

PhD Thesis

**THE QUALITY AND FEED SAFETY QUESTIONS OF GRAINS
FROM FIELD TO FEED PRODUCTION**

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INTRODUCTION AND OBJECTIVES OF THE DISSERTATION

The growth of global population increases the demand for animal products, and for feed grain too. While agriculture and the industry compete for natural resources, the increasing quality requirements of customers and the stricter legal obligations present challenge for food production (*Horn, 2013; Popp, 2013*). The several micro, small, and medium sized enterprises operating in the agri-food sector of the European Union are in a difficult position due to their low technological level. They need to adapt their strategies, focusing on innovation in order to meet consumer requirements and to compete on the market. The place of innovation is more and more the network the company is embedded in (*Hightech Europe, 2013*).

Grain crops are used in large quantities as feed materials. Their quality – from the field to the place of feed production – is influenced by biological, environmental, agricultural technological factors, as well as by the different processes and competences of the grain farmers. According to *Győri et al. (2006)* in Hungary the principle of „From Field to Fork” is valid only from the compound feed production to the table of the customer. The risk assessments of primary agricultural products and the quality assessment system are not elaborated, the transport and storage are the weakest areas from quality assurance point of view.

With the decrease of the livestock in Hungary, the market of feed grains had shrunk as well. While the quality of feed gets emphasized and HACCP is introduced into agricultural cultivation, the hungarian grains are not competitive in the export markets due to the lack of homogeneous batches and high transport costs. The income of grain farmers depends on the crop quantity, even if they should produce the wheat on the same quality standards as the best ones on the marketplace (*Vancsura, 2015*).

As my professional experience increased, it has been recognised that operations of companies in the feed grain supply chains may occur in various combinations (crop production, grain storage and trading, feed manufacturing for sale or for own animal stock) and quality assurance practices are also diverse. The differences have not been examined yet. My questions were related to the fulfilment of quality requirements of grains, the effectiveness of quality assurance systems, and the quality improvement in the supply chain. Consultations with my supervisor, industry professionals, authorities and researchers helped to integrate further aspects into the examination.

The objective of my empiric research was to assess control processes connected with grain quality and feed safety in the supply chains from the field to the entry point of feed production. Particularly I reckoned with the definition of quality requirements and supplier performance assessment. I intend to analyse how the quality attributes and feed safety hazards of grains are controlled and monitored by the companies in the hungarian feed sector. Ideally, my research could contribute to define directions for developing more efficient supply chains based on continuous improvement.

Hypotheses:

1. The feed producers assess at best the operations of grain warehouses in the grain supply chain, the assessments of processes at grain farmers or hauliers is not typical.
2. The risk assessments of feed safety hazards of grains is not holistic at the enterprises, the relation of risk assessments to the definition of quality requirements, inbound quality control and supplier evaluations is not systematic.
3. Most companies at the purchase of feed grains follow the quality criteria in the relevant Hungarian Standards of grains, information about other quality requirements of feed companies do not get passed back to plant production.
4. The inbound quality control of feed grains and the related processes are different at grain warehouses and at feed manufacturers.
5. The feed-back mechanisms of inbound quality control results and supplier assessment have not developed to reach the raw material purchase and product formulation functions.

RESEARCH METHODOLOGY

Literature research

As a secondary research I sought to review a wide section of the hungarian and international (in english) literature to approach the subject from a number of aspects (eg. economical, technological, legal, quality management). The findings are presented in the dissertation grouped around the following topics:

- characteristics of hungarian grain and compound feed production
- general and specific technicalities of quality and food safety
- feed product development
- quality attributes and food safety hazards of grains
- quality control of products and supplier processes
- oportunites related to quality as competitive advantage.

The examined populations

I intended to examine the hypotheses on representative samples of the hungarian companies who operate in the local grain supply chains of feed production, focusing on supplier quality assurance practices and control systems analysed from the side of buyers as well as from the side of suppliers. More populations had been defined:

- on the one hand the compound feed manufacturers as buyers,
- on the other hand their suppliers, the companies dealing with storage and trading of grains.

Planning data collection methods of the research

Two thematic questionnaires have been created with Google Forms application to collect the data connected to the cause and effect relations of the hypotheses:

1. for compound feed producers: a questionnaire containing 49 questions
2. for grain warehouses and traders: a questionnaire containing 40 questions

Before distribution the questionnaires had been checked by two feed companies and the representatives of the hungarian trade associations. Based on their suggestions the questionnaires had been modified before the formal survey started.

Sampling and characteristics of the samples

Compound feed manufacturers: for the sampling the list of registered and approved feed producing establishments had been used that is maintained by National Food Chain Safety Office (NÉBIH). The list was filtered for firms coded with C (compound feed production for distribution) or D (compound feed production for own use) in order to find those companies that use grains in large quantities. As the references in secondary research indicated that the hungarian feed sector was concentrated, I tried finding those organisations that contribute significantly to the hungarian compound feed production. I sought further information about the firms (products, volumes, net sales revenues) through the homepages and the Company Information and Electronic Company Registration Service of the Ministry of Justice. However, to better classify the size of the organisations (micro-, small, medium, large enterprises) the data about the number of employees were to be collected in the surveys.

In October 2015 I phoned 42 compound feed companies representing 51% of those 82 feed manufacturers that the Hungarian Central Statistical Office (KSH) registered with more than 10 employees. I have explained the purpose and main questions of the research for the manager in charge for quality at each company and agreed if they support the study by completing the form. The questionnaires were sent in a day after the calls directly to the e-mail address of the responsible and informed managers.

37 companies submitted answers (high, 88% response rate), all together producing approximately 1,5 million tons of compound feed. That is roughly 54% of the annual domestic feed production of 2,8 million tons (KSH, 2013). The distribution of companies by number of employees is 3% (1) micro, 32% (12) small, 51% (19) medium, and 14% (5) large enterprises. The companies can be sorted into 4 groups based on their operations in the stages of the supply chain (Figure 1):

- Group A (12 companies, 32% of the sample): specialist compound feed manufacturers without plant cultivation or livestock, whole amount of grain demand is purchased, products are made for distribution in the market. This group has the highest portion of international companies (41%) and firms with production over 30 000 tons per annum (58%).
- Group B (10 companies, 27% of the sample): feed manufacturers without own grain production, but products are partly or entirely fed to own livestock. 50% of the group is made of firms over 30 000 tons per annum production volume, however the proportion of international companies is only 20%.

- Group C (1 company, 2,7% of the sample): the only one company in this group has own grain farming, but without livestock its products are entirely sold on the market. (The results are not representative due to low number of data).
- Group D (14 companies, 38% of the sample): companies active in three stages of the supply chain (grain farming, compound feed production, raising livestock). All of them are hungarian companies, their products are partly or entirely feed for own livestock. 43% of them covers almost all of the grain demand from own production.

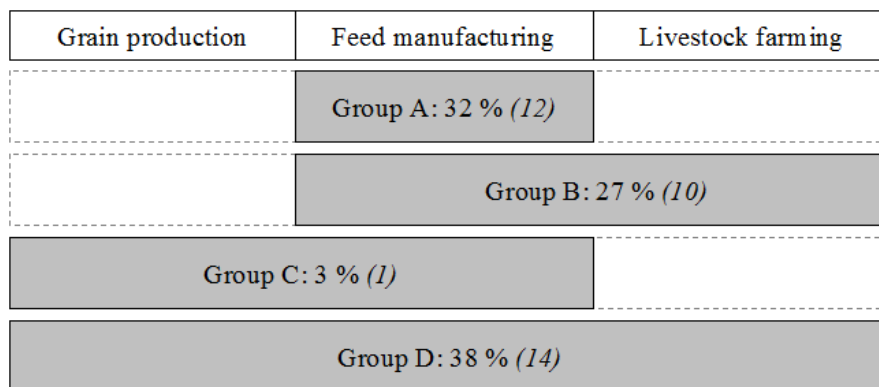


Figure 1. Groups of compound feed companies according to their operations
(Source: own edition)

Grain warehouses and traders: the sampling had been supported by two trade associations in Hungary between November 2015 and January 2016:

- With the help of the Association of Hungarian Grain Processors Manufacturers and Traders the questionnaire had been sent to 83 companies, and was completed by 15 of them (18% response rate). Three firms had only commercial activities without physical storage, therefore only 12 grain warehousing organisations' took part in the research from this source.
- The questionnaire for grain warehouses was e-mailed to approximately 2000 members of the hungarian Grain Producer's Association (GOSZ). 77 responses were valid (4% response rate), but actually only 36 of them stored grains.

All together the sample consisted of 48 respondents with grain warehouses, they store annually 1,3 million tons of grains. This is roughly 9.4% of the total 14 million tons of hungarian grain production in 2015. The distribution of respondents according to the number of employees is 6% (3) self-employed, 23% (11) micro, 63% (30) small and medium sized, 8% (4) large enterprises. The companies can be sorted in 3 groups based on their operations in the stages of the supply chain (Figure 2):

Grain production	Grain Storage / Trading	Feed / Livestock
Group I: 50% (24)		
Group II: 27% (13)		
	Group III: 23% (11)	

Figure 2. Groups of grain storage companies according to their operations
(Source: own edition)

- Group I. (24 companies, 50% of the sample): companies that deal with grain farming as well as grain warehousing, selling the whole stock on the market. 78% of them store less than 10 000 tons of grain per annum.
- Group II. (13 companies, 27% of the sample): companies that have own grain production and livestock also. Grains are partly used for feeding own animals, partly sold on the market.
- Group III. (11 companies, 23% of the sample): companies that do not produce but buy, store and sell grains. They do not have own livestock. The proportion of firms storing more than 30 000 tons of grains annually is 64%.

Through GOSZ I could get to know the opinion of 41 farmers without warehousing operation. Even though they were not strictly in the scope of the study, and considering that the respondents are not likely to represent the whole population of hungarian grain farmers, I share these results too in my dissertation.

Data processing

The answers from Google Forms had been converted into Microsoft Excel format for data analysis. After checking and coding the data Pivot tables were used to review the figures, and a database was created for Statgraphics Centurion XVII software to carry out crosstabulation and χ^2 analysis. To create diagrams as visual presentation of the results I used the graphical solutions of Microsoft Excel.

RESULTS AND CONCLUSIONS

The groups set up in accordance with the level of vertical integration had been more often in connection with elements of supplier quality assurance than it was expected. The processes and quality systems of feed manufacturers in Group A turned out to be on the highest level from many aspects. All of these organisations make products for market distribution, therefore they aim to satisfy the customers' requirements as good as possible – also through quality assurance processes. Typically they manufacture large quantities of feed, half of the companies are local production sites of international groups, transferring the know-how of the mother-company into their operation. Characteristically they have an assigned quality manager in charge, who maintains the quality and feed safety system applying his professional competencies in order to fully satisfy customers expectations. The implementation, the maintenance of the quality system, getting the certifications, the salaries of professional employees, the prices of laboratory analysis represent significant costs for the enterprises, that the larger companies could cover from their profit, particularly if their competitiveness also increases at the same time.

On the contrary, the mainly hungarian feed firms dealing with own grain production and livestock (Group D) lag behind regarding quality assurance. They cover the grain demand of feed production from own farming or with grains bought from farmers according to the Hungarian Standards. Besides not always being able to finance costs of quality assurance, the feed production for own livestock also does not stimulate the improvements of company processes, the pressure of market competition is smaller. Moreover, these organisations as buyers are not stimulating the development of their suppliers either. They are less able to cover the costs related to the operation of the quality management system.

The picture was similarly heterogenous in case of grain trading companies. The smaller grain warehouses that also produce grain by themselves, storing a few thousand tons (Group I) from quality assurance point of view lag behind those companies in Group III that often trade with many ten or hundred thousand tons of grains. The traders in Group III maintain certified quality and food safety management systems, particularly to satisfy customer requirements. They aim to increase their competitiveness through meeting customer expectations, however developing their supplier base (grain farmers and smaller traders) is less in their focus.

Analysis of hypotheses

Hypothesis 1: The feed producers assess at best the operations of grain warehouses in the grain supply chain, the assessments of processes at grain farmers or hauliers is not typical.

The assessment of suppliers is the requirement of many quality management system standards. In case of feed companies and grain warehouses too, there is a relationship between if the company had certified quality system and evaluated supplier grain warehouses. 73% of feed manufacturers, and 88% of those firms that produce more than 30 001 tons per annum have their quality management system certified against at least one standard. This proportion is much lower at grain warehouses (31%). Certifications occur mainly at warehouses storing more than 70 000 tons annually, and in Group III.

Having a certified quality management system gives a competitive advantage, however its implementation, operation and obtaining the certification cost a significant amount. Larger companies may invest sooner in certified quality management system, especially if customers require or specify having it. For a quality management system meeting the criteria of the quality standards, the necessary competencies are provided by the quality manager of the company, whose assignment demonstrates the management commitment for quality to the customers.

The assessments of grain warehouses are carried out by 56% of feed companies (Figure 3) and 34% of grain traders, typically annually. Often, the costs of control and assessment are negligible compared to the value of grain or to the risk of loss due to inappropriate storage. The warehouses were assessed by all international companies of the sample, and by all of those firms that produce over 70 000 tons per year, and two thirds of the companies that possess at least one type of the quality certifications. However, the assessment itself is considered fully appropriate to prevent quality problems by only 20% and rather appropriate by 36% of the companies. The most common aspects of assessment are the warehousing conditions, the quality of the grain, and the timeliness of delivery.

Supplier grain warehouses are audited mainly by those grain traders that store more than 30 000 tons annually and the organisations of Group III. Almost half of the grain warehouses are audited by buyers and certification bodies yearly. Internal audits take

place also every year at two thirds of the companies. Characteristically the companies of Group I had never been audited yet and their internal audits are also not regular.

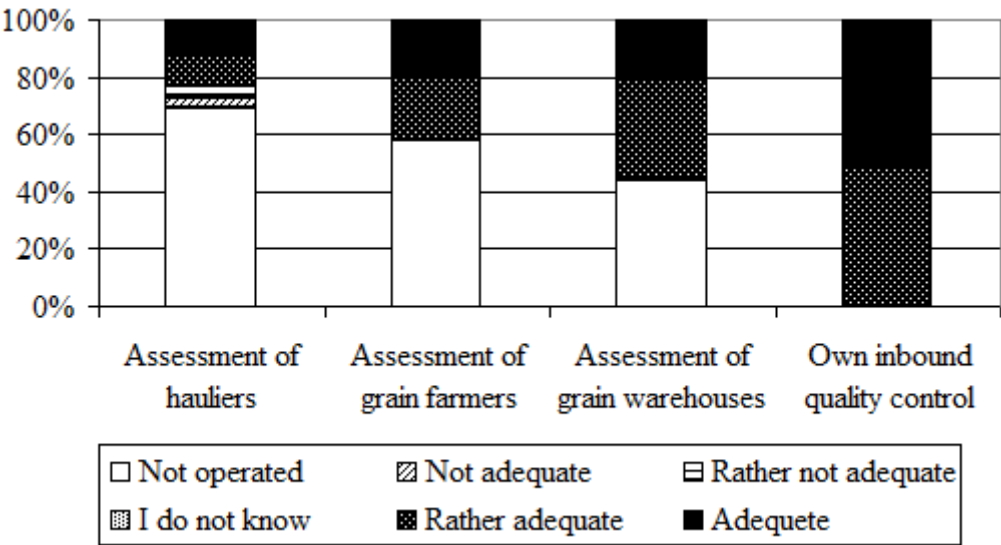


Figure 3. Views of managers on effectiveness of supplier quality assurance elements to prevent quality problems from the supply chain (Source: own edition)

Assessments of grain farmers are not happening at 58% of feed companies and grain traders, mainly because of the large number and frequent change of farmers. The 56-68% of cereal producing companies stated that their processes have never been audited. The international compound feed firms and the ones above 30 000 tons production per year typically assess the farmers too, most frequently based on the quality of the grain, however other aspects are less important (eg. timeliness of delivery, or right documentation). The companies considered the evaluation rather adequate in higher proportion than fully adequate to prevent quality issues. Among from grain traders particularly those assess the farmers that store more than 30 000 tons of grain and belong to Group III.

Evaluation of hauliers did not happen at 69% of feed companies, and only 30% of them gives out transport instructions including quality and hygiene requirements. Most frequently those firms assess the hauliers that possess at least one type of quality certifications, taking into account mainly the timeliness of deliveries, and cleanliness of the trucks. 27% of grain warehouses and traders also assess the hauliers, mainly those that store grains over 30 000 tons quantity, and those that belong to Group III.

Feed manufacturers consider inbound quality control of each delivery more adequate than supplier assessments to prevent quality issues from the supply chain. The

full, 100% control is applied when the capability of supplier process is not adequate or when the non conforming product of the supplier would cause serious consequences (Kemény et al., 2001). The participants of the supply chain reduce the risks by the examinations of grains at inbound quality control.

Based on the results above the hypothesis has been accepted.

Hypothesis 2: The risk assessments of feed safety hazards of grains is not holistic at the enterprises, the relation of risk assessments to the definition of quality requirements, inbound quality control and supplier evaluations is not systematic.

Documented risk assessment of feed safety hazards related to grains are available at 59% of feed manufacturers, and 56% of grain warehouses, however it is missing from 41% and 44% respectively. The availability of risk assessments are more common at those feed companies that employ an assigned quality manager, at grain traders that maintain a certified quality management system, and at ones storing more than 30 001 tons per year. More than half of the respondents mentioned that the reason why the risk assessments were missing was that risk assessments were not required internally or externally, so their customers did not request either that the processes would be adjusted to the risks.

The update of risk assessments is done usually at the harvest of the new crop. The most often analysed hazards (aflatoxins, DON, high moisture content of the crop, admixture) in the risk assessments have been mentioned in similar proportions by the feed companies and grain warehouses. The fact that aflatoxins and DON are the most often assessed hazards indicates that a big part of those companies evaluate these risks as well that apply the relevant Hungarian Standards of grains. By feed manufacturers the risks associated with living pests, by grain traders the risks associated with broken, sprouting grains are evaluated more often in their risk assessments. The effect of variable raw protein content of grains is examined in risk assessments by one third of feed companies (particularly the ones that produce feed for own livestock), and by 60% of grain traders. The protein content is related to the quality grading of wheat either for milling or for animal feed. The risks of other mycotoxins apart from aflatoxins and DON toxin as well as other possible contaminants (eg. heavy metals, residues of pesticides) are more often assessed by feed manufacturers than grain warehouses.

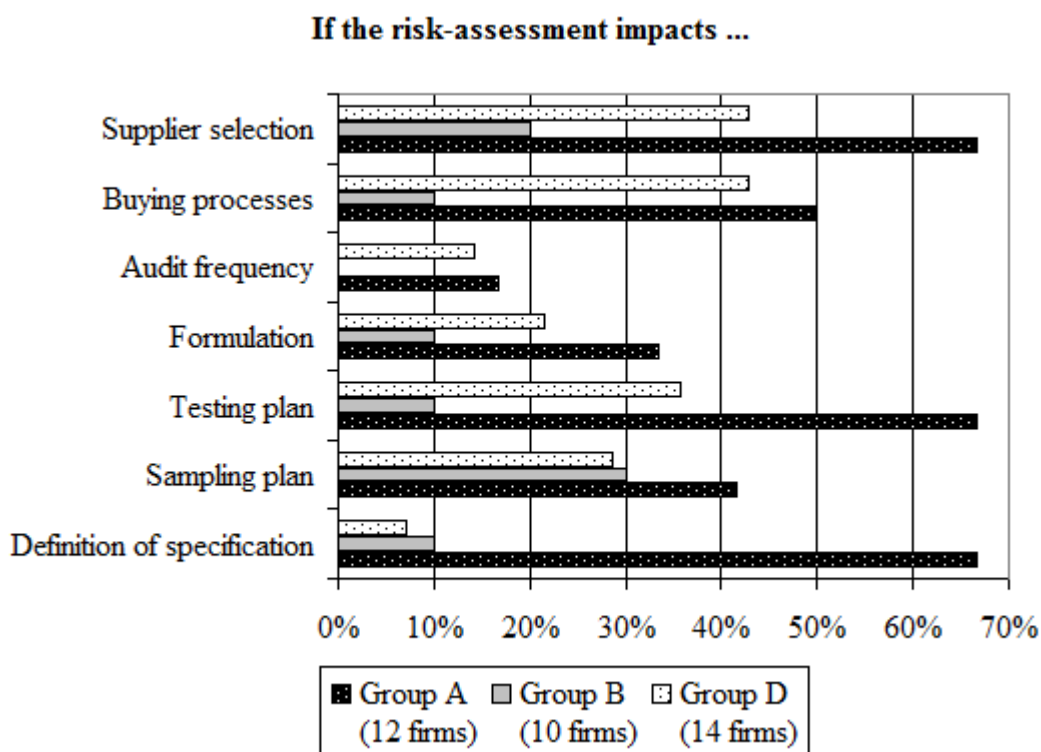


Figure 4. Incidences of relationships between risk assessment and processes at groups of feed manufacturers¹ (Source: own edition)

The outcome of risk assessment impacts company processes differently. The feed producers adjust the supplier selection, the buying process and the inbound sampling and testing plan to the actual risk level. The grain warehouses and traders principally modify the content of buying specifications, the sales channels and the frequency of stock control according to the actual risks.

Using the result of risk assessment for reviewing buying specifications happens more often at those feed firms that produce also for distribution, and that have assigned quality manager. Two thirds of Group A take into consideration the outcome of risk assessment to define the quality requirements in the buying specification. In Group B and D the outcome of the risk assessment do not imply the review of buying criteria as these organisations prefer using the relevant Hungarian Standards for buying the crops, beyond that they may specify extra requirements in contracts (Figure 4).

Three quarters of grain traders in Group I and II, and half of Group III regard risk assessments as a difficult task. This might bear a relation to that the large

¹ The only one company of Group C did not answer the question

companies in Group III with certified quality management systems are likely to know better the method of risk assessment. Although the proportion of using the results of risk assessment for supplier selection (38%) and audits (25%) in Group III is still lower compared to feed producers, but it is still higher than in other groups of grain traders.

However, it must be mentioned that the small companies of Group I store the crop from own or nearby farmers' production, therefore these activities are rare.

Based on the results above the hypothesis has been accepted.

Hypothesis 3: Most companies at the purchase of feed grains follow the quality criteria in the relevant Hungarian Standards of cereals, information about other quality requirements of feed companies do not get passed back to plant production.

The most of feed manufacturers and grain warehouses, traders (49% és 51%) define quality requirements of grains by referring to the relevant Hungarian Standards. Only one third of feed companies, and one tenth of grain traders give out own specification for buying the grains. 20% of feed companies, 9% of grain warehouses do not or only verbally define the quality requirements for suppliers and 30% of grain traders purchase and assess the quality of grains based on their customers' specifications. (Figure 5).

The application of Hungarian Standards of cereals has been explained with their „generally accepted” status by 78% of feed companies, and 33% of grain traders. Conversely, 58% of grain warehouses use the Hungarian Standards of grains because those „satisfy the needs of the customers and their own”, so the expectations of customers are also not higher than the criteria in the Standards. Most of the organisations do not miss any further parameter from the Standards, that are regarded as „common ground” by the participants in the supply chain, which was the purpose of the Standards anyway. Only one third of feed producers request the supplier certificate about mycotoxin content, and a tenth of them about the use of pesticides.

The organisations giving out own specifications decided to do so because they can shape the requirements according to their own, and – in case of warehouses – according to their customers needs.

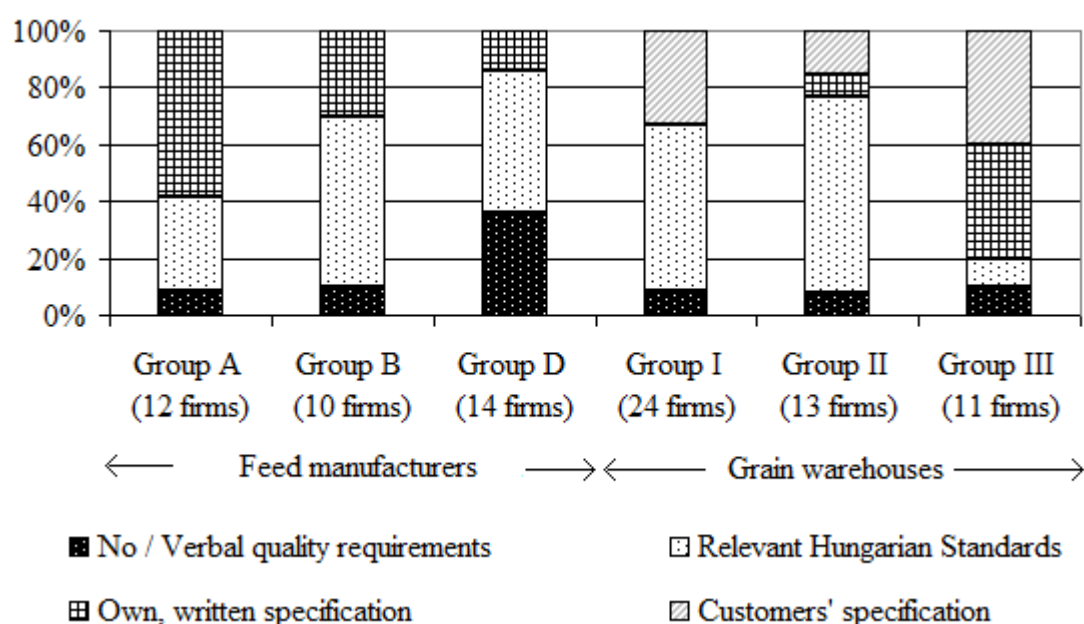


Figure 5. Definition methods of quality requirements in the groups ²

(Source: own edition)

The proportion of using own specification increases together with the size of the companies, and the proportion of using the Hungarian Standards decreases. The 75% of small sized feed companies, and almost half of the medium sized companies apply the Hungarian Standards. All of the large companies use own specifications, and quarter of small and medium sized enterprises too. The data has shown that most of the international feed companies and the ones distributing their products buy the grains according to own specifications. The most of the hungarian companies and the ones that make feed only for own livestock henceforward apply the Hungarian Standards (Group B and D). The traders that also produce grains (Group I and II) rather use the Hungarian Standards, while 40% of Group III has own buying specifications for grains and an other 40% of them follow customers' specifications.

A relationship exists between large feed companies purchasing grains from traders and the use of own specification. This can be explained with that the trading warehouses handling large stock can deliver more flexibly and reliably against the particular quality criteria of larger feed companies.

² Group C is missing due to low number of data (1 company)

Two thirds of grain warehouses become aware of the quality requirements of the market from the customers, a quarter of them from trade associations, 14% from the media. Only two thirds of them (mainly the small firms in Group I and II producing and storing the grains) and 61% of the grain farmers are satisfied with the information. 44% of companies in Group III also regarded the information sufficient. Typically those firms found the information adequate, that follow the Hungarian Standards, however those working to satisfy customers' specification found in greater proportion the available information insufficient.

75% of companies reviews the quality requirements related to grains with the new crop at harvest, and 50% of them also do so when the results of inbound quality control or the experience of colleagues indicate risks. The product development gets involved in the creation of raw material specifications only at 20% of the companies, highlighting the slight significance of quality planning in grain purchases.

Based on the results above the hypothesis has been accepted.

Hypothesis 4: The inbound quality control of feed grains and the related processes are different at grain warehouses and at feed manufacturers.

The inbound quality control of cereals are carried out at most of the companies by own quality controller. The moisture content, the admixture and the presence of living pests in bulk grains are checked most frequently (in each delivery) at the arrival. This can be explained with ease of the examinations (simple, cheap, fast) and the potentially high feed safety risk of non-conformities. DON toxin is checked by 85%, aflatoxins by 77% of of the feed companies in every batch or many times a year. These proportions are lower at the grain warehouses, 46 and 50%. The control of other mycotoxins (eg. Zearalenon, T-2, HT-2) in each batch or many times a year takes place at 65-75% of the feed companies, and at only 25-35% of grain traders. There is a difference between the feed manufacturers and the grain traders in case of the analysis of contaminants too, even though the tests are less frequent: pesticide residues are not analysed by 42% of feed producers and 57% of warehouses, heavy metals by 43% and 65%, GMO contaminations by 56% and 63%, the microbiological status is not tested by 25% and 70%. The reason why companies tend to neglect the analysis might be the high cost associated with these analysis.

Approximately three quarters of companies have laboratory to carry out at least the quick tests on grains samples. Having a laboratory showed relationship to higher production or trading volumes. Using accredited laboratories is also common, often as control tests to validate own analysis. Laboratory of some firms is also accredited.

A quarter of companies do not request any supplier certificate. However, at the same time, 41% of feed manufacturers ask for supplier certificate about non-GMO status, 33% about nutritional parameters, 30% about pesticide residues, 26% about mycotoxin contamination, 11% about heavy metal and microbiological status, 7% about PCB, PAH and dioxins, or 22% about conformance according to Hungarian Standards. 63% of grain traders asks for supplier certificate about the conformance of the crop, 52% about quality analysis certificates, 33% about treatments on the crop. Three quarters of companies in Group II and III request these documents from their suppliers.

The most often occurring quality problems discovered at inbound quality control of grains are the admixture (according to 52% of feed firms and 38% of trading companies), the high moisture content (41% and 38%), mycotoxin contamination (41% and 35%), living pests (41 and 18%), or *Fusarium*-infestation (21% and 18%).

The classical elements of inbound quality control process (e.g. available, documented sampling and testing plans, intake or rejection criterias) are considered by 79% and 68% of feed producers, and 57% and 50% of traders as fully adequate in their operations. 60% of feed companies and 46% of grain warehouses said that the intake or rejection decision was typically made by trained quality controller.

At least once a year 68% of feed firms and only 27% grain traders analyse the quality issues and the root causes typically. 38% of feed manufacturers and only 17% of warehouses also typically involve the suppliers into the solution of quality problems.

Based on the results above the hypothesis has been accepted.

Hypothesis 5: The feed-back mechanisms of inbound quality control results and supplier assessment have not developed to reach the raw material purchase and product formulation functions.

Elements of supplier quality assurance (inbound quality control, supplier audits) generate significant amount of data, that the companies and their suppliers could use to improve their processes and supplier – buyer relationships. For data analysis it is

practical to collect data electronically, in standardized format, that at 35% of feed manufacturers and at 64% of grain warehouses is realized not always or not to the full extent. Based on the results of secondary research, in the future the more integrated information systems are expected to spread. Nevertheless, even in case of integrated systems the lack of full data availability would cause issues and extra costs (more expensive recipes, variable product quality). Therefore informatical and organisational developments will be needed at these participants of the supply chain to draw up with the international best practices.

The data from inbound quality control is used only by less than a third of feed producers, mainly by those that buying the grains from suppliers, maintain a certified quality system, produce large quantity of compound feed for distribution. In group A 58% of organisations analyse the data statistically, so their processes are built more often on actual data than at firms in other groups.

51% of feed companies use the inbound quality control data to validate the fulfilment of purchase quality requirements, typically those firms where an assigned quality manager or other manager is responsible for quality, or firms that make products for distribution. Two thirds of Group A, half of Group B, and only third of Group D validate the fulfilment of of purchase quality requirements based on inbound quality control data. 57% of feed manufacturers use the data to review the sampling and testing plan, and only 43% of them to review risk assessments (Table 1).

Table 1. Frequency of using inbound quality control data in various business processes
(Source: own edition)

Business processes	Rate
Statistical analysis of data	27%
Supplier performance assessment	35%
Review of risk assessments	43%
Developing new recipes	49%
Verification of fulfilment of purchase requirements	51%
Review of sampling and testing plan	57%
Price negotiations	62%
Updating nutritional data for formulation	65%
Checking recipe conformity	73%

Nearly two thirds of feed firms refer to inbound quality analysis results at price negotiations, however only third of them (all produce feed for dsitribution) take the data into account for supplier performance assessment making an effort to establish

partnerships and qualified supplier base. The latter case is twice more frequent among international companies than among their hungarian counterparts. Almost three quarters of feed producing organisations take advantage of quality control results to check the conformity of recipes, two thirds of them to re-optimize recipes, and approximately half of them also to develop new formulas.

A hypothesis was not accepted because at a large proportion of feed companies there are feedback mechanisms to recipe formulation as well as to raw material buying, however in case of the latter one the results of quality examinations are mainly used in price negotiations. The full availability and statistical analysis of data to improve the supplier base is working only at a small part of organisations.

NEW SCIENTIFIC RESULTS

1. The supplier quality assurance processes of the groups set up according to their level of vertical integration are different. Compared to the specialist (often international) compound feed firms distributing products on the market, the supplier quality assurance processes of hungarian feed companies (producing grain and owning animal stock) drop behind. Similarly, compared to the big warehousing-trading companies, the quality assurance systems of smaller grain warehouses with own grain farming need development. The companies making products for the market in large quantities invest in the necessary resources and competencies for the operation of the quality management system in order to better fulfil customer requirements and leverage on competitiveness. If the feed produced by the company is used only for the own livestock, that does not urge the improvement of own or supplier processes, the impact of market competition is more moderate. Mainly those larger companies assess their suppliers that have their quality management system certified against one of the recognised quality standards: the assessment of warehouse operations is more common, the assessments of the crop production or the transport are rare.
2. From among the feed safety hazards the companies most often assess the risks of aflatoxins, DON, high moisture content of the grain, and purity or admixture. The feed companies assess the risks of living pests, contaminants more often than grain warehouses, that tend to assess rather the risks of damaged grains, at harvest characteristically. Based on the risks, the feed manufacturers adjust their supplier selection and purchasing process, the inbound sampling and testing plan, while the grain warehouses mostly alter the storage control regime, the purchasing specification and the sales channels.
3. As a buyer, only the one third of feed companies and one tenth of grain traders define in own specifications their quality requirements for grains, most of the organisations apply the relevant Hungarian Standards of cereal grains. As a seller, only those grain warehouses consider the available information about quality as sufficient, that have own grain farming operation, and follow the relevant Hungarian Standards. However, the available market information about quality is considered to

be insufficient by most of those specialist grain traders, that follow their customers' specifications. To prevent the quality problems of grain supply the companies consider the inbound quality control (often of each delivery) the most adequate. The buyers control the most frequently those attributes of cereals (moisture content, presence of living pests, purity) that can be analysed easily, fast and at low cost. A greater proportion of compound feed companies than the grain traders requests the expensive tests of mycotoxins and other contaminants. At auditing grain warehouses, the feed companies find issues the most often with pest control, conditions of the premises, batch identification and separated storage. On the contrary, the trading companies consider the risk assessment, the implementation of HACCP, the traceability and batch identification as the most difficult criteria to meet.

4. The data of inbound control examinations are collected in electronic format and used for checking recipe conformance, and for price negotiations by two thirds of feed companies. However, only one third of them use the data for supplier selection. The collection of inbound control data in electronic databases happens only at one third of grain traders. By the establishment of the right information-technological solutions and the harmonisation of quality requirements, that quality related data management could be integrated within the supply chain. This needs common interests and professional cooperation. Many companies highlighted that quality oriented crop production and quality dependant market prices would hold the development potentials.

PRACTICAL USE OF RESULTS

There could be more possibilities to use the results of my research.

- Due to the fact that the quality assurance processes of participants in the hungarian feed grain supply chain have never been examined, the conclusions might be interesting for feed producers as well as for grain traders, warehouses as a benchmarking tool. In other words the firms can compare their operations to the practices of the sector. Doing so the given company may be able to locate its processes on the scale developed. In the hungarian feed grain supply chains the specialized companies producing feed for distribution and aiming the highest satisfaction of customer requirements invest more resources and competences into the appropriate operation of their food safety and quality management system than the enterprises operating in the early stages of the supply chain. Based on this result companies can develop processes intentionally.
- The conclusions of my research may support the mission of trade associations or the work of authorities. Unfortunately the quality of feed grains is a hardly mentioned topic nowadays, however, as the results of the secondary research also had confirmed, quality is going to become a competitive advantage in this sector too. The support of quality management system developments would serve as prevention, even reducing the demand for laboratory analysis. With the development of suitable informatical platforms and the harmonisation of quality requirements along the supply chain, the integrated management of quality related data would be possible between supply chain participants. However, for this, shared interests and cooperations are necessary.
- While one part of the feed companies consider the current agricultural subsidy system as an obstacle of quality improvements, the grain traders lack a standardized assessment system reflecting the real quality demands of the market. The most of companies highlighted that the quality oriented crop production would be the development opportunity. For this, it would be reasonable to modify the agricultural subsidy system available for the farmers, and to reach the quality dependant market prices of the crops, that would expectedly urge companies in the sector for improvement.

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PUBLICATIONS



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List of publications related to the dissertation

Hungarian scientific articles in Hungarian journals (1)

1. Csikai, A. E.: Vevőközpontúság megvalósulása minőségi és takarmánybiztonsági hazai keveréktakarmány-gyártásban.
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