A world alimentation chance estimate based on protein production of crop species

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Abstract: Food is any substance consumed to provide nutritional support for the body. It is usually of plant or animal origin, and contains essential nutrients, such as carbohydrates, fats, proteins, vitamins and minerals. The substance is ingested by an organism and assimilated by the organism's cells in an effort to produce energy, maintain life, or stimulate growth. Food security means to provide food for anyone, recognizing the „right to an adequate standard of living, including adequate food", as well as the „fundamental right to be free from hunger".

The present paper provides information upon the results of research focusing on the protein production of some field crop species. An assessment study has been done at the Szent István University, Gödöllő to evaluate field crop species. Twelve field crop species (Sugar beet *Beta vulgaris*, spring and winter barley *Hordeum vulgare*, winter wheat *Triticum aestivum,* maize *Zea mays*, sunflower *Helianthus annuus*, peas *Pisum sativum*, potato *Solanum tuberosum*, alfalfa *Medicago sativa*, canola *Brassica napus*, rye *Secale cereale* and oats *Avena sativa*) were involved in the study.

The results obtained suggest that regarding their protein production field crop species could be sorted into three distinguished groups. Alfalfa, barley and peas were the most productive field crops and also the most economic considering the cost of protein yield. Most of the grain crops and oil seed crops formed a middle range with considerable protein formation but with highly variable costs. Spring barley was the only exception within this group since the species is dedicated basically to low protein formation patterns. The two tuber and root crops had low protein yields at high cost.

The final conclusion of the research is, that the rapidly increasing human population may have still reserves in cropland globally however crop species show some twofold differences in protein output while the price gap of that may be around 30 times wider.

Keywords: aimentation, nutrient intake, protein production

Received 15 January 2019, Revised 21 March 2019, Accepted 24 May 2019

Introduction

All living organisms rely on biochemical processes. To supply these physiological structures any of them has to have availability to certain chemical elements in the form of food. Food is any substance consumed to provide nutritional support for the living organism. It is usually of plant or animal origin, and contains essential nutrients, such as carbohydrates, fats, proteins, vitamins, minerals, fibres and water. The substance is ingested by an organism and assimilated by the organism's cells in an effort to produce energy, maintain life, or stimulate growth (WHO 2013a, 2013b). Food security means to provide food for anyone, recognizing the „*right to an adequate standard of living, including adequate food* „, as well as the „*fundamental right to be free from hunger* „ (WHO 2004, Lean 2015).

The human population of the world has been increasing in an unprecedented pattern during the past century. By the time of our study the global population has reached 7 .7 billion and it is expected to be over 11 billion (Figure 1.) by the end of the 21st Century. The problem of this increment is twofold. On one hand this enormous amount of human beings will have to be supplied with adequate quantity and quality of food. The other is the environmental impact of this demographic phenomenon, namely the environmental footprint of the human society (Várallyay 2008). Frankly it has to be identified how much is the influence of ours and how can we control this impact.

Crop site × crop plant interactions have a profound role in yield formation regarding crop yield quantity and quality (Pepó 2010,

DOI: 10.18380/SZIE.COLUM.2019.6.35

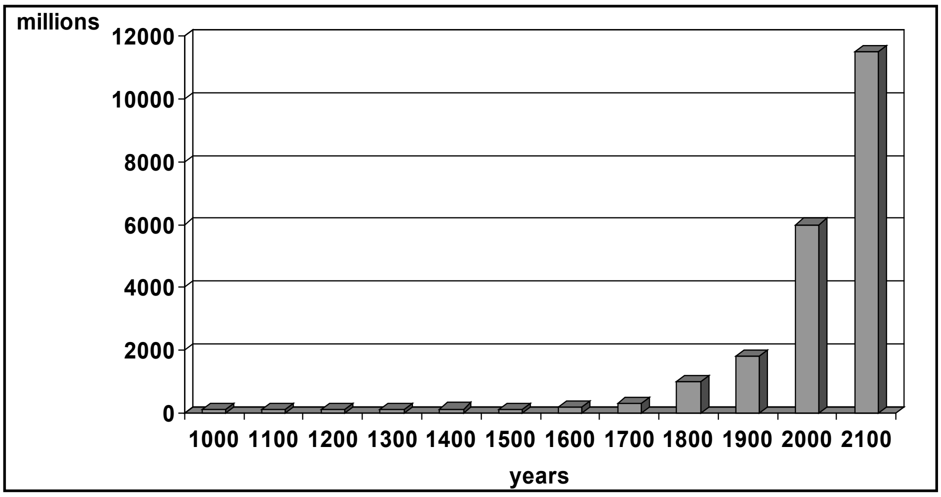

Figure 1: World population increment. Source: Montgomery 2014

Tarnawa et al. 2006, 2011 and 2018). Plant development depends on optimum environmental conditions from among which water availability, nutrient supply and photosynthetic processes may influence yield formation and the manifestation of quality characteristics.

Climate change research results in Hungary have highlighted the variation induced by water availability on protein formation of field crops (Kassai et al. 2019; Eser et al, 2019; Jolánkai et al 2018, 2019).

The alimentation of the human race is based on agricultural activities including field crop production and its output converted into food and feed. All biochemical processes that are yielding the essential groups of food are supplied by a unique process, the only active carbon sequestration; the photosynthesis. The highest amount of converted chemical compounds containing C, H, O and N are the carbohydrate substances including monosaccharides and polysaccharides as well as triglycerides forming various fats, and last but not least proteins which are built from a wide range of amino acids, many of them having no abilities to be produced by certain living organisms, therefore such compounds are to be obtained from other live individuals within the food chain.

Field crops represent therefore a sort of a basis of almost all food and feed products and in an indirect way of higher levels of animal food conversion that are intended to be consumed by humans. Field crops have a high variation regarding their botany, agronomic patterns, and the yield and its chemical properties (Hohls 1995, Jolánkai et al 2018, Kassai 1994, Máté et al 1993). In this study the twelve most widespread field crop species have been studied including grain crops, oil seed crops, root and tuber crops and leguminous forages. From among the nutritional compounds protein output of field crop species was evaluated since these chemical structures provide a common basis for comparison between plant yields.

Materials and methods

The materials and methods of the present study cover a rather broad field, since there are various topics of research work done by the SIU Crop Production Institute, Hungary. Majority of the results are based on experimental research, however, some evaluations were implemented by using national public data, or observation results published (FM 2017, FAOSTAT 2017).

An assessment study has been done by the authors to evaluate and identify the agronomic parameters of protein yield of field crop species. Twelve field crop species (Sugar beet *Beta vulgaris*, spring and winter barley *Hordeum vulgare*, winter wheat *Triticum aestivum,* maize *Zea mays*, sunflower *Helianthus annuus*, peas *Pisum sativum*, potato *Solanum tuberosum*, alfalfa *Medicago sativa*, canola *Brassica napus*, rye *Secale cereale* and oats *Avena sativa*) were involved in the study. Evapotranspiration patterns (ET) of the crops studied have been identified and physiologically reliable protein ranges within crop yields were evaluated.

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Table 1: Protein production of twelve crop plant species. SIU, 2017

Crop	protein %	crop yield t ha^{-1}	protein yield kg ha^{-1}	Crop price 1000 HUF t^{-1}	Cost of 1 kg protein output HUF	DRI/ha person
Medicago sativa	18.0	4.35*	783	22.5	125.0	42.9
Solanum tuberosum	2.0	24.9	498	65.7	3285.0	27.2
Beta vulgaris	1.1	41.2	453	15.0	1364.2	24.8
Triticum aestivum	13.0	4.8	624	45.0	346.1	34.1
Hordeum vulgare	16.5	4.1	676.5	43.5	263.6	37.0
Hordeum vulgare distichon	11.2	3.7	414.4	45.0	401.8	22.6
Secale cereale	12.8	4.2	537.6	43.8	342.1	29.4
Avena sativa	13.6	4.4	598.4	44.1	324.2	32.7
Zea mays	9.5	5.8	551	46.9	493.7	30.1
Helianthus annuus	18.5	3.3	610.5	93.0	502.7	33.4
Brassica napus	22.6	3.2	723.2	105.0	500.0	39.6
Pisum sativum	24.0	2.8	672.0	71.0	295.8	36.8

*hay

In the study experimental mean values of identical agronomic treatments and homogenized bulk yield samples were used only. Precipitation records have been evaluated in relation with yield quantity and quality. Quality characteristics were determined at the Research Laboratory of the SIU Crop Production Institute, according to Hungarian standards (MSZ, 1998, Győri 2006, Győri 2008). Analyses were done by statistical programmes with respect to the methodology of phenotypic crop adaptation (Eberhart and Russell 1966; Finlay and Wilkinson 1963; Hohls, 1995). The meteorological database of the research referring to precipitation as well as temperature data was provided by the Hungarian Meteorological Service (OMSZ). Statistical evaluations, crop ecological model adaptations, and calculations were done by regular methods (Sváb, 1981; Finlay and Wilkinson, 1963).

The alimentary evaluations of the field crop species studied were done in accordance with WHO (2004, 2013a, 2013b), Lean (2015) and Eser et al (2019). Dietary Reference Intake (DRI) estimates were applied by methods in accordance with Gunnars (2018).

The present paper produces results of an ongoing research in relation with weather impacts on quality and quantity of crop production (Kassai et al. 2019, Tarnawa et al. 2006, 2011 and 2018, Jolánkai et al. 2018, 2019, Eser et al 2019). Such an assessment has a diverse nature. Once, it is beneficial regarding the abundance and the duration of baseline data. On the other hand, it is restricted to the available structure and moreover it is bound mainly to available figures giving less chance for deep layer evaluations. However, the study could provide some novel specific information on crop performance in relation with food security.

Results and discussion

The results obtained suggest that regarding their protein production, field crop species could be sorted into three distinguished groups. Alfalfa, barley and peas were the most productive field crops and also the most economic considering the cost of protein yield. Most of the grain crops and oil seed crops formed a middle range with considerable protein formation but with highly variable costs. Spring barley was the only exception within this group since the species is dedicated basically to low protein formation patterns. The two tuber and root crops had low protein yields at high cost (Table 1.).

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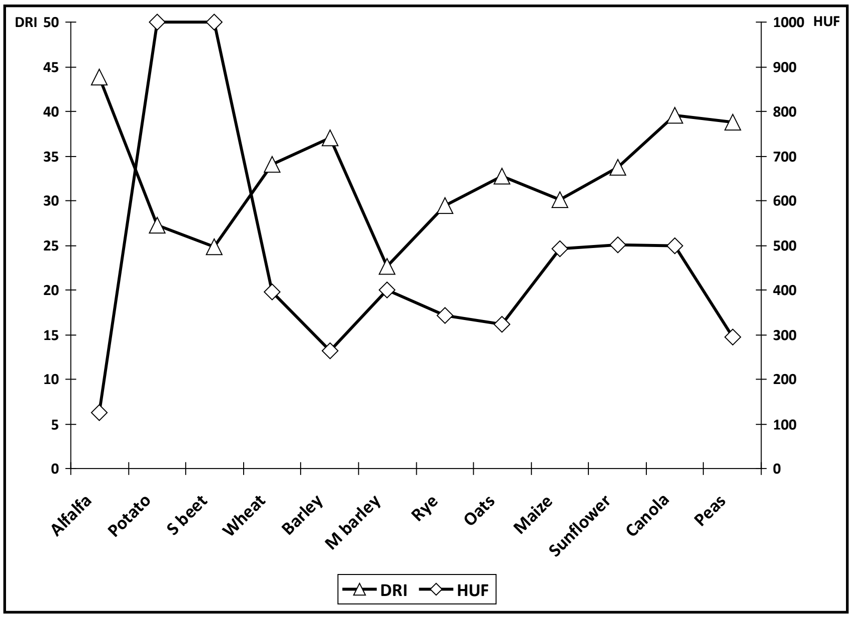

Figure 2: DRI supply and the cost of protein of twelve crop plant species. SIU, 2017

be around 30 times wider (Figure 2.). Today there is no alternative to field crop production, and so no other major resources for human alimentation than agriculture. From the Neolithic age mankind had to move from hunting and gathering to agricultural activities providing food and feed rather than exploiting natural ecosystems. Nowadays with an exception of ocean fisheries, most of the alimentation of mankind is based on human controlled input-output systems using photosynthetic energy conversion. Concerning Dietary Reference Intake demand one hectare of land may supply 20 to 40 average adults according to the species produced. This theoretic value was based on experimental conditions therefore commercial production can be much different from that. More research is needed to precise crop plant × crop site interactions with a special view on global spatial performance.

Acknowledgement

This paper presents research results obtained from field crop trials supported by TÁMOP, NVKP and VKSZ funds of the Government of Hungary.

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