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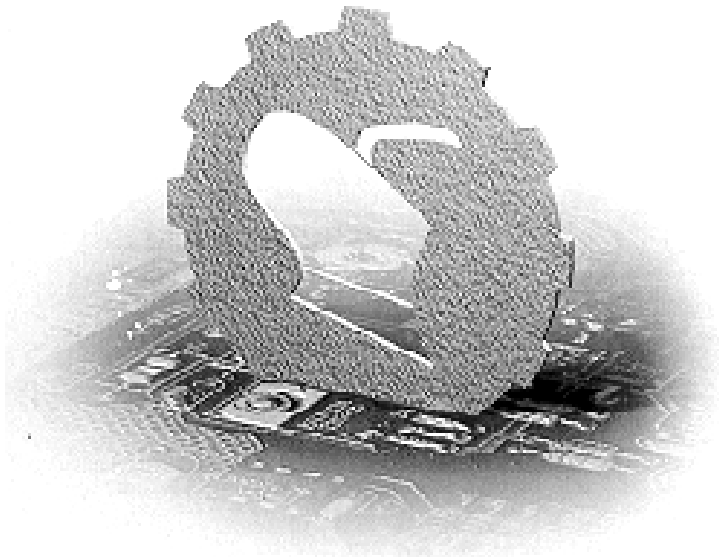
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S A D R Ž A J

C O N T E N T S

FLUIDIZATION QUALITY DETERMINATION METHOD IN DRYERS WITH PSEUDOFLUIDIZED GRAIN LAYER

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Abstract: The investigation results of pseudofluidization grain uniformity in grain dryers. The new method of fluidization quality estimation that allows providing more uniform heating of grain material and enhancing drying process is suggested. The method consists in determining light beam intensity, penetrating through grain layer. The recommendations on choice of optimal structural parameters of drying chamber of grain dryers which should be followed at its designing are given.

Key words: drying, dryer, method, grain, pseudofluidization, gas distribution grid

INTRODUCTION

At the present time in agricultural production convective drying of grain material by organic matter combustion products being used as a fuel with higher combustion temperature is widely applied [1-8]. A significant fault of these dryers is high energy consumption (5. ..7 MJ/kg of vaporized moisture) [1].

It dictates the necessity for developing new, less energy consuming, environmentally appropriate technology of grain drying.

The usage of food products drying method in pseudofluidized layer allows speeding up the process significantly. It is very important for increase of technical and economic indicators of drying installations.

The grain layer description in dryers functioning according to the pseudofluidization principle can be at best estimated only visually which is not quite objective. It is

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generally recognized and no doubts for this reason many attempts to find more precise determination of pseudofluidization quality were done.

The widest application at gas pseudofluidization the fluidization quality measurements by means of capacity probes is recognized [6-7]. These probes are electric capacitors of different configuration being plunged into boiling layer.

The example of capacity sensor for fine layers with electric field concentrated inside it is presented in figure 1. Sensor plates with coarse perforation are plunged into boiling layer vertically in order to violate solid phase mass circulation in the capacitor measured volume least of all.

As distinct from translucence methods the placement of capacity sensor inside boiling layer as well as any other object causes definite destruction of layer local structure just therein the measurements are being done. For example, extra large bubble can not at all penetrate into test volume between capacitor plates.

Much lesser structural destructions must be caused by open bar sensors. Fig. 2 presents the construction of the similar sensor. Even with ultimate cylindrical symmetry the electrical field inside capacitor is non-uniform and it decreases with a distance from the central electrode. That is why strong change of material density at the test volume periphery will distort the field and influence on total electric capacity just as lower density located immediately nearby the central electrode.

a – construction; b – electric scheme
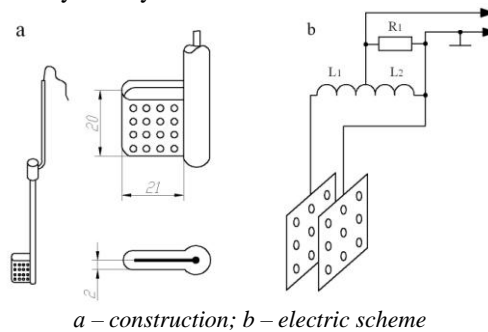
Figure 1. Laminar capacity sensor (dimensions, mm)
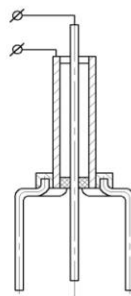
Figure 2. Bar capacity sensor

The reliability of quantitative results obtained at usage of quite open "point" sensors is much less, when only one small-sized electrode is plunged into the layer and the

second one (for example, the chamber wall) is sufficiently removed. These probes can be used to register just highly sharp discontinuity, for example, the appearance and passing of bubbles. Placing such sensors one above the other while processing oscillograph recordings of both probes it is possible to estimate bubble rise velocity and their diameters.

Thus, in known methods foreign objects should be plunged into pseudofluidized layer. It influenced on pseudofluidization nature [1].

MATERIAL AND METHODS

We suggested the method of determination of pseudofluidization uniformity consisting in determining light beam intensity, penetrating through grain layer. Experimental tests were done on the developed and manufactured installation presented in Fig. 3.

Under the influence of the heated with electric heating elements 8 air flow created by ventilator 9 on grain layer 5 which is located on gas distribution grid 7 the intergrain contacts become weak, bed void fraction increases, and its structure is destructed under certain conditions. Dense grain layer in working chamber 4 merges into condition that reminds boiling liquid h.e. pseudofluidization condition. At that the uniformity degree of pseudofluidized grain layer produces the main effect on drying quality.
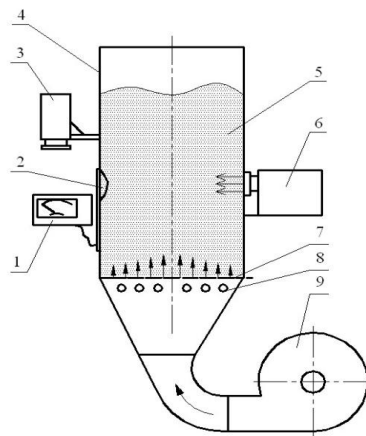
1 - luxmeter; 2 – selenium sensor; 3 – video camera; 4 - drying chamber; 5 – grain layer; 6 – light source; 7 – gas distribution device; 8 – electric heating elements; 9 – ventilator

Figure 3. Scheme of experimental installation and devices arrangement to determine the pseudofluidization uniformity degree

Light emission produced by directed light source 6 was detected by selenium sensor 2, and registered by luxmeter 1 and was recorded by video camera 3.

Oscillograph recordings of luxmeter readings have the form presented in Fig. 4, and allow obtaining detailed amplitude and frequency data. Different lines and hatchings in Fig. 5 present the processing of these recordings to obtain the necessary information.
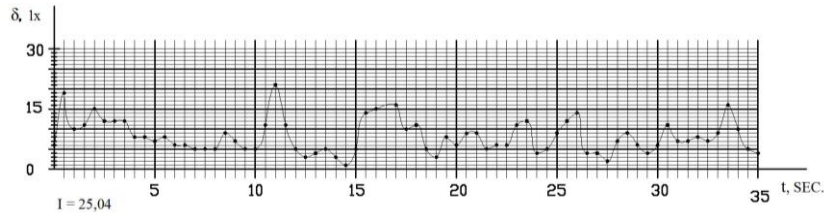
abscissa – test duration t, sec; ordinate – light flow δ, lux;
I – uniformity index (I = 25,04)

Figure 4. Determining of fluidization uniformity index

Thus, distinguishing definite sufficiently large time interval T, we summarized area under curve $\delta(t)$ and determined mean average deviation $\bar{\delta}$ *of light emission*:

$$\bar{\delta} = \frac{1}{T}\int_0^T \delta(t)dt \qquad (1)$$

Further we drew the corresponding horizontal that separated areas with $\delta > \bar{\delta}$ (spaces with sign «+») from areas $\delta < \bar{\delta}$ (spaces with sign «–»).
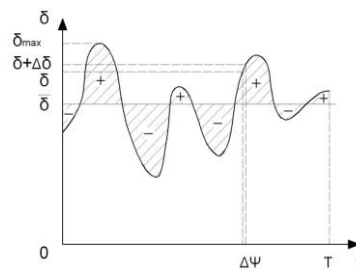
Figure 5. Processing of luxmeter readings

Integrating separately the areas of truncated positive and negative spaces we determine average absolute deviation:

$$\left|\Delta\bar{\delta}\right| = \frac{1}{T}\int_0^T \left|\delta(t) - \bar{\delta}\right|dt = \frac{2}{t}\int_0^T \Delta\delta + dt = \frac{2}{T}\int_0^T \Delta\delta\_dt \qquad (2)$$

Drawing at the same figure number of horizontals corresponding to neighboring values δ and $\delta + \Delta\delta$, it is possible to add up continuances $\Delta\psi$, during which the light intensity was enclosed in this interval, and to determine this event relative probability $\Delta\omega(\delta) = \sum \Delta\psi / T$.

Uniformity index *I* was interpreted as relation of average deviation $\bar{\delta}$, to oscillation frequency ν: $I = \bar{\delta}/\nu$, where ν oscillation frequency.

According to the experiment uniformity indexes were connected with pseudofluidization in the following way: high degree of uniformity corresponds to index 7, satisfactory – index from 7 to 15, low, with increasing piston flow – from 15 to 32.

RESULTS AND DISCUSSION

Experimental investigations were done in order to ground the drying chamber structural parameters providing the specified limits of variation of uniformity index *I* of wheat seeds pseudofluidized layer, which was determined according to intensity variation of light beam penetrating through grain layer. In this regard it was necessary to study the effect of the variation of diameter d and pitch h of holes of gas distribution grid of drying chamber on uniformity index *I* of grain seeds pseudofluidized layer.

Hole diameter was chosen according to the following values: d = 2; 2,2; 2,4; 2,6; 2,8; 3 mm. At that hole pitch was equal to h = 1; 1,5; 2 mm.

Experimental results of the study of the mentioned above factors effects on uniformity index of pseudofluidized material in the drying chamber are presented in the form of characteristic curves in Fig. 6 and 7. The obtained uniformity index dependences of the fluidized material from holes diameter of gas distribution grid (Fig. 6) at different pitch of the given holes have linear character.

Sharp decrease of uniformity index *I* with grid hole diameter increase takes place to the specified value, and then its continuous increase occurs. Minimum value of index *I* corresponds to the grid diameter values arranged in the interval from 2,4 to 2,6 mm.

On the ground of the obtained results it is necessary in further investigations and also in practical usage to apply grids with c holes diameter from 2 to 3 mm. Further increase of grid hole diameter is unreasonable because of spillage of the part of grain material through them.

Characteristic curves (Fig. 7) of uniformity index *I* from grid hole pitch h indicates that with increase h uniformity index decreases and reaches the minimum value at h = 1,5 mm. The sequential increase of holes pitches results in gradual increase of uniformity index at any specified values of grid diameter.
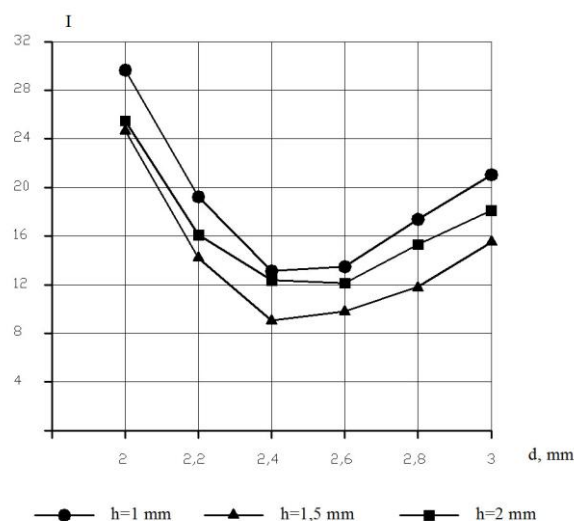
Figure 6. Dependence of uniformity index I from hole diameter d of gas distribution grid at different values of holes pitch h

We consider the further hole pitches increase in gas distribution grid is impossible because of reduction of grid open space and as a result of considerable increase of its hydraulic resistance. The type of the dependence obtained in the course of investigations with sufficient high accuracy corresponds to theoretical one.
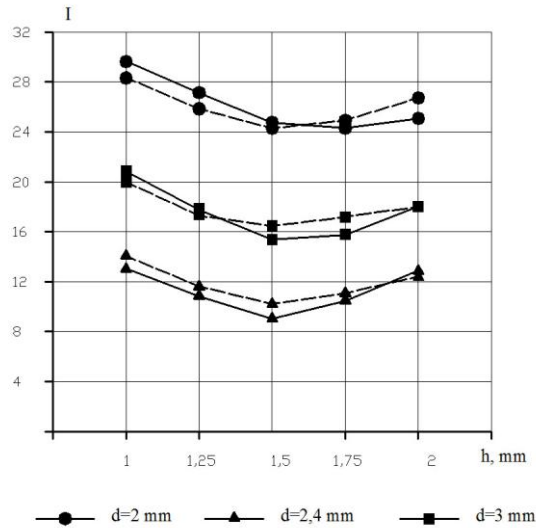
Figure 7. Dependence of uniformity index I from hole pitch h gas distribution grid at different values of hole diameter d
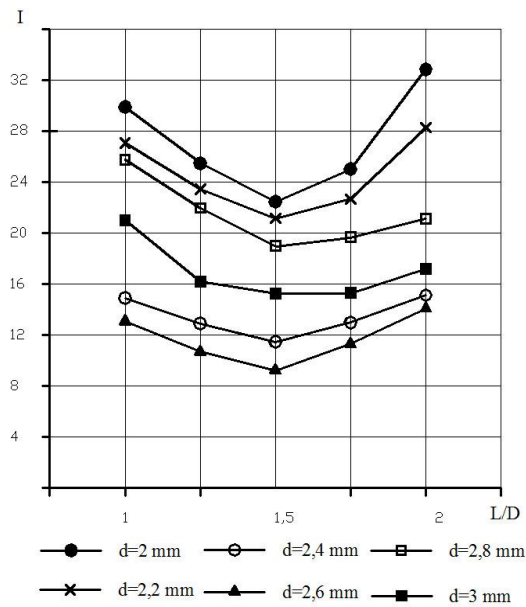
Figure 8. Dependence of uniformity index I from relation value L/D

Pseudofluidization characteristic also depends on relation of height L to diameter D of grain layer. Minimum relation L/D was admitted equal to 1, further decrease this value is unreasonable due to economic reasons, because dryer capacity decreases significantly. Maximum value of relation of height to grain layer diameter, which does not violate fluidization stability was determined by test and was admitted L/D = 2. Characteristic curve analysis of uniformity index *I* from relation value L/D (Fig. 8) at different gas distribution grid hole diameters *d* indicates that the process of grain material fluidization to the value of relation L/D = 2 is stable.

Further increase of value L/D results in transition from fluidized state to piston flow and grain material emission from drying chamber, h.e. at L/D > 2 grain dryer is impossible.

The most qualitative fluidization at minimum uniformity index was observed at L/D =1,5.

Thus, while designing experimental dryer it is necessary to limit the relation range L/D from 1 to 2.

CONCLUSIONS

The optimal parameters of gas distribution device of dryers are determined: diameter and hole pitch of the grid, relation of grain layer height to drying chamber diameter.

At the sake of the specified parameters the best distribution of air flow in pseudofluidized grain layer is performed, its uniformity is increased, the active surfaces values of heat exchange between separate grain and dryer agent are increased, and drying enhancement and more uniform heat penetration of grain are carried out.

The obtained investigation results can be used at designing dryers that operate according to grain layer pseudofluidization principle.

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METOD ODREĐIVANJA KVALITETA FLUIDIZACIJE
U SUŠARAMA SA PSEUDOFLUIDIZOVANIM SLOJEM ZRNA

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Sažetak: U radu su prikazani rezultati ispitivanja ujednačenosti pseudofluidizacije u sušarama za zrno. Predložen je novi metod ocene kvaliteta fluidizacije koji omogućuje dobijanje ujednačenijeg grejanja zrnastog materijala i unapređenje procesa sušenja. Metod se sastoji iz određivanja intenziteta zraka koji prodire kroz sloj zrna. Date su preporuke za izbor optimalnih strukturnih parametara komore u sušari za zrno kojih se treba pridržavati pri njenom konstruisanju.

Ključne reči: sušenje, sušara, metod, zrno, pseudofluidizacija, rešetka za distribuciju gasa
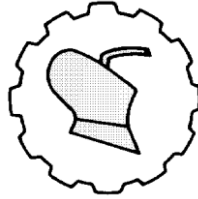
AUDIT AS FACTOR OF IMPROVEMENT OF MANAGEMENT IN AGRICULTURAL COMPANY

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Abstract: The audit can contribute to improving the management of the company. This can start the process of reducing the interval of risk in all parts of agricultural company. Management should be seen as a body that is constantly looking for innovative solutions that will improve the management of the company. The process of establishing control mechanisms should serve the improvement of the overall enterprise management. An audit can provide full management support, especially in the first phase of collecting data from the relevant stakeholders in the company. The authors primarily emphasize that there is no unified methodology initiated by the audit which would be considered generally accepted. Secondary authors point out that there is no generally accepted best practice that could be applied universally to the whole economy of the Republic of Serbia. With this work the authors emphasize profitability management efforts designed to take into account the recommendations of the audit, especially in the agricultural enterprise.

Keywords: audits, process management, agriculture, risks.

INTRODUCTION

Management requires management to new approaches based on the use of audit instructions, recommendations and information [1]. An appreciation of such viewpoints,

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especially in agricultural companies, [2], can be made a number of benefits [3]. Agricultural companies in the business need to use statistical analysis of [4], because it generally improves the operation of the whole agricultural sector [5], [6], [7].

It can serve as a revision of the first monitoring and control functions in the company [8], [9]. This can improve the practical functioning of the agricultural firm may [10], [11], [12]. All processes are based on the standardization of in general may help to improve the overall results of the management [13].

In the aggregate behavior of agricultural management is conducive to changing the overall behavior within the branch, that is, one word contributes to changing the socio-economic behavior within the state [14].

Thus, it can be seen that it is important for the business establishment of internal control mechanisms, which will reduce the risk to the overall operations of the company. This is achieved using heterogeneous models improve the management of [16], [17], [18]. In brief any revision within the enterprise can provide positive effects on the overall performance of [19].

MATERIAL AND METHODS

To create a work the authors used the testing of top management and middle management levels in the medium enterprise of the Republic of Serbia, which has several decades of existence in the market from the dominant business of agriculture. Selected company owns more than 100 pieces of agricultural equipment that can be run in several subgroups.

To highlight the importance of auditing the authors have identified that risk interval ranging from 1-10, except that 1 is the lowest risk and 10 the highest risk to the company. The main risks based on risk identification date by the audit are grouped into 10 subgroups. The objective of these activities was to identify the highest risk, as he would be presented to management, who continue to take measures to prevent them, reduce or cancel other measures.

The criteria for assessing the financial condition of the company are the second level of testing, with the main reason analysis of the most significant risks to the company, which was established in the first part of the research. The last level research through the test was to 5 subgroups agricultural equipment presents management with the aim of finding the equipment that has the highest risk compared to the same age.

All activities that have occurred on the basis of the objectives defined by the authors were taken for a reason finding the greatest risk to appear in a realistic way the importance of auditing in everyday business can be a real driver of audit activities within the agricultural enterprise.

RESULTS AND DISCUSSION

The importance of this study is to highlight the importance of audits in agricultural enterprises. The authors point out that there is no universal model for governance to be improved. In this regard, in Tabs. 1, 2 and 3 further show the research of agricultural companies in relation to the intervals risk. Tabulation 1 provides basic categorized risks

to agricultural company, tabulation 2 draws attention to the greatest risk to the company or the company's financial risk; tabulation 3 presents the evaluation of agricultural equipment in relation to the risk to the company.

Table 1. Categorized basic risks to agricultural enterprise

No	The main risks based on risk identification date by audit	The results related to the nominal value expressed by a single risk
1	Reputational risks	6
2	Operational risk	6
3	Strategic risk	8
4	Risks related to the rules that have already been made in the company	5
5	Social risk	5
6	Risks related to contracts concluded in the enterprise	4
7	The financial risk of the company	10
8	Control risk	9
9	Regulatory risk companies	5
10	Technological risk for the company	7

Table 2. Possible criteria for risk assessment
in relation to the agricultural operations of financial companies

No	The criteria for assessing the financial condition of the company	Interval observation	The results expressed in nominal terms risk
1	Days Insolvency	Until the 7	3
		Until the day 15	7
		Until the day 30	10
2	Debt Indicators	=1	3
		1-2	7
		2 or more	10
3	Profitability Ratios	above 8	2
		0-8	6
		loss	10

Based on these results it can be concluded that the biggest risk to the agricultural enterprise risk financially. Its value is expressed in nominal terms by 10. The biggest risk to the agricultural enterprise is still covered by a triple analysis as follows: the number of days of illiquidity, indicators of indebtedness and profitability indicators. Insolvency is nominally expressed with the highest number i.e. 10 for overdrafts over 30 days. With charge indicated by a value 2 and is more nominal terms with the highest number, i.e. 10, and in this situation there are major difficulties for the company. The return to a situation of expression loss is nominally expressed with the highest number i.e. 10, that the situation is very difficult at the company.

Age agricultural equipment affects the possible risk events per company. Only five categories show that small subgroups agricultural machinery, irrigation systems and greenhouses are fairly highest level of risk.

Table 3. Selected types of agricultural equipment by age and compared
to the results of risk in relation to the fair value of the business books

No	Type of farm equipment	Age farm equipment	The results expressed in nominal terms risk by management in relation to the fair value of agricultural techniques
1	Tractors	To 5 years	4
		To 10 years	6
		Over 10 years	9
2	Towing agricultural vehicles	To 5 years	4
		To 10 years	7
		Over 10 years	9
3	Small agricultural machinery	To 5 years	9
		To 10 years	10
		Over 10 years	10
4	Irrigation systems	To 5 years	5
		To 10 years	8
		Over 10 years	10
5	Greenhouse	To 5 years	8
		To 10 years	10
		Over 10 years	10

CONCLUSIONS

The process of introduction of audit work, a process this is designed by the top-management. The goal activity is gaining reasonable assurance in order to prevent events in future period's operations.

These jobs generally affect:
• improve the efficiency of decision-making by the management,
• increase the reliability of financial reporting,
• Preservation of compliance with applicable laws and regulations and
• contribute to the protection of property.

With this work the authors point out that the results are such that the greatest risk in the opinion of the surveyed participants of financial risk. The same influences and increases the risks of a situation where the insolvency longer than 30 days, when the indicators = 2 or more than 2, that is, when the result of the loss of business. In addition to analyzing the results shown Agricultural equipment according to category 5, valuing the total risk in all age periods software can be concluded that the greatest risk to management under the category of small and agricultural machinery (28) and greenhouses (28).

Just mentioned under the category with the highest risk should be the focus of management in terms of making future decisions relating to business improvement. They should pay the most attention and take measures that will in future be offset the risky business. This confirms the importance of the audit because it may indicate at the earliest stage possible risks in business.

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REVIZIJA KAO FAKTOR POBOLJŠANJA RADA MENADŽMENTA U POLJOPRIVREDNOM PREDUZEĆU

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Sažetak: Revizija može da doprinese poboljšanju upravljanja preduzeća. Time se može pokrenuti proces smanjivanja intervala rizika u svim delovima poljoprivrednog preduzeća. Menadžment treba posmatrati kao telo koje stalno traga za inovativnim rešenjima kojima će poboljšati upravljanje preduzećem. Procesi uspostavljanja kontrolnih mehanizmama treba da posluže poboljšanju ukupnog upravljanja preduzećem. Revizija može da pruže punu podršku menadžmentu, pogotovo u prvoj fazi prikupljanja podataka od relevantnih subjekata u preduzeću. Autori primarno ističu da ne postoji unificirana metodologija inicirana od strane revizije koja bi se smatrala opšteprihvaćenom. Autori sekundarno ističu da ne postoji opšte prihvaćena najbolja praksa koja bi se univerzalno primenila na celu privredu Republike Srbije. Ovim radom autori ističu isplativost napora menadžmenta da uvaži osmišljene preporuke revizije pogotovo u poljoprivrednom preduzeću.

Ključne reči: *revizija, proces upravljanja, agrar, rizici.*
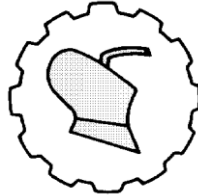
DELINEATION OF GROUNDWATER POTENTIAL ZONES AND IDENTIFICATION OF ARTIFICIAL RECHARGE SITES IN DHARTA WATERSHED, UDAIPUR, RAJASTHAN, USING RS & GIS

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Abstract: Groundwater is a precious resource of limited extent. A systematic planning of groundwater exploitation using modern techniques is essential for the proper utilization and management of this precious but shrinking natural resource. In the present study, Geographical Information System (GIS) is used to integrate multi parametric data to generate several thematic maps, delineate groundwater potential zones and identify sites of artificial recharge in the Dharta watershed, Udaipur, Rajasthan (India). The thematic layers considered to delineate groundwater potential zones are geomorphology, recharge, geology, soil, slope, topographic elevation and transmissivity, which were prepared using conventional maps and data. All these themes and their individual features were then assigned weights according to their relative importance in groundwater occurrence and the corresponding normalized weights were obtained based on the Saaty's analytical hierarchy process. The thematic layers were finally added using Arc GIS software to yield groundwater potential zone map of the study area. Thus, three different groundwater potential zones were identified viz., 'good', 'moderate' and 'poor'. The area having 'good' groundwater potential is about 10.7 km2 which is about 19.62 per cent of the total study area. The thematic layers used in this study to determine artificial recharge zones are transmissivity, recharge, topographic elevation, soil and slope. These layers were combined using boolean logic analysis to delineate zones of suitability for artificial recharge structures. The area suitable for artificial recharge is 7.84 km2 which is 14.37 per cent of the total study area.

Key words: artificial recharge zoning, GIS, groundwater management, remote sensing, water scarcity

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INTRODUCTION

Artificial groundwater recharge has emerged as basic tools for the sustainable management of vital freshwater resources (both groundwater and surface water). The concept of using modern techniques like remote sensing and geographical information systems (GIS) in groundwater management studies is comparatively new. As groundwater is dynamic and interdisciplinary in nature, an integrated approach of remote sensing (RS) and GIS technique is very useful in various groundwater management studies. Remote sensing can provide diverse datasets over a large inaccessible area that can be efficiently handled and analyzed in a GIS framework. Applications of RS and GIS in groundwater management such as artificial recharge have been reported by a limited number of researchers (Saraf and Choudhury 1998; Ghayoumian *et.al.* 2005; Anbazhagan *et.al.* 2005; Ravi Shankar and Mohan 2005; Alivia Chowdhury *et.al.* 2009). They considered a varying number of thematic layers, such as geology, geomorphology, soil, slope, topographic elevation, recharge, aquifer transmissivity, land use/ land cover. A set of weights for the different themes and their individual features was decided based on personal judgments considering their relative importance from the artificial recharge viewpoint. These thematic maps were then integrated in a GIS framework to identify suitable zones for artificial recharge. The study area is severely afflicted with water scarcity problems. Therefore, aquifer replenishment through artificial recharge is necessary to sustain groundwater resources of the area on a long-term basis. Process based techniques like numerical modeling of groundwater systems (flow and/or transport) demand lots of spatiotemporal field data, which are unfortunately not available in the study area. Bearing this fact in mind, a methodology has been proposed in the present study for the delineation of artificial recharge zones and the identification of possible sites for artificial recharge in the Dharta watershed, Udaipur, Rajasthan, using RS, GIS and multi-criteria decision-making (MCDM) techniques with available field data and conventional maps.

Study Area. Dharta watershed is located at Bhinder Block of Udaipur District. The area is bounded by longitudes $74^0 08'$ to $74^0 15'$E & $24^0 30'$ to $24^0 36'$N latitudes and falls in Survey of India (SOI) topo sheets of 45L6, 45L12.It is situated at distance of 12 km. from Tehsil headquarter and covering an area of about 54.53 km^2.The watershed is characterized by sub-tropical and sub-humid to semi-arid climatic conditions. The average annual rainfall of the basin is 60.90 cm, about 90 per cent of which is experienced during the rainy season through Arabian Sea monsoon winds.

MATERIAL AND METHODS

Delineation of Dharta watershed and Selection of Observation Wells. The extent of the Dharta watershed (Figure 1) was extracted by digitizing boundaries of the basin from the geometrically rectified topo sheets. The boundaries of the watershed on the topo sheets were identified and located based on watershed approach. Groundwater levels over the Dharta watershed were monitored in 30 selected open dug wells for the study period. Four wells were selected for conducting pumping tests. The location of these wells is given in the Fig. 1.
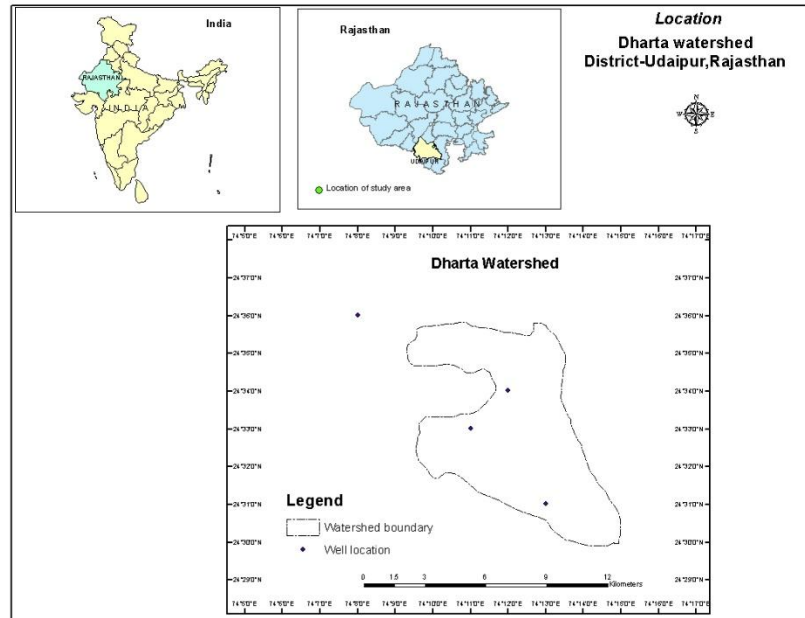
Figure 1. Map showing the study area and monitoring wells location of pumping test sites

Generation of Thematic Layers. The thematic layer of geomorphology was prepared from SOI topo sheets. The soil layer was prepared by digitizing the soil map obtained from the NBSS&LUP, Udaipur at 1:250,000 scale. Topographic elevation layer was generated from the topographic data downloaded from USGS (2004). Slope map was prepared from Digital Elevation Model (DEM), which was taken from SRTM website (USGS, 2004). Groundwater level fluctuation for individual 30 observation wells were computed for two years (viz. 2012 and 2013) and then mean of these two years was considered for generating the thematic layer on groundwater fluctuation. The point map was created in the Arc GIS 9.3.1 software using these values. This point map was then interpolated to get a raster map by using Inverse Distance Weighing Moving Average (IDWMA) Method. Transmissivity values obtained in pumping tests were used to prepare a thematic layer on transmissivity. Recharge for the study area was estimated using Water Table Fluctuation Method. These values were used to prepare a thematic layer of Recharge.

Selection of Thematic layers for identification of Artificial Recharge Zones. A Remote Sensing and GIS based method is found to be very useful in suitability analysis for artificial recharge sites in the hard rock terrain (Saraf and Choudhary, 1998). The thematic layers used in this study for determining recharge zones are transmissivity, recharge, topographic elevation, soil and slope. All the five thematic layers were combined using Boolean Logic Analysis to delineate zones of suitability for artificial recharge structures. The prime task in this method is to identify the criterion and to formulate the set of logical conditions to extract the suitable zones. With this criterion, the output has only two classes: suitable or unsuitable. The areas in which the defined conditions of the information layers are fulfilled together, a value of 1 is given whereas

the remaining part will have a zero value. The criteria considered in this study for demarcating suitable zones for artificial recharge are:

Table 1. Suitability Criteria for Artificial Recharge Zone

Thematic Layer	Suitability Criteria
Slope	1-3 & 3-8 %
Transmissivity	360-390 m^2/day
Recharge	2-4 cm/year
Topographic elevation	<470 m
Soil	Clayey Soil, Fine Loamy Soil

RESULTS AND DISCUSSION

Zones of Groundwater Potential and Artificial Recharge. The groundwater potential map of Dharta watershed (Fig. 2) reveals three distinct classes (zones) representing 'good', 'moderate' and 'poor' groundwater potential in the area. The area covered by 'good' groundwater potential zone is about 10.70 km^2 (19.62 per cent).The north and northeastern portion of the study area falls under moderate groundwater potential zone. It encompasses an area of 17.33 km^2 which is 31.78 per cent of the total area.
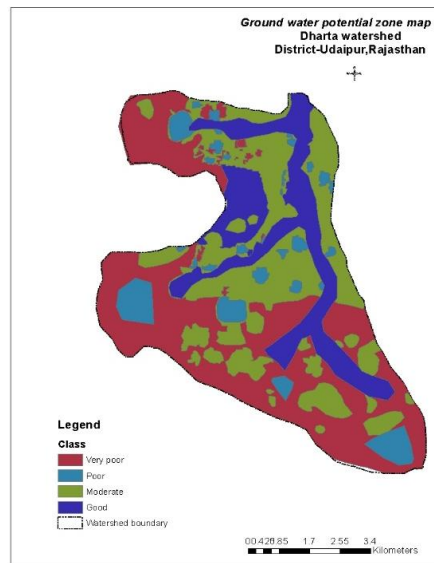
Figure 2. Groundwater potential zone map of Dharta Watershed

However, the groundwater potential along the boundaries of the study area is very poor. It covers an area of 21.91 km^2 which is 40.17 per cent of the total area. The 'poor' groundwater potential is due to presence of girdle of hills surrounding the study area. 7.84 km^2 of the area which is 14.37 per cent of the study area is suitable for artificial

recharge which lies in the northern part. The area suitable for artificial recharge is 7.84 km^2 which is 14.37 per cent of the total study area.
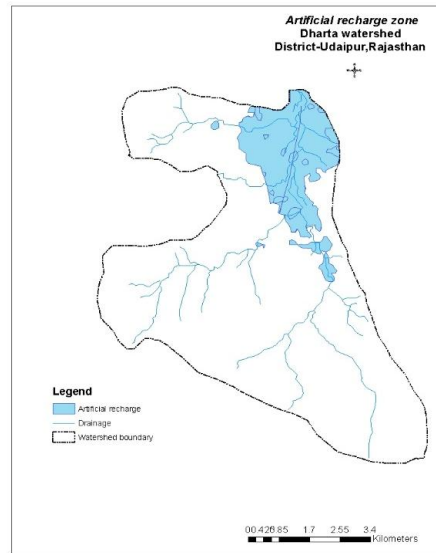
Figure 3. Map showing zones favorable for Artificial Groundwater Recharge

CONCLUSIONS

The application of GIS & Remote sensing technique is demonstrated as the best tools for the identification of groundwater potential zones and artificial recharge zone in the Dharta watershed. This potential map will serve as the basis of information to local authorities and planners about the suitable area for prospective exploration of groundwater and construction of different structure of artificial recharge. These maps also help in water management in the area for domestic and agriculture uses.

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MAPIRANJE POTENCIJALNIH ZONA PODZEMNIH VODA I IDENTIFIKACIJA VEŠTAČKIH IZVORA DOPUNE U OBLASTI DHARTA WATERSHED, UDAIPUR, RAJASTHAN, UPOTREBOM RS I GIS

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Sažetak: Podzemna voda je dragocen izvor ograničenog obima. Sistematsko planiranje korišćenja podzemne vode upotrebom savremenih tehnika je osnova pravilne upotrebe i upravljanja ovim dragocenim prirodnim resursom. U ovom istraživanju je korišćen GIS za integraciju više parametara i dobijanje nekoliko tematskih mapa potencijalnih izvora podzemne vode. Tematski slojevi su: geomorfologija, obnova, geologija, zemljište, nagib, topografska elevacija i prenosivost, koji su pripremljeni upotrebom konvencionalnih mapa i podataka. Sve ove teme i njihovi pojedini entiteti su vrednovani prema značaju za pojavu podzemne vode. Tematski slojevi su na kraju dodati Arc GIS programom u mapu potencijalnih zona podzemne vode. Tako su identifikovane tri različite zone: 'dobra', 'umerena' i 'slaba'. Oblast u klasi 'dobra' ima oko 10.7 km^2 što je oko 19.62% cele oblasti.

Ključne reči: zoniranje veštačke dopune, GIS, upravljanje podzemnim vodama, daljinska detekcija, nestašica vode
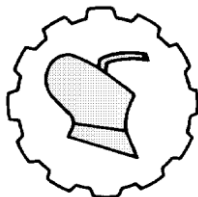
CENSUS WORK FOR FINANCIAL REPORTING OF AGRICULTURAL ENTERPRISES IN SERBIA

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Abstract: The census (ordinary and extraordinary) is done on the basis of Article 16 of the Accounting Act ("Official Gazette" No. 62/13), and the Regulations on the organization and implementation of the inventory of assets and liabilities and the balance of alignment with the actual situation of the company. In addition mentioned or frame for making a decision on the list of wrecks there are legal frameworks regulation PPUT the Statute of the company, as well as the managing authority such as company directors and the supervisory board of the company. For the census is necessary that managing authorities Dons decision on the list and form a commission to inventory the assets and liabilities as of the day of the cross-section of the business situation. The aim of the implementation of these activities is to determine the actual state property and equipment at the disposal of the company. These jobs fall into the regular activities and contribute to improving the safety of the company.

Keywords: audits, process management, agriculture, risks.

INTRODUCTION

Management with respect to financial reporting is possible in several ways. Gradually improve training significantly observing the operation of a wide range of agricultural companies that must have an accurate record of a compliant and [1], [2], [3]. Reconciliation of unique ways to improve financial reporting [4], [5], heterogeneous

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enterprise is a very delicate work [6], [7], [8], which must be in accordance with the legal provisions at the state level.

The biological observation in relation to the improvement of RA [9], [10], also has its own specificity, particularly in agricultural companies. It is usually in the form of the manifestation of observation evaluation of crop production at a given day (greenhouse production of soft, hard and softwood sawmills).

Implementation of all those methods improvements possible with the establishment of internal control mechanisms and other agricultural enterprises [11], [12], [13], [14].

Regardless of this entire constant quest for the Improvement of governance of the imperatives of a large number of agile managers. One way to improve is addressed in this paper in the form of a character by the list company.

MATERIAL AND METHODS

For preparation of this work used data obtained from the top management of agricultural startups that exist in the market for over 50 years with a dominant business in the field of agriculture.

Presumption was that a company with so many years on the market has a reference to its financial reporting relevant to the acquisition of real images and real business. Was used census data says the date 31.12.2016. To achieve credibility paper is divided into three segments observation. The first was to emphasize the importance of forming a group of property and equipment in financial reporting. This is done in the deployment: groups 020, 022, 0230, 10300, 0263, 025, and 027. The second part has been highlighting cases of missing equipment. The third part of the observation was to emphasize not the standard case of the experts, or the case of gifts of property, equipment or other legal entity.

The last segment was related to highlight the importance of writing notes in the financial report, or in the documentation accompanying the financial statements to the management bodies of companies.

RESULTS AND DISCUSSION

Decision Directors of the Company may be formed over the Commission for a list headed by the one called Central Census Commission. This precisely defines the starting time of work and the deadline for completion of the work of the individual committees and the Central Census Commission. Additionally need to complete the work and submit a report on the inventory to advance the specified deadline, and it is submitted for review and how many copies of the report.

The list of assets and liabilities must be conducted in accordance with the instructions of the Director or supervisory authority companies. Central Census Commission shall be appointed on the basis of Decisions of the Director of the Company and is defined by forming no steam members.

The same co-ordinates the work of the Commission for the list, as well as:
    - takes into account the limits of the census,
    - controls the accuracy of the performed inventory
    - as well as other tasks necessary for the successful implementation of the list.

The authors like to give an overview of the mandatory part of the report on the census, which were systematized in a slide in Tab. 1-3. Tab. 1 gives an overview of the first demarcation equipment and assets of agricultural enterprises by groups. Table 2 shows a real example of the resulting lack established by the Commission within the agricultural enterprise. Tab. 3 presents the not-so-frequent cases of gifts of assets to another legal entity.

Table 1. Display the categorization of keeping the accounts of the company

No	The categories for which the guidance according to spending property, plant and equipment in the enterprise	Leading by accounts of the company (the Group's accounts or sub-accounts)
1	Land	020
2	Buildings	022
3	Plant and equipment	0230
4	Small inventory in use	10300
5	Artworks	0263
6	Biological resources	025
7	Property, plant and equipment and biological assets under preparation	027

Table 2. Only, the missing equipment of agricultural enterprises

No	Name of equipment	Unit of measure	Purchase value (The estimated value of the dinar)	Value correction (The estimated value of the dinar)	The present value as at 31.12.2016. (The estimated value of the dinar)	Years procurement
8175	Hedge Trimmers Fs450 Pa 14	1	70.559,01	30.054,76	40.504,25	2014
7770	Hedge Trimmers Stihl Fs 450	1	55.882,73	32.117,48	23.765,25	2010

Table 3. Display donating equipment agricultural company to another legal entity

No	Name of equipment	Unit of measure	Purchase value (The estimated value of the dinar)	Value correction (The estimated value of the dinar)	The present value as at 31.12.2016. (The estimated value of the dinar)	Years procurement
1025401	Samsung laser ML 1610	1	7.980,00	7.980,00	1.000,00	2006
1025402	Samsung laser ML 1610	1	7.980,00	7.980,00	1.000,00	2006
7371	PC Computer Ada integra	1	30.239,58	30.239,58	1.000,00	2006
7035	PC Computer integra 2500	1	42.335,41	42.335,41	1.000,00	2006

All of the Commission for the list before starting works given operating instructions in writing from the Central Census Commission, oral interpretation and guidance. For additional information, through the Central Census Commission, if necessary, consulted professional services Company, so the list of fully executed in accordance with the Regulations on the organization and implementation of the inventory of assets and liabilities and adjustment of balance of the actual situation of the Company in which it conducts census.

An examination of the work of the Commission for the list, as well as their reports, it can be concluded that the Commission's work in plenary and in the presence of competent accountants, with additional members of the Central Control Commission, internal control and external auditors.

The Commission for inventory of intangible assets, real estate, plant and equipment shall be appointed by the decision of the Director of the Company and has an odd number of members, to all organizational units of the company. A note arising from the real case of agricultural enterprises who is the data allegations, which were made on the basis of the list on the day 31.12.2016.

1. The necessity of a classification OPRM and property on account groups 020, 022, 0230, 10300, 0263, 025, and 027.

2. Highlight missing with mandatory written explanation whose content is given as:

a) The Commission stated that the Brush cutter STIHL FS 450 (inventory number 7770) stolen. Police report is attached to the Journal of the accountant (in the meantime and collected damages from the insurance company-a copy of policies attached).

b). Motor HAIR FS450 PA 14 (inventory number 8175), noted the disappearance and it is treated as a deficit.

Besides the lack of a Commission proposal gives the decision of the commission, whose model is given as:

a) Established Commission may propose that the recorded deficit of basic resources of brush cutter STIHL FS 450 (inventory number 7770), debited to the Company since it was stealing.

b) Disappearance of brush cutter FS450 PA 14 (inventory number 8175), found a commission has formed in order to determine where a missing piece. The Commission, with the approval of Directors proposes that the deficit charged to the Company.

3. A tribute to another legal entity, where the Commission submits the attached report as a list of presents proposal (Table 3).

The explanation can be done in accordance with a situation where the company data resources (computer equipment) are unable to return the computers and printers, it is necessary to write off equipment. Being removed from books is treated as a gift, the tax is levied on a gift and donated equipment is considered. The Commission has identified a single market value on the day 31.12.2016., the year is shown in Table 3.

CONCLUSIONS

The authors point out three important works. The first relates to the importance of sorting equipment and the company's assets to a group of accounts 020, 022, 0230, 10300, 0263, 025, and 027, in order to unify the monitoring and establish control over the monitoring of all developments related to the equipment companies. The second part

highlights the case of the occurrence of missing, and that the same prevails. Also within this Commission requires that, in the framework of the legal department makes a decision on the debt or discharge of all of the above. The third part concerns the case rarely treatment in enterprises, which is the case when performing estrangement equipment free of charge, with the explanation that he must pay tax on the estimated value of the equipment.

Essentially speaking, the importance of regular and proper census is of great importance for improving safety management in all companies, and therefore in agricultural enterprises.

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POPIS U FUNKCIJI FINANSIJSKOG IZVEŠTAVANJA POLJOPRIVREDNIH PREDUZEĆA U SRBIJI

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Sažetak: Sprovođenje popisa (redovnog i vanrednog), vrši se na osnovu člana 16. Zakona o računovodstvu („Službeni glasnik RS"broj 62/13) i odredbi Pravilnika o organizaciji i sprovođenju popisa imovine i obaveza i usklađivanja knjigovodstvenog stanja sa stvarnim stanjem preduzeća. Osim pomentuog, odnosno okvira za donošenje odluke o popisu postoje i bitini okviri pravnog reulisanja pput, Statuta preduzeća, kao i organa upravljanja poput: direktora preduzeća i nadzornog odbora preduzeća. Za sprovođenje popisa potrebno je da organi upravljanja donsu Odluku o popisu i obrazuju komisiju za popis imovine i obaveza sa stanjem na dan kada se vrši presek situacije poslovanja. Cilj sprovođenja ovakvih aktivnosti je utvrđivanje stvarnog stanja imovine i opreme sa kojom raspolaže preduzeće. Pomenuti poslovi spadaju u redovne aktivnosti i doprinose poboljšanju sigurnosti upravljanja preduzeća.

Ključne reči: popis, finansijsko izveštavanje, upravljanje.
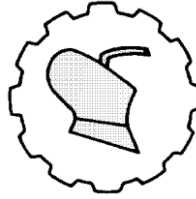
DEVELOPING TEST EQUIPMENT SUITABLE FOR TESTING TORQUE TRANSFER SYSTEMS USED IN AGRICULTURE

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Abstract: It is a very common machine design task for engineers to create high-efficiency energy transfer, for which a standardized calculation methods as well as design factors determined by empirical and laboratory experiments are used. Contrary to general technical practice, these design factors are not always available for scaling the machine elements operating in agricultural and food industry equipment. Without this, we can only rely on the results of our own costly lifetime tests. Our aim is to create such a laboratory test bench with which the operation of the machine elements involved in the drive can be tested under working conditions.

Key words: *test bench, drives, transmission, infrared thermal analysis, efficiency, slow motion, active support, bearing*

INTRODUCTION

The defined research tasks can be solved by experimental methods, relying on their results. "During the experiment, the phenomenon being tested is artificially produced in a strictly controllable situation the conditions of which can be modified and reproduced [1]". A specially designed test bench was created to reproduce the working load and conditions of the machine elements making up the torque transfer systems used in agriculture and the food industry. Machinery operating on the arable field and food industry equipment is exposed to specific environmental impacts and stresses, unlike the

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common conditions in general engineering. In the following, four factors are highlighted:

Stochastic load. The load and stress of agricultural machinery occurs due to the interaction with materials having specific physical-mechanical and other properties (plants, fruit, soil, manure, animals, etc.). As a result, the testing of organic materials as a "workpiece" is particularly important [3]. Not only do the material properties but also other characteristics (stock density, dimensions, maturity, moisture content, etc.) of the agricultural materials and plant stock to be treated vary within a wide range, which results in a dynamic load of the machines, i.e. the acting forces are random. These dynamic stresses have an adverse effect on the components of the machines, but at the same time the phenomenon can be used, for example, for the energy-saving shredding of fiber feed. Via the stochastic description of the load process the straw cutting drum can be optimized and thus the edgewise vibrations of the straw cutting blades, which greatly reduces cutting energy [4,5].

Climatic and arable land relations. Agricultural machines working on arable land generally operate in extreme weather conditions and an environment contaminated with dust, leaf and stem residues, which has an impact on the operation and lifetime of the entire structure. Primarily, polymeric components are sensitive to environmental influences (temperature, humidity, abrasive materials, etc.), which greatly modify the material and friction properties [7]. For example, the components of harvesters may reach extremely high temperatures during the summer harvest, depending on how far they are situated away from the engine room. Machine elements often operate between a temperature range of 80 to 110°C under the plate cover. Extremely low temperatures often occur in the food industry. In the case of refrigerators or the equipment of cooled rooms, it is common to have an environment of -18°C [6]. Field machines are not only affected by climatic impacts, but large volumes of stirred dust (solid, mineral particles, small particles), leaf and stem residues also appear as contaminants and cause the abrasive wear of the parts. The dust particles adhere to the active surface of the machine elements, which depends on the moisture content of the air, the hygroscopicity of the particles, the electrostatic properties of the granules, and the shape of the particles, thus affecting the friction and wear processes [2].

Geometric machine setup errors on field machines. The agricultural harvesting machines are large plate-body self-propelled structures on which the power supply of the (threshing, cleaning, moving, etc.) machine units handling the crop is realized via mechanical drives. The distance and angular misalignment of the shafts involved in the drive may vary widely, which may arise from the uncertainty of mounting - deriving from the plate construction - and from the deformation of the frame structure occurring during operation. In such cases, by selecting a suitable drive the power transfer can be assured, but the additional loads of the set-up errors result in reduction in efficiency and service life.

Process medium. In the case of agricultural machines, the presence of dry matter loads is very common and high, and in the case of food processing machines, operating areas with humid and liquid medium can be mentioned. Among the machinery units used in technical life it can be mentioned regarding rolling element bearings that the use of widely used metal rolling bearings in a process medium is only possible if the serious sealing problems are solved. Process fluids (water, alkali or acid fluids, apple juice, wine, milk, etc.) have an adverse effect on the operation of bearings. In these cases, on

the one hand the occurring corrosive effects must be expected as well as the inadequate lubrication of bearings. By now, due to the large development of materials science and manufacturing processes bearings with plastic outer and inner race and some kind of aseptic rolling element (e.g. glass, acid-resistant steel or ceramic) have appeared in the areas of rolling bearings, however, their behaviour against process media is still unclear.

MATERIAL AND METHODS

Construction of the test bench. The test bench basically consists of a bench, two motor units, accessory elements as well as an electrical and measuring system (Fig. 1). The stand structure is made up of two independent grooved tables that can be assembled in any position. The set-up of the drive parameters and data collection is facilitated by the manual control panel and the touch screen display.
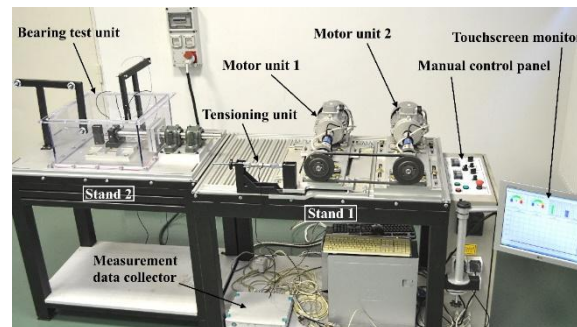

Figure 1. The construction of the test bench

Either of the two motor units is capable of fulfilling the drive or braking function, thus the transmission direction can be changed in a fixed arrangement. When testing the torque transfer components, one of the motors dedicated as the drive generates the performance to be transferred, the other one converts it into electric power as a generator and feeds the generated current back to the system, so only the losses must be compensated from the mains. With this solution, long-term lifetime experiments can be economically realized. The revolution of the three-phase asynchronous motors with forced cooling (NERIMOTORI IEC 34-1, 1.5 kW) and the braking torque can be adjusted manually using two Fuji Electric 5E1S-7E inverters (Variable Frequency Drives (VFDs)). In addition, the drive characteristics can be controlled by a programmable logic controller (PLC) produced by Moeller and the unique load function of the machine elements to be tested can be created. During the measurements it is possible to fix all the drive parameters and to precisely measure them with the help of an 8-channel HBM Spider 8 type data acquisition system. The torque values are supplied by NCTE 2200-17,5 torque transducers (measuring range: 0 to 17.5 Nm; accuracy class 1). The revolutions, the angular speed fluctuations, the angular accelerations, the angular deviations and sliding of the shafts can be measured using Hengstler 0538633 RI76TD/5000ED incremental encoders with a resolution of 5000 pulses per revolution. The diagram of the electric and metering system of the test bench is shown in Fig. 2.
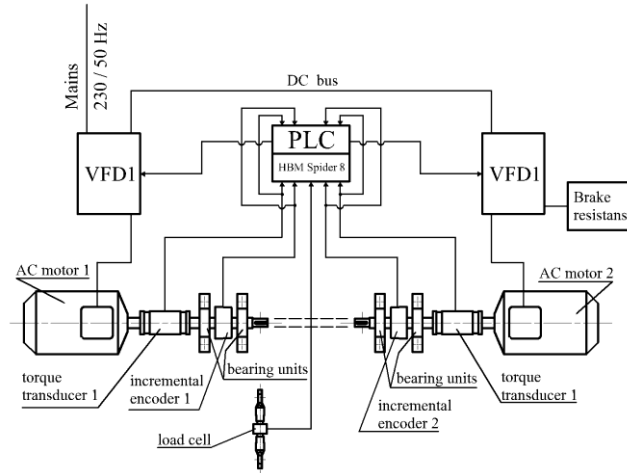
Figure 2. Schematic diagram of the electrical and measuring system

Test arrangement of belt drives. For the testing of the belt drives the drive unit is fixed to a tensioning mechanism guided by a linear bearing. The pretensioning of the belt can be set with an adjusting spindle and a load cell (HBM U9B 10kN) connected in series with it, whose line of action coincides with that of the shaft pulling force (F_H). In this way the pre-tensioning force can be measured directly. The construction of the universal test bench assembled for the belt drive tests is shown in Fig. 3.
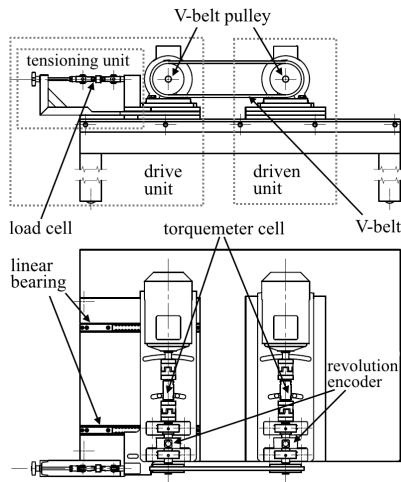

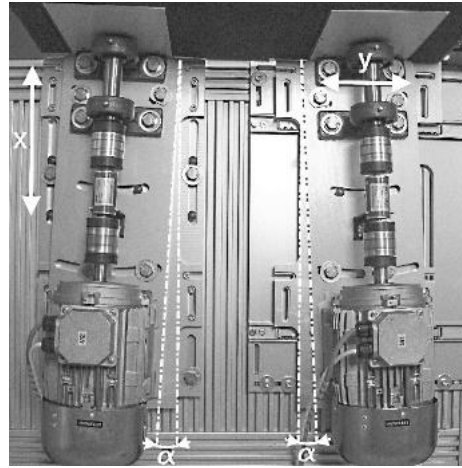*Figure 3. Test bench assembled for belt drive tests*

Figure 4. Setting the geometric error on the test bench

Such a locking mechanism has been created to fix the drive and braking motor units to the stand which allows a variety of machine setting errors to be realized on the drive to be tested (Fig. 4).

The shaft end of the motor units can be adjusted angularly and axially to accurately create and repeat the parallel and angular errors of the drive shafts.

Experimental layout to test the active supports. During the bearing tests, one motor unit was fixed to one grooved table and the other table contained a set of structural elements required for the bearing tests. The conceptual structure is shown in Fig. 5.
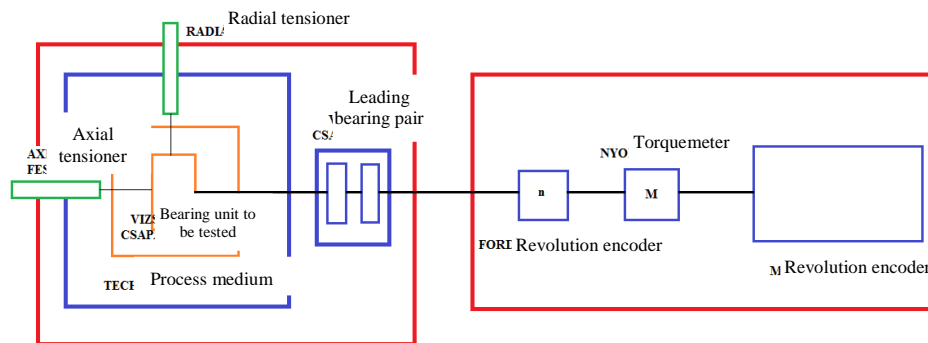

Figure 5. Block diagram of the bearing test bench

Basically, there are three main bearing rolling parameters to be modified. In addition to the radial and axial loads, it is necessary to realize the change of the rotation according to different needs. The introduction of the drive shaft into a polycarbonate cabin was realized by means of two specially designed and manufactured seal cases attached to each other by bolt connection. In order to avoid possible leakage between the seal case and the cabin, the cases are connected to the side of the cabin with an endless, foamed, silicone O-ring, ensuring complete sealing. The sealing next to the shaft is provided by two spring sealing rings (Fig. 6).
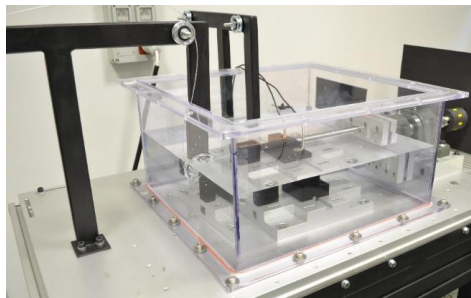
Figure 6. The medium retention conditioning cabin

The load system ensures the constant load of the bearings by weight force. Thus, in this case, the bearing block is not fixed during the measurement runs, it acts as a floating bearing housing, which can move both radially and axially. In order to test the torque-transmitting elements in the process medium it was necessary to provide a medium-retention solution with which the machine element to be tested can be separated from the

outside environment so it is only affected by the effects of the process medium. For this purpose a polycarbonate conditioning cabin was designed and manufactured.

Test Methods. During the experiments not only the values measured by the test bench $(n_1; n_2; M_1; M_2; \omega_1; \omega_2; F_i; T_i; s)$ can provide a test parameter, but other measuring instruments can be incorporated into the experimental arrangement too. It is also possible to measure the temperature, temperature distribution or change (such as loss intensity) of machine elements operated under artificially created conditions by means of a thermal camera. In addition, a high-speed camera can be fitted into the experimental arrangement, with which the fast processes occurring among realistic motion relationships can be analysed.

The temperature is measured with an infra camera type NEC H2640. Its infrared detector has a high resolution (640 x 480), a sensitivity of 0.03°C and a temperature measurement range from -40°C to + 500°C. The thermal camera images can be recorded at a frequency of 0.25 - 30 Hz, through which the process of warming can be observed.
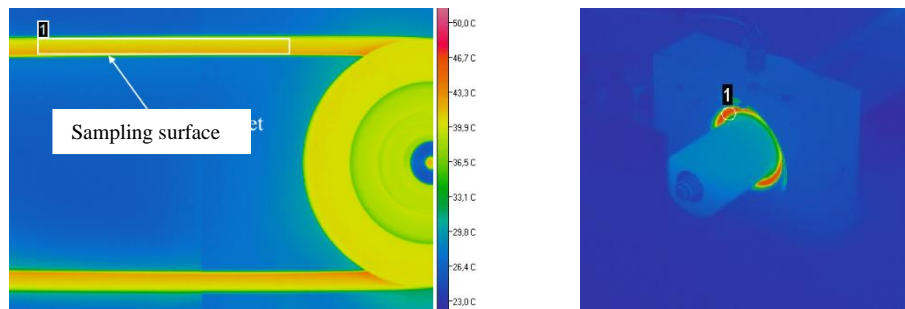
Figure 7. Thermal camera imaging and the sampling surface

Temperature data is obtained from the thermal image taken of the surface of the tested machine element by using the evaluation software Image Processor Pro II (Fig. 7). From the infrared camera images the temperature of the sampling surface marked on the measured object gives the temperature rise of the machine element. This temperature rise is described by the Baule-Mitscherlich saturation function (Fig. 8), in which the measured parameters change along a decreasing gradient towards the maximum of saturation.

Figure 8. The measurement data and the saturation function

Different stable (saturation) temperature and heat generation rates belong to each experimental setting so the duration of the measurement is also dependent on the setting. With the help of the mentioned mathematical model the steady-state operating temperature can be determined and during the experiments it is not necessa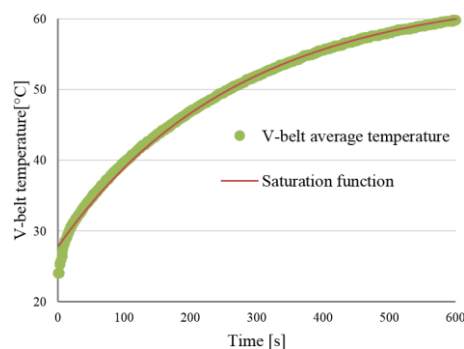ry to reach it, so the duration of the measurements can be the same regardless of whether or not the temperature of the machine element has stabilized under the circumstances. The temperature change can be determined from the difference of the starting and the saturation temperature, which means the power loss between the two steady states - between the workshop and the stabilized state of the operating temperature.

The general equation of the function of saturation:

$$Y = A \cdot \left(1 - e^{z + c \cdot X}\right) \tag{1}$$

The test arrangement with the high-speed camera is shown in Fig. 9, where an Olympus i-SPEED TR camera is used to make an image of the torque transfer element. The components to be tested are provided with measuring points whose path of motion describes the movement of the machine elements. For high-speed camera application a special DC powered light source has to be utilized to avoid periodic variation of illumination and provide sufficient light intensity. The image sensor (CMOS) is set parallel to the plane of motion to avoid a parallax error. The operation of the unit is supported by the central control unit, which displays a real-time image.
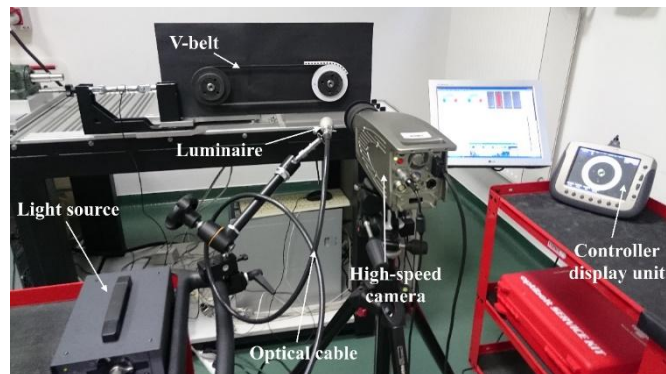
Figure 9. Experimental arrangement of relative motion tests

The motion path described by the measuring points is determined by the i-SPEED Control Pro imaging software belonging to the camera. To retrieve the selected object, it is necessary to correct the recorded images, during which the color images are converted to grayscale first. Then in order to highlight the tested marks two-color black and white frames are created from the grayscale images to separate the test points (pixel sets) from the background without losing information. In the following image analysis step the size of the object in the image is calibrated and a general coordinate system is given. The built-in algorithm of the software creates the coordinates of the manually selected object

at the selected length of the image and then the coordinate data are processed using an Excel spreadsheet program.

RESULTS AND DISCUSSION

The universal test bench is a tool used both in the research program and educational work of the Szent István University, Faculty of Mechanical Engineering, Institute of Mechanics and Machinery. The research results obtained with the test equipment are shown below, which can be discussed in two main directions.

Testing of installation and machine setting of torque transfer systems. During the tests related to bearings performed so far a conclusion was drawn regarding the changes in physical and geometrical parameters impacting the operation of bearings, due to the effect of process fluids. In connection with this, an installation technology recommendation was developed to help decide what shaft or nest fittings are necessary in the case of the given non-metal rolling bearing for ideal bearing use. The recommendation takes into account the operating temperature of the bearing, the type of process medium, or the special material properties coming from the relaxation process.

Manufacturers prescribe such a small size interval for the geometry setting of V-belts that cannot be maintained in agricultural equipment. The impact of machine setting defects on V-belt drive was tested by experimenting on the test bench. During the experiments the heat loss of the belt drives and the lost motion were taken into account together. An error limit was determined, where V-belt drives were still working at adequate efficiency. Furthermore, it was found that in addition to the magnitude of the differences between the pulleys, the nature of the fault also affects the loss of performance.

Testing the operating characteristics of torque transfer systems. For the technical world using roller bearings, the relationship between radial and axial loads in the case of some bearing types is not new. In the case of conventional metal base bearings, the equivalent static load can be calculated from the radial and axial components of the static load. This is the load (radial with radial bearings, axial with axial bearings) that would cause the same maximum rolling load in the bearings as the actual loads. In the case of non-metallic bearings, such a relationship between axial and radial loads has not been available for technical life so far. As a result of the research work, a ratio has been established, which helps to interpret the relationship between the two main directions of load. Within the framework of the research program, it was important to establish and prove the assumption what function is described by the temperature change parameters in the case of changing the three main parameters affecting the operation of the bearings. After describing these functions, the maximum operating temperature of the non-metal rolling bearing can also be calculated with different setting parameters. The significance of the result is that based on them in most cases it will be possible to avoid bearing damage due to bearing overheating.

It was justified in the scope of the major characteristics affecting the power loss of V-belt drives that by ideally selecting the parameters of the V-belt drive, power loss can be measurably reduced. Based on the heat generation of the V-belts, the mathematical model for loss of performance was established, where it was determined by the variance

analysis of variables that the size (or reciprocal) of the diameter of the disc influences the heating-up of the belt to the greatest extent. The effect of the bending frequency and the pulling-through rate is nearly identical, but at the same time this effect is more than an order of magnitude less than that of the pulley diameter.

CONCLUSIONS

Using the test bench developed by the authors, through laboratory experiments, the torque transfer systems operating in different agricultural and food industry conditions can be tested, the result of which is indispensable in the sizing, operation and product development of machine elements. The test equipment is suitable for testing the operation, lifetime and efficiency of drives and other rotating machine elements (different belt drives, gear drives, clutches, active supports, etc.) operating under the mentioned conditions.

The development and implementation of the test bench suitable for examining the machine elements presented in this article is currently in the state described above. The current state makes it possible to examine torque transfer systems with different settings in the cabin flooded with the process medium. In the future, there might be an opportunity for closing the cabin and for the programmed adjustment of the indoor environment. The long-term goal of the development is to create the controlled inner medium. According to the current concept, PLC controlling will allow the cabin temperature, humidity and the internal atmosphere to be controlled.

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RAZVOJ OPREME ZA TESTIRANJE SISTEMA PRENOSA MOMENTA SILE KOJI SE KORISTE U POLJOPRIVREDI

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Sažetak: Veoma uobičajen zadatak za inženjere konstruktore mašina je konstrukcija visoko efikasnog prenosnika pogona, za koju se koriste standardizovane metode proračuna, kao i faktori koji određeni empirijskim i laboratorijskim ogledima. Nasuprot opštoj tehničkoj praksi, ovi elementi konstrukcije nisu uvek dostupni za kapacitet mašinskih elemenata primenjenih u opremi za poljoprivredu i prehrambenu industriju. Bez ovoga možemo da se oslonimo samo na rezultate dostupne rezultate sopstvenih ispitivanja. Naš cilj je da konstrušemo takav laboratorijski sto za testiranje na kome ćemo moći da ispitujemo rad mašinskih elemenata ugrađenih u prenosnik pogona u radnim uslovima.

Ključne reči: sto za testiranje, pogoni, transmisija, infracrvena termalna analiza, efikasnost, usporeni snimak, aktivna podrška, ležaj
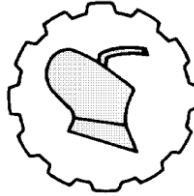
SURVEY OF THE EUROPEAN MARKET DISTRIBUTION OF THE TOWED BALERS, SPRAYERS AND FERTILIZER SPREADERS

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Abstract: Trailed machinery and transporters with various types of suspension account for a large proportion of the manufacture and sale of agricultural machinery in Europe. These trailed vehicles cover a wide functional range: agricultural trailers, tanker trailers, trailed fertilizers and manure spreaders, sprayers and fodder mixing wagons. They also have many different types of suspension: tandem, tridem, sprung, rigid, steered, etc. Of the product groups under examination, those with the highest levels of sales in terms of number of units were round balers, trailed sprayers and fertilizer spreaders. There is also a substantial market in large square balers, but rather than the number of units, it is the value of machines sold that is significant.

Key words: *agricultural machinery, towed machinery, trailer, suspension, market share*

INTRODUCTION

Trailed machinery and transporters with various types of suspension account for a large proportion of the manufacture and sale of agricultural machinery in Europe. These trailed vehicles cover a wide functional range: agricultural trailers, tanker trailers, trailed fertilizers and manure spreaders, sprayers and fodder mixing wagons. They also have many different types of suspension: tandem, tridem, sprung, rigid, steered, etc. [2, 7, 8]

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MATERIAL AND METHODS

The data of the survey was gathered from the publications of national statistical offices, professional associations and from the information and catalogues of the manufacturers. [1, 3, 4, 9]

We present the results of systematically data collection and analysis regarding our survey of the European market of towed agricultural machinery.

RESULTS AND DISCUSSION

Determination of the market shares of major manufacturers by product category. Round balers, which come in of various constructions and sizes, are made by about 40 companies worldwide. Total annual sales vary between 30,000 and 50,000 units, but have been typically between 30,000 and 35,000 in recent years. Round balers have the common feature of being towed and driven by tractor. All have either a single-axle or – the versions combined with a bale wrapper – twin or tandem axle suspensions. The latter, owing to their weight and towing speed, which is maximized at up to 40–50 km/h, generally require braked axles.

Most round baler machinery manufacturers are based in Europe, and the largest number of units are made in Germany and Italy.
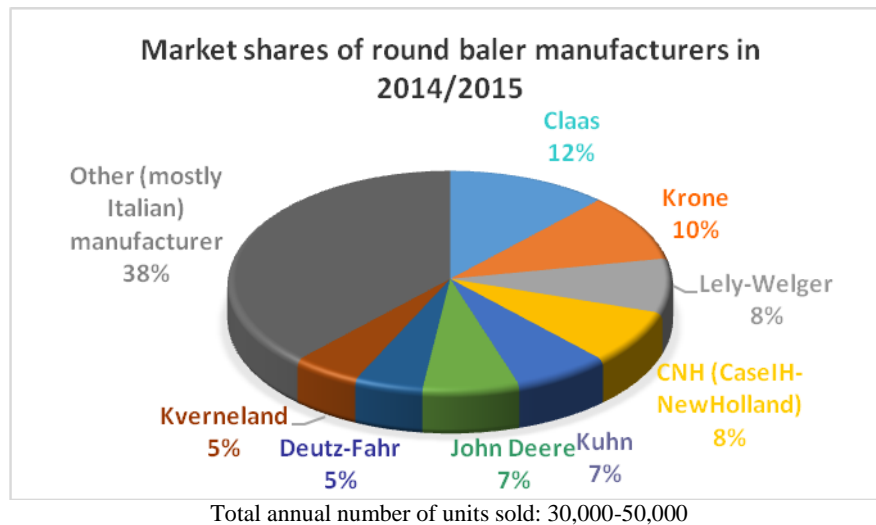

Total annual number of units sold: 30,000-50,000

Figure 1. Market shares of round baler manufacturers

The two largest manufacturers are Claas and Krone of Germany. They produce the largest range of types and models and alternate in the position of European market leader. Other large manufacturers are the Lely-Welger (German-Dutch), the CNH Agriculture (Italian), the Kuhn (French) and the John Deere (USA). Welger filed the first patent for a fixed-chamber baler and is a dynamic manufacturer and developer within the

Lely Group. CNH Agriculture engages in cooperation in the manufacture of balers. Deutz-Fahr of Germany, part of the SDF Group, also makes balers. Kverneland, owned by Kubota, sells balers from its Italian Gallignani baler manufacturing base under the names Kverneland, Vicon and Kubota. Most of the remaining manufacturers (Bergam, Ferraboli, Mascar, Maschio, Wollagri etc.) are Italian. See Figure 1.

There are considerably fewer companies – 13 or 14 worldwide – that make the more complicated large square balers. Europe has the greatest concentration of production, with nine manufacturers. There are about 3500–3700 large square balers sold annually worldwide.

The design is based on a machine produced by Hesston (now part of AGCO) of the USA. The two large manufacturers, Claas and Krone, dominate the market in this product group. Claas is the outright market leader, but Krone does not lag it in the range of types and models. Another major manufacturer is CNH Agriculture, which markets several models under both of its brand names, New Holland and Case IH. John Deere recently added large square balers to its product range and is rapidly developing new models. Previously, it sold large square balers made by Krone.

Massey Ferguson has been marketing these products for some time and has recently been joined by Fendt, another AGCO brand. Kuhn also holds a 5% market share. Among the other manufacturers are Deutz-Fahr and several Italian companies, including Supertino and Cicoria. See Figure 2.

Square balers are also tractor-trailed. Depending on size, balers may have single-axle suspension or twin or tandem axle braked suspension, with balloon tyres.
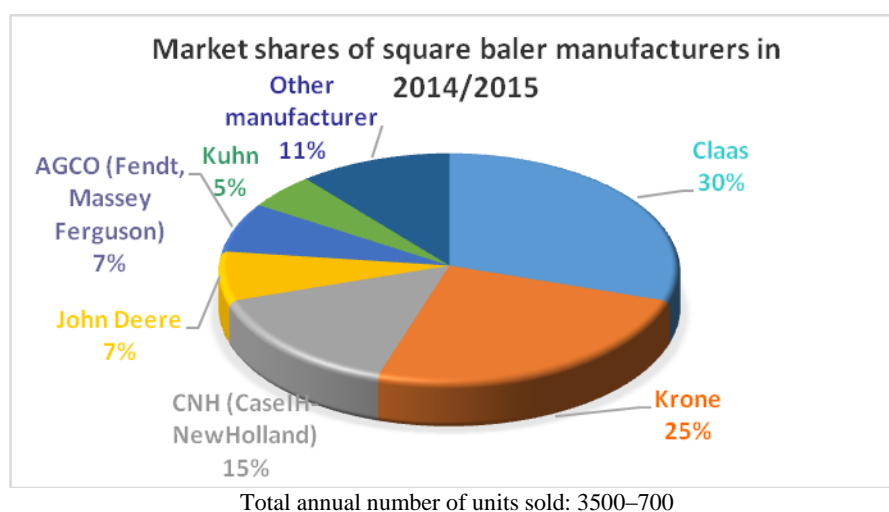

Total annual number of units sold: 3500–700

Figure 2. Market shares of square baler manufacturers

Sprayers are made by more than 80 companies worldwide. They are made in a wide range of constructions (suspended, liftmounted, trailed and self-propelled) and sizes.

In Europe, some 55 manufactures make sprayers (field flat and axial fan, directed nozzle, tunnel, etc.). Most of them make trailed sprayers with single and double axle suspension, with tanks ranging in size from 1000 to 12,000 litres.
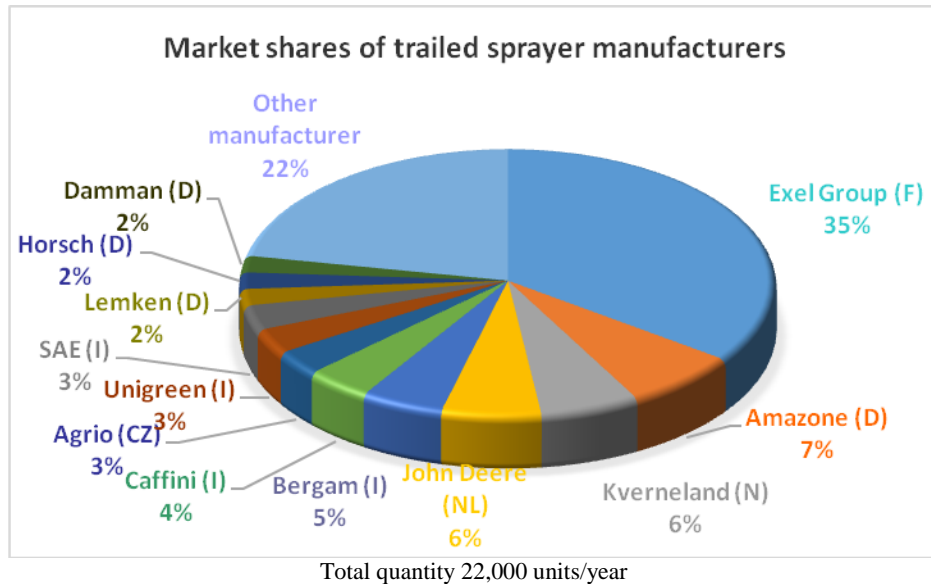
Total quantity 22,000 units/year

Figure 3. Market shares of trailed sprayer manufacturers
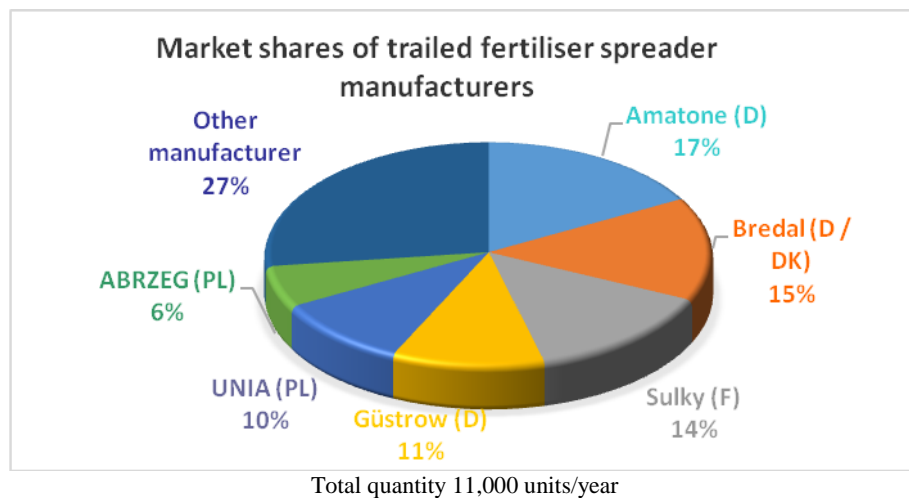

Total quantity 11,000 units/year

Figure 4. Market shares of trailed fertilizer spreader manufacturers

Trailed and self-propelled sprayers are dominant in agriculture outside Europe (North and South America, Australia, etc.). About 22,000 trailed field and plantation sprayers are sold each year. The most widespread among European small farms are tractor-mounted sprayers of small capacities (between 400 and 1500 litres). The features of trailed sprayers are of benefit primarily to large and commercial farms and agricultural contractors. The largest worldwide manufacturer of trailed sprayers is the French Exel Group, which owns two previously independent brands, one of which –

Hardi – is the clear market leader. Other large manufacturers are Amazone, the Kubota/Kverneland Group, John Deere, the Bargam Group, Caffini, Agrio, the plantation sprayer companies SAE and Unigreen, and more recently Horsch and Lemken. Damman is strong in self-propelled sprayers, but also has a presence with trailed sprayers. See Figure 3.

Fertiliser spreaders are also made in various constructions. Most widespread in Europe are tractor-mounted spinning disc types with tank capacities of between 400 and 3000 litres. Trailed spreaders, with tank capacities of between 3500 and 10,000 litres, are used mainly on large farms and are made in much smaller quantities. In large farms outside Europe, particularly in Australia, trailed fertiliser spreaders are in the majority. About 11,000 of them are sold worldwide each year. Most typically, they have a tank of between 5000 and 8000 litres capacity and single-axle braked suspension. Those with larger fertiliser tanks have braked twin or tandem axles. In Europe, Amazone of Germany is the largest manufacturer, producing trailed single-axle fertiliser spreaders of capacities between 5500 and 8200 litres. Other large manufacturers are Bredal, Güstrow and the French company Sulky, although the two Polish manufacturers UNIA and Abrzeg also have good positions on European markets. See Figure 4.

Global and regional agriculture machinery market trends.

There are cyclical variations in agricultural machinery manufacture. This means that the numbers of units of trailed agricultural vehicles increases in some periods and decreases in others. Agriculture is subsidised in every country of Europe. The cycles are to some extent due to the unequal effects of subsidies, but also to the periodic overproduction, cutbacks and increased demand that arise from the laws of the market.

Overall, the market in agricultural machinery contracted by 9% worldwide in 2015, as shown on Figure 5. The 91 billion-euro turnover exactly matches that of 2011. The recession is clearly perceptible.
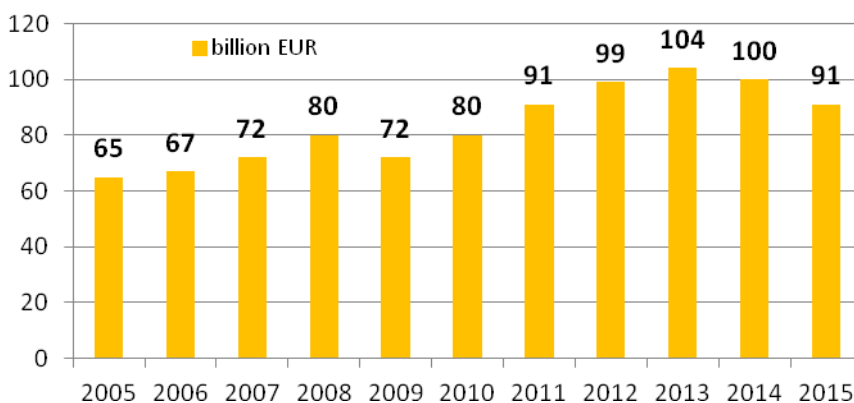

Figure 5. World agricultural machinery turnover between 2005 and 2015. [6]

There has been a steady contraction in the EU agricultural machinery market over the last two or three years. This is clear from Figure 6. In 2015, there was a decrease of 8%: the total value of agricultural machinery sales was 23.8 billion euros that year,

compared with 26 billion in 2014. The peak was in the post-recession years of 2012 and 2013, when the EU agricultural machinery market swelled to 26.6 and 26.7 billion euros respectively. The figure for 2015 was the lowest for the EU in the period following the economic crisis of 2009–2010.
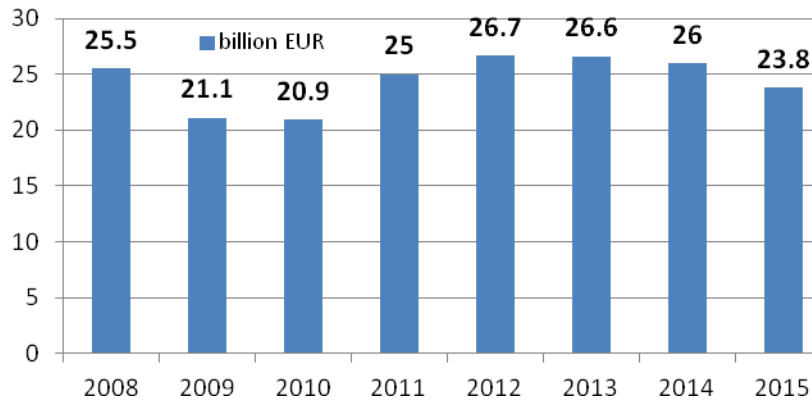

Figure 6. Agricultural machinery turnover in EU countries between 2008 and 2015. [6]
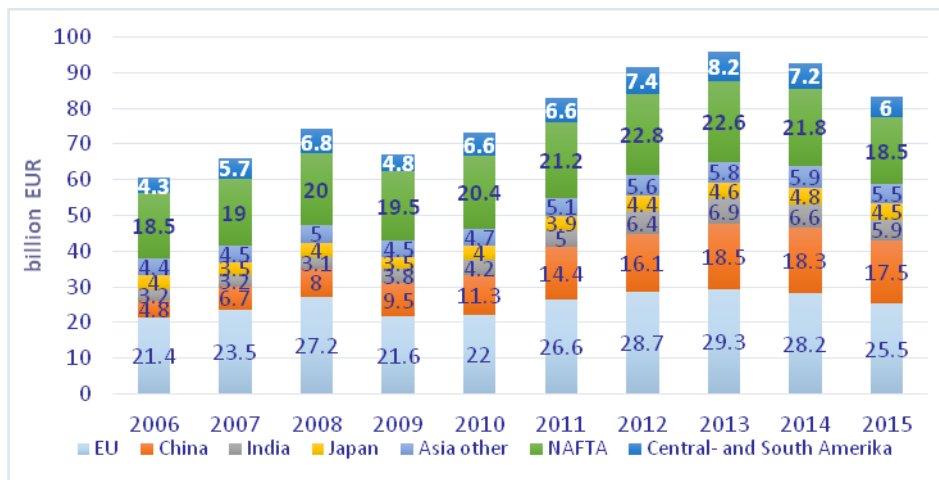

Figure 7. Agricultural machinery manufacturing volume worldwide in billion euros. [5]

A good illustration of global trends in the agricultural machinery market is world agricultural machinery production, shown in Figure 7. Following the crisis of 2009, output grew steeply every year until 2013; it then faltered and entered a decreasing trend. There was stagnation until 2014, but preliminary figures show a major downturn in 2015.

This global trend appears with some phase lag in countries such as Japan and the Asian countries (not including India and China). There, machinery manufacturing reached its peak in 2014 and started to go down only in 2015. Low world price levels are

currently being forecast for agricultural commodities, and it can only be hoped that the machinery manufacturing output and the agricultural machinery market, now sunk to 2011 levels, will now stabilize.

CONCLUSIONS

The purpose of our analysis was to determine the European market shares of towed agricultural machinery.

Of the product groups under examination, those with the highest levels of sales in terms of number of units were round balers, trailed sprayers and fertilizer spreaders. There is also a substantial market in large square balers, but rather than the number of units, it is the value of machines sold that is significant.

The market for agricultural trailers and machinery built on trailer superstructures is highly diverse and complex, posing serious difficulties for evaluation and statistical analysis of the data and for determination of actual sales figures. [10]

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PREGLED DISTRIBUCIJE EVROPSKOG TRŽIŠTA VUČENIH BALERA, PRSKALICA I RASIPAČA ĐUBRIVA

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Sažetak: Vučene mašine i prikolice sa različitim tipovima suspenzija imaju veliki udeo u proizvodnji i prodaji poljoprivrednih mašina u Evropi. Ova vučena vozila pokrivaju široki funkcionalni opseg: poljoprivredne prikolice, prikolice cisterne, vučeni rasipači mineralnih đubriva i stajnjaka, prskalice i mikser prikolice za stočnu hranu. Takođe imaju mnogo različitih vrsta suspenzija: tandem, tridem, opružna, kruta, upravljana itd. Od ispitanih grupa proizvoda, oni sa najvišim nivoom prodaje po broju prodatih jedinica su rol baleri, vučene prskalice i rasipači đubriva Postoji i značajno tržište velikih balera, ali ne po broju nego po vrednosti prodatih mašina.

Ključne reči: poljoprivredne mašine, vučene mašine, prikolica, suspenzija, tržišno učešće