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PREFACE

The Agricultural Engineering Board of the Hungarian Academy of Sciences which supervises the development of this branch organises annually a conference at Gödöllő, which is the central place of the Hungarian agricultural scientific activity.

During the sessions, research scientist, developing engineers, experts of institutions engaged in agricultural engineering development strong in numbers the organizer, the hungarian universities and other higher grades of education, the research institutions: Hungarian Institute of Agricultural Engineering at Gödöllő, Faculty of Agricultural Engineering of the University of Agriculture at Gödöllő and foreign guests give account of their results obtained in the research work and development of agricultural machinery.

This yearly English-Language publication the "Hungarian Agricultural Engineering", started at 1988, contains selected papers presented at the conference of 1998. We do hope that this publication will be found interesting to a big part of agricultural engineers.

Dr. László Fenyvesi
Director

Hungarian Institute of Agricultural Engineering
Gödöllő

PART I.

ABSTRACT OF SELECTED PAPERS

INTERPRETATION OF THE DRYING CONSTANT IN MICROWAVE DRYING

Dr. J. Beke
University of Agricultural Sciences, Gödöllő

Drying experiments were carried out using a special microwave surface to examine the drying kinetics of corn, carrot and potato samples. The process of internal moisture and heat transfer was analysed in the light of the experimental data obtained It was found that the modified exponential law describes the water removal process of materials within an acceptable confidence range when the specific microwave performance is the driving force for the internal moisture movement. Applying the modified exponential law the drying constant has a key roll.

INVESTIGATION OF WHEAT KERNEL HARDNESS OF DIFFERENT VARIETIES BY MEANS OF MEASURING GRINDING RESISTANCE

Dr. A. Véha - E. Gyimes,
JATE University, College of Food Industry, Szeged
Dr. I. Bölöni,
Hungarian Institute of Agricultural Engineering, Gödöllő

The e_s ($kWh{\cdot}cm^{-2}$) specific superficial grinding energy demand shows up significant deviations depending on the wheat variety, if e_g ($kWh{\cdot}t^{-1}$) simple specific grinding energy requirement varies between[e_g = 1,9...2,1 $kWh{\cdot}t^{-1}$ e.i. remains roughly constant around $e_g \cong 2{,}0\ kWh{\cdot}t^{-1}$.

The variety Jubilejnaja 50 and GK-Öthalom have the average „grinding resistance": $e_s = 0{,}566...0{,}541{\cdot}10^{-7}\ kWh{\cdot}cm^{-2}$. At the same time the vitreousity of these varieties is the highest: 79,4 and 81,0 %

At a similar vitreousity the varieties GK-Duna and GK-Tavasz are just on the fourth and fifth places, while the Izabella milling mixture of unknouwn varieties with its 59,9 % has the third, quite high „grinding resistance". Probably this was caused by the subjective uncertainity of the diaphonoscope measuring method.

Finally the softest variety became GK-Kata having the smallest specific grinding energy conxumption: $e_s = 0{,}275{\cdot}10^{-7}\ kWh{\cdot}cm^{-2}$.

THE MYRIAD-MINDED WATER

Dr. P. Szendrő - Dr. A. Szász - Sz. Szőke
University of Agricultural Sciences, Gödöllő

Special structure of water and its bio-effects has been discussed in our present paper. Electromagnetic effects could modify the geometric arrangement (cluster structure) of water molecules. This influence could be positive or negative for the bio-systems, having large amount water content, depending on the character of interaction. We clarified the strong effect of magnetic- (vector-) potential on the properties of water: its evaporation- energy, viscosity and surface tension depends on the treatments. Our strategic aim to use these results in agriculture.

DETERMINATION OF LACTATION CURVES ON THE BASIS OF DAILY AND MONTHLY MONITORING

Dr. L. Tóth
University of Agricultural Sciences, Gödöllő
Dr. J. Bak
Hungarian Institute of Agricultural Engineering, Gödöllő
Dr. A. Erényi
University of Agricultural Sciences, Gödöllő, Mezőtúr College

The authors seek for the answer to the question how the controlling milking frequency - daily and monthly monitoring - influences the lactation curve determination as the accuracy of milk quantity measuring is effected.

According to the domestic practice the individual milk production of the cows are determined on the basis of monthly controlling milking. Mechanical milk quantity measuring instrument (TRU-TEST) is used which has an error less than 2 %. In practice the error may be even as high as 5 % under extreme conditions.

Based on modelling and measurements the authors arrived at the consequence that it is enough to use less expensive 3-5 % accuracy milk quantity measuring devices with computerised data acquisition systems in the case of two milk quality measurement daily.

COMBINED ENERGY TRANSFER (MICROWAVE-CONVECTIVE) BY DRYING OF AGRICULTURAL MATERIALS

G. Szabó - R. Rajkó - C. Hodúr
JATE University, College of Food Industry, Szeged

The microwave heat transfer is a considerably more advantageous procedure in contradiction to the traditional methods as a result of the possible quantity of the energy stream which is transportable in the mass unit of the material and the uniform temperature distribution developing in the material. With the help of this method numerous procedures can be carried out faster when applying a continuous technology and a lower energy consumption as well, ensuring a better product quality. The fundamental problem of the microwave material processing is to assure the uniform distribution of the electromagnetic field. According to the one possible version of the know methods and technical solutions, the uniformity can be increased by introducing the microwave energy into the operating field at two perhaps three places. In the procedure developed by us this technology was improved with a uniform mixing of layers in the inhomogeneous electromagnetic field produced by moving the vibroaerofluid layer of the material under treatment. Since the effective relative loss factor (ε''_{eff}) of the food powders is generally low, therefore, the degree of the energy absorption was increased by rewetting the material. In the course of this process the agglomeration of the powder takes place and a capillar porous structure is produced which considerably increases the solubility characteristics. A bactericidal effect is also attained as a result of the release of the intensive energy in the form of heat.

EFFECT OF TECHNICAL CHARACTERISTICS ON THE QUALITY OF PELLETS

Dr. J. Csermely - Dr. Z. Bellus - Gy. Komka
Hungarian Institute of Agricultural Engineering, Gödöllő

The quality of pelleted fodder mixture as end-product depends on number of factors. Knowing of the influence of these factors has a basic importance in order to produce pellets of physical characteristics that can preserve their shape and low inclination to shredding during transport storage and other processing before using them up.

Problems of industrial scale pellet producing and influence of technologies have been experienced for many years of testing carried our Institute. Taking the above mentioned into consideration investigations were carried out concerning material characteristics as well as some parameters of the machine of pellets in the frame of number T 013144 theme.

FAILURE AND WEAK POINT ANALYSIS OF COMBINED HARVESTER

Dr. P. Vermes
University of Agricultural Sciences, Gödöllő, Mezőtúr College

The **failure** is that **state** of a product in which the product can not meet the prescribed functions, except if this state occurs during the preventive maintenance or any other planned activity or it takes place in the lack of external resources. The product reaches the failure state as a result of breaking down by exceeding the failure limit.

The **failure analysis** discovers the failure frequency, cost, type, reason, consequence and other characteristics with the aim of making the appropriate executive measures. So it is focused on the failure. In the failure analysis the mechanism of breaking down (the steps of failure formulation) is followed in reverse order:

failure phenomenon → type of failure → reason for failure

APPLYING TWO-VARIABLE ENERGETIC FUNCTIONS IN FEED GRINDING (OTKA 016124)

Dr. I. Bölöni - Dr. Z. Bellus
Hungarian Institute of Agricultural Engineering, Gödöllő

Three most important theses of the formerly developed energetic equations of feed grinding were managed to verify:

1) e_g ($kWh \cdot t^{-1}$) specific grinding energy requirement vs. $\bar{x}_g$ (cm) grist particle mean size,
2) e_s ($kWh \cdot cm^{-2}$) specific superficial grinding energy consumption vs. $\bar{x}_g$ (cm) grist particle mean size,
3) e_g ($kWh \cdot t^{-1}$) specific grinding energy requirement vs. Δa_g ($cm^2 \cdot g^{-1}$) grist specific surface increase.

ANALYSING CHOPPED GREEN MAIZE FORAGES BY THE FRACTIONS

Dr. P. Szendrő - P. Kis - L. Bense
University of Agricultural Sciences, Gödöllő

Nutrient intake of cattle and the efficiency of its protein transformation depend on several factors. Most important among them are the feed value and the physical form structure. Concerning the optimal nutrient composition of forage, accurate data stand at our disposal, while the physical structure (particularly in case of chopped forages) forms subject of debate. Disagreements derive from different requirements on the structure of forage. The guided fermentation process taking place during conservation, demands the least chaff-dimension due to the proper compressibility of silage.

NEW METHOD AND EQUIPMENT FOR CURING OF FLUE-CURED TOBACCO

Dr. B. Kerekes
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In Hungary many types of curing barns are used for production flue-cured tobacco. In these equipments the air-circulation is the usual (from bottom to up), which is not advantageous in the rack-type barns. In the old equipments there are big fans with too much air-volume and high velocity.

In our institution a curing system has been developed. It means a new curing method and equipment, which in an energy-saving and multi-purpose construction. Briefly, it means a counter air-circulation (from top to down). It favours to the water-loss of the tobacco-leaves, arranged in the racks.

The curing equipment is complex, installed with special heat and sun trap, and can he used out of the curing season, for example as a greenhouse in spring.

The measurement of some components has shown that there is a close relationship between the quality categories and the chemical characteristics of flue-cured tobacco. The amount of reducing sugar and total nitrogen varies considerably, depending on the curing schedule. The nicotine content does not change significantly. This means, that we are not able to influence the nicotine content by using this curing technology. Another result is clear, that the quality alters at different ripening levels.

In Hungary it is very important to improve the quality of flue-cured tobacco. The author hopes that the new (advanced) applied curing schedule can contribute to it.

PROBLEMS AND POSSIBILITIES OF HUNGARIAN AGRICULTURAL INNOVATION

Dr. I. Husti
University of Agricultural Sciences, Gödöllő

According to the classical opinion, innovation is the **engine of development**. How can one renew its activities, products/ services and how can adjust itself to the newest challenges? It is especially important in a competitive environment.

Dealing with innovation just now is **actual,** because Hungarian economy and agriculture have been in a deep crisis for years and it seems that the needed „power concentration" is missing. The present Hungarian recession could be considered, as a period of preparing for the prosperity, but it is to be feared that the lack of innovation results an unbeneficial situation for the participants of the Hungarian economy, which has an intention of integration.

The Hungarian agriculture badly needs innovation processes to improve its competitiveness, which has been impoverished during the last years.

ORIGIN OF PINK-NOISE IN BIO-SYSTEMS

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University of Agricultural Sciences, Gödöllő
Dr. A. Szász
Department of Civil Engineering, Strathclyde University, UK

The pink- (1/f -) noise is one of the most common behaviour of the bio-systems. Our present paper is devoted to clarify the origin of this interesting fact.

Recently much attention has been given to the theoretical and experimental studies of the self-organisation processes in various physical, chemical and biological systems. The living system is self-organising, which could be realised by a random stationary stochastic processes.

The self-organising procedure connected by the time-fractal and a special noise, which has a power spectrum definitely reversibly proportional with the frequency, (1/f-noise or pink-noise, or Flicker-noise).

A new physiology (so-called "Fractal Physiology") has been developed in the last few years. It is well known that there are some new diagnostic methods, which are checking the noise spectrum of the bio-systems to control their proper function.

AN EXAMINATION OF THE ROLE OF FAMILY FARMS AND FACTORS AFFECTING THEIR STANDARD OF LIVING DURING THE PERIOD OF HUNGARIAN AGRICULTURAL TRANSFORMATION (T-024079 OTKA)

Dr. Katalin Takács-György, Ph.D.
University of Agricultural Sciences, Gödöllő

Concomitant with the economic and social changes in agriculture in central- and eastern-Europe in the 1990's was a change in the nature of the concept of ownership. As a result of this, both forms and means of measurement in farming underwent change. In this period of transformation, in place of the then-existing Production Cooperatives, economically and socially divergent forms of business, reworked cooperatives and family farm units began to appear.

During this time, as a result of the agricultural transformation, more than 1,800,000 households came into control of land. They owned more than 50 % of land. This percentage of ownership does not reflect the level of the farming economy.

The average size of holdings in the EU during this same time of those who pursued a living in agricultural production as their main occupation, thus considered as earning their living in this way, were: in Great Britain, 109.7 hectares; France, 44.8 hectares; Germany, 28.9 hectares; Denmark and Spain, 22 hectares; Italy, 9.3 hectares; Portugal, 8 hectares; and Greece, 6.4 hectares. Within this, on the long term, a tendency toward concentration of holdings and growth in economic size is characteristic of the member states.

In the wake of the economic and social changeover in Hungary, during this period a significant growth was experienced in the change in the percentage of those managing above 20 hectares, as well as in their absolute number.

INVESTIGATION OF FORESTRY DEEP SUBSOILING BY THE FINITE ELEMENT METHOD

Abdul Mounem Mouazen - Dr. M. Neményi
PANNON Agricultural University, Mosonmagyaróvár
Dr. B. Horváth
Sopron University, Sopron

The finite element method was used to study deep cutting of sandy loam soil by a forestry deep subsoiler. The numerical analysis was performed with a COSMOS/M finite element software. The material of the soil was considered as elastic-perfectly plastic. Therefore, the Drucker-Prager elastic-perfectly plastic material model was adopted with the flow rule of associated plasticity. The material and geometrical non-linearity of soil were taken into account. Soil-tool interaction was simulated adopting the Coulomb's law of dry friction. The draught and vertical forces, vertical and forward soil movement and stress distribution fields were reported. The total vertical force was negative in direction due to the high negative vertical force of the shank, which would have pushed the subsoiler upwards. However, the wing total vertical force was positive in direction.

SOME QUESTIONS OF MANUFACTURING OPTIMAL SPECIFIC WEIGHT MACHINES

Dr. I. Pálinkás - G. Fledrich
Univesity of Agricultural Sciences, Gödöllő

The Department of Machine Manufacturing and Reparation Technology has been dealing with the questions of material and energy saving manufacturing of agricultural machines for one and a half decade. At present the actuality of the topic needs no evidence, but the situation was not always the same in during the development of the industry. Now the effect of the machine fabrication is surveyed in the areas of material and energy saving as well as the environment protection.

The level of the industry of the country can be characterised by the figures of material used up for the gross national production. According to the reports 185 kg steel was used to produce $1000 national income in Hungary while the same figure was 80 kg in Germany and 60 kg in Japan. The investigations of the Department proved that the specific weight of the agricultural machines exceeded the average of foreign ones by 20-50 %.

As for saving energy two factors are considered. On the one hand to produce basic material is an extremely energy consuming process, so that reducing basic material and premanufactured product application results in significant energy saving. On the other hand the operation of the lower mass machines needs less energy.

The machine manufacturing has many direct and indirect connections to the environment from the metal mining to the waste material reutilization when the wear out machine is processed. The protection of the fertile soil is exposed in this area what is covered by more scientific fields. In our case it means that the lower specific weight machines compact the soil in less extent. The too high soil compacting is a significant damaging factor of the mechanised agriculture.

In the past nearly one decade delivered considerable changes in the ownership conditions and structure of our industry. As a consequence the differences mentioned have reduced between the domestic and international machine manufacturing, however there are still problems to improve. Considering that the efforts of development for material saving will provide result rather for the user or the national economy than for the manufacturer, it is important to demonstrate those effects.

THE USE OF WIND ENERGY IN HUNGARY

Dr. L. Tóth - G. Horváth, Ph.D. - G. Tóth, Ph.D.
University of Agricultural Sciences, Gödöllö

The main task of this research is to measure and calculate the local wind circumstances and to design an optimised blade. The first evaluated wind measurements were made in North-Western part of Hungary. The wind energy is the most preferable in this part of the country. The results and the feasibility study indicates that the wind power plant installation is feasible in case of making some parts in Hungary. There is a way for analising blade production for local circumstances We have to take into account the local wind speed and design the optimised blade with inverse design methods.

Nowadays, the use of renewable energy is becoming an important question. Wind energy is currently viewed as one of the most promising energy source. The use of wind energy has no toxical emissions so this matter will be important concerning EU energy norms. Wind energy is an unlimited source of energy. It is not an easy task to choose a site for a wind generator because we have to take into account many factors. The most imporatant factors are wind speed, the energy of the wind, generator type and the feasibility study.

Windmills have been working since the earliest antiquity. The first modern wind turbines driving electric generators appeared at the dawn of the 20^{th} century, then spread all over the world. Nowadays the use of wind energy is concentrated on producing electricity.

The moving air has energy, so on site measurements are used for determining the data for installation and technical properties. The first evaluated wind measurements were made in North-Western part of Hungary in Kis-Alföld region in Osztffyasszonyfa. The local wind measurements were made in order to determine the wind speed, the main wind directions and the energy. We have to perform statistical study of local winds, in order to state accurately the wind turbine model to be used and the rated wind velocity to be considered for determining the geometrical characteristics of the wind rotor.

MACHINERY-DEVELOPMENT OF AFFORESTATION

Dr. B. Horváth
Sopron University, Sopron

Our socio-economic situation has been rapidly changing nowadays and as a result forest management should meet the requirements of the high demands of this new challenge. Forestry mechanisation and forest machinery is also expected to meet the constantly changing demands. Machines and machinery-systems should satisfy the following requirements:

- should be adjusted to the structural changes (in our future forest management machinery should not be the aim of development but only a tool);
- flexibility should be maintained to implement new technologies;
- cost-effective technologies should be supported;
- new technologies should be suitable both for the quality and the environmental requirements.

YIELD MAPPING

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Dr. I. Földesi - L. Kovács
Hungarian Institute of Agricultural Engineering, Gödöllő

There are efforts on the development and practical use of different methods and means for precision farming, or rather site specific farming. Site specific farming means a technology according to which the fertilizers, herbicides, seeds are controlled according to the local conditions within the field and tillage operations are performed accordingly, as well.

The yield map of a field, that includes the yield variations within the field, can be a useful source of information and a considerable contribution to the application of site specific farming. At first the efforts were concentrated on yield measurement with combine harvesters (Macy, 1994; Reitz and Kutzbach, 1994), and forage harvesters (Auernhammer et al, 1995). Lately the yield was measured with other machines, such as potato, sugar beet, pea and bean harvesters, as well.

Different Global Positioning Systems (short: GPS) can be used to determine the location of the machines, the combine harvesters, within the field during the operation. This can be performed by the NAVSTAR (Navigation Satellite Timing and Ranging) time and distance measurement navigation system. This is based on minimum four satellites of the 24 NAVSTAR satellites by using the signals of the satellites for the momentary location by a GPS. Such a way the position is determined by three geographic coordinates (longitude, latitude and altitude), therefore tree dimensional location can be performed and used for the speed and time measurement at any place along the Earth.

The original high precision signals of the satellites are not available for civil purposes. The maximum error of location can be up to 100 m by the signal available. Therefore some kind of improvement of the accuracy of the signal is needed. For this purpose a GPS is fitted to the combine harvester and a second GPS is located at a point the coordinates of which are known. Assuming that there is an appropriate radio connection between the two GPS a so called differential operation is used to reduce the error to 2 to 5 m. In several developed countries such a differential signal is available via a special radio channel to perform the correction needed. Such a situation exists in some parts of Hungary now and will be soon all over the country, as well.

ANALYSIS OF FUNCTIONAL MICROPROCESS OF DIESEL ENGINES FOR DIAGNOSTIC PURPOSE

Z. Bártfai
University of Agricultural Sciences, Gödöllő

The effectiveness and economy of the agricultural operations depends on some conditions and parameters of the tractor engine such as: loading factor, technical condition, optimum settings.

During the operation the load and some diagnostic parameters of the engine can be changed. Because of the mentioned parameters are functions of e.g. the fuel consumption, their continuos observation during the operation should be desirable. It means that it would be desirable to find a physical parameter which indicates serviceable informations about the engine operation for diagnostic and energetic purpose. The angle velocity of the crankshaft seems to be a good parameter for this purpose.

LOGISTIC CONCEPTS FOR ENERGY CROPS

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The availability of adequate logistic systems, which include harvesting, recovery, compaction, transport and storage represents a basic requirement for the utilisation of energy crops as feedstocks for industrial and energy purposes. Each conversion technology has specific requirements concerning dry matter content, shape, size and particle consistency of the raw material. The logistics of the raw materials is the tool to establishing an effective link between agricultural production systems and industrial activities.

Harvesting of agricultural products is always associated with the need of handling, transportation and processing of large volumes. This refers particularly to the harvest of biofuels from annually yielding herbaceous field crops, such as energy cereals, miscanthus, straw and hay. As for these crops, because the total dry matter contributes to the energetic yield, the annual turnover can be extremely high. Moreover, cost-effective combustion units have to exceed a certain size; thus the area for biofuel production and supply has to be relatively large and increases the demand for long-distance transportation in order to meet the demand of biofuel. Here, the dilemma with biofuels shows quite clearly: while the mass- related energetic density of solid biomass varies only little, the required volume for a single unit of fuel equivalent can easily vary by the factor ten, depending on the method of harvesting or processing.

AUTOMATIC STEERING CONTROL OF PLANTATION TRACTOR BASED ON IMAGE PROCESSING

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University of Horticulture and Food Industry, Budapest

The driving by man in straight line and turning at the end of the row of the plantation demands high concentration which may limit the possible speed of the vehicle. With automatic steering controll working speed can be increased and there is no health hazard when working with chemicals.

The necessary input information for the automatic steering can be taken from the natural surrounding. In the plantations the stems of the plants are the most characteristic objects, the bottom of the stems appear in a straight line. The equation of such a line is not influenced by the distance between the stems.

In the project described below a CCD camera mounted on the front of a model tractor takes pictures from one side of the plantation row. Evaluating the images in real time the necessary intervention for keeping the vehicle in straight line can be calculated. The basic equations for steering control and the first image processing experiences are presented.

Keywords: Automatic steering, image processing, plantation, self-propelled machine, tractor.

PART II.

SELECTED SCIENTIFIC PAPERS

INTERPRETATION OF THE DRYING CONSTANT IN MICROWAVE DRYING

Dr. J. Beke
University of Agricultural Sciences, Gödöllő

Abstract

Drying experiments were carried out using a special microwave surface to examine the drying kinetics of corn, carrot and potato samples. The process of internal moisture and heat transfer was analysed in the light of the experimental data obtained It was found that the modified exponential law describes the water removal process of materials within an acceptable confidence range when the specific microwave performance is the driving force for the internal moisture movement. Applying the modified exponential law the drying constant has a key roll.

Introduction

There has been a boom in modelling the drying process of agricultural products lately. Many attempts have been made to derive a precise mathematical method and to find a reliable solution to describe the drying processes of various materials. However, applying the well-known theory of heat and mass transfer has limited possibilities in agricultural practice, because, from the nature of agricultural products, it is not possible to follow the classical theory of drying. The accuracy of drying simulation mainly depends on applied drying equations.

A number of versions are known for convective drying, but there are still a mass of questions to be answered in the process of dewatering farm produce in microwave fields. This paper endeavours to make a contribution to the microwave drying of some farm produce, based on experiments carried out with corn, carrot and potato samples in microwave fields of different parameters. It also analyses how equations derived from convective drying can be used in microwave conditions.

For experiments a special test equipment was used The microwave generator operates at a frequency of 2.45 GHz; its power can be varied continuously within the range 0-2500 W. The high frequency energy reaches the surface wave applicator (SWA) - which is a linear strapped bar structure without a back wall - through a rectangular waveguide. It was shown in earlier tests that the material treated in the sample holder shows a homogenous dissipation of microwave power (BOSISIO, BEKE AND MUJUMDAR, 1993).

Results and discuss

The measured data show a significant difference between the process features of drying the products.

For example the drying process of shelled maize - within the range of the usual harvesting moisture content - takes place in the receding front period. The drying rate curves also prove that the dehydration of samples occurs in the range of decreasing drying rates. Furthermore, there is a characteristic point on every curve, which divides the falling rate period. (BEKE et al. 1995). As is clear from Fig. 1, which shows the drying rate of shelled maize (DR) as a function of the moisture ratio (Y) and the specific microwave performance (p).

In contrast to the drying process of shelled maize, the whole water removal process of potato (similarly to the drying process of carrot) can be divided into two parts: a constant and a falling drying rate period, irrespective of the applied field strength and initial moisture content of the samples (Fig. 2). However, the duration of the steady drying rate period depends on the two parameters mentioned above. A linear relationship can be found

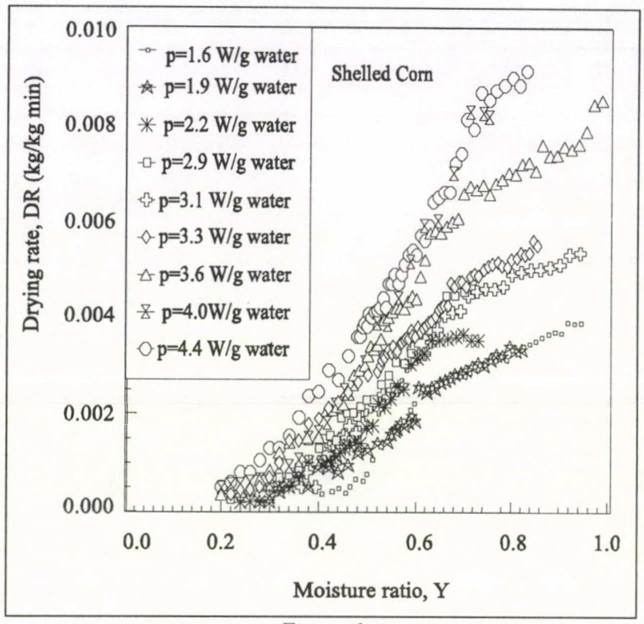

Figure 1
Drying rate of shelled maize (DR) as a function of the moisture ratio (Y) and the specific microwave performance (p)

between the place of the critical point as a function of the moisture ratio and the applied specific microwave performance. As the kinetic curves proved, the first parts of the curves, disregarding the initial warming up period, can be substituted with straight lines. The reason for this phenomenon is that samples have a high moisture content with uniform inner distribution and are not bordered with peels of water resistance. Since the initial water content is over the critical moisture content, a rather high level of specific microwave power can be applied without overheating the samples and without any limitation of the drying rate caused by the capacity of the giving-off water of the drying material. As a result of these factors, a high drying rate is established. At a certain point of the kinetic curve (at a certain moisture content) a balance is reached between the internal moisture movement pointing to the sample surface and the evaporation rate (critical point). From that moment, the vaporisation front moves gradually from the surface to the deeper layers of the drying material. As the measurements indicate, besides the drying front withdrawing inside the sample, there is an additional obstacle to the quick drying process. Namely, in the receding front period a thin hard layer is established on the surface of the material, which hinders the water removal process. This is the reason that the kinetic curves approach the horizontal co-ordinate axis asymptotically.

Some questions of the process simulation

Drying simulation - in a certain respect - can be divided into two main groups, depending on the applied type of drying equations, namely, theoretical and empirical models.

At first sight, empirical model seem the easiest solution for drying problems, because they make it possible to apply the "black box" approach, using only the input and output parameters to characterize the process of water removal.

Typical groups of empirical models are analogous to Newton's cooling law. The very first of them, the so-called exponential law, was derived by Lewis (LEWIS 1921). This assumed that the drying rate is proportional to the difference between the actual average and the equilibrium moisture content of material as follows:

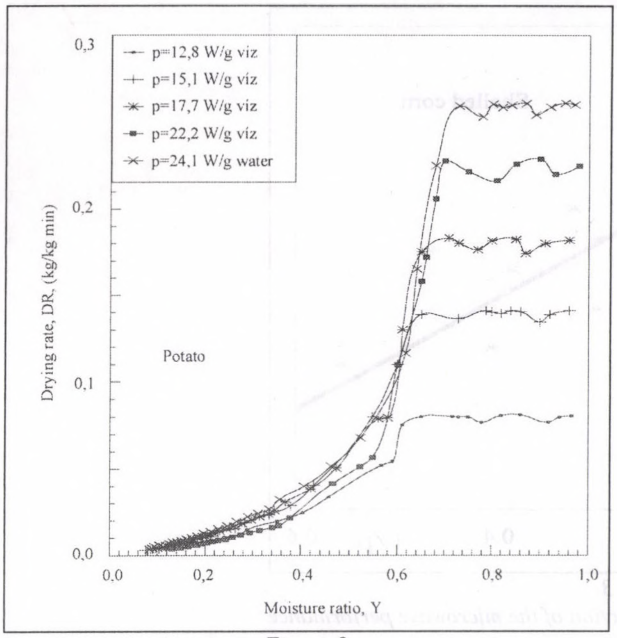

Figure 2
The drying rate curves of Potato

$$\frac{X-X_e}{X_o-X_e}=\exp(-k\tau) \qquad (1)$$

where k is the drying constant and where the left side of Equation (1) is frequently called moisture ratio (Y). The assumption on which Equation (1) is based has some inadequacy, because the linearity of the sorption isotherms of most farm produce can be observed only within the air relative humidity range of 0.2 to 0.8 (BEKE and VAS 1994).

Applying a simple empirical modification on the exponential law allows us to obtain a more precise method to describe changes in the measured data, especially for the initial stage of the drying process (PAGE 1949), which is expressed by Equation (2).

$$\frac{X-X_e}{X_o-X_e}=\exp\left(-k\tau^m\right) \qquad (2)$$

The drying constant was investigated by several researchers and it was found that k can be described with an Arrhenius-type equation as a function of drying air temperature (HENDERSON and PABIS 1961, etc.):

$$k=C_1\exp\left(-\frac{C_2}{\Theta}\right). \qquad (3)$$

It must be mentioned that in the case of determining the moisture ratio by Equation (1), k depends on the residence time as well.

All of these equations were derived from convective conditions. The question is whether the dehydration process of some farm produce in microwave fields could be described by the functions resembling those of the convective procedure.

As far as the drying constant is concerned, if we investigate it as a function of the specific microwave power (p), some similarity can be observed with that of the convective method where the drying constant is the function of the drying air temperature. From this phenomenon it is postulated that for simple modeling purposes that the specific microwave power is the driving force of the water removal process. In this way a modified Arrhenius equation seems an appropriate tool to specify the moisture ratio as a function of the specific microwave performance, which is expressed as

$$k=C_3\exp-\left(\frac{C_4}{p}\right) \qquad (4)$$

Experimental data prove that after the warming up period the change of the specific microwave performance is low enough to ignore its influence on C_3 and C_4. On this assumption the next two equations can be set up to determine k for two optional value of specific microwave power:

$$\ln k_1=-\frac{C_4}{p_1}+\ln C_3 \quad \text{and} \qquad (5a)$$

$$\ln k_2=-\frac{C_4}{p_2}+\ln C_3 \qquad (5b)$$

From Equation (5a) and Equation (5b) we can obtain:

$$C_4=\frac{p_1p_2}{p_1-p_2}\ln\frac{k_1}{k_2} \qquad (6)$$

Representing the process described by Equation (6) in the *ln k – 1/p* co-ordinate system a straight line is obtained with a slope of $tg\alpha=C_4$. As Fig. 3, 4 and 5 show the measured data follow the Arrhenius theory with an acceptable deviation for both products. In this respect C_4, which is energy akin to the so-called activity energy in chemical reaction kinetics, needed so that the drying process starts. Its value is in a reciprocal relation to the applied specific microwave power.

Conclusions

The specific microwave performance is the driving force of the internal moisture movement, fulfilling the same role in microwave conditions as the air temperature does in the convective water removal process.

The drying constant as a function of the specific microwave performance fulfills a similar function in microwave drying as the specific reaction rate in chemical reaction kinetics and it follows the Arrhenius theory of simple reactions.

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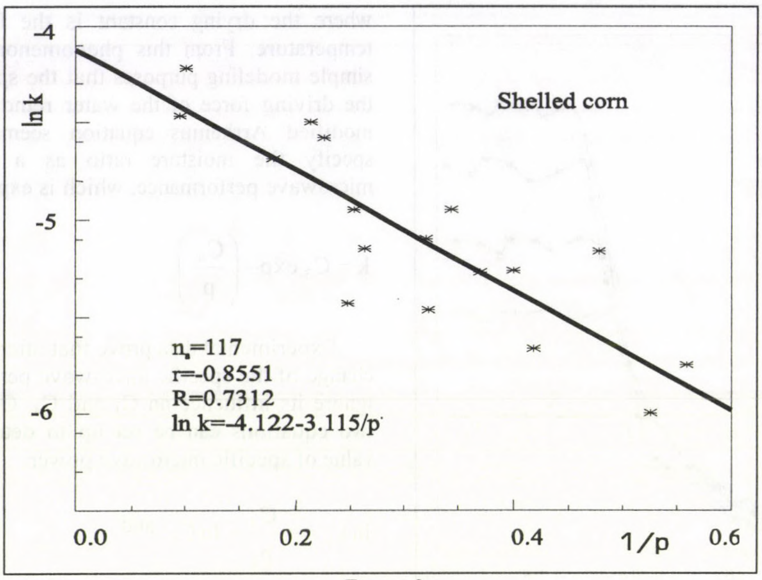

Figure 3
Drying constant of shelled maize as a function of the microwave performance

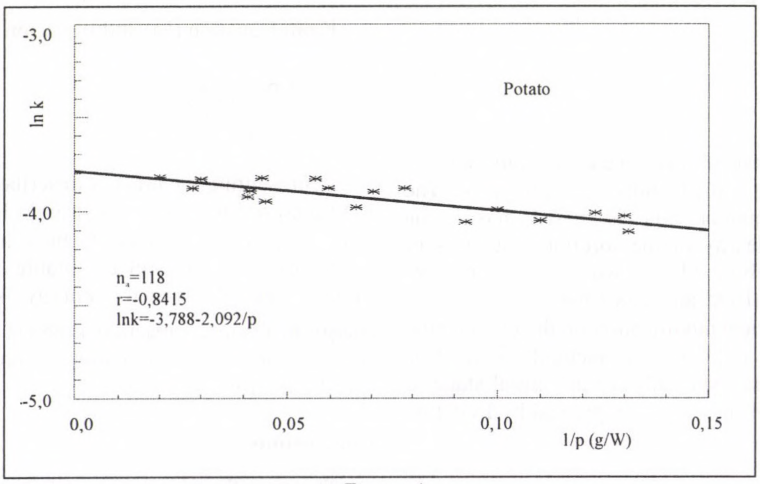

Figure 4
Drying constant of potato as a function of the microwave performance

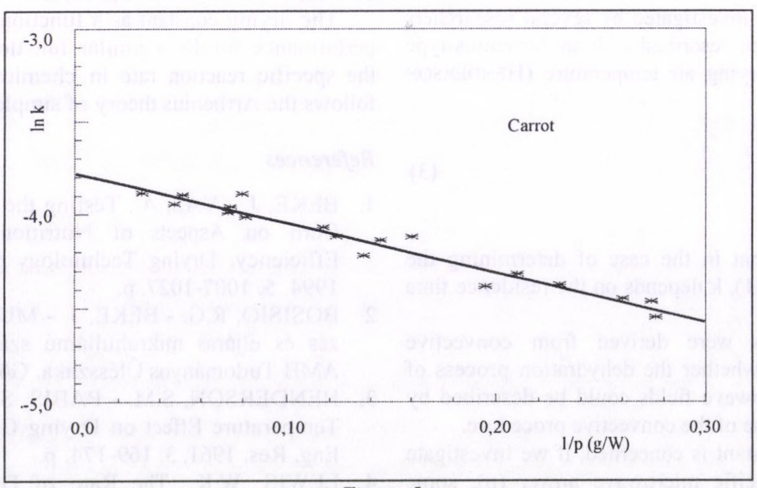

Figure 5
Drying constant of carrot as a function of the microwave performance

INVESTIGATION OF WHEAT KERNEL HARDNESS OF DIFFERENT VARIETIES BY MEANS OF MEASURING GRINDING RESISTANCE

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For determination of kernel hardness of different wheat varieties many testing procedures were developed. In this country the vitreousity percent became popular and applied by help of a simple shearing equipment and the so called „diaphonoscope".

Since the wheat hardness index is not only for the users very important but it has a great influence on the specific grinding energy requirement, too, that is why in this examination the wheat kernel hardness of different five varieties (GK-Öthalom, GK-Duna, GK-Tavasz, GK-Kata and Jubilejnaja 50 and one milling mixture named Izabella) were tried to be determined on the basis of the specific superficial grinding energy consumption ($kWh \cdot cm^{-2}$). Besides the approximative hardness ranges were also defined.

In principle it was checked that the different wheat varieries how fine grist and by and by what e_s ($kWh \cdot cm^{-2}$) specific superficial grinding energy demand do create, if the simple specific grinding energy requirement ($kWh \cdot t^{-1}$) is kept constant. This means the stabilization of Charpy's impact strength (or the permanent strain work) given directly to the grain kernels and particles.

Testing methods

To the grinding experiments a laboratory hammermill, type KD-161S made by the SALINA Ltd., Pusztaszabolcs, Hungary was used. The electric energy consumption (kWh) was determined by means of a CONRAD ELECTRONIC watt-hourmeter, type EKM 265. The upper limit of its power input has been 2,65 kW.

From the different wheat varieties six portions of 3-3 kgs were ground applying a screen of 4 mm hole diameter. Then samples were taken for sieve analysis which were carried out by help of a Ro-Tap machine, model AP-20. Particle mean size, average specific surface of grist and the specific surface increase ($cm^2 \cdot g^{-1}$) etc. were calculated acoording to the rules of mathematical statistics.

On the bases of Bölöni's earlier research (1996) the relevant data points within the range of $e_g = 1{,}9...2{,}1\ kWh \cdot t^{-1} \cong 2{,}0\ kWh \cdot t^{-1}$ constants were selected from the total 120 measurements. This way the relationship of e_s ($kWh \cdot cm^{-2}$) specific grinding energy consumption - as a „grinding resistance" - and of Δa_g ($cm^2 \cdot g^{-1}$) grist specific surface increase was evaluated at a „quasi" stabilization of the simple grinding energy requirement (e_g: $kWh \cdot t^{-1}$).

It has to be mentioned that net grinding energy demands were calculated by subtraction of the outside (electric) and inside (air friction of rotor) power losses.

Results and conclusions

The actualy stated wheat kernel hardness values - as average specific superficial grinding energy consumption e_s ($10^{-7} \cdot kWh.cm^{-2}$) - for five varieties and one milling mixture (Izabella) are to be seen Table 1.

In the last column of Table 1. the suggested hardness grades are shown. According to these data between the hardest- and the softest variety there is round 100 % difference in „grinding resistance".

The „changing" correlation of e_s ($kWh \cdot cm^{-2}$) specific superficial grinding energy demand and Q_g ($kg \cdot h^{-1}$) feed flow rate (Fig. 1) it is a surprise. Formerly it seemed to be constant. By the varieties of GK-Kata and GK.Öthalom e_s ($kWh \cdot cm^{-2}$) is still almost but with other varieties (GK-Tavasz, GK-Duna and Jubilejnaja 50) it is quite increasing. This phenomenon likely depends not only on the different kernel structures but also on the inside grinding mechanisme of the hammermill.

The relationship of e_s ($kWh \cdot cm^{-2}$) specific grinding energy consumption and Δa_g ($cm^2 \cdot g^{-1}$) grist specific surface increase is show in Fig. 2, while the specific grinding energy requirement related to the mass unit remains $e_g = 1{,}9...2{,}1\ kWh \cdot t^{-1} \cong$ constant. Since the scales of the coordinate axes are logaritmic that is why the angle of the oblique straight line makes 45^0 demonstrating the prevail of a first grade hyperbole.

Summary

The e_s ($kWh \cdot cm^{-2}$) specific superficial grinding energy demand shows up significant deviations depending on the wheat variety, if e_g ($kWh \cdot t^{-1}$) simple specific grinding energy requirement varies between[$e_g = 1{,}9...2{,}1\ kWh \cdot t^{-1}$ e.i. remains roughly constant around $e_g \cong 2{,}0\ kWh \cdot t^{-1}$.

The variety Jubilejnaja 50 and GK-Öthalom have the average „grinding resistance": $e_s = 0{,}566...0{,}541 \cdot 10^{-7}\ kWh \cdot cm^{-2}$. At the same time the vitreousity of these varieties is the highest: 79,4 and 81,0 %

At a similar vitreousity the varieties GK-Duna and GK-Tavasz are just on the fourth and fifth places, while the Izabella milling mixture of unknouwn varieties with its 59,9 % has the third, quite high „grinding resistance". Probably this was caused by the subjective uncertainity of the diaphonoscope measuring method.

Finally the softest variety became GK-Kata having the smallest specific grinding energy conxumption:
$e_s = 0{,}275 \cdot 10^{-7}\ kWh \cdot cm^{-2}$.

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Table 1

Kernel hardness ranges of tested wheat varieties

Sign	Variety	Vitreousity	Average specifis grinding energy requirement	Avarage specifis surface increase of grist	Avarage specific superfificial grinding energy consumption[(1)]	Kernel hardness grades
		V	e_g	Δa_g	e_s	
		%	$kWh \cdot t^{-1}$	$cm^2 \cdot g^{-1}$	$10^{-7} \cdot kWh \cdot cm^{-2}$	
1.	Jubilejnaja	81,0	2,09	36,9	0,566	hard
2.	GK-Öthalom	79,4	1,95	36,0	0,541	hard
3.	Izabella M	59,1	2,02	39,2	0,525	hard
4.	GK-Duna	79,4	2,05	40,2	0,510	semi-hard
5.	GK-Tavasz	81,3	2,28[(2)]	49,2	0,463	semi-hard
6.	GK-Kata	60,5	1,95	71,0	0,275	soft

Remarks: (1) Considered as „grinding resistance”

(2) That was the lowest specific grinding energy demand of the variety GK-Tavasz nearest to the arbitrarily taken upper limit: $e_g = 2,1 \cdot kWh \cdot t^{-1}$

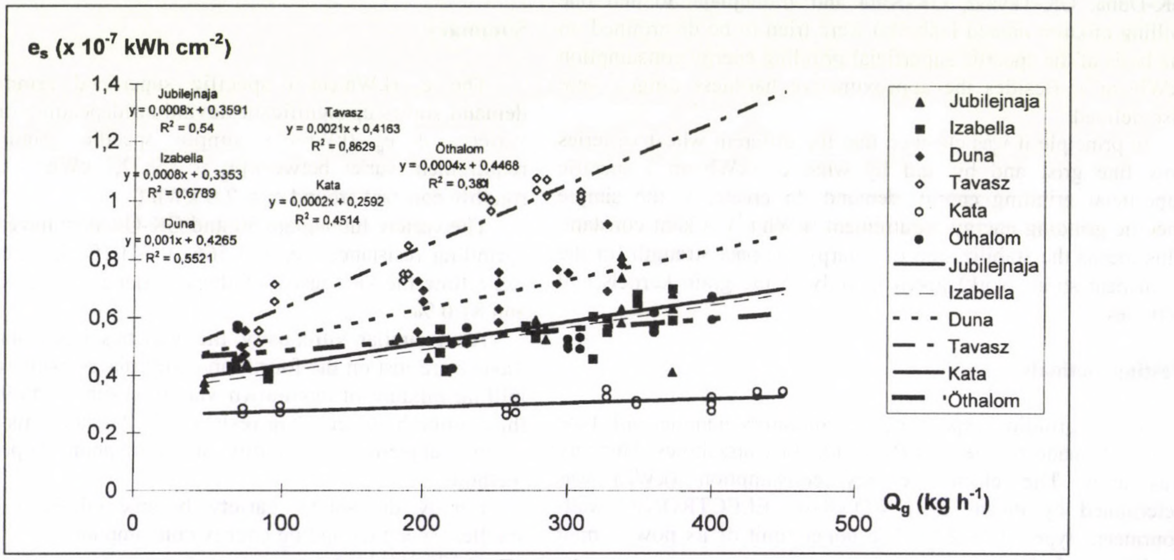

Figure 1

Specific superficial grinding energy requirement es (kWh.cm-2) vs. feed flow rate Qg (kg.h-1) with different wheat varieties

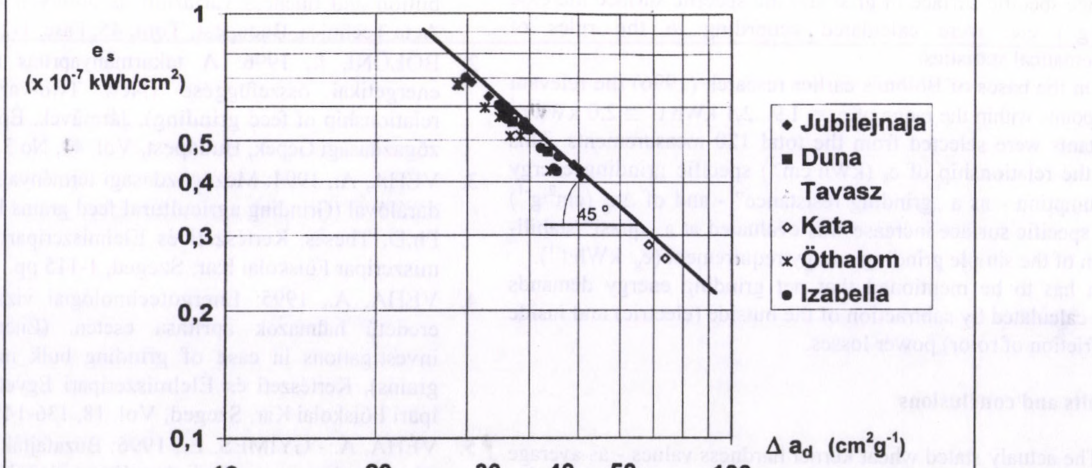

Figure 2

Specific superficial grinding energy consumption $_s$ (kWh.cm^{-2}) vs. grist specific surface increase Δa_g ((cm^2.g^{-1}) illustrated on power net with different wheat varieties, if e_g (kWh.t^{-1}) specific grinding energy demand is kept constant (e_g = 1,9...2,1 kWh.t^{-1}).

THE MYRIAD-MINDED WATER

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Abstract

Special structure of water and its bio-effects has been discussed in our present paper. Electromagnetic effects could modify the geometric arrangement (cluster structure) of water molecules. This influence could be positive or negative for the bio-systems, having large amount water content, depending on the character of interaction. We clarified the strong effect of magnetic- (vector-) potential on the properties of water: its evaporation-energy, viscosity and surface tension depends on the treatments. Our strategic aim to use these results in agriculture.

Introduction

One of the most important materials in our environment is the water. The water is the most common liquid on our globe, but in many respects it is abnormal: its thermodynamic parameters (melting point, boiling point, vaporisation-heat) make this material exceptional.

Water was mystic somehow in the human culture. It was the central material in many philosophies started by the huge old Greek philosophers, (Thales, Herakleitos) [1] through the various religions (the Tao from Far East, but it is well estabilished even in the catholic ideas as well), and it presents some enigmas in the modern techniques [2]. Furthermore the water gives some scientific surprises even in our modern era, because its structure is under continuously discussion, and not a surprise that a full series and a lot of other books are dedicated to the water itself [3, 4]. The thinking on the living processes must be formulated in the connection of the water:

For the biologist the water is the mother of the evolution, the matter which is the basic of life, furthermore it is the basic of energy production of the life in our globe,

$O_2 + 4H^+ + 4e^- = 2H_2O$

which proceeded by the radiation energy of the Sun, and without that the life would be entirely impossible.

For the chemist the water can be regarded as the material which is finally oxidized in the living process, and so it the ground state of the living reactions [5].

For the physicist the driving force of the life is the gradual energy loss of the electrons through the metabolic processes, to where the highly energized electron originated from the photosynthetic reaction and finishes in the lowest energy state, in the hydrogen-oxide (water).

In summary of the present introduction: the life is a processes in aqueous solution, the life has born from and died into the water, the life in the Earth is tightly connected with the water, which is its well balanced condition.

The aim

Better understanding of the water is an aim for ages. This is especially accentuated in the last decades of the XX-th century when the technique development and research of material science offers an exceptional possibility for the scientists. We would like to join to this trend with our present investigation. Our aim is to get better knowledge about the basic elements of the living processes by the water-studies, to investigate the physical structure of the living-cells processes and to analyze the effect of electromagnetic interactions. These investigation could reduce also damaging effects of electrosmog existing the whole environment.

The water molecule

The water formation from hydrogen and oxygen gives pretty high energy (the change of the free enthalpy between the mixture of the hydrogen-oxygen to the water is -57.8 kcal/mol), but a remarcable activation energy (104.2 kcal/mol) required for the reaction.

The water molecule (H_2O) is rather simple in its chemical composition. The quantum-mechanical description of the bonds between the oxygen and the hydrogens is also not very complicated [6]. The bonds schematics is shown in Fig.1. From the four electron-pairs two are bonding the hydrogen (proton) and two are alone (lone pairs, non-bonding pairs). Due the electrostatic effects the pairs are seeking to distribute their places homogeneously in the sphere around the oxygen. If the four electron pairs would be identical, the angle between them would be equal (109.5°). According to the non-equivalent bonds, the angle between the hydrogens is about 105°, while between the lone-pairs about 120.2°. This structure, a water molecule alone, is a non-regular tetrahedron in the space (Fig.2)

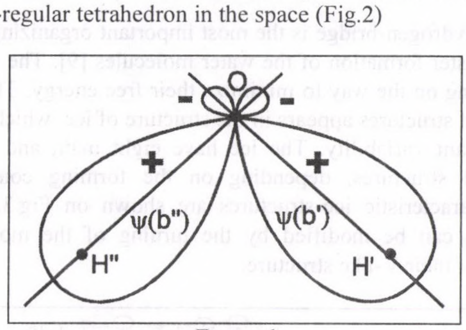

Figure 1
Schematic picture of the bonds in water molecule

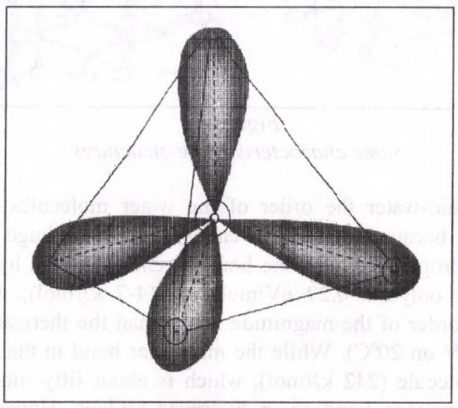

Figure 2
Water-tetrahedron in 3-dimension

The molecule has not only a special geometry, but a special physical property as well: due to the non-uniform distribution of the charges in the molecule, the system has a dipole-momentum in its original form, without any external electronic field. This dipole is not a simple one, arranged like two simple dipoles having a common positive pole. It means, that it has more complicated dipole-field than a simple dipole.

The water structure

The structure of the liquid water is definitely complicated, because connected with many unusual effects:

1. the hydrogen atoms could jump on the other oxygen, creating a so called hydrogen bond,
2. the dipole interactions and arrangements are not simple due to the above described V -like dipole structure,
3. the water tetrahedra can not fill the space properly, internal hole must be definitely appear.

These above are the points, which make the structure of water a very exiting problem.

The hydrogen bond is a special quantum-mechanical effect based on the migration of the proton (hydrogen ion) between the water molecules. This process means, that the proton itself is highly delocalized [7], which gives a chemical equilibrium:

$$2H_2O \rightarrow OH^- + H_3O^+ \qquad (2)$$

Not only the protons, but the electrons can also delocalized, forming the so called hydrated electron [8]

$$2H_2O \rightarrow H_3O^+ + e^-_{aq.} + OH \qquad (3)$$

The hydrogen-bridge is the most important organizing factor of the cluster formation of the water molecules [9]. The clusters are forming on the way to minimize their free energy. This type of ordered structures appears in the structure of ice, which shows a significant variability. The ice have eight main and several additional structures, depending on the forming conditions. Some characteristic ice-structures are shown on Fig.3. These structures can be modified by the turning of the molecules, because of their V-like structure.

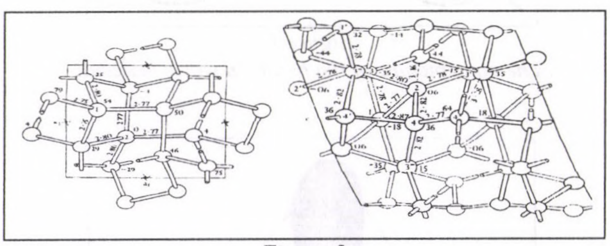

Figure 3
Some characteristic ice-structures

In liquid-water the order of the water molecules can not stabilized, because the thermal-energy destroys a huge fraction of the hydrogen-bridges. The bonding energy of the hydrogen-bridges is only0.17-0.29 eV/molecule (4-7 kJ/mol); which is only one order of the magnitude larger than the thermal energy (~0.025 eV on 20ºC). While the molecular bond in the water is 10 eV/molecule (242 kJ/mol), which is about fifty times more than the average bonding in hydrogen-bridges. However, the remarkable part of the hydrogen-bonds existing in the liquid even on the temperatures as high as its boiling point [10].

The existence of the clustering of water is well observable on the radial distribution function, measured by X-ray diffraction [6]. These measured hydrogen-bridges show, that the ice-structure not vanishing at once on the melting point, at first only some domains (like islands) are disconnected from each other, and at the increasing of the temperature these are gradually broken on the smaller and smaller domains. These domains are not static structures, they are fluctuating in their sizes, but the average is definitely characterising the actual state. This means, that the normal water, - having a gradual melting from ice, - has two structurally different phases: the monomer water-molecules and the water-clusters, Fig. 4.

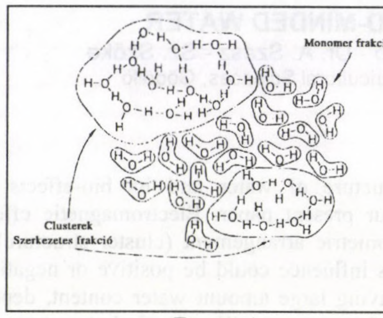

Figure 4
Two phases of the normal water

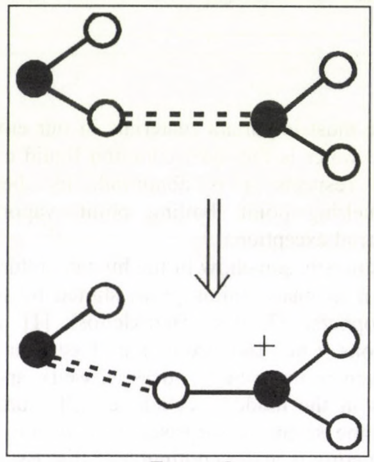

Figure 5
A schematic process of the hydrogen migration in water

A dynamic effect: frustrated connections

It is well known that the chemical equilibrium in aqueous solutions is based on a dynamic balance of the reagents. Water itself also defines a chemically equilibrium of the OH^- and H_3O^+ ions.

One of the most important dynamic equilibrium is included in the hydrogen-bridges. The hydrogen-ion (proton) which is involved in the bridge, migrates between the two oxygen molecules. It is in fact bounded in a double-well potential and does not strictly belong to one molecule alone. This means that the proton is frustrated: the tetrahedral bond-structure becomes bifurcated [11]. This effect offers path in the hydrogen network with lower energy barriers than the hydrogen bonds. This process reconstructs the actual network effectively and relatively fast. The frustration effect can be so intensive that the proton migration becomes delocalised for a large area, giving an instability in the liquid water. The structure of the water, from the point of view of the proton localization, is similar to a gel structure [12] which, regarding quantum mechanical effects, can be considered to be a so called quantum-gel state. Consequently, water itself is not homogenous is this meaning of hydrogen-bond either.

The proton migration effectively changes the geometry of the water-tetrahedron, (recall that the angle between two bonded hydrogen connected to the oxygen is approx. 105º, while between the hydrogen bridges it is approx. 110º and between the lone pairs approx. 120º). In this way the water-tetrahedron is not a fixed geometrical arrangement, but its edges are vibrating in accordance to the proton migration. Consequently it can be regarded a smeared or soft polyhedra in the duration of a considerable longer time period than the characteristic migration time.

This proton migration helped by an external electric field becomes dynamical, and more presents a corkscrew-like motion in the different structures (Fig.5.) and in the water is equivalent with currents, which means that the structural units can be influenced by the magnetic field. For example one mole of NaCl dissolved in water contains $6x10^{23}$ Na and $6x10^{23}$ Cl ions and is equivalent with 10^4-10^5 current–flow. The charge migration is not observable because the two type of charge is moving in the same direction and the effects are discharged, but only apparent because if we consider the system with different currents flowing in contrary sense we could describe like a whirlpool space. This space creates an extremely typical magnetic dipole system which results a vector potential changing.

The experiments

In the basic of this concept it is understandable the magnetic field influence to the water. As we mentioned above, and based on our admittance and about the publications in the scientific literature we aim in the GATE's Institute of Farm Machinery to examine the effects of electric fields and electromagnetic potential on the water. In our experiences we used freshly double distilled water. We expose the samples in electromagnetic field generated by solenoid- and biffilar-coils and we examined in comparison the properties of the treated and untreated water. We studied the samples by four methods:

- spectrophotometry,
- viscosity measurements,
- drop-weight method,
- evaporation experiments.

For the treatments we performed by two equipments:

- a logarithmic (Lakhovsky) aerial antenna,
- solenoid / biffilar coil.

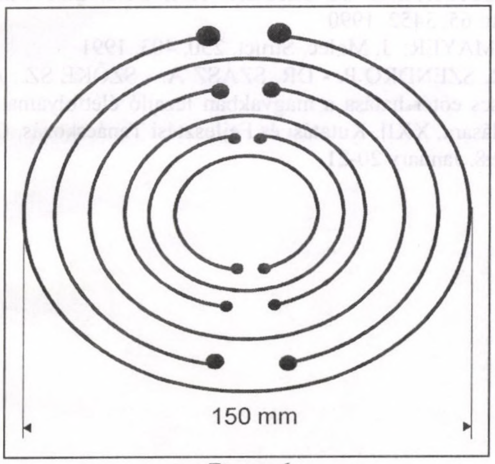

Figure 6
The Lakhovsky antenna

The Lakhovsky antenna (Fig. 6) is made from concentrically arranged circle-curved wires and the radius ratio: R_I / R_{I+2} = 1.618. On the each end of the circles metal sphere had been mounted. The solid wires have 2 mm diameter. The wire with the biggest diameter is supplied with high voltage discharge. This antenna radiates Hertz frequency from 10 Ghz and up to 100 Thz. Nearby the aerial the magnetic field intensity is so low that we don't need to take into consideration. The intensity of magnetic vector potential is much bigger. The situation is the same in the case of biffilar coils. Biffilar coil is made from two solenoids turned with the same coil pitch, but the sense is contrary. The two magnetic fields from two solenoid coils are canceling each other. In that situation only the vector potential influences the water put in interior of the biffilar-coil.

Results

In the spectrophotometrical experiments our team examined the absorbance and transmittance capability of the treated and untreated water. We found a decrease of the transmittance of treated water by with 5-10 % (Fig. 7).

With the drop-weight method we inspected the mass changing of the treated water. The measured quantity in each experiment was 500 drops. Based on 50 repetition we observed that the mass of treated water drops increased significant (Fig. 8).

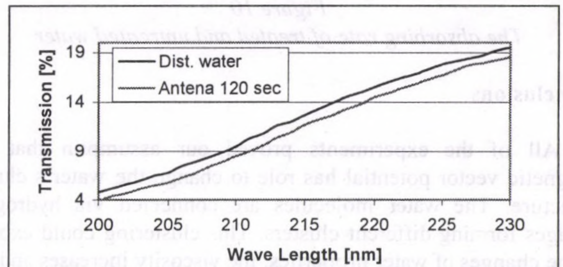

Figure 7
The transmittance of treated and untreated water

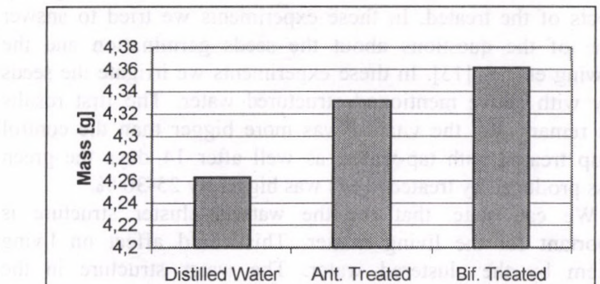

Figure 8
The mass of the treated and untreated water

The surface energy were examined by the evaporation rate of the treated and untreated water. We did the measurements at the same temperature on a precision-type balance (the measuring precision is 100 □g). The results were recorded by computer in every 3 minutes. The dynamics of the evaporation is presented on Fig. 9.

By the viscosity measurements of the untreated respectively the treated water we followed two methods. First we used a special viscosymeter and a simple absorbing method using absorbent paper. The viscosity changed in all cases about 10 %. The result of this experiment is presented on Fig. 10. The diagram shows the absorbed quantity in units of time, and we can easily register the viscosity difference between the distilled and electromagnetically treated water.

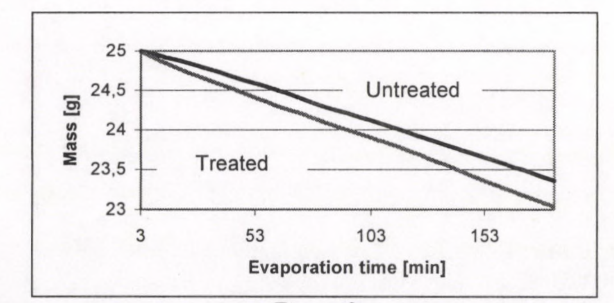

Figure 9
The evaporation velocity of treated and untreated water

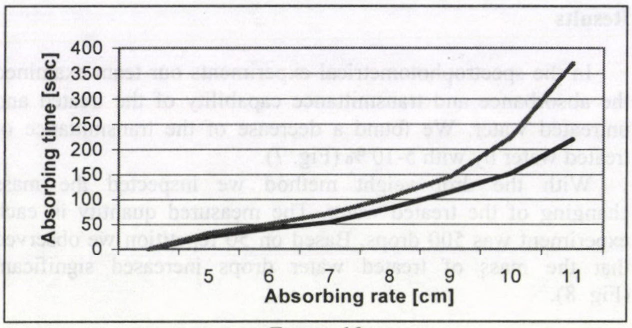

Figure 10

The absorbing rate of treated and untreated water

Conclusions

All of the experiments proved our assumptin that the magnetic vector potential has role to change the water's cluster structure. The water molecules are connected via hydrogen-bridges forming different clusters. This clustering could explain some changes of water properties: the viscosity increases and the surface tension decreases by the treatments, moreover the treated water could form bigger drops, evaporates more rapidly and the absorption increases.

Our research team moreover examined the biologically effects of the treated. In these experiments we tried to answer some of the questions about the seeds germination and the growing energy [13]. In these experiments we irrigate the seeds only with above mentioned structured water. The first results was remarkable: the vitality was more bigger than the control group treated with tap-water, as well after 14 days the green mass produced by treated seeds was bigger by 25-30 %.

We can state, that for the water's cluster structure is important for the living matter. This could affect on living system by the clustered water. The water structure in the different vegetables, fruits and living organisms is clustered. Could be possible that not only the vitamins and minerals from the plants are important, the clustered water of the plants has significant importance for people health.

Suggestions

The structural and electrodinamical properties of the water still is concealing many inherence. We are convinced that in the biology in the future the water structure will be the main target of the researchers. For that reason our team would like to continue to find out more structural properties about the water and its influence to the biological matters. This has an essential importance to get answered many of the biological questions and to understand better the living matter behavior moreover to manage better with the water stocks.

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DETERMINATION OF LACTATION CURVES ON THE BASIS OF DAILY AND MONTHLY MONITORING

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Summary

The authors seek for the answer to the question how the controlling milking frequency - daily and monthly monitoring - influences the lactation curve determination as the accuracy of milk quantity measuring is effected.

According to the domestic practice the individual milk production of the cows are determined on the basis of monthly controlling milking. Mechanical milk quantity measuring instrument (TRU-TEST) is used which has an error less than 2 %. In practice the error may be even as high as 5 % under extreme conditions.

Based on modelling and measurements the authors arrived at the consequence that it is enough to use less expensive 3-5 % accuracy milk quantity measuring devices with computerised data acquisition systems in the case of two milk quality measurement daily.

Introduction

In dairy farms it is of ultimate importance to determine the individual performance of cows for breeding purposes. In breeding stocks it is especially important to record the life performance as the age of the cows increases on the basis of yearly change. The individual milk production is determined by the monthly controlling milking in national level.

Materials and methods

In a herd of 600 cows was examined in the Fábiánsebestyén farm. The accuracy of the monthly controlling milking was monitored such a way that the individual milk quantities were compared to the total collected milk quantity in the milk tank. Of course, the milking processes, the ill cows and other disturbing factors were carefully taken into account.

The is a milk quantity measuring system in the Kiscséri-puszta dairy farm of the Enying share company which measures milking by milking. The data produced by this system was used to study the individual milk measuring curve, the group average curve and the changes of the herd average curve.

Making use of the previous operation data modelling was carried out to find out how the allowed measuring error of the milk measuring device can be increased in % if two measurements are carried out daily instead of the one monthly.

Results

At pipeline milking systems and milking stands the mechanical milk measuring devices combined with flow-through system volumetric sampling appliance has spread (TRU-TEST). They have the advantage of simple design. In theory they can brake down only in the case of breaking and mechanical damaging. The laboratory precision category of them is around 1 %. The measuring precision, however, is influenced by the fat content of the milk, the circumstances of measurement (levelling, the position of vacuum and milk tubes, etc.). In extreme conditions the error may be as high as 3-5 %. A significant fluctuation is experienced in the daily individual milk production of the cows (see Fig. 1 and 2). The main influencing factor is the weather and the feeding but health and other environmental factors (such as illness, selection and grouping, regrouping of the animals, etc.) have effects also. The deviation in the daily milk production can be considered acceptable if it is below 20 %. The lactation curves can be well characterised by mathematical formula (Fig. 3). The average lactation curve recorded in the level of a dairy farm (for 80-100 cows) has great deviation. Within a group a similarly great deviation can be experienced which is smaller for groups selected according to production. In the case of a given individual cow considerable differences can be found due to the previously anomalisms.

If one monitoring milking is made monthly there is a probability of making the controlling milking on aberration days (Fig. 4). The measuring data recorded in such an occasion may distortion the lactation production the shape of curve. The problem is greater if the recorded data are used to production rated feeding in the next period. The negative deviation results in insufficient feeding and the positive deviation in luxury consumption.

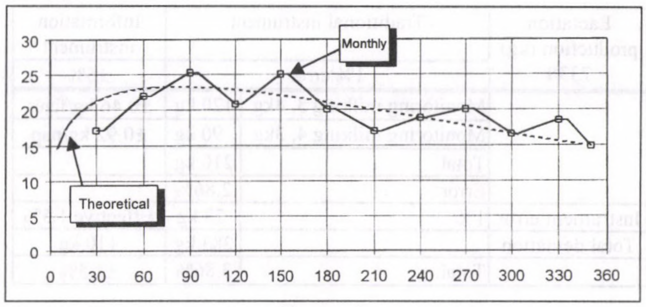


Figure 1

Monthly monitoring measurements and the theoretical lactation curve

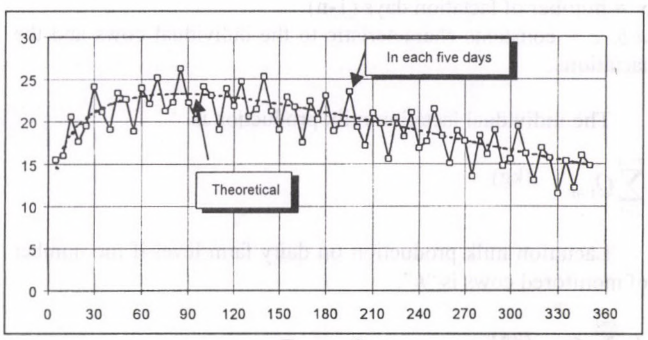


Figure 2

Monitoring measurements in each five days and the theoretical lactation curve

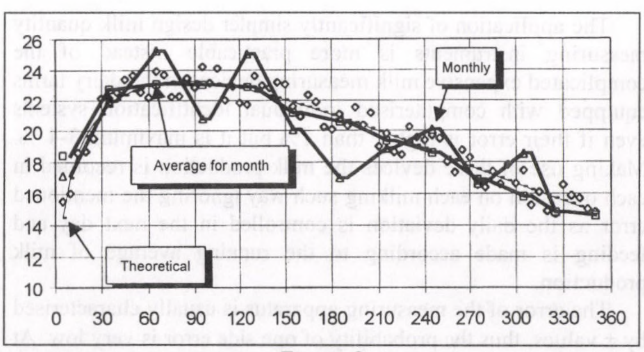


Figure 3

Curves of the theoretical, the monthly average computed from measurements in each five days and of the traditional monthly controlling measurements

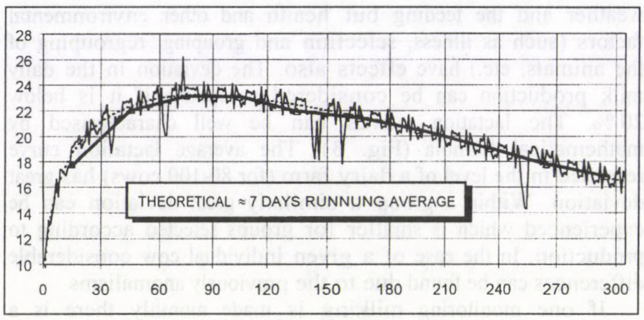


Figure 4

Lactation curve drawn on the basis of daily measurements

Error of 1 % accuracy instrument for monthly monitoring milking of two occasions and the lactation error of daily measurement with 5% accuracy at a 7338 kg lactation production cow

Lactation production (kg) 7338	Traditional instrument 1% error		Information instrument ±5%
	Monitoring milking 3, 4kg	120 kg	±0.46 kg/fejés
	Monitoring milking 4, 3kg	90 kg	±0.92 kg/nap
	Total:	210 kg	
	Error:	2.86%	
Instrument error	1%	73 kg	Effective 1.5%
Total deviation		283 kg	110 kg
	Total:	3.86%	±1.5%

$$Q = x^{a} \cdot e^{b \pm cx} \quad \text{(kg)}$$

where

Q = daily milk production (kg)

x = number of lactation days (1-n)

$a;b;\ c$ = constants characteristic to the individual cows and the lactations.

The individual lactation milk production is

$$\sum_{x=1}^{x=n} Q_{1-n} \quad \text{(kg)}$$

Lactation milk production on dairy farm level if the number of monitored cows is "*k*":

$$k \cdot \sum_{x=1}^{x=n} Q_{1-n} \quad \text{(kg)}$$

Discussion

The application of significantly simpler design milk quantity measuring instruments is more practicable instead of the complicated expensive milk measuring devices in the dairy farms equipped with computerised individual identification systems even if their error is higher than 1% but it is maximum 3-4 %. Making use of these devices the milk production is recorded in each occasion on each milking such way ignoring the mentioned error as the daily deviation is controlled in the next day and feeding is made according to the running average of milk production.

The error of the measuring apparatus is usually characterised by ± values, thus the probability of one side error is very low. At the same time the large number of measuring values - 500-600 within a lactation - gives similar safety as the fewer number of data (20-30 in a lactation) recorded by higher accuracy device. Mathematically the large number of measuring values gives higher safeness and less possibility of misfeeding and it means also considerably less expensive investment and operation.

It would be a task to qualify and accept such measuring systems in given place under practical circumstances.

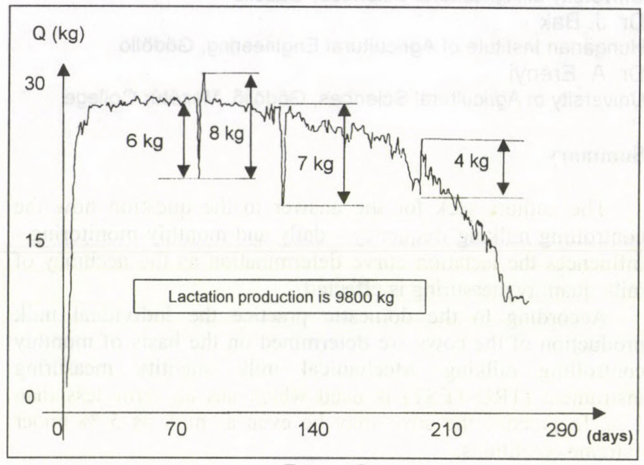
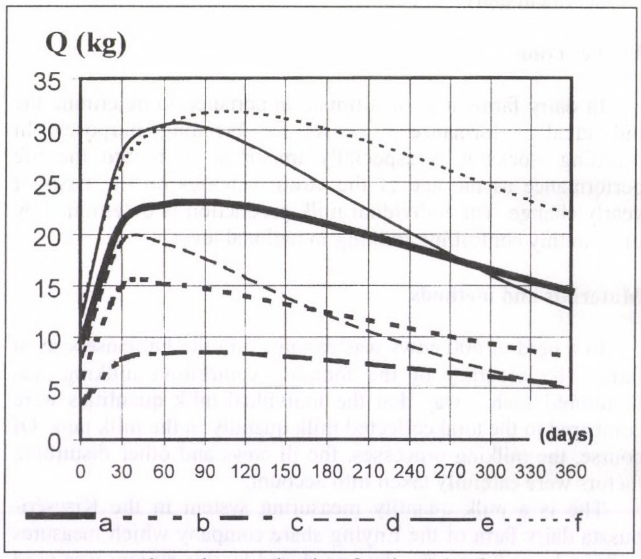


Figure 5

One or two days production decreasing experienced with an individual cow in a whole lactation



a = lactation production for the dairy farm;

b - … - f = individual lactation curves

Figure 6

Dairy farm level and individual lactation curves on the basis of statistic relationships

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COMBINED ENERGY TRANSFER (MICROWAVE-CONVECTIVE) BY DRYING OF AGRICULTURAL MATERIALS

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Introduction

The microwave heat transfer is a considerably more advantageous procedure in contradiction to the traditional methods as a result of the possible quantity of the energy stream which is transportable in the mass unit of the material and the uniform temperature distribution developing in the material. With the help of this method numerous procedures can be carried out faster when applying a continuous technology and a lower energy consumption as well, ensuring a better product quality. The fundamental problem of the microwave material processing is to assure the uniform distribution of the electromagnetic field. According to the one possible version of the know methods and technical solutions, the uniformity can be increased by introducing the microwave energy into the operating field at two perhaps three places. In the procedure developed by us this technology was improved with a uniform mixing of layers in the inhomogeneous electromagnetic field produced by moving the vibroaerofluid layer of the material under treatment. Since the effective relative loss factor (ε''_{eff}) of the food powders is generally low, therefore, the degree of the energy absorption was increased by rewetting the material. In the course of this process the agglomeration of the powder takes place and a capillar porous structure is produced which considerably increases the solubility characteristics. A bactericidal effect is also attained as a result of the release of the intensive energy in the form of heat.

1. Experimental conditions

Our experiments were performed in a factory-scale equipment running intermittent by getting the rewetted powder onto the gas distribution grids of the equipment vibrated in the vertical plane is the essence of the procedure. Hot air is transported through the layer and simultaneously the microwave energy is irradiated from above into the vibroaerofluid layer. The built-in microwave power was **P=5kW** at a frequency of **f=2,45GHz** and 6 magnetrons were applied. The operating field was shaped in the form of a cavity resonator. The energy input at three places results in the formation 10 modes at least for the given resonator size **/570x750x610/**. Microwave energy transfer was applied in pulse mode in two cycles:

• In the first period of the first cycle an irradiation of maximal power was applied until the attainment of the thermoplastic temperature of the material. Then the microwave energy transfer was stopped in the second period of the cycle.

• At the end of the second period in the first cycle magnetrons were re-switched, but the energy transfer took place at a reduced power. As the temperature of the material reached a constant value, the second cycle was finished.

Overheating was inhibited by means of a low temperature air flow through the layer. Simultaneously with this air flow, the transfer of nascent vapours was also performed. The operating time and the specific power expressed in the dry product were measured as well.

The physico-chemical and microbiológical characteristics of the powder were determined at the end of each experiment. As a result of each experimental adjustment a well soluble product was obtained and the total germ count decreased by two-three orders of magnitude as compared to that of the initial powder.

2. Procedure of mathematical-physical modelling

2.1 Specific power and operating time as a function of agglomeration-drying process

Procedure of the agglomeration-drying of combined energy transfer and vibroaerofluid layer is influenced essentially by seven coefficients wich can be called factors.

- initial moisture content after rewetting the powder: **X_S**, kg/kg (factor **X1**),
- specific microwave energy referred to unit surface: **P_S**, $kW.m^{-2}$ (factor **X2**),
- specific grid load: **m_S**, $kg . m^{-2}$ (factor **X3**),
- densitiy of air mass flow: **$\phi_{a,m}$**, $kg.m^{-2} \cdot S^{1}$ (factor **X4**),
- air temperature: **T_a** K (factor **X5**),
- amplitude of vibration: **A** mm (factor **X6**),
- oscillating frequency: **f** s^{-1} (factor **X7**).

Variational intervals of the parameters were determined for all the factors in preliminary experiments and three levels, a lower (**A1**), a middle (**A2**) and an upper (**A3**) levels were chosen. Since the number of the experimental adjustments belonging to the three levels of the seven parameters is great (3^7=**2187**), therefore such method for designing the experiments was selected by wich the number of experimental adjustments can be reduced significantly. The physical meaning of the procedure can also be revealed as a result of experiments performed with this method. Experimental adjustments for the seven factors and their three levels were realized on the basis of a matrix constructed according to Latin cube. There are **27 experiments**, i.e. **9 adjustments** for each factor and level. Measuring the value of the response function (**y**) , the average value of the measured results for each factor and level can be determined using the relationship [1].

$$\bar{y}_{e,n,i} = \frac{\sum_{1}^{9} (y_{e,n,i})_{A_i}}{9} \qquad (1)$$

where $(y_{e,n,i})_{Ai}$ is the obtained experimental result for each level and factor, **n** and **i** are the numbers and the level of the factors, respectively.On the basis of the obtained values ($\bar{y}_{e,n,i}$) a regression analysis was carried out to characterize the interaction between the **7 parameters** - wich influence the agglomeration-drying process - and the specific power moreover the operating time. The mathematical-statistical analysis was performad with seven regression equations (*linear, hyperbolic, different exponents, exponential, inverse hyperbolic, quadratic polynomic and inverse polynomic*). The value of the regression coefficient was determined for each equation. A data matrix was constructed to facilitate the data processing and the statistical evaluation [Fig.1].

The effective functionality can be selected considering the results of the statistical evaluation made with the results of the seven equations determined for each factor and the physical meaning of the model. Substituting the optimal values of each parameter into equation [2] the value of the response function can be calculated. In a complex manner, this equation reflects the influence of the individual factors on the specific power and operating time.

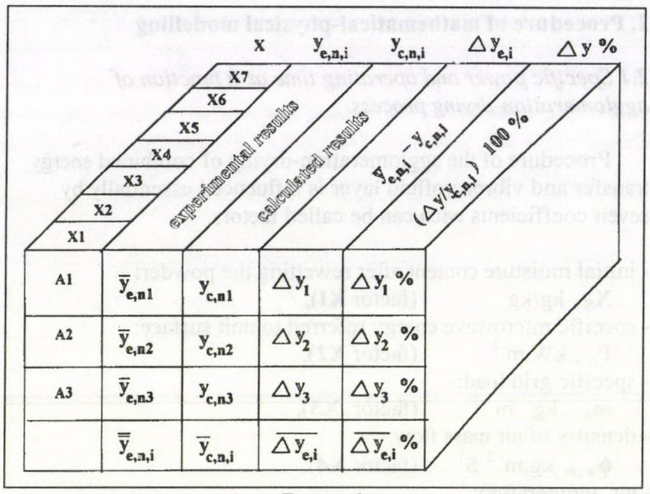

Figure 1

Data matrix for processing the experimental result

$$y_p = \frac{\prod_{j=1}^{n} f(y_j)}{\left(\sum_{l=1}^{k} y_l\right)^{n-1}} \qquad (2)$$

where $f(y_j)$ is the effective function for each factor, y_l are the values belonging to the individual experiments adjustment, while **k** and **n** are the numbers of experiments and factors, respectively. It can be stated of the functionality determined on the basis of experimental data that the specific power, i. e. the intensity of the process is essentially determined by the specific microwave energy and the amplitude of the vibration.

2.2. Physical-mathematical model for the determination of operating time

Kinetics of agglomeration-drying process - the time dependence on the moisture content and that on the temperature - was carried out to determine the operating time. During our experiments samples were taken at given intervals and their moisture content was determined. This was performed in every experimental adjustment, data were recorded on floppy-disks and the drying curves were drawn. The drying curves are plotted in **Fig. 2** for three characteristic experiments. In these experiments the values m_s, x_s, and x_f were constant, but the operating parameters (**P_s , T_a , etc.**) changed.. The processing was performed in a pulse mode as it was mentioned before.

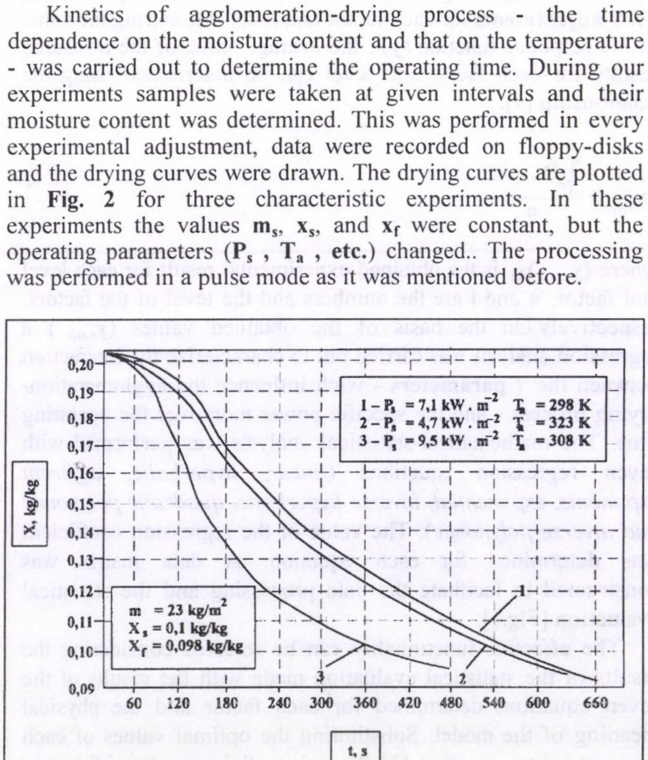

Figure 2

Drying curves of the plasma powder at different operating parameters

Drying curves are suitable for evaluating the operating time if critical moisture content values are known. These values determine the characteristic points of the drying process. **V.V.Krasznyikov's** hypothesis was used for our experiments. According to the theory, in the case of a given processing the **t/t_a** value is constant for all momentary moisture content x under conditions **m_s=const**. and **x_s=const.** and **x_f=constant**. During time intervals t and t_a the moisture content changes from x_s to x and from the initial x_s to the final x_f values, respectively. The above hypothesis was verified by our examinations, therefore, the t/t_a value can be accepted as a united parameter. This is proven by **Fig. 3**, where only one curve, the united drying curve, was obtained in the coordinate system **(x-x_e) - t/t_a**. Where x_e represents the moisture content at equilibrium.

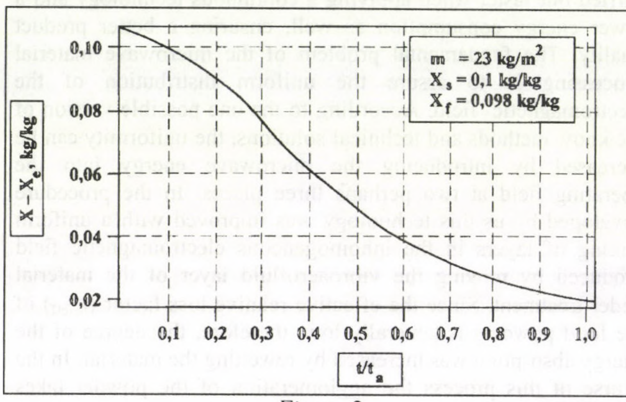

Figure 3

United drying curve of the plasma powder

Therefore only one drying curve is enough to be determined and from this a series of such curves can be constructed for other process parameters considering the given limits. Since the relationship between t_a and process parameters can be determined according to equation [2], the operating time can be calculated for any process parameter. The united drying rate curve was on the basis of the united drying curve and experimental data [Fig. 4].

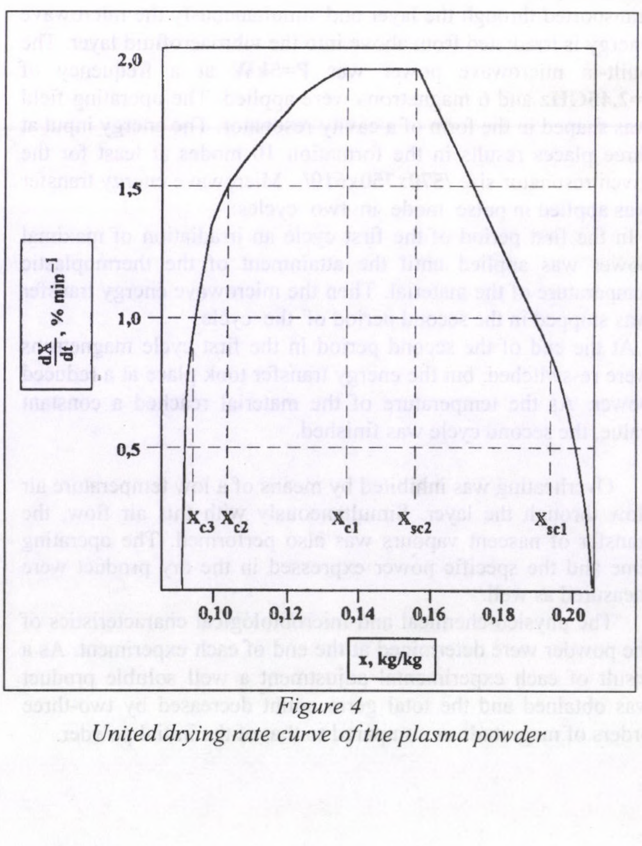

Figure 4

United drying rate curve of the plasma powder

Plotting the united drying curve in the coordinate system **ln (x-x$_e$) - t/t$_a$**, straight lines are obtained the intersections of wich correspond to the values of the critical moisture content.

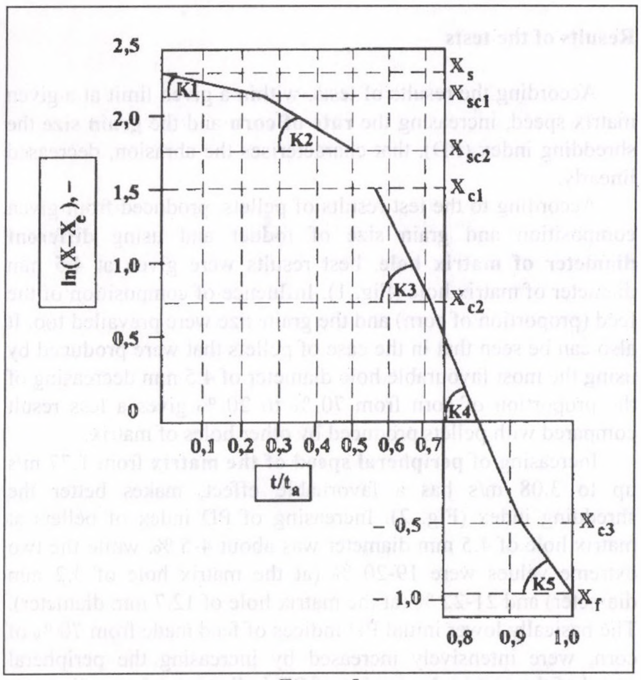

Figure 5

United drying rate curve in the cordinate system ln (x-x$_e$) - t/t $_a$

Critical moisture contents and relative drying coefficients can be determined from the equations. By means of these values the length of the **first period** with maximal energy transfer (t_1) in the first cycle can be calculated by the equation [3]:

$$t_1 = \left[\frac{1}{K_1} \ln \frac{X_S - X_e}{X_{SC1} - X_e} + \frac{1}{K_2} \ln \frac{X_{SC1} - X_e}{X_{SC2} - X_e} \right] \cdot t_a \quad (3)$$

where t_a is the operating time wich can be calculated from equation [2]

Relative drying coefficients (K) and cricital moisture content values (x_{cl}) can be determined also for sections of decreasing drying rates.Length of the second period of the procesing (decreased energy transfer) can be calculated with the equation:

$$t_3 = \left[\frac{1}{K_3} \ln \frac{X_{C1} - X_e}{X_{C2} - X_e} + \frac{1}{K_4} \ln \frac{X_{C2} - X_e}{X_{C3} - X_e} + \frac{1}{K_5} \ln \frac{X_{C3} - X_e}{X_f - X_e} \right] \cdot t_a \quad (4)$$

Restarting time of the magnetrons is given with:

$$t_2 = t_a - (t_1 + t_3) \quad (5)$$

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EFFECT OF TECHNICAL CHARACTERISTICS ON THE QUALITY OF PELLETS

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Preliminaries

The quality of pelleted fodder mixture as end-product depends on number of factors. Knowing of the influence of these factors has a basic importance in order to produce pellets of physical characteristics that can preserve their shape and low inclination to shredding during transport storage and other processing before using them up.

Problems of industrial scale pellet producing and influence of technologies have been experienced for many years of testing carried our Institute. Taking the above mentioned into consideration investigations were carried out concerning material characteristics as well as some parameters of the machine of pellets in the frame of number T 013144 theme.

Method

Investigations were carried out by CPM-CLP-3 type laboratory size pelleting equipment in one hand and by CPM 7726-7 type pelleting machine on the other one. In the latter case the feed had been expanded by OE.30.2. type equipment.

Conditioning was solved by using water addition at **laboratory size pelleting machine.** Cross-section of the matrix hole (27-28.5 cm^2) and the discharge coefficient (0.27-0.28) were near constant.

Technical data of the matrixes were as follows:
- diameter of hole (d): 3.2.-4.5.-6.0 and 12.7 mm
- long of hole (L): 19.1-25.4-31.7 and 50.8 mm

Peripheral speed of matrixes could be adjusted in four grade between 1.33-3.08 m/s.

During the test, carried out by **OE.30.2. type expander**, mainly the influence of changing of pressure was followed with attention (0-5-10-15-20-25-30 bar).

Other influencing factors as the adjusted output (16.2-16.5 t/h), volume of added water (0.8-1.0 kg/min), conditioning temperature (76-80 °C) and the expanding temperature (96-103 °C) were kept on constant level.

Pellet producing, following expanding, happened by **CPM 7726-8 type pelleting machine** with steam conditioning.

Technical data of the matrix at pellet producing were as follows:
- diameter of hole (d): 5 mm
- long of hole (L): 50.8 mm
- peripheral speed: 6.6 m/s

Physical state of the produced pellets were characterized by their inclination to shredding (PD index) and the crumbling force (hardness).

Determination of the PD index was carried out by **Q-Tester** , according to the standard of our Institute No MÉM MI 39-71-3-1-80 in compliance with the foreign standards.

For determining the crumbling force (hardness) the **KAHL type hardness measure meter** was used.

Pellets were produced from mixtured fodder of different composition. During laboratory tests proportions of corn-wheat were 70:12.5 %, 40:27.5 % and 20:37.5 %.

Measures of grain size were d_{50} = 0.5-1.5 and 2.5 mm.

Unequality coefficients (U) of the fodder mixture varied between 1.1-1.5 showing that the mixture was compiled from grain of same size.

During operation tests the corn-wheat proportions were 50: 18 %, 18: 50 % and 8: 60 % at a given feed.

The average grain size was 0.8-0.9 mm while the unequality coefficient was 4.2-4.6.

Results of the tests

According the results of tests, within a given limit at a given matrix speed, increasing the **rate of corn** and the **grain size** the shredding index (PD), that characterises the abrasion, decreased linearly.

According to the test results of pellets, produced from given composition and grain size of fodder and using **different diameter of matrix hole**, best results were given at 4.5 mm diameter of matrix hole (Fig. 1). Influence of composition of the feed (proportion of corn) and the grain size were prevailed too. It also can be seen that in the case of pellets that were produced by using the most favourable hole diameter of 4.5 mm decreasing of the proportion of corn from 70 % to 20 % gives a less result compared with pellets produced by other holes of matrix.

Increasing of **peripheral speed of the matrix** from 1.77 m/s up to 3.08 m/s has a favoruable effect, makes better the shredding index (Fig. 2). Increasing of PD index of pellets at matrix hole of 4.5 mm diameter was about 4-5 %, while the two extreme values were 19-20 % (at the matrix hole of 3.2 mm diameter) and 21-22 % (at the matrix hole of 12.7 mm diameter). The basically lower initial PD indices of feed made from 70 % of corn, were intensively increased by increasing the peripheral speed of the matrix. Increasing of PD indices at 4.5 mm diameter of pellets were 11-12 % while in extreme cases were 27-28 % (∅ 3.2 mm) and 45-46 % (∅ 12.7 mm). These results show the possibilities that are hidden in the suitable exploitation of the machine and the technology.

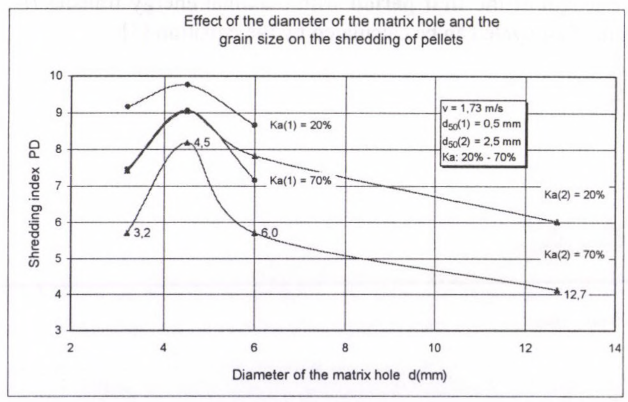

Figure 1

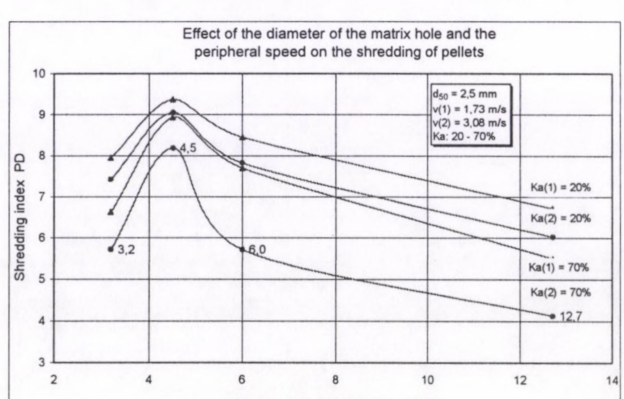

Figure 2

Compared the test results, concerning PD index of pellets produced with **laboratory size pelleting equipment**, with the similar results of the plant pelleting machine taking into consideration only the corn proportion, we can observe a quite similar tendency (Fig. 3). This means that test results of laboratory size pelleting machine can be utilized well at operational tests of pelleting technologies.

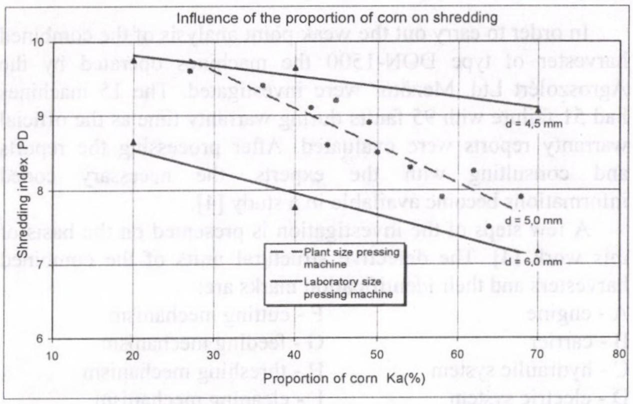

Figure 3

During our research work tests, carried out under operational conditions, were directed to examining the effect of the expander pressure on the physical properties of pellets. Changing the expander pressure the initial average grain size of fodder also was increased and the typical d_{50} = 0.8 mm average grain size reached the 1.4-1.7 mm measure after expanding the fodder on 30 bar pressure. The lower value was happened at the corn content of 50 % while the upper one at 8 %.

Pelleting the increased pellets of grain size, owing to the higher expander pressure, the ratio of shredded material showed a decreasing tendency. This concretely means that the shredding ratio decreased by 40.5-38.5 % at producing feed with 50 % or 8 % corn content concerning the pellet producing without expanding.

Increasing of expander pressure is also favourable as for stability characteristics of pellets. Both the **shredding index (PD)** and the **crumbling force of pellets** show a lineary increasing with expander pressure (Fig. 4). Influence of composition, as it was known above, in this case was also succeeded.

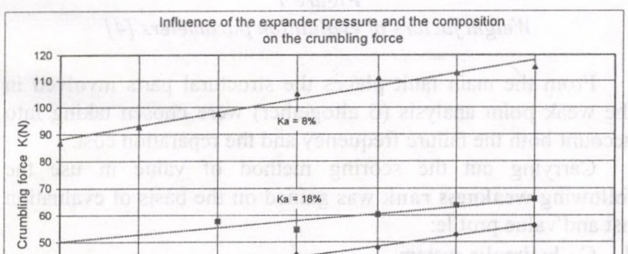

Figure 4

Searching for the **connection between** the **PD index**, that can be determined in laboratory circumstances, and the **crumbling force**, that can be measured under operational conditions, it can be stated that there is a tight linear connection between the two kind of stability characteristics at a given composition and the expander pressure range (Fig. 5).

Changing of crumbling force between 32-57 N pertain to changing of PD index of 6.4-8.4 value at 0-30 bar expander pressure in the case of pellets with 8 % corn content, crumbling force of 88-116 N pretain to 8.1-9.8 PD index. 1 N of crumbling force increasing results 0.08 or 0.057 value of PD index rising.

This proves our former statement that pellets with initially favourable, stability characteristics can be improved better specifically by expanding.

On the basis of the tight connection between the **crumbling force** and **shredding index**, that were determined in examinations with 5 mm diameter of pellets of 16 kind of feed at near **constant** (15-20 bar) **expander pressure**, values of crumbling forces, proper to the suitable range of PD indices, can be determined. Crumbling force, at the same time, can be measured by a simpler hand-operated measuring tool at the site of the pellet producing plant (Fig. 6).

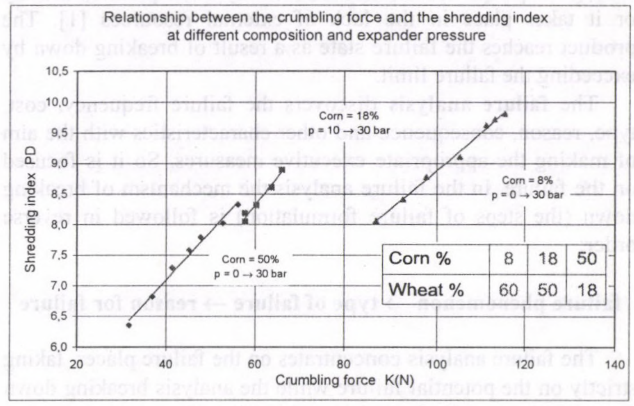

Figure 5

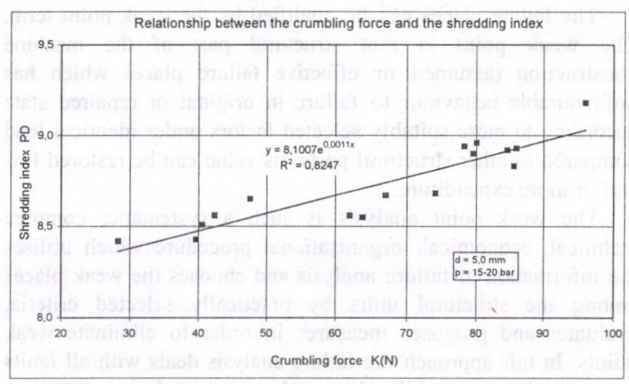

Figure 6

Conclusions

Results of researches have proved that shredding index (PD), that characterizes the abrasive stability of pellets, and the connected crumbling force (pellet hardness) can be improved by means of material characteristics, pelleting technology and heat treatment that came before pelleting. Proportion of corn and decreasing of the grain size cause increase linearly of the PD indices of pellets. Increasing of peripheral speed of matrix improves the shredding stability of pellets. Hole diameter of a given equipment can be choosen optimally.

Shredding index and crumbling force of pellets can be risen by increasing of expander pressure.

Relationship between the crumbling force (K) and the shredding index (PD) at constant expander pressure, diameter of matrix hole and changing composition, can be described well by the function of $PD = 8.1007 e^{0.0011 K}$ ($R^2 = 0.8247$).

The closed relation between the inclination to shredding and the crumbling force **can be utilized directly in the fodder mixture plant** because the crumbling force can be determined during the pelleting process quickly and so some technological parameters can be changed at once in the interest of producing the required pellets of hardness or PD index. During the production of harder pellets it is possible to decrease shredding and in this way the transport and storage of the product can be made more economic.

FAILURE AND WEAK POINT ANALYSIS OF COMBINED HARVESTER

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Introduction: The terms and definition of failure and weak point analysis

The **failure** is that **state** of a product in which the product can not meet the prescribed functions, except if this state occurs during the preventive maintenance or any other planned activity or it takes place in the lack of external resources [1]. The product reaches the failure state as a result of breaking down by exceeding the failure limit.

The **failure analysis** discovers the failure frequency, cost, type, reason, consequence and other characteristics with the aim of making the appropriate executive measures. So it is focused on the failure. In the failure analysis the mechanism of breaking down (the steps of failure formulation) is followed in reverse order:

failure phenomenon → type of failure → reason for failure

The failure analysis concentrates on the failure places, taking strictly on the potential failure while the analysis breaking down process relates to the faults have taken place. In our investigation the term of failure analysis is used in a general sense.

The failure places can be qualified by the weak point term. The **weak point** is that structural part of the machine construction (assumed or effective failure place) which has unfavourable behaviour to failure in original or repaired state according to more suitably selected factors under identical load compared to other structural parts: its value can be restored less and/or more expenditure.

The weak point analysis is such a systematic, complex technical, economical, organisational procedure which utilises the information of failure analysis and chooses the weak places among the structural units by practically selected criteria, evaluates and proposes measures in order to eliminate weak points. In this approach the failure analysis deals with all faults in same the way while the weak point analysis sets up a (weakness) rank of faults as the **weak point is a relative term**.

The fault analysis may be considered as a more general term. If the weak point analysis is also expressed it is reasonable to use the expression **fault and weak point analysis**.

The **methods applied** have wide scale. Whilst material testing and fracture mechanics methods are used to the determination of fault types from the breaking down phenomenon, the failure reasons are discovered by by general methods, such as Kepner-Tregoe method, general problem solution, Pareto analysis, fault matrix, fault tree analysis, distribution analysis, etc. General (e.g. that of five steps) and special auxiliary methods (polar diagram, rank analysis, etc.) can be applied to weak point analysis. To solve the problem - in a generalised way - complex methods (complex fault and weak point analysis, complex evaluation method, etc.) have been elaborated [2].

The applied method

From the methods considered the weak point analysis based on the value in use was selected which has already been applied to hydraulic rotary loader machine [3]. The steps and algorithms of the procedure is not described here, they are mergeable into the **complex evaluation method** [2].

The goal was to verify the applicability of the method and the refinement of the steps.

The **selected machine type** was the known self-propelled, of wheels, threshing drum, 6 m cutting width mower **DON-1500 type** (original PCM-6 marked) combined harvester.

The results of the investigation

In order to carry out the weak point analysis of the combined harvester of type DON-1500 the machines operated by the Agroszolért Ltd. Mezőtúr were investigated. The 15 machines had 51 failure with 95 faults during warranty time as the official warranty reports were evaluated. After processing the reports and consulting with the experts, the necessary coded informations become available in a study [4].

A few steps of the investigation is presented on the basis of this work [4]. The defective structural units of the combined harvesters and their identification marks are:

A - engine	F - cutting mechanism
B - carrier	G - feeding mechanism
C - hydraulic system	H - threshing mechanism
D - electric system	I - cleaning mechanism
E - electronic control system	J - discharge mechanism

Treating those units as a complex system four persons classified it using five evaluation parameters (Fig. 1).

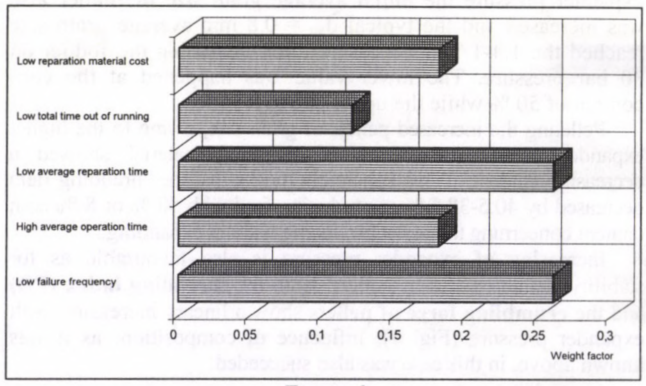

Figure 1
Weight factors of evaluation parameters [4]

From the main fault places the structural parts involved in the weak point analysis (6 altogether) were chosen taking into account both the failure frequency and the reparation cost.

Carrying out the scoring method of value in use the following **weakness rank** was gained on the basis of evaluation list and value profile:

1. C - hydraulic system
2. A - engine
3. H - threshing mechanism
4. J - discharge mechanism
5. F - cutting mechanism
6. G - feeding mechanism

The **fault analysis** was carried out for six fault places in detail and they are shown in same type of diagrams.

• Fig. 2 shows the **fault types** (characteristic failure phenomena) according to the fault places and in average. The determining ones were unsealing (23 %) and fracture (38 %).
• In Fig. 3 the failure reasons are shown according to the fault places and in average. The failure reasons were 46 % material defects, 21 % machining faults and 17 % assembling defects

making the product defects. In warranty time the low ratio of wearing is natural.

• The methods of reparations are shown in Fig. 4. The replacement of parts is dominant (64 %), the adjustment is significant (15 %) as the law makes possible to use new factory parts during the warranty time.

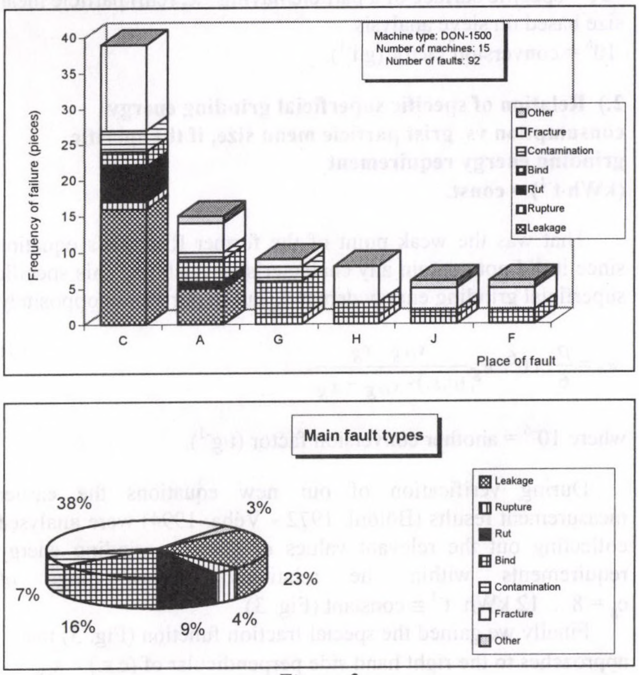

Figure 2

Fault places and types [4]

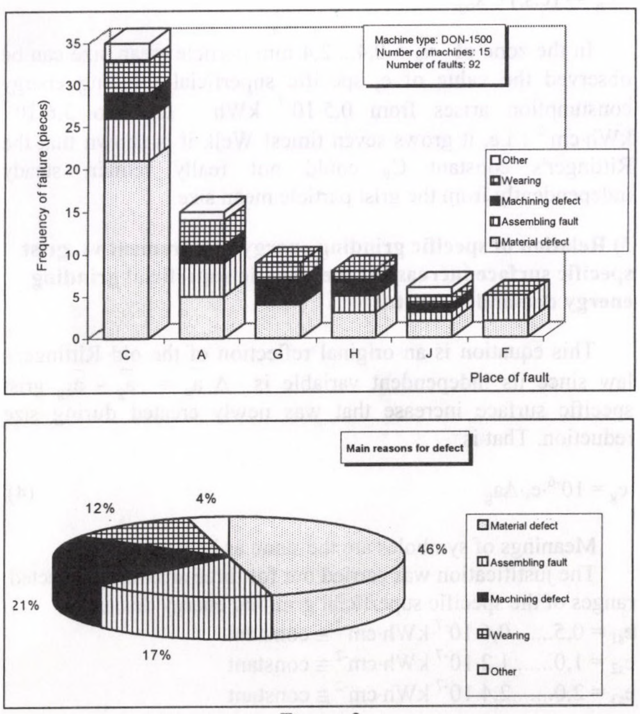

Figure 3

Places and reasons of fault

On the basis of analysis it is possible to make proposals to the manufacturer (design, material selection, technology, etc), to the user (operation defects) and to the maintaining service (maintenance fault) to make the appropriate measures. The information is inevitable for the dealer and the extension service.

Such way the failure and weak point analysis is a tool of the innovation. In general it can be stated that the information about failure mast not be abandoned.

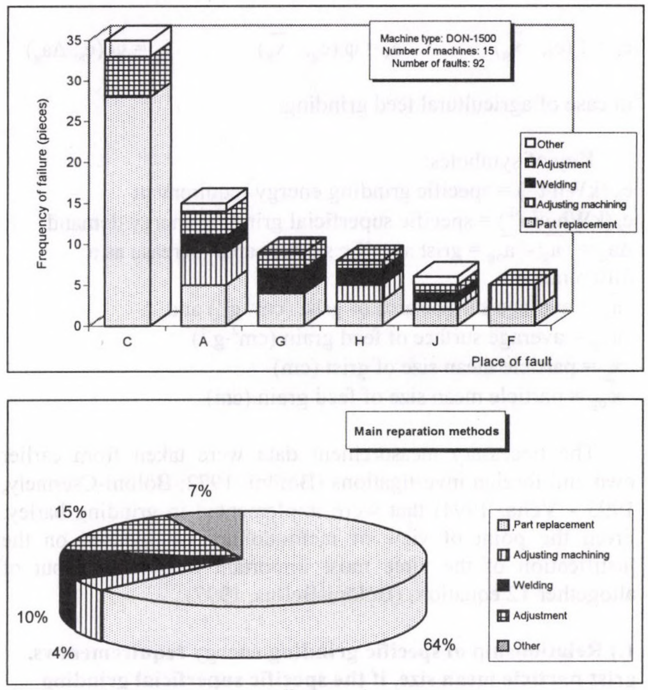

Figure 4

Places of faults and reparation methods

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APPLYING TWO-VARIABLE ENERGETIC FUNCTIONS IN FEED GRINDING

(OTKA 016124)

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Goal of the research done in 1997 was the verification of the previously developed two-variable functions (Bölöni-Bellus, 1997):

$e_g = f(e_s, \overline{x}_g)$ $e_s = \varphi(e_g, \overline{x}_g)$ $e_g = \psi(e_s, \Delta a_g)$

in case of agricultural feed grinding.

Key of symboles:
e_g (kWh·t^{-1}) = specific grinding energy requirement
e_s (kWh·cm^{-2}) = specific superficial grinding energy demand
$\Delta a_g = \overline{a}_g - \overline{a}_{og}$ = grist specific surface area increase as a difference of
$\overline{a}_g$ = average surface area of grist (cm^2·g^{-1}) and
$\overline{a}_{og}$ = average surface of feed grain (cm^2·g^{-1})
$\overline{x}_g$ = particle mean size of grist (cm)
$\overline{x}_{og}$ = particle mean size of feed grain (cm)

The necessary measurement data were taken from earlier own and foreign investigations (Bölöni, 1972; Bölöni-Csermely, 1993 - Véha, 1994) that were implemented in grinding barley. From the point of view of methodology we focused on the justification of the three most important relationships out of altogether 12 equations (Bölöni-Bellus, 1997).

1.) Relationship of specific grinding energy requirement vs. grist particle mean size, if the specific superficial grinding energy demand (kWh·cm^{-2}) = constant

Literature of grinding applied the following equations (Charles, 1957 - Beke, 1963) formerly:

$$e_g = C_R \cdot \left[\frac{1}{x_g} - \frac{1}{x_{og}}\right] \qquad (1)$$

where furtheron
C_R = kWh·t^{-1}·mm = Rittinger's constant
$\overline{x}_g$ = mean size of ground material (mm)
$\overline{x}_o$ = mean size of fed in material (mm)

As in Equn. (1) is to be seen every other characteristics, except mean sizes, are included in the constant C_R. Which consequence of became that measurement results did not verify prevailing of the first grade hyperbole, but the exponent of $\overline{x}_g$ seemed to be $n > 1$ (Henderson-Hansen, 1966) that was not to be explained physically.

In our mathematical model the above interdependence is described by the next new hyperbole, if e_s specific grinding energy consumption (kWh·cm^{-2}) = constant: (Fig. 1 and Fig. 2)

$$e_g = \frac{6 \cdot 10^6}{\rho} \cdot e_S \cdot \left[\frac{c.s.}{x_g} - \frac{1}{x_{og}}\right] \qquad (2)$$

Meaning of newer symboles:
$\overline{x}_g$ = particle mean size of grist (cm)
$\overline{x}_{og}$ = particle mean size of feed grain (cm)
ρ = true density of feed grain (g· cm^{-3})
6 = shape factor originated of the hypotethic cube form of ground particles
c.s. = coefficient of skewness of particle size distribution function = $\overline{a}_g : a_x$ where
$\overline{a}_g$ = average specific surface area of ground material according to sieve analysis,
$\overline{a}_x$ = specific surface of a particle having $\overline{x}_g$ (cm) particle mean size based on sieve analysis
10^6 = conversion factor (g·t^{-1}).

2.) Relation of specific superficial grinding energy consumption vs. grist particle mean size, if the specific grinding energy requirement (kWh·t^{-1}) = const.

That was the weak point of the former Rittinger's equation since it did not contain any characteristics such like this specific superficial grinding energy demand. But in our model oppositely

$$e_S = \frac{\rho}{6} \cdot 10^6 \cdot e_g \frac{x_{og} \cdot x_g}{(c.s.) \cdot x_{og} - x_g} \qquad (3)$$

where 10^{-6} = another conversion factor (t·g^{-1}).

During verification of our new equations the earlier measurement results (Bölöni, 1972 - Véha, 1994) were analysed collecting out the relevant values of specific grinding energy requirements within the relatively narrow range of $e_g = 8 \ldots 12$ kWh ·t^{-1} ≅ constant (Fig. 3)

Finally we gained the special fraction function (Fig. 3) that approaches to the right hand side perpendicular of (c.s.) · $\overline{x}_{og}$ line as an asymptote, if

$\overline{x}_g \to (c.s.) \cdot \overline{x}_{og}$.

In the zone of $\overline{x}_g$ = 0,4....2,4 mm particle mean size can be observed the value of e_s specific superficial grinding energy consumption arises from 0,5·10^{-7} kWh · cm^{-2} to 3,6·10^{-7} kWh·cm^{-2} : i.e. it grows seven times! Well, it is shown that the Rittinger's constant C_R could not really remain steady independently from the grist particle mean size.

3) Relation of specific grinding energy requirement vs. grist specific surface increase, if the specific superficial grinding energy demand = const.

This equation is an original reflection of the old Rittinger's law since its independent variable is $\Delta \overline{a}_g = \overline{a}_g - \overline{a}_{og}$ grist specific surface increase that was newly created during size reduction. That is

$$e_g = 10^{-6} \cdot e_s \cdot \Delta a_g \qquad (4)$$

Meanings of symboles are the same as before.

The justification was carried out for three arbitrarily selected ranges of the specific superficial grinding energy demand:
e_{s1} = 0,5.......0,6·10^{-7} kWh·cm^{-2} ≅ constant
e_{s2} = 1,0.......1,2·10^{-7} kWh·cm^{-2} ≅ constant
e_{s3} = 2,0.......2,4·10^{-7} kWh·cm^{-2} ≅ constant

The oblique straight lines show the expected linear correlation's (Fig. 4). Finally we received the following statement that is to be generalized for size reduction of all other agricultural feed grains: the linearity of the e_g (Δa_g) relationship prevails independently of mill type (speaking about hammermills), screen hole diameter, feed grain variety, being a considerable new scientific result.

Summary

Three most important theses of the formerly developed energetic equations of feed grinding were managed to verify:

1) e_g (kWh·t^{-1}) specific grinding energy requirement vs. $\bar{x}_g$ (cm) grist particle mean size,
2) e_s (kWh·cm^{-2}) specific superficial grinding energy consumption vs. $\bar{x}_g$ (cm) grist particle mean size,
3) e_g (kWh·t^{-1}) specific grinding energy requirement vs. Δa_g (cm^2·g^{-1}) grist specific surface increase.

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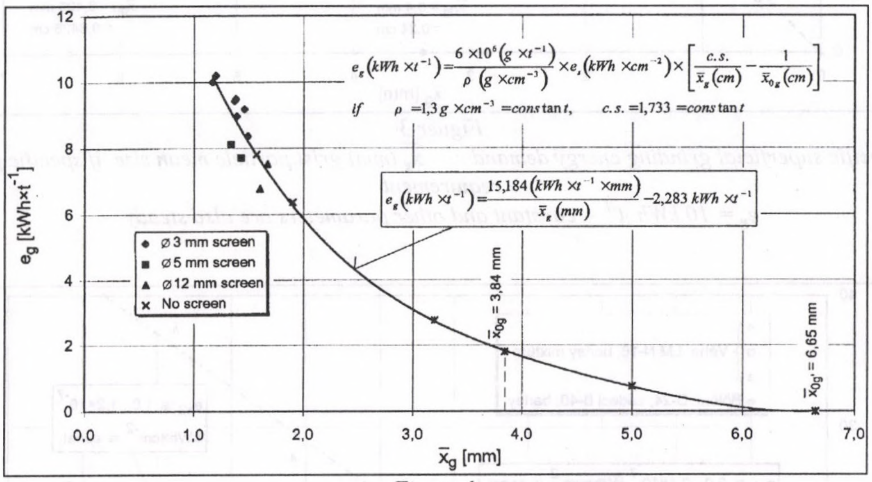


Figure 1

e_g (kWh·t^{-1}) specific grinding energy requirement vs. $\bar{x}_g$ (mm) grist particle mean size presented on linear scales of co-ordinate axes, if the specific superficial grinding energy demand e_s = 1,8 ..... 2,0·10^{-7} kWh·cm^{-2} ≅ constant. (Hammermill type D-24. Feed grain: Barley Lédeci Béta 40)

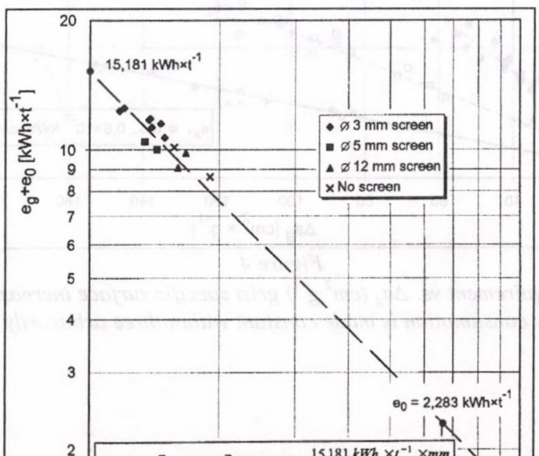
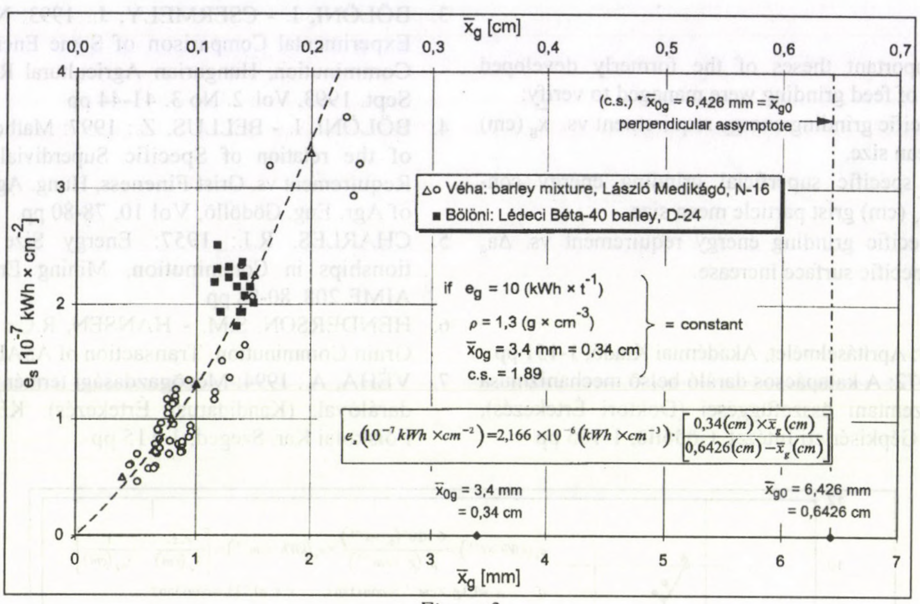


Figure 2

Total specific grinding energy input (e_g + e_o) (kWh·t^{-1}) vs· $\bar{x}_g$ grist particle mean size using logarithmic scales on co-ordinate axes, if specific superficial grinding energy consumption e_s = 1,8.......2,0·10^{-7} kWh·cm^{-2} ≅ constant.



Figuer 3

e_s (kWh·cm^{-2}) specific superficial grinding energy demand vs. $\bar{x}_g$ (mm) grist particle mean size, if specific grinding energy requirement
e_g = 10 kWh·t^{-1} = constant and other parameters are also steady

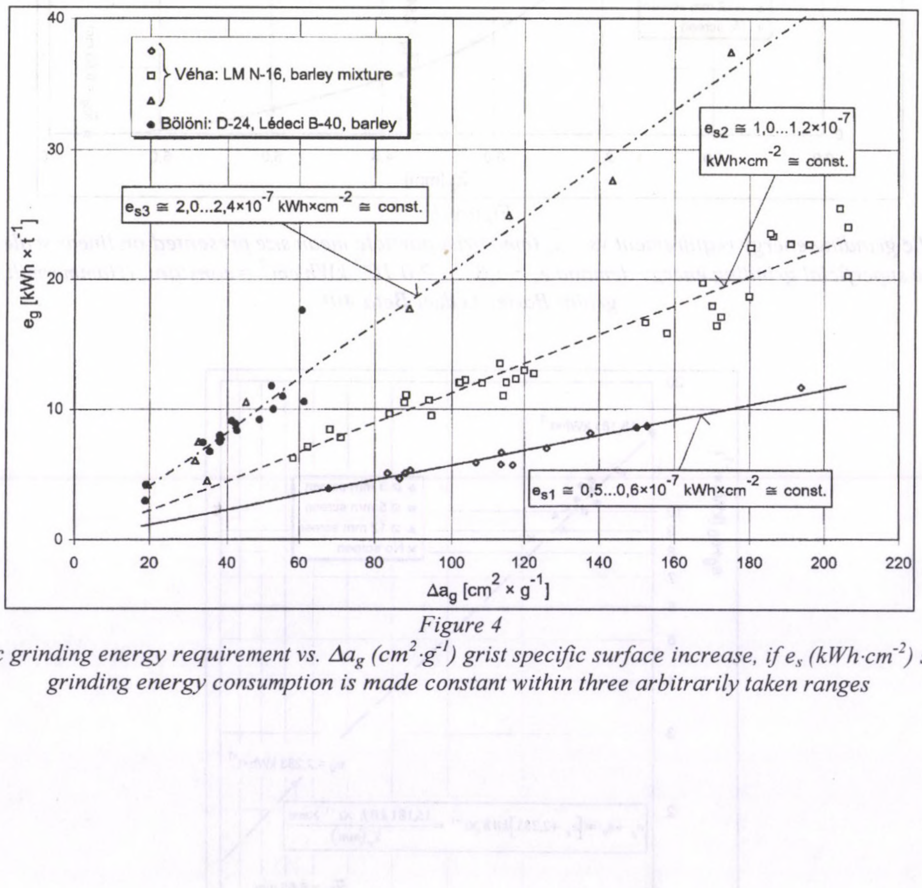


Figure 4

e_g (kWh·t^{-1}) specific grinding energy requirement vs. Δa_g (cm^2·g^{-1}) grist specific surface increase, if e_s (kWh·cm^{-2}) specific superficial grinding energy consumption is made constant within three arbitrarily taken ranges

ANALYSING CHOPPED GREEN MAIZE FORAGES BY THE FRACTIONS

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Nutrient intake of cattle and the efficiency of its protein transformation depend on several factors. Most important among them are the feed value and the physical form structure. Concerning the optimal nutrient composition of forage, accurate data stand at our disposal, while the physical structure (particularly in case of chopped forages) forms subject of debate. Disagreements derive from different requirements on the structure of forage. The guided fermentation process taking place during conservation, demands the least chaff-dimension due to the proper compressibility of silage.

Short chopping length accelerates breaking down function of bacteria and improves forage intake and usage in consequence of its risen specific surface. Small chaff dimension on the other hand cuts back structured crude-fibre content which may result in rumen sluggishness and sink of milk fat content. Some researchers [1] observed fall in forage-intake feeding smaller chaffs if dry matter content was over 35 %. Equipments for reducing chop-length were the many-knifed cutterhead developed originally to produce Corn-Cob-Mix (CCM), and recutters. Both constructions rose dramatically specific fuel consumption of choppers, in the same time causing fall in their throughput, making operators to employ bigger chop lengths. Due to diverse requirements of the fermentation, digestion-biology and energetic aspects stood on the forage structure, it is comprehensible that there is no generally accepted optimal chop length.

Table 1
Recommended chop-length for silo maize

Year	1976	1977	1979	1985
Length From-to (mm)	4-6	4-6	4-6	6-8
Source	DERNEDDE	SCHURIG	KROMER	RATSCHOW
Year	1986	1988	1995	1997
Length From-to (mm)	4-8	<7	10-30	<38
Source	WENNER	SCHWARZ	SZENDRŐ	J. LINN, C. KUEHN

For describing physical form of materials (as an important influencing factor for conserving and feed intake), its structure needs to be analysed. Such methods are mentioned in literature each assuming that chaff bulk is homogenous. This means so rough approach which causes 60% difference in the projected surface area of chaff bulks.

Inhomogenous feature of chaff bulks can be traced back to plant-biological reasons. Plants namely consist of more parts (stalk, leaf, crop) differing definitely from each other not only in shape but also in density and - what is really important from the point of view of feeding - in feed value. The chopping harvest technology has been developed to fine bulks consisting mainly of stalk and leaves fractions, and for this reason chop-length-homogeneity can only be assured for these fractions. Oscillations in chopping construction, slip in compressing set, oblique feed of stems and their limited length contribute in every case to scatter of chop length. For this reason, the most adequate chop-length distribution model [1] if maize kernels are in milk-ripe stage interprets chopped-bulk by means of a 6 parameter blend distribution. In milk-ripe stage kernels are not present as a separate fraction since they get spread on the surface of other plant parts during chopping process.

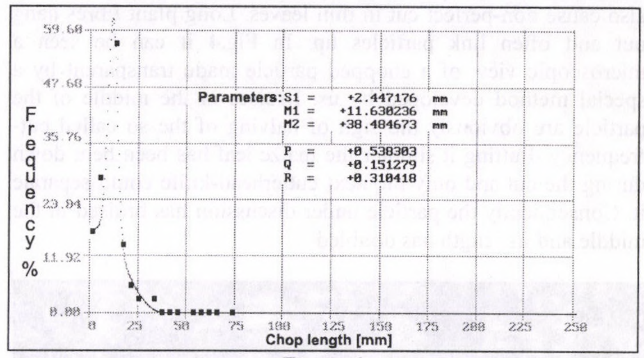


Figure 1
6 parameter mathematical model developed for approaching particle length histogram of milk-ripe silomaize chopped bulk
Legend:
M1 - Expected value of the normal distribution fraction
S1 - Scatter of the normal distribution fraction
M2 - Parameter of the parabolic distribution fraction
P - Proportion of the normal distribution
Q - Proportion of the uniform distribution
R - Proportion of the parabolic distribution

It is obvious according to these, that though the model presents the most accurate description among all known ones for a whole chopped bulk, it is most suitable for describing chopped bulk consisting only of stalk (Fig. 2).

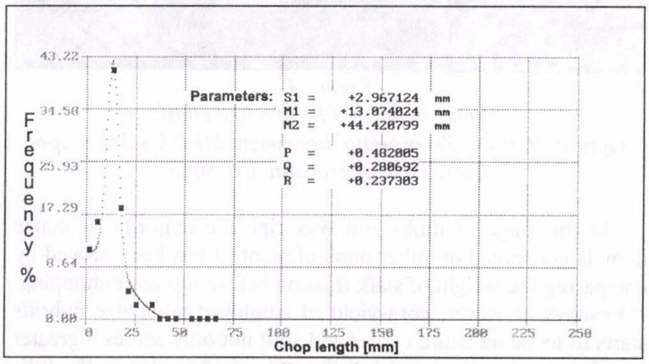


Figure 2
Histogram-fitting to chopped maize stalks

The characteristic dimension for leaves is the length as well (Fig.2), but the expected value of normal distribution (M2) is lower, while the scatter (S1) is higher than those of fitted to the histogram of stalk fraction of the same sample.

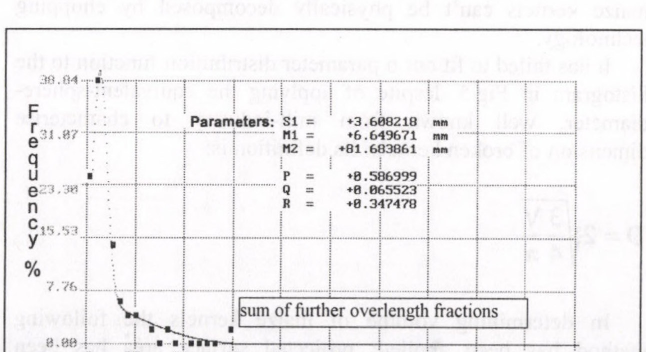


Figure 3
Histogram-fitting to chopped maize leaves

This means that the grinding, dragging and creasing effect of chopping construction present themselves stronger in case of shorter leaves-fraction. Worn cutterhead knives or false gap may also cause non-perfect cut in thin leaves. Long plant fibres hang out and often link particles up. In Fig.4 it can be seen a microscopic view of a chopped particle made transparent by a special method developed by us. Bruises in the middle of the particle are obviously the sign of halving of the so called cut-frequency. Putting it simpler the maize leaf has been bent down during the cut and only the next cutterhead-knife could separate it. Consequently the particle under discussion has bruised in the middle and its length has doubled.

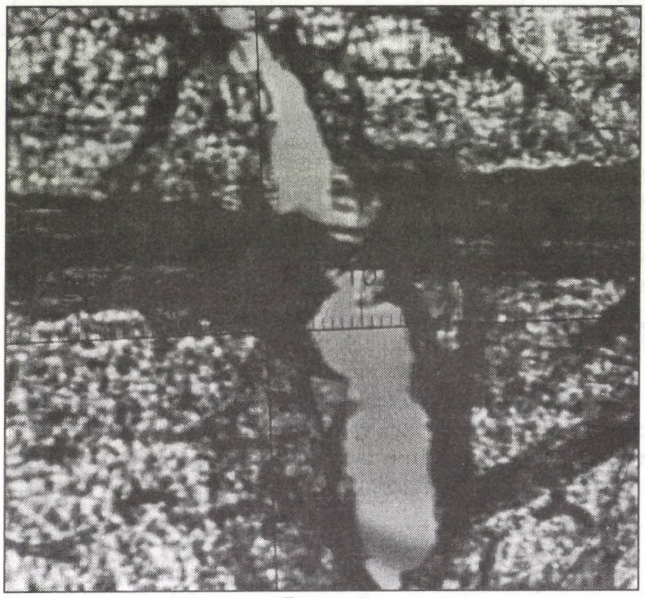


Figure 4
Bruise in the middle of a leaf chaff
(Optics: 20/0.4 + Zeiss photo attachment MFP k 3.2:1 + opal filter. Time of exposition: 1/30s.)

In the stage of milk- and wax ripe the majority of maize kernels get spread on other parts of plant. It has been proved by comparing the weight of stalk fraction before and after chopping. Nowadays, however, corn-yield of employed silomaize hybrids starts to loose moisture earlier and so it not only serves a greater quantity of green material but the corn-yield is also in the full-ripe stage which is the richest from the pint of view of relative energy. Approximately 1/3 of the metal-hard kernels get through the so called exact chopping method intact (Fig. 5). These intact kernels won't get decomposed either fermentation or feeding, thus highly nutritional kernels pass through the digestion system of ruminants without being processed. It means that full-ripe maize kernels can't be physically decomposed by chopping technology.

It has failed to fit our 6 parameter distribution function to the histogram in Fig.5 despite of applying the equivalent-sphere-diameter, well known from mill-industry to characterise dimension of broken kernels. Its definition is:

$$D = 2\sqrt[3]{\frac{3\,V}{4\,\pi}}$$

In determining volume of maize kernels the following method has been applied: projected surface area has been determined by means of digital image processing developed by us, and the obtained mean value has been multiplied by the mean thickness of kernels. As mentioned earlier whole kernels leave digestion system of ruminants unutilised. Decomposing kernels increases digestible energy value of fodder by 10-15 % [3], therefore great agricultural machine producers have completed chopping construction with the so called corn-cracker working similarly to roller mills (Fig.6).

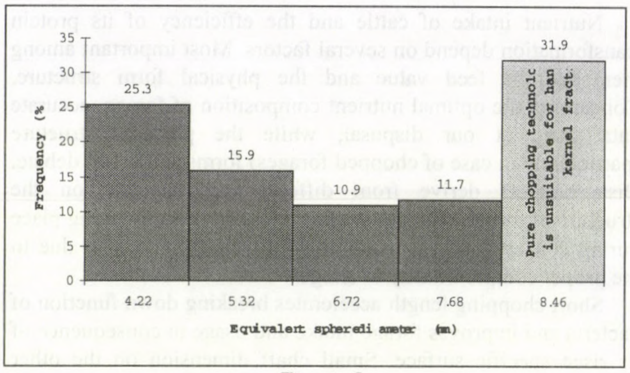


Figure 5
Distribution histogram for kernel fraction of silomaize chaffs made without corn-cracker

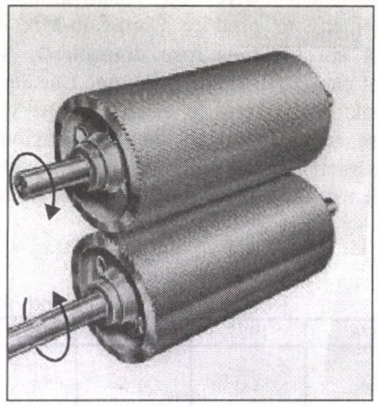


Figure 6
Corn-cracker rollers

Corn crackers proved to be better for energetic reasons in comparison with earlier used recutters. Regardless certain cut down in throughput it really assures the total decomposition of kernels (Fig. 7).

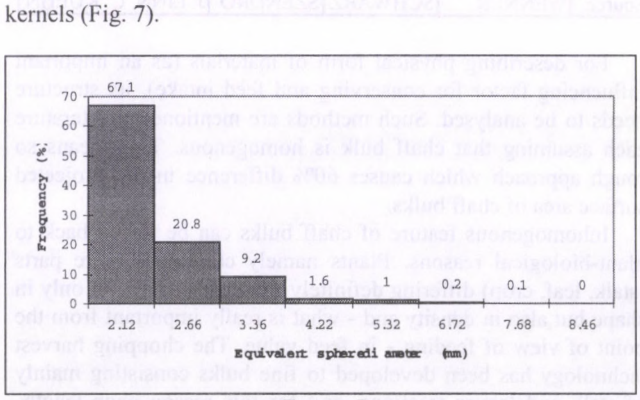


Figure 7
Distribution histogram for kernel fraction of silomaize chaffs made with corn-cracker

Working conditions of rolls in corn-cracker are, however, far not perfect. High moisture content of kernels-even if they are full-ripe- relatively big amount of stems and leaves can often be the reason of blocking of construction, therefore determining required roll gap profile, speed and optimal gap are of great importance. Another problem is to solve the reaccelerating of slowed down material flow by the corn-cracker, set after the cutterhead in self loading constructions. Working out a novel distribution model which handles kernels as a separate fraction and a rheological model being crucial for exact silage material description and quality assuring of beef- and milk products are also ahead of us.

From technical point of view generally can be said that rough profiles are for rough endproducts and fine profiles are for fine endproducts to use. In Fig. 8 it can be seen a summary of the most important roll corrugation profiles [5]:

- Stevens and Ross Flaking Cut are both primarily used for flaking such as corn or milo for animal feed
- Dawson and modified Dawson corrugations are approximately 90 percent used in flour mill applications
- Le Page is a corrugation with one roll having a circumferential (Ring) cut while the mating roll has a horizontal cut. This corrugation was developed to produce a greater percent of coarse product with less fines. A drawback is as a general rule, the capacity is approximately 10-15 % less than that of a sawtooth corrugation.

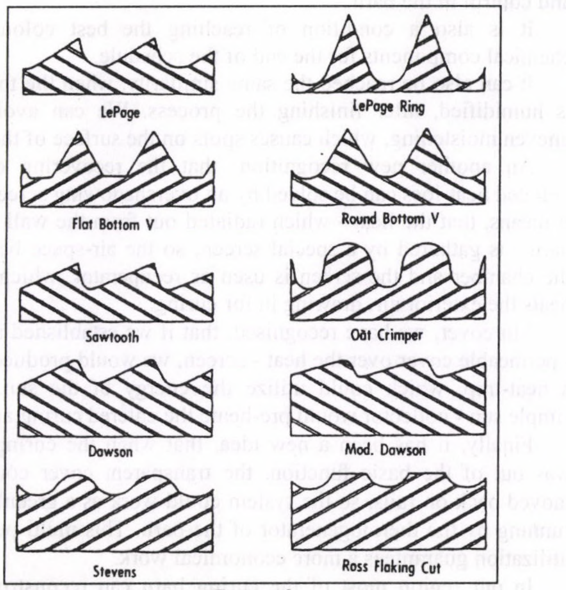


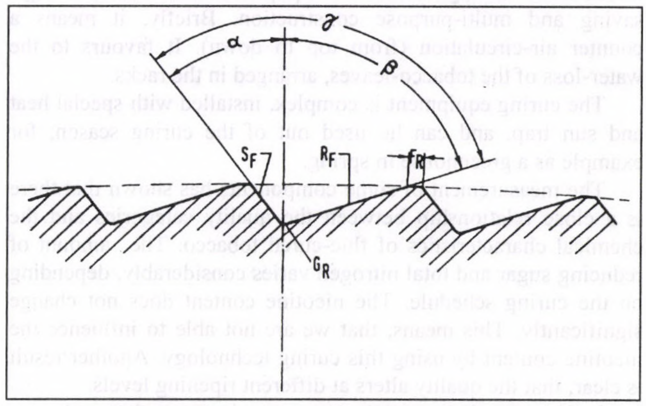
Figure 8

Roll corrugation profiles

Diameter of rolls are about 200 mm, number of teeth are 80-100. It is recommended to use the lower number when harvesting maize while the other is for GPS.[1] Depth of toothprofile is 5-6 mm, the angle of profile (γ) is 55°-60°. Gap between rolls can be adjusted between 1-20 mm usually, and rolls can also be eliminated by pulling them apart. In some makes it can be done by turning of a lever without any dismounting (e.g. Claas jaguar 870). Grinding effect of the construction is often improved by different speed, which however cannot be adjusted within a certain make, though it changes among different makes. Its value is 20-30 %.

A function model is planned to build which is suitable for optimising corn-cracker. By means of the model it is possible to examine the effect of different Profiles, speeds, speed differences, gaps on the endproduct. Paralell with this, structure-modelling basic researches are in progress. We let the scientific public know about the results of our researches in the future too as far as possible.

Most recently used modern chopping machines employ mainly the Round Bottom V and Sawtooth profiles. In Fig. 9 one of the most frequently used corrugation profile can be seen with its main parameters.



α- Edge angle S_F = Edge surface
β- Back angle R_F = Back surface
γ- Profile angle F_R = Profile-peak surface
G_R = Profile-valley surface

Figure 9

Characteristic parameters of the sawtooth profile

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[1] GPS-Abbrevation for Ganz Planzen Silage (Ger.). Whole-Plant -Silage

NEW METHOD AND EQUIPMENT FOR CURING OF FLUE-CURED TOBACCO

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Abstract

In Hungary many types of curing barns are used for production flue-cured tobacco. In these equipments the air-circulation is the usual (from bottom to up), which is not advantageous in the rack-type barns. In the old equipments there are big fans with too much air-volume and high velocity.

In our institution a curing system has been developed. It means a new curing method and equipment, which in an energy-saving and multi-purpose construction. Briefly, it means a counter air-circulation (from top to down). It favours to the water-loss of the tobacco-leaves, arranged in the racks.

The curing equipment is complex, installed with special heat and sun trap, and can he used out of the curing season, for example as a greenhouse in spring.

The measurement of some components has shown that there is a close relationship between the quality categories and the chemical characteristics of flue-cured tobacco. The amount of reducing sugar and total nitrogen varies considerably, depending on the curing schedule. The nicotine content does not change significantly. This means, that we are not able to influence the nicotine content by using this curing technology. Another result is clear, that the quality alters at different ripening levels.

In Hungary it is very important to improve the quality of flue-cured tobacco. The author hopes that the new (advanced) applied curing schedule can contribute to it.

Statement of the developing work

It is well-known, that under curing of flue-cured tobacco, the task is not only to remove the water from the leaf but to help the enzyme changing in the tobacco. Most of the curing barns using in Hungary have many drawbacks.

The circulation of the curing air works in opposition to the natural position of the hanged up tobacco leaf. The air blowed upwards from below moves the leaves, the laminas are compressed, so the distribution of air circulation is uneven and the air-resistance is increased because of the deviated leaves. In this case a higher capacity fan is required to maintain the necessary ventilation.

The intensive air-circulation of the bigger fan results a higher pressure in the curing chamber, so there is a continuous blowing through the gaps of the barn. It means a considerable heat-loss and vapour decreasing. The deficit of the temperature sets back the economic result and the lower relative humidity causes a worse quality of the end-product.

When the air-circulation happens upwards from below, at first the laminas are touched intensively by the air, so they will be dried out earlier than the veins and midribs. Due to this effect, it needs much time and energy to reach the end of curing, while the valuable parts are overdried.

The heat insulation of the curing barns is not solved perfectly, especially at the old type „SIROKKÓ" equipments. In the period of curing, big amount of radiated heat can escape - mainly in the night -, which means plus cost maintaining the temperature balance (Fig. 1).

There is another disadvantage, that the existing curing barns can only be used in a short period of the year, so the utilization rate is bad. Generally we can say, that the surplus expenditures is not realized in the quality of the cured tobacco and income.

Our purpose has been to develop a new method and equipment, which eliminates the above detailed disadvantages and results some fowarding solutions.

It has been verified experimentally, that if the tobacco leaves are hanged up in raks as usually and the curing air is circuled evenly from above to downwards, then the laminas of the leaves are blowed as a flag in the direction of the circulation. It is such a surplus effect, which assures a lower resistance and uniform air-ventilation in the curing chamber. In this case the energy demand of the ventilation is less, than the same volume curing air circulated upwords from below.

It can be guaranteed a constant intensity air movement in the whole cross-section of the barn by the evaporating air, forced in the direction of the gravitation. It is a condition of the uniform and homogeneous drying.

The heated air circulated from above to downwards, touches the upper part of the high water content midrib at first, so the too early drying out of the lamina can be avoid. It has been a surplus recognition, because this solution can assure favourable heat-effect for the whole leaves. On the other hand, the protected leaf lamina has a smaller heat-load and it has a chance to maintain an optimum respiration process, during the yellowing and colour fixing.

The uniform air-distribution and the homogeneous curing renders a precise temperature and relative humidity monitoring and control in the barn.

It is also a condition of reaching the best colour and chemical components for the end of the schedule.

It can also be reached the same similarity, when the tobacco is humidified, after finishing the process. We can avoid the uneven moistening, which causes spots on the surface of the leaf.

An another new recognition, that the recovering of the radiated heat-loss can be solved by an overshadowing screen. It means, that the heat - which radiated out from the wall of the barn - is gathered by a special screen, so the air-space between the chamber and the screen is used as recuperator, which pre - heats the exterior air, drawing in for curing.

Moreover, we have recognised, that if we established a light - permeable cover over the heat - screen, we would produce such a heat-trap, which could utilize the energy of the sun. This simple sun - collector would pre-heate the entered curing air.

Finally, it has been a new idea, that when the curing barn was out of the basic function, the transparent cover could be moved back on rails, so the system could work as a greenhouse, running by the thermogenerator of the barn. This multi-purpose utilization guarantees a more economical work.

In our region most of the curing barn can reconstruct for drying of fruits or vegetables.

In the Fig. 2 you can study the setting up of the multipurpose curing barn.

Comparative examinations

In Hungary many smaller tobacco curing barns have been developed in the past ten years, according to the requirements of the tobacco growers and the processing enterprises.

When starting production of the Virginia type tobacco, the cooperatives used mainly the big capacity „SIROKKÓ"-type barns. Most of these equipments have heen working continuously after the privatisation, but they have consumed too much energy and they have not been able to produce a high quality dried tobacco.

They must be renewed and reconstructed in the near future.

We have made an extended experimental and practical examination, regarding to the stated new development.

The technical data and the specific curing characteristics of the new system barn have been compared with a conventional system, but newly manufactured tobacco equipment.

The „KDSZ-1,5"type curing barn is mostly the same as the old „SIROKKÓ" barns, except the capacity.

The Table 1 contains the comparison of the most important technical data, and the Table 2 represents the results of the practical curing, comparing the measured and calculated curing features.

Table 1
Comparing of the main technical data

Denomination	Type of the curing barn	
	new system (MKD-25)	old system (KDSZ-1,5)
Sizes of the barn		
width (m)	3,2	2,1
height (m)	2,3	2,0
length (m)	5,5	4,8
Effective volume (m^3)	27	18
Number of the racks (pieces)	54	52
Capacity (tons green tobacco)	2	1,5
Oil (gas) burner type	Thyssen N-10A	Thyssen N-10A
heat-power (kW)	17-46	33-92
oil-consumption (kg/h)	1,9-3,8	3,6-7,5
Heat-exchanger		
heating area (m^2)	7	6
capacity (kW)	15-35	10-30
system	smoke-air	hot water
Fan (ventilator)		
type	TV 4/960	A4 OM 15/15
air-volume (m^3/h)	6800	6500
power of electric motor (kW)	1,5	1,5

Table 2
Comparing of the most important specific curing characteristics

Description of character	Type of the curing barn	
	new system (MKD-25)	old system (KDSZ-1,5)
Curing period (hours)	120-140	130-150
Average oil-consumption (kg/h)	1,28	1,36
Specific oil-consumption (kg/kg dried tobacco)	0,54	0,82
Specific heat-demand for evaporation of water (kJ/kg water)	4200	7800
Specific electric energy consumption (kwh/kg dried tobacco)	0,46	0,87
Substance-rate (greent./dried tobacco)	4,7	5,5
Water-evaporation capacity of the barn (kg/h)	12,7	6,2
Capacity of humidifying (kg/h)	5,9	4,1
Period of humidifying (hours)	9,6	7,1
Specific heat-loss (kWh/h) (ambient temperature:10°C) internal temperature: 70°C)	10	22

Technological developments

Despite the technical development, our purpose have been to improve the quality of the cured tobacco and decrease the energy demand by working out a new curing technology.

In the Fig. 3 an experimental drying schedule is demonstrated.

The exactly controlled temperature increment and reduction of the relative humidy of the drying air results a better quality, regarding to the chemical components of the dried tobacco, and at the same time the cost of the drying energy also more favourable, comparing with the conventional curing schedule.

The cost of energy has a close relation with the air and heat consumption during curing. The variation of the air demand is shown in the Fig. 4. The change of the heat requirement can be calculated from the Fig. 5.

My main aim has been to monitor the influence of different practical technological features on the important quality characteristics. Fulfilling this requirement, I have arranged to study altogether four curing cycles on two farms, applying a convectional and an advanced technology at the same time.

Four samples have been taken from each curing barn and transported to the local quality testing laboratory of the tobacco processing company, where the four most important internal compoment have been identifed (carbohydrate, reducing, sugar, total nitrogen, nicotine). In addition they have measured the moisture content.

The results of the analytical work are summarised in the Table 3.

Table 3
Comparison of the component features of differently cured tobacco

Curing method	Carbohydrate %	Reducing sugar %	Total nitrogen %	Nicotine %
Conventional	13,85	8,72	2,48	1,77
Advanced	17,96	12,38	2,10	1,46

It is now clear that measurement with the advanced (new) technology has resulted in more favourable levels of some important chemical components, that is, it has been produced a better quality at the end of the curing of Virginia type (H-11) tobacco. the above table indicates that, while using the advanced curing schedule, the content of carbohydrate was greater by 29 % . the samples had 41 % greater level of reducing sugar and 18 % less total nitrogen as well as a21 % lower nicotine content.

These results are unambiguous, indicating that these technological developments have an important role in the improvement of quality.

Final conclusions

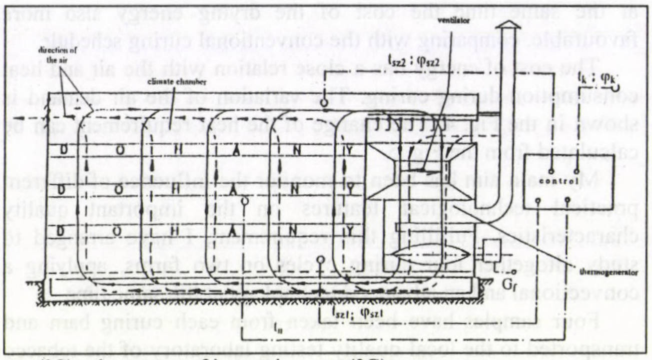
The presented research work has tried to summarise the technical and technological development work in curing of flue-cured tobacco and to find relationships between the most important parameters which can influence the final quality of the flue-cured tobacco. Namely: how do the starting conditions of the practical curing parameters influence the quality of the relevant chemical components appearing in the end-produce ?

The evaluation model and the collection of information can provide useful basic data for tobacco growers and processing companies.

The results will contribute to the preparation of a new, more precise quality assurance system, and service the development of the engineering side (new equipment).

The discovery of these quantitative relationships between the curing technology and internal leaf characteristics is new both from a scientific and practical point of view.

The Agricultural College of Gödöllő University will incorporate these developments into the running training programmes and will establish cooperation with local tobacco farmers and the processing corporation.



t_{sz1} (°C) - dry temp. of input air $\quad$ t_n (°C) - wet temp.
φ_{sz1} (%) - rel. hum. of input air $\quad$ t_k (°C) - temp. of ambient air
t_{sz2} (°C) - dry temp. of output air $\quad$ φ_k (%) - rel. hum. of ambient air
φ_{sz2} (%) - rel. hum. of output air $\quad$ G_f (l) - fuel consumption

Figure 1
Drawing of the „SIROKKÓ TDO" curing bar

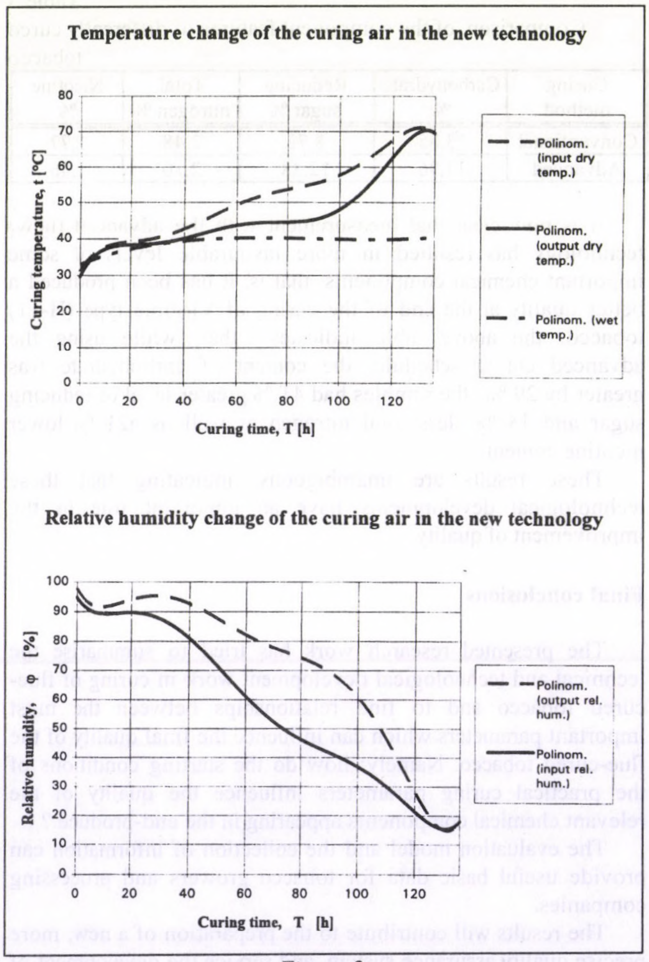


Figure 3
Advanced curing technology

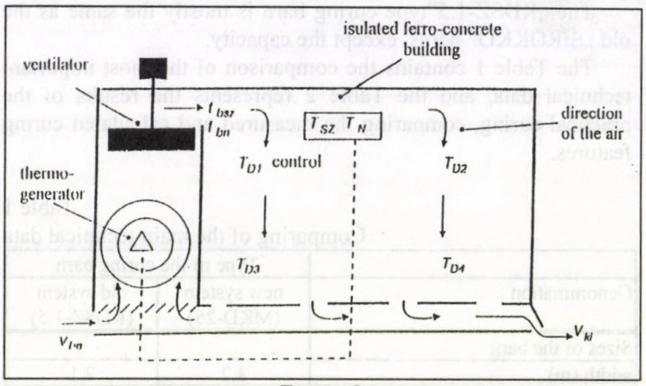


Figure 2
Outline of the „MKD-25" small barn

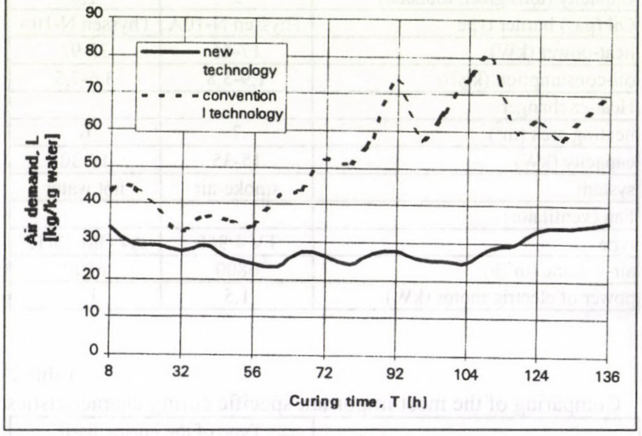


Figure 4
Variation of the air demand of curing

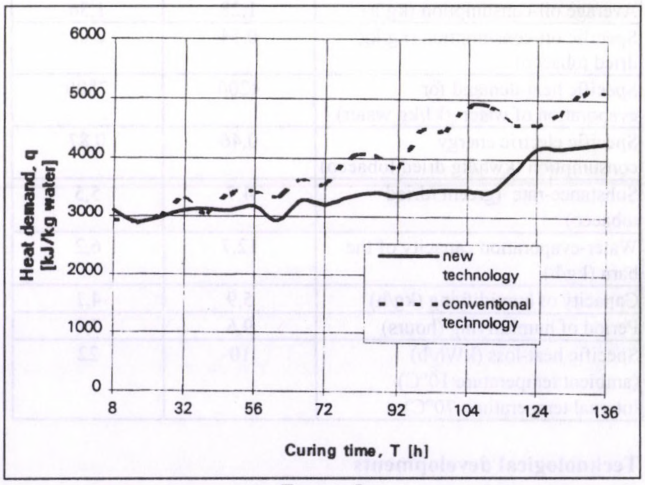


Figure 5
Variation of the heat requirement of curing

PROBLEMS AND POSSIBILITIES OF HUNGARIAN AGRICULTURAL INNOVATION[1]

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1. Introduction

According to the classical opinion, innovation is the **engine of development**. How can one renew its activities, products/ services and how can adjust itself to the newest challenges? It is especially important in a competitive environment.

Dealing with innovation just now is **actual,** because Hungarian economy and agriculture have been in a deep crisis for years and it seems that the needed „power concentration" is missing. The present Hungarian recession could be considered, as a period of preparing for the prosperity, but it is to be feared that the lack of innovation results an unbeneficial situation for the participants of the Hungarian economy, which has an intention of integration.

The Hungarian agriculture badly needs innovation processes to improve its competitiveness, which has been impoverished during the last years.

2. Features of agricultural innovation

There are some **agricultural features,** which must be considered dealing with the chances and possibilities of agricultural innovation. They are as follows:

- The agricultural production and its conditions are more **complex and unaffected** comparing with most of the industrial activities. The main reason of it, that the final success of the agricultural products and technologies are influenced by a great number of factors and most of these factors can only partly, or can not be influenced by the producers.
- Both product - and procedure innovations - partly because of the above-mentioned reasons - have **fewer possibilities** comparing with the other branches of national economy.
- The **determinant role of the natural factors** sometimes „make things more difficult" in agricultural innovation. Sometimes the innovations are not successful, because ones do not take into consideration these factors or the innovators „give it up" at the very beginning, saying „there is nothing to do against the natural factors so it is not worth to fight".
- Because of the **economic features** of agricultural economy - the costs and income relations - it is rather complicated to monitor the economic influences of the innovations. That is why, it is really difficult to determine the connection, between the success or failure and the innovation. Because of all these, the economic and effectiveness aspects do not play an important role among the interest motivation of agricultural innovation.
- Partly because of the above-mentioned factors in agricultural innovation the **central influence** plays an important role. It means, that the participants of the agricultural economy traditionally wait for a permanent support to realise the plans of innovation. The operation of the market mechanisms is very rare and limited, but the same mechanisms heat the innovation in other branches.

The simplified modell of agricultural innovation flow is shown in **Fig. 1.**

To appreciate the features of agricultural innovation the following must be **stressed**:

- Because of the complex conditions of agricultural production, there are integrated innovation processes of minimum three independent areas in agricultural innovation. They are the innovation activities, which create the biological, chemical and technical conditions.
  - The **biological** conditions connected to the raw materials of production, the applied species and breeds and they need the improving and gene technological activities. It is known, that creating and keeping „up-to-date" breeds means a complex task.
  - The **chemical** innovations connected to the production of artificial fertilisers, plant-protecting materials, means of veterinary science and plastics. Agriculture is an important market for the great chemical companies, so there is a hard competition and the appearance of new products and technologies is quite dynamic.
  - The **technical** innovations connected to the modernising of machines and equipment, buildings and building engineering, automation and energy-supply. This area is rather colourful which needs a number of innovation processes.

Because of the differences among the agricultural branches, there are different tasks in plant production, horticulture and animal keeping.

- **Technical development** has an important role because the task of all activities is to transform the results of research into practise and to ensure the other means of production development.

It is very important to take into consideration – besides the above-mentioned – all those, which are integrated in **human resource management** during the phase of technical development within the process of agricultural innovation, because the role of human resources is essential and can not be substituted in agricultural production. **(Fig. 2)**

The prerequisite of technical development and its mission to improve efficiency is to have something to transform somewhere. It means that the situation is suitable when there is a **„pressure" in supply (push)** and a **„vacuum" in demand (pull)** at the same time.

- It can be also important to take into consideration - as I have mentioned above – the **ecological** conditions, because they basically determine the breed, equipment and the production organisation methods, which can be used.
- The question of planing agricultural **production technologies** is rather special. The results of the complex technical development can be found more easily in technologies in a suitable situation. Considering it as a model, development of technologies is a pile of tasks „between" the production and technical development.
- The synthesis of all these takes place in the **production** or service in a certain company. We can also say, it turns out there, „What is theory worth?". It must be stressed that the „agricultural features" appear again and basically determine the final success. The factors causing success or failure must be separated. One group of them is connected with human activities the other is not. If it is not possible to separate the

[1] The paper is connected to the OTKA research number T015991

factors, we can not find the real reason of the success or failure.

- The **buying up** often inserts between the **production** and **processing,** which is necessary, but not really good. It divides responsibility and profit and at the same time it influences the quality and (sometimes quantity) features of the products.
- The situation is very similar in the connection of **processing** and **distribution** because distributors deliver the products to the consumers. As the **success of the innovation turns out on the market** all the previous activities must be followed by a good job on the market. It is possible that mistakes, which were made in the earlier phases, can be corrected in this phase, but the earlier good results can fail, too.
- Several factors influence the **success** of innovation. Some of these factors can be found in the innovation process itself, but some of them are outside of it. It can be important, that to treat the „problem" factors – if we know them – inside of the innovation processes is mostly easier and more unambiguous than outside of it. I must remark that it is difficult to speak about success or failure in absolute terms. It may happen that something is successful for a social stratum or a group, but it is failure for the others. The question of success and failure shows that innovation is a **dynamic** category so **time and space** must be considered.

From the point of view of success of innovations the harmony between the connected phases - as a special **minimum law** - is important. **Knowledge** based on experiences and information and adjustment to **market demands and opportunities** play an important roll to create this harmony.

3. Present position and development possibilities of the Hungarian agricultural innovation

I do think that the **main problem** of present Hungarian agricultural innovation that, its exist can not be perceived. There is no real co-operation between those, who are interested in innovation. The previous mechanisms do not function anymore and the new ones have not started their function yet. It is disquieting, that the imagined participants of the agricultural innovation are mostly busy with themselves and with the problems of their own surviving so usually they have no energy to co-ordinate with the partners of innovation. It is sad, but quite often even the willingness is missing. I consider it is a great problem, because the activity of R&D sector and the job of the processing and distributing organisations all were „parts" of the previous successes of the Hungarian agriculture. It would be a **mistake to think** that the activity of the organisations of education-research-improvment-development-production-breeding-manufacturing-buying up-distribution can be separated for a long time without any disadvantages referring to real or unreal business interests, because all of them are interested in the development of the Hungarian agriculture and food industry.

- **The general social-political and economic situation** basically influences the chances of agricultural innovation. Concerning it – among other things – it is disquieting that the resources spent for research and development decreased a lot. **Table 1.** shows it well.

There were 1818 persons, from that 344 researchers, who worked in research institutes which belong to the **Ministry of Agriculture** and financed by the budget in 1996. As compared to 1990 the decrease of research staff is 36 %, concerning all staff numbers is 46 %.

The number of research institutes, which belong to the Ministry of Agriculture and financed by the budget, is 11. The number of agricultural institutes, which belong to the Hungarian Academy of Sciences and run with its budget, is 4. There are 10 economic organisations of R&D, which belong to the Ministry of Agriculture and the number of agricultural institutions of higher education and their research institutes, which belong to the Ministry of Education is 10.
One agricultural research institute belongs to the State Privatisation Company and 7 privatised research institutes can be mentioned.

The data show that the network of agricultural research institutes of the country consists of many units and there are no real results of the intention of integration.
Most of the research institutes are in a bad financial situation. Sometimes they finance more than 50% of their operation costs from the money they applied for, but the aim of this amount would be to serve the real research. (1.)
In this situation, the research institutes are not able to produce new results, but they can not even fulfil the interface-tasks of the international technologies. The present situation is rather bad because in the previous period the network of the higher education-research institutes of the country was more effectively integrated into the economic activity of agriculture.

- **Users** can generate the expansion of innovations, too. In the middle of the transition of the Hungarian agriculture, it does not seem to work. The agricultural organisations operate in small compass and they are unsure about their existence, so they have a lot of everyday problems beside innovation. It is typical that the **short-term thinking became the equal of the strategy** and the only aim is surviving.
  New organisational and market problems appeared and most of the organisations can not solve them. It is rather disturbing that in spite of several declarations most of those who are interested in agricultural production have **no vision and mission** so their strategies are also in mystery. It is difficult to develop such a complex system like an agricultural enterprise without knowing where we are and where we want to get.
- In the mirror of the repeatedly mentioned **intention to join the EC**, we must not forget that the development and the expansion of innovation go on at our competitors. We can get into a disadvantage, which will be very hard to compensate by our comparative advantages. It is also clear that adjusting to the conception of **multifunctional rural development**, which was accepted in EC, needs or supposes a „Euro-conform" politics of agricultural innovation but it is only in the bud in our country.

Concerning the future the attitude of - research and development organisations, the agricultural producers of the regions and those who are interested in buying up, processing, and distribution - those who are interested in agricultural innovation to the problems mentioned in the paper is a key-question. From the point of view of leap forward the state willingness and the help of providing the background can be essential.

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Table 1.

Share of the research and development in human and financial resources

Name	1990	1991	1992	1993	1994	1995	1996
R&D staff number of total employed (%)	0,81	0,63	0,57	0,58	0,59	0,54	0,55
R&D total costs of GDP (%)	1,62	1,09	1,08	1,0	0,93	0,77	0,67
R&D investments of state investments (%)	1,27	0,71	0,76	0,57	0,58	0,56	0,50
Total staff number (Converted into full-time)	36384	29397	24192	22609	22008	19583	19776

Source: KSH Tudományos Kutatás és Kísérleti Fejlesztés vonatkozó évkönyvei (1.)

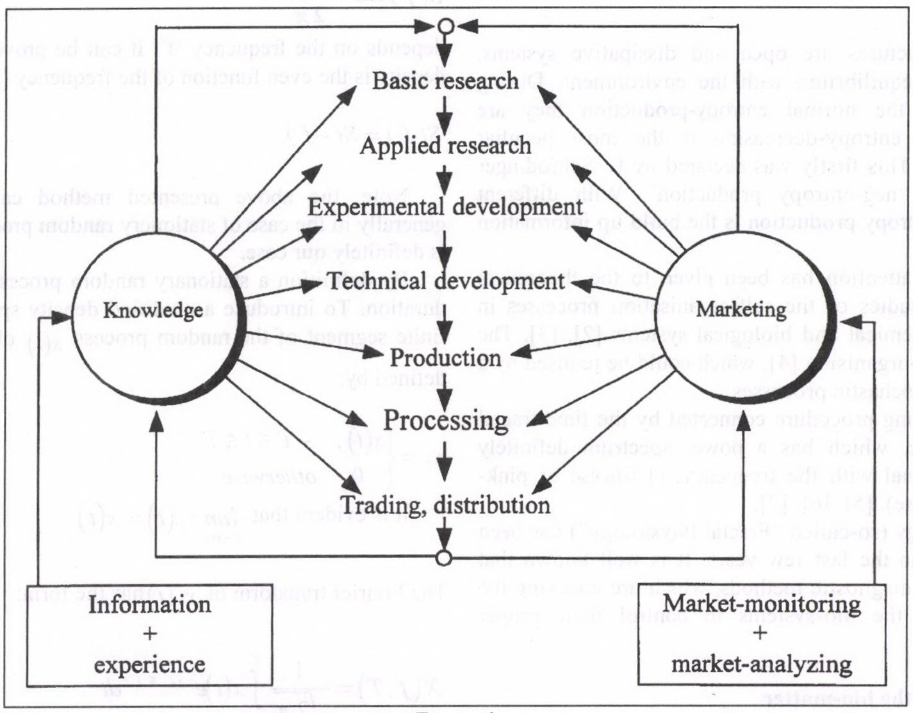
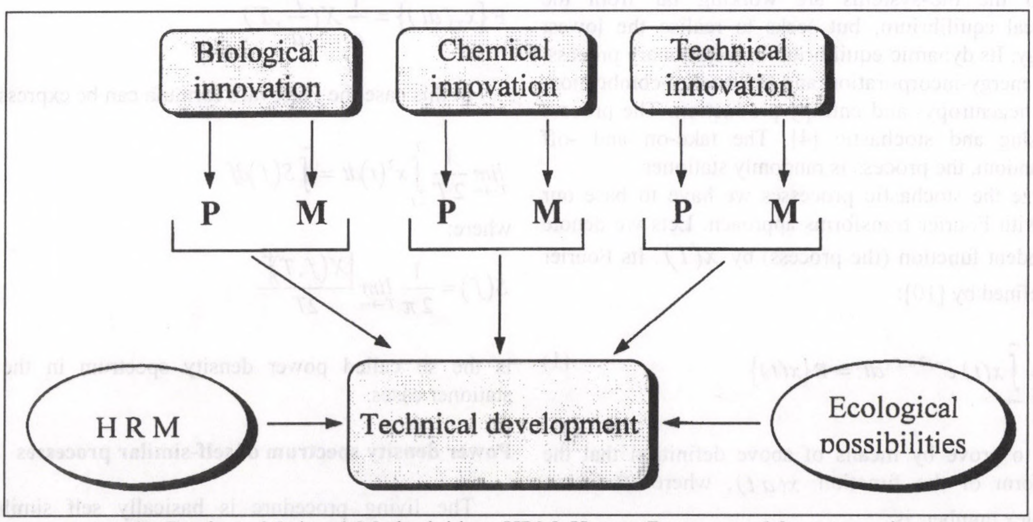


Figure 1

Simplified modell of agricultural innovation flow



(P: Product, M: (new) Method, idea, HRM: Human Reseources Management)

Figure 2

The integration funkcions of technical development in the agricultural innovation flow

ORIGIN OF PINK-NOISE IN BIO-SYSTEMS

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Abstract

The pink- (1/f -) noise is one of the most common behaviour of the bio-systems. Our present paper is devoted to clarify the origin of this interesting fact.

Introduction

All the bio-structures are open and dissipative systems, having a dynamic equilibrium with the environment. During their 'life' beside the normal entropy-production they are entropy sinks, the entropy-decreasing is the most peculiar physical behaviour. This firstly was declared by E. Schrodinger [1], and called a "neg-entropy production". With different wording, the neg-entropy production is the build up information into the system.

Recently much attention has been given to the theoretical and experimental studies of the self-organisation processes in various physical, chemical and biological systems [2], [3]. The living system is self-organising [4], which could be realised by a random stationary stochastic processes.

The self-organising procedure connected by the time-fractal and a special noise, which has a power spectrum definitely reversibly proportional with the frequency, (1/f-noise or pink-noise, or Flicker-noise), [5], [6], [7].

A new physiology (so-called "Fractal Physiology") has been developed [8], [9] in the last few years. It is well known that there are some new diagnostic methods, which are checking the noise spectrum of the bio-systems to control their proper function.

Power spectrum of the bio-matter

The bio-systems are open and dissipative. However the bio-objects are functionally and morphologically complex and highly organised. All the bio-systems are working far from the thermodynamical equilibrium, but seeks to realise the lowest available energy. Its dynamic equilibrium is a stationary process, balancing the energy-incorporation and the energy-combustion, as well as the negentropy- and entropy-production. The process is self-organising and stochastic [4]. The take-on and -off procedure is random, the process is randomly stationer.

To modelize the stochastic processes we have to base our investigation with Fourier transforms approach. Lets we denote the time dependent function (the process) by $x(t)$. Its Fourier transform is defined by [10]:

$$X(f)=\frac{1}{\sqrt{2\pi}}\int_{-\infty}^{\infty} x(t)\,e^{-j2\pi f t}dt := \mathrm{F}\{x(t)\} \qquad (1)$$

where $j^2=-1$.

It is easy to prove by means of above definition that the Fourier transform of the function $x(a\,t)$, where a is an arbitrary complex number, is:

$$\mathrm{F}\{x(at)\}=\frac{1}{a}X(\frac{f}{a}) \qquad (2)$$

Let define the work of the $x(t)$ process by

$$W:=\int_{-\infty}^{\infty} x^2(t)dt \qquad (3)$$

From Parseval's formula [10] follows that this work may be evaluated by:

$$W=\int_{-\infty}^{\infty} x^2(t)dt=\int_{-\infty}^{\infty} S(f)df \qquad (4)$$

where the so called spectral density function $S(f)$ is

$$S(f)=\frac{|X(f)|^2}{2\pi} \qquad (5)$$

depends on the frequency 'f'. It can be proved that the spectral density is the even function of the frequency [10], i.e.:

$$S(f)=S(-f) \qquad (6)$$

Note, the above presented method can not be applied generally in the case of stationery random processes, [10], which is definitely our case.

By definition a stationary random process has an indefinite duration. To introduce a modified density spectrum, consider a finite segment of the random process $x(t)$ of duration on $2T$, defined by:

$$x_T=\begin{cases} x(t), & -T\le t\le T \\ 0, & otherwise \end{cases} \qquad (7)$$

It is evident that $\lim_{T\to\infty} x_T(t)=x(t)$

The Fourier transform of $x_T(t)$ has the form:

$$X(f,T)=\frac{1}{\sqrt{2\pi}}\int_{-T}^{T} x(t)e^{-j2\pi f t}dt \qquad (8)$$

and

$$\mathrm{F}\{x_T(at)\}=\frac{1}{a}X(\frac{f}{a},T) \qquad (9)$$

In this case the Parseval's formula can be expressed as:

$$\lim_{T\to\infty}\frac{1}{2T}\int_{-T}^{T} x^2(t)dt=\int_{-\infty}^{\infty} S(f)df \qquad (10)$$

where:

$$S(f)=\frac{1}{2\pi}\lim_{T\to\infty}\frac{|X(f,T)|^2}{2T} \qquad (11)$$

is the so called power density spectrum in the randomly stationer cases.

Power density spectrum of self-similar processes

The living procedure is basically self similar, so it is convenient to define the self-similarity of a stochastic process. A stochastic process is said to be self-similar if the effective power of the stochastic process representation $x(t)$ equals the effective power of the representation $x(a\,t)$ defined over time scale $a\,t$, for every positive scalar a, i.e.:

$$\lim_{T\to\infty}\frac{1}{2T}\int_{-T}^{T}x^2(t)dt=\lim_{T\to\infty}\frac{1}{2T}\int_{-T}^{T}x^2(a\,t)d(at) \qquad (12)$$

If we apply the Parseval's formula to the equation (7) then we get

$$a\int_{-\infty}^{\infty}\frac{1}{a^2}S\left(\frac{f}{a}\right)df=\int_{-\infty}^{\infty}S(f)df \qquad (13)$$

where Eq. (2) was taken into account.

Also, for the power spectral density function holds the functional equation

$$S\left(\frac{f}{a}\right)=a\,S(f) \qquad (14)$$

for every positive scalar 'a' and every scalar 'f'.

To solve this equation assumes that $f>0$ and set for 'a' the value $a=f$. Hence:

$$S(f)=\frac{S(1)}{f} \qquad (15)$$

On the other hand, if $f<0$ then $f=-|f|$, also one can write

$$\frac{1}{a}S\left(\frac{f}{a}\right)=\frac{1}{a}S\left(-\frac{|f|}{a}\right)=S(f) \qquad (16)$$

Set for 'a' the value $a=|f|$ and take into account that the power density function is even one can obtain:

$$S(f)=\frac{S(1)}{|f|} \qquad (17)$$

This power spectrum characterises the so-called pink- (1/f -, Flicker-) noise. {In general, a stationary self-similar stochastic process follows pink-noise if its power spectral density function is proportional with 1/f, like: $S(f)\approx\frac{1}{|f|}$.}

So all the bio-systems are originally pink-noise generators, due to their stationer stochastic processes.

Self-similarity in terms of correlation function

According to ergodic hypothesis, the autocorrelation function of a stationary random process $x(t)$ can be defined as:

$$R_{xx}(\tau)=\lim_{T\to\infty}\frac{1}{2T}\int_{-T}^{T}x(t)x(t+\tau)dt \qquad (18)$$

which is even function of time shift τ, i.e.

$$R_{xx}(\tau)=R_{xx}(-\tau) \qquad (19)$$

The relation between autocorrelation function and the power density spectrum can be expressed by the Fourier transform of autocorrelation function (Wiener-Khinchine theorem [10]), namely

$$R_{xx}(f)=\frac{1}{\sqrt{2\pi}}\int_{-\infty}^{\infty}R_{xx}(\tau)\,e^{-j2\pi f\tau}d\tau \qquad (20)$$

or conversely

$$R_{xx}(\tau)=\frac{1}{\sqrt{2\pi}}\int_{-\infty}^{\infty}R_{xx}(f)\,e^{j2\pi f\tau}df \qquad (21)$$

From the last equation and the definition of autocorrelation function, in the case of $\tau=0$, follows

$$R_{xx}(\tau=0)=\lim_{T\to\infty}\frac{1}{2T}\int_{-T}^{T}x^2(t)dt=\frac{1}{\sqrt{2\pi}}\int_{-\infty}^{\infty}R_{xx}(f)\,df \qquad (22)$$

Compare this relation with the Parseval's formula, we get:

$$R_{xx}(f)=\sqrt{2\pi}\,S(f) \qquad (23)$$

Also the autocorrelation function can be evaluated from power density spectrum by inverse Fourier transform:

$$R_{xx}(\tau)=\frac{1}{\sqrt{2\pi}}\int_{-\infty}^{\infty}R_{xx}(f)\,e^{j2\pi f\tau}df=\int_{-\infty}^{\infty}S(f)\,e^{j2\pi f\tau}df \qquad (24)$$

Apply this relation to the pink-noise then follows [11]:

$$R_{xx}(\tau)=\int_{-\infty}^{\infty}S(f)\,e^{j2\pi f\tau}df=\int_{-\infty}^{\infty}\frac{S(1)}{|f|}\,e^{j2\pi f\tau}df=\frac{\sqrt{2\pi}\,S(1)}{|\tau|} \qquad (25)$$

This remarkable result shows that the autocorrelation function of a pink-noise of stationary random processes is similar function both in time-shift τ and frequency f. So the autocorrelation of living effects is inversely proportional with the time-shift, characterising the interdependence of the process-events. This is a clear fingerprint of the self-organising structure of the living processes, [4].

Conclusion

In our present work we presented an explanation of the pink-noise generated by the stationary random stochastic processes. It had been shown that the energetic equation in self-similar conditions is enough to generalise the pink noise in a given system described by any kind and number of variables. These conditions make possible to understand the common pink-noise behaviour of the living objects.

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AN EXAMINATION OF THE ROLE OF FAMILY FARMS AND FACTORS AFFECTING THEIR STANDARD OF LIVING DURING THE PERIOD OF HUNGARIAN AGRICULTURAL TRANSFORMATION

(T-024079 OTKA)

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Introduction, preliminary remarks

Concomitant with the economic and social changes in agriculture in central- and eastern-Europe in the 1990's was a change in the nature of the concept of ownership. As a result of this, both forms and means of measurement in farming underwent change. In this period of transformation, in place of the then-existing Production Cooperatives, economically and socially divergent forms of business, reworked cooperatives and family farm units began to appear.

During this time, as a result of the agricultural transformation, more than 1,800,000 households came into control of land. They owned more than 50 % of land. This percentage of ownership does not reflect the level of the farming economy.

The average size of holdings in the EU during this same time of those who pursued a living in agricultural production as their main occupation, thus considered as earning their living in this way, were: in Great Britain, 109.7 hectares; France, 44.8 hectares; Germany, 28.9 hectares; Denmark and Spain, 22 hectares; Italy, 9.3 hectares; Portugal, 8 hectares; and Greece, 6.4 hectares. Within this, on the long term, a tendency toward concentration of holdings and growth in economic size is characteristic of the member states.

In the wake of the economic and social changeover in Hungary, during this period a significant growth was experienced in the change in the percentage of those managing above 20 hectares, as well as in their absolute number.

Statement of goals

In Hungary in the previous time-period, there appeared among the forms of enterprise the family farm, a new and specialised form of emerging ownership. It may be called at the present time a small- rather than medium-sized business endeavour. Its role in the production economy may become more and more significant, but it must meet certain conditions in order to become truly competitive. Among the different condition systems, a cash-making production facility is assumed to meet declared minimum standards of plant size as determined by working businesses.

In my study, I have found the following to be prerequisite to being termed a family farm:

- agricultural work must require at least one man-year of full-time work and occupy one or more family members in a part-time capacity, and employ seasonal and permanent workers as well;
- in order to carry out the activity, at least a part of production capacity must be privately owned or rented, or the producer must be able to bring in outside help;
- it must be a decidedly crop-production business;
- the income derived from crop production must cover the costs of the family's basic income and the costs of simple crop replanting.

In the research here carried out concerning the transformation period in Hungary, I sought the answer to a single question, that is, according to the different conditions set down, what size holdings are needed in the management of small farms in order for them to succeed in the long term?

In order to investigate family farms as a factor affecting economic systems, I had to analyse those units which, according to various viewpoints, affect the emergence of the size of the system. Both outer factors coming from the environment and the system's inner working mechanisms have effects on one another, and the outcome of the entire system and its efficiency. The agricultural industrial system is affected in part by the dynamic mutual effects of production processes occurring within it (branching), as well as by the combined effects on the system of ecology, economy, and socio-economic factors.

Not specifiing all the main factors affecting the emergence of potential manageable-sized ownings I emphasise the most important ones in my research:

- *agroecology, production site factors,*;
- *limited amount of arable land,* which, with potential purchasable land and a lack of rentable land, causes the flexibility of management uncultivated land to suffer;
- *the change in the nature of ownership*;
- *worker benefits and unemployment*;
- *on-hand machines and tools*;
- *crop make-up.*

For these reasons, my statement of goals is the following:

- determination of the farm size necessary for a family operation to ensure that:
  - at least a minimal (for upkeep of standard of living) family income;
  - a return on capitol invested;
  - expansion of resources, and repayment of interest on credit and capitol investment.
- examination was undertaken of the single and combined change in the following itemised factors influencing management unit size:
  - *crop make-up* (in the development of which agro-ecology, production site and market factors play a role),
  - *production level,*
  - *mechanisation*, technologically determined machine system, amount of tools on hand, and their ability to carry out tasks,
  - source of mechanisation, percentage of *outside funding* and the influence of changes in *interest levels,*
  - as well as an examination of the relationship between the value of *invested capitol*, *production level* and income-producing management size.

Results

Aside from the review of the concrete model I would like to demonstrate my results. On the basis of the results obtained from model examination of family crop-producing farms, I showed the following:

1. Each machine system's belonging to a power machine category as to the size of a cultivable area depends on the following:

- *on crop make-up*, showing that
  - industrial crop-producing systems provided the smallest upper farm-size limitation;
  - spiked wheat production system gave a smaller cultivable area;
  - mass fodder content in crop make-up resulted in the largest cultivable area of each technical system;
- *on the givens of a production site*, which in large sizes determine production levels; farms in less amenable

surroundings are less capable of production results on each level of power-machinery and manual farming, that is, the time-interval serving for the execution of optimal performance of tasks can be smaller;

2. Farms' *economically-induced minimum size* (break-even point size) is influenced by:
- the give amount of bound capitol in an indicative tool system;
- production level;
- also on crop make-up, on which the preceding have a smaller influence;
- beside a determined production structure, the amount of growth in bound capitol (higher value indicative machine system) increases the break-even point's location (Table 1);

Table 1

Different break-even points according to tool value

Machine value	location of break-even point		
	production level		
	low "A"	medium "B"	high "C"
1 million HUF	51 he	15 he	10 he
4 million HUF	80 he	30 he	20 he
9 million HUF	140 he	65 he	45 he

- *use of outside funding* in every case increases economically-induced minimum farm size (Chart 1);
  - because of the budget growth due to the interest burden concomitant with the use of outside funding, the lower limit of the farm's amount of production grows as well, given the budgetary aspect's self-financing amount;
  - from an examination of *production levels and outside sources together*, it was established that the smaller the production level on a farm, the more sensitively it will react to a rise in the interest levels in outside funding, which often brings about liquidity financing problems, resulting in its financial state becoming untenable; in this situation, there is no farm size which can keep itself in operation generating income, and at the same time accounting for interest as well.

3. The *growth in bound tool value* combined with the percentage of outside financing combined, within the area of tool value, to give a higher location to the break-even point, tightening the income producing interval of cultivable territory of a given production structure and level.

4. *Repayment of outside financing* (capitol burden) from taxable income and certified depreciation from usable cash-flow is possible. The suitable condition for this was that the amount of growth in minimal capitol repayment coverage depended on received outside capitol amount and percentage.

5. When bound capitol was examined as a function of the break-even point at differing production levels, it could be established that each *break-even point of bound-capitol decreases as production levels increase*. In the case of an average farm with high production levels, the relationship between the break-even point and bound capitol can be considered linear. Decreased production in and of itself demands a higher break-even point (size), and as a function of bound capitol, the necessary growth of size is progressive. In a system working on an average or better level- because of the linear relationship between bound capitol and the break-even point- it was always possible to find, among the territories I examined, a farm size bigger than which would cause the system to produce income (chart 2). A decrease in the level of farming forced this size up. Smaller than average farm production influences the amount of available capitol. It was not possible to find a farm size which could produce income using a 6.5-7 million HUF machine system and having a low level of production (the level of bound capitol examined was in the range of 25 million HUF, which in Hungarian terms of tool and capitol support represents the upper limit for farms examined).

Consequences, suggestions

- It is necessary to alert farmers to the reality that besides the given size of a machine system's bound capitol, production levels also have significant influence on the economically-caused minimum size of a farm. Growth in production levels causes reductions in the break even point. In other words, this means that besides a farm's given size, by increasing agricultural yields, a farm can become more able to pay for itself and for those who work it.
- Because of the interest burden on outside capitol used to finance agricultural development, the lower limit of the farm's production size and the self-financing minimum size is also growing. The growth in the interest budget needed to repay the rising interest rates on outside funding sources results, even in larger farms, in a growth in the minimum farm size needed to meet family income and living demands, interest and repayment of capitol.
- Within the agricultural subsidies system, beside the interest subsidies for development, in the case of each preferred production goal investment, the further upholding of allocations of non-repayable permanent capitol is warranted. In this way, within the structure of the transforming agro-business sector, subsidies can help the newly-starting or strengthening family farms capitol allocations to achieve financial liquidity in the long-term. Non-burdening and permanent subsidisation is the only means available to them as, even if they are able to get credit, amortisation raises the break-even point to a level that most farmers cannot reach.
- Paying back outside financing (capitol burden) from taxable income and certified depreciation, from usable cash-flow, is possible. I have shown that capitol cannot always be amortised by farm income at harvest time. All this draws our attention to the fact that for the upkeep of family farms, income-producing management is not enough by itself; yearly systematic cash-flow production levels must occur on a level so as to reach this goal. This is something that should be taken into much deeper consideration by those managing family farms. The given values indicate the importance of the fact that every decision concerning the development of family farms must take into account not only the locating of financial sources, but the harmonising of this with fundamental conditions and abilities.

I also feel it important to point out that a consequence of the economic, and social transformation in central- and eastern Europe was that in Hungary, as well as in other places, many began farming without knowledge and/ or experience in the field. Many of these were so-called forced farmers, who began by initiating developments, the satisfaction of which they did not know the background or conditions, thus being unable to meet amortisation repayment demands and going bankrupt. They could not become connected with crop production, and as a result, their and their families' lives were adversely affected. In order for fewer such events to occur in the future, analyses and examinations are necessary to provide farmers with information so that they and their families can make better, more well-informed decisions. In my work, I want to make a small contribution to this end and to the better knowledge of Hungarian farming conditions.

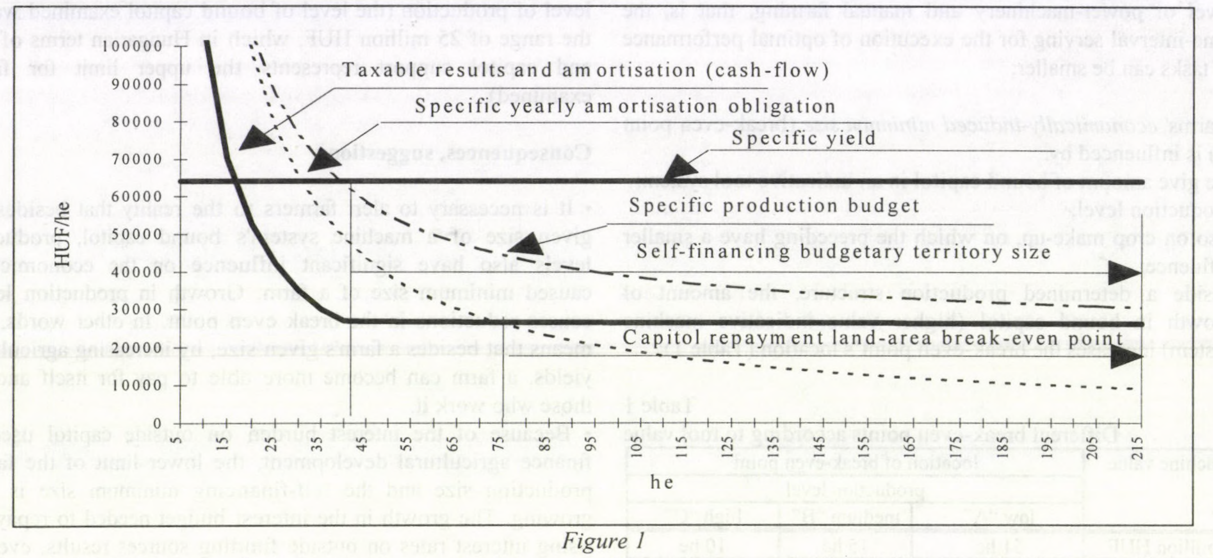

Figure 1

The relationship between financing development and farm size (the entry year capitol burden's changing influence on farm size 120 kW power machine category, at highest production levels)

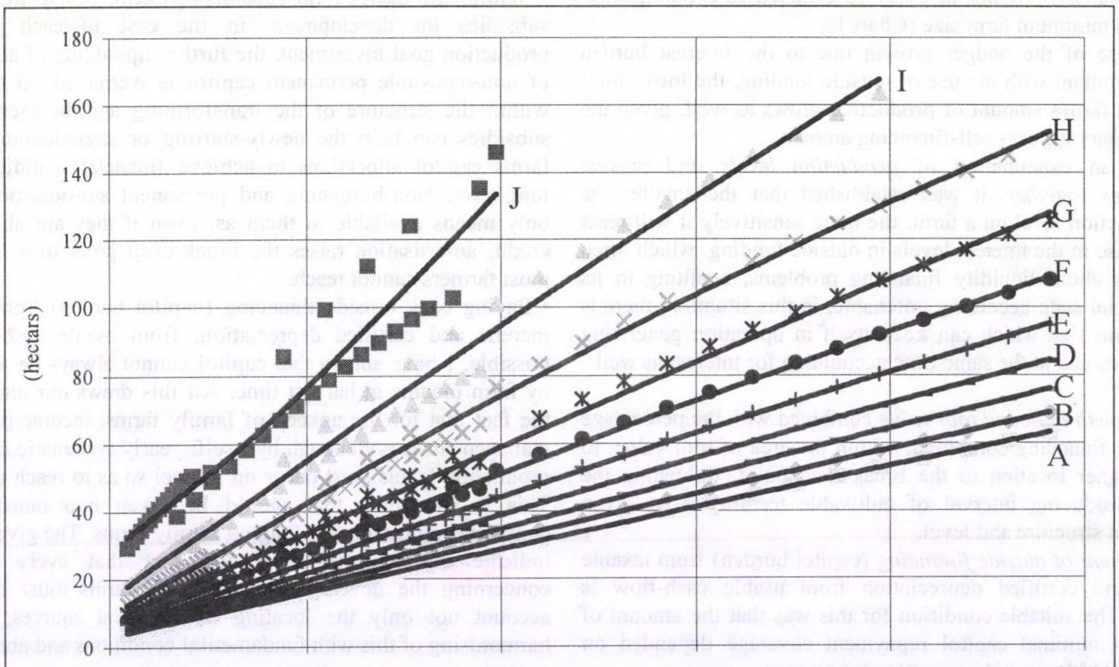

Figure 2

Relationship of bound capitol and break-even point value on varying production levels. Product levels in wheat yield-equivalent

A=5.9 t/he B=5.6 t/he C=5.3 t/he D=5.0 t/he E=4.7 t/he
F=4.4 t/he G=4.1 t/he H=3.8 t/he I=3.5 t/he J=3.2 t/he

INVESTIGATION OF FORESTRY DEEP SUBSOILING BY THE FINITE ELEMENT METHOD

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1. Abstract

The finite element method was used to study deep cutting of sandy loam soil by a forestry deep subsoiler. The numerical analysis was performed with a COSMOS/M finite element software. The material of the soil was considered as elastic-perfectly plastic. Therefore, the Drucker-Prager elastic-perfectly plastic material model was adopted with the flow rule of associated plasticity. The material and geometrical non-linearity of soil were taken into account. Soil-tool interaction was simulated adopting the Coulomb's law of dry friction. The draught and vertical forces, vertical and forward soil movement and stress distribution fields were reported. The total vertical force was negative in direction due to the high negative vertical force of the shank, which would have pushed the subsoiler upwards. However, the wing total vertical force was positive in direction.

2. Objectives

The objectives of the study can be summarised by the following three points:

1. Development of a non-linear three-dimensional finite element model (FEM) of soil cutting by a forestry deep-subsoiler.
2. Calculation of the draught and vertical forces of the subsoiler two parts.
3. Determination of positions of soil loosening and soil compaction due to the subsoiler action in the soil.

3. Tool geometry and finite element model

The subsoiler studied mainly consists of two parts, namely the shank and the wings. The shank that is inclined to define 145° with the horizontal (Fig. 1) protects the wings installed behind from being broken by hard bodied such as stumps or rocks. Two wings are installed on the rear side of the shank, one on each side. Soil loosening takes place by the wing lifting of the soil, leading to soil volume increase.

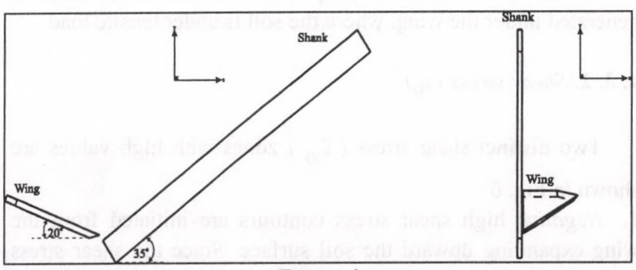

Figure 1
Illustration of the subsoiler parts in two views

Eight-node, linear solid elements, were selected to represent the soil material. The subsoiler was assumed to be a rigid body. The total number of nodal points and elements were 2580 and 1978, respectively. The analyses were performed by using a COSMOS/M FEM software.

Since the problem studied was symmetric about the central plane, only one half of the total region was meshed and considered during the analysis. The calculated subsoiler forces were then duplicated in magnitude in order to obtain the total forces.

The Drucker-Prager elastic-perfectly plastic material model was adopted to simulate the elastic-perfectly plastic material behaviour of a sandy loam soil. A COSMOS/M 1.71 FEM software was used to run the analysis. The material non-linearity was solved by adopting an incremental technique, and inside each step the Newton-Raphson iteration method was used. To study the interaction and sliding characteristics of the soil-subsoiler system, Coulomb's criterion of dry friction is utilised. The material and interface properties used for the FEM analysis for a sandy loam soil are summarised in Table (1).

Table 1
Soil texture, soil and soil-metal interface properties (Mouazen, 1997).

Terms	Value
***Soil texture*:**	
Sand (%)	68.2
Silt (%)	18.4
Clay (%)	13.4
Material properties of soil:	
Soil moisture content d.b., (%)	14.5
Cohesion (kPa)	15.50
Internal friction angle (deg.)	31.8
Wet bulk density (kg/m^3)	1731
Poisson's ratio	0.3596
Modulus of elasticity (kPa)	8067
Material properties for the interface:	
Soil-metal friction angle (deg.)	23
Soil-tool adhesion (kPa)	0

Soil physical and mechanical properties were measured at the Geotechnical Department, Faculty of Civil Engineering, Technical University of Budapest.

4. Results and Discussion

4. 1. ***Subsoiler Forces***

The subsoiler forces were separately computed for the wing and shank. Subsequently, the total subsoiler forces at a given increment were obtained by the addition of the particular forces of both parts.

Fig. 2 illustrates the FEM calculated components of the draught force against displacement. The rate of increase of the wing and shank draught force is relatively high at low displacement, but then decreases with increasing displacement. The wing draught force after nearly 4 cm stops increasing, showing steady state of draught force. Supposing constant values of the Young's modulus and Poisson's ratio along with the FEM analysis increases the shank draught force. This increasing continues even after the draught force curve of the wing shows a steady state (Fig, 2). Soil expansion (volume increase) upwards and sideways due to the wing loading alleviates draught increasing and eliminates it after 4 cm displacement.

Since the soil is compressed downwards by the shank and only very slight expansion occurs at the soil surface, the draught force calculated for the shank continues increasing with high rates (Fig. 2).

Considering constant values of the soil stiffness, the calculated vertical forces show similar tendency to the one of the draught forces. On the other hand, while the particular vertical force of the wing tends to increase with displacement, the vertical force of the shank tends to decrease with displacement (Fig. 3). The negative vertical force of the shank is the force tending to lift the shank upwards. The overall vertical force of the subsoiler is negative because the magnitude of the shank negative vertical force is much higher than the wing positive vertical force. This negative total vertical force pushes the subsoiler upwards. Therefore, some weights are needed to overcome the upward pushing and keep the subsoiler at the required cutting depth.

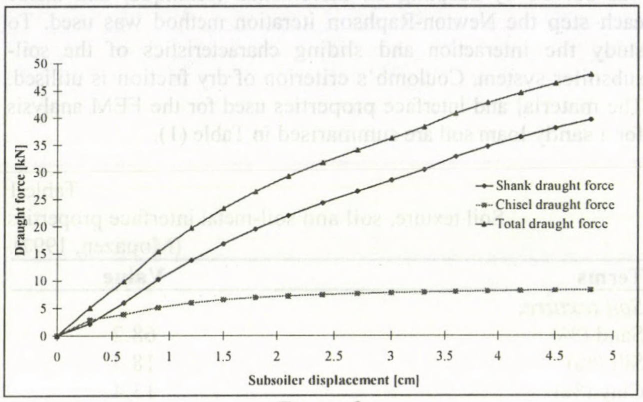

Figure 2

Total, wing and shank draught forces as a function of subsoiler displacement

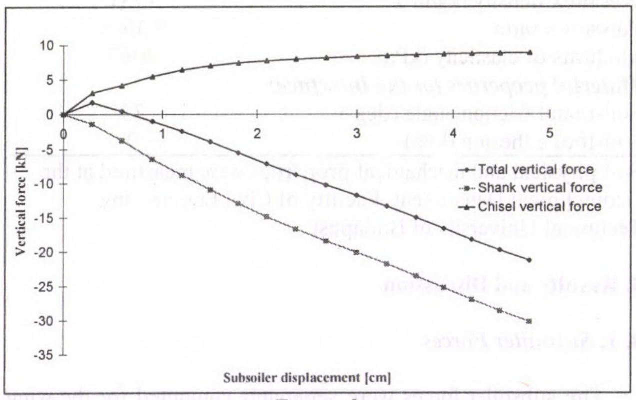

Figure 3

Total, wing and shank vertical forces as a function of subsoiler displacement

4. 2. *Soil Movement*

Since the subsoiler two parts enclose different angles with the horizontal, they have different effects on the soil movement pattern and direction (see Fig. 4).

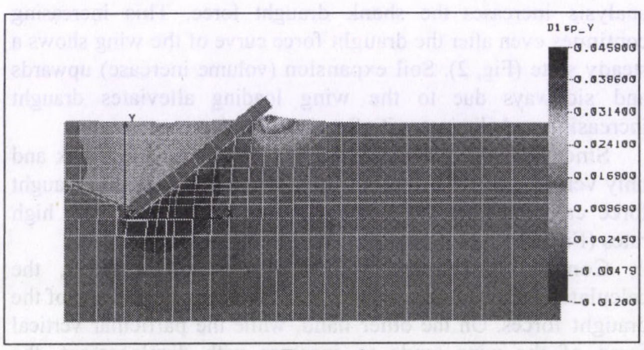

Figure 4

Upward soil movement after 5 cm tool displacement

Soil situated above the wing is lifted and the soil movement occurs upwards and sideways. This movement increases the soil volume, which assures the loosening of the soil above the wing. On the other hand, the inclination of the shank downward obliges the soil in front of the shank to move downwards and sideways. In other words, the shank compresses the soil before cutting it. However, maximum upward soil movement is generated on the soil surface directly in front of the shank, where the shape of soil deformation is consistent with a wedge-shaped soil upheaval.

4.3. *Stress distribution*

4. 3. 1. *Normal stress (σ_x)*

Fig. 5 illustrates the distribution of the normal stress (σ_x) contours, from which three main zones of *negative* compressive stress can be distinguished:

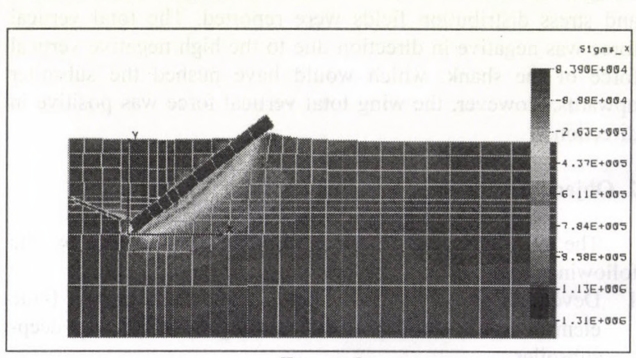

Figure 5

Distribution of the normal stress (σ_x) throughout the central plane

1. A maximum horizontal x-stress zone of -1310 kPa is generated in front of the shank. In fact, the whole zone situated in front of the shank is under compressive loading, and will be disrupted later by the direct cutting of the shank. However, the extension of the high normal stress below the cutting depth of the shank interprets the initiation of a new compaction below the shank.

2. At the tip of the wing appears another high compressive stress zone of -350 kPa. This compressive stress leads to soil cracking initiated from the tip of the wing.

On the other hand, lower *positive* normal stress zone is generated under the wing, where the soil is under tensile load.

4. 3. 2. *Shear stress (τ_{xy})*

Two distinct shear stress (τ_{xy}) zones with high values are shown in Fig. 6:

1. *Negative* high shear stress contours are initiated from the wing expanding upward the soil surface. Since the shear stress contours in this zone are negative, the shearing is of the counter-clockwise type and this zone is under lifting action as expected. These contours characterise a similar zone to the Rankine passive earthpressure zone proposed at the conventional analytical methods of the soil cutting process. However, at the conventional analytical methods the Rankine passive earthpressure zone is initiated from the tip of the cutting tool, whereas at this study it is initiated from the middle of the wing. This is because the shank runs in front of the wing.

2. Another shear stress zone of *positive* contours spreads along the front side of the shank. This area is actually under the compression stress exerted by the shank, confining earthpressure at rest and the soil coming behind, simultaneously, for which it exhibits shear failure behaviour. A maximum positive shear stress of 254 kPa is situated at the bottom of the shank, which decreases upward the soil surface.

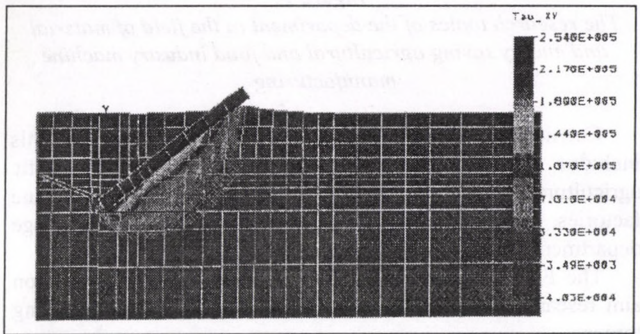

Figure 6

Distribution of the shear stress (τ_{xy}) throughout the central plane

5. Conclusions

1. The draught and vertical forces could be separately calculated from the FEM model for the wing and shank. The vertical force of the shank was negative in direction, whereas it was positive for the wing.
2. The upward lifting of the soil by the wing increased the soil volume, which assured the loosening of the soil above the wing. On the other hand, the inclination of the shank downward obliged the soil in front of the shank to move downwards and sideways. In other words, the shank compressed the soil before cutting it.
3. The FEM demonstration of stress distribution fields showed positions where soil was failed either in shear or tensile. Soil above the wing was under lifting and shear failure, whereas below it the soil was under tensile failure.

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SOME QUESTIONS OF MANUFACTURING OPTIMAL SPECIFIC WEIGHT MACHINES

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Introduction

The Department of Machine Manufacturing and Reparation Technology has been dealing with the questions of material and energy saving manufacturing of agricultural machines for one and a half decade. At present the actuality of the topic needs no evidence, but the situation was not always the same in during the development of the industry. Now the effect of the machine fabrication is surveyed in the areas of material and energy saving as well as the environment protection.

The level of the industry of the country can be characterised by the figures of material used up for the gross national production. According to the reports 185 kg steel was used to produce $1000 national income in Hungary while the same figure was 80 kg in Germany and 60 kg in Japan. The investigations of the Department proved that the specific weight of the agricultural machines exceeded the average of foreign ones by 20-50 %.

As for saving energy two factors are considered. On the one hand to produce basic material is an extremely energy consuming process, so that reducing basic material and premanufactured product application results in significant energy saving. On the other hand the operation of the lower mass machines needs less energy.

The machine manufacturing has many direct and indirect connections to the environment from the metal mining to the waste material reutilization when the wear out machine is processed. The protection of the fertile soil is exposed in this area what is covered by more scientific fields. In our case it means that the lower specific weight machines compact the soil in less extent. The too high soil compacting is a significant damaging factor of the mechanised agriculture.

In the past nearly one decade delivered considerable changes in the ownership conditions and structure of our industry. As a consequence the differences mentioned have reduced between the domestic and international machine manufacturing, however there are still problems to improve. Considering that the efforts of development for material saving will provide result rather for the user or the national economy than for the manufacturer, it is important to demonstrate those effects.

Description and structuring the research topic

The definition, characterisation and assignation of the research field of *Material and Energy Saving Agricultural and Food Industry* are especially important for the research fields and mainly for the work.
The interpretation of the theme may be even of three kinds.

According to an interpretation the aim of the research is to elaborate by what processes and how the given products can be manufactured to achieve the least material loss and energy consumption of the *manufacturing process*.

In the second interpretation the investigation and the development include the aim of the material saving manufactured goods (which means usually less mass) and energy saving operation.

As for the third interpretation, the field unites both of the previous interpretations. So that the field includes all the *product and process development activity research* which has the primary goal to develop optimum mass and the possible least operation energy need manufactured goods and their manufacturing at the least energy consumption and material loss.

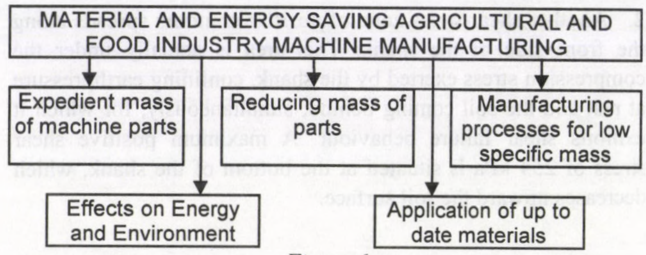

Figure 1
The research topics of the department in the field of material and energy saving agricultural and food industry machine manufacturing

Considering the last interpretation one can see that this includes the complete innovation activity of the domestic agricultural industry. In this wide area can be shared by machine factories, research institutes and university and college departments including us, too.

The Fig. 1 shows that in the elaboration of mass reduction aim research our department achieved results in the following topics.

The expedient machine mass, mass utilisation factor

The expedient mass (m_h) is a part of the machine mass which is necessary to meet the function of the machine. Among the soil cultivation machines and especially for the ploughs and disc-harrows one can state that it is that part of the machine mass which ensures to keep the cultivation element in the soil in the required depth. If similarly to the specific mass the expedient mass m_h is related to the parameter characteristic to the machine, to the working width with tillage machines, the specific expedient mass of the given machine type is determined (m_{fh}). In the case of tillage machines

$$\mathbf{m_h = C\, k\, B\, h_{max}} \quad \text{(kg)}$$
$$\mathbf{m_{fh} = C\, k\, h_{max}} \quad \text{(kg/m)}$$

where h_{max} - cultivation depth (m)
k - specific pulling resistance (M/m^2)
C - factor depending on the character, design and operation way.
B - working width (m)

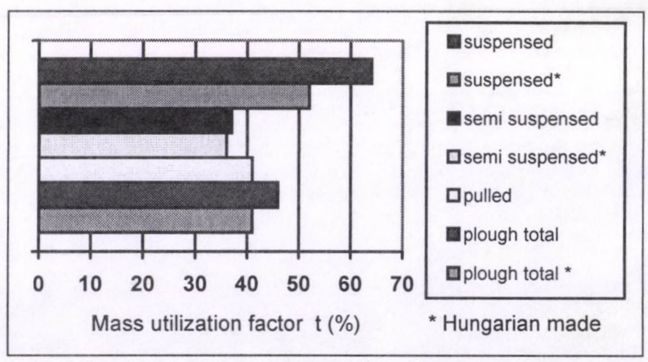

Figure 2
Mass utilization factor of the examined bed plow

The *mass utilization factor (t)* is given by the expression

$$\mathbf{t = 10^2\, m_h m^{-1}}$$

which expresses what percent of the given tillage machine mass (m) is necessary to meet the function. Making use of this parameter not only the same but the different duty machines can be also compared, so that the measure of their excess mass could be found. Fig. 2 shows the mass utilization factor of the examined ploughs.

Energy and environmental effects

In relation to the machine mass reduction the change of the energy consumption, the basis of machine aggregate energy cost, is expressed by

$$dE' = (1 + m_e m_1^{-1} + a\,t)^{-1}\,dm' \ (\%)$$

where

dE' - the change of tillage energy need (%)
m_e - the mass of power machine (kg)
m_1 - mass of the implement before reduction (kg)
a - factor depending on the type of tillage
t - mass utilization factor (%)

The reduction of pressure caused by the wheels of the implement and the power machine on the soil as an effect of the material saving (mass reduction) is shown in Fig. 3.

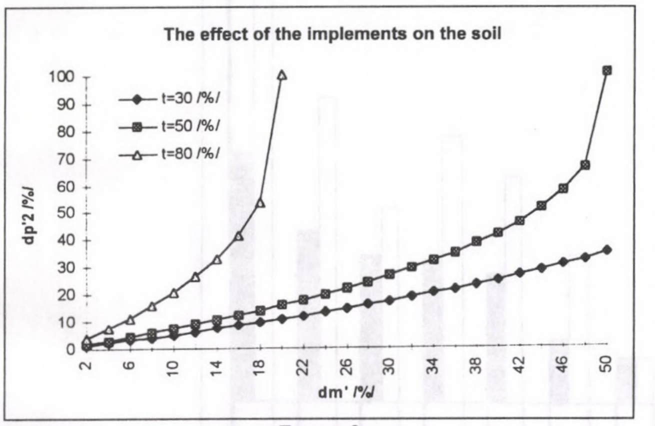

Figure 3
Reduction of the pressure caused by the wheels of the implement

In the case of the tractor

$$dp_1' = 10^2(1-(1-10^{-2}dG_{adh})^{1/3}) \ (\%)$$

where
G_{adh} - the adhesion weight of the implement on the rear wheels

Reduction of the pressure caused by the wheels of the tillage machine on the soil:

$$dp_2' = 10^2(1-(1-(10^{-2}t)^{-1}dm')^{1/3}) \ (\%)$$

Determination of the achievable mass reduction of the machines

To the preliminary determination of the results of the material reduction in the development process a double calculation method based on stress computations was elaborated and the terms of <u>profile factor</u> (Z) and <u>material factor</u> (H) were introduced.

The <u>profile factor</u> is a characteristic parameter which depends on the shape and area of cross section. It is applicable to range the section profiles from the viewpoint of material saving. Using higher profile factor element may result in lower mass part of equivalent stress characteristics.

The <u>material factor</u> is a parameter depending on the physical and mechanical properties of the material of part and is characteristic to the examined material. It is applicable to range the different materials in the point of view of material saving. Using higher material factor element may result in lower mass part of equivalent stress characteristics.

Load	Mark	Profile factor $Z_{i;j}$	Material factor $H_{i;p}$
Tension-Compression	0	-	$H_{0;p}=10R_{mp}\rho_p^{-1}$
Bending	1	$Z_{1;j}=K_{1;j}^{2/3}A_j^{-1}$	$H_{1;p}=10^2R_{mp}\rho_p^{-1}$
Torsion	3	$Z_{3;j}=K_{3;j}^{2/3}A_j^{-1}$	$H_{3;p}=10^2\tau_{mp}^{2/3}\rho_p^{-1}$

where

0…3 - the mark of load type
$_1$ - the mark for the state before development
$_2$ - the mark for the state after development
K - cross section coefficient (m^3)
A - cross section area (m^2)
R_{mp} - ultimate tensile stress (Pa)
ρ - specific density (kg/m^3)
τ - ultimate shear stress (Pa)

The achievable mass reduction functions was determined both for simple and complex loads. The method is applicable to determine the absolute and relative values of the achievable mass reduction by changing the shape of the cross section and/or material quality.

Tension-bending $dm'=f(\varepsilon_1,\rho_1,\rho_2,H_{0;1},H_{0;2},Z_{0;1},Z_{1;2},A)$ (%)
Tension-torsion $dm'=f(\varepsilon_2,\rho_1,\rho_2,H_{0;1},H_{0;2},H_{3;1},H_{3;2},Z_{3;1},Z_{3;2},A)$ (%)
Bending-torsion $dm'=f(\varepsilon_3,\rho_1,\rho_2,H_{0;1},H_{0;2},Z_{3;1},Z_{3;2},Z_{1;1},Z_{1;2},)$ (%)

where

$\varepsilon_1 =$ M_1/F load ratio, the ratio of the bending moment and the tensile force
$\varepsilon_2 =$ M_3/F load ratio, the ratio of the torque and the tensile force
$\varepsilon_3 =$ M_1/M_3 load ratio, the ratio of bending moment and the torque

Application of the up to date materials

Comparing the material factors of the material groups one can experience large differences. For example, in the case of torsion load the ratio of the material factor (Fig. 4) can be as high as 7 for general purpose steels and alloyed aluminium. Replacing those materials may result even in a mass reduction above 80 %.

The material factors are in a wide range even in a group of materials (Fig. 4). The ratio of the maximum and minimum values is higher than 2 for tempering steels and alloyed aluminium. According to this mass reduction can be reached simply by changing the basic material within a material group. This can be as high as 50 % for the mentioned examples.

The role of the technical plastics are revalued as their density is only one sixth of that of the steels and in some fields their abrasion and chemical resistance of theirs are also more favourable.

Recently we made some steps in this professional field, too. We undertook significant role to make known and spread the *high strength technical plastics*.

It managed to compile considerable material as a result of the co-operation with manufacturers, domestic experts about the structure and properties of them.

Extension course was organised for practical experts within the framework of a PHARE project. Well known professionals gave a series of lectures and practical demonstrations what was liked by the audience.

The information on the applicability and machining processes of the technical plastics are shown on professional conferences.

The mentioned material has been published with the leading and contribution of our colleagues in the form of a professional book.

The manufacturing processes of low specific mass parts

The research connecting to the part manufacturing processes should be concentrated on the following areas:

The examination of the machining possibilities and difficulties is an important task during the poduct development. It is mentioned as example that the cutting, welding and bonding technologies of the mentioned technical plastics has been well elaborated. The questions of plastic shaping still need further investigations.

The effect of the applied technologies on the material properties has continuously increasing significance. The effect of plastic shaping on the metals and the favourable change of the mechanical properties should be considered in an increasing extent. The cold forming processes should be preferred to the cutting when it is possible.

In more and more fields the manufacturing technologies of thin wall structures should be developed. The application of pressure cast is being widened, which is used to produce good quality thin wall chambered cast parts (e.g. aluminium cast parts). It is expected that an additional need is arising for mass reduction of shaft parts. The realization of the need will result in the application of hollow shafts more widely.

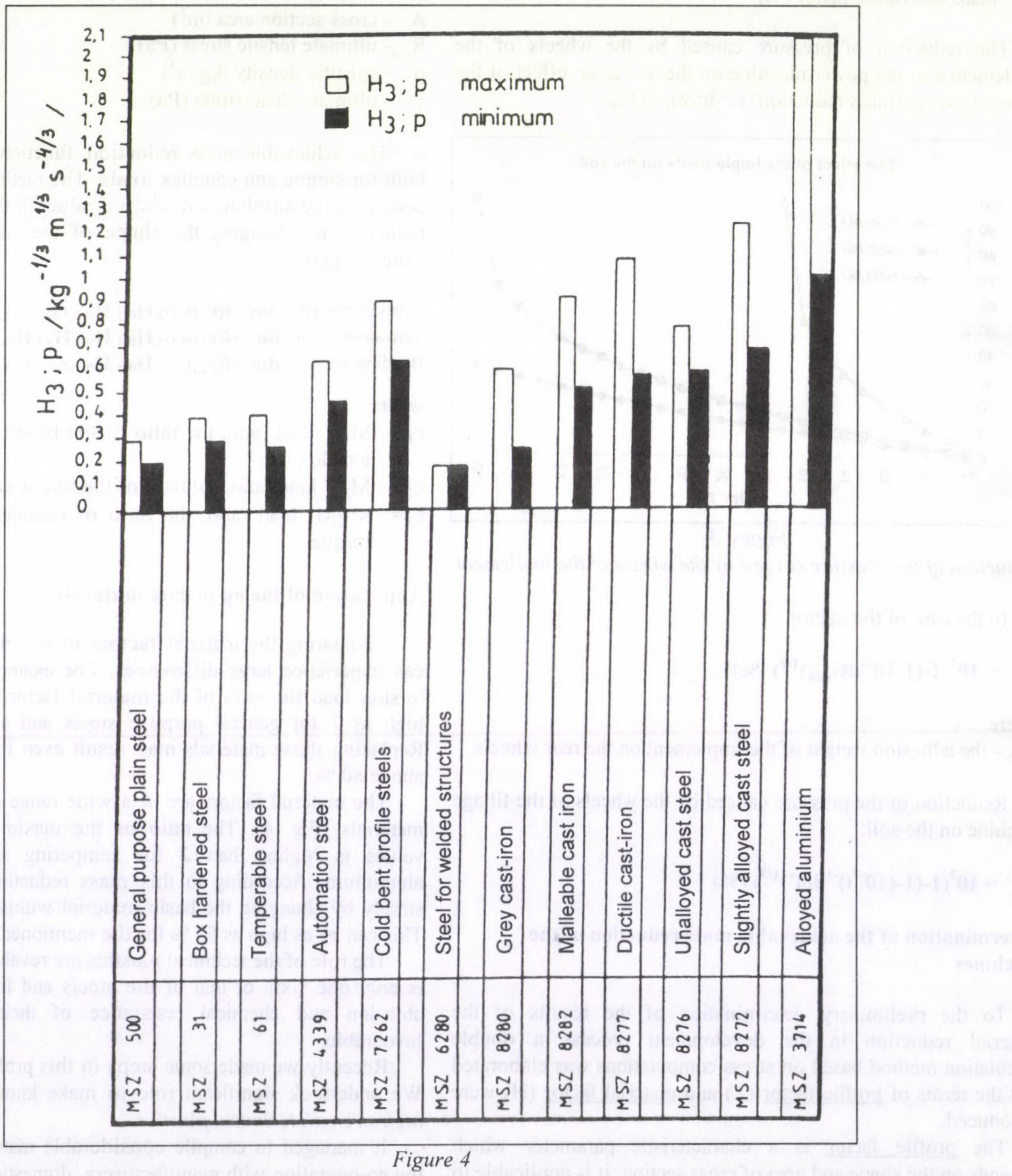

Figure 4
Material factors for torsion load

THE USE OF WIND ENERGY IN HUNGARY

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University of Agricultural Sciences, Gödöllő

Summary

The main task of this research is to measure and calculate the local wind circumstances and to design an optimised blade. The first evaluated wind measurements were made in North-Western part of Hungary. The wind energy is the most preferable in this part of the country. The results and the feasibility study indicates that the wind power plant installation is feasible in case of making some parts in Hungary. There is a way for analising blade production for local circumstances We have to take into account the local wind speed and design the optimised blade with inverse design methods.

Introduction

Nowadays, the use of renewable energy is becoming an important question. Wind energy is currently viewed as one of the most promising energy source. The use of wind energy has no toxical emissions so this matter will be important concerning EU energy norms. Wind energy is an unlimited source of energy.

It is not an easy task to choose a site for a wind generator because we have to take into account many factors. The most imporatant factors are wind speed, the energy of the wind, generator type and the feasibility study.

Windmills have been working since the earliest antiquity. The first modern wind turbines driving electric generators appeared at the dawn of the 20th century, then spread all over the world. Nowadays the use of wind energy is concentrated on producing electricity.

The moving air has energy, so on site measurements are used for determining the data for installation and technical properties. The first evaluated wind measurements were made in North-Western part of Hungary in Kis-Alföld region in Osztffyasszonyfa. The local wind measurements were made in order to determine the wind speed, the main wind directions and the energy. We have to perform statistical study of local winds, in order to state accurately the wind turbine model to be used and the rated wind velocity to be considered for determining the geometrical characteristics of the wind rotor.

Method of Analysis

The wind increases with the altitude. Wind speed on the desired height can be computed from the following equation:

$$\frac{v_2}{v_1} = \sqrt[5]{\frac{h_2}{h_1}}$$

If the the average wind speed is known the frequency of the wind speed on a certain spot can be determined by the Rayleigh's distribution curve:

$$f(v) = \frac{\pi \cdot v}{v_a^2} \cdot e^{-\frac{\pi}{4} \cdot (\frac{v}{v_a})^2}$$

f(v) is the relative frequency of the wind speed (v).

The measurements data should be recalculated for the required 45 m height.

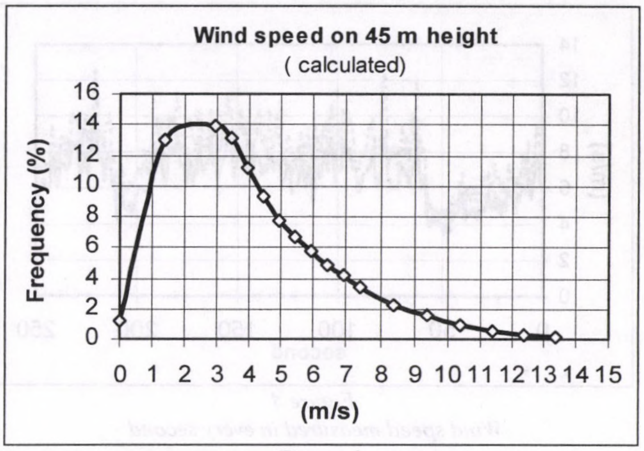

Figure 1
Wind speed distribution curve

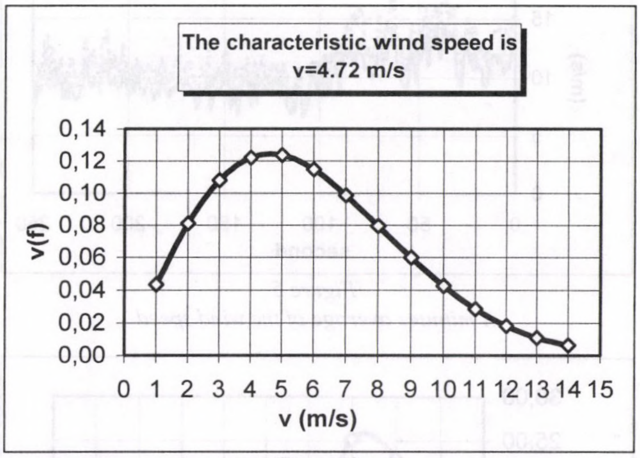

Figure 2
Characteristic wind speed

The wind speed to be used is the value of the most frequently blowing wind. The wind speed is at the maximum value of distribution curve.

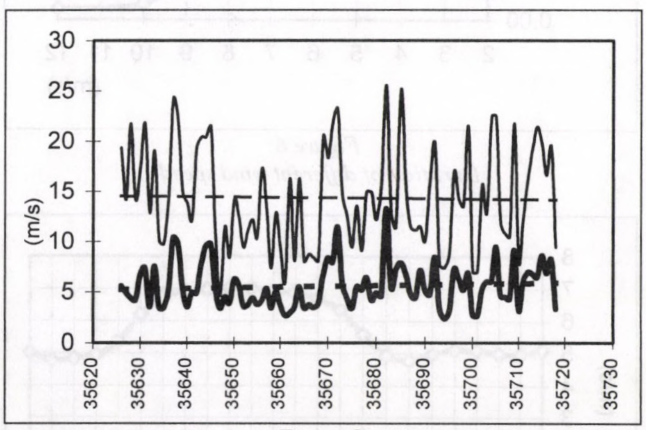

Figure 3
Daily average and maximal wind speed

The average wind speed is up to 8-14 m/s and maximum wind speed is 25 m/s on windy days. The main part of usable wind energy is in this region.

The next data were taken in every second. The difference between the average and maximum wind speed is 1.5-2.0 m/s so the wind continuity is acceptable.

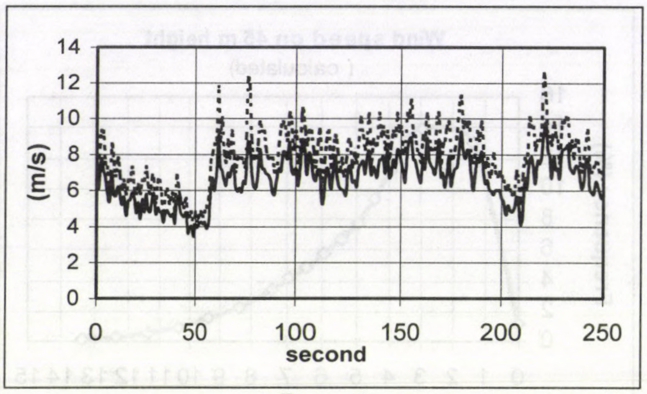

Figure 4
Wind speed measured in every second

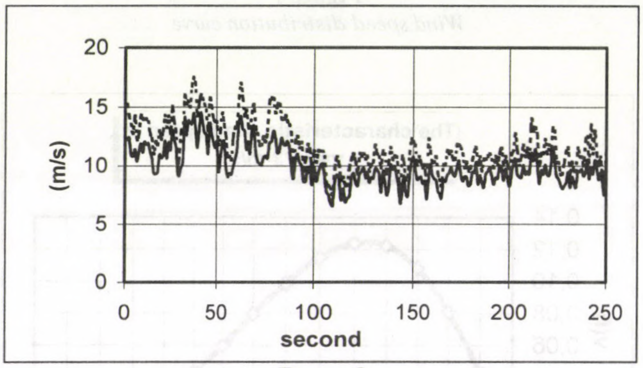

Figure 5
A minutes average of the wind speed

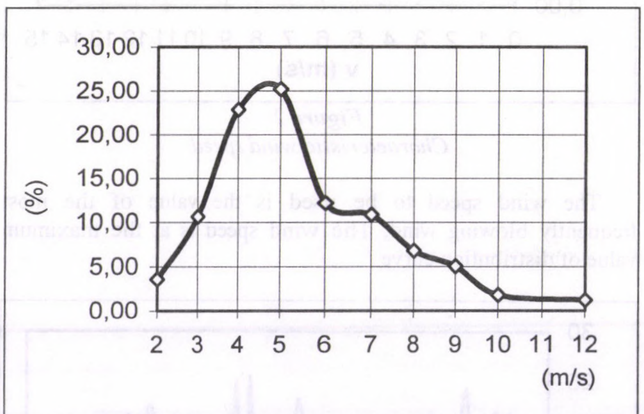

Figure 6
Duration of different wind speed

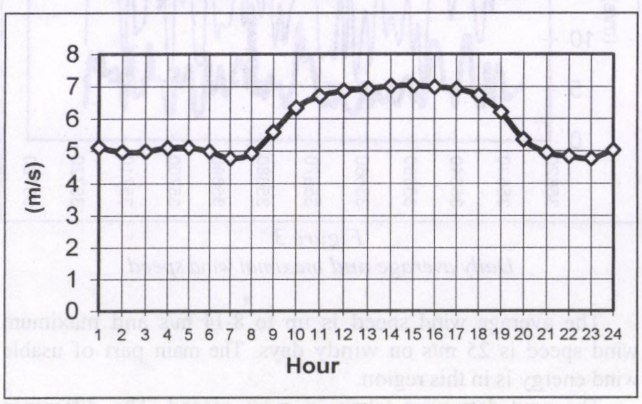

Figure 7
The average wind speed in one day period

According to the data obtained from the distribution curve leads us to determination of the duration of different wind speed on an average day. The 56 % of the wind is acceptable in the way of using wind energy.

The main wind directions are NW, W and S. The wind from North has 13 % average.

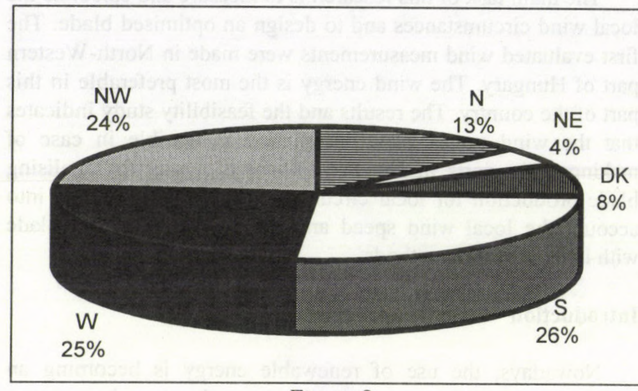

Figure 8
Main wind directions

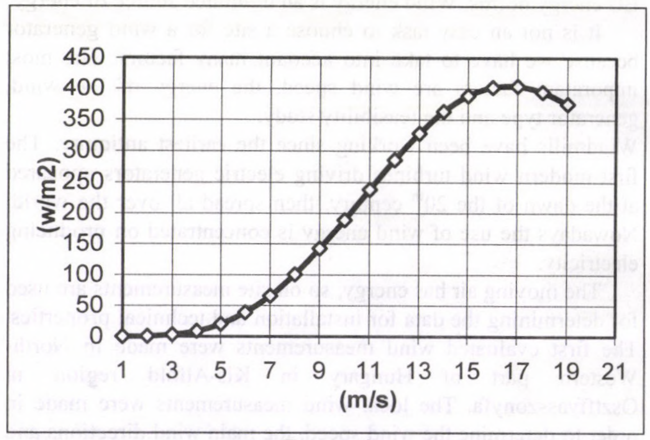

Figure 9
Wind power on the chosen location

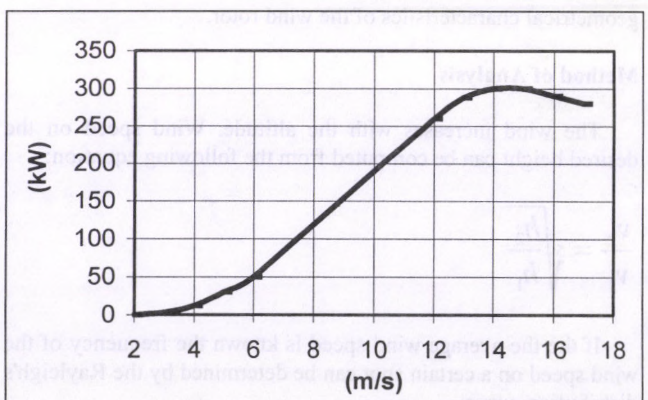

Figure 10
The optimal wind generator power characteristics curve

The wind generator power characteristic was determined on local wind circumstances. The continental wind differs from wind blowing from the see in speed dynamics and frequent direction changes. The environment is not so windy so it moved the curve in a lower average wind speeds.

Design philosophy

The design is based on a wind speed and power requirement. It is done on a locally available wind speed taking into account the primary loads. The methodology is based on a three step procedure : to choose an airfoil, to design a wind turbine blade and make stress calculations.

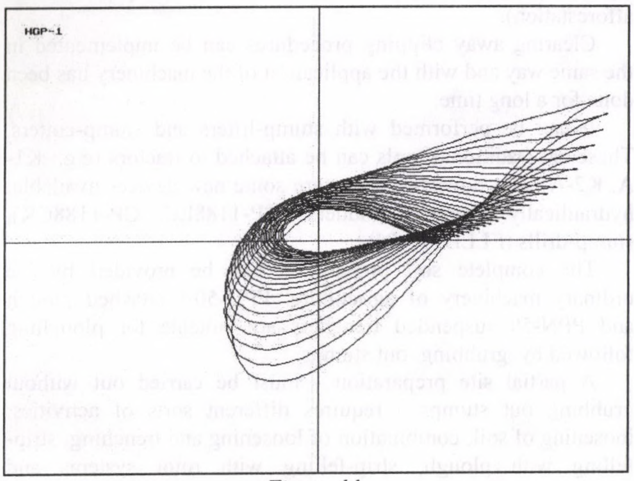

Figure 11
The airfoil influence the whole blade

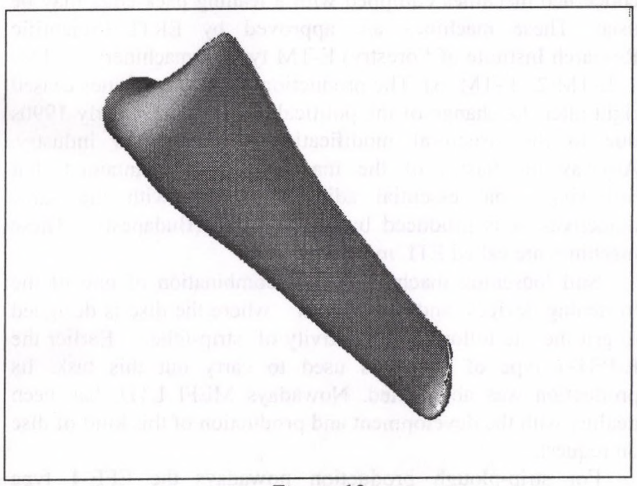

Figure 12
The 3d model

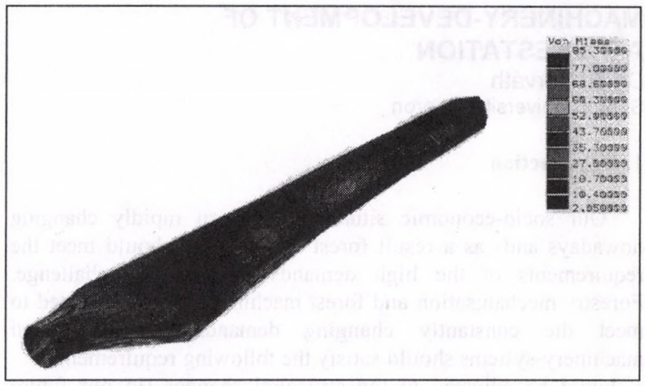

Figure 13
Stress distribution on the blade

The primary objective was to determine how the tension distribution varies with the blade thickness. The loads are gravitational, angular and aerodynamical. Another result of the work showed that blade mass for this structural configuration can be predicted with good accuracy.

The power cefficient is related to geometry. There is a method for blade design where data is based on a desired wind power characteristics. So determining the power characteristics is the first step and the geometry comes after. The best efficiency can be reached in this way. We have to observe the critical buckling, too.

Conclusions

Special care must be taken into account when we choose a site for a wind generator. The theory of wind measurement is related to this question. The first on site wind measurement has been done connected to the feasibility study. The installation needs a great planning procedure. The results showed that the plan is feasible on a long term. There is a way for manufacturing parts in the country. So we are to analyse the tower and blade for local conditions.

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MACHINERY-DEVELOPMENT OF AFFORESTATION

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1. Introduction

Our socio-economic situation has been rapidly changing nowadays and as a result forest management should meet the requirements of the high demands of this new challenge. Forestry mechanisation and forest machinery is also expected to meet the constantly changing demands. Machines and machinery-systems should satisfy the following requirements:

- should be adjusted to the structural changes (in our future forest management machinery should not be the aim of development but only a tool);
- flexibility should be maintained to implement new technologies;
- cost-effective technologies should be supported;
- new technologies should be suitable both for the quality and the environmental requirements.

The above listed criteria are also relevant as far as the machinery development of afforestation is concerned.

A very significant development of forest machinery seems to be urgent nowadays. This opinion is reinforced by the following weighty arguments:

- the changing attitude of the forest management;
- obsolescence of the machinery used before;
- a real claim to restart the domestic forest machinery production;
- a projected increment of afforestation.

The future of the mechanization of forest machinery seems to be determined since neither the forest activities nor the additional activities can be implemented without an acceptable level of machinery. At the same time we have to emphasise that only a high technical level of forest mechanization can meet the requirements of the new economic environment to maintain competitiveness. A spade and axe level of technology can not be supported any more.

As far as the state forests are concerned, machinery owned by the limited companies seems to be optimal. Either the limited companies operate with the machines or entrepreneurs rent the machinery and rental fee paid by the entrepreneurs could accumulate in a certain redemption fund to enable the limited company to buy new machines. As far as the privately owned forests are concerned a mutual utilization of machinery operation is expected. Machinery services provided by entrepreneurs should be expected for expensive forest activities.

The new structure of the forest ownership will be reflected in the forest mechanization as well:

- a significant role will be played by the tractors, and attached trailers and adapters;
- and purpose built machinery.

Another very significant proposal should be: utilization of the domestic machinery since operational costs are a lot less than the imported ones. Utilization of imported machinery is supported only in that case when a domestic one is not available.

Tractors and attached trailers and adapters are to be utilized on a large scale since for the limited companies or the private forest owners this only order of magnitude is available. Most forest activities nowadays seem to be seasonal so this type of machinery can be exploited in an efficient way.

2. Machinery

The most significant activities of afforestation technologies are as follows: clearing away, clipping, grubbing out stumps, complete or partial soil preparation, planting and nursing. A particular afforestation or forest-plantation technology is a special aggregate of certain operations (grubbing out stumps for example is not involved in the procedure of afforestation).

Clearing away clipping procedures can be implemented in the same way and with the application of the machinery has been done for a long time.

It can be performed with stump-lifters and stump-cutters. These are traditional tools can be attached to tractors (e.g.: K1-A, K2-A). But nowadays there are some new devices available: hydraulically operated skidders (CP-1188LC, CP-1188CK), stump-drills (ELLETTARI).

The complete soil preparation can be provided by the ordinary machinery of agriculture. PPU-50A attached plough and PPN-50 suspended trenchers are suitable for ploughing followed by grubbing out stumps.

A partial site preparation - must be carried out without grubbing out stumps - requires different sorts of activities: loosening of soil, combination of loosening and trenching, strip-felling with plough, strip-felling with rotor systems and operations with disc trenchers.

As far as the loosening devices applied in stumpy areas are concerned machines equipped with a leaning back edge may be used. These machines are approved by ERTI (Scientific Research Institute of Forestry) E-TM type of machinery (E-TM-1, E-TM-2, E-TM- 3). The production of these machines ceased right after the change of the political system in the early 1990s due to the structural modification of Hungarian industry. Anyway the basics of the machinery was maintained, but following some essential adjustments and with the same objectives, it is produced by MEFI LTD. (Budapest). These machines are called ETL machines.

Soil loosening machinery is a combination of one of the loosening devices and a unilinear where the disc is designed to grit the site following the activity of strip-feller. Earlier the E-PST-1 type of disc was used to carry out this task. Its production was abandoned. Nowadays MEFI LTD. has been dealing with the development and production of this kind of disc on request.

For strip-plough production nowadays the EFE-1 type produced by ERDŐGÉP LTD. seems to be optimal.

Hard discs are available without drive or with drive. ERDŐGÉP LTD. product NT-6 without drive is worth mentioning. Discs being driven are operated with one or two discs-harrows driven by hydroengine. Domestic production does not exist so these machines must be imported. Tanulmányi Erdõgazdaság RT. (Forest Research Institute LTD.) has been carrying out experiments with a Slovak product called TPF-2. Hopefully it would be a tremendous step forward as far as a driven disc is concerned.

Rotor strip system machinery experiments also seem to have a brilliant future based on experiments by Bagod Mezőgép LTD. Their construction is a patent holder and its crucial point is that it is able to loosen the soil - meanwhile avoiding stumps - with a special system of revolving knives. It is also available with attached strip-ploughs or splitter, on request. This new set of machinery is still available in two types:

- BPG-600 type, a bigger machine suitable for deeper and slightly wider site operation perfectly optimal for nursery plantation;

• BMP-900 type, suitable for lesser depth and wider site operation which is ideal for providing suitable seedbeds for natural seeding and acorns are to be gritted.

The soil loosening machines LENO-77 made in Finland seems to be an optimal solution. It is a hydraulically operated machine fitted with a cultivating tool. This machine is able to provide different lengths of patches depending on pre-stress meanwhile avoiding stumps.

Sliding splitters and planting machines equipped with swinging arms are ideal for plantation. When the projected planting site is covered with stumps, machines fitted with a leaning back edge could be considered. ERTI E-Ü-1 is a typical example of the machines of this kind. Nowadays Sáskalapos Forest LTD. (Balatonszállás) is in charge of its production. Planting machines fitted with swinging arms are not utilized in Hungary in spite of the fact that they could be applied in stumpy areas with a great efficiency. This kind of machinery was represented earlier in Hungary by the QUICKWOOD planting machine made in Austria. It is worth considering whether to apply this machine in the future, or to use a similar one in case it is available.

Nursery activity in stumpy areas could be done by mechanical or chemical methods. Some of the mechanical procedures are as follows:

• reinforced line-space discs;
• stalk - crushing machines - with perpendicular axle (ERZ machines produced by MEFI LTD. available in different width workability);
• stalk-crushing machines-with horizontal axle (VTZ machines produced by MEFI LTD., HIDROT types also available in different width workability).

As far as chemical control is concerned - chemical herbicides should be applied by either spraying or lubricating- a cost-effective chemical utilization must be adopted. A professional application carries full instructions regarding application rate, timing and the protection of the operator and the environment. Suspended machinery is required in stumpy areas. An increasing and more effective chemical lubricating technology is required in order to reduce costs in weed control programmes. A very smart domestic product called SZVF-60 is available to satisfy the demands.

3. Power machines

Power machines of the forest technologies are tractors (14-40 kN pulling power) MTZ and Zetor types. There are certain operations which require an increased pulling power of 20-40 kN and caterpillar, (grubbing out stumps, deep-ploughing, deep-loosening, hard trenching.) For narrow interline spacing and flat-land sites, smaller capacity tractors are also available. Operational costs of these machines are specifically more expensive than other ones with similar technical properties. That is why experts predict that they will be used only for a short time. In future, efficient universal tractors will play a dominant role which can meet the requirements for operating in narrow interline spacing simultaneously.

Forest tractors which can be used in cross-country areas should be utilized in sloping areas. Jointed tractors- having been utilized with tremendous efficiency in other fields of forest mechanization- seem to be the easiest and most acceptable tool (LKT types). A future development of this type will be satisfactory to meet the requirements of future challanges. This is going to be a suspended technical solution. The developing procedure is in progress:

• a mechanically operated suspended device was developed by ERTI;
• a mechanically operated suspended device has been recently developed by Zalaerdõ LTD. (it is a Zetor-Crystal suspended device, joined to the protective shield, moved by spool donkey);
• TAEG LTD. and Department of Forest Machinery of Sopron University launched a new project to manufacture a prototype of a hydraulically operated suspended device, which can be attached to LKT-80 and LKT-81 tractors. The device has been completed but some further slight modifications are required since it is technically ready for operation but its adjustability does not satisfy the expectations.

4. Proposal for Further Development

Mechanization of afforestation technologies is designed to create a kind of a new attitude which based on the current scientific and environmental awareness will foster a nature - friendly forest management approach. The main objectives are as follows:

• a) in close connection with the machines already in use;
• b) fosters the mechanization of grubbing out stumps;
• c) mechanization of partial soil preparation;
• d) mechanization and nursing of narrow interline spacing;
• e) mechanization of afforestation of sloping sites.

a) This group of machinery refers to machines whose production has ceased. However these machines have been utilized for a long time. The restart of their production is inevitable as is their technical development. There are still some companies on the market with a dominant role of re-launching the production, Mezõgépfejlesztõ Ipari Rt. (Agricultural Industrial LTD.) of Budapest, and Erdõgép Rt. (Forest Machinery LTD.) of Kaposvár, Both firms has been co-operating with the Department of Forest Mechanization of Sopron University. These firms have been manufacturing forest machines for silviculture as well based on licensing and own technical development. The most significant ones are as follows: under-cutter, applied in forestry nurseries, called ALV-1 produced by MEFI LTD., forest soil loosener, called ETL-3, forest discs family, called ETB, forest crushing machine-family, called ERZ-strip cutter pough, called EFE-1, produced by Erdõgép LTD., hard disc, called VNT-14, clipping clearing away device called VÁGTA, forest crushing machine, called ZÚZÓ-1.

b) A forest crushing machine with a horizontal axle was developed to carry out stump cutting and clearing away and clipping. It was developed by MEFI LTD. called VTAZ. A stump-driller was developed to remove the whole stump. It was developed by NEFAG LTD. Machines built to remove stumps.

c) Strip felling plough, developed by ERDÕGÉP LTD., Mecsek Forest LTD. Special development of purpose built strip fallers (Bagod Agricultural Machinery LTD.). This new device will have a brilliant future. It was built for use in stumpy areas, operates with knives leaning back, and has a revolving system.

d) It is one of the most significant and urgent jobs since there are huge ecological expectations. In narrow interline spacing afforestation and plantation (1 – 2 m) this device is required. This should be the basic forest network for a further afforestation. The current afforestation technology is suitable for the wider interline spacing 2,5 – 3 meters. Afforestation technologies in huge state farms applied this method to efficiently utilize of their tractors (MTZ) with 14 kN pulling power. Machinery with these properties can not be utilized efficiently nowadays. The real solution seems to be a rapid technological development of the attached machine- tools. Planting and nursing require machinery which is harmonized in its operation. That is why new development and production is required. A particular kind of machinery is required which is flexible enough to operate simultaneously in different interline spaces and it can be adjusted to work in the requested spacing lines. There are certain criteria to meet the requirements:

- being applicable in stumpy areas, so it will be the optimal technical device without grubbing out stumps;
- it is suitable for a complete site preparation, so it will be the optimal technical device used in afforestation technologies.

e) The technical development of the forest mechanization is based on a jointed tractor fitted with a suspended device that can operate on sloping areas. LKT tractor is one of the possible solutions, but the LKT company in the Slovak Republic is about to launch a new product: it is a LKT jointed tractor, and in front and at the back it is fitted with suspended device of three points, which satisfies the European standards. The functional properties of this new machine should not be different from the ones described earlier.

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Summary

This study was designed to sum up the results of the mechanization of different afforestation technologies. Mechanization of certain forest activities of afforestation satisfies high demands of new challenges in flatland operations and wide interline spacing operations. At the same time mechanization of afforestation of sloping areas and narrow interline spacing requires further scientific development based on the current achievements.

YIELD MAPPING

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Introduction

There are efforts on the development and practical use of different methods and means for precision farming, or rather site specific farming. Site specific farming means a technology according to which the fertilizers, herbicides, seeds are controlled according to the local conditions within the field and tillage operations are performed accordingly, as well.

The yield map of a field, that includes the yield variations within the field, can be a useful source of information and a considerable contribution to the application of site specific farming. At first the efforts were concentrated on yield measurement with combine harvesters (Macy, 1994; Reitz and Kutzbach, 1994), and forage harvesters (Auernhammer et al, 1995). Lately the yield was measured with other machines, such as potato, sugar beet, pea and bean harvesters, as well.

Different Global Positioning Systems (short: GPS) can be used to determine the location of the machines, the combine harvesters, within the field during the operation. This can be performed by the NAVSTAR (Navigation Satellite Timing and Ranging) time and distance measurement navigation system. This is based on minimum four satellites of the 24 NAVSTAR satellites by using the signals of the satellites for the momentary location by a GPS. Such a way the position is determined by three geographic coordinates (longitude, latitude and altitude), therefore tree dimensional location can be performed and used for the speed and time measurement at any place along the Earth.

The original high precision signals of the satellites are not available for civil purposes. The maximum error of location can be up to 100 m by the signal available. Therefore some kind of improvement of the accuracy of the signal is needed. For this purpose a GPS is fitted to the combine harvester and a second GPS is located at a point the coordinates of which are known. Assuming that there is an appropriate radio connection between the two GPS a so called differential operation is used to reduce the error to 2 to 5 m. In several developed countries such a differential signal is available via a special radio channel to perform the correction needed. Such a situation exists in some parts of Hungary now and will be soon all over the country, as well.

Objective

The objective of the paper reported herein was to analyze the experiences with yield mapping and the perspectives of yield mapping, as well. Furthermore the objective was to determine the possibilities for the practical application of field yield maps to site specific agricultural operations and site specific farming.

Means and methods

Yield measurements and field yield mapping were performed by

- the CERES-2 yield monitor of RDS Technology Ltd. (Fig. 1) and
- the DATAVISION system.

The CERES-2 yield monitor is fitted with optical sensors in the grain elevator, just under the grain tank. The sensors sense the height of the grain level in the elements of the grain elevator, therefore the volume of he harvested grain is measured. The yield is calculated from the grain volume and the specific weight of the grain. However, the specific weight and the moisture content of the grain are determined separately when starting the harvest and the appropriate data should be set on the console of the yield monitor. The yield monitor measures and displays the yield (ton/ha), the forward speed, the area harvested, and the average yield for a definite part of the field. The measured values are stored in the memory of the yield monitor and can be transmitted to a PC, or to a printer to be printed. 256 test result protocols can be stored in the memory of the console of the yield monitor.

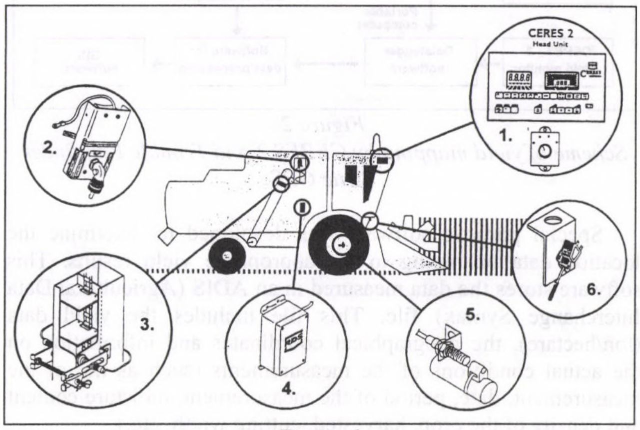

Figure 1

Scheme of grain throughput measurement with CERES-2 yield monitor

1 – console, 2 – moisture sensor (optional), 3 – yield sensor, 4 – hillside sensor, 5 – speed sensor, 6 – area cut-out switch

The results of the yield measurements can be transmitted continuously from the serial port of the console of the yield monitor to a data logger, or PC. Each measurement is performed on a length of 10 m, therefore the area for the yield measurement is a plot where the width of the plot is equal to the cutting width and the length of the plot is 10 m. This is the basis area for the yield calculation.

The appropriate and accurate operation of the yield monitor is dependent on the error of the grain flow measurement and on the error of the location by dGPS. The accuracy of the grain flow, the measurement is dependent on the calibration of the weight of the grain harvested from a definite part of the field. The calibration value is determined on the basis of this calibration and it should be set on the console of the yield monitor.

The location of the combine harvester can be measured by GPS. The positioning can be done by a JUPITER dGPS receiver produced by RDS. However other GPS can be used as well. Our experiments were performed with a GPS of Trimble Pathfinder Basic. With this GPS the measurements are performed at 1.0 s intervals. Since having no differential signal for the GPS, the correction of location data were improved by postprocessing by the means of the PFINDER software. These improved results were used to determine the yield map of the tested field. The postprocessing of the results of the location were performed by the use of the data recorded by the basic GPS station being at a definite point of known geographical coordinates at KGPO (Cosmic Geodetic Observatory).

The scheme of yield mapping is shown in Fig. 2. The yield data and the geographical coordinates are to be measured continuously and recorded. The yield data were recorded after every 10 m by a Lap top connected to CERES-2. The geographical coordinates were recorded simultaneously by the GPS fitted to the combine harvester. These results were corrected by postprocessing with respect to the data recorded by the GPS at the basic station.

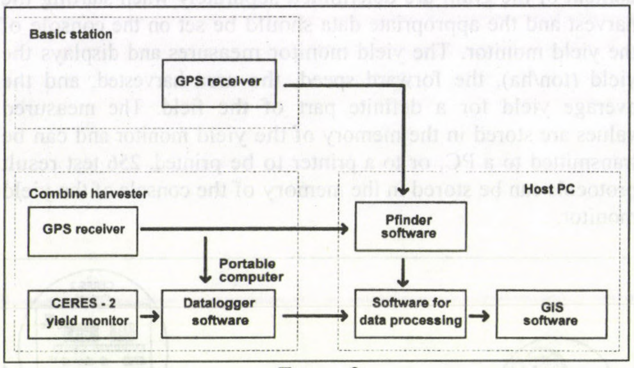

Figure 2
Scheme of yield mapping by CERES 2 and Trimble Pathfinder Basic GPS

Special purpose software was developed to determine the location data belonging to the appropriate yield results. This software stores the data measured in an ADIS (Agricultural Data Interchange Syntax) file. This file includes the yield data (ton/hectare), the geographical coordinates and information on the actual conditions of the measurements (such as no. of the measurement, date, period of the measurement, moisture content and density of the crop harvested, cutting width, etc.).

The yield data together with the geographical coordinates were measured and recorded for further processing. Field yield maps are generated by different methods. Simple programs of the earlier mentioned ADIS file was used to draw the map. The software used with our experiments was the vector type MAPINFO 3.0. However from the data measured by RDS CERES 2 yield monitor and JUPITER GPS receiver yield maps can be drawn by the means of the HERMES data processor, as well.

The DATAVISION system is a board computer that among others is able to monitor the yield. The yield is measured by an indirect method at the output of the grain elevator. The grain throughput is measured by gamma ray method, where the grain flows through between the ray source and the ray receiver (Fig. 3). Therefore attenuation of the ray because of the grain between the source and the receiver is measured and this is proportional to the density and the weight of the grain throughput. The source and the receiver is in a closed housing.

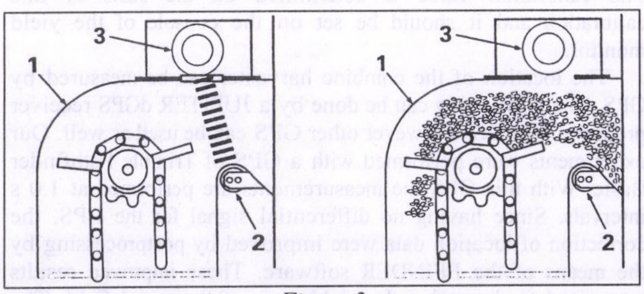

Figure 3
Scheme of grain throughput measurement with DATAVISION system
1 – grain elevator, 2 – ray source, 3 – receiver

The position of the combine harvester is determined by the means of a GPS receiver fitted to the combine harvester. A basic stationary GPS receiver station was used for position data correction. The data transfer was done by a Motorola radio between the GPS receiver on the combine harvester and the stationary GPS receiver.

The yield and position data are stored in chip card in the DATAVISION system. A chip card is able to store data up to 90 hectares. The measured yield and position data are transferred to the host PC by the means of the chip card. The software SURFER is used to process the data and to prepare the yield maps. During the preparation of the yield map the errors of the measurement can corrected.

The appropriate and accurate yield monitoring is dependent on the error of the grain flow measurement and on the error of the location by the GPS. The accuracy of the grain flow, the measurement is dependent on the calibration of the weight of the grain harvested from a definite part of the field. The calibration value is determined on the basis of this calibration and it should be set on the console of the yield monitor with CERES 2 and on the keyboard of the DATAVISION system.

Results and discussion

A typical yield map is shown in Fig. 4. The yield maps, such as the shown one, are useful means for having detailed information on the field and indirect information on the soil, nutrient content of the soil, etc. Yield maps include information on the variations in the yields along the field. Such information has not been available without yield mapping. The yield map of a definite field is only a specific element of an information system. However this element is not enough to develop a strategy for crop production.

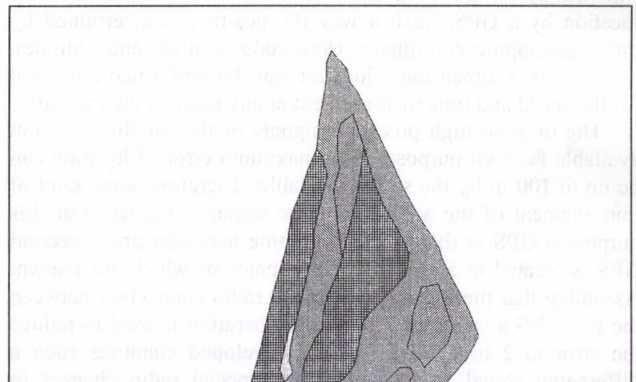

Figure 4
A typical yield map

As a result of yield mapping the fields can be analyzed as detailed as it is possible with respect to the minimum plot size. Key problem is the appropriate area of the plot that can be the basis for composing maps to help the agricultural operations.

In the case of RDS CERES 2 yield monitor and Claas Mega 202 combine harvester the minimal area of the plot, "length of measurement" x "cutting width" is equal to 10 x 5 = 50 m^2. Therefore the yield map can be composed from 50 m^2 plots.

The minimum appropriate plot size that can be suitable for site specific farming depends mainly on application rate control with fertilizing. If the error in the area is maximum 5 % with application rate control of fertilizing, the appropriate plot size is maximum 6 hectares according to calculations. When taking into account that the minimum plot size with yield measurement is approximately 50 m^2, or 0.005 hectares when using CERES 2 fitted to Claas Mega 202 combine harvester, accordingly, approximately 120 yield measurements can be performed within 6.0 hectares. Therefore he minimum plot size from the yield measurement does not limit appropriate plot size for an application rate map.

The analysis of the error of yield mapping shows the there are two types of error sources, such as

- the errors because of yield measurement
- the error because of location by means of GPS.

The experiences collected during the tests and the evaluation of data processing shows that the calibration has a considerable influence on the accuracy of the yield measurement and therefore on mapping. If the calibration is not accurate enough, the inappropriate calibration constant can cause an error of approximately 10 % or maybe higher. Further error sources with yield measurement are, as follows:

- difference between the actual cutting width and set cutting width of the combine harvester
- if the table is not lifted while turning at the headlands, or if the sensor of operating position of the table is not correctly set.

The error sources of the yield measurement show that the appropriate operation of the yield monitor and the inappropriate adjustment of the monitor by the operator of the combine harvester have a considerable influence on the total error of yield mapping.

The errors caused by the location errors are, as follows:

- the error not corrected by the differential signal of the GPS
- the error caused by the lack of suitable signal for the GPS, that can occur because the GPS receiver on the combine harvester is in "shadow relative to the satellites" because of trees, or other obstacle.

Therefore it is suggested to compare the actual yield of the field measured by conventional method (e.g. by weighing) to the yield measured by the yield monitor and to use this proportion for correcting the yield mapping.

Additional information is needed when analyzing the meaning of the yield map. Such additional information can be the knowledge of the genetic soil map and the soil nutrient content map of the field. This additional information on soil can contribute to the better understanding of the yield map.

Having the soil map and the yield map of the field as well, better crop production plans are to be developed for the fields. Therefore the results improve the process of decision making on the different agricultural operations, such as drilling (the seed/hectare rate), the tillage and on the estimation of the yield and the efficiency of crop production.

The yield map is only a part of the field information system. This system should include soil nutrient content map of the field, as well and consequently the field information system is to be developed and site specific farming is to be introduced. Consequently site specific fertilizer application rate control is to be used as the first element of precision farming.

Conclusions

The conclusions from the results and the discussion reached are as summarized as follows.

The error of the yield mapping includes two types of errors, such as the errors because of yield measurement and the error because of location by means of GPS.

The error sources of yield measurement are because of

- the difference between the actual cutting width and set cutting width of the combine harvester and
- the inappropriate adjustment of the sensor of the table lift while headland turning

The location error can be caused either by the error of the received differential signal, or by the lack of available signal for the GPS. Some obstacles could result such a phenomenon.

The perspectives of yield mapping can be concluded as follows:

- the yield mapping of fields can contribute to collecting more detailed information on the fields and on the soils of the fields
- better and distinguished evaluation of the efficiency of the soils
- the application of site specific fertilizing
- the improved accuracy of the estimation of the efficiency of the soils.

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ANALYSIS OF FUNCTIONAL MICROPROCESS OF DIESEL ENGINES FOR DIAGNOSTIC PURPOSE

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Introduction

The effectiveness and economy of the agricultural operations depends on some conditions and parameters of the tractor engine such as: loading factor, technical condition, optimum settings. During the operation the load and some diagnostic parameters of the engine can be changed. Because of the mentioned parameters are functions of e.g. the fuel consumption, their continuos observation during the operation should be desirable. It means that it would be desirable to find a physical parameter which indicates serviceable informations about the engine operation for diagnostic and energetic purpose. The angle velocity of the crankshaft seems to be a good parameter for this purpose.

Discussion

The operation process of an internal combustion engine can be traced by the internal microprocess. One form of these manifestations is the angular velocity of the crankshaft, and the oscillation of it. The changes of the diagnostic parameters, technical condition, loading factor can be find and observed in the degree and tendency of the angular velocity.

At the department of Machinery Management and Engineering Systems we have been searching the applicability of this principle in the following areas:

I. Technical diagnostics

- continuos observation during the operation of the diesel engine as a power source.
- revelation of the reasons of abnormal engine operations

II. Energetics

- registering the momentary loading level
- analysis of the operation process according to loading level
- integrated energy consumption
- continuos control of the energy consumption in every parts of the technical process

Research principle and method

The fuel combustion can be considered as an energy input which generates increasing angular velocity of the crankshaft. This can be observed during the expansion. The other cycles and the work doing by the engine consumes the energy that comes from the fuel. During these cycles (exhaust, suction, compression) reducing angular velocity can be measured. In the case of four cylindered, four cycled engine in the period of 90 degrees of crankshaft rotation following the combustion, angular acceleration of the crank shaft can be measured. In the period of the rotation from 90 degrees to 180 degrees the crank shaft will decelerate. (Figure 1.)

The energetic equlibrium of the diesel engines can be written by the following equation which is able to determine the complex technical condition without using an external load:

$$Mi + / - I \cdot \frac{d\omega}{dt} - Mmech = 0$$

Mi = indicated torque of the engine
Mmech = mechanical torque for the internal losses
I = moment of inertia reduced to the center line of the crank shaft
ω = angle velocity
t = time

The experimental measuring system

Measuring the crankshaft acceleration and deceleration we applied an optoelectronic tachometer installed to the shaft-end. Its accuracy is 1000 marks per one turn.

Parts of the system:

1. *ROD 426 E 1000 electronic marker for measuring the revolution of the crank shaft*
2. *RS 2326 asynchronous timer interface with two channels*
3. *IBM PC + measuring card*

Results of the investigation

Exploring the applicability of the principle and the connection between changes of angle velocity and the momentary loading level of the engine, some measurements have been carried out. With the aim of establishing the technical parameters and making several loading levels I used a swirl typed block testing stand. In every steady state conditions the changes of angle velocity were determined as well. *Table 1.* shows the determined data.

Type of the examined engine: IFA VD 14.5/12-1 diesel engine (lorry)

The applied computer program probes all the point of the curve by Fourier-analysis. The base of this method is to make mathematical analysis by interpolating sine curves on every point of the revolution curve. To estimate the angle velocity curves using mathematical statistical methods seemed to be a good procedure.

Representing the measured data in a diagram where the crank shaft rotation in degrees is shown versus the oscillation of crankshaft-angle velocity in percentage, some interesting occurrence can be seen. (Fig. 1)

A regression analysis was carried out with the purpose of compareing the load level with the rate of the angle velocity growth or angle velocity reduction. The Fig. 2 shows the acceleration and deceleration of the cylinder num. 3 with different loading levels, and constant 1884 1/min revolution of the crankshaft. As it can be seen when the load level was higher, the rise of the curve was also higher. Further increasement of the load level resulted higher and higher rise of the angle velocity-changes step by step. This happenes in the case of accelaration and deceleration as well.

Summary

This principle and method seems to be applicable for diagnostic and energetic purpose to determine some connections in the microprocess of the engine. The following steps of the investigation have to be focused on the more exact determination of the relation between the angle velocity changes and those parameters of the engine which are important to be known in order to realize an economic operation. According to our experience the sort of electronic marker for measuring the revolution of the crank shaft need to be changed for another one as it is sensitive too much to the vibration deriving from the operation of the examined engine.

Table 1

n..	n min^{-1}	F N	P kW	T Nm	p_{eff} bar	G g	t s	B kg/h	b g/kWh	wat. in °C	wat. out °C	exh. gas °C	mot. oil °C	oil. pres bar	inj. pres bar	inj. ang. °	file num.
1.	855	0	0	0	0	100	271,1	1,328	-	69	71	108	81	3,8	150	25	150-151
2.	2220	0	0	0	0	100	69,99	5,374	-	72	74	204	82	5,0	150	17	152-153
3.	2185	150	24,574	107,40	2,057	100	41,00	8,780	34,31	78	80	305	88	5,2	150	17	154-155
4.	2155	300	48,474	214,80	4,115	100	27,83	12,936	266,86	80	82	430	91	5,2	150	19	156-159
5.	2130	450	71,867	322,20	6,172	100	19,01	18,848	262,26	82	86	601	95	5,2	150	22	158-159
6.	2098	480	75,507	343,68	6,583	100	18,69	19,260	255,07	85	88	661	98	5,0	150	23	-
7.	2055	500	77,041	358,00	6,858	100	18,45	19,512	25326	84	87	678	98	5,0	150	23	160-161
8.	1936	520	75,483	372,32	7,132	100	19,41	18,550	245,75	85	89	670	100	5,0	150	23	-
9.	1740	540	70,450	386,64	7,406	100	21,63	16,643	229,14	85	89	647	100	5,0	150	23	162-163
10.	1440	550	59,383	393,80	7,543	100	26,10	13,793	232,27	86	90	609	100	4,5	150	24	164-165
11.	1332	550	54,929	393,80	7,543	100	28,67	12,550	228,47	88	92	597	100	4,5	150	24	-

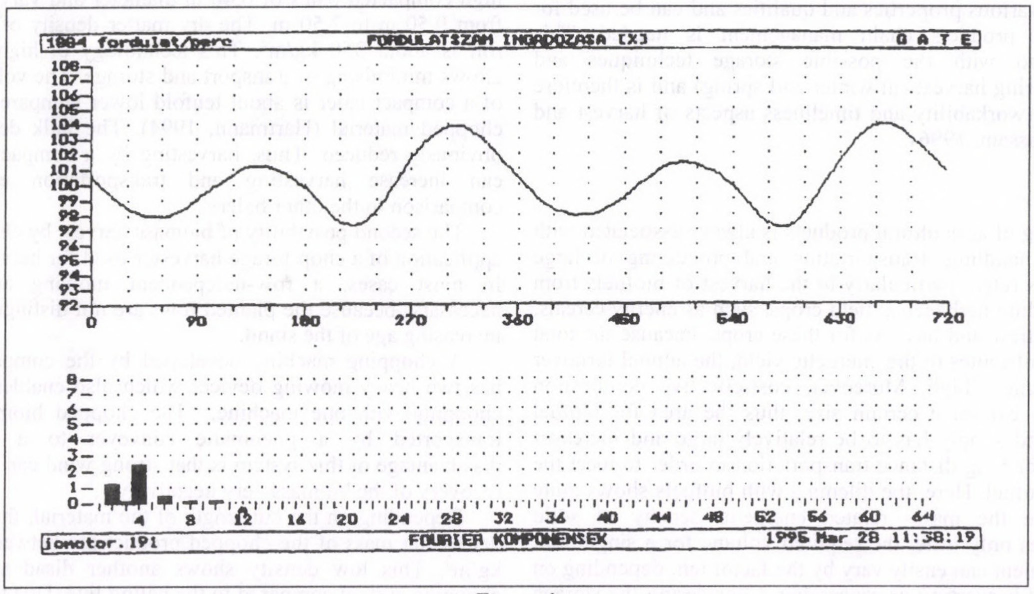

Figure 1

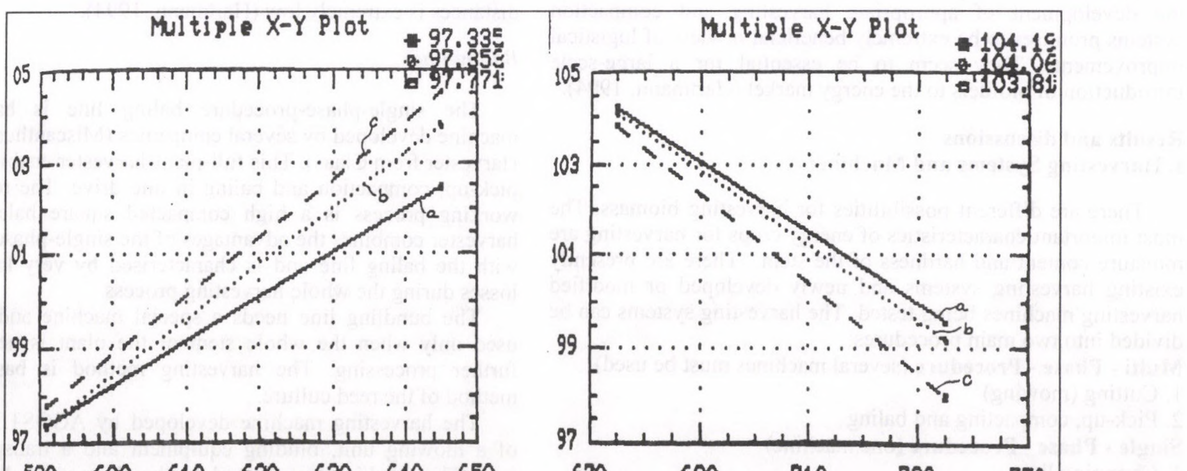

Figure 2

Marks of the Fig. 2.: a- 0dN b- 30dN c- 50dN

LOGISTIC CONCEPTS FOR ENERGY CROPS

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Introduction

The availability of adequate logistic systems, which include harvesting, recovery, compaction, transport and storage represents a basic requirement for the utilisation of energy crops as feedstocks for industrial and energy purposes. Each conversion technology has specific requirements concerning dry matter content, shape, size and particle consistency of the raw material. The logistics of the raw materials is the tool to establishing an effective link between agricultural production systems and industrial activities.

Mechanisation of harvest, transport and storage is defined by the methods and processing of the primary products and the need for year round availability. Since semi-finished products can be created with various properties and qualities and can be used for various final products chain management is needed. This interferes also with the possible storage techniques and conditions during harvest (in winter and spring) and is therefore related to the workability and timeliness aspects of harvest and storage (El Bassam, 1996).

Methods

Harvesting of agricultural products is always associated with the need of handling, transportation and processing of large volumes. This refers particularly to the harvest of biofuels from annually yielding herbaceous field crops, such as energy cereals, miscanthus, straw and hay. As for these crops, because the total dry matter contributes to the energetic yield, the annual turnover can be extremely high. Moreover, cost-effective combustion units have to exceed a certain size; thus the area for biofuel production and supply has to be relatively large and increases the demand for long-distance transportation in order to meet the demand of biofuel. Here, the dilemma with biofuels shows quite clearly: while the mass- related energetic density of solid biomass varies only little, the required volume for a single unit of fuel equivalent can easily vary by the factor ten, depending on the method of harvesting or processing. Considering the storage of chopped biomass, the volume demand can be reduced tenfold by application of a high-density compression technology. Thus, the development of appropriate harvesting and compaction systems promises to be extremely beneficial in view of logistical improvements. They seem to be essential for a large-scale introduction of biofuels to the energy market (Hartmann, 1994).

Results and discussions

I. Harvesting Systems and Machinery

There are different possibilities for harvesting biomass. The most important characteristics of energy crops for harvesting are moisture content and hardness of the stem. There are presently existing harvesting systems and newly developed or modified harvesting machines being tested. The harvesting systems can be divided into two main procedures:

Multi - Phase - Procedure (several machines must be used)
1. Cutting (mowing)
2. Pick-up, compacting and baling

Single - Phase - Procedure (one machine)
1. Chopping line
2. Baling line
3. Bundling line
4. Pelleting line

Single-Phase-Procedure

Chopping line

Two different systems can be used for the single-phase-chopping-line. The chopping system, normally used for short rotation forestry consists of a mowing unit in front of a tractor in combination with a trailer. Depending on the cutting unit, this system can be applied in stands with or without special row spacing.

For the multi-phase-procedure existing harvesting machines such as mowers and balers can be used. A double knife mower or a rotary mower can do cutting of the whole crop before baling.

Before baling, the crop must be mowed and put on swath. After swathing, the following balers machine nearly completely picks-up the harvested material. There are numerous baling machines, which produce different bales. Rectangular bales, round bales and compact rolls are the results of the baling machines. The big-round-baler (John Deere) and the big-rectangular-baler have demonstrated good results for compacting. Dry matter density is about 120 kg/m^3 for these high-pressure bales.

The Compact-Round-Baler Welger CRP 400 produces very high compacted bales of 0,40 m diameter and varying in length from 0.50 m to 2.50 m. The dry matter density of the compact roll is about 350 kg/m^3. This technology of high compacting allows minimising of transport and storage. The volume demand of a compact baler is about tenfold lower compared to those of chopped material (Hartmann, 1994). The bulk density can be obviously reduced. Thus, harvesting by a compact roller baler can increase harvesting and transportation efficiency in comparison to the other balers.

The second possibility of biomass harvest by chopping is the application of a chop forage harvester used for harvesting maize. In most cases, a row-independent mowing attachment is necessary, because the planted rows are not distinguishable with increasing age of the stand.

A chopping machine developed by the company CLAAS, has two heavy mowing devices which also enables cutting and chopping with one machine. The chopped biomass is to be transported by a pneumatic conveyer to a trailer. One disadvantage of this system is that strong wind can influence the recovery of the biomass very negatively.

Depending on the cut length of the material, the densities in dry matter mass of the chopped product are between 70 and 95 kg/m^3. This low density shows another disadvantage of the chopping system compared to the baling line. Due to the low dry matter density chopped material needs very high transport and storage capacity; the transportation efficiency especially by long distances is extremely low (Hartmann, 1994).

Baling line

The single-phase-procedure baling line is based on a machine developed by several companies (Miscanthus-Combine-Harvester from Claas). This full-plant-harvester enables mowing, pick-up, compaction and baling in one drive. The result of the working process is a high compacted square bale. This full harvester combines the advantages of the single-phase-procedure with the baling line and is characterised by very low biomass losses during the whole harvesting process.

The bundling line needs a special machine and should be used only when the whole stem of the plant is necessary for further processing. The harvesting method is based on the method of the reed culture.

The harvesting machine developed by AGOSTINI consists of a mowing unit, binding equipment and a transport/deposit unit. The machine is attached to the three-point linkage of a tractor. The crop is cut with a cutterbar and transported via the binding unit to the side. The density of the bundles is approx. 140 kg/m^3, the weight 9 kg and the bundle diameter 0.2 m. The machine is a low cost and comprehensive unit.

Pelleting line

The pelleting line can be utilised because of the newly developed 'Biotruck 2000' from the company HAIMER. This machine allows mowing, chopping and pelleting in one procedure on the field. After mowing and chopping the material is pre-dryed by using the thermal energy of the engine. The raw material is compacted, pressed and pelleted without additional bonding agents. The result of the working process is a corrugated plate with a length between 30 and 100 mm. The single pellet density ranges from 850 to 1000 kg/m^3, the bulk density is about 300-500 kg/m^3. The Biotruck has a capacity of 3-8 t/h.

This method ensures an excellent opportunity for reducing bulk density, transportation and storage requirements. In addition, the handling of pellets can be easier than the handling of the chopped material or bales. Depending on the further utilisation, the possibility for automatic handling is very good for such pellets (El Bassam, 1996).

II. Storage and Conservation

For year round delivery, storage on the farm is necessary. Experiences with crop harvests have shown that the moisture content at spring harvest ranges mostly between 20 and 40 %. Therefore, a drying process is necessary before storing. It is important to preserve the quality of the product. Depending on the harvest method used the material to be stored can be:

- Chopped (different lengths)
- Bales
- Bundles
- Pellets

Chopped material

Maximum moisture content for storage of chopped material is 25%. For a safe storage during a longer period (for example one year) the moisture content must be 18 % or lower. When harvest conditions are poor and the material contains more than 25% moisture, the chopped material can be stored in any storage facility where ventilation from a floor system is possible. Tests show that daily ventilation for 1,5 hours with ambient air, already reduces moisture content sufficiently. The cheapest way of storing chopped material is in piles outside, covered with plastic that allows vapours to pass through. Experiments with outside storage piles have given different results concerning moisture content of the plant material.

One pile had a ventilation channel and was covered with normal plastic. A net to prevent the material from blowing away only covered the other pile. After We months the covered pile had a moisture content ranging from 15 % in the centre to 10 % on the top layer. The open pile showed an increase in moisture content ranging from 24 % in the centre and 64 % on the top layer. The results indicate that a covered and non-mechanical ventilated pile is preferable. The open pile in this experiment was very small. Storage in a bigger open pile could be possible. The characteristics of the outside layer, such as thickness and behaviour, are subjects for further research (El Bassam, 1996).

Another storage method is to ensilage. the fresh biomass, this is commonly used for grass, maize and hemp. The silage could then be pressed so that the solid phase provides a feedstock with more than 50 % dry matter content. The liquid will be fermented to produce biogas.

Bales

The compaction rates and the density of the baler are very important parameters for identifying the methods of storage. Two possibilities of storage are:

- Field storage (open)
- Storage under cover with and without drying system.

The moisture content of the bales at the time of harvest are important factors to decide which type of storage should be implemented in relation to the weather conditions at the site. Big bales can be stored with up to 25 % moisture. Drying of big bales is difficult. Bales with high moisture contents (about 40 %) at the time of harvest will tend to built mildew especially under field storage conditions.

The compact rolls with dry matter density of 350 kg/m^3 cannot be dried anymore. Thus, the moisture content of the material has to be lower than 25 %. On the other hand, higher compaction density will enable storage of the bales under field conditions without big losses. The reason for this is that in the case of rainy weather only the first 10 cm layer will absorb water and this layer protects other deeper layers. The storage under cover is a most favourable method due to the fact that the sides are open so that air can circulate and dry the bales.

Bundles

Bundles can be stored outside. In experiments two different kinds of bundles were tested. One bundle was tight binded and the- other had loose binding. Two variations were made covered with plastic and non-covered. Results showed a great difference in the months July and September between the covered and non-covered bundles. The difference between loose and tight binding is greater when the bundles are not covered. The water that has infiltrated the tight bundle cannot easily evaporate or trickle through. Storage of the bundles outside is very well possible. A plastic cover against rain prevents fluctuations in moisture content.

Conclusion

The advantages of high-density compaction systems for biofuel treatment become obvious when the logistical improvement for long-distance transportation to a combustion unit is considered. However, advanced big square bales and small size compact roller bales (400 mm diameter) present an interesting advantage, since the differences towards palletised fuels are rather marginal. This statement is also confirmed by the aggregated energy demand and the total costs. However, there is a strong suggestion that the use of pellets is associated with a series of benefits for combustion, such as the reduced risk of breakdown. The interactions of biofuel treatment and combustion performance are still due to be investigated systematically.

High density biofuel feedstock (compact bales or pellets) have two important advantages: they need much less space for storage and transport and the recovery capacity (tons dry matter per man power hour) is about 4 times higher than chopped feedstock (Strehler, 1994).

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AUTOMATIC STEERING CONTROL OF PLANTATION TRACTOR BASED ON IMAGE PROCESSING

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Abstract

The driving by man in straight line and turning at the end of the row of the plantation demands high concentration which may limit the possible speed of the vehicle. With automatic steering controll working speed can be increased and there is no health hazard when working with chemicals.

The necessary input information for the automatic steering can be taken from the natural surrounding. In the plantations the stems of the plants are the most characteristic objects, the bottom of the stems appear in a straight line. The equation of such a line is not influenced by the distance between the stems.

In the project described below a CCD camera mounted on the front of a model tractor takes pictures from one side of the plantation row. Evaluating the images in real time the necessary intervention for keeping the vehicle in straight line can be calculated. The basic equations for steering control and the first image processing experiences are presented.

Keywords: Automatic steering, image processing, plantation, self-propelled machine, tractor

1. Introduction

When a tractor or a self-propelled machine is working in the plantation (orchard, vineyard etc.) it has to run long straight road sections and make turns on the end of the row. The main task of the driver is to keep the machine in straight line. This simple task however demands high concentration so in some cases it limits the speed of the vehicle although the technology would allow it. Despite protection working with chemicals is a health hazard.

When unmanned vehicle with automatic steering control is used, the speed may be increased for 24 hours of the day and there is no health risk.

Many researchers are dealing with automatic tractor control of different working principle. Those attempts can be divided in two large groups. In the first one the signal for interference is taken in real time. It may come from satellites , whereby the GPS is well known and is used in more and more parts of the world. The input signal can also be created using the immediate surrounding of the tractor. Video camera and real time image processing can be used in many ways for this. One of them is the segmentation of natural scenes, it means to create input signal from a moor or less continuous sign parallel to the desired path of tractor (1,2). Yoshiaki Misao (3) uses red target boards at the end of the orchard rows and a video camera on the tractor. Distance to the board and tractor position related to the centre line can be calculated in real time this way. Noguchi, N. et al. (4) suggest the use of geomagnetic direction sensor on the tractor and steady cameras to observe its path. According the pre-set program the vehicle is steered relative the geomagnetic data and its position is controlled and is feed back by the CCD cameras.

Ultrasonic telemetry is another way to guide the tractor in row (5). A 2D mapping of the ultrasonic data is made during the motion and a recursive linear regression is made on the 2D co-ordinates to extract the orchard alley axis.

In the second group of attempts is to run the tractor „blind" on the field or in the plantation by pre-programming all the straight stages and turns needed to fulfil a certain task. Using odometer and gyrometer it can be done with an accuracy depending on the accuracy of the instrumentation and of the field size.

Ultrasonic telemetry may be combined with odometer and gyrometer for the U turn at the end of the row when no real data is available (5). Also the combination of GPS and dead reckon is studied with good results for vehicle control system (6).

As basic functions for an automatic steering controlled tractor the remote starting, automatic steering, turning at the end of the row, emergency stop, then restart and remote stopping of the vehicle can be regarded.

The Technical Department of the University of Horticulture and Food started also a project in 1997 on automatic steering control of plantation tractor based on image processing. It is financed by OTKA (Hungarian Scientific Research Fund). This paper attempts to describe the working principle and the geometrical relation of the automatic controlled tractor to the plantation.

2. Method

In the project started by the Technical Department the necessary input information for the automatic steering is taken from the natural surrounding. In the plantations the stems of the plants are the most characteristic objects. In most of the cases they are not covered totally by leaves and also their colour differs from the green foliage and cover plants. Studying the binarised picture of an orchard row the best basis for steering information is the bottom of the stem. If the cover plant is regularly mowed the bottoms of the stems appear in the same line (Fig. 1). The equation of such a line is not influenced by the distance between the stems (doesn't matter if a plant or more is missing). Based on the information described above the work of the plantation tractor is planed as follows: while travelling a video camera mounted on the front takes pictures from one side of the plantation row which are binarised and processed. After "finding" the bottom points of stems on a given picture a computer program generates the equation of a straight line which includes those points. It also calculates the line's angle to the horizontal.

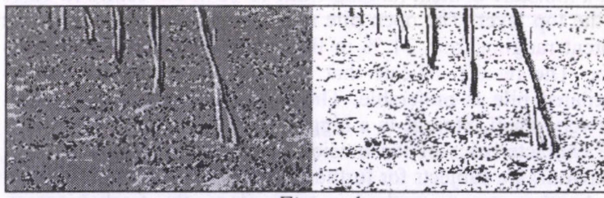

Figure 1
Binarised and partly processed image of an orchard row

Fig. 2 shows the position of the camera relative to the row of plants. It is mounted on the tractor in a special position: the central line of is in a vertical plane ACD, it's angle to the horizon is β. BC is the horizontal distance between the focal point and the row of plants and CD between focal point and ground level.

In straight forward position of the tractor the plain ACD is intersected by the line BC in angle α, by the line AB in angle 90-α. On the image taken by the camera the slope of line AB will appear as α' instead of α (see the right side of Fig. 2). The angle α' is the projection of the angle α onto the screen AEF. The screen is perpendicular to AD, to the central line of the camera. If the tractor lives its desired path steering action must take place. Turning and parallel displacement can occur.

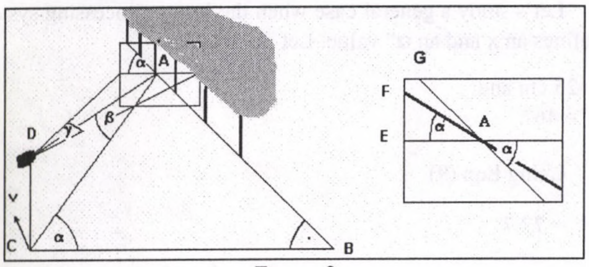

Figure 2

The position of the camera on the tractor relative to the plantation row

Let's examine how the camera „sees" the turning of the tractor. Obviously turning means the change of both α and α'. The equation needed to the calculation of the main geometric sizes are as follows (see Fig. 2):

$$AC=\frac{BC}{\cos\alpha} \tag{1}$$

$$\beta=0.8+\frac{\delta}{2} \tag{2}$$

$$CD=AC\cdot \mathrm{tg}\,\beta \tag{3}$$

$$AD=\frac{CD}{\sin\beta} \tag{4}$$

$$AE=AD\cdot \mathrm{tg}\frac{\gamma}{2} \tag{5}$$

$$AF=AE\cdot\sqrt{1+(\mathrm{tg}\alpha\cdot\sin\beta)^2} \tag{6}$$

$$AF\geq 2.5\,\mathrm{m} \tag{7}$$

whereby: BC is the half of the space between the rows
γ is the horizontal visual angle of the camera
δ is the vertical visual angle of the camera

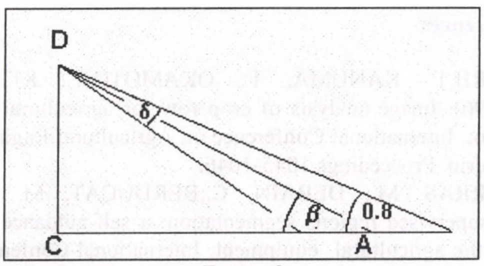

Figure 3

The slope of the camera's central line

The equation 6 for AF is explained by the Fig. 4.

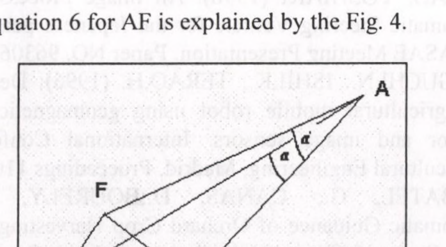

Figure 4

The definition of α and β for the calculation of AF

The equation 7 expresses that at least 2 stems are seen in AF if the distance between the plants is 1.5 meter.

The angle α will be seen by the camera as

$$\alpha' = \mathrm{arctg}(\mathrm{tg}\alpha.\sin\beta) \tag{8}$$

(see Figure 4).

When the vehicle turns the angle α' seen by the camera will change to α" on the screen. The real angle α will change to α^1 :

$$\alpha^1=\mathrm{arctg}\frac{\mathrm{tg}\alpha''}{\sin\beta} \tag{9}$$

Turning changes not only the vehicle's angle position α to α^1 and α' to α" but also the position of the line AF on the screen. The length of AC will change by AA', where

$$AA'=\left|\frac{BC}{\cos\alpha_1}-\frac{BC}{\cos\alpha}\right| \tag{10}$$

The value x^1 , which is the difference of the x co-ordinates of the lines on the x axis (see the right side of Fig. 5) can be calculated according Fig. 6:

$$x_1=\frac{AA'\cdot CD}{\frac{CD}{\sin\beta}\pm AA'\cdot\cos\beta} \tag{11}$$

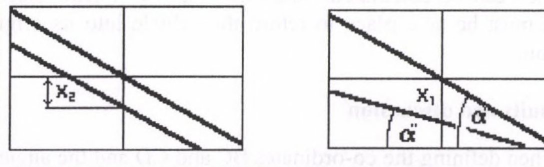

Figure 5

Turning (right) and parallel displacement (left) of the vehicle seen on the screen

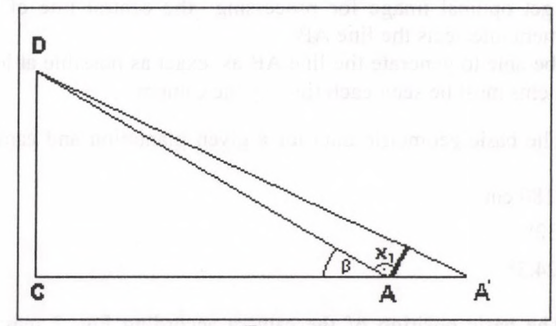

Figure 6

The distance AA' seen by the camera as x^1

Let's study the case when parallel displacement takes place , it means the vehicle is running parallel to the central line of the orchard road. The displacement from the central line is characterised by the change of distance BC (see Fig. 2).As the camera is fixed on the vehicle, α, β and the distance CD don't change. The position of the line AF however changes in the image as shown on the left side of Fig. 5. The displacement of A to A" can be calculated using the following equation (see Fig. 7) :

$$AA"=\frac{x_2}{\sin\beta} \quad (12)$$

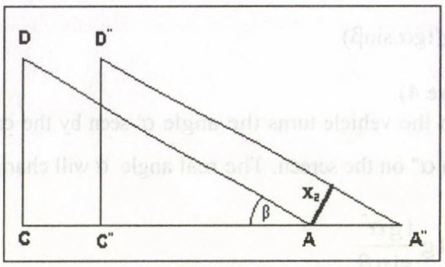

Figure 7

The distance AA" seen by the camera as x2 and the new distance B_1C_1.

$$B_1C_1=(AC\pm AA")\cdot\cos\alpha_1=(AC\pm\frac{x_2}{\sin\beta})\cdot\cos\alpha_1 \quad (13)$$

where $x2$ is the distance between the two line's x co-ordinates on the screen.

When the vehicle turns and its path is parallel displaced as well the image processing system calculates an x value which is the sum of $x1$ and $x2$. For steering control two data: the distance B_1C_1 and the angle $\alpha1$ is needed. Solving Eqn (9) $\alpha1$ is available. To calculate B_1C_1 Eqn (13) may be used but first $x2$ have to be defined. Substituting Eqn (10) into Eqn (11) $x1$ can be calculated, then $x2 = x - x1$. Now steering action must be take place to return the vehicle into its original position.

3. Results and discussion

When defining the co-ordinates BC and CD and the angles α and β the following consideration were made:

- to avoid direct sunshine into the optic the upper side of the vertical visual angle δ was set to 0.8^0 (see Fig. 3)
- to get optimal image for processing the central line of the camera intersects the line AB
- to be able to generate the line AB as exact as possible at least 4 stems must be seen each time by the camera

The basic geometric data for a given plantation and camera are:

BC=180 cm
γ= 32°
δ =24.3°

The basic position of the camera according Fig. 2 may be defined using the data above. If

$\alpha=75^0$ then
AF= 266 cm, which fulfils Eqn 7.
CD=160 cm above ground level
AC=694 cm

Substituting the data calculated before into equation 8:

$\alpha' = 40^0$.

It is a favourable angle taking into consideration the laying rectangle shape of the image taken by the camera.

Let's study a general case when the image processing system defines an x and an α" value. Let for example

x=25 cm and
α"= 46°.

Using Eqn (9)

$\alpha1$ = 77.7°

Solving Eqn (10)

AA'=149,4 cm
Eqn (11) gives
x=27.9 cm

which is the results of parallel displacement and turning of the tractor. To know which part parallel displacement plays in the result the equation

$x2 = x - x1$

may be used. Whit x=27.9 cm

$x2$ = -2,9 cm.

Finally the actual horizontal distance of the camera to the row

B_1C_1= 145,1 cm.

The tractor has turned 2.27° and a parallel displacement of 34,9 cm occurred.

4. Conclusion

Processing the image of the camera, mounted on a tractor a straight line can be defined in the screen which is composed of the bottom point of stems in one side of the row. The angle of this line and its intersection with the symmetry axes of the screen gives the necessary information to define the exact position of the vehicle in the row. As a next step different image processing techniques (segmentation) will be examined and laboratory tests will be carried out to prove the results of calculations.

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