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PREFACE

In the name of the Comittee of Agricultural and Biosystem Engineering of the Hungarian Academy of Sciences we would like to welcome everyone who is interested in reading our journal. The Hungarian Agricultural Engineering (HAE) journal was published 29 years ago for the very first time with an aim to introduce the most valuable and internationally recognized (from 2014 already DOI numbered and crossReferenced) Hungarian studies about mechanization in the field of agriculture and environmental protection. In the year of 2014 the drafting committee decided to spread it also in electronic (on-line) edition and make it entirely international. From this year exclusively the Szent István University's Faculty of Mechanical Engineering took the responsibility to publish the paper in cooperation with the Hungarian Academy of Sciences. Our goal is to occasionally report the most recent researches regarding mechanization in agricultural sciences (agricultural and environmental technology and chemistry, livestock, crop production, feed and food processing, agricultural and environmental economics and energy production) with the help of several authors. The drafting committee has been established with the involvement of outstanding Hungarian researchers who are recognized on international level as well. All papers have been selected by our editorial board and double blind reviewed by prominent experts, which process could give the highest guarantee for the best scientific quality. We hope that our journal provides with accurate information for the international scientific community and serves the aim of the Hungarian agricultural and environmental engineering research and development - from 2015 twice a year.

Gödöllő, 31.01.2016.

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TECHNOLOGY INNOVATION IN SUSTAINABLE GROWING AND DISTRIBUTION OF KING OYSTER MUSHROOM

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Abstract

Mushrooms are great food for humans with low energy content but high nutritional values. While in most Asian countries growing, eating exotic mushrooms as well as their medical use have a long tradition, unfortunately we do not make use of their potential hidden value here in Europe.

The aim of our current work is to work out growing king oyster mushroom [Pleurotus eryngii (DC.:Fr.) Quél.] adapted to Hungarian resources and Far Eastern polypropylene bottled technology while the efficiency of investment and growing was examined how to meet the expectations of sustainable farming.

To grow this species, the growing organic substrate was based on using mainly agricultural, industrial and forestry by-products and formed by considering Hungarian opportunities since this species is capable of degrading and utilising different lignocellulose materials.

In the course of the work polypropylene bottled technology in line with an automated system was first used in growing this excellent edible mushroom species in the Carpathian Basin. In the future this technology can mean the base for growing not only P. eryngii but also other mushroom species (e.g. Flammulina velutipes, Hericium erinaceus, Hypsizygus marmoreus etc.) at plant-level sustainable production.

Keywords

mushroom growing, sustainable farming, supply chain, sustainable production, polypropylene bottled technology

1. Introduction

From nutritional and physiological aspect mushrooms are really valuable foods having low energy, containing various minerals, fibres, essential amino acids and important vitamins.

Several varieties have healing effects but traditional ones are also delicious and cheap food for many of us. More and more people recognize mushroom as a kind of gastronomic delicacy. Mushroom is the best friend of those who are on a diet or living with diabetes because it does not contain fat (0 g), it has only traces of carbohydrates and calories. It is a real "vitamin bomb" because it contains a high amount of vitamins B1, B2, C and D, magnesium, iron, phosphorus, zinc, potassium, copper, selenium, manganese, niacin, pantothenic acid, folic acid, especially in case of oyster mushroom which at the same time reduces cholesterol and has healing effects. Its economic importance is great since it can be grown based on plants, established several times a year meanwhile it provides growers with economic income in a sustainable way.

The unique significance of mushroom growing is that by its nature it can be grown in a sustainable way because it does not have any negative effects on the landscape, does not cause unwanted pollution, is very income intensive and the participants can earn a good living from it, too. It cannot be neglected that it utilises several by-products and supplies the energy sector or agriculture with them.

The success of mushroom growing depends on whether we find a unique growing technology version and an effective cooperation strategy by which the success of the whole supply chain can be maintained.

In the past years several innovative technological developments were made which markedly change mushroom growing and farming method as well as its sustainability aspects.

For some people mushroom growing seems to be difficult and risky while it can bring huge profit to others. The explanation for this substantial difference can be often found in innovation or its lack. Maybe it is accidental that both in the biggest competitor countries (like Poland) and in Hungary several innovative development experiments concerning technology and reaching customers were and are being carried out these days.

Originally in the home country of mushroom growing, so in France growing was taking place is stone mines and cellars [1], however, today completely new technologies appear.

It is a key question that we should learn and evaluate the possibilities, expectations of the new technologies as soon as possible.

2. Methodological background

In our study we intend to evaluate and analyse the latest technological development possibilities by comparative analysis. By a detailed analysis of the technology selected in the experiment we wish to state what advantages and disadvantages the new technology has, and whether the advantages exceed the disadvantages.

During the analysis we do not only want to concentrate on growing technology questions but also judge the real added values of the development alternatives and long-term sustainability at the level of the whole supply chain. The final decision is made from the aspect of the customer, the end point of consumption. It is a proved fact that nowadays neither products nor rival enterprises but whole supply chains are competing in the market [2, 3]. In this fierce situation 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.

With our method we would like to make inductive conclusions based on our experiences in our growing experiment which is still an ongoing research today. We want to reveal and summarize the preliminary results of these experiments in a scientific way.

Besides these we wish to compare certain technological alternatives in the comparative analysis carried out in the study, and on the basis of the experiences we want to use the method of giving recommendations to make them improve.

3. Discussion

Introducing the king oyster mushroom:

The king oyster mushroom [Pleurotus eryngii (DC.:Fr.) Quél.] is the king of the oyster mushrooms, less known among the consumers but delicious and nutritious mushroom variety.

Like the examined mushroom varieties, those of "higher value" have the following characters Szarvas [4]:

- consuming mushrooms can meet the protein need for those who do not eat animal source food or for countries which lack animal proteins;
- we can regard mushrooms as dietetic foods;
- as supplementary foods and products containing healing substances, mushrooms offer unexploited treasures for natural therapies;
- they can well match vegetarian meals.

In many parts of Hungary and Europe the king oyster mushroom grows outdoors, unlike other oyster mushrooms they do not live on wood parts but on the dead taproot of the tumbleweed which gives the Hungarian name, too [5]. The intensive growing of the king oyster mushroom began in Hungary in 1950 for the first time in the world [6].

At present the biggest countries of growing king oyster mushrooms are Japan, China, Korea and Italy. Regarding quantity, its growing in China increased from 21,000 tons to 114,000 tons between 2001 and 2003 [7], and the Italian demand also exceeds the 2,000 tons per year [8]. Wild varieties of this mushroom are collected and sold freshly at the local markets both in Italy and Spain. In the United States of America its growing for sales began in 2000 and 85 tons were grown until 2004 [9, 10]. Its favourable character is that it can be stored for a long time and its market price is high [11]. The mushroom belonging to the oyster mushroom family is the most delicious grown variety, both fresh (packed on trays) and processed (mushroom slices, dried mushroom, mushroom powder, mushroom cans, Chinese growers put them in salty juice and pack them in metal cans or plastic bags then sell them). The price of the mushroom can be really high if the product comes from organic farms free from chemicals and pesticides, and the consumers should know this information as well.

The significance and varieties of growing king oyster mushrooms:

Growing mushrooms is important because it can match the value network of other agricultural activities because they can utilise (practically recycle) various agricultural by-products and wastes and this way they provide new valuable food for mankind.

Regarding the king oyster mushroom four growing methods are known as usual:

- plastic bag,
- cover,
- bottled,
- outdoor method [12].

Plastic bag method: The essence of this method is that the mushroom compost is put into different (0.5-5.0 kg of weight) polypropylene sometimes polyethylene bags; after sterilizing the material the bags are inoculated and homogenized.

The permeating and ripening of the mushroom threads take 15-25 days on average at 23-25°C then the temperature is reduced to 10-18 °C so as the spawns (primordia) should grow. After that the bags are opened in order to make the fruit bodies grow. After the first growing cycle the wasted compost is usually thrown away [13, 14].

Cover method: This method is usually used when concerning the climate there is a less controlled growing environment available. In this case there is a need to prevent the water loss of the compost. Interestingly, the mushroom does not tolerate posterior water replacement. The cover layer (peat, sand, soil etc.) is loaded up to 1.5-3 cm after permeating the compost. With this method three growing cycles can be reached [10]. Győrfi and his colleagues [15] pointed out the positive effect of the cover on the harvest.

Bottled method: As for the method applied in Japan, Korea, China and slightly in the USA the soil is put into recycled polypropylene bottles (of 850-1050 ml), and after sterilization and inoculation the upper part of the bottles are foiled and after the removal of the foil the first fruit bodies can be expected to grow. With this method a growing cycle can be achieved but it is up to the way of inoculation (liquid, side cut etc.) and the clever placement of the bottles [10, 11, 13].

Outdoor growing: The cover method mentioned above can be used for outdoor growing as well. This method is mainly applied in Italy. The plastic bags containing the soil are pasteurized, inoculated and incubated indoors. After permeating is completely over, the plastic bags are removed and the soil is placed into a ditch outdoors and covered by the soil found there. A metallic structure is built with the purpose of shielding and protecting then covered by cloth. Watering is carried out periodically [16]. The disadvantage of the method is that it has to be adjusted to the seasonal period, however, the growing period can be extended with appropriate placement [10]. In growing experiments the most common measurement and quality parameter is Biological Efficiency, BE(%). Defining BE is as follows:

$$BE(\%) = \text{mushroom fresh weight} / \text{compost dry weight} \times 100$$

Formula 1. The definition of Biological Efficiency, BE% [17]

Another useful parameter is Productivity (P%), which was defined by this formula:

$$P(\%) = \text{mushroom fresh weight} / \text{compost fresh weight} \times 100$$

Formula 2. The definition of Productivity, P% [18]

4. Results

98 percent of the whole growing of the mushroom industry plant in Demjén and the National Crown Mushroom Grown Union is growing agaricus, and the remaining 2 percent is oyster and exotic mushroom species (shiitake, king oyster etc.). Growing king oyster mushroom is small in quantity, however, its significance is far beyond that. It has many points of contact, development possibilities and strategy options for the future which can substantially be built into the structure of the whole supply chain in value creation. The importance of growing oyster mushrooms exceeds the Hungarian needs; it reaches international dimensions

and often steps out of the agricultural frames. There has not been a new oyster mushroom variety in the market for a long time, the utilisation areas of the current varieties are just being unfold from large scale waste utilisation to energy industry. There are many experiments ongoing in the world with a focus on the unique cellulose degrading capacity of oyster mushrooms and their nutritional values.

Furthermore using the extended map of mushroom supply chain [19], looking at the individual value creating points of the supply chain we introduce the determining elements, possible development options of the "new technology" and their versions known from international sources. We do not only mean growing technology simply as technology but rather the value creating solutions and sustainability criteria lying inside the complex relation system of the whole supply chain from the grower to the customer.

An important criterion for sustainability is that we should list the factors (hazard analysis) threatening the value of the end product [20, 21] and the value creating ability of the whole supply chain. In the following we are presenting these criteria.

The basic questions of a successful and value creating strategy are 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?

Growing step:

In creating modern mushroom farms traditional and new types of growing concepts and methods are competing. Growing can take place in cellars, areas, tents, rooms created for this reason, and in the so-called Dutch type of growing houses etc. Thanks to the bigger yields per cubic metres the growing tunnel and the multi-level technology seems to better and more modern than other solutions but there can be other combinations as well. It is important that the grant system to support growers should be synchronized with the new technologies continuously.

Considering mushroom growing as a whole last year the main areas of research were 1. elaborating professional growing 2. modernization and mechanization of the individual growing phases, technological development 3. cost reduction and 4. reaching special goals. These developments help reduce the energy costs and improve the quality of the mushroom grown.

- One of the key questions of the modern mushroom growing plants is energy cost which gives a major part of the total cost. Based on this we consider every solution aiming at energy efficiency as a value creating solution. Several experiments support how important the utilisation of renewable energy sources, geothermal energy and solar energy is in mushroom growing. Regarding by-products the utilisation of agricultural waste (trimmings, energy plants, secondary materials containing energy) can be possible with modern furnaces, energy producing and air-conditioning appliances. Cooling, air circulation and humidity regulation is as important in summer as in winter. In case of air handling unit developing modern heat recovery systems is reasonable to retrieve energy. Irrigation and ensuring the necessary humidity result in significant costs. The establishment of automatic irrigation system or the prevention of water loss can mean a possible direction to development.
- Besides energy costs manual picking of mushroom also has significant cost in mushroom growing and the greatest demand of labour force. Manual picking takes a lot of working hours and is considered as very hard work (to different extent depending on the technology), that is why it is hard to find and keep suitable labour force. Using well-known and tried methods in car industry the colleagues of Vineland Research and Innovation Center are working on developing a mushroom picking robot. Vineland's automated system allows the growers to programme different rules for individual mushrooms in order to determine which mushrooms and when to harvest. With this step growing can be optimized and the amount of mushrooms grown in one unit of compost can be increased. The technology can ensure mushrooms of equal size with a perfect shape free from damage and scratches as demanded by customers. The end product below its maximum size means potential loss for the grower.
- The essence of the computer aided technology cannot only be used in picking but in providing special conditions necessary for mushroom growing such as controlling humidity, temperature, carbon dioxide concentration which can directly influence the quantity of the yield.
- The oyster mushroom is used throughout the world for bioremediation that is degrading waste of different types. Concerning mainly by-products and wastes they are used in degrading waste of wheat and barley straw, coffee grounds or tequila production. Degrading cellulose is not easy because cellulose is an extremely durable material but the enzymes of the oyster mushrooms living on the trees as parasites can perfectly degrade it. It is not so common that it is very difficult to get rid of disposable and naturally degradable nappies, normally their degradation takes centuries in the traditional way as observations prove. According to Alethia Vázquez-Morillas [22], the researcher of the Autonomous Metropolitan University in Mexico City the process of degrading can be speeded up with the help of oyster mushroom. This species is able to degrade 90% of the nappy's material in 2 months and completely degrade it in 4 months. As opposed to the initial reluctance, "the mushrooms grown this way are cleaner than most of the vegetables you can find in the market ..."

Figure 1. King oyster mushroom and polypropylene bottled growing

The determining elements of the technology examined in the experiment:

Growing is based on polypropylene bottled technology with growing tunnels. The key issue in growing is to achieve the biggest harvest possible in a small place. In case of polypropylene bottled technology the mixture of the compost consists of beech sawdust and wheat bran mixed 80:20; 85:15 or 90:10 with humidity of 60-65 %. The pH of the material is reduced from 6-7 to 4-5 with the initial nitrogen content of 1-1.2 %.

In the experimental technology bottles of 1100 ml are used. After 30 days from the inoculation the mushrooms are ready for harvesting (after 13-16 days from scraping). As a part of the technology examined in the experiment the mushrooms are only touched in picking; after twisting the fruit body the ends of the stalk are cut back then mushrooms of 150 grams on average are put onto trays.

As a result of the examination the value of biological efficiency BE% (fresh mushroom weight related to dry compost weight) is around 70% on average.

Processing and sales step:

The success of mushroom growing does not exclusively depend on real growing. The impeccable end product must be brought, packed or processed and delivered to the customers in impeccable quality. In this area several innovations have appeared which can provide additional values to the product. The majority of developments are about 1. storing and preserving mushrooms, 2. preparing, processing and packing mushrooms, 3. logistics distribution.

- As a result of Polish development Europe's most modern mushroom growing and distribution centre as well as cold store called Champion was established which join more than 30 Polish mushroom farms' growing (Grzybek Łosicki Cooperative). The building complex was able to significantly reduce the energy cost of the growing rooms and cooling buildings with the help of the most modern architectural innovations and technological systems. Besides growing activity Champion provides mushroom growers with complex services including planning, building, equipment and the implementation of technological systems according to local and regional needs as well as meteorological circumstances. The company's main products are mushroom growing shelf systems, picking cars, ventilation, air-conditioning, automated watering, cooling rooms, cooling water and special lighting systems, carpets and any other devices.
- In the area of packing there are many ways to develop from recyclable or recycled materials to the packages best suiting the customers' needs. For example Shine Boudreault, Earthcycle Packaging Ltd. offers vacuum foil palm fibre trays which can be disposed in a natural way. These trays are ready to be composted and on the other hand they are able to resist the wet product or sometimes higher humidity. The company paid attention to the fact that mushrooms should not touch each other and stand still with the help of spacers. In packing the customers' needs should be considered in the first place since like other animals humans are capable of determining based on various features, signs and symptoms whether the food put in front them is edible or not. This subjective judgment is made based on consistency, taste, odour, vision (shape, colour, shade, patches, threads, spots, particles, knobs, traces of pests etc.) because these innervations remained during human evolution and we are still using them during shopping in a supermarket and choosing the food we like. For example as for mushrooms we prefer tough caps free from contamination and closed sheets free from spores. It could happen in reality that a less attractive or old mushroom tastes the same but selling these mushrooms is much harder. Customers are really sensitive to colour changes and colouring due to damages or overripening or decaying (falling spores) mushrooms. It is natural when due to apoptosis (the death of cells) caused by stress genes the mushroom strives to keep certain cells alive with sacrificing other cells, and using the cap storing energy to ripen the spores. This latter is usually accompanied by cracking, browning, rarely spore scattering. After all quality care packing should be able to slow down these processes and make the beautiful mushroom shapes visible. On the one hand packing should breathe in order to avoid dampness or dehydration. The very first thing here is freshness. A widespread method is using protective gas and cooling which are good at keeping freshness and against infections but they cannot stop but slow down the processes mentioned above. Using protective gases inside packing or the intensive and fast cooling prevents considerably the spread of bacteria in the product, so the quality of the mushroom can be preserved. Many European stores use paper bags to store mushrooms to prevent dampening due to mushroom's breathing and vastly blocks the spread of bacteria situated on the cap but developing breathable packing is in progress as well. Developments preventing deterioration in quality are very complex and expensive; there are only a few of physiological researches.
- The role of packing in customer information and marketing. In the past few years the information content placed on packing becomes more and more significant. Customers are more conscious and the information about growing is relevant to them such as free from preservatives and chemicals, label "bio". In case of mushroom "offering the product" can mean added value namely information in a photo or in words can stimulate good mood to consumption since most customers are uncertain about using. Good examples are a spectacular photo, special recipes, utilisation tips, or presenting information referring to specialities. Innovations mean an area to be exploited.
- The logistic role of packing is also important because the added value shows that the products must be put into unit loads while avoiding mechanical damages. If the fine grid structure of mushroom threads cannot resist the pressure of the hand or other things, colourful patches will appear due to enzyme reaction. In this situation the tyrosinase or polyphenol oxidase enzymes as catalysts will start the oxidation of phenol compounds causing the patches. During the long lasting storage mainly at the end cut of the stalk white mushroom threads can often appear. It does not mean mould infection rather the mushroom tries to get back to its mycelium state when the mushroom is able to utilize the rest of the nutrients more efficiently. The quality deterioration appears on the product quickly after picking, overripening should be avoided.
- The most usual direction of processing is canning but there are many other possibilities such as pickled in salt or vinegar, ready-made and completely processed food. For example Highline, the biggest Canadian mushroom growing company sells stuffed Portabella mushrooms as snacks to raise the customers' interest. In other cases growers sell the grown mushrooms in the local market or to the restaurants in the region.

The determining elements of the technology examined in the experiment:

The customers' preferences can vary in the countries. In Italy the small and thin stalks with wide and dark caps are favoured. The Spanish consumers like mushrooms with lighter caps. But the customers in China prefer wider stalks and smaller caps. The king oyster mushroom has a nice thick and white stalk with a small cap. In Hungary these stereotypes have not appeared so far, unlike agaricus almost every mushroom is new for an average consumer.

In the experiment examined the mushrooms picked freshly are first pre-cooled at 10°C after that chilled at 1-3 °C, packed and labelled. Plastic packing is used with transparent foil cover. The packed mushrooms are delivered to the hypermarkets in the areas nearby but the export is also remarkable (Table 1).

Table 1. The comparison of the experimental bottled growing and block growing

Polypropylene bottled technology	Bag (block) technology
The bottles can be recycled many times.	The bags can be used twice at the maximum, a lot of waste takes place.
A little compost is used which gives good harvest in spite of less total surface.	A lot of compost is used which gives relatively poor harvest.
The bottling process is completely automated.	The bagging process needs more manual work which means hard work.
The biological efficiency BE% is between 60 and 70 %.	The biological efficiency is very low, BE %= 35 %.
The quality of the mushrooms is more steady (depends on the environment).	The quality of mushrooms is uneven (depends not only on the environment).
Mushroom growth is synchronised (scraping and spraying water).	Mushroom growth is less synchronised (no scraping, no spraying water).

5. Conclusion

The conclusion of our research is that polypropylene bottled technology can be effectively applied in Hungary and continued with Hungarian materials. Machine lines applied for filling and moving bottles can be matched with the technology requirements and the previously created growing houses with growing tunnels. During the experiment we achieved a competitive quantity in growing. The BE value is approximately 70%.

Our further statements and recommendations are as follows:

- There is a demand for this mushroom variety and it can be increased with an extensive promotion of the mushroom.
- Growing this mushroom variety can be made more economical with further innovation particularly a bigger exploitation of renewable resources such as geothermal energy, solar energy, green energy and waste utilisation.
- Further added value can be achieved by establishing processing and logistics centres as the Polish example proves.
- In the future there are unexploited opportunities in packing developments preserving quality and further marketing value done with regard to logistic packing and end users.

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APPLYING SIMULATION IN MODELLING A COMPANY'S ECONOMIC PROCESSES

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Abstract

Due to growing competition, companies' future orientation and future-oriented strategy have recently been appreciated. However, this presumes the existence of an appropriate company vision and more accurate knowledge about resources and possibilities of actions.

The subject of our research is scientific uncertainty which is one of the most important issues of economic and social sciences nowadays. Managers and company owners still have neither an exact method nor an indicator to tell which production factor to which extent can contribute to the organization's output, result and efficiency. Besides several concepts, theoretical bases, the question is still open in case of specific business activities. The solution to the problem is not unambiguous even for practical experts and managers who are familiar with economic processes. It is not evident which to analyse and which methods are used.

In a case like this, how we can expect that enterprises should create successful objectives and achievable vision in an accelerated competition?

In our work we examine a novel methodology which combines artificial intelligence with simulation modelling and tries to find limits of an arbitrary process, and to determine results of the possible combinations by modelling real life processes and testing virtual entities (orders, units of material flow, process objects).

In this article we focus on the unutilised possibilities of the process modelling. We do not create another cost optimizing algorithm but to search for new possibilities to utilize experiences of simulation experiments in practice.

Keywords

simulation, artificial intelligence, controlling, optimisation

1. Introduction

System Uncertainty

It is commonly accepted that results of business organisations depend on the combination of resources and the chosen strategy. Plenty of scientific approaches also suggest that processes can be predicted and optimised by profound researches of systems and better understanding of relations.

However, several factors support the fact which the interpretation of processes in complex systems is not always coherent; moreover, even results are not consistent in all cases. Forecasting the internal operation of systems and the critical factors affecting mostly the results can be difficult due to several reasons. The main reasons, which are the follows:

- In case of simple systems the operation of a system is predictable and easy to model and optimise physically and mathematically. As increasing the complexity of systems they become more and more chaotic, and the results depend less and less on predictable factors. In other words it is the so-called "butterfly effect" when connections of the separate events are form a complex system in which the separate states are not predictable by formal logical methods either now or later. Someone says what future "quantum" computers will solve this problem but there is no guarantee for that.
- Business systems as well as other systems have their idiosyncrasy which result of the system operation is determined not only by the kind of the object connections of the system but also by external effects (external disturbing factors) which usually can only partly be modelled or not at all (e.g. natural forces, instationary phenomena, competitors' reactions, human factor). In extreme cases the outcome might be unfavourable despite appropriate decisions and strategy due to external disturbing factors unpredictable and uninfluenced by decision makers.
- In the course of modelling systems we find a frequent phenomenon which reliability of a system model is sometimes not enough due to data uncertainty which is intensified by multiple data links and the model becomes useless. Due to the uncertainty of data, static theoretical and practical (experimental) models are often useless for managers; that is why the confidence level significantly decreases in methods.
- Mathematical and modelling difficulties. Today several types of modelling techniques are available (hyperbolic programming, convex-concave programming, quadratic programming, stochastic programming models involving uncertainty values and utility functions) although these methods handle a problem only from a certain point of view not by their complex combinations like in real systems. Furthermore a traditional way of modelling several coherences and target criteria is difficult or even it is completely impossible without excessive simplifications. In many cases even the formulation of the target criterion is impossible since the decision maker cannot formulate it without excessive simplifications because they involve factors and conditions

which cannot be merged or are antagonist or even cannot be measured.
– Nonlinear character of relations. Biological and social systems, consequently economic systems are not of self-consistent character [1] in every case therefore the reaction of the system is not predictable even we have full knowledge about it. Sometimes the system gives different reactions to identical events under identical circumstances. Changes may not happen incrementally, certain changes may not lead to a state change because the system is buffering until a certain level, and which is more certain effects may happen with time delay [2].
– Modelling paradox means the phenomenon when the more realistic model is less possible has to optimise (or to solve it for a given target function). If the accuracy of a model is not legging behind that of the real system, it is as impossible to solve as the real one. The dilemma of modelling is which the model should be simplified enough to work with while it should be complex enough to be worth considering its results. We call this dilemma is the modelling paradox.
– The trap of decision making means that we can accept or refuse the result of the optimising model, namely the proposal; there is little possibility to utilize the results partially. Optimising models do not pay enough attention to suboptimal solutions which are closed to optimal but not reaching that; yet in other terms they can be valuable since several relations that cannot be modelled can give reasons for them. If we interpret the relationships of systems in such a static way, even the best model does not be satisfactory for us.

Although the IT toolkit of decision support is widespread and diversified due to the factors mentioned above, their practical application does not reach the expectations even at a global level.

Business organisations try to interpret their own processes from necessity and they continuously try to improve their efficiency with obvious reasons. Despite these efforts they have to cope with several poorly structured (under informed) problems. To handle these problems, companies usually set up indicators and precedence's but they cannot be confident either about modelling or about answering questions. Solutions provided by indicators can give promising results; however, the adequate and expected results integrated into the factor of subjectivity do not seem satisfactory.

Validated real-time realistic data, solutions and alternatives to choose, which are supported by experimental results, are still missing; these could guarantee results and also provide further information in connection with the systems investigated.

Earlier several efforts have been made to find a solution for this problem, but only a few concepts were introduced which were able to raise the decision maker's activity level (association plane) and standard, which are the followings:
– The widespread balance sheet based approach can be used to improve decisions but the main problems are that data collection serves external interests and its aim is an accurate and reliable presentation and recording of the past instead of preparation for decisions.
– As opposed to the balance sheet based approach the cash flow based approach has the advantage of referring to a certain period instead of one moment in time. The measures of data are not so relevant rather the dynamics of their change and the extremes. Its disadvantage lies in being aware of that it is more difficult to decide which is to do in a given moment.
– Transaction following systems' great advantage is which they make possible for us to recognize important processes and help in ensuring possibilities to intervene. Their disadvantage is which they have distracted our attention from the objectives and strategy since the real target is not the process but the result.
– The great advantage of value stream mapping focuses on the importance of certain processes. Since value is in the focus the value has been creating ability of the whole system improve. However, the method does not tell us anything about solutions (resource combinations) which are better or worse at the level of a complex system.
– Proper allocation or optimisation of resources is good in local terms but at the level of the whole system contradictions and conflicts can take place while complex optimisation sees barriers of modelling (see above).
– Dilemmas of indicator systems (e.g. BSC [3]; ABC [4]; Controlling [5]; Performance Prism [6]) have been mentioned earlier (system reliability, modelling difficulties, etc.). In general, these methods can give answers to recognize problems rather than solving them.

There is still uncertainty about the question where exactly managers should intervene into processes and consequences, which should be expected. As for decision making traditional methods have the following deficiencies:
– traditional accounting and controlling mainly focus on the past, which mostly data-oriented;
– corporate problem and growth management focus only on individual subprocesses, are not holistic;
– specific and complex components of company output are either unmeasured or operated by rough theoretical models that do not have a dimension of practical or operative use.

Besides these traditional analytical or logic bases the interpretation and modelling have barriers not only due to general characteristics of a system but also human factors, which bring further uncertainty into systems expecting improvement.

Personal Uncertainty

When leaders of company have to operate and improve complex systems, they often make decisions to assume company organisation and especially its human factor, which do not affect on the consequences of the decisions. It is obviously not true in real situations. Participants' attitude towards decision making is personal relationships and motivation among the most important factors. It is easy to imagine that even a good action can result inadequate or unfavourable changes in case of participants' disinterest. Naturally it can happen that the other way round and so inadequate actions can bring partial success. In this latter case the principle of erudition cannot be applied and this can mislead the arrogant decision maker. Therefore the role of personal factors is important and cannot be neglected. The most important factors, which are as follows:
– The decision maker does not usually act rationally even if he intends to do something. Rational decision making is hampered by lack of information, needs of the moment, bottlenecks, limits, subjective attitudes and the contradiction, which state that making decisions are for future outcomes in the present based on current preferences.
– In many cases the decision makers' successful or bad experiences can detain the rational behaviour of systems. Objectives and decision making criteria should not depend on earlier positive or negative experiences.
– Decision makers cannot act absolutely rationally, because decision making, as the process itself and also the execution of decisions have economic sacrifice, which affects the choice among the decision alternatives.

As a summary, companies are not able to optimise their systems, or even in many cases to minimal discernment due to system characteristics, the participants' unpredictable attitude and the absence of normative conditions of decision making. Therefore we need to create a modelling technique that tries to solve the problem in a completely different way [7, 8].

2. Material and method

Conscious vision making has always played a role in the professional governance of business organisations, and this was mostly the task of managers. For a long time this has been sufficient which these visions existed only in the managers' mind. As the competition is intensifying, this informal way of planning for future is less and less sufficient. As the company develops and expands its scope of activity, the increasing competition and the changing environmental factors make demands for creating methods of structured planning.

Although strategic planning has the same objectives, reaching conscious and scientific results are difficult because of problems of chosen methods and system and personal uncertainties (see above). Large diversified companies often communicate that they perform better by using strategic planning consciously than without it. Nevertheless, even Mintzberg [9] and Meyer [10] criticised strategic planning:

– the process of strategic planning cannot be fully integrated into the operations of the company organisation;
– planning is sometimes inflexible because this detains quick changes in the plan;
– strategic planning separates the development and the execution of the strategy considerably.

In the next part we present the basic elements of the modelling technique developed by us; we recommend that as such kind of methodology to professionals facing with the same problems [11].

Novel Modelling Solutions

The interest of social sciences towards complex systems and non-linear models has been increased by the extension of computing capacities [12]. Corporate performance measurement and evaluation as well as planning and decision support (i.e. management) have key importance in every business organisation for it, which is a part of the control process in the company. In this article we put the emphasis on planning and decision support using a simulation methodology.

Simulation models are used worldwide. For example, Europe's Airbus Industries uses simulation for testing aerodynamics of their newly developed airplanes. The U.S. Army tests military actions with simulation "games". Business school students test their knowledge with business simulation games. Car manufacturers test their products with simulation instead of costly crash tests. Even ports are tested virtually under different loads in the phase of design. The world's most large enterprises use different kinds of simulation models.

A heuristic simulation model was used to optimise the processes with time limit in biomass production in agricultural areas as micro logistics systems [13, 14]. To realize Just in Time, work has to be organised taking into consideration the possibility of both cost minimisation (economical operation) and finishing tasks within optimal time limit. Briefly, plant cultivation process has to be optimised. The optimum can be found by the coexistence of minimum cost and time limit.

Simulation is a mathematical and/or logical model which can reflect the best original system in operation from certain point of view. Another essential element in the interpretation of simulation is the possibility to perform sequential experiments with the helping model in a virtual environment in order to assess the effects of different interventions. The basic idea of simulation can be split into three parts (steps):

1. mathematical-logical mapping of real situations,
2. then educational system specialities and functional characteristics using these models, and
3. finally making conclusions and decisions of actions based on results of the simulation experiments [15, 16].

The decision maker can apply simulation in a given situation "… to rationalize existing systems, or to design creating new (sub)systems" [17]. Common purposes of application are the follows:

– to avoid of planning errors in case of complex systems;
– to compare (expected functioning of) alternative plans in realistic environment;
– to determine maximum and marginal performances (bottlenecks) for a certain system;
– to forecast operational dysfunctions and to investigate possibilities of their elimination [18];
– to test and induce proposals for kaisen development;
– to prepare strategic decisions by getting (practical) experiences that could have been obtained in real life only through decades of active involvement, or it would risk human lives or extremely large amount of capital.

Due to the variety of problems, the build-up of simulation is evidently various, however, there is always a concept which can be set up (standardized) for different cases. Figure 1 below shows that the so-called simulation core or in other terms the system model fits a framework which seems to be standard. The system model can exist in several different varieties such as Monte Carlo Simulation (simulation of randomized state), genetic algorithm, or neural learning system or even an optimising linear programming model [19, 20, 21].

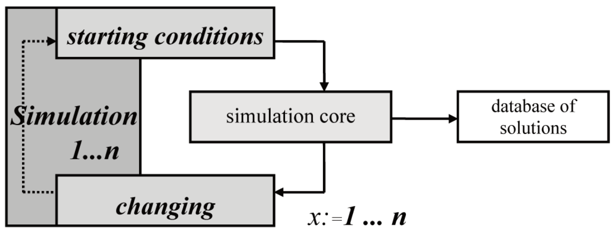

Figure 1. The theoretical build-up structure of a multifunctional simulation

1. In the general model the simulation framework program makes possible not only "stepping" a variable simply but also changing more "coefficients" (conditions) together at the same time in a programmed method regarding the research goals determined initially.
2. Data obtained in the model can be made visual or present in a number of methods, for example in the form of raw data, multi-dimensional collecting graphs, dynamic graphs, charts, structural diagrams, virtually generated pictures, animations, virtual reality (VR) simulation.
3. In the course of feedback we start a dependent or independent cycle. In the case of independence the individual cycles make use of the "brutal power" of IT (e.g. randomized states), otherwise we can get models developing in certain directions based on the advancement of "heuristics" or "artificial intelligences". In this latter case an adaptive model can be envisioned in which the results obtained in the cycle make an impact on the starting conditions of the next round.

Main phases of creating and building up simulation of economic processes, which are as follows:

1. Research work: Analysing and mapping the processes of the system involved (data collection, interview, value stream, semantic and numerical analysis). In this phase of being aware of the mapped system we attempt to determine goals of the simulation. It can easily and often happen that it is later modified during modelling or model use.

2. Modelling: Creating and background programming a specific process simulation model, its parameterisation, forming definitions at model level. By testing the model systematically and programming agents at several levels a balanced model takes place which virtually represents results obtained in reality. Modelling continues until it becomes capable of being validated, as comparable with the operation of a real system and its results as data.

3. Model use: Executing "process" research with analysing simulation cycles, discrete event simulation with different conditions. In relation to the effects of agents on each other analysing the utilisation of given resources, limits and bottlenecks, economic forecast. In using a model new questions and building up new model variants can occur depending on demands. In this phase using a model decision support work and learning process are going on. Continuous result evaluation and analysis also take place.

4. Working out new applications, methods, procedures consisting of forming proposals, creating new models, observing regularities, making inductive conclusions and decisions, creating inductive theories.

Different interpretations of goals in the simulation of economic processes

There is a significant new difference in the approach towards the simulation of economic processes [22, 23], which is in many cases due to problems of modelling mentioned earlier and especially decision making, which we are not looking for somewhat ideal state (see system uncertainty and personal uncertainty). In the area of technical sciences (planning, operation, logistics, electronics etc.) we create a simulation with a purpose of finding a seemingly ideal combination or a much better combination than a satisfactory solution. In case of economic process modelling or simulation we experient that there is a much more substantial goal of putting the decision maker into a real decision making situation by recognizing (and visualizing) the real character of problems, and obtaining experimental experiences.

With the help of the method the sensitivity areas of solutions and the limitations of their more intensive changes can be followed. This new approach can be seen as a great advantage of our method. With proving this approach the main goal is to examine the location of solutions (in many cases "suboptimal" solutions) being realized among different conditions, their mutual relations, critical domain, and to widen the professional knowledge of the participants in decision making in favour and more satisfactory attitude (Figure 2).

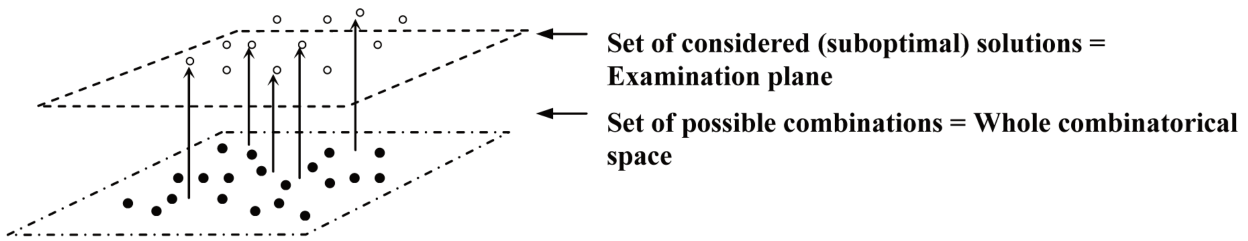

Figure 2. Lifting up possible "solutions" from the combination space

Simulation technology itself has not been a new approach since simulation technology as an analytical method remarkably conquered some areas of industry in the last decade, moreover in social sciences various system dynamic models appeared in measurement. In our opinion the simulation modelling, namely a complex modelling of economic processes (covering not only technical processes) is ready for widespread use in the future. Simulation is available for modelling real processes, flow analysis, observation as well as manipulation.

A novel interpretation of time factor in simulation of economic processes

Usual quantitative methods focus on state-like examination of individual process characters and key indicators assessing the initial situation and then by interventions they describe the changed state characters. This kind of static examination satisfies most of the needs for analysing which is a revolutionary event as opposed to situations without measurement. For creators of decision supporting systems or systems calculating (optimising) or forecasting a certain future state, it is a frequent critical view that the later real state did not reflect the earlier planned and forecast state. In these cases it is difficult to defend the professional point of view which holds that factors changed in the meantime due to forecasts or regardless of them.

However, the problem is actually more difficult than that since at those points of analysis where results of the initial state and the endpoint were determined the analysis can be correct; the conclusions can be acceptable while reality is of different nature though. The main reason for that is the basic nature of time dimension. When time moments of a continuous phenomenon undergo an analysis then we truly force a discrete approach to a continuous phenomenon together with its errors. In a case like this either at analysis level or at decision making level there was no information about which really happened in the given process among individual points of time.

This problem can be solved theoretically if we have a great number (greater than usual) of measuring points in time for each and every result indicator. This task is almost unaccomplished in most of cases such as analysing a process of 6 months fragmented into seconds. One of the greatest advantages of our simulation methodology lies in the fact that it can examine time factor dynamically and not as a series of snapshots. Agents forming a process, elements of a process, resources and latent factors together affect the entities of the process; they can cause changes happening in quasi real time and can be observed in real time or slowed down, or speeded up. With our modelling method we try to visualise dynamics, which can present the nature of processes with great accuracy. Speeding or slowing time factor results new discoveries just like in biology. Think about growing trees and plants or the micro world of quantum physics (see more detailed in case of small and medium scale enterprises [24].

Time factor has another advantage in the course of analysis in a simulation environment, namely modelling the changes of agents. During going ahead in the process the agents participating in the process can iterate with each other, develop or decline, their characters can be modified. Great numbers of agents, probability distribution of outcomes, and their variability in time can be modelled by a dynamic framework, which is capable of analysing and representing the time factor of the process. In our opinion this should be made visualised for the decision maker.

Novel interpretation of interactivity in simulation of economic processes

The other novelty in our approach is interactivity. Usual analysing methods are capable of creating different variants by changing initial parameters, and certain sensitivity analysing tasks can be done by changing parameters among steps and recalculating models. However if there are more changing parameters and they are able to take a value changing with time then it is rather hard to find appropriate tool support for the analyses.

A novelty of the method applied by us is that the user can intervene in running a given model in real time so as the result of intervention certain components of the operating process are altered while the process does not start again but run considering the new settings. As opposed to static systems its importance occurs in a way that the venue and complexity of different interventions, and their impact on the results cannot be interpreted in another way.

Combining discrete event simulation and multi-agent modelling

Agents and agent architectures are artificial creatures which have individual characters, and consequently they are capable of behaving and making decisions at a certain level. An important feature of agents is that they can show not only different behaviours but they also react on the simulation environment or their characters can develop with time. It can be solved by help of the latest modelling techniques that classic discrete event simulation should be combined with agent type of modelling with which we are able to create a simulation closer to reality. A combined simulation has a greater importance in those cases where human factor is considerable as opposed to relative estimate of technical processes.

Case study: Call Center

Representing the principles above we describe the structure of a simulation model with the following example.

Logical bases of the model

Customers call in with various problems, the arrival process of calls shows Poisson distribution. The intensity and type of incoming calls can be changed. The average service time per a call is also changeable. Waiting in line takes place according to a priority based on the types of cases but this priority is increasing by time (Figure 3).

Agent and DES (discrete event simulation) based combined simulation

Customers are agents whose rate of upset is ooted in their individual characters.

Customer – agent: has different upset numbers in different groups. Upset is increasing during waiting and also depends on the type of the case. A customer agent may have several characters which determines his behaviour as well as the process (Figure 4).

Main customer features determining their characters:

1. Sex (male, female)
2. Time of call in (time of the day, a day of the week, time before or after a public holiday, situation after vis maior …)
3. Time of customer's waiting (how much upset he will be – being graded)
4. Type of the case (case of type A, B, C)

These factors determine which they have behaviour features. For example a female is waiting long on Monday, her upset number is around 5; if a male comes with a case of type 'F' on Friday afternoon, then he is calm, his upset number shows lognormal distribution between 1 and 3. Colleagues are also agents, they are calm at the beginning but can become upset if the customer is upset or they have a lot of cases to manage in a short period of time; they have performance dispersion for every case type.

Co-wokers are also agents whose characters are affected by demands of customers. Customer service representative – agent: if the customer is upset, then the representative will also be upset; his performance dispersion is getting worse and the customer service process becomes longer which is more expensive, the own cost increases, customer satisfaction (as a KPI) goes down. If a customer is too upset or is waiting too long (this is the maximum of his waiting), then he hangs up and the case will be unserved. However, the case served may be effective or ineffective depending on the case type and the rate of upset. The effective cases can be satisfied or dissatisfied.

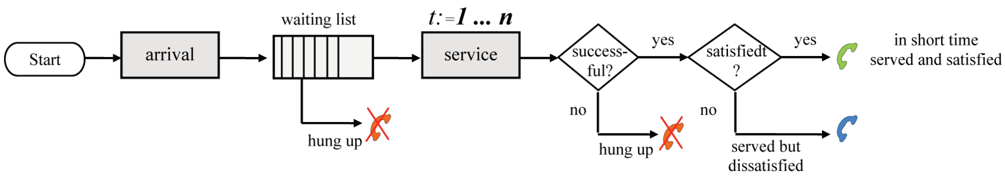

Figure 3. Call Center process

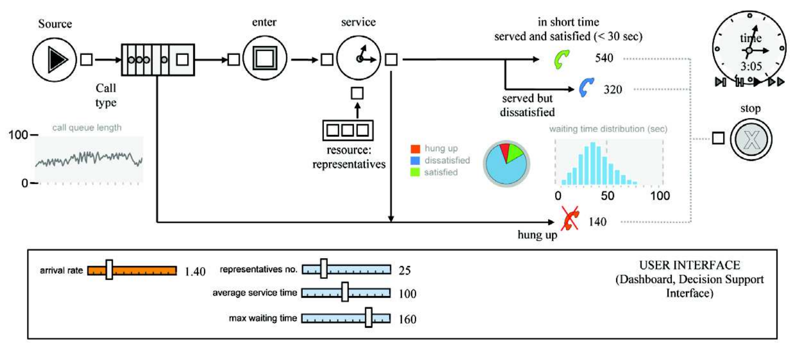

Figure 4. Interactive user interface of the simulation

3. Conclusion

Analysing the methodology above we see different interpretations of goals, a novel modelling accomplishment of time factor and interactivity as a methodological result. Our practical experience proves that simulation models built up along the principles above lift the work of managers of complex systems, chief executives and decision makers up to a new level. Although we have created a simulation methodology, the end result is an interactive surface running online on the Internet; it became a decision support tool in the hand of an experienced leader with which he could solve the problem dynamically even he also could interpret it at a new level by expanding his knowledge, he could ask new questions which have not been apparent so far concerning the given problem.

With the help of the solution the decision maker was able to analyse the operation of his complex system in a new dimension, he obtained new observations and experiences while he did not risk the owners' capital and performance. We are sure that this is a direction for the future by all means and every company leader directing a system complex enough needs a system like this, and he can discover totally new limits of competitiveness on his own meanwhile modelling and an older approach of (quantitative) optimisation can mean an intermediate step here.

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Faculty of Mechanical Engineering

THE MARKET ORIENTED IMPROVEMENT OF THE ENVIRONMENTALLY FRIENDLY COLLECTOR TRAY OF THE GREEN TRACK SYSTEM FOR FULL SCALE RAILWAY AND ROAD TRAFFIC APPLICATION

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Abstract

We have carried out a research regarding the collection of materials escaping into the environment during the process of draining and filling of liquid carrying container devices. We found that at the moment the collection of liquids getting into the environment is not always managed properly. Therefore we conducted a study in which we took account of the present issue and we are looking for the solution to have a collecting device made.

A mobile collector tray would be a solution in these cases. To be able to define the physical and chemical characteristics of this tray we must be acquainted with the liquids presently being delivered. It is important to note that we can collect only such liquids which do not become combustible when mixing with air and do not produce toxic gases.

Keywords

environment, composite technology

1. Introduction

Firstly, we examined two main areas. On one hand we looked into the container devices currently being used for carrying liquid and considered their sizes in order to match the tray in size. On the other hand we examined the transported materials to find out what materials the tray should be resistant to.

A significant aspect is that the collector tray should be as light as possible and as easy to fit as possible during the process of application.

Presently the liquid materials are transported/moved by rail or by road or within agricultural areas. Filling and emptying is generally done on fixed locations.

As for the physical setup the tray must be placed between the tracks. In public traffic or in agricultural areas it must be placed on the ground in such a way that the wastage would flow into the tray.

The collector tray must fulfil the following physical and chemical requirements:

- physical size (width, length, height)
- mechanical straining (pulling, pressing, clipping, beating)
- weather (durability, between -20°C +40°C, humidity (oxidation) resistance to UV effects)
- resistance to fossil liquids
- resistance to acids and alkali solutions
- skid-resisting property
- easy and quick cleanability (in order for materials not to react between two emptying processes)
- flame resistance
- protection against static charging

Obviously many conditions must be fulfilled for a tray like this to be made which is a seemingly easy task. With one type of material we would not be able to fulfil all the requirements, therefore we came to the conclusion that the collector tray must be made of composites.

Polymers have less mass volume than metals therefore they are lighter. Since the trays must be able to be moved by people, we made the decision to use lighter polymer materials. We design the collector tray to be made of composite polymers. This is how we can ensure to have a material which fulfils all criteria.

Composites are heterogeneous systems which are formed by connecting (laminating) two or more materials. Oftentimes the chemical properties and shapes of the elements are different. Composites can provide such characteristics and property combinations which the different elements on their own would not be able to provide. Composites are often made in such a way that they are in their final form (Figure 1).

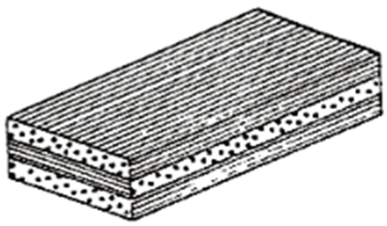

Figure 1. Composite Layers

2. Empirical session

According to the morphology of the composites regarding their structures they can be particulate, fibrous or laminated [1].

The top layer of the layered composite must be abrasion-resistant, skid-resistant and it must have chemical resistance and UV resistance as well. The layers underneath must have reinforced fibres which are resistant to mechanical strain, flash point and build-up of statics. The bottom layer must be adhesion free for the purpose of making the moving and cleaning easier.

These layers must be well connected to each other for a longer period of time because if they lack this quality then their primary characteristics are lost and they will be useless.

The layers on top of each other also must be made of composites, for example reinforced-fibre matrix polymer, metal, ceramic etc. The material of the matrix determines the strength of the layer-composite and the maximum composition of application. The preparation of composites greatly depends on the composite material [1, 2].

The layer structure suggested by us is the following:

- top layer: resin
- adequate adhesive material which connects the two layers on a big surface
- 1st laminated composite(s)
- core on which the laminated composites are applied
- 2nd laminated composite(s)
- bottom layer: adhesion-free layer

The materials of this layer structure can be diverse. Naturally, the order of the final layer structure might differ due to professional reasons. It is imperative to examine the chosen materials in light of their producibleness and connection to each other.

Producing sandwich structures:

Sandwich-structured composites can be made with various methods:

- The two reinforced composite cover layers are made in a form and then the core material is glued between.
- The cover layers are made the same way as described in the previous point and by using a spacing tool the core material is expanded between the layers.
- On the composite plate which is still soft, not cross-linked yet and is in the mould, the core material is pressed, then the laminate is cured and cross linked so the core material sticks to the plate. Then either in the mould or taken out of the mould the other plate is sandwiched on the free side of the core material.
- On the pre-cut, bent or combined core material which is a firm structure the composite cover layers are sandwiched on both sides [3, 4].

It is important that all layers have their own role and all these will make up the basic material of the collector tray which has the characteristics needed.

The design can be approached in various ways.

We chose the approach based on the materials of the layers:

The top layer is the resin. This layer must be abrasion-resistant, well-adhering and it must resist chemical materials, must be non-thermoplastic, as well as heat and UV resistant. Such a resin type must be chosen here which has all these qualities. Non-thermoplastic resin types are illustrated in Table 1.

Table 1. Non-thermoplastic resin types [5]

Plastic	Epoxy	Phenolic resin	Polyester	Vinyl ester
Density [g/cm^3]	1,2-1,3	1,2-1,4	1,1-1,4	1,1-1,2
Tenacity [MPa]	50-130	35-60	40-90	70-90
Tensile modulus [GPa]	2,5-5,0	2,7-4,1	1,6-4,1	3,0-4,0
Breaking strain [%]	<9	-	<5	<6
Bending strength [MPa]	110-215	-	60-160	120-140
Compressive strength [MPa]	110-210	-	90-200	-
Operating temperature which can be applied continuously [°C]	80-215	70-250	60-150	-

The epoxy resin has good resistance against corrosion and chemicals but has a breaking tendency which for us would be problematic since due to the continual handling this layer might break (crack) therefore the structure itself would lose these properties in a short period of time.

Phenolic resins are resistant to heat, friction and chemicals, nevertheless their mechanical properties are quite bad so this type is not useful for our purposes.

Polyester resins are widely used due to them being cost effective, easy to handle and they are fast to harden. Furthermore, resistance to atmospheric effects, good mechanical, electrical and chemical properties make them useful. This seems acceptable to us.

Vinyl ester resins are varieties of the poly (vinyl-alcohol)-based polyester modified by epoxy resin, novolac resin or epoxy-novolac resin. They are basically different from polyesters in that the reactive places are at the end of the chain. They contain less ester groups therefore they are less sensitive to degradation caused by water. The long carbon chains make them more resistant and they have a better load transferring property.

Better mechanical properties, higher heat resistance and excellent resistance to chemicals cause these resins to be different from polyester resins. There are less possibilities for cross-linkage in the vinyl ester polymer therefore it is more flexible and it strings better.

Based on the above properties we will choose the vinyl ester resin with the characteristic of 470-300 which is resistant to chemicals and has a high heat resistance quality. The disadvantage as opposed to the polyester resin is that this type of resin has higher costs but on the other hand it is less sensitive to the degradation caused by water (humidity). This aspect is also important and this is why we choose the vinyl ester resin.

The composites with inside plates are on top of each other in a multi-layered structure. The layer order of the composites with plates is described by starting from the core towards the boundary layers.

The core material is the material on which surface we apply the composite layers (Table 2).

Table 2. Properties of composite sandwich core materials

Alveolar structures	Plate thickness [μm]	Density [kg/m^3]	Resistance to Compression [MPa]
Aluminium alloy 5052	25,4	36,8	1,20
Aluminium alloy 5024	38,1	44,8	1,72
Glass fibre fabric/phenolic resin	–	56,0	3,45
Glass fibre fabric/polyester	–	64,1	3,86
Glass fibre fabric/polyimide	–	64,1	3,03
Aramid/phenolic resin	50,8	48,1	2,65
Kraft paper/phenolic resin	–	80,1	2,76

When choosing the core material it is important that the feeder layer would be well connected to it. The layer thickness of the core material is determined by applicability. The thinner it is, the more flexible it is and the thicker it is, the heavier and the firmer it is. This layer is protected the most from outside effects and it is important that its mechanical properties would be good. The core material must be chosen according to this aspect. Producibility aspects also must be considered.

The core material has two sides therefore we should choose the same material for both sides. On the bottom part the adhesive free layer can be put on and on top, if necessary, other adhesive layers can follow, then on the top layer comes the resin.

The material on the two sides of the core material can be different but in our case the same composite material is satisfactory. The reinforcing fibres greatly influence the properties of the composite.

It is important for us that the reinforcing fibres would be of great firmness that they would bear the demands of everyday transporting and it would withstand the environmental changes in temperature. Since it is not directly subjected to UV light or humidity therefore it must not necessarily comply with these. However, in case of the top layer being damaged, these properties might be useful but necessarily needed.

Since the tray can be subjected to the same amount of stress from all directions therefore the cut glass fibre (Figure 2) mat structure or the glass fibre fabric can be the right solution.

The glass fibre mat is made up of various different grain directions among which gaps can be found and these lessen its firmness but its mechanical properties are of equal distribution in all directions of the plane. Due to its short thread length the unique production is easier and it is suitable for making complicated structures as well.

The glass fibre fabric structure is made up of long stranded threads which are distributed equally in the two main directions of the plane. It has great resistance to shear stress but in case of felter this property deteriorates. During the production technology process thread stretching can occur which cannot be corrected and this greatly influences its properties [6, 7]

We chose the glass fibre mat because the stress effects in regular circumstances are not very strong but in our case they can occur in any direction during usage and in regular circumstances it will not be subjected to great stress.

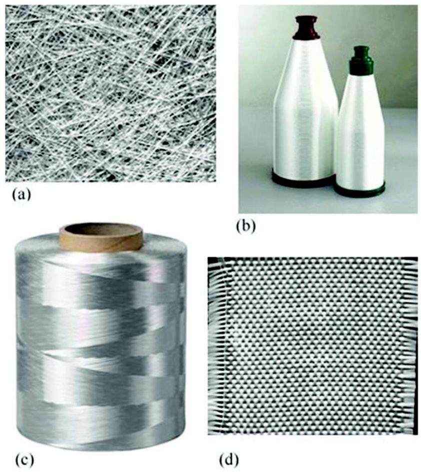

Figure 2. Typical forms of glass fibre made for composite [4]
a) cut glass fibre mat, b) glass fibre thread, c) roving,
d) glass fibre fabric

We chose the glass fibre mat because the stress effects in regular circumstances are not very strong but in our case they can occur in any direction during usage and in regular circumstances it will not be subjected to great stress.

The bottom layer of the composite tray under the fibre glass mat should be a material with low adhering property in order to avoid the contaminants adhering to it and when in use the tray would be easy to slide and keep clean. In this case vinyl ester resin can be used with added paraffin or cheap polyester where the aspect of choosing is the low adhering property.

Above the core material we choose the fibre glass mat and we choose a glue type which can be used for connecting this with the outside resin layer. The chosen glue must adhere well to both the fibre glass mat and the vinyl ester resin. We chose the Vlies veil.

The thickness and arrangement of the composites must be optimally defined which can be checked during the testing process of the prototype. If necessary, we can change the order of layers and their thickness (Table 3). By doing this we do not lessen the chemical properties but rather enhancing the physical properties of the tray and the result is that we will have a durable, easy-to-handle and good quality tray (Figure 3) to go into production.

Table 3. Layers chosen by us

Figure 3. Installed element of the GREEN TRACK collector tray

Vinyl ester gel coat	Derakane 470 resin +Aerosil 202 + colouring paste (10%)	800 micron thickness	1-1,2 kg/m^2
1 layer veil	D77-60 vlies		1 m^2 vlies 0,2 kg/m2 resin
2 layers 450 g/m^2 fibre glass mat	450 g/m2 fibre glass mat + Derakane 470 resin	1,6 mm layer thickness	1,8 kg/m^2 glass fibre mat 3,6 kg/m^2 resin
Core material	Coremat 3 mm thick	3 mm	1,8 kg/m^2 resin
2 layers 450 g/m^2 fibre glass mat	450 g/m2 fibre glass mat + Derakane 470 resin	1,6 mm layer thickness	1,8 kg/m^2 fibre glass mat 3,6 kg/m^2 resin
Top coat layer adhesion free	Can be the vinyl ester gel coat from above + paraffin or polyester, coloured VUP 960 BE	800 micron thickness	1-1,2 kg/m^2

3. Conclusions

As engineers we must not be satisfied with just discovering the problem but we must find a solution and we have to correct it and eliminate it. In this case the issue of the liquid escaping during the filling and emptying processes could not be eliminated therefore the goal was to collect the liquids. In this situation our aim was to collect and prevent harmful materials (e.g. petroleum fractions) or valuable materials (e.g. water) getting into the environment. This way we can ensure the protection of the environment and recycle these materials. We feel we are on the right track, the aim is clear for us and we are working on the stages of realization.

Acknowledgements

The aim of the research and development project is to improve the existing GREEN TRACK system® to be applicable on a full scale in regards of the railway and road traffic. Our research was supported by "The market oriented improvement of the environmental friendly collector tray of the GREEN TRACK system for full scale railway and road traffic application" project identification number: PIAC_13-1-2013-0078.

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STRIP TILL: AN ECONOMIC ALTERNATIVE FOR THE HUNGARIAN AGRICULTURE

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Abstract

Strip till is a preserving, energy and cost efficient seedbed making and nursing technology that – compared to traditional solutions – has many advantages. The method has been widely used in the US for several decades and KITE takes credit for introducing and propagating it in Hungary. The paper sums up both the pros and cons of this method giving a good understanding of some of the experience domestic users encountered so far. According to that, the biggest advantage is the propellant savings: in case of different soil types these were above 50% (11% on cost and 41% on labour) compared to traditional tillage. The article also points out that agro-technical and economic advantages are traceable in case of both early and late plants like corn and sunflower. The initial favourable American and domestic experience proves the adaptation of strip till to be successful resulting in a process innovation with several farming advantage.

Keywords

innovation, global position system, strip till, technical development.

1. Introduction

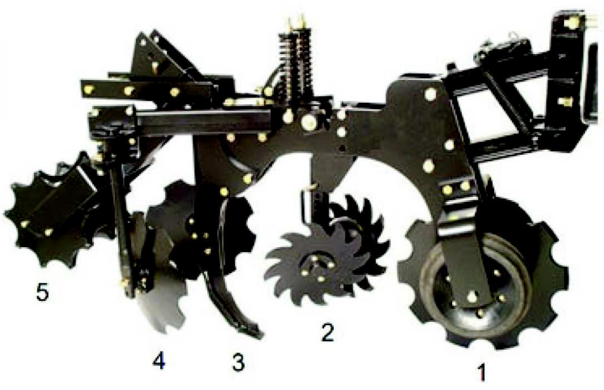

Figure 1. Basic components of a typical strip-till unit include: (1) opening coulter; (2) residue managers; (3) mole knife/NH3 injector; (4) covering disks; and (5) seedbed conditioner. (Photo courtesy of Yetter Manufacturing, Hagenstaller, 2103)

Strip tillage is a form of conservation tillage in which only the row zones are tilled, leaving the 9- to 12-inch inter-row zone undisturbed. The soil is not ploughed. It combines the soil drying and warming benefits of conventional tillage with the soil-protecting advantages of no-till by disturbing only the portion of the soil that is to contain the seed row. This type of tillage is performed with special equipment (Figure 1) and can require the farmer to make multiple trips, depending on the strip-till implement used, and field conditions

Typical equipment requirements for strip-till include a heavy tool bar to which row markers, opening coulters, knives and covering disks are attached. Rolling harrow baskets and other seedbed conditioner attachments are often added to the back of the unit as well.

Benefits of strip till

Strip till warms the soil, it allows an aerobic condition, and it allows for a better seedbed than no-till. Strip-till allows the soil's nutrients to be better adapted to the plant's needs, while still giving residue cover to the soil between the rows. The system will still allow for some soil water contact that could cause erosion, however, the amount of erosion on a strip-tilled field would be light compared to the amount of erosion on an intensively tilled field. Furthermore, when liquid fertilizer is being applied, it can be directly applied in these rows where the seed is being planted, reducing the amount of fertilizer needed while improving proximity of the fertilizer to the roots.

Compared to intensive tillage, strip tillage saves considerable time and money. Strip tillage can reduce the amount of trips through a field down to two or possibly one trip when using a strip till implement combined with other machinery such as a planter, fertilizer spreader, and chemical sprayer. This can save the farmer a considerable amount of time and fuel, while reducing soil compaction due to few passes in a field. With the use of GPS-guided tractors, this precision farming can increase overall yields. Strip-till conserves more soil moisture compared to intensive tillage systems. However, compared to no-till, strip-till may in some cases reduce soil moisture.

The specific advantages of strip tillage include the following:
- Equal or greater crop yields
- Increased profit through elimination of several tillage operations
- Reduced labor, fuel, and fertilizer costs
- Reduced nutrient loss to runoff and leaching

– Reduced soil erosion and soil compaction
– Increased water savings
– Reduced soil temperature (Figure 2) [1]

2. Experimental session

At the site in which dry edible beans were grown in 2011, soil temperature sensors were installed at about 4-inch depth in the inter-row zone in order to determine whether or not the residue from the strip tillage would keep the soil cooler. Assuming that the locations where the sensors were installed were representative of the entire field, the conventional tillage consistently reached higher temperatures than the strip tillage between the months of June and September (Figure 2). The soil at 4-inch depth in the conventional tillage area was 4 to 6°F hotter in the early afternoon than with strip-tillage residue growing dry beans. All other things being equal, cooler temperatures should result in decreased evaporation and, ultimately, higher soil moisture. This is especially advantageous for shallow-rooted crops such as dry beans, whose roots do not reach the deeper soil moisture [1].

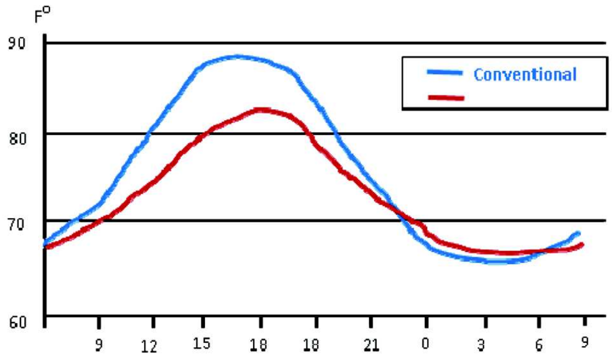

Figure 2. Average daily temperatures at 4-inch depth under conventional and strip tillage for a typical day [1]

Practical experiences

Mark Kimmel a Nebraska(USA) farmer says:

"Since going strip-till, we've cut our fuel use by 60% vs. our old conventional-tillage program. We've cut at least three tillage passes, and the time savings is huge."

"Out here, the wind is blasting our sandy loam soils all the time," Kimmel says. "Strip-tilling leaves more residue to protect the soil, especially in our corn-on-corn fields.

Kimmel says he believes that strip-tilled corn yields more than corn grown with conventional tillage, but says that better hybrids also account for yield increases, too. The yield advantage definitely shows up in sugar beets [2].

Károly Józsa is a farmer in Kiskunlacháza (Hungary). He has already been using an Orthman equipment for several years (Figure 3).

Figure 3. The main components of Orhtman 1tRIPr equipment (Photo by István Husti)

Based on his experiences he says:

'His experiences from 2013 also justify the advantages of strip till and conventional tilling, since compared to traditional tilling, water didn't stay as much on the surface of the land that was cultivated using the former technologies. The surface of the areas not ploughed is covered with residues that help absorb spring rainwater as well as playing a role in keeping the moisture in. In the previous years we experienced that water stayed in the rut after a sudden rainstorm on a sugar beet area that was ploughed, while we could work on areas cultivated through conventional tilling because the cultivated land absorbed the water thus didn't hinder our work.'

'According to our latest observations we managed to save almost 10 liter/ha on fuel compared to traditional tilling. On top of that we can mention the savings on second operations of fertilizer spilling as well as additional advantages like the decrease of soil treading. Related to this the operation cost in case of traditional tilling were 16-17 thousand HUF/ha while that of conventional tilling was around 11-12 thousand HU/ha. Considering that the area for conventional tilling was 250 hectare, this fact resulted in a saving of 1 million 250 thousand HUF while the outputs were similar.

Based on our calculations, the amount invested in creating the condition system for conventional tilling would pay back in 4-5 years.' [3]

3. The economic aspects of strip till

With fuel prices soaring, producers may want to look to strip tillage as an option to save fuel, time, and money.

Norberg's [4] data (Table 1) according to 2007, but these information could be relevant and useful today, as well.

Table 1. Reduced Costs

Reduced Costs			
	Labor and Machinery	Herbicide and Fuel	Total
Disking	$13.25		$13.25
Plowing	$27.00		$27.00
Disking	$13.25		$13.25
Groundhog	$12.50		$12.50
Total1	$66.00		
Added Costs			
Spraying Glyphosate	$8.45	$4	$12.45
Fuel and Labor Strip Till	$3.50	$1	$4.50
Total2	$16.95		
Savings left per acre to pay for strip till unit	$49.05/acre		

The economic studies done at KITE help professionals get a reliable picture of the real domestic results and experience of conventional trilling. They started their first experiment in 2011/12 with the new method, and then after it got widespread in 2014, they shared their experiences of their 2012-2013 studies with the professionals in the industry.

They followed an analyzed the results of conditional tilling on a wider scale (in case of corn production they had 198 measuring points in 2012 while 175 in 2013) comparing the results of the traditional tilling method with conventional tilling.

The sites in experiments were taken into three groups based on types of soil (loam, clayey loam, clay). These were connected to the three HP-levels (240, 270, 300 HP). Operating performance (ha/h) and the fuel-consumption (l/ha) are on the Table 2.

Regarding to the whole technology, it's worth to analyze the results in two areas: after the early and after the late harvested crops. (Table 3 and 4)

Table 2. Data on operating performance and the fuel-consumption [5] A: Loam + 240 HP, B: Clayey loam + 270 LE, C: Clay + 300 LE

	Strip till			Conventional tillage		
	A	B	C	A	B	C
ha/h	3,05	3,05	3,05	1,51	1,51	1,51
l/ha	13,1	14,8	16,4	25,5	28,7	31,8

Table 3. Some characteristics after the early harvested crops [5]

Technology	Number of operations	Operating time (h/ha)	Operating time ratio	Cost (Ft/ha)	Cost ratio
Conventional tillage	11	2,16	100%	80788	100%
Ploughing	9	1,93	89%	76456	95%
Strip till	8	1,4	65%	69448	86%

Table 4. Some characteristics after the late harvested crops [5]

Technology	Number of operations	Operating time (h/ha)	Operating time ratio	Cost (Ft/ha)	Cost ratio
Conventional tillage	9	1,82	100%	68710	100%
Ploughing	7	1,71	94%	65917	95%
Strip till	6	1,18	65%	58909	86%

4. Conclusion

Tips for success:

- Seek information from producers who are already using strip tillage,
- Allow time to learn a new farming system,
- Don't conduct strip tillage or plant when it's too wet,
- Planting in the centre of the strip-tillage row will be worth your time, effort, and money,
- Apply fertilizer in rows for greater efficiency,
- Avoid compaction in the strip-tillage row,
- Anticipate new weed problems [1].

By analyzing the information we can say that conventional tilling compared to traditional tilling is a realistic alternative for domestic farmers. The studies conducted in Hungary based on the results of the analyzed time horizon validated that the positive international results –coming from mostly the US – could be realized in Hungary as well. It means that in the domestic plant production the adaptation of strip tilling is a realistic and forward-thinking effort.

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A RESEARCH ON PRODUCTION OF BABY LEAF VEGETABLES IN FLOATING SYSTEM

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Abstract

In this research, the possibility of dill, parsley and leaf lettuce growth in a floating system was studied with the purpose of less nutrient (fertilizer) use. These baby leaf vegetables have short production cycles. The effect of full and half strength nutrient solutions on yield, quality and leaf nutrient status was studied. Research was carried during the spring production seasons of 2010. Standard nutrient solution ((mM) 12 N-NO_3, 3.8 N-NH_4, 2.8 P, 8.4 K, 3.5 Ca, 1.4 Mg, 9.5 Na, 8.0 Cl, 2.7 S, 0.04 Fe) was used as full strength (control treatment) and compared to half strength Hoagland nutrient solution. In both of the seasons total yield changed between 1030.78-1149.90 g m^{-2} in dill, 604.73-659.70 g m^{-2} parsley and leaf lettuce 162.60- 143 g $plant^{-1}$ respectively. In this study, the effect of treatments on some quality parameters (dry weight, vitamin C, nitrate, pH and EC) and nutrients uptake by plant were determined. When the results are evaluated as a whole, it was concluded that half strength nutrient solution decreased yield. Some savings could be achieved in terms of nutrient solution consumed by the plant with the negative impact on the environment.

Keywords

Floating system; Hoagland nutrient solution; yield; quality, baby leaf vegetable

1. Introduction

Baby leaf vegetables like dill, parsley and leaf lettuce are popular spice vegetables used in Turkey. Generally, leaves are used for garnish and flavoring dishes. Dill (Anethum graveolens) is a herb leaves and seeds are used for flavouring and seasoning [1]. It is the sole species of the genus Dill use fresh and dried leaves (sometimes called "dill weed" to distinguish it from dill seed) which are widely used as herbs in Europe and central Asia. Dill is best when used fresh as it loses its flavour rapidly if dried; however, freeze-dried dill leaves retain their flavour relatively well for a few months. Parsley is naturalized (grown) elsewhere and widely cultivated as a herb, a spice, and a vegetable. Parsley is one of the most important vegetables produced in the world. Its varieties differ according to the commercial organs. There are leafed parsley such as plain and curly leafed varieties and fleshy root parsley such as Hamburg varieties [2, 3]. Lettuce (Lactuca sativa L.) is a vegetable from Compositeae (Asteraceae) family which grows both in open field and greenhouse conditions during all year and consumed fresh and in salads and has appetizing character with vitamins and minerals in their leaves [4, 5, 6].

Dill, parsley and leaf lettuce which are the three types of leaf-edible vegetables used widely and increasingly in our country are also grown in Mediterranean and Southern European countries. These vegetables can be used fresh as salad and garnish and can be grown all year round [7]. They are rich in vitamins and minerals. It is known that Vitamin C is especially effective on many biological activities in human body [8].

Small-size leafy vegetables can profitably be cultivated in a floating system to get fresh market products or ready-to-use salads that are arousing more and more interest by consumers. Among hydroponic methods, the floating system is the easiest and cheapest way to produce baby leaf vegetables when soil cultivation is not feasible any more [9]. At the same time, fertilization is one of the most practical and effective ways of controlling and improving the yield and nutritional quality of crops for human consumption. The optimal fertilizer concentration for baby leaf vegetables depends on the environmental conditions.

The objective of this study was to investigate the possibility of the production of dill, parsley and leaf lettuce which have short production cycles and baby leaf vegetable to reduce the concentration of nutrient solution in floating system.

2. Materials and methods

The research was conducted in an 18 x 40 m sized PE greenhouse belonging to Ege University Bayindir Vocational Training School (27° 40' D, 38° 11' K) in the growing periods of spring and autumn 2010-2011.

Dill (Anethum graveolens L. cv. Gönen), parsley (Petroselinum crispum cv. Italian Giant) and leaf lettuce (Lactuca sativa cv. Nika) were the vegetable materials of the experiment. In the study, desks covered with polyethylene covering at a height of 1 meter from the ground, made of galvanized steel and sized 2.40 x 1.40 x 0.30 m. were used. Viols of 53.5 x 34 cm were placed inside the desks. Two big perlite sheets were spread to the growing area. The seeds were planted manually as 1.5 g seeds per m^2 [7].

Cultivation started by seeding and seven days later viols were placed in the pond. In the study, nutrient solution was applied as

(1) full strength and (2) half strength. Hoagland solution [10] was the full strength nutrient solution and accepted as the control treatment (Table 1). The pH of nutrient solution was kept between 5.5-6.0 and the electrical conductivity between 1.8-2.2 dS m^{-1}.

Vegetables reached harvest maturity in 50-65 days in the autumn period and 30-40 days in the spring period. The total weight of the crops harvested was calculated in grams (g). Measurements are given as g m^{-2}. Vitamin C (mg 100ml^{-1}) and nitrate (mg kg^{-1}) [11] values were specified related to the characteristics of leaf quality on December 3, 2010 and April 20, 2011.

During the study period, the water budget technique was utilized for calculating the vegetable water consumption values related to the topics. Seasonal vegetable water consumption was determined by subtracting the nutrient solution volume filled in the pond at the beginning of the production period and the nutrient solution volume remaining in the ponds at the end of the production period and by dividing them into vegetable cultivation area. The results are presented as the consumed nutrient solution amount (mm) [12, 13].

All the statistical analysis was done on a completely randomized blocks design with three replications. The data obtained was subjected to analysis of variance (ANOVA) and the mean differences were compared by LSD tests at the significant level of 95%.

3. Results

Yield

Parsley (Petroselinum crispum)

Every season one harvest was made and effect of treatments was evaluated. In this regard, no significant effect was determined. Marketable yields during the spring of 2010 were obtained as 604.73 and 659.70, respectively (Table 1.).

Table 1. Effect of treatments on marketable yield of parsley (g m^{-2}). Spring, 2010

Treatments (Hoagland solution)	Marketable yield (g m^{-2})
Full -strength (1)	659.70
Half-strength (2)	604.73
LSD$_{(0.05)}$	*ns*

Dill (Anethum graveolens)

Dill was grown only during spring 2010 and significant difference was not observed between with a single harvest. Marketable yields of Dill varied about 1030.78 to 1149.90 g m-2 of fresh matter (Table 2.).

Table 2. The effect of treatments on marketable yieldof dill (g m^{-2}). (Spring, 2010)

Treatments (Hoagland solution)	Marketable Yield
Full -strength (1)	1149.90
Half-strength (2)	1030.78
LSD$_{(0.05)}$	*ns*

Leaf Lettuce

In the autumn period of 2011, effect of treatments on the marketable yield of lettuce was found statistically significant at the full strength treatment, and it was increased the plant weight 12.5%.

Although higher marketable yield of leaf salad was found in the full treatment, effect of the treatments on the number of leaves was found not significant (Table 3.).

Table 3. The treatments on Effect of Marketable yield of leaf lettuce (g m^2) (Autumn, 2010).

Treatments (Hoagland solution)	Marketable Yield (g plant^{-1})	Number of Leaves (piece plant^{-1})
Full -strength (1)	162.60 a	23.75
Half-strength (2)	143.00 b	17.75
LSD$_{(0.05)}$	*9.85*	*ns*

Some Quality parameters

Parsley

In the autumn period of 2010 dry matter of parsley changed significantly differed according to the treatments. The EC of the plant (leaf extracts) was significantly different in the spring period of 2011. However, other quality parameters as L, hue, Croma, vitamin C, nitrate, and pH was found non-significant according to treatments in all three periods. During the autumn of 2010, dry weight (%) of the leaves was found 24.7 % higher, and EC of leaf 15.3% higher during the spring season of 2011 in the half-strength Hoagland solution (Table 4).

Table 4. The effect of treatments on some quality parameters in Parsley.

Year& Period	Treatment (Hoagland solution)	Color			D.W (%)	Vit C (mgg^{-1})	Nitrate (mgkg^{-1})	EC (dSm^{-1})	pH
		L	Hue	Croma					
2010 Spring	Full -strength (1)	41.867	127.84	29.50	5.96	0.12	61.00	2.81	6.16
	Half-strength (2)	41.257	128.60	31.23	6.53	0.14	37.02	2.59	5.90
	LSD $_{(0.05)}$	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*

Dill

No effect of treatments on the studied quality parameters was determined on samples taken from the dill grown in spring 2010 (Table 5.).

Leaf lettuce

In the trial 2011 autumn, vitamin C content of the leaves changed significantly. Full-strength treatments of vitamin C values were found 28.37% higher. The effect of treatments on leaf dry weight and nitrates were not statistically significant (Table 6.).

Table 5. The effect of treatments on some quality parameters in Dill.

Year& Period	Treatments (Hoagland solution)	Color			D.W (%)	Vit C mgg^{-1}	Nitrate ($mgkg^{-1}$)	EC (dSm^{-1})	pH
		L	Hue	Croma					
2010 Spring	Full - strength (1)	46.67	126.67	34.36	7.00	0.16	58.19	2.67	6.0
	Half- strength (2)	47.67	126.33	36.43	6.00	0.23	53.13	3.00	6.0
	LSD $_{(0.05)}$	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*

Table 6. The effect of treatments on some quality parameters of leaf lettuce.

Year & Period	Treatments (Hoagland solution)	DW (%)	Vit. C (mgg^{-1})	Nitrate ($mgkg^{-1}$)
2011 Autumn	Full -strength (1)	9.99	76.33 a	90.82
	Half-strength (2)	15.56	54.67 b	68.85
	LSD (0.05)	*ns*	*13.68*	*ns*

Plant water consumption

Amount of nutrient solution consumed by the plant in floating system according to the growing period were given in Figure 1, 2, 3 and 4. Both years of 2010 and 2011 in spring and autumn periods, amount of nutrient solution consumed by plants in Full–strength treatment was found 35.71, 23.81, 34.23 and 22:32 mm and 32.74, 25.80, were 35.71 and 23.81 mm in half-strength.

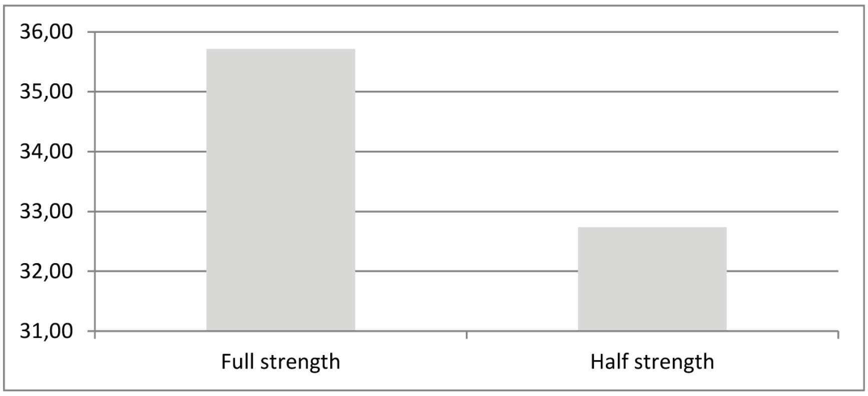

Figure 1. The amount of nutrient solution consumed by the plant (mm) (Spring 2010).

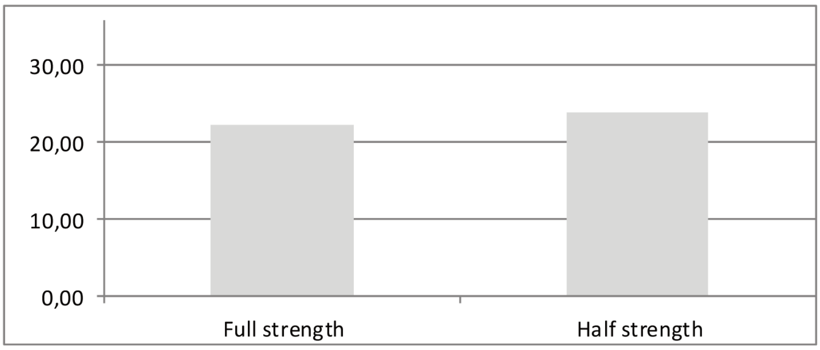

Figure 2. The amount of nutrient solution consumed by the plant (mm) (2010 Autumn).

4. Discussion

Vegetable production varies depending on many factors as cultivation period, method of production and climatic conditions, such as the number of plants per unit area. In our study, the effect of different nutrient solutions on yield with respect to growing period and plant species was found statistically non-significant.

In our study, the average leaf lettuce yields was 162.60g plant-1 in full strength and 143.00 g plant-1 in half strength nutrient solution, below the limits specified in the literature [14]. There was no difference in quality parameters between treatments.

In our experiment, the nitrate content of the leaves of Parsley, dill and leaf lettuce was determined below the limits constitute a hazard to human health [8, 15]

5. Conclusion

It is concluded that baby leaf vegetables grown in a floating system can successfully be grown under unheated greenhouse conditions. It is also concluded that half strength Hoagland nutrient solution can be suggested in order to preserve water and environment by providing nutrient use efficiency.

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WORKING HOURS DEMAND OF TRANSPORTATION TASKS IN FOIL COVERED FIELD VEGETABLE PRODUCTION TECHNOLOGY

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Abstract

In the paper we present the up-to-date mechanized production technology of cucumber production with regard to the transportation tasks. By the presentation of the performance and working hours data of machines necessary for production, we are emphasizing the significant volume of transport tasks in the production technology of cucumber. In the present cucumber production technology the working hour demand of machine operations and material handling is about 4,5 hours/tonne, besides a calculated average yield of about 12 t/ha. It can be stated on the basis of the results that the total working hour demand of the machines amounts 54 hours per hectare, which include the volume of transport and material handling tasks in value of 17 hours/ha. Special attention is to be paid to the machine operations like foil tunnel preparation, picking and planting which the most time demanding ones are representing about 9, 10 and 20 % of the total machine working hours. It is worth mentioning that time demand of transport and material handling takes the highest value, about 33 % of the total shift hours of production technology.

Keywords

foil covered field cucumber production, logistic, mechanisation, working hours demand, machine cost, material handling

1. Introduction

The subject of the present study is the mechanized production of field vegetables developing rapidly in the last years [1, 2].

The cucumber is one of the most important vegetable crops in Hungary. The home consumption and the exported quantity is also remarkable. Regarding the production area and the quantity produced pickled cucumber is the most significant in Hungary. The production area is roughly 3-4 thousand hectares.

The most important link in the chain of production and distribution is the solid inland processing industrial background which is essential for the export of fresh products as well [3, 4].

By the presentation of the performance and economic data of machines necessary for production, we are emphasizing the significant volume of transport tasks in the production technology of pickling gherkins. [5, 6]

2. Material and method

Presentation of the Production Technology

The machine technology of production is presented on the basis of Table 1. The table shows the operations, the machine applied for the certain operation, and the power category of the power machine connected to it. Table 2 shows the shift performance of the connected machines. Some of the economic data are also included: the price of the working machine and the power machine in the year 2014, the operational cost of the same per shift hour together with the operational cost of the connected machines [7].

The Major Machines of the Production Technology

The technology is based on drop irrigation, soil-cover cultivation method for which ridge forming machine type HORTUS HPD-165 and foil and tube layer type AF1 is used. In order to further early ripening and crop safety plant covering foil tubes can be prepared by the machine type AFF-1000.

For harvesting picking machines type STIEGER with picking belt are used by which crop can be harvested on the same territory 2-3-times a week without causing treading damage to the vegetation. [8]

The machine is – subject to framing – attended by 16-28 hand picking workers working in a lying position in order to avoid treading the vegetation. The collecting belt of the machine mounted on a tractor collects and forwards the cucumber into the trailer pulled by the power machine. According to measurements, the structure of the machine creates an appropriate position for the picking workers and fulfils the tasks of transport within the field at the same time [9].

3. Results and discussion

The results of the economic survey of cucumber production on a 20 hectare area are shown in Table 3. Apparently, the machine working time necessary for the cultivation of the 20 hectare growing area in case of connected machines has been stipulated related to the individual operations. Based on this, the direct operational cost of the connected machines can be easily calculated by multiplying the direct operational cost of the machine per shift hour (Table 2) with the effective working time. As a result, the cost of the individual operations related to 20 hectare growing area has been defined the total production costs of cucumber production on 20 hectares and also the specific cost per hectare has been determinate. The costs of field cucumber production and harvesting are specified in the Table 3.

It can be stated on the basis of the results that the operational cost of the working machines (11.196 EUR) is the half of the power machines (22.567 EUR). The total operational cost amounts to 33.763 EUR, 1688 EUR per hectare.

Table 1. The machine technology of production of foil covered field cucumber production

Operations	Type of machine applied in the technology	
	working machine	**power machine**
Stubble ploughing	Kühne 770-7,2 disc harrow	140 kW tractor
Medium deep loosing	RÁBA 10-14/5	140 kW tractor
Spreading organic manure	AGRO 65 TSZ tandem	60 kW tractor
Fertilizer transport	MBP 6,5 R	60 kW tractor
Spreading of fertilizer	Tornado 5	70 kW tractor
Deep ploughing	Kühne 720-7/6-16-M-TJ	140 kW tractor
Fertilizer transport	MBP 6,5 R	60 kW tractor
Spreading of fertilizer	Tornado 5	70 kW tractor
Ploughing processing	S-2 H/M	140 kW tractor
Seed bed preparation	Lemken Korund 600 K	140 kW tractor
Levelling the surface	Kühne KH - 5,6 S	60 kW tractor
Ridge bed preparation	Hortus HPD-165	70 kW tractor
Mulching, hauling in the hosepipe	AF 1	70 kW tractor
Water supply	DETK-115 tanker	60 kW tractor
Transport of plantlets	MBP - 6,5	60 kW tractor
Planting	Fedele Mario	70 kW tractor
Preparation of foil tunnel	AFF-1000	70 kW tractor
Irrigation	Nadir	
Spray mixture transport (12x)	DETK-115 tanker	70 kW tractor
Spraying (12x)	Gambetti GB E. 1500/16 v	60 kW tractor
Picking	Steiger	70 kW tractor
Transport	MBP - 6,5 – 2 pcs	60 kW tractor
Transport following pre-grading	HL 92.02 road	Trailer

Table 2. The basic economic data of the operations of cucumber production

Operations:	Shift performance (ha / hour)	Price of (th EUR)		Direct cost of operation (EUR/hour)		
		working machine	**power machine**	**working machine**	**power machine**	**total**
Stubble ploughing	3	19	141	10	29	39
Medium deep loosing	1,2	3,6	141	3	29	32
Spreading organic manure	0,7	7,1	65	4	16	19
Fertilizer transport	4	6	65	2	16	18
Spreading of fertilizer	4	9,6	72	6	19	26
Deep ploughing	1,5	8,3	141	6	29	36
Fertilizer transport	4	6	65	2	16	18
Spreading of fertilizer	4	9,6	72	6	19	26
Ploughing processing	4,8	7,4	141	7	29	37
Seed bed preparation	4	14	141	9	29	39
Levelling the surface	3,8	5,7	65	4	16	19
Ridge bed preparation	0,4	10	72	12	19	31
Mulching, hauling in the hosepipe	0,25	4,3	72	3	19	22
Water supply	0,9	6,8	65	4	16	20
Transport of plantlets	4	6	65	2	16	18
Planting	0,1	3,6	72	4	19	24
Preparation of foil tunnel	0,2	7,4	72	14	19	33
Irrigation	0,25	8,8	0	24	0	24
Spray mixture transport (12x)	4,8	6,8	72	4	19	23
Spraying (12x)	4,8	16	65	9	16	25
Picking	0,2	44	72	16	19	35
Transport		12	65	4	16	20
Transport following pre-grading		7,5	33	3	20	22

Table 3. The shift hours demand and the costs of the operations of foil covered field cucumber production on 20 ha

Operations	Machine working hours (h)	Cost of operation (EUR)
Stubble ploughing	6	284
Medium deep loosing	16	616
Spreading organic manure	28	672
Fertilizer transport	***5***	***106***
Spreading of fertilizer	5	153
Deep ploughing	13	553
Fertilizer transport	***5***	***106***
Spreading of fertilizer	5	153
Ploughing processing	4	176
Seed bed preparation	5	234
Levelling the surface	5	118
Ridge bed preparation	50	1958
Mulching, hauling in the hosepipe	80	2120
Water supply	***22***	***531***
Transport of plantlets	***5***	***106***
Planting	200	5773
Preparation of foil tunnel	100	4170
Irrigation	80	2388
Spray mixture transport (12x)	***48***	***1351***
Spraying (12x)	48	1503
Picking	100	4441
Transport	***100***	***2407***
Transport following pre-grading	***150***	***3844***
Technology - total	**1.080**	**33763**
Shift hour per hectare (sh/ha)	**54**	**-**
Cost per hectare (EUR/ha)	**-**	**1688**

The investment cost of the machines applied in the production technology is 510.396 EUR out of which the purchasing price of the working machines amounts to 197.300 EUR, which equals about 39 % of the total investment cost. The purchasing price of the power machines is 313.096 EUR, about 61 % of the total cost of machines.

In case of power machines it can be stated that one power machine with an engine capacity of 140 kW is needed for the hard cultivation works. The tasks of nutrients delivery, ridge-bed preparation, mulching, hauling the hosepipe, planting, foil tunnel preparation, plant protection, harvesting and tractor delivery are fulfilled by a 70 kW main and a 60 kW aid machine. A low-cost trailer can be used for the road transportation of the product. With this selection of power machines lower acquisition costs and a more effective utilization of power machines can be achieved [10].

Cucumber production on 20 ha demands 1080 shift hours of machine work, out of which the two lower capacity tractors represent a great proportion, about 800. In comparison to this the 44 shift hour performance of the high capacity power machine in the course of cultivation is negligible. Transport by tractor from the field (100 shift hour) and road transport by trailer to the processing plant (150 shift hour) is one of the most time-demanding operations.

Tasks like fertilizer transport, water supply, transport of plantlets, spray mixture transport takes only 85 shift hours on 20 hectares.

4. Conclusion

The machine work costs of field foil covered cucumber production compared to the production costs of other field vegetable varieties are high [11, 12].

The significant hand labour demand is characteristic of this product by planting as well as by the preparation of the foil tunnel but first of all by harvesting when the expert and quality work of 28 persons might as well be needed. A high quality final product can be ensured through hand picking, but it comes at a price. The picking personnel of 16-28 persons represents a remarkable loan cost.

In the present production technology the shift hour demand of machine operations and material handling is about 4,5 hours/tonne, besides a calculated average yield of about 12 t/ha.

It can be stated on the basis of the results that the total shift hour demand of the machines amounts 54 hours per hectare, which include the volume of transport and material handling tasks in value of 17 hours/ha.

Special attention is to be paid to the machine operations like foil tunnel preparation, picking and planting which the most time demanding ones are representing about 9, 10 and 20 % of the total machine working hours. It is worth mentioning that time demand of transport and material handling takes the highest value, about 33 % of the total shift hours of production technology.

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Faculty of Mechanical Engineering

USE OF DIRECT MARKETING STRATEGIES BY FARMERS IN IZMIR, TURKEY: A CASE STUDY OF ARTICHOKE GROWERS

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Abstract

This study was carried out in Balikliova-Urla, Izmir Province of Turkey to determine artichoke growers' direct farm marketing options, future plans, and challenges.

The most common direct marketing strategy employed by growers was roadside stands. Roadside stands and community supported agriculture were emerged as the most drawn attention among possible direct marketing strategies. As farm size and gross farm income increased, average direct marketing revenues per farm also increased. However, there was no statistically significant difference found between the farms, in terms of both direct sales as a share of gross farm income and direct marketing share of total artichokes sales. Reaching consumers directly was identified as the most significant challenge by growers.

Keywords

direct marketing, artichoke, growers, direct marketing strategies

1. Introduction

Most producers devote their time to what they know best, planting, growing and harvesting food, leaving the processing and marketing to agri-business. However, selling directly to consumers is growing in popularity with some producers. Several reasons account for the increased interest in farm direct marketing. One is dissatisfaction with farm commodity prices. The farm price is often only a fraction of the retail food price. Prices for produce sold directly to consumers can be substantially higher than typical wholesale prices. Another reason is that producers value the relationships they form with the consumers, as well as the opportunity to receive immediate feedback on their products. Consumers value the fresh, quality products along with the opportunity to support local producers [1].

Farmer-to-consumer marketing is of growing importance, not only in providing many farmers with greater net returns but also in retaining food traditions. The direct contact between farmers and consumers enables both sides to boost special qualities like traditional agricultural products, organic food, denomination of origin etc. Consumer studies have revealed that purchasing at farms is typically connected with high involvement [2].

Direct marketing includes any marketing method whereby farmers sell their products directly to consumers [3]. A direct marketing strategy (DMS) applies to both crop and livestock products/commodities. Examples of DMS employed by farmers included use of farmers markets, you-pick operations, consumer cooperatives, and locally branded meats [4].

Specifically, growers can sell their products directly to consumers through market channels such as farmers markets, U-Pick or pick-your-own (PYO) operations, seasonal roadside stands or farm stands, Internet sales, and Community Supported Agriculture (CSA) [5]. The roadside stand is usually located on the farm and sells farm fresh products directly to consumers. In u-pick operations, the customer comes to the farm, does the harvesting, pays cash for the produce harvested and transports it home. Community supported agriculture consists of a partnership between consumers and producers in which consumers contract or buy shares in farm products in advance and producers commit to supply a range of products over the entire season. Often, consumers have the option to participate in planting, cultivation and harvest. The arrangement can be initiated by the producer or by a group of consumers [1].

The studies related to direct farm marketing in Turkey is one of the most neglected areas. There have been only a few studies deal with direct farm marketing. Adanacioglu [6] identified factors that affect cherry farmers' decision to participate in direct marketing in Kemalpasa District, Izmir. Using data from a survey of artichoke growers in Izmir, Adanacioglu [7] also investigated efficiency of both direct-to-consumer marketing and intermediated channels. Using data from a survey of artichoke growers engaged in direct marketing in Balikliova which is a small village in the Urla district, Izmir Province of Turkey, this paper explores what options of direct farm marketing are being used by growers and their future plans for direct marketing strategies. This paper also examines the challenges faced by artichoke growers in direct marketing.

Artichoke (Cynara scolymus L.) is an ancient perennial plant species native to the Mediterranean Basin and known since the first century AD. Artichoke is particularly widespread in the Mediterranean Basin, where the climate is characterized by warm summers and mild winters. According to the latest available data, the world surface area of artichoke cultivation in 2012 amounted to 125351 ha, yielding 1634219 t. Over the last decade (2003–2012), there has been an increase in world production (+27.8%), while the total surface has remained substantially unchanged (+1.6%) [8]. Egypt, Italy, Spain, Peru and Argentina are top five countries of the world production in 2012. Turkey is ranked 11th in the world with 32173 tons. In Turkey, artichoke production areas were located in western parts of Turkey, mainly in Aegean and Eastern Marmara regions [9].

2. Materials and methods

The data were collected from artichoke growers engaged in direct marketing between April and May 2014 via personal interviews, obtaining a total of 25 surveys. The survey was conducted in Balikliova which is a small village in the Urla district, Izmir Province of Turkey. Artichoke production in the Izmir was about 11330 tons in 2014, according to the Izmir Directorate of Provincial Food Agriculture and Livestock [10]. Urla provides 26% of Izmir's artichoke production.

A five-point Likert-scale was used to measure artichoke growers' attitudes towards direct farm marketing. Data were compared using Mann-Whitney-U-test.

3. Results and discussion

The Socio-Economic Characteristics of Artichoke Farms

Table 1 summarizes the survey results on socio-economic characteristics of the artichoke farms. The average age of farm household operators was about 54 years old. The experience of farmers in artichoke production was on an average 33.82 years. The average number of years in school of the household operators in the sample was about 7 years. The average size of holding in different size classes varies farm 0.3 to 7 hectares with average of 1.72 hectares. On average, 25 percent area of the total land holding was under artichoke orchards. The average area of artichoke grown was 0.43 hectares. 92 percent of artichoke farms were smaller than one hectare. Only 8 percent of the remaining farms were larger than one hectare. The average farm household had an annual net income of nearly €5937. The average household size was about four.

Table 1. Socio-economic characteristics of artichoke farms [11]

	Min	Max	Mean	Std dev.
Age of farm operator (yrs)	27.00	78.00	54.00	15.036
Farming experience of farm operator (yrs)	1.50	63.00	33.82	16.362
Artichoke farming experience of farm operator (yrs)	1.50	30.00	15.66	8.896
Year of education of farm operator (yrs)	2.00	15.00	7.00	3.532
Farm size (hectares)	0.30	7.00	1.72	1.742
Size of the artichoke orchard (hectares)	0.10	1.50	0.43	0.331
Annual farm income (€)*	516.10	14450.87	5937.10	3567.666
Household size (person)	1.00	8.00	3.80	1.633

*The average exchange rates between Turkish Lira (TRY) and the Euro (€) for April and May 2014 is 1 EUR = 2.9064 TRY.

Most of the farmers who were producing artichokes produced two or three crops. They produce not only artichokes but also other products such as olives, tomatoes, fresh broad beans, mandarin, pomegranates, and flowers. Most farmers were engaged in animal husbandry, especially sheep and goat breeding.

Marketing Channels Used by Farms

The surveyed artichoke growers used an average of 1.5 marketing channels to sell their products. Three marketing channels were identified in this survey: "direct marketing to consumers", "wholesale to traders", and "wholesale to exporters".

Direct marketing channel was the common channel used by growers. 56% of the growers used only direct marketing channels and 44% of them used both intermediate and direct marketing channels simultaneously when selling their products (Table 2). "Wholesale to traders" was the most commonly used channel by the growers in intermediated marketing channels. "Wholesale to exporters" was used the least, by only 4 percent of the growers.

Table 2. Marketing channels used by direct marketing artichoke growers

Sales channels	Number of farms	Percent
Direct-to-consumer channels only	14	56.00
Direct-to-consumer and intermediated marketing channels	11	44.00
Total	25	100.00

Table 3. Direct sales by farm size, area of land under artichokes production, and gross farm income
* denotes significance at the 5% level

	n	Average direct sales per farm(€)	Mann-Whitney U test results (2-tailed P value)	Direct sales as a share of gross farm income (%)	Mann-Whitney U test results (2-tailed P value)	Direct marketing share of total artichokes sales (%)	Mann-Whitney U test results (2-tailed P value)
by farm size							
Less than 1 hectare	11	710.03		27.50		72.22	
1 hectare and over	14	2154.11	0.014*	36.09	0.180	80.62	0.567
by area of land under artichokes production							
Less than 0.5 hectare	19	1194.28		32.93		81.02	
0.5 hectare and over	6	2546.11	0.018*	30.36	0.525	63.94	0.195
by gross farm income							
less than 5000 euro	9	646.08		42.91		83.70	
5000 euro or more	16	2009.57	0.020*	26.35	0.396	73.11	0.383
All farms	25	1518.72		32.31		76.92	

Direct Sales by Farm Size and Gross Farm Income

The average value of direct consumer sales per farm was €1518.72. For all sizes of farms, direct sales accounted for 32 percent of gross farm income, on average. The average percentage of artichokes sales from direct sales to consumers was approximately 77 percent.

As farm size and gross farm income increased, average direct sales per farm increased. Mann-Whitney U test showed that there was a statistically significant difference between the growers who owned less than one hectare of land and one hectare and over of land in terms of direct sales. As regards the area of land under artichokes production, Mann-Whitney U test showed that there was statistically significant difference between the growers who produced artichokes less than 0.5 hectare and 0.5 hectare and over. According to the Mann-Whitney U test, there was statistically significant difference between the growers who earned less than €5000 and €5000 and more annually from farm work. However, Mann-Whitney U tests indicated no statistically significant difference between the farms, in terms of both direct sales as a share of gross farm income and direct marketing share of total artichokes sales (Table 3).

Use of Direct Marketing Strategies by Artichoke Growers

Seven common forms of farm direct marketing for fresh produce are: u-pick, roadside stands and markets, farmers' markets, internet and mail order, direct to restaurants and institutions, community supported agriculture, and participation in agri-tourism. When selecting one or more methods, consider personal preference, farm location, and the volume and nature of the products and services to be sold. Targeting the consumer is important. In some cases, more than one method may fit your marketing plan [12]. New York direct marketing vegetable farms usually used multiple methods to retail their products [13].

Direct marketing methods identified in this study include roadside stands, selling direct to neighbours and acquaintances, peddling , mail order, community supported agriculture, internet, district markets, and farmers' markets (Table 4). The most common direct marketing strategy employed by artichoke growers was roadside stands. Roadside stands are used most often, because of near the farm or orchard, lower transport costs, strong demand for local artichokes, and high prices. Roadside stands were also one of the most commonly used direct marketing strategies by New York direct marketing vegetable farms. Roadside stands were used by 77 percent of the farms [13]. The other direct marketing strategies employed by artichoke growers were somewhat less popular in general.

Table 4. Direct marketing strategies employed by the artichoke growers

Strategy	$\bar{x}$
Roadside stands	4.36
Selling direct to neighbours and acquaintances	1.92
Peddling	1.56
Mail order	1.36
Community Supported Agriculture	1.36
Local vegetable and fruit markets in Urla district, Izmir	1.28
Farmers markets in Urla district, Izmir	1.20
Local vegetable and fruit markets in Izmir province	1.16
Internet	1.12
Farmers markets in Izmir province	1.00

$\bar{x}$ he mean score of 5-point Likert scale (1 = absolutely not, 2 = preferably not, 3 = neutral, 4 = possibly, or 5 = definitively

[1]Peddling is a direct marketing option in which producers sell and deliver to retail stores, institutions, restaurants, etc. Operators might also sell from the backs of their trucks, take orders, and deliver or sell door-to-door where permissible [14].

Planning Strategies for Future Direct Marketing Initiatives

The surveyed direct marketing artichoke growers were asked to identify changes they foresee for different direct marketing strategies in their operation in the next years. In examining the possible direct marketing strategies which the artichoke growers plan to use in the future in case of selling directly to consumers, roadside stands and community supported agriculture were emerged as the most drawn attention (Table 5). Most of the artichoke growers were most likely to focus on expanding in roadside stands and community supported agriculture in the near future.

The least preferred direct marketing strategies for artichoke growers in planning strategies for future direct marketing initiatives were mail order, farmers' markets, internet, selling direct to neighbours and acquaintances, peddling, and district markets.

Table 5. Future plans for direct marketing artichoke growers

Strategy	$\bar{x}$
Roadside stands	4.08
Community Supported Agriculture	4.04
Mail order	2.84
Farmers markets in Urla district, Izmir	2.32
Internet	2.20
Selling direct to neighbours and acquaintances	2.16
Farmers markets in Izmir province	2.12
Peddling	2.04
Local vegetable and fruit markets in Urla district, Izmir	1.92
Local vegetable and fruit markets in Izmir province	1.72

$\bar{x}$ the mean score of 5-point Likert scale (1 = absolutely not, 2 = preferably not, 3 = neutral, 4 = possibly, or 5 = definitively

The Challenges Faced by Artichoke Growers in Direct Marketing.

Farmers marketing products directly to consumers face many challenges. In a survey conducted with New York direct marketing vegetable farms, respondents were asked the top barriers or problems facing their direct marketing operations. The survey results showed that competition in a saturated market and labor related challenges were the top barriers to success in many direct marketing operators' minds. Concerns include competition from supermarkets, discount stores, import goods, and other farm markets, and labor related challenges including lack of labor pool and hard-to-find seasonal help, difficulty in finding good labor and keeping qualified labor, and high costs of labor. Other top barriers were location, limited resources (capital, land and products), changing market and consumer demand (one-stop shopping and year-round supply), and regulations and community development pressure [13].

According to the results of a survey that was conducted in California, growers were asked if there was anything preventing them from being even more successful in their direct marketing efforts. Generally, smaller farms reported the largest barrier to be a lack of access to land. Larger farms perceived a lack of marketing outlets, long distance to markets, and a lack of time [15].

The results from this study provide also insight about challenges faced by direct marketing artichoke growers. The findings showed that reaching consumers directly was identified as the most significant challenge facing artichoke growers in their direct marketing operations. The other major challenges facing growers were lack of a farmers' market in their locality; having a general concern about selling all of their crop through direct marketing channels; and lack of knowledge in using direct-marketing techniques (Table 6).

Table 6. Challenges facing direct marketing artichoke farms

Challenges	$\bar{x}$
Challenge of reaching consumers	3.72
Lack of a farmers' market in their locality	3.28
Having a general concern about selling all of their crop through direct marketing channels	3.24
Lack of knowledge in using direct-marketing techniques	3.24
Lower selling prices	2.28
General absence of refrigerated transport	2.16
Lack of cold storage to keep artichokes fresh	2.04
Inability to meet consumer expectations for high quality and standard products.	1.48

$\bar{x}$ the mean score of 5-point Likert scale (1 = "Not at all effective" and 5 = "Highly effective").

4. Conclusions

Using data from a survey of artichoke growers engaged in direct marketing in Balikliova which is a small village in the Urla district, Izmir Province of Turkey, this paper explores what options of direct farm marketing are being used by growers and their future plans for direct marketing strategies. This paper also examines the challenges faced by artichoke growers in direct marketing.

Direct marketing channel was the common channel used by growers. As farm size and gross farm income increased, average direct marketing revenues per farm also increased. However, the results indicated that there was no statistically significant difference between the farms, in terms of both direct sales as a share of gross farm income and direct marketing share of total artichokes sales. This means that tendency to direct marketing channel is not related with artichoke farm size or gross farm income.

The most common direct marketing strategy employed by artichoke growers was roadside stands. In examining the possible direct marketing strategies which the artichoke growers plan to use in the future in case of selling directly to consumers, roadside stands and community supported agriculture were emerged as the most drawn attention.

The findings showed that reaching consumers directly was identified as the most significant challenge facing artichoke growers in their direct marketing operations. In order to serve growers' needs, organizations such as producers' associations, cooperatives, local administrations, voluntary consumer groups around business and family, civil society organizations and etc., should be created. With these organizations, the growers who willing to sell their products by direct marketing channels may be equipped with information for being more successful in their direct marketing efforts.

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THE ROLE OF RE-USE IN REDUCING INDUSTRIAL COSTS. A CASE STUDY IN THE GENERAL COMPANY FOR ELECTRICAL INDUSTRIES, IN DIYALA, IRAQ

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Abstract

This study analyzes the impact of reusing of some industrial parts to reduce costs at a company in Iraq. In the research, the company's records and quantity data were collected and analyzed about the reused parts from a factory of electrical transformers. Secondly, a comparison was made between the cost of making new parts and used parts that the company returned it. The results of study were referred to the yield achieved, when the company reuses the used parts. The study also provides some of the conclusions and recommendations including reuse of parts that could be used in the manufacture of products without affecting the quality of product.

Keywords

waste management, reuse programs, industrial costs, cost reduction, Iraq

1. Introduction

In today's competitive industrial environment, industrial companies all over the world shall face massive challenges. It is not a secret, that industrial companies are more competitive than ever, because of the globalization and the new technologies that affect all aspects of today's business environment, especially in the companies of the industrial sector. Besides globalization and the continuous technological development, the environmental aspects also became important factor of the economy. Nowadays, the reuse of products and components become the matter which cannot be avoided.

Industrial companies are struggling to get competitive advantage and this goal can be achieved through discovering new and creative methods in manufacturing of products with less cost, and providing appropriate means and materials in order to offer the best products which characterized by quality and appropriate cost. The idea of this study comes from this point. Therefore, the study tries to investigate the role of reuse in the reduction of industrial costs in the General Company for Electrical Industries, in Diyala, Iraq.

2. Concepts of reuse

When reusing materials instead of creating new products from virgin materials, there is less burden on the economy and the environment. Reuse is an economical way for people of all socio-economic circles to acquire the items they need. From business furniture to household items, from cars to appliances, and many more devices it is less expensive to buy used than new.

In 1994, the Ricoh Group, a Japanese multinational imaging and electronics company, established the Comet Circle as the basis to encourage towards sustainability (Figure 1). The Comet Circle describes an environmental impact reduction scheme, which includes not only the scope of the Ricoh Group as a manufacturer and sales company, but also the entire lifecycle of their products.

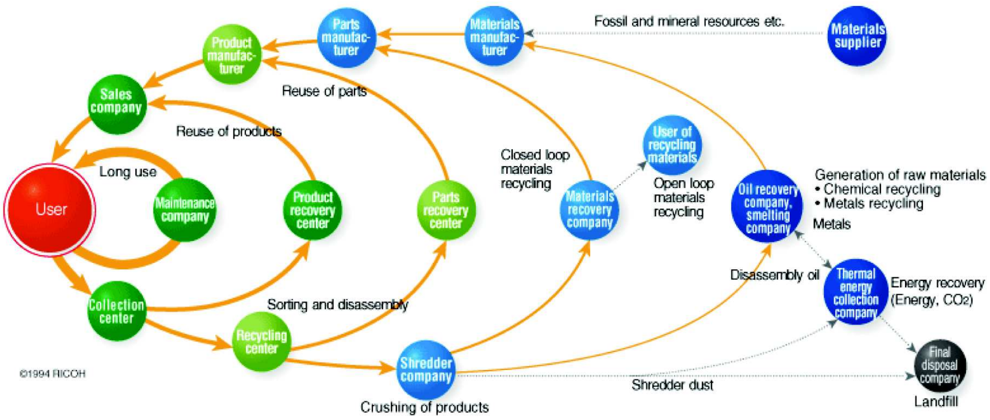

Figure 1. Concept of a Sustainable Society: The Comet Circle™ [1]

Each circle in Figure 1. represents the company's partners that can help develop a sustainable society. The new resources which are taken by the materials supplier from the natural environment (right at the top) will be turned into a product through moving from right to left along the upper route, finally reaching the users, i.e. customers. The used products will follow the route which can be seen in the lines below from left to right.

The concept illustrated by Figure 1 expresses the whole chain of resources. The green circles in the middle and the right side of the figure (product manufacturer, sales company, maintenance company, collection centre, product recovery centre, parts recovery centre, recycling centre are those parts of the chain which are evaluated in the present study.

Besides the reduction of the environmental impacts which will have direct and indirect external effects (on the natural environment and the society) the economic impacts may also be evaluated. The economic impacts are measurable in money terms at company level.

The information of the Comet Circle may be interpreted from other aspects as well. It is also important to recognize that the sustainable growth in reuse efforts, as well as the sustainable interest of the reuse industry, derives mostly from the solid waste reduction hierarchy [2]. Reduce, reuse, recycle, recover and dispose may be illustrated as a hierarchy as well (Figure 2.).

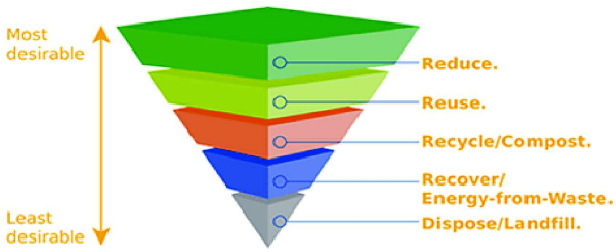

Figure 2. The hierarchy of recovery options [3]

The term "Reuse" can be defined as any operation by which products or components that are not waste, are used again for the same purpose for which they were conceived. To prepare different items for reuse means to conduct some checking, cleaning or repairing recovery operations on them, by which those products or components of products that might have become waste. These items are in such condition so that they can be reused without any other pre-processing [4].

Other literature sources [5, 6, 7] concluded similarly, in the system of waste management energy and raw materials from the environment are used in all production systems. From the production system in addition to the products, emissions, including solid waste, leave the system and enter the environment. If we use less raw materials, and reuse the relevant items, the amount waste that leaves the system at the end, may be much less.

It is very important to reduce waste and costs by using such manufacture products, which may be used many times or can be recycled to reduce its environmental effect as well as achieving financial benefits and production of new sources of revenue for communities [7]. Of course, the reusability of components will depend on several factors such as the degree of generality, complexity, and fit to expected use, as well as the quality of the component.

In addition – as it was already mentioned through the Comet Circle – the component has to be available [8], and it should be highlighted that there are many benefits for reuse of products and components which represent not only economic benefits but also environmental and community benefits. Reuse achieves savings in the cost of purchase materials or new products, and also reduces the amount of waste generated, as well as it requires little efforts [9].

3. Methodology

The methodology of this study depends on the resources and previous studies introduced in the previous, theoretical part of the study, while the practical part will be covered through analyzing and explaining the collected data from the records of the company under research.

Hypothesis

The main hypothesis of the present research is the following: the re-use of the used parts leads to reduce of industrial costs.

Data and sampling

The companies are the most crucial sources to enhance industrial research and provide researchers with important data to calculate industrial costs and working to study it. For the analyses conducted by this study, the General Company for Electrical Industries, in Diyala, Iraq was chosen as a population, because it is one of the Iraqi companies which returns used components and tries to reduce industrial costs under the current competition.

The study analyses the electrical transformer factory. The research focused on the main parts needed for manufacturing the electrical transformer KVA 11/ 250 (tank, core, cover, coil) which can be reused more than one time.

The company returns the reused parts in accordance with the contract with Directorates of Electricity in the country which gives financial discounts for each returned parts if it valid to use. The discount is based on the real manufacturing cost for each part, as illustrated in the Table 1.

Table 1. Discount percentage of different parts

Name of parts	Discount percentage
Tank	5%
Cover	2%
Core	1%
Coil	6%

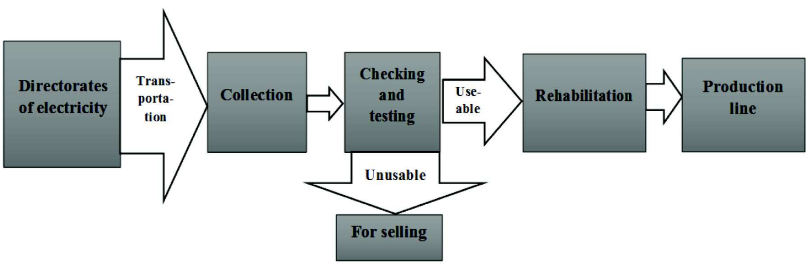

Figure 3. Processes of product return in the General Company for Electrical Industries- Diyala

After the return of used parts, the company works to inspect the parts to ensure its validity then a rehabilitation stage will appear. It means that, if necessary, some cleaning or dyeing processes should be inserted before entering back to the production line to assemble a new product. These processes are illustrated by Figure 3.

Data collection

The data were collected from records of the electrical transformer for the years 2013 and 2014, about the main parts to manufacture of electrical transformers (tank, core, cover, coil). The data were provided by the company from the relevant financial records.

4. Economic evaluation of reuse

This part includes explaining the hypothesis and data of study. The results of the calculations are summarized in Table 2. The first column represents the four main parts which may be reused. In the columns of costs the different real costs and the discounts were given in accordance with the data introduced in Table 1. The approximate costs of rehabilitation and transportation represent those costs which may appear during the rehabilitation process of the used industrial parts.

Table 2. The realized savings by USD$ from the reuse of parts in the General Company for Electrical Industries Diyala, for 2013 and 2014

Type of parts	Year	Costs					Savings		
		Approx. real cost for manufac-turing new part	Discount % for used parts	Cost of Discount	Approx. cost of re-habilitation and trans-portation	Total cost for used parts	Realized savings for each part	The number of returned parts	Total savings for each part
Tank	2013	333	5%	16,65	24	40,65	292,35	89	26 019,15
	2014	333	5%	16,65	24	40,65	292,35	101	29 527,35
Cover	2013	167	2%	3,34	32	35,34	131,66	152	20 012,32
	2014	167	2%	3,34	32	35,34	131,66	236	31 071,76
Core	2013	417	1%	12,51	21	33,51	383,49	134	51 387,66
	2014	417	1%	12,51	21	33,51	383,49	122	46 785,78
Coil	2013	800	6%	48	35	83	717	114	81 738,00
	2014	800	6%	48	35	83	717	92	65 964,00
Total savings for 2013									179 157,13
Total savings for 2014									173 348,89

The company works on returning the used parts from the directorates of electricity and give a discount for each returned part that depend on manufacturing cost of the new part. The cost of discount is a very low if we compare it with the manufacturing cost of part as shown above in Table 2. For example, manufacturing cost of the transformer tank 11/250 KVA is 333$, while the cost of the discount 16,65$ plus cost of rehabilitation and transportation 24$. In this case, total cost become 40,65$. Therefore, the realized savings for each tank = 333$ – 40,65$ = 292,35$.

Table (2) above explains the costs of the parts and savings for each part for two years 2013, 2014. The calculation of the realized savings for each part as follows:

$$\text{Realized savings for each part} = \text{Real cost of manufacturing new part} - \text{Total cost for used part.} \quad (1)$$

$$\text{Total cost for used parts} = \text{Cost of Discount} + \text{Cost of rehabilitation and transportation.} \quad (2)$$

$$\text{Cost of Discount} = \text{Real cost for manufacturing new part} \times \text{Discount percentage for used part.} \quad (3)$$

We can note from the results of Table 2, that the rate of savings was different in the different years, for the different industrial parts (which may be resulted by the different conditions of the items or the different processes they were in use etc.), nevertheless, the trends show the worth of reuse in money terms as well.

5. Conclusion

The complexities of our times and high competitiveness in business environment have significant impacts on the organizations in general and industrial organizations in particular. The business companies of the industrial sector shall face many requirements, rules and regulations in connection with environmental protection, which they must adapt into their present processes. In addition, they shall face the turbulent changes in the technology and also in the economic environment. Organizations – especially those who are working in industrial sector – are looking for the necessary and modern mechanisms in order to reduce their industrial costs. A rational planning of reuse of relevant industrial parts or devices used in the production process may help to keep the balance between the environmental requirements, technical-technological development and business success. These three pillars should be built into the planning of manufacturing processes of each industrial companies.

The results of our research give some insights into these aspects. Based on the experiences of an electric company in Iraq, our data analysis indicated that significant savings might be achieved through reusing of used parts. At the same time savings in time could be detected due to the necessary efforts and quick work, and, in addition, energy savings and savings of raw materials can also be detected. All these benefits will work to enhance sustainability and protection of environment.

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HUNGARY'S YOUNG, TECHNICALLY EDUCATED WORKFORCE ENGAGED IN WORKING ABROAD

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Abstract

This article is a demographic summary of a research database capturing the reasons that young Hungarians have left to work abroad, their typical age, target country, and their planned duration of overseas work. It is the preliminary product of the processing of research data collected over 4 years from interviews with more than 380 young Hungarians who are working, or have worked, overseas. In addition to demographic data, the research also captures the Hungarians' reasons for moving abroad, their environments, background, and the extent of their integration to the host country. Additionally, the interviews collected information about how prepared the person was when they started working abroad, if their language skills were adequate, if they obtained the job through a company or on their own, and if they were able to get jobs appropriate to their education and skills and match their expectations as engineers. The data are presented in a summarised, intermediate form, and will form the foundation of further research.

Keywords

work abroad, technical education, young work force, demographic summary

1. Introduction

This study draws on a database that is collected mainly by master's students studying social sciences and economics. Our duties are – as university lecturers and researchers – to pay attention to the labour market position of graduates and follow the evolution of their careers. Within the framework of the International Management course, students have therefore conducted structured interviews with those who attempted to work abroad. Our goal is to grant access to the Hungarian reality through the eyes of young people, particularly those with technical qualifications.

"What do they know of England, who only England know?" was Kipling's lament: that the country's neighbours knew and cared so little about their achievements, and obligations, in the wide world. Though it was asked in 1891 [1], Kipling's rhetorical question continues to be topical today.

2. Literature review

Hungarian labour market landscape

In the 1990s, following the transition shock, Hungary was one of the leading economies in Central and Eastern Europe. It had a high share of foreign direct investments, its economy was modernizing and there were favourable convergence trends (in terms of GDP per capita), all of which manifested itself in a relatively high standard of living and good economic prospects. This trend ground to a halt in the first half of the 2000s and the country's leading position gradually disappeared. The reasons were many and varied, but a high budget deficit and uncontrolled spending (which resulted in increasing public debt) were important elements [2].

According to the survey of Csehné Pap [3], the typical situation for graduates is that nine months after finishing vocational education, less than half of the young graduates were in work – neither holding a job, working as an entrepreneur, or self-employed. What can those young unemployed people do to find a job? If family background allows, they continue their studies either at a higher level or by pursuing a profession qualification, with which may then increase their chances of finding work. On average, more than a quarter of the graduates were engaged in further studies nine months after leaving secondary vocational education. According to the 2014 study of Pásztóy [4] the ambition to study further is more common among women than men.

There are, however, families that are unable or even unwilling to support further education; young graduates from this kind of background are simply unemployed. Youth unemployment is increasing and is high in international terms. The reasons for this are varied: primarily, the unemployment rate depends on the participation rate of the corresponding age group, which is connected to the proportion of those in school, the type of vocational school system (i.e. classroom or dual vocational training; how much practical and work experience those at school receive) and also the practice of students at school being employed part time. All these reasons combine to make activity among young people rather low in Hungary [5].

According to another survey, "when questioned about the knowledge obtained during their education - the interviewees judged themselves rather negatively. Less than half of the respondents/students felt that he/she adequately acquired the skills of the given trade. The tendency of undervaluation, mentioned often in the literature, can play a part in this, as well as the school experience, when one evaluates himself or herself on the basis of the marks received in school." [6].

Unemployment in the 15–24 age group is high. If, however, instead of examining the youth unemployment rate (relative to the active population), we look at the youth unemployment ratio (the number of unemployed young people as a percentage of the total youth population), the result is rather better. The Hungarian youth unemployment rate was 26.1 per cent in 2011, while the EU-27 average was 21.4 per cent (i.e. it is nearly 25% higher than average in Hungary). However, the youth unemployment ratio was around 6.5 per cent in Hungary, compared to 9.1 per cent in 2011 in the EU-27 – i.e. the Hungarian ratio is more than 30% lower than the EU average. Youth unemployment rates reflect the difficulties faced by those young people who are on the labour market [5].

Csehné Papp says in a 2014 study that the reason for high unemployment is the high proportion of respondents nominated for the "skilled workers" (48%) and "not proper approach to work" (42%). High values are obtained even the "inadequate training" (38%), the "infrastructure deficiencies" (35%), the "employer's attitude" (37%) and "inappropriate attitude to learning" (32%).

In the light of these data it is not surprising that young people try their luck abroad. But such journeys are not only undertaken by unemployed youth.

Competencies required for working internationally

The process of adjusting to a foreign culture is always a long road, and managing differences abroad requires the following skills:

- Interpersonal skills are most often the most important. They help to integrate the person into the social fabric of the host culture. They satisfy the needs for friendship and intimacy, but also facilitate the transfer of knowledge, and improve coordination and control.
- Linguistic ability: this helps to establish contact, indicates an eagerness to communicate and to connect with host nationals. However, it is often most effective to pick up bits of 'conversational currency' (local expressions, information, and interest) rather than speaking the entire language.
- Motivation to live abroad; expatriate should select themselves based on a genuine interest in other cultures and new experiences.
- Tolerance for uncertainty and ambiguity: action often has to be taken on the basis of insufficient, unreliable and/or conflicting information. Additionally, circumstances may change unexpectedly, and the behaviour and reactions of local people may be unpredictable. Expatriates should therefore be able to tolerate uncertainty and ambiguity. This often requires letting go of control and 'going with the flow' of the host culture.
- Patience and respect: this is necessary because different cultures have different rhythms and it takes time to understand the local way of doing things.
- Cultural empathy: this requires respecting behaviour, ideas, feelings, thoughts, and experience of others.
- Strong sense of self: this allows interaction with another person or culture without fear of losing one's own identity. This also enables the manager to be self-critical and open to feedback. It also reinforces the ability to handle stress.
- Sense of humour: humour is important on two levels: as a coping mechanism and for relationship building. It is seen as a way for managers to buffer frustration, uncertainty, and confusion [7].

Culture shock

Culture shock can often be a disturbing phenomenon, but it is not that sudden as the term 'shock' implies. In most cases it is the gradual decrease from positive to negative mood after the initial euphoria of arrival, and an actual crisis resulting from that. As it is also used to describe the entire adaptation process, the word 'shock' does not appear to fit too well. The disturbing impression does not always effect the own cultural concept. In some cases the experience of culture shock might even strengthen cultural identity, which is not the best approach either. The factors that cause culture shock are not really unwelcome, but they are foreign and different, and thus irritating. It is this irritation that is actually unwelcome [8].

Homesickness is an emotion for which prescriptions cannot be written in advance. It can only be prepared for in theory but when it arrives, it urgently requires a cure. These experiences can lead to depression.

The various psychological and physical symptoms of expatriatism are covered thoroughly in this work. Nevertheless, this does not mean that it is impossible to overcome these issues and become functioning again. Culture shock also varies largely in severity.

Some adapt more quickly while others need a longer time to get adjusted, but most people do overcome the crisis. Appropriate intercultural training and therefore intercultural competence helps a lot during the culture shock process, but unfortunately it cannot always be avoided. Altogether the assumption was not completely wrong. Culture Shock is a shock caused by being confronted with a different culture, but there is far more to the concept than that [8].

Experiencing a variety of symptoms and outcomes is a completely normal physical and psychological reaction to a foreign environment [9].

"It is a myth that experiencing Culture Shock is a weakness or a negative indication of future international success. Culture shock in all its diverse forms is completely normal and is part of a successful process of adaptation." [10].

"Culture shock is the best and maybe even the only means to experience and understand foreign cultures." [11].

The anxiety and stress related to the adaptation process are not intrinsically bad. The extent of adjustment does not depend on whether the negative symptoms of culture shock are experienced, but how they are coped with. In fact, they can have positive outcomes in the end, by serving as a hint that something is not right and therefore motivating thinking about how to adjust [12]

Culture shock serves as an indicator that there is something to explore about the foreign as well as the own culture [11].

In many cases, people move back because of the difficulties caused by culture shock. Who knows the correct answer for those questions: to go abroad or stay at home? Or to stay abroad or to return home?

3. Method

Data in this research was collected by students of Szent István University attending the International Management course. The students conducted structured interviews from which the data was collected, cleaned and coded to be used in SPSS software. In SPSS correlations, cross table analyses, frequencies and averages were examined.

4. Data summary

In the course of our culture shock research, a preliminary analysis of the data was created to summarise some commonalities between Hungarians who moved abroad. 43% of the participants of the survey were female and 56% male. Out of 180 respondents most of the people (82%) had a university degree at the time. The average age at the time of moving was 28.5 years (Figure 1).

The majority of people in the study tried their luck right or shortly after graduating from university, but most of them already had at least 2 years' work experience.

Out of those who left Hungary, 30% went to English-speaking countries and 24.5% to German-speaking countries. 73% of respondents moved within the European Economic Area, 9% moved to the USA and Canada, and 14% ventured to other parts of the world (Figure 2).

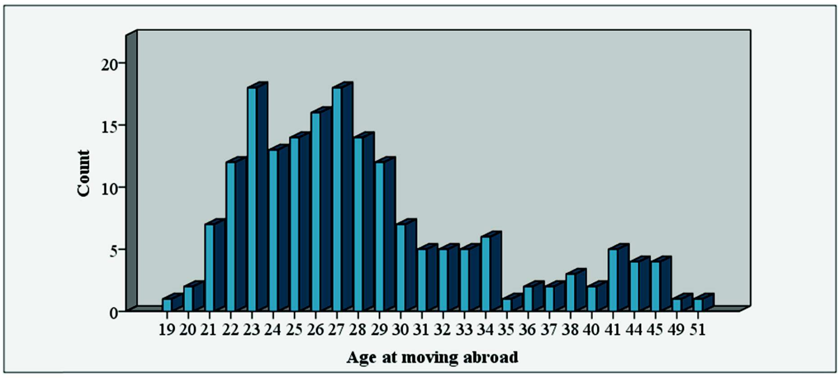

Figure 1. Age of moving abroad

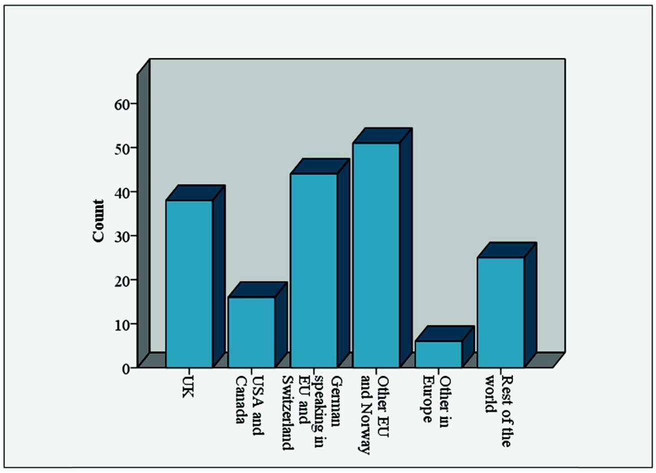

Figure 2. Countries to which Hungarians moved

When trying to start a new life abroad it is always an important factor if expatriates can do what they are best at: namely finding a job in their own profession. Finding the best job depends on many things. Applicants have to be better than others to get the job, so having a university degree and appropriate experience is always an asset, but speaking the accepted working language on a professional level is also essential, otherwise their performance will be hindered.

On average 79% found a job in their own field, but achieving that appears to be easier with a university degree, since 85% of graduates managed to do that compared to the 48% success of the people with only middle school education.

Having prior work experience mattered most in the question of getting a job in their own profession, since 89% with experience managed to achieve that compared to 58% who had no experience.

Generally, moving to a higher position while working abroad was very rare, which could be explained by the average short time spent abroad by the people questioned in the research. The average time spent abroad is 2.5 years but this includes people who have already lived and worked for more than 5 or even 10 years outside Hungary. Those who did step up in the hierarchy generally started very low and spent at least 4-5 years in the same company.

All the people in the survey had at least a basic knowledge of the working language of their chosen territory but most (86%) had at least good or excellent command of the language. The most typical working language was English at 74% followed by German at 35%. In several cases, more than one language was used at work.

Only 35% started looking for a job on their own; 65% of respondents were either recommended by someone already working at the company, or were hired with the help of a recruitment company; the remainder were sent overseas by the organisation they were already working for.

At the time of moving most of the people were single, not even in a casual relationship. Only 24% were married or living with someone. Out of the people who were married, 60% moved with their family.

Summary of people with a technical background

31% of survey participants had a technical profession, 87.5% of them accompanied by with a university degree. Out of those, 89% found a job in their chosen field. The gender ratio for this answer shifted compared to the total number asked: in this group 89% were male and only 11% female.

The selected countries for technical workers differed slightly to those selected by all respondents. Technical people tend to choose German speaking countries (37.5% compared to 24.5% when looking at all data), and 25% went to English speaking countries. 80% stayed in Europe, while 14% ventured to other parts of the world excluding the USA and Canada, where 5% found jobs.

Half of technical respondents already had some years of work experience at the time of moving, and were in the 25-29 age group. 98% of these got a job in the same or higher position than in Hungary, but promotion has not been common afterwards (Figure 3).

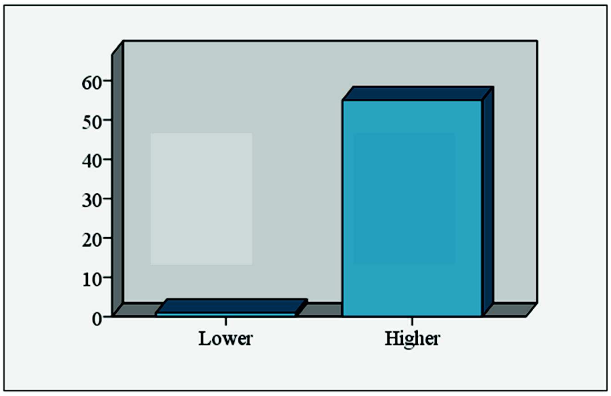

Figure 3. Are positions taken abroad higher or lower than in Hungary?

On average they spent 2.5 years abroad. Those with technical degrees achieved the highest position on average compared to people with economics, commerce or tourism degrees. Their knowledge of the working language was good: a mean of 4.23 on a 5-point scale (Figure 4).

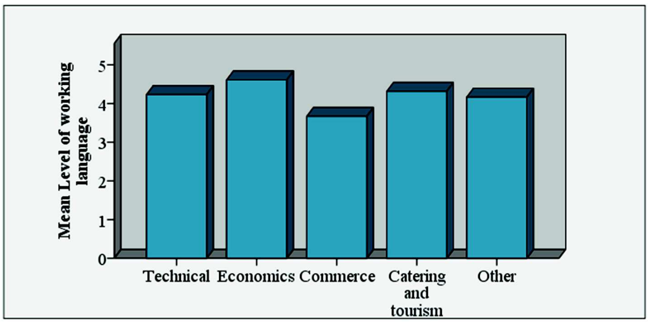

Figure 4. Language levels of people of different fields

Fewer people with technical backgrounds found jobs on their own: 27% compared to all respondents, of whom 66% were already working at the company who sent them abroad.

5. Conclusion

Young Hungarian people generally fare well abroad, especially those with a university degree. On average they spend at least 23 years in their chosen country, and get jobs in the same level as in Hungary or higher. They do not have significant problems communicating with colleagues in a different language. From the data examined, making the decision to move abroad has proved to be the right one, and most young expatriated Hungarians benefit from the experience gained from the adventure.

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EFFECTS OF IRRIGATION WITH TREATED DOMESTIC WASTEWATER ON VARIOUS CHEMICAL PROPERTIES OF THE SOIL

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Abstract

The present study aimed to investigate the impacts of irrigation using treated wastewater on various soil chemical properties. The research was conducted over three years by completely randomized design with three replications. Treated domestic wastewater, well water and mixtures of these waters were used in the experiment. Five different irrigation treatments were designed. According to the results of analysis, Na, K, Ca, Mg, Cl and SO4 in soil extracts increased very slightly, while HCO3 decreased slightly.

Keywords

domestic waste water, irrigation, water properties, soil extract properties

1. Introduction

Turkey is a country whose water resources are at risk from global warming. For this reason it is of the utmost importance that the country should use its water resources in an efficient way.

Turkey's average annual rainfall is 643 mm, which is equivalent to an annual average of 501 billion m^3. A large proportion of this water is lost to evaporation, evapotranspiration, or river flow, while an annual average of 7 billion m3 comes from neighboring countries [1].

Turkey produces 3.7 km^3/year of urban wastewater and 3.0 km3/year of industrial wastewater. However, these values do not show the full extent of Turkey's wastewater, and the small size of these values is somewhat influenced by a lack of data. Until today, not all urban waste water is fully treated and so cannot be released to the environment.

When wastewater has been used in irrigation, generally beneficial results have been obtained, such as solving the problem of water scarcity, disposing of large amounts of poor quality water with minimal environmental risk, providing an economic benefit with a content of plant nutrients, and enabling the clean water currently used in agriculture to be used elsewhere [2].

Along with global warming, the average annual precipitation in the research area in recent years, 537 mm, has been progressively declining, and in 2007 fell to 219 mm. Therefore, the use of wastewater in irrigation is increasing. The content and quality of wastewater are variable, and uncertainty concerning the effects of using this water on the soil and on plants is a concern. Wastewater is sometimes used directly for irrigation, and is sometimes first subjected to varying levels of treatment.

The present study aimed to investigate the impacts of irrigation using treated wastewater on various chemical properties of soil.

2. Material and method

The research was conducted in the Menemen Plain in the west of Turkey, on loamy and silt loam textured soils. The wastewater used in the study was taken from Menemen Biological Wastewater Treatment Plant, of which capacity is 21600 m3 per day. According to long-term climate data, the average total annual rainfall is 537 mm, evaporation is 1513 mm, and the average temperature is 17°C [3].

In the study, polyester tanks of dimensions 100 x 140 x 140 cm, open above and below, and with free drainage, were employed. These tanks were located in the soil to a depth of 120 cm so that 20 cm remained above the soil surface. In order to prevent the flow of water directly downwards from the inside of the tank, a 3 cm wide piece of PVC was added 40 cm downwards from the top of the tank on all sides. The soil inside the tanks was in an undisturbed natural state.

The research was conducted over three years by completely randomized design, with three replications. Treated domestic wastewater, well water and mixtures of these waters were used in the experiment. Five different irrigation treatments were designed. The treatments were as follows: 100% domestic treated wastewater (A), 25% well water with 75% domestic treated wastewater (B), 50% well water with 50% domestic treated wastewater (C), 75% well water with 25% domestic treated wastewater (D) and 100% well water (E).

The crops used in the study were cotton and vetch. The vetch was irrigated once in March, and the cotton four times not including pre-irrigation. 105 mm of water was given at each irrigation [4].

Before each irrigation water samples were taken, and analyses were made of COD, BOD, NO3-N, total N, total P, TSS, EC, pH, B and soluble ions. Also, counts of total and fecal coliform bacteria in irrigation water were made for water from treatment works and for well water.

Soil samples were taken twice a year after the vetch and cotton harvests from a soil profile at a depth of 0-120 cm from layers whose profiles had been defined. These samples were analyzed (in me/l) for Na, K, Ca, Mg, Cl, HCO_3 and SO_4 ions in soil extract.

The evaluation of the results obtained was achieved with the help of the guidelines of FAO 29 [5], FAO 47 [6], the USEPA guide [7] on the reuse of water, the WHO guide [8] on the microbiological quality of wastewater reused in agriculture, and from Turkey, AATTUT "Technical Procedure Notice on Wastewater Treatment Facilities" (Official Gazette, dated 20.03.2010 and numbered 27527).

Graphs and tables were used in the evaluation of the physical and chemical characteristics of irrigation water quality and soil extract characteristics.

3. Results and discussion

Characteristics of Irrigation Water

Analyses were made before each irrigation of the treated wastewater used in the study, the well water used as a control, and the various mixtures of these, and the three-year averages of the results are shown in Table 1.

Table 1. Three-year averages of various chemical characteristics of the irrigation waters

Irrigation water quality parameters	Treatments				
	A	B	C	D	E
pH	7.8	7.7	7.8	7.8	7.7
EC (dS/m)	1.69	1.42	1.22	0.95	0.61
SAR	6.4	5.3	4.5	3.6	1.9
Bor (mg/l)	0.68	0.59	0.49	0.42	0.26
Na (me/l)	9.3	7.2	5.8	4.1	1.9
K (me/l)	0.5	0.4	0.3	0.3	0.2
Ca (me/l)	4.4	3.9	3.5	3.0	2.1
Mg (me/l)	5.4	4.4	4.0	3.0	2.1
HCO_3 (me/l)	8.6	7.4	6.9	6.0	4.5
Cl (me/l)	8.4	6.6	5.3	3.6	1.6
SO_4 (me/l)	2.6	1.9	1.4	0.8	0.4
COD (mg/l)	49	40	33	29	22
BOD (mg/l)	27	22	18	16	12
Total Suspended Solids (mg/l)	10	7	5	4	3
NO_3-N (mg/l)	14	11	10	7	5
Total P (mg/l)	2.6	2.0	1.5	0.9	0.2
Total N (mg/l)	38	30	23	21	15
Total coliform (CFU/100ml)	$2.4*10^5$	-	-	-	$8.6*10^2$
Fecal coliform (CFU/100ml)	$5.9*10^3$	-	-	-	$4.4*10^1$

The pH values of the waters used in the study did not differ greatly between experimental treatments. In terms of three-year general average values, these waters were within the limits set by AATTUT and FAO 47, and caused no problems.

When the irrigation treatments were evaluated according to AATTUT and FAO 47, it was concluded that well water (0.61 dS/m) would not cause a problem with regard to electrical conductivity, but that the other waters (0.95-1.69 dS/m) would cause problems at a medium level. With regard to boron, no restriction was found for use in irrigation for any of the treatments. Treatment E, with 1.9 me/l of Na, could be used without problems in surface and sprinkler irrigation, but treatment A, with 9.3 me/l of Na, could cause serious problems when used in surface irrigation. The other treatments, with Na contents varying between 4.1 and 7.2 me/l, could cause medium problems when used for surface or sprinkler irrigation. In terms of HCO_3 content, treatment A, with 8.6 me/l of HCO_3, could cause serious problems when used for irrigation, while the other treatments could cause medium problems. With regard to Cl content, treatment E could be used without problems in surface and sprinkler irrigation, as could treatment D in surface irrigation, while the other treatments could be used in surface and sprinkler irrigation with medium-level problems. In terms of NO_3-N content, treatment E, with 5 mg/l of NO_3-N, was in class I which would not cause problems, but treatment A, with 14 mg/l of NO3-N, was in class III which could cause medium problems.

It was found that although the amount of Mg in treatment A could cause serious problems when used in irrigation according to FAO 29, there would be no problems in the other treatments.

Examining BOD5 values in the pollution parameters according to AATTUT and USEPA (the US Environmental Protection Agency), it was found that treated wastewater could only be used in crops which were to be processed and in the surface irrigation of orchards and vines. In treatment A, the COD value was 49 mg/l and the TSS value was 10 mg/l; in treatment E these values were 22 mg/l and 3 mg/l respectively; thus both treatments were in class I.

According to AATTUT and USEPA, treated wastewater cannot be used because of the fecal coliform count, and well water can only be used in crops which are to be processed and in the irrigation of trees and vines. According to the WHO (WHO, 1989), well water can be used in the irrigation of grains and fields or plantations of industrial crops, but is not to be used in the irrigation of crops which are consumed raw, parks which are open to the public, or sports fields.

The amount of soluble cations and anions in the soil extract

At the beginning of the experiment, after the harvest of each crop and at the end of the experiment, soil samples were taken from layers on which pedon description had been performed. The content (me/l) of Na, K, Ca, Mg, HCO_3, Cl, and SO4 of the extract of these soils samples was determined, and graphs were drawn of the temporal variations in the soil layers.

Figure 1 shows the temporal variation in Na contents by soil layer. An increasing trend was seen in Na values throughout the experiment in all irrigation treatments and all soil layers. The increase was greatest in treatment A, and varied according to the proportion of treated waste water in the irrigation water of the treatments. However, this increase was not continuous, and while there was an increase in the 0-28, 28-43, 43-67 and 0-120 cm soil layers in samples taken at the cotton harvest, there was a decrease in samples taken in those layers after the harvest of vetch, grown as a winter crop. In the 67-86 and 86-120 cm layers, increases after the cotton harvest and decreases in samples taken after the vetch harvest were irregular.

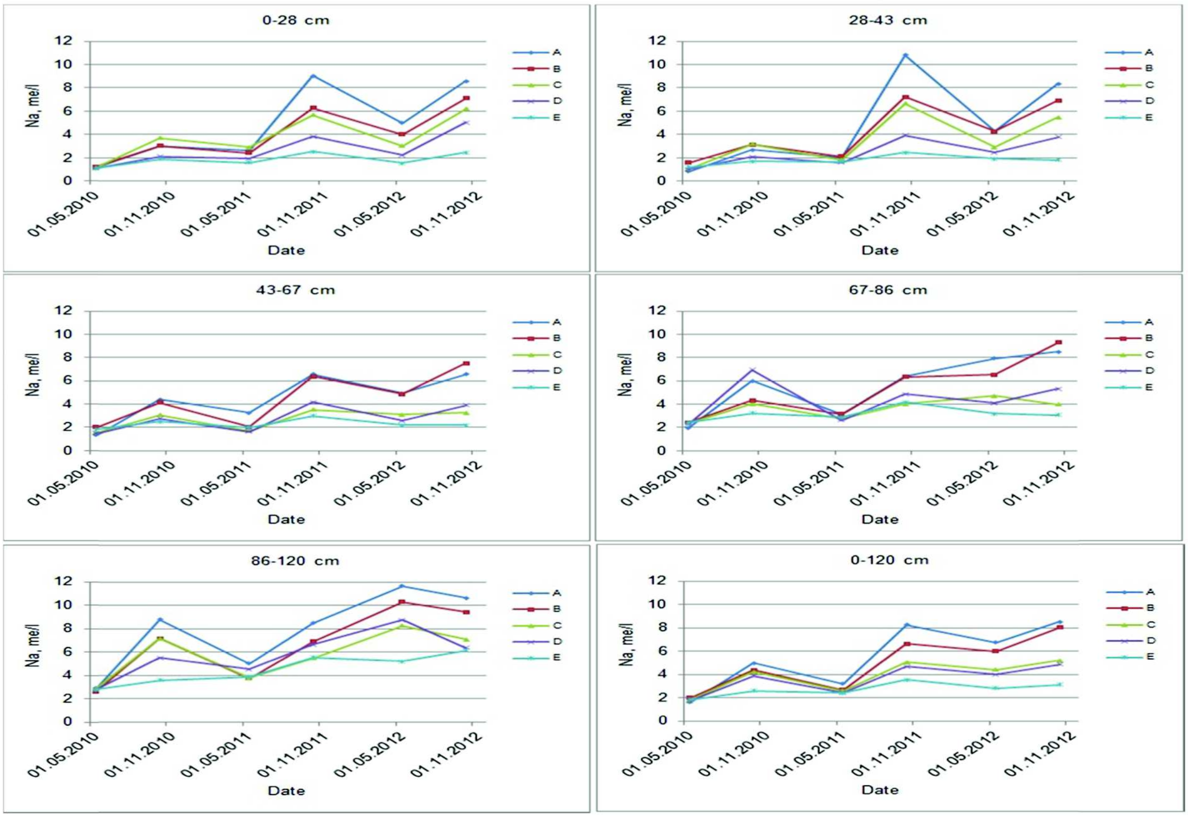

Figure 1. Temporal variation in the Na value of experimental soil extract by research treatments and soil layers

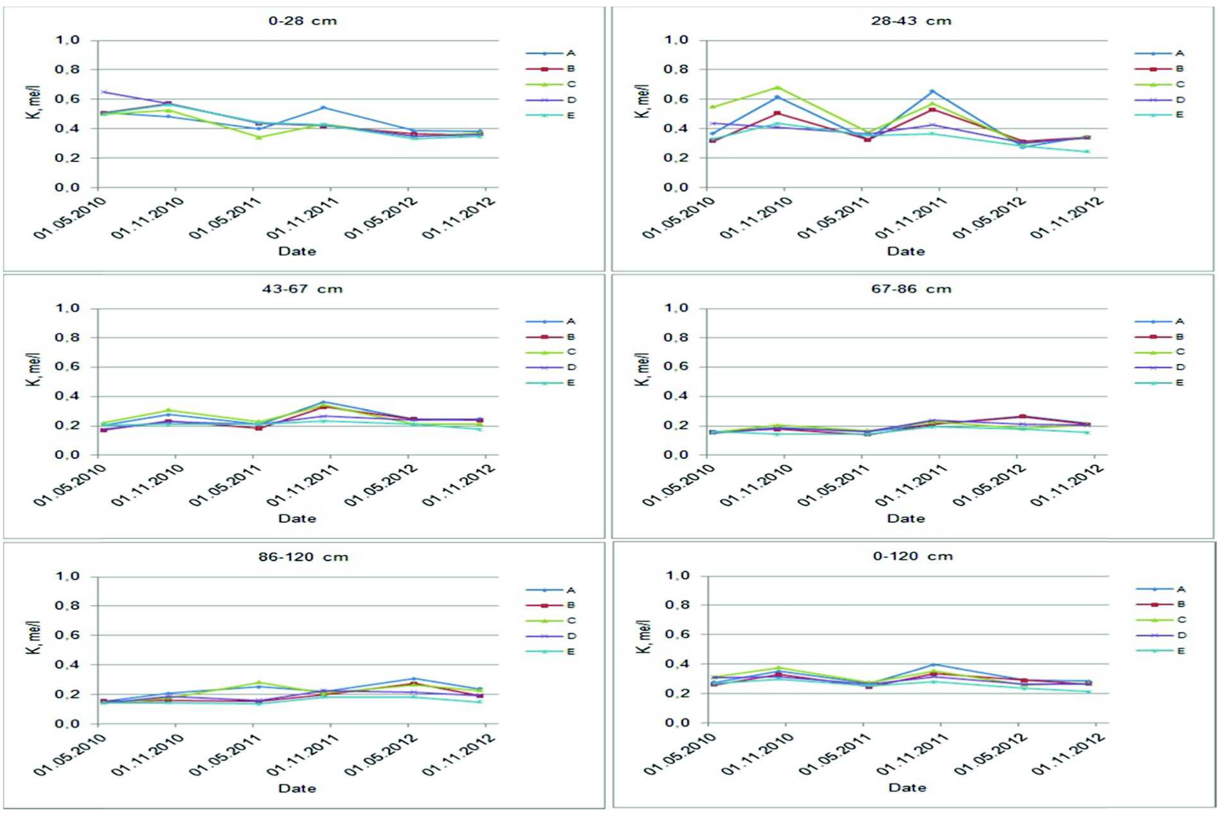

Figure 2. Temporal variation in the K value of experimental soil extract by research treatments and soil layers

Figure 2 shows the temporal variations in content of the element potassium (K, me/l) in the soil extract from the experimental soils by soil layers. An examination of the figure shows that in the 0-28 and 28-43 cm soil layers there was a decreasing trend from 0.5 me/l to 0.35 me/l over the course of the experiment in all irrigation treatments. However this decrease was not continuous in the 28-43 cm soil layer, and there was an increase in the samples taken at the cotton harvest, and a decrease in the samples taken after the harvest of vetch grown as a winter crop. In other soil layers, levels remained unchanged at 0.2 me/l throughout the experiment.

Figure 3 shows the temporal variation of the element calcium (Ca, me/l) in the soil extract from the experimental soils by soil layer. An examination of the figure shows that there was no great variation in calcium values throughout the experiment in the 0-28 cm soil layer of all the treatments. In the 28-43 cm and 43-67 cm layers however there was an increase in samples taken at the cotton harvest and a reduction in samples taken after the harvest of vetch, which was grown as a winter crop. In the 28-43 cm and 43-67 cm soil layers, the amount of calcium, which was approximately 2 me/l at the beginning of the experiment, varied at the end of the experiment from 1.5 to 4.0 me/l according to the proportions of wastewater used in the irrigation treatments. In the 86-120 cm soil layer, the amount of calcium was approximately 1.0 me/l, and at the end of the experiment it varied between 1.0 and 3.0 me/l according to the proportion of wastewater used in the irrigation treatments.

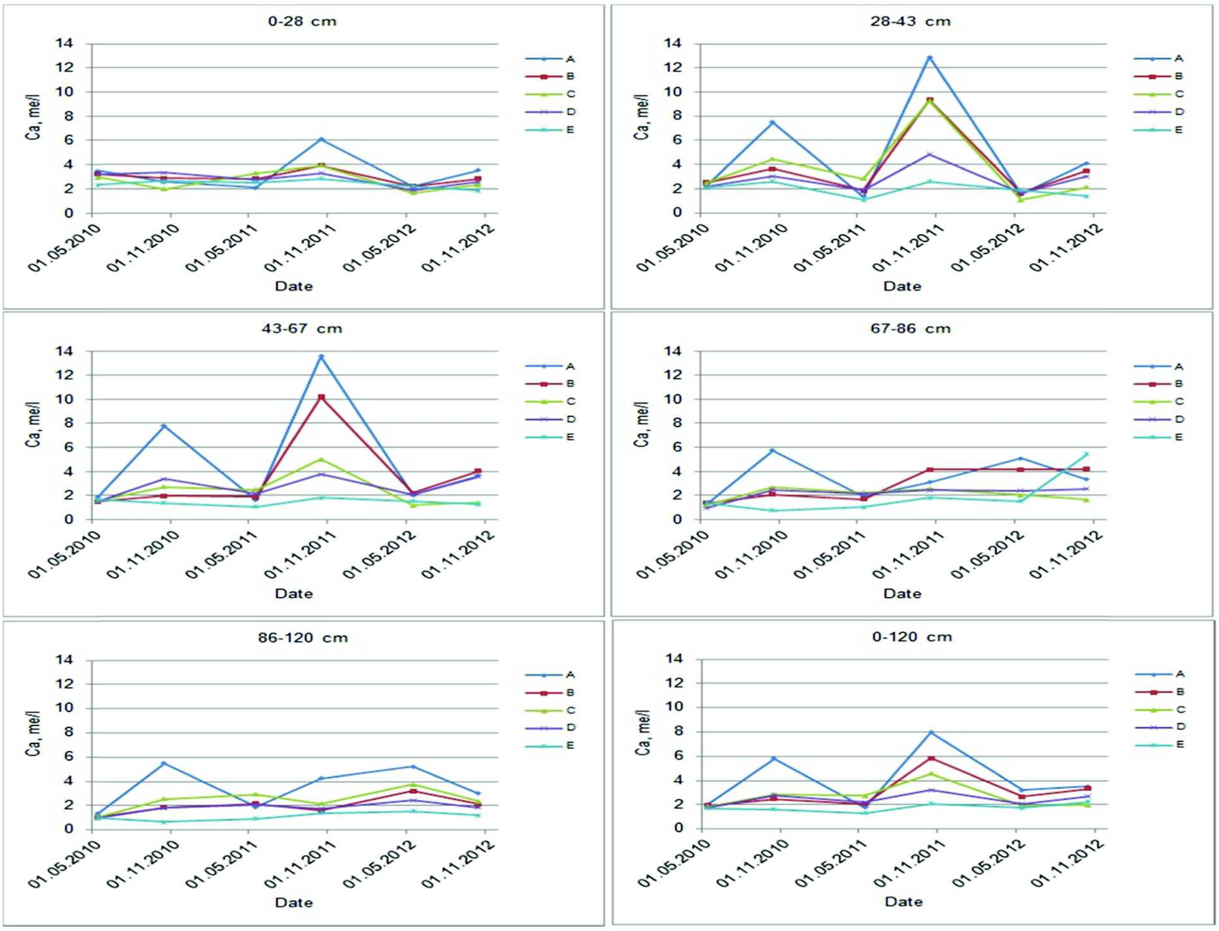

Figure 3. Temporal variation in the Ca value of experimental soil extract by research treatments and soil layers

Figure 4 shows the temporal variation in magnesium content (Mg, me/l) in the soil extract from the experimental soils by soil layers. An examination of the figure shows an increasing trend in magnesium values throughout the experiment in all soil layers of all irrigation treatments. Increases in magnesium were greatest in treatment A, and varied in relation to the proportion of wastewater used in the irrigation treatments. However, this increase was not constant, and while there was an increase in the 0-28, 28-43, 43-67 and 0-120 cm soil layers in samples taken at the cotton harvest, there was a decrease in samples taken after the harvest of vetch grown as a winter crop. In samples taken after the vetch harvest in 2012, there was an increase in Mg values in the 67-86 cm and 86-120 cm soil layers, in contrast to a decrease in the other soil layers.

Figure 5 shows the temporal variation in the HCO_3 content (me/l) of the soil extract from the experimental soils by soil layers. In all soil layers and all irrigation treatments a decreasing trend in HCO_3 values was observed throughout the experiment. This decrease averaged 5.1-3.4 me/l in the 0-28 cm soil layer, 4.3-2.5 me/l in the 28-43 cm layer, and 3.6-2.3 me/l in the 43-67 and 67-86 cm layers.

Figure 6 shows the temporal variation in chlorine content (Cl, me/l) in the soil extract from the experimental soils by soil layers. An examination of the figure shows an increasing trend in chlorine values throughout the experiment in all irrigation treatments and all soil layers. Increases in chlorine were greatest in treatment A, and varied in relation to the proportion of wastewater used in the irrigation treatments. However, this increase was not constant, and while there was an increase in the 0-28, 28-43, 43-67 and 0-120 cm soil layers in samples taken at the cotton harvest, there was a decrease in samples taken after the harvest of vetch grown as a winter crop. In samples taken after

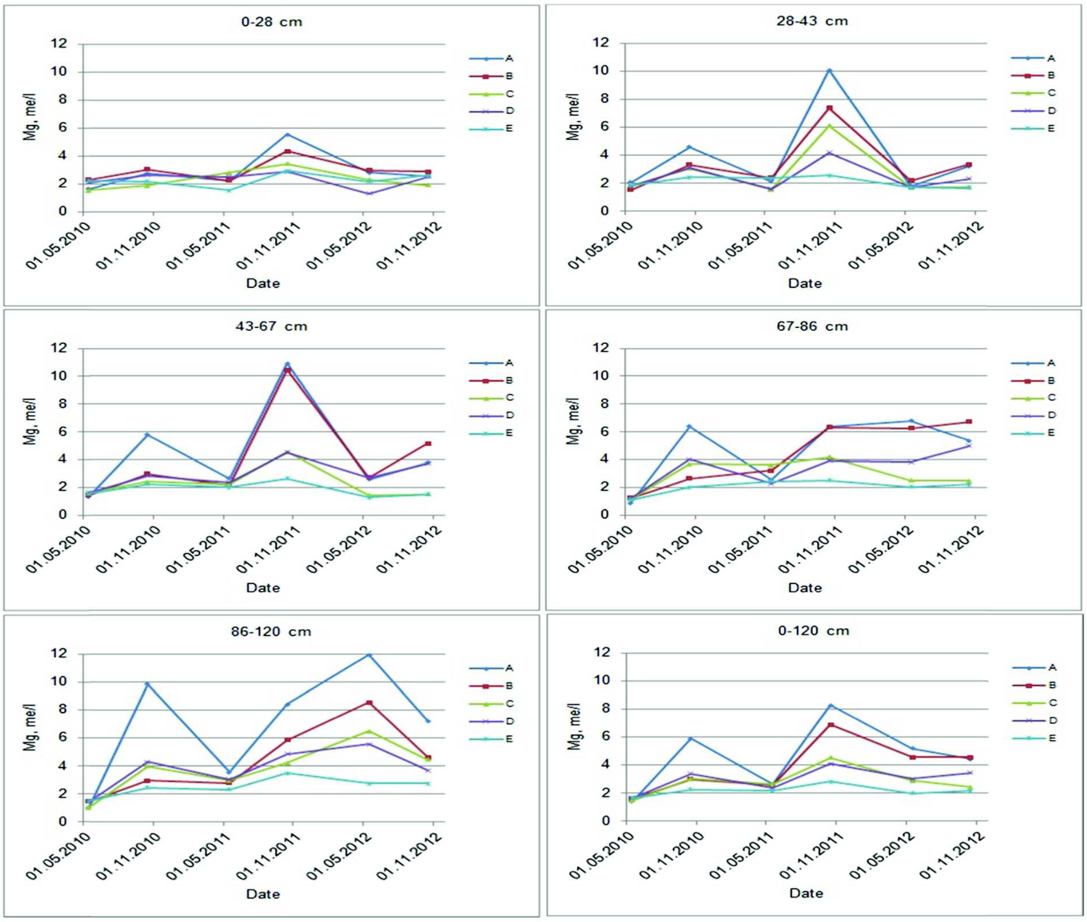

Figure 4. Temporal variation in the Mg value of experimental soil extract by research treatments and soil layers

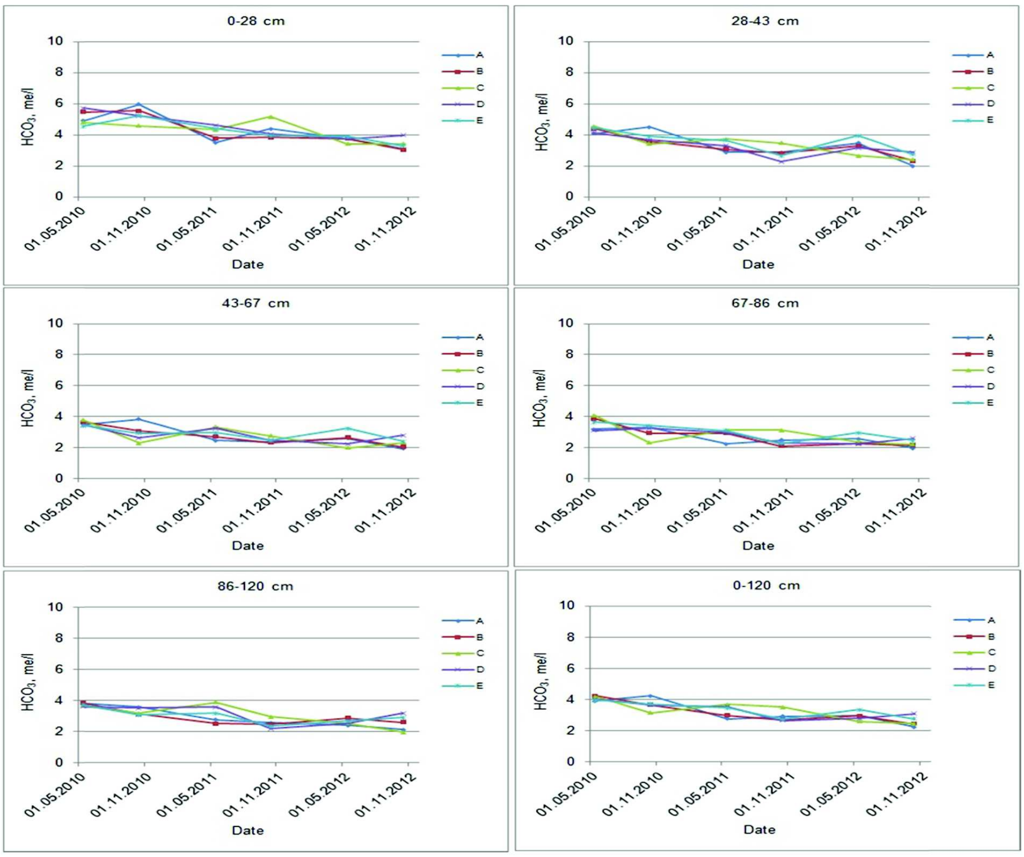

Figure 5. Temporal variation in the HCO3 value of experimental soil extract by research treatments and soil layers

the vetch harvest in 2012, there was an increase in Cl values in the 67-86 cm and 86-120 cm soil layers, in contrast to a decrease in the other soil layers.

Figure 7 shows temporal variations in SO_4 content in the soil extract from the experimental soils by soil layer. An examination of the figure shows that SO_4 values showed an increasing tendency throughout the experiment in all irrigation treatments and all soil layers. This increase in SO_4 values was greatest in treatment A, and varied according to the proportion of wastewater used in irrigation. However, the increase varied irregularly by soil layers.

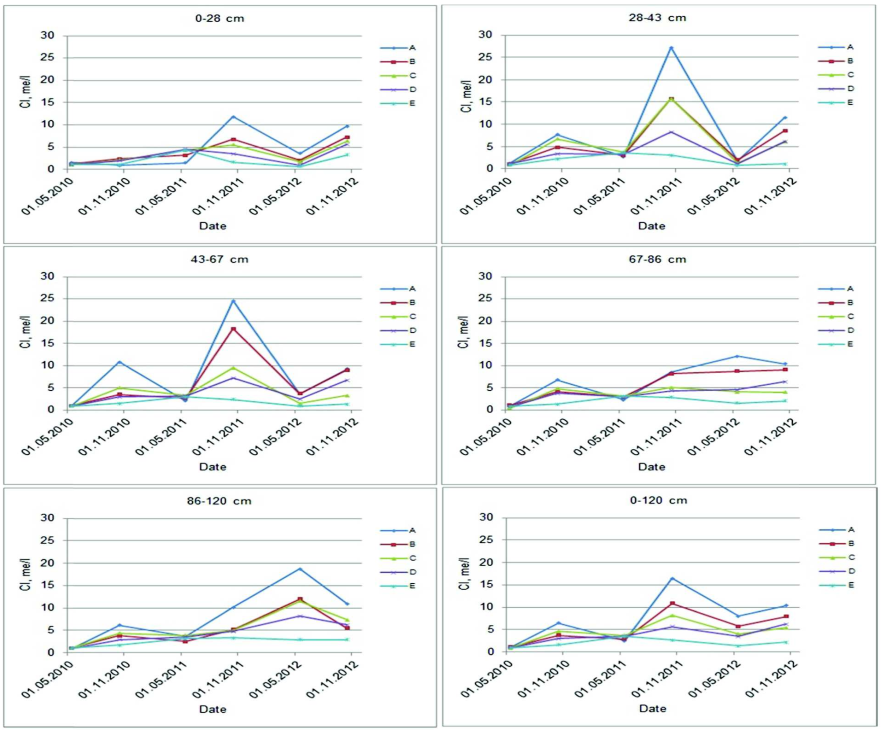

Figure 6. Temporal variation in the Cl value of experimental soil extract by research treatments and soil layers

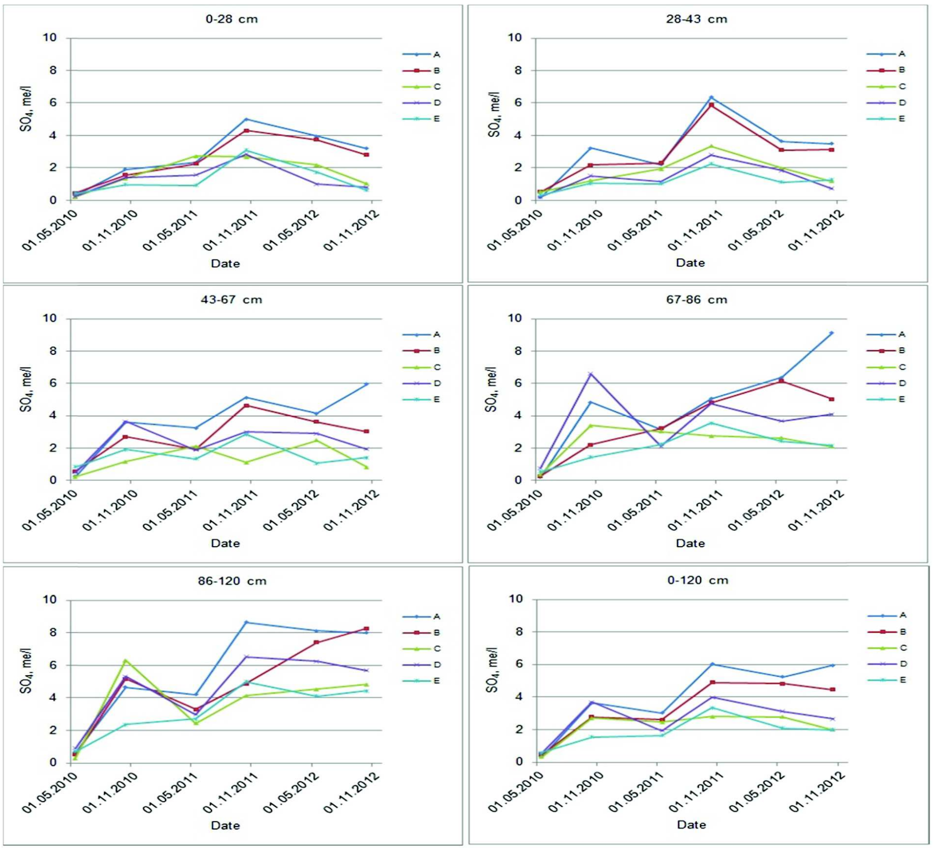

Figure 7. Temporal variation in the SO_4 value of experimental soil extract by research treatments and soil layers

4. Conclusion

This study was conducted with the aim of determining the effect of treated urban wastewater on various chemical characteristics of the soil. In accordance with this aim, extracts were prepared from soil samples and these were analyzed. The results showed that Na, Mg, Cl and SO4 values generally showed an increase compared with the beginning of the experiment in all treatments and in all soil layers, while HCO3 values showed a decrease. K values fell compared with the beginning of the experiment in the first two layers of all irrigation treatments, but generally did not change in the other layers. Ca values generally showed no change compared with the beginning of the experiment in the first layer of all irrigation treatments, but in other layers increased slightly.

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METHOD FOR MEASURING FRUIT FAILURE CAUSED BY DIFFERENT MECHANICAL LOADS

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Abstract

There are different limit values of mechanical effects causing bruise or failure of fruits during the variety of processes: the allowable drop height (fruit harvesting), the static load of fruit column at storage bin, or maximal vibration acceleration while transporting. To reproduce each forces from manipulation, different measuring devices have to be employed. Using the DyMaTest instrument, we can analyze the failure mechanism of fruits producing various load-functions: constant, linear or cyclic waveforms. With a developed measuring method, we have the opportunity to determine the fruit's failure parameters, and compare the deformation graphs using different compressive loads.

Keywords

material testing, fruit processing, bruise investigation

1. Introduction

When mechanical injury remain undetected, the quality of the product decreases, and in some cases, this leads to the spoilage of the fruit, which can infect other crops in the storage bin. If the injured horticultural product can be recognized, we can remove it from the process. For this purpose, there are several effective image and thermal processing methods developed (e.g. discriminate bruised and non-bruised apples with visual and near-infrared spectroscopy [1] or detecting early-bruises using hyperspectral data and thermal imaging [2]). The damage often appears inside the fruit texture (e.g. enzyme browning inside apples and pears – [3] or hidden bruise on kiwi fruits [4]), the spectral investigation is also adaptable for this occurrence. These methods are able to spot the damaged fruits effectively, but if we want to reduce the losses, the mechanical injuries must be prevented. For this reason, the processing environment and the manipulating equipment must be designed properly (e.g. determine the optimal depth of hamper during transportation [5] or designing appropriate displacement components for tree-shaker systems [6]). Therefore, it is essential to reproduce the mechanical effects of manipulation in laboratory conditions.

Biological yield occurs, when the mechanical stress is step over the allowable limit value, and a tissue failure appears. This also means the destruction of fruit. The mechanical loads are very often come about repeatedly (e.g. during transport). Exposing the product to a periodic mechanical effect, the fruit texture is getting fatigued, and the biological yield point can be reached sooner. Loading the product with such an effect, the deformation is also periodic [7]. Besides the magnitude, the frequency of mechanical load also have a major role in emerging bruises.

Beyond the non-destructive examinations (e.g. vibration tests for determine stiffness factor [8, 9]), destructive techniques must be applied for study the failure mechanism of biological materials. Many measuring equipments developed to produce different mechanical loads. There are quasi-static compression devices like the Magness-Taylor hand-held penetrometer and the MGA-109 electronic penetrometer for off-laboratory field measurements, or the precision penetrometer for laboratory investigations [10]. To produce dynamic effects, impact tests can be executed, or we can use laboratory devices to create dynamic or cyclic force, loading the crop surface with a measuring pin. For our study, we using a computer-controlled compressive testing instrument called DyMaTest [11]. Applying this instrument, the effects of static, dynamic and periodic loads on fruits can be investigated.

2. Methods and materials

Most of the conventional material testing devices generating static load or low-rate deformation, the oscillatory instruments produce only periodic loads. Our instrument has all these abilities. Besides the linear load, DyMaTest can produce sinusoidal, saw-tooth and square signs in single or multiple sweep mode. Deformation can be measured with a laser sensor, the measurement data collected and displayed by a computer. The fruit sample placed into a sand bed during the examinations. The measuring circuit and the scheme of the measuring set-up are shown at Figure 1.

For most of our tested fruits or tubercular roots, approximately 10 N of compressive force needed during measurements. For rheological tests, the commonly used Ø 4 mm, 5 mm and 6 mm loading pins are available for the device. The technical specifications of DyMaTest instrument can be seen at Table 1.

With the PC measuring system, the force set-up and data acquisition can be executed in calibration and data handling (saving and loading) modes. The results of measurements can be seen immediately with the software's graphic chart (e.g. force-time, deformation-time and force-deformation functions), and the saved data can be exported and processed with other software.

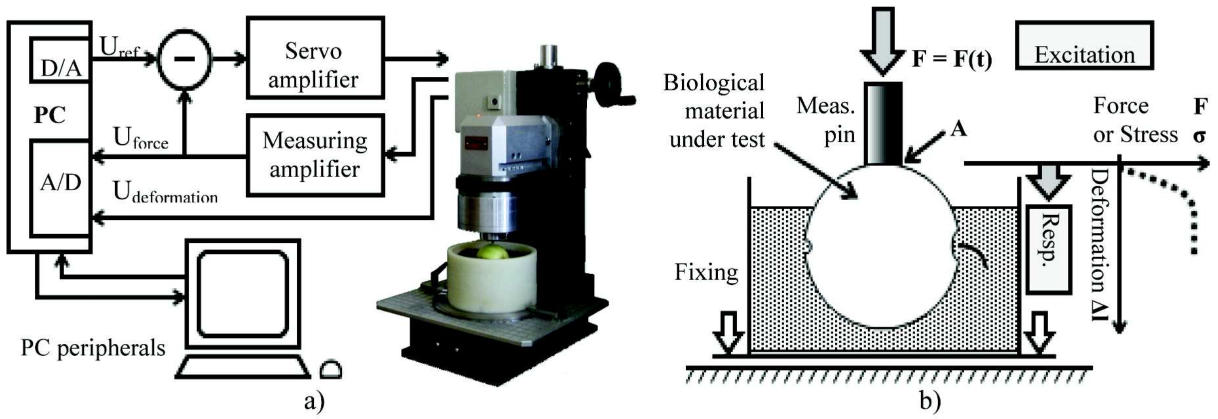

Figure 1. a) Measuring circuit, b) scheme of the measuring set-up [11]

Table 1. DyMaTest specifications

Max. compressive load	15 N
Force transducer	Low-mass special strain gage force transducer
Load	Single or periodic function
Force-time functions of the load	Constant load, linear up/down load, sinusoidal load, square-wave load
Deformation range	Max.10 mm

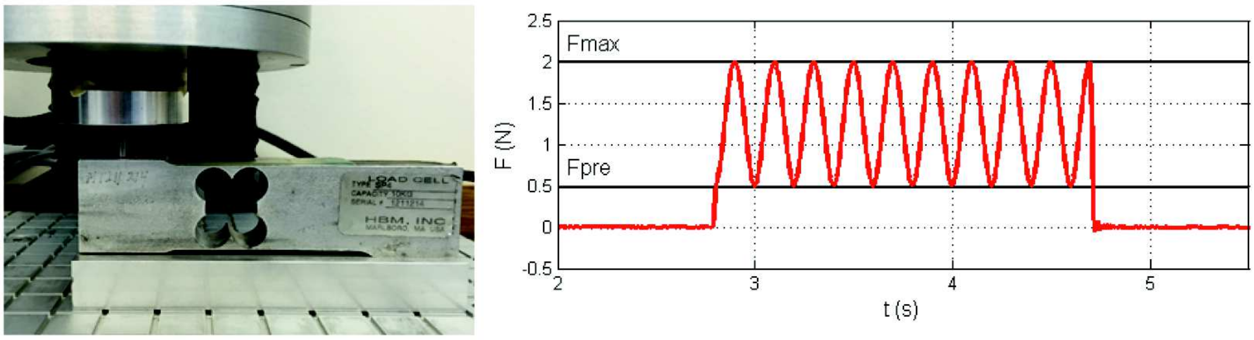

Figure 2. Adjusted periodic compressive load measured with HBM load cell

To provide the same contact circumstances on each examined fruit sample, there is an adjustable preload setting placed in the PC software's user interface. The periodic graph in Figure 2. is showing the relation between the compressive load (Fmax – set to 2 N) and the preload value (Fpre – set to 0,5 N), measured with a HBM SP4 type 100 N load cell.

3. Results and discussion

Our tests implemented in pears with different load functions, the results can be seen at Figure 3. The adjusted force-time functions marked with dashed line, the fruit texture's deformation indicated with solid line. Generally, we study the examined fruit's deformation-time function in our thesis.

Using a developed method, the "failure point" of the tested fruit (e.g. the graph endings placed the "bruise during test" column at Figure 3) can be defined. A deformation graph of an examined pear exposed to periodic load is shown at Figure 4. The periodic load has a constant amplitude, but the resulting deformation has a non-constant amplitude and time varying average. The enveloping or the average curves have a similar character to the creeping caused by a constant load, therefore, we can call this phenomenon to dynamic creeping [12].

Two different parts can be separated here. At the starting point of the second section (from point A - the phase of failure), the fruit texture is getting softened, and a fracture is beginning on the tissue. The end of the curve (point B) is showing, that the peel is teared through, and a permanent deformation occurring. The failure point can be defined between the two parts of the exponential regression curve (A), or at the breaking point of the peel (B - which is the ending of the deformation graph). The point between the two sections is more difficult to determine, because the failure probability has to be examined by studying the fruit spoilage process.

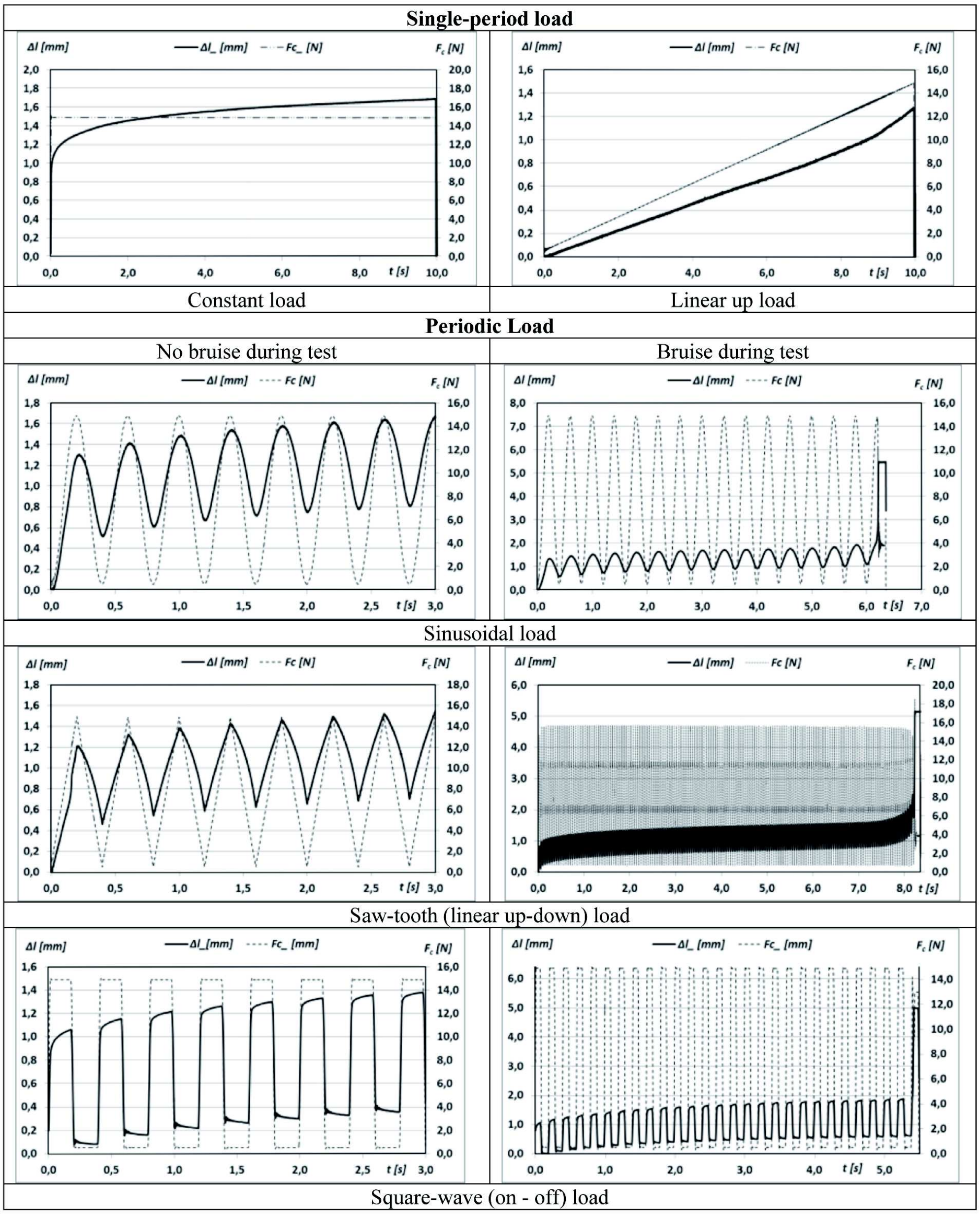

Figure 3. Deformation of pear texture measured with different compressive loads [11]

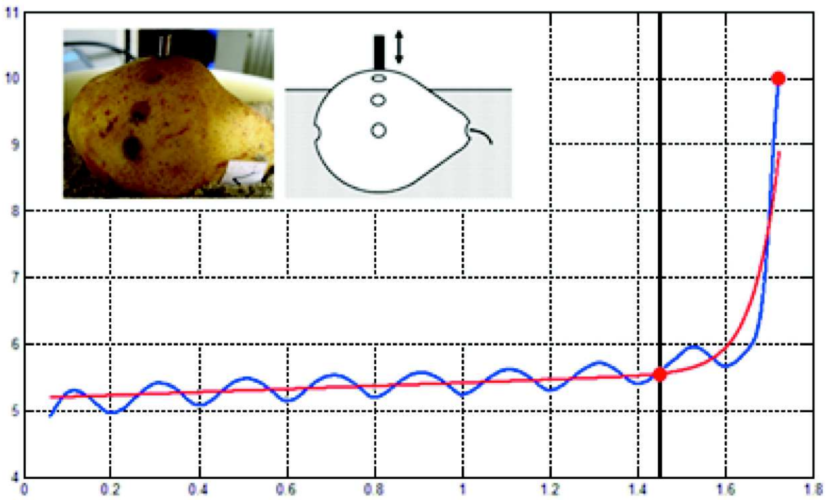

Figure 4. Dynamic creeping caused by periodic load

4. Conclusions

Beyond the static examinations, we are able to study the dynamic viscoelastic properties of fruit materials or plastics with our measuring system. Using cyclic mechanical loads, the fatigue phenomenon of biological materials can be investigated. With the resulted deformation functions, elements for a rheological model can be determined. We are also able to examine the damage susceptibility of specific fruits, influenced by different parameters of compressive load forces (e.g. frequency or wave-form). A more complex factor-analysis can be made, if we take in consideration other fruit properties, such as storage temperature, ripening status (related to moisture content) or spectral data. If we have a more accurate history of mechanical impacts effecting the crop (e.g. using a measuring fruit), we can reproduce the force values with generating stochastic loads.

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POSSIBLE CLIMATE FRIENDLY INNOVATION WAYS AND TECHNICAL SOLUTIONS IN THE AGRICULTURAL SECTOR FOR 2030

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Abstract

Agriculture became the focus of the European Union's climate policy, and can be said to one of the most contradictory of the newly regulated sectors (constructed environment, transportation, waste management). This sector is responsible for the highest amount of emission regarding the two most dangerous greenhouse gases (N_2O, CH_4), which have a very high amount of carbon dioxide equivalent. The regulation topics of agriculture are an important question in the EU, and have been since a long time ago, from both an environmental, and an economical perspective. This is due to the post-WW2 Joint Agriculture Policy's main agricultural goals (foodstuff safety, and ensuring that safe food is acquirable) force decision makers to take a protectionist position, if this sector is involved. This is due to the fact that the actors of the sector reason how reining the budget in also makes it harder for them to complete the goals, in case any action is planned. Technically, even the sector's division into sub-sectors isn't final, since no definite action was taken to either include or exclude the LULUCF (Land Use, Land Use Change and Forestry) sector. The goal of our research is to define low-carbon (material- and cost-effective) development paths using the assumed future trends of the Hungarian agriculture, which may aid the sector in achieving the climate policy goals it was given.

Keywords

low-carbon agriculture, climate policy, GHG reduction, renewable energy, energy efficiency

1. Introduction

The climate policy of the European Union shows agriculture as an individual sector to be one of the most contradictory sectors [1]. The first hardship is the actors themselves, who have to be regulated somehow, as they appear as a harder-to-count target audience than the industrial units which were regulated before. This is due to the dominant presence of the private sector, which makes it harder to divide emission resources. Even though this problem plagues many other sectors as well, which were included in the EU climate policy's interests after 2012, similarly to agriculture, taking regulatory actions is the hardest for agriculture [2]. Agriculture became an important part of the global European thinking's interests, when the foodstuff safety, and securing safe food became one of the most fundamental factors of the Joint Agricultural Policy, which grew to one of the main political priorities of the continent. Ever since then, economy professionals knew that the competitiveness of the sector is having problems due to the artificial regulations of today, which originates from the protectionist handling around it [3]. This behaviour makes it hard to advocate regulations from a climate policy perspective. Since any regulatory actions result in the sector's stakeholders arguing how they would be constricted in aiming to fulfil the objectives mentioned before [4].

Another important element is the uncertainty around the LULUCF (Land Use, Land Use Change and Forestry) sector, which further complicates the already complicated topic. It's important to note about the LULUCF sector that it has a significant GHG (greenhouse gas) capturing share [5], which lowers the CO2 balance of various countries. However, it's not under the jurisdiction of agriculture's regulation policy. This mainly appears as a disadvantage for countries like Ireland, where most of the emission results from this sector [6]. Nowadays, these countries have the main objective of reasoning for the inclusion of LULUCF, but decision makers still refuse to accept it. The reason for this is that introducing the system might cause countries with a high agricultural GHG emission to invest in cheap forestation projects instead of development projects which would yield more in-depth innovation and significant emission rate decreases [7, 8]. If we take a look at how Hungary fares, the situation is not as complicated as for global European processes. Many professionals think that our country is at the front in the race for completing GHG reduction goals, and the most significant threat is the unused potentials causing deadweight [9]. After all, agriculture is not only an energy consumer, but an energy producer as well [10], which may not only cause it to be self-sufficient, but also serve as a supplier for other sectors [11]. Though Hungary has a bio-ethanol production significant even in the EU, most of it is exported, and other methods of energy production (f.e. biogas) are still not taken advantage of [12]. The above mentioned facts therefore makes the goal of our research to evaluate possibilities of climate friendly development for the next program timeframe in the European Union after 2020, and to determine technology-development paths which we find to be the best.

2. Material and methods

Due to climate policy goals, and the many faces of the sector we analysed, we chose to base our evaluation on the benchmarking method. Benchmarking in essence is a level-comparison method, which uses a specifically created indicator system that makes it possible for us to compare a sector's state both in space and time [13]. We primarily employ a mechanism which also evaluates future developments based on the condition system tailored for the present state of affairs. The reason for choosing this methodology is that benchmarking is an analysis which can be shaped at will, and tailored specifically to analysis goals [14, 15]. Our analysis concluded this according to the cornerstones of the European Union's climate policy, taking the development processes of Hungary's agriculture which are currently underway into consideration. Our analysis aspects were the following:

– shares of renewable energy resources in the sector,
– level of energy-efficiency, and opportunities to raise it,
– aspects of decreasing CO_2 or GHG emission rates.

It's widely known that the EU values are defined according to the criteria listed for both 2020 and 2030, therefore, we mainly concentrated on how successfully will Hungary be able to achieve these values. Finally, as this analysis evaluates the opportunities of agricultural low-carbon developments, we were careful in making sure that all indicators define the technological side of the analysis aspects. This can be seen in Tables 1, 2 and 3.

Table 1. Indicator group 1 of the agriculture sector's benchmarking analysis
Abbreviations: "RS1, 2, 3" - state indicators of renewable energy's shares by dimension; "RP1, 2, 3" - performance indicators of renewable energy's shares by dimension

Code	State indicators	Code	Performance indicators (and how they were formed)
ASPECTS OF RENEWABLE ENERGY SHARE			
RS1	Specific analysis and general attributes of used energy mix	RP1	Change in usage of non-renewable energy sources, increase or decrease of fossilised energy sources used in the sector between 2020 and 2030
RS2	Standard of attributes for producing renewable energy	RP2	Development of energy plant's evolution
RS3	Level and attributes of using renewable energy sources	RP3	Possibilities of using renewable energy sources in the sector

Table 2. Indicator group 2 of the agriculture sector's benchmarking analysis
Abbreviations: "ES1, 2, 3" - state indicators of the energy efficiency aspect by dimension; "EP1, 2, 3" - performance indicators of the energy efficiency aspect by dimension

Code	State indicators	Code	Performance indicators (and how they were formed)
ASPECTS OF INCREASING ENERGY EFFICIENCY			
ES1	Share of electric energy usage compared to other sectors	EP1	Share of electric energy usage of the total energy needed
ES2	Amount of consumption limited by ETS sectors	EP2	Usage of electric energy
ES3	Opportunity and level/amount of cleantech implementation	EP3	Growth potential of energy from manure

Table 3. Indicator group 3 of the agriculture sector's benchmarking analysis
Abbreviations: "CS1, 2, 3" - state indicators of the CO2 decrease aspect by dimension; "CP1, 2, 3" - performance indicators of the CO2 decrease aspect by dimension

Code	State indicators	Code	Performance indicators (and how they were formed)
ASPECTS OF DECREASING CO_2 EMISSION LEVELS			
CS1	Intensity of GHG emission by technology	CP1	GHG emission levels by evaluation of available technological solutions
CS2	Possibility of introducing low-carbon technologies in the sector	CP2	Share of bio-ethanol in the usage of bio-fuels
CS3	Composition and volume index of typical GHGs	CP3	Decrease potential of CO_2 share in all GHG emission

As Table 1 clearly shows, our indicators were further sorted to two aspects, state and performance indicator groups. The former signifies a starting point, the knowledge of which is required for an overall analysis of the agriculture. The latter is an indicator based on the former, which makes it possible to measure the static state indicator element, which can be used to determine the way and amount of changes in the system. However, for forecasts in 2030, we had to create an analysis basis, which could be used to relate the assumed state. This is what we designated the year 2020 for, which is the program timeframe's end date for the current European Union program. Therefore, the indicators above were defined for 2020 using the currently known basis of 2010 via a calculation, and after defining the 2010-2020 interval, we were capable of evaluating the 2020-2030 interval.

Evaluating the indicators listed was required to determine the external effects (non-marketed influencing factors) in the sector.

Climate policy interpretation of externalities

During our analysis, external effects aren't interpreted as classic economy does in literature sources [16, 17], but instead are used to evaluate all positive or negative factors, which may have an effect on the future changes, engineering development of agriculture, but are excluded from decisions [18]. As for analyses which are used to evaluate the appearance of externalities, those are used to localise market errors, the contradictions of development paths, and other factors which may aid or impair the development of the system. During the evaluation of various indicators, we followed a simple principle - how the given element influences the sector in its goal to reach climate policy results. This is how all 3-3 indicators of each group were assigned a value of (-2), (-1), (0), (1), or (2), where negative numbers represent under-performance, while positive numbers represent over-performance. 0 is the optimal operation of the system (best practice), and any difference compared to this value means externalities are amassed by the system. In case this shows a positive change, the system doesn't operate at maximum efficiency, since it holds potential not taken advantage of. And in case there are overall negative externalities present, we can say the system's framework is fundamentally wrong, which has to be changed before any kind of development actions are taken [19, 20].

3. Results

Based on what we've written in the methodological introduction, we summarised our research results in Table 4. We followed 3 guidelines when summarising externalities. Guideline "A" (amount of net positive externalities) required us to mathematically summarise positive and negative externalities, which is how we were able to get the net positive values. Guideline "B" was interesting due to the total amount of externalities (positive and negative alike) present in the system, which is why their absolute values were summarised. The most important guideline was "C", where we checked how much the share of net positive externalities (A) is in total externalities (B). Therefore, if the former already produces a negative value, "C" also became 0%.

Table 4. Evaluation of the agriculture sector's benchmark analysis
Explanation - A: Net positive externality ∑ (1;3): the amount of positive externalities within various aspects in 2020 nd 2030, if there are no concrete climate policy developments outside of BAU; B: total externality ABS ∑ (1;3): the amount of all externalities in absolute value; C: the share of net positive external effects in the total external effect in percentage, which shows the dimension of possibility for developing for the analysis' focus sector.

Number	**ASPECTS OF RENEWABLE ENERGY SHARE**		**ASPECTS OF INCREASING ENERGY EFFICIENCY**		**ASPECTS OF DECREASING CO_2 EMISSION LEVELS**	
	2010/2020	**2020/2030**	**2010/2020**	**2020/2030**	**2010/2020**	**2020/2030**
1	-1	0	-1	0	-1	-1
2	2	1	-1	0	1	2
3	1	2	1	2	2	2
A: Net positive externality ∑ (1;3)	**2**	**3**	**-1**	**2**	**2**	**3**
B: Total externality ABS (1;3)	**4**	**3**	**3**	**2**	**4**	**5**
C: Net positive externality's share in total externality	**50%**	**100%**	**0%**	**100%**	**50%**	**66%**

Now, let us see how the structure of externality amassment changed between analysed intervals. Illustration 1 already shows the final state in 2030, where the mass of positive externalities shows unused potentials. This isn't a shock, seeing how decision makers tend to do their business, as it's been widely known for a while that agriculture has enough energy production possibilities not only for itself, but for other sectors as well [21]. However, we should also use Table 4 to understand what processes concluded in the sector to reach this state. We can see that the aspects of renewable energy share and CO_2 emission decrease have positive externality masses already, meaning the system doesn't operate efficiently even now. Therefore, it's no surprise that not properly making use of low-carbon technological solutions causes the wrong framework of raising energy efficiency, which makes this the only negative externality amassing aspect until 2020, according to the analysis. The changes seen in the technological dimension of the sector therefore point to the need for spreading low GHG emission technological solutions to realise an optimal agricultural sector from a climate policy perspective, not only in the long-, but also the short-term.

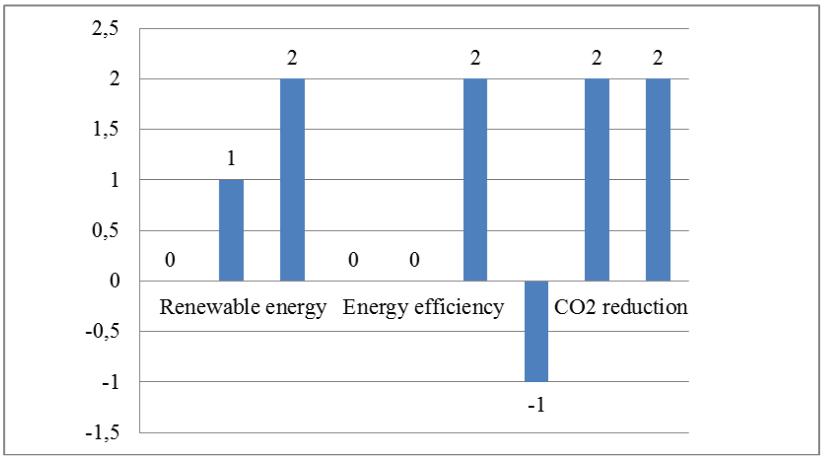

Figure 1. The number of externalities in 2030 regarding technological development

4. Conclusion

The goal of our analyses was to understand what level of influence technological development solutions have, or may have in the agriculture sector's, as a sector under climate policy regulation, endeavours in reaching long-term goals. Basically, we began from the hypothesis that the agriculture is a sector with an energy production potential that can support not only itself, but other related sectors with environment-friendly green energy. The analysis' results showed that our previous statement held true, since not properly used opportunities represented by positive externalities were concentrated within the agricultural system. This operation, not even close to efficiency leads to the fact that apart from energy efficiency, GHG emission decrease, which is the main goal of climate policy doesn't get enough of a role either. This fact may pose a serious problem long-term (until 2030, or 2050) not only for our country, but for the EU as well, for two reasons. One would be that it doesn't help with balancing the performance of sectors where basically negative operations can be seen, and even then, we need a high amount of costs to reach an advantageous GHG emission value. Another would be that currently unused potentials always cause an emergency, since if their investments are neglected today, we can't know what price tag they will have tomorrow. The reasons we listed, and the research results show that it's highly advised to begin the low-carbon, intensive development of the sector, as quickly as possible. The main goal of the climate-friendly developments may be the realisation of the energy self-sufficient program of the agricultural system based on energy-efficient agricultural methods, since it has a relatively low GHG emission prevention cost, 60-80% less compared to other sectors. The climate friendly development of agriculture may continue with agriculture entering the energy supply market after leaving the self-sufficient level, but this requires the energy resource produced to be competitive in trade. This may only become a proper alternative with extremely high (100-130 USD for a Brent of oil) fossilised energy resource prices, and stable consumption trends, according to currently available information.

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Faculty of Mechanical Engineering

EVALUATION OF BIOCHAR LIFECYCLE PROCESSES AND RELATED LIFECYCLE ASSESSMENTS

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Abstract

In the case of lifecycle analyses, pyrolysis biochar systems have all integrated treatment and usage systems for any products resulting from the carbonisation of biomass. These systems require biomass ingredients as an input material source, which is a fuel available in many forms, f.e. forestry by-products, sewage waste, animal manure, etc. These materials are put into the pyrolysis process, where the produced biochar (active coal) is fed into the soil, where the circulation of the coal restarts. The biochar system is a complex system which requires multiple components and details to be taken into consideration to allow for a proper lifecycle assessment, in order to make the proper decisions.

Keywords

biochar, lifecycle assessment, pyrolysis, biomass,

1. Introduction

Environment protection and environment-friendly production is becoming a central element of our lives nowadays. The need for methods which reduce the effects produced and consumed products may possibly have on the environment, and which try to prevent these effects is on the rise. One of the most widely used special process of these methods is the lifecycle assessment, or lifecycle analysis (LCA).

During the lifecycle assessment, various environmental factors and potential environmental effects are unearthed, and are evaluated for various products and services from the cradle to the grave. Conducting a lifecycle assessment provides the opportunity to examine the entire life of the product. The usage of resources, and the effects endangering human health and ecological balance are some of the evaluated areas.
The lifecycle assessment may help in:

- understanding the opportunities of improving the various products' environmental factors, at the various different stages of the product's lifecycle,
- decision-making for the industrial sector, the government, and the non-governmental organisations (strategic planning, defining priorities, process planning),
- choosing the appropriate indicators and methods for environmental performance.

Our study aimed to compare LCA-s related to producing biochar using pyrolysis, during which we evaluated the 'best practices' which our current literature describes. According to the definition of Lehman et al. [1], biochar is the fine-grain material produced during the relatively low-temperature thermo-chemical disintegration of biomass, which has low oxygen content, high carbon content, and is porous. Manyá [2] describe it as the charcoal used for environment protection and agriculture.

Biochar is a very versatile, natural material which has many advantageous biological and chemical attributes. It improves the composition of soil, and decreases the GHG emission of the soil due to its physical attributes [3].

2. Discussion

ISO 14040:2006 standard for lifecycle

Both in Hungary and internationally, the usage of the ISO 14040:2006 standard [4] is the most widespread, and most accommodated nowadays. The standard defines the main routes and parameters of conducting a lifecycle assessment and registry, using which we can construct the properly detailed and quality analysis and evaluation of various products or services.

The MSZ EN ISO 14040 standard series related to evaluating the lifecycle lists all the goals, tools, and processes used to identify environmental factors and effects related to the various products, using the lifecycle evaluation. This international standard describes the basics and boundaries of conducting a lifecycle evaluation study, and a report of its findings, and lists some requirements as well.

The lifecycle assessment has four different phases:

1. Phase of designating the goals of the LCA, and the areas of the evaluation
2. Phase of the lifecycle registry
3. Effect analysis
4. Interpretation

The actual topic of the lifecycle assessment, the pre-determined boundaries, and the level of detail we wish to conduct the analysis is usually dependent on the goals we wish to achieve, and the usage of the results we achieved during the research. Depending on the goals, the depth of various lifecycle assessments may vary.

The lifecycle registry is the second phase of the analysis, during which we register the input materials entering the system, and the output materials leaving it.

During the effect analysis phase, we conduct the evaluation of the input and output energies' environmental effects, and the final phase is the interpretation and recording of the results yielded by the evaluation phases. In this final phase, we summarise and evaluate the relations and data unearthed during the lifecycle assessment, using which we define advisory remarks, draw final conclusions in accordance with the LCA goals, and aid the process of decision-making.

The lifecycle assessment has to include the boundaries of the goals and topics, the lifecycle registry evaluation, the effect analysis, and the evaluation of the results achieved, according to Figure 1.

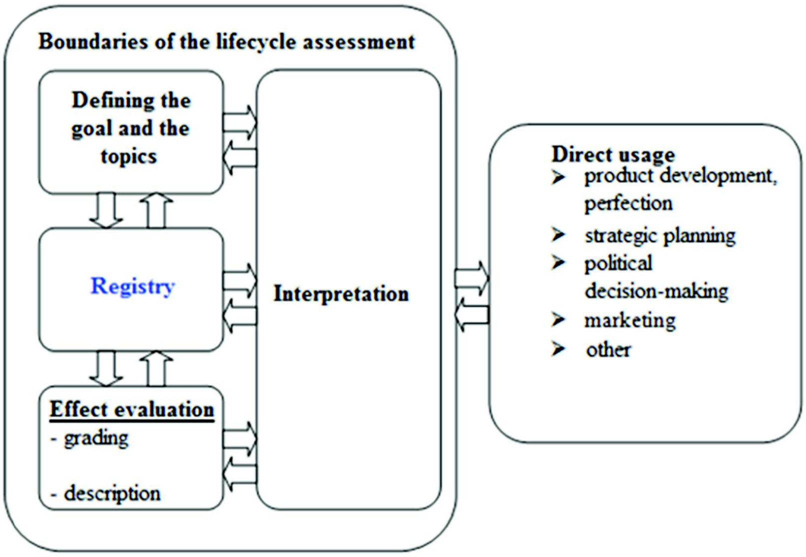

Figure 1. Boundaries of the LCA

ISO 14040 standard

The context and boundaries of the assessment is defined during the definition of goals and topics phase. Defining the unity of functions is also important, since the results of the assessment won't cover that (f.e. 1 kWh, 1 ton of biochar). Every material- and energy flow must be present in the registry phase. The input and output flows have to be precisely defined for all steps of the LCA. These may be products, base materials, in-between products, or emissions.

Quality of data

During conducting LCAs, the condition systems related to the quality criteria of data has to be handled especially carefully. In the case of biochar projects, one of the most significant problem is the bad availability of data required for lifecycle assessments. Since biochar projects don't exactly have a long history, only some reliable data sources are at hand, f.e. related to special biochar production units, and the usage of biochar. Missing values are usually filled in by estimations, or collecting data from literature.

Biochar LCAs in international literature

Multiple biochar LCAs are in the various literature sources, but these may differ significantly. Most of them are introduced in this study, but the simplest LCA model can be seen on Figure 2.

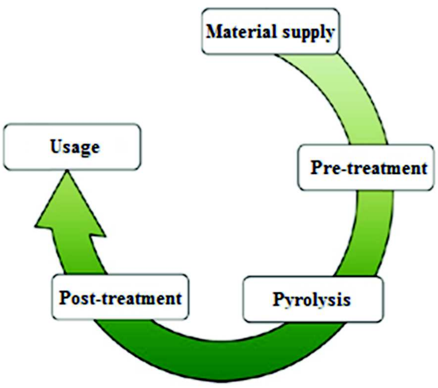

Figure 2. Basic diagram of biochar lifecycle [5]

Currently, due to the availability of data, the most problematic steps of the biochar LCA are usage and pyrolysis.

Two more significant complete LCA analyses were published specifically for biochar production, but both yielded substantially different results. These are the Gaunt and Lehmann [6], and the McCarl assessments.

Gaunt and Lehmann compared the slow pyrolysis biochar process to the slow pyrolysis process optimised for energy production. Their results were that slow pyrolysis optimised for biochar output, and feeding the biochar into the soil yields twice-thrice as much carbon efficiency, when compared to pyrolysis optimised for energy production. They conducted a limited economic analysis as well, which concluded with a 47 USD of biochar price needed to compensate for the missing profits compared to the version optimised for energy production. Their LCA also includes various uncertainty factors, like the specific parameter system of the pyrolysis process, and that the assumed outputs aren't at hand during the assessment, or that there are no data available. Bruce McCarl evaluated the economic condition system of biochar production in more detail, and analysed two big pyrolysis machines, both of which have an annual capacity of 70.000 tonnes. They analysed slow pyrolysis used for energy production, and fast pyrolysis using corn remains as basic material, optimised for energy production. McCarl and company included several steps in the lifecycle assessment, and relied on more conservative estimations in case an uncertainty in data came up [7].

Dutta and Raghwan [8] conducted their research in 2014, during which they highlighted the significance of LCA used for estimating the total GHG emission and the economic implementation possibilities during the complete lifecycle of biochar systems. Their analysis was conducted along optimised pyrolysis parameters for agricultural wastes, corn remains and forestry by-products. Their analysis yielded the results that both corn remains and forestry by-products avoided GHG emission. In our case, the stabilised carbon content of biochar significantly aided emission rate decrease. They constructed their lifecycle assessment as follows (Figure 3).

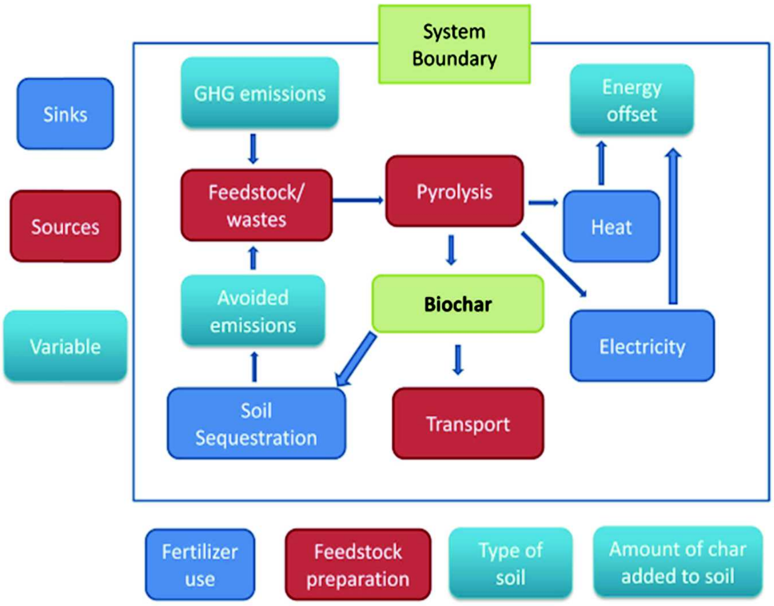

Figure 3. Biochar LCA flow diagram [8]

Biochar systems can also use biomass source materials as input material, or as an energy source [9].

The source of these can be:

- Cellulose-based biomass (timber chips, splinters, tree bark)
- Sewage waste
- Forestry biomass
- Paper production facilities' sludge
- Animal manure

Biochar producting process, the pyrolisys

Pyrolysis is a thermo-chemical disintegration process, during which we convert organic materials into carbon-rich solid products in a no-oxygen environment [10]. When biomass enters the pyrolysis process, biochar and energy are the results. We differentiate between two different types of the process - these are the low-temperature and high-temperature pyrolysis processes. In the case of the former - as its name also suggests - we work on a high temperature (around 500 °C) short gas treatment. In this case, we usually need materials produced from small molecules, and we need to devise a system where the gas can immediately released after the solid product is formed. And in case of the low-temperature pyrolysis, we differentiate between processes producing traditional charcoal, and other, more modern processes. However, the basic characteristics are also determined in this case, according to which the end product is procured on lower temperatures (around 400 °C), and with a longer gas treatment [9]. Though the goal is - again - to produce charcoal, we can also see end products of liquid and gaseous nature as outputs of the procedure. Our research however requires more modern - meaning the end of the 20'th century - processes, since biochar can only be produced using these methods. The process needs a horizontal furnace reminiscent of a pipe, which are further aided by drum furnaces and rotating furnaces in shaping the biomass. The latter were included in the system for the goal of the pyrolysis treatment of the biomass, beyond traditional charcoal production. This aspect has to be stressed because even though processes specialising in these products were in use since quite a while, the method specialising in biochar hasn't gained widespread acclaim in the business world up to now [11]. All in all, though pyrolysis is only one of the technologies producing energy from biomass [12], it differs from other alternative systems producing energy (from biomass), as biochar, a material rich in carbon is also yielded from the pyrolysis process (Figure 4).

In Lehmann's model, bio-energy is also being produced in the form of synthetic gases and bio-oils, apart from biochar, and these can be properly exploited in the following energy production processes. The bio-energy, which is a by-product of the pyrolysis process, similarly to biochar, also offers the opportunity of producing environmentally friendly energy. The technological potential may cause the production to be carbon-negative, which means that each produced or consumed unit of energy may cause GHGs to be removed/grounded from the atmosphere.

Bess-Ouko [13] also got results on sustainable biochar production similar to Lehmann (Figure 5).

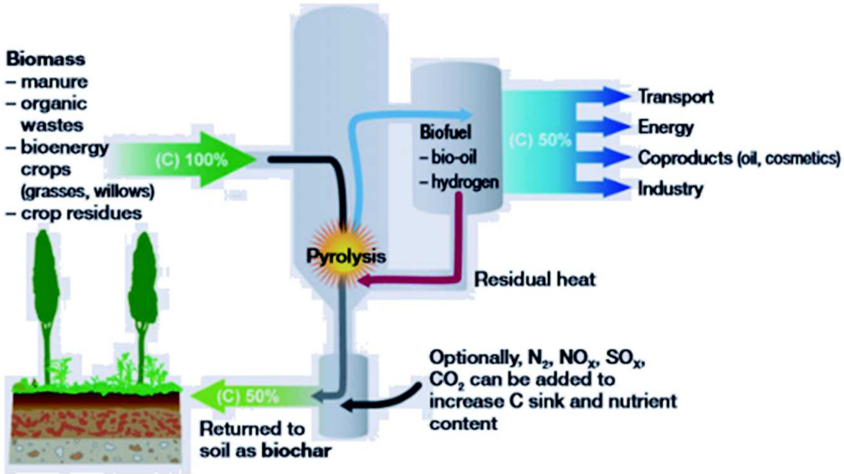

Figure 4. Model of producing biochar using low-temperature pyrolysis process [9]

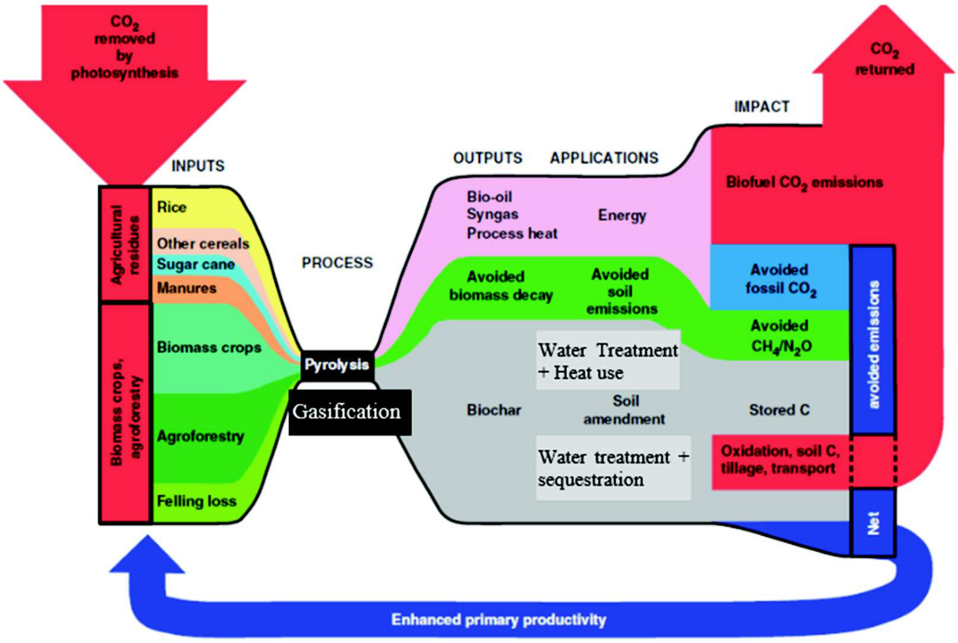

Figure 5. Concept of sustainable biochar production [6, 13]

From the perspective of GHG emission, the process of pyrolysis during biochar production is exceptionally important. The biochar production process has the advantages of carbon grounding, energy production, improving the quality of soil, and waste management. All products resulting from the carbonisation of biomass, f.e. biochar, carbon-monoxide, and bio-oils can be used in following processes.

3. Conclusion

International literature has LCA studies related to biochar, which can be used sufficiently, but can't be adapted as are to domestic biochar plants. Most LCAs base on the ISO 14040 standard as a starting point, but approach the process of biochar production from different perspectives, which is due to the multiple technological solutions and possible input materials. Our study introduced various LCAs, which may serve as a starting point for a facility's specifically tailored LCA, but all cases require the limitation of system elements related to the assessment in order to reach precise results (f.e. in what depth do we want to conduct the LCA in). Various software solutions can be used (Umberto, GaBi, CMLCA), which may aid in the lifecycle assessment. When we create the LCAs related to biochar, we have to take various basic factors into consideration, like the technological solutions at hand, the logistics processes, by-products, processes of handling intermediary products, if we need to introduce a specific pyrolysis unit during the assessment, and if we work with sufficient aggregated values, etc. We might want to introduce a supplementary footprint-calculation method into the analysis, f.e. water footprint, or carbon footprint methodologies. According to the sustainable agricultural methods, we have to offer sufficient development and usage space for biochar in the future.

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