes into being in several steps and goes to the customer although these days not only the goods as end products are in the focus since those values have come into being which are made by other actors, built into the end products. Not only the product but also the cumulative performance (see value elements) of the whole supply chain count in the

customer's decision. (Think about packing, transporting, marketing or even sustainability as social values.)

Culinary interest towards mushrooms shows big differences in various cultures all around the world. (Kovács, 2011) In certain places housewives would not put mushrooms on the table at all while in other places a great deal of money is paid for them. Currently mushroom is not a basic food rather supplementary; thanks to its particular nutritional values it appears more often instead of meat or garnishing as a part of healthy nutrition. Inside agriculture the sector has gone through an impressive development within the last couple of years. (Kovács, 2011) The world's current mushroom growing is about 3.6 million tons annually (FAOSTAT, 2011) which is more than three times that thirty years ago (1.1 million tons), and even one and a half times greater than ten years ago (2.4 million tons). The world's mushroom growing and consumption have soared in big leaps. Once Hungary was a big force in mushroom growing meanwhile today the consumers' mushroom culture is fairly poor and the public consumption is uneven.

Nowadays the biggest mushroom grower country in the world is China both in amount and the number of species. 40-50 percent of the world's mushroom consumption comes from here but their own data state that it is a lot more since Food and Agriculture Organization of the United Nations (FAO) statistics do not contain several of their grown varieties (Hu and Zhang, 2010). China's mushroom export to Europe is also significant.

The present economic actors should suit old traditions, changing needs and the more intensified growing requirements, modern technologies at the same time. It is a real challenge requiring a continuous innovation of the supply chain.

Growing in cellars or caves has become old-fashioned today, and the Dutch type of mushroom houses is not so new either. One of the main directions of the innovation is to intensify the amount grown on one square metre which is a key question concerning thriftiness. The other main direction is to improve quality which determines existence on the market and it is closely connected to the selling price, however this latter is only connected to the grower's performance. Logistics, processing and packing also matter, even the way of selling which needs a complex supply chain strategy.

Material and method

In this study we raise the attention to the sustainable supply chain of mushroom growing. The primary goal was to analyse the importance of mushroom growing and its sustainability criteria based on secondary literature sources of the mushroom sector. Putting Porter's theoretical method of value chains into practice we applied that to determine and interpret the primary value creating processes of mushroom growing, then we interpreted the indirect value creating role and elements of the supporting processes as well. To write this study we made three deep interview analyses with well-known mushroom grower experts and dealers between January and March 2015. The deep interview was split into five big topics such as the company's situation in the sector, company management, development, the supplier and the customer sides of intercompany connections. For deepening practical knowledge the company's plan tours and site visits were provided.

The research results and the connection points mapped were gathered in a novel complex and extended supply chain figure developed by us, and the value creating points were also marked in that. In this extended supply chain figure we wanted to map the whole value flow from the supplier to the customer and those connection systems which can provide the customers with further values besides mushroom as end product. The enterprise integrated into the case study well represents the exploitation of connected advantages in a complex system, consequently the creation of a sustainable system.

Discussion

The significance of mushroom growing

Inside agricultural sciences mushroom growing is one of the dynamically developing branches of horticultural sciences; as opposed to the fifties the yields have increased five times until now due to constant researches.

Mushroom was known and grown as a delicious dish in ancient times, however, its scientific research (Rácz and Koronczy, 2001) exists only from the 18th century. Mushrooms grown have a greater role in the world's feeding with the increasing population (Mutsy, 2005). From nutritional and physiological aspect mushrooms are valuable food since they contain essential aminoacids, minerals and important vitamins in huge amounts. Several types of them can be applied effectively against tumours and there are other types reducing cholesterol and blood sugar levels. Mushroom consumption in

Hungary is 1.5 kg/person/year which is far beyond the European average; for example in the United Kingdom only *agaricus* consumption is 2.9 kg/person/year while in Spain its consumption reaches 3.5 kg/person/year. According to FAO data the amount grown in the world is 8 million tons annually, 75-80 percent of this is *Agaricus bisporus* and 15 percent is oyster mushroom (Research Institute of Agricultural Economics, 2015).

One fifth of *agaricus* grown in the world comes from the European Union although growing is placed to Eastern and Central Europe. The biggest grower, Poland made great developments during last years, increased its growing to 150,000 m² and started building several logistics centres.

Before World War II Hungary had been the world's third biggest mushroom grower behind France and the United States with its 1,200 tons grown in 1938. In Hungary growing took place on 200,000 m² in 1940 and after the war this amount fell significantly (Uzonyi, 1971). Currently in Hungary about 20,000 tons of mushrooms are grown annually, and the decrease halted by now thanks to New Hungary Rural Development Program but the aim is to take over the leading role with 50,000 tons grown. The purpose of development covers encouraging Hungarian consumption, expanding export, creating new mushroom growing farms as well as mushroom compost producers and a huge increase of processing capacity. Efficiency and profitability can be less increased nowadays with creating better technologies but logistics developments provide much greater development potential. (Dupcsák and Marselek, 2015)

Growing mushrooms and sustainability

The great significance of mushroom growing lies in that by its nature mushroom can be grown in a sustainable way since it 1. does not have any negative effects on the landscape, 2. does not cause any unwanted contamination, 3. is extremely sensitive to income, and consequently provides economical income to the participants in growing while using several by-products. During last years several innovative technological developments became known which put mushroom growing in the focus of sustainable farming. Originally in the home country of mushroom growing, so in France growing was taking place in stone mines and cellars (Szabó, 1990), today due to innovative development technologies there is a possibility to use reusable polypropylene plastic bottles instead of fast worn-out plastic bags (in case of king oyster mushroom), or other growing processes with trays or multi-level shelves etc.

Several points of the mushroom growing supply chain can be remarkably connected to other points of agricultural growing. For example, according to local conditions mushroom compost needed to mushroom growing is suitable for using by-products (e.g. industrial, forestry, agricultural by-products, sawdust or straws of other agricultural plants). After the growing cycle depending on the technology mushroom compost grown is extremely suitable for improving soil, containing many types of nutrients, macro and micro elements; pesticides are not so typical in mushroom growing so there are only a few remains.

An important criterion for sustainability is that we should list the factors (hazard analysis) threatening the value of the end product and the value creating ability of the whole supply chain. In the following in every phase we are presenting the most important risks and the methods which help avoiding the possible dangers so they can give sustainability. The three keystones of every successful strategy and value creation are the three questions to answer as follows: 1. How can this activity be profitable? 2. How can this profitability be sustainable, repeatable persistently? 3. How can this activity be different from others, having individual advantages?

Results

Value creation in mushroom growing

Using the value chain method (Porter, 1985, p. 37) we created the value chain of mushroom growing with discovering the primary activities as the main process of the business, their order in time, then we determined the supporting activities and evaluated the contents of the individual activities. The process of value creation is highly influenced by "... the characteristics of mushroom growing (living organisms, weather, environment conditions etc.)". "Among these influencing factors the most important are time and seasonality ..." (Téglá et al., 2012).

Primary activities:

(The following activities directly contribute to the creation of added value.) The first chain element and at the same time a part of the incoming logistics is mushroom compost buying and/or production. Horse manure and poultry manure, short straw, gypsum and water are used to produce compost. Wheat straw is usually used from straw types. The fibrous components such as straw give water holding capacity and consistency. Quality is influenced by the origin and management of organic components, artificial materials inside, pesticides, and minerals such as nitrogen content of chicken manure. Gypsum is an important ballast material, what is essential that it should not contain any heavy metal contamination.

Concerning the ultimate quality of the supply chain and the end product the most important thing is homogeneous and well selected compost available regularly at the same quality. The quality of the compost and mainly its fixedness are so important factors that in our study the compost is produced in special plants.

The growing/production phase in the value chain consists of spawn (mycelium) production, casing soil production and real growing phase which provides another substantial added value. Mycelium production takes place in precise laboratory conditions since this step is one of the elements with the greatest uncertainty and the highest costs. For engrafting the seed of millet or other crops is used, its quality is crucial since it should not contain strange (weed) seeds, causative agents, pests and contaminations. The next phase is casing soil production, mushrooms cannot create fruit bodies without it. Being free from causative agents and pests is extremely important in case of the casing soil concerning the quality of the end product. We can get nice

mushrooms only if the casing soil is clear and has a good water holding and water loss capacity and its nutrient content is low. The mixture of peat types and chalk powder is mainly used in Hungary. Then the real growing is a kind of waiting and caring, followed by "harvesting". The key to growing is ensuring conditions (light, heat, humidity etc.) undisturbed and eliminating factors causing errors, ensuring undisturbedness. Growing mushrooms can take place in cellars, or in agricultural building of other aims, in tents of Dutch type etc.

In our case the outgoing logistics consists of distribution and sales. For the grower the end product should be in a good shape to transport and/or sell. It is a good question whether the product is transported directly into the commercial channel or used for processing. From the view of the supply chain it is an extremely important question what kind of packing the product has because it should serve logistics needs and ultimate customer needs as well. In the latter case there is an exceptional big development and the ultimate differences are also big since the customer evaluates the ultimate quality of the product based on this latter one. Due to inappropriate packing it can occur that the customer receives a product of excellent quality at an improper quality, for instance broken, damaged, or its marketing value is lower than the rival's. "Green logistics has a greater significance in organising supply chains. ... Hungarian food industry companies extended their portfolios with environment-friendly packing techniques." (Pónusz and Horváth, 2014)

Marketing activity consists of pricing, product and brand creation, and the character of the relationship with the customers. In case of mushroom several solutions should be used and they can bring additional value for the customer because the majority of the customers are not regular mushroom consumers. That is why these needs should not only be satisfied but also encouraged.

The last element of the value chain is further elements after sales such as product safety and tracking. As opposed to industrial products attention should be paid to these values because they can be values of trust for the customers.

Supporting activities:

(These activities only indirectly contribute to the creation of added value; we cannot say exactly when and what value they are responsible for) In case of buying/supplying coordination long-term strategic relationships are typical regarding special expert needs. Concerning technology development mushroom growing is characterised by intensive researches, almost every big grower takes part in this kind of activity. Considering human resources management mushroom growing hides great opportunities for this activity is effectively done with employing undergraduates and those living with disabilities. Mushroom growing has high living labour force and capital needs. Concerning corporate infrastructure and management the size is typically family business (for a summary see Fig. 1).

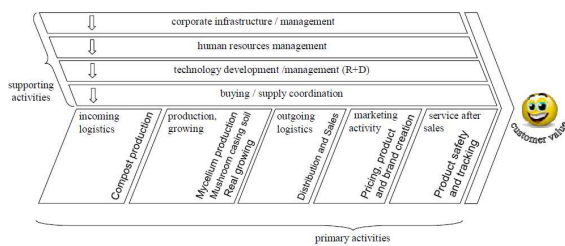


Fig. 1. The value chain of mushroom growing inside a company (Source: own creation based on Porter (1985) p. 37)

The value chain and supply chain of mushroom growing

It is well-known that nowadays neither products/services nor enterprises but whole supply chains are competing. In today's sharpened and turbulent competitive environment those enterprises will be successful which can effectively take part in making value flow in the supply chain, their role and significance can become a determining factor, and they can satisfy the customers' dynamically changing needs faster and more exactly as well as regularly. The questions what kind of and how big position can be reserved and by whom in the whole supply chain are important elements of the strategy. In our interpretation value chain means that how corporate processes (functions) can be connected inside a company in a sustainable way and today crossing the borders of the company into a supply chain. The supply chain is such a value chain in which the series of value creating processes create values (not only products and services!) suitable for satisfying customer needs through co-operating companies.

The company in our case study has covered several elements of the whole sector since its foundation in 1990 (see Fig. 2).

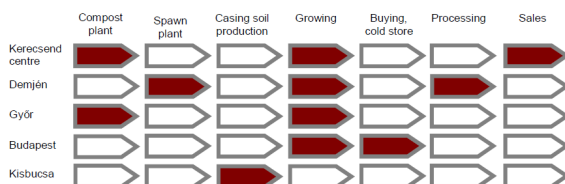


Fig. 2. The value chain and supply chain of mushroom growing (Source: own construction)

In harmonising real processes between companies there is an opportunity by which the competitive situation of the participant companies (1) can be improved, and even the performance of the whole chain can be optimised and improved. We define supply chain management as a conscious activity of the supply chain harmonising the participant companies' value creating points and improving the values built in.

Also important is the growers' effort to make their connections closer with the mediators of the sales process to sell their product to the customers in a better quality (Pagh and Cooper, 1998). The specific structure and the type of the supply chains are always determined by the goals and values wanted. These goals and values are related to the basic function of the supply chain (Fisher, 1997).

A case study of a Hungarian sustainable mushroom growing business

Mushroom industry plant in Demjén and the National Crown Mushroom Grown Union (NCMGU) are one of the biggest mushroom growing companies (representing cca 35-40 percent of Hungary's mushroom growing). 98 percent of the whole growing is agaricus growing, and the remaining 2 percent is oyster and exotic mushroom species (shiitake, king oyster etc.). The enterprise deals with almost the whole spectrum of mushroom growing namely spawn production, mushroom compost production, fresh mushrooms and canned products appear.

The spawn plant and research laboratory in Demjén produces mother spawn in great amounts which is demanded both in Hungary and abroad.

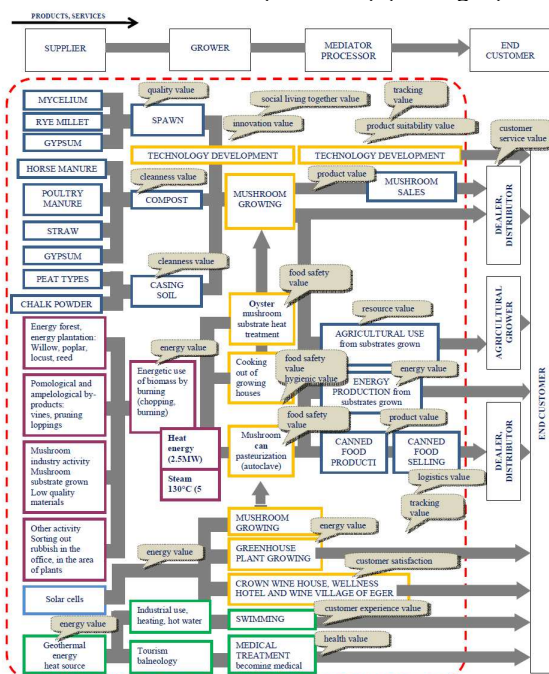
Aspects of sustainability:

- In case of mushroom compost production in Kerecsend indoor technology is used as an experiment to reduce the plant's external odour emission which is unpleasant for those living nearby. In favour of sustainable farming the plant annually uses 17,650 tons of wheat straw, 14,700 tons of poultry manure, 3,528 tons of horse manure to grow agaricus mushroom. Besides these the use of other lignocellulose (saw dust, straw) materials and additives (e.g. soy thickening, wheat bran etc.) is significant to the growing needs of oyster and other exotic mushroom species. In 2009 in the framework of Special Accession Programme for Agriculture and Rural Development (SAPARD) the furnace was changed to a type working with grapevine bought from Crown Wine House of Eger; so the plant received renewable energy while also utilising the waste of the Crown Wine House. A good example of ecological and economical farming that some parts of the mushrooms grown can be used for catering at the Hotel of the Wine House.
- The company complex does other crop production activity as well (grape and fruit growing, tree plantation, energy plantation). This activity results in a huge amount of plant biomass so the company also works a furnace burning biomass which maintains the temperature needed for pasteurisation and autoclaving to produce canned mushrooms. In this case energy production is secondary since food gives a higher added value for everyone. The example of sustainability shows well that some of the mushroom substrates grown are used as organic manure, the rest is burnt in a thermal power station (performance of 950MW) nearby meanwhile producing electric power.
- In case of mushroom growing a special dimension of sustainability means that in favour of local social acceptance researches and investments are in progress to make possible deflecting, washing and conveying through biofilter in order to reduce odour emission. As the result of washing with ammonia ammonium-sulphate fertilizer can be turned back into the

compost production process. As calculations prove this process itself emit as much carbon dioxide as the plant population can endure in the previous or the given year.

- In growing the heating of the mushroom growing houses over the ground is solved by thermal water in more and more plants by a partner company since Hungary's geothermal capacities are really favourable; especially in the region mentioned above (Demjén, Egerszálók etc.) where one of the whole Europe and almost the world's greatest and the most popular geothermal treasures is hiding, its importance in tourism is great as well. The system fertilizing (cooking out) the mushroom growing houses is based on biomass energy.
- The company's environmentally conscious view is proved by the solar cell programme which will decrease the cooling and air-conditioning costs of the sites in summer.
- The 44 types of mushroom products do not contain preservatives; the processed (canned) products are made by International Organization for Standardization (ISO) 9002 and Hazard Analysis and Critical Control Points (HACCP) regulations.

The organization sells the fresh mushroom on site or in supermarkets such as Tesco, Metro, Spar, Lidl, Penny Market, CBA, Real stores but export is important mainly in Austria, Croatia, Finland, Italy and Romania. The following figure describes the extended supply chain of mushroom plant in Demjén and the National Crown Mushroom Grown Union (NCMGU) (see Fig. 3).



Conclusion

As seen from the situation analysis above it can be stated according to the analysis of mushroom growing value chain and supply chain that mushroom growing and agaricus included is highly suitable for sustainable growing. Shown as best practice in this case study the

Hungarian enterprise and its strategic efforts convince us that their business is about value creation, examined both in small and large economic environment it provides relevant groups with value.

The real importance of our research is that after using theoretical models and seeing them as logical framework we have mapped the inner structure, individual realization of a given supply chain, highlighting those connection points which presumably contribute to the spectacular success of the analysed case during the last years.

By applying the theoretical models we developed these models further such as the extended interpretation of the supply chain and marking the value creation points.

The results and conclusions of our supply chain analysis showing value points can be utilised as a best practice for mushroom grower competitor enterprises as well as the newcomers to the market; on the other hand it is suitable for a better understanding of the value creating points, and this way developing co-operation. Creating sustainability is exactly based on understanding better and exploiting these connections.

Landais (1998) states that sustainable development is a long-term perspective which is present in the amount of incomes, the complexity of the work, the number of people employed in the area and in protecting both the environment and biodiversity.

In our analysis a condition of sustainable growing is to identify the most important elements of value creation (income production) in order to determine the factors threatening it, then to make such a strategy that provides the key elements of value creation. Szilágyi et al. (2013) say that "... processes are often formed by know-how and coincidences ..." (Note "often both"). The same authors also state that the following risk types should be examined namely 1. financial; 2. time; 3. personal; 4. social; 5. psychological risks. In our analysis we suggest examining further risks such as 6. technological 7. product and product consumption risks besides 8. the connection of key elements of supply chain.

The conclusion of our research is that the elements of the supply chain are so connected that all the participants in the supply chain should think in terms of a system to maximise the value of the end product. This latter strategy practically means that in case of the given activity elements those aspects should also be considered which are not closely connected to the activity itself. For example the producer of the compost should pay attention to the end product's expected content value or the external needs of the people living nearby. In growing and harvesting packing with logistics and marketing purposes should be thought over so as our customers' satisfaction could increase. The strategy of producing an integrated product needs the supply chain participants' cooperation closer than earlier. We can see a best practice for this strategy in case of the organization network examined.

The question of quality (concerning compost, casing soil and spawn) is not only a question of hygiene but also the key to standard quality. The second conclusion of our analysis is the question of quality is of greatest importance regarding several value elements of the supply chain that means if it is not suitable then there will

be no yield at all. In this sense we can talk about the same rate of importance and greatest importance in case of compost, casing soil and spawn production.

The third conclusion is that mushroom growers should deal with issues for example how they can satisfy the customers' dynamically changing needs faster and more exactly, or how they can provide the customers with products satisfying their needs regularly and in a reliable way.

Value forming elements

We see the following value forming elements as key factors:

- As opposed to its mechanized character mushroom growing has a high level of handwork need. As for growing the phase of stocking, casing, ruffling, cropping and sterilization needs physical power while harvesting needs skills and is usually done by women. Operations executed just in time and with a technique influence the quantity and the quality of the yield. There is a great opportunity for creating jobs in mushroom growing.
- Agaricus mushrooms are sold and put on trays with foil. In harvesting mushrooms are touched only once to avoid physical and other damages.
- Packing has not only selling and logistics purposes but also contributes and profoundly matches the value of the end product. The customer evaluates the product based on subjective feelings and prior knowledge such as outlook, odour, moisture, mechanical damages, colour, size or the way of using etc. With paying attention to ecological and economical factors the goal of mushroom growing is to produce food of excellent quality whose outer appearance does not only meet expectations but whose content values are appropriate and free from remains of chemicals and harmful components.
- The connections of the sector bring excellent opportunities and more value creation. A great number of examples for this situation have been presented earlier in our case study.
- An advantage of mushroom growing is that it does not need any special growing appliances, buildings and tools of other purposes can be remarkably utilised.
- Hygiene has an important role in the whole supply chain of the sector, in case of different materials their intact transportation and logistics free from contamination should be in the focus.
- With the help of renewable energy resources mushroom growing can be matched with the concept of the sustainable farming more efficiently.
- Mushroom growing intertwines with intensive Research and Development (R+D) worldwide, this covers technologies, profitability, environment protection, the content value of mushroom species and the latest logistics solutions.

The continuation of the research

The results presented here in this current study are seen as the first step of a research series. We would like to continue our research in some directions whose expected steps in the future are as follows:

- to analyse and interpret the value elements of the NCMGU's extended mushroom growing supply chain;
- to make a feasibility study for Hungarian mushroom growing enterprises;
- to explore and make a comparative analysis of international best practices.

Not long ago in the research institute in Eger, Hungary a green house was built which can be sustained by renewable energy sources, variety experiments will be soon launched and analysed economically. In the future the goal of the research is to find that exotic mushroom variety or varieties which can exploit the opportunities lying in renewable energy sources at the maximum.

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S u m m a r y

Finally as a summary mushroom growing will play a thoughtful role in solving the world's feeding problems and working sustainable farming in the future and hopefully an important role in the world of sustainable farming. Its economic significance is inevitable since it can be grown based on plants, established several times a year and having high nutritional value it is a cheap source of protein.

KEYWORDS: mushroom growing, sustainable agriculture, supply chain, added value, sustainable production

RECEIVED: 31 March 2016

ACCEPTED: 20 April 2016

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