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INTEGRATED QUALITY MANAGEMENT IN FOOD SUPPLY CHAIN[1]

ZINTEGROWANE ZARZĄDZANIE JAKOŚCIĄ W ŻYWNOŚCIOWYCH ŁAŃCUCHACH DOSTAW

Key words: traceability, integration, supply chain, quality management

Słowa kluczowe: identyfikalność, integracja, łańcuch dostaw, zarządzanie jakością

Abstract. Traceability in solids is difficult to ensure, as in piece goods. The batch as a whole will change constantly mixing processes by their composition and size. For traceability not only an appropriate identification system but also an approach to batch management is required. The systems supporting traceability provides a sophisticated batch concept and a batch coding persecution of lots within a single company, between customer-supplier dyads, as well as along the entire distribution chain. The introduction of a traceability systems is connected with technical and organizational effort. In the event of an inter-company implementation further agreements with suppliers and/or customers are required. Is a traceability system implemented, but it offers flexible opportunities to share quality information and thus to improve quality across the entire grain chain.

Introduction

In context of the way from intra- to inter-organizational quality management in the literature often can be found for example, the development of transport and warehouse management (selected subsystems), but rather in terms of partial recognition than as a complete connection of all stages of the chain: manufacturers, retailers and customers [Klepacki 2008]. A system ensuring product tracking and tracing is needed for well-functioning chain-wide quality management. Such a system should include all stages of the chain and also coordinate the classical functions of quality management, such as [Schiefer 2005]:

– quality policy and quality planning,
– quality assurance and quality improvement,
– internal and external verification of quality capability.

The entire food supply chain has to ensure efficient assurance of quality, hygiene and safety of all intermediate and final products. Assurance of products has to be guaranteed already at the beginning of the chain (farms with their suppliers); regardless of what the further use of the supplied raw materials is [Schiefer 2005].

Material and methods

To study of the interdependence occurring between the individual stages in the supply chain, and identify the type, scope and strength of the interaction between factors the following methods were used: study of literature, interviews, analysis of processes in the food processing chain. Flow of goods is presented in the paper using data coming from selected grain supply chain in Poland. The stages of the chain included in the paper are: agricultural production, grain trade, grain processing (grain mill), bakery, food retail.

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Results

Agricultural production is subject to a natural combination of quantity and quality of produced raw materials, leading to uncertainties in the chain. Reduction of this knowledge deficit and an increase in efficiency can be achieved through improved information exchange between the chain's members. In order minimize the uncertainties within the chain, all the potential factors need to be identified at all stages of the chain [Schiefer 2004]. The following chapter present the dependency between quality management and traceability, intra-organizational flow of goods in several stages of grain chain and intra-organizational flow of information.

Quality management and traceability

Many companies of the food industry lack the ability to control quality of products [Windyga et al. 2006]. Traceability is the basis for this and it is used for organization of product quality development within the framework of various operational processes. Therefore, statements concerning product quality at the end of the production chain are formulated [Schiefer 2004].

According to the EU regulations, companies of the food industry are obliged to implement the traceability concept, so that in the case of a crisis causes of existing health hazards can be identified and eliminated. As a part of company's quality policy, traceability supports the organization and quality of operational processes as well as operational process management [Schiefer 2004].

An information and communication system should be established to ensure efficient quality assurance. The system combines inner and intra-company traceability [Schiefer 2004].

Quality management is a traditional business-related, dynamic management approach based principally on 3 pillars. These are integrated in a systematic, continuously improved process [Pfeifer 2001]. The important elements of quality management are as follows [Schiefer 2003]:

– focusing of company's activities on the market thanks to the best possible and continuously improved satisfaction of customer expectations (=quality),
– security (and thus guarantee) and efficiency in the delivery of the promised quality thanks to the best possible organization and stabilization of business processes,
– integration and motivation of all employees thanks to the best possible support of a company and ongoing compliance with the demand for quality.
– system management is shaped by elements of quality-based process management. The basic elements of well-known, general concepts of organization of quality management systems are as follows:
– requirements of International Organisation for Standarization (ISO): pursuit of quality objectives,
– requirements of HACCP (Hazard Analysis and Critical Control Points): food security, the corresponding control and intervention points within the framework of process control,
– traceability – identification of flow of goods.

Tracking and tracing of products (T&T) represents the legal minimum requirements within the framework of measures for improvement of food security (see Regulation EG 178/2002) [Jarzębowski 2008]. An improvement of crisis management is the most important aspect in case of damage. Such understanding of T&T is not suitable for the potential of T&T systems [Golan, Krissoff, Kuchler 2002]. An appropriately organized T&T system enables not only to trace products but also to combine information on quality assurance and to transfer it along the chain [Poignée, Hannus 2003]. Applying the T&T system as a quality control system requires a concept that not only indicates branched flows of goods within the production chain. It is also associated with control and documentation regime of quality measures [Poignée, Hannus 2003].

Intra-organizational flow of goods using grain chain as an example

Flow of goods is presented in the paper using data coming from selected grain chain in Poland. Acceptance of raw materials in the chain occurs in a traditional way. Raw materials for flour production are purchased from external agricultural trade or directly from farmers. They

are stored in one of the two grain elevators or sent further to the flat warehouse (2 units). From there, grain is called up as necessary and delivered to the mill – either to one of the four grain silos or directly to be milled. After the manufacturing process, the final product - flour – is stored in one of the flour silos or delivered by tank tracks. Flour from the flour silo needs to be bagged and transported to the final product warehouse. The flour can be transported to bakeries or other customers by tank trucks or removed from the final product warehouse (Fig. 1).

The main areas of flow of goods, mainly „storage", „flour production", "bakery and pastry products production", are discussed in detail in the next part of the paper. Their exact identification serves as the basis for ensuring the chain-wide tracking and tracing.

The first process "storage" includes all activities that are connected with raw materials acceptance, quality assessment, storage and delivery of raw materials to the production in mills or to the sale phase.

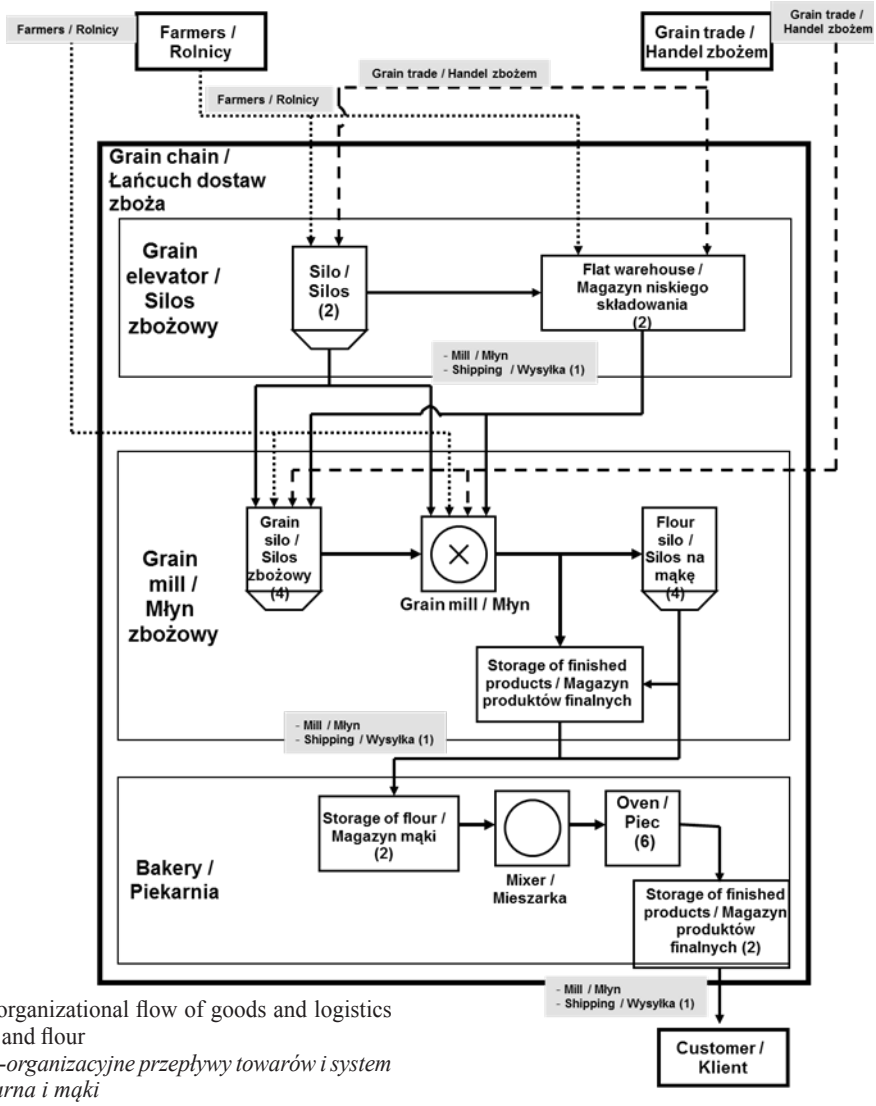

Figure 1. Intra-organizational flow of goods and logistics system of grain and flour
Rysunek 1. Intra-organizacyjne przepływy towarów i system logistyczny z ziarna i mąki
Source: own study
Źródło: opracowanie własne

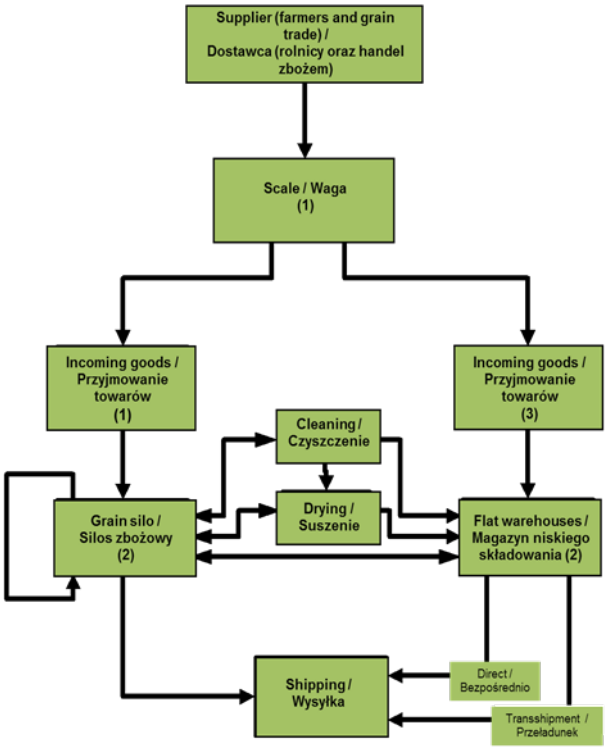

Figure 2. Detailed process „ flow of goods – agricultural trade"
Rysunek 2. Szczegółowy proces „przepływ towarów - handel rolny"
Source: own study
Źródło: opracowanie własne

The delivered quantities of raw materials are measured by scales. The weighted grain is either sent directly to one of the two flat warehouses through one of the three small grain hoppers or to one of the two grain silos through the big grain hopper. Grain is stored here or further relocated to one of the flat warehouses. It is also possible to dry or clean grain as necessary. Grain can be relocated between and within the flat warehouses as well. If needed, grain is delivered to the mill or to external customers. The process "storage" is shown in Figure 2.

The process „flour production" is associated with the processing of grain raw materials. These are all tasks that are related to the grain intake and quality assessment, milling, flour storage and transport.

This process can be divided into main areas: production preparation and milling.

Production preparation. Cereal supply for about 2-4 manufacturing days is maintained in the mill. The actual grain storage takes place within the framework of the agricultural trade. Therefore if necessary, the mill makes a request for grain from the agricultural trade. The mill places an order for grain at least a week in advance. There are four grain silos in the mill. High quality grain is stored in one or two silos and average grain is kept in remaining ones. Before any silos is refilled, pre-cleaning takes place.

The orders from bakeries go to the production manager of the mill. He decides whether the appropriate flour is available in any of four silos. If not, the requested flour is produced. The production manager has to decide whether there is an adequate quantity and quality of grain for production. If not, he needs to order appropriate grain from agricultural trade. In urgent cases, flour can be produced directly and sent to the bakeries the next day. In general, the bakeries place an order for flour a few days earlier (preferably a week in advance).

The milling. The production manager determines which grain should be mixed in which grain cell. Then, the mixing takes place in one (or both) humidification cell(s). The content of the humidification cell(s) can be transported individually or jointly to mill rolls. Grain is cleaned first and then it goes to mill rolls. During the milling, two types of flour are produced simultaneously in varying proportions. Flour from mill rolls is transferred to a mixing box. Depending on the type of flour, various mixing boxes are chosen. At this stage different microelements may be added in order to improve the flour quality. Flour from the mixing boxes is stored in one of the four flour silos. Alternatively BigPacks may be filled with flour. There is also the possibility of direct loading into tank trucks. Flour from silos is packed in small items using packing facilities and sent to the final product warehouse, where the filled BigPacks are already. From this place stored flour is transported to bakeries and external customers.

During the milling process, bran is produced as a side product. Bran is sent to both of the bran silos, then bagged and delivered to the final product warehouse. At the end the side product is transported by trucks to customers. The process "flour production" is shown in Figure 3.

The process "bakery and pastry products production" includes bread and confectionery production. These are all activities associated with the preparation of the appropriate paste and types of bread, baking, packaging and transportation of final products to customers. This process can be divided into two stages: production preparation and bakery and pastry products production.

Production preparation. Production managers receive orders for brad from the food retailers. Bakeries order flour from the mills, depending on their stock and consumption level. The goods are delivered after being bagged. Flour for further processing is supplied by the agricultural mills and stored by its types in the flour warehouses.

Bakery and pastry products production. The bakeries run in 2 shifts. Depending on the shift different types of bread are produced. The bakeries determine how much of what flour type on which shift is used. Currently wheat and rye breads are produced during the night shift (the main production runs in the night). The day shift focuses on production of mixed bread and wheat bread as required.

The bakeries also document how much bread was produced. Any delivery can include bread from this two production shifts. Firstly, paste are prepared. For each type of bread and pastry different paste are made. Then the appropriate ingredients are added. Bread is prepared from paste batch and baked. After the baking, bread is relocated to the fermentation plants. Then some breads are cut and wrapped in foil. The last activity is getting together all required typed and quantities of bread and delivering them to customers.

The pastry parties are prepared for baking, backed depending to their type. Products intended for direct delivery are cooled. According to the ordered quantities and types of products, they are delivered to customers.

The process "bakery and pastry products production" is shown in Figure 4.

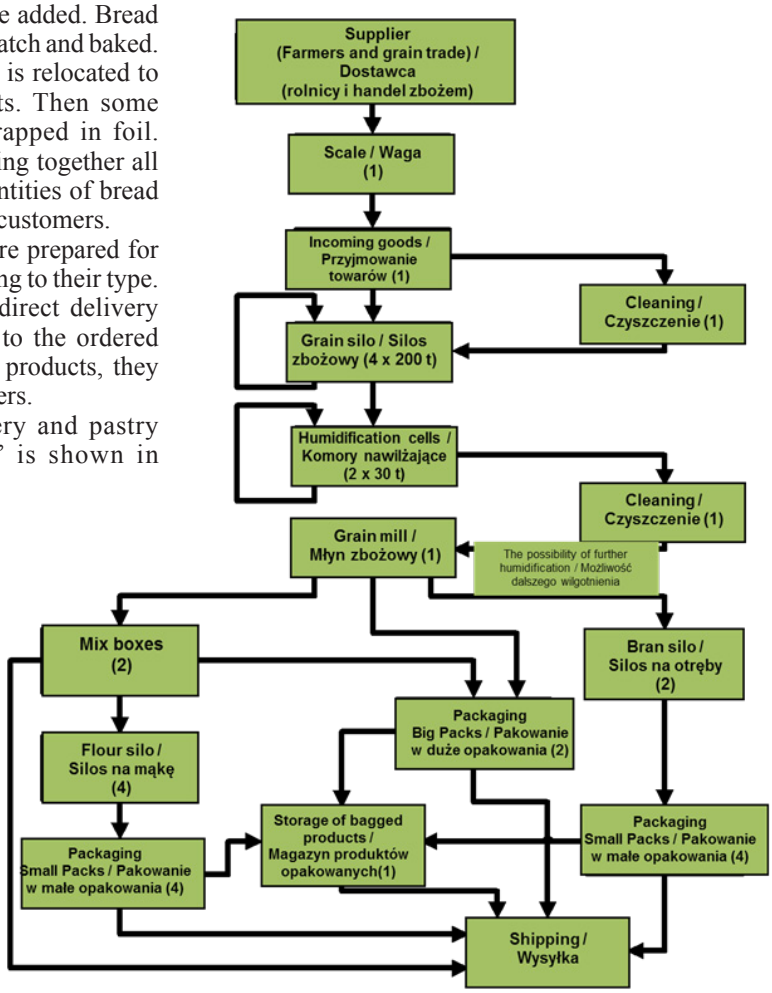

Figure 3. Detailed process „Flow of goods – wheat mill"
Rysunek 3. Szczegółowy proces "Przepływ towarów – młyn zbożowy"
Source: own study
Źródło: opracowanie własne

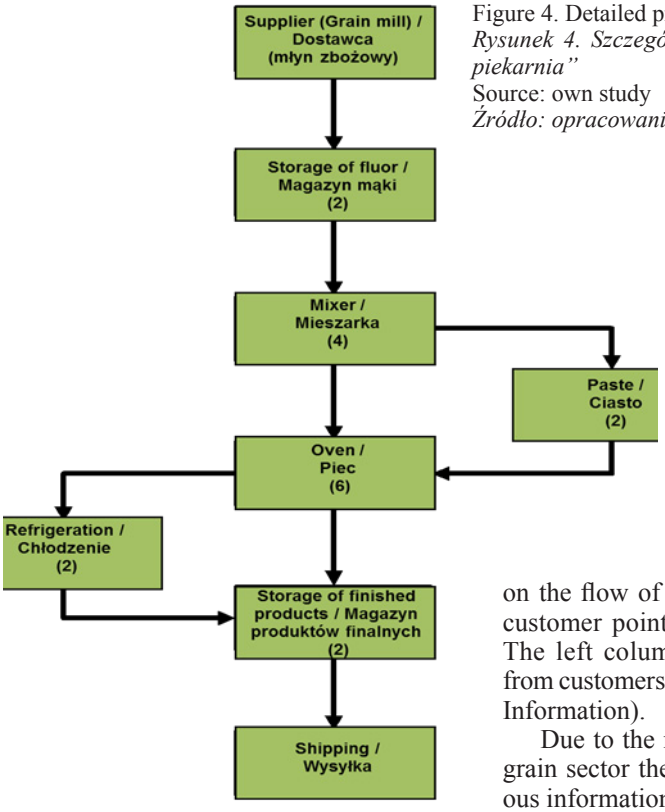

Figure 4. Detailed pro-cess „Flow of goods - bakery"
Rysunek 4. Szczegółowy proces "Przepływ to-warów - piekarnia"
Source: own study
Źródło: opracowanie własne

Intra-organizational flow of information

Information is exchanged in both directions among the chain members, namely farmers, agricultural trade, mills, bakeries and food retailing.

Figure 5 presents the flow of information within the analyzed grain chain. The chain stages are in the middle column. The right column includes information on the flow of goods that are relevant from the customer point of view (push-up information). The left column contains information flowing from customers towards their suppliers (Pull down Information).

Due to the network-oriented character of the grain sector the companies are involved in various information and communication chains. This requires coordination of different content.

The data are collected and exchanged at the different stages of the analyzed chain. The organization of information exchange can be described by the following characteristics:

– content of information: trade data, product information, requirements of internal and external customers. No information on processes is shared,
– organization of information exchange: within the grain chain the information is exchanged between companies, i.e. there is no central data storage,
– direction of information exchange: Information flows from farmers to customers (with the flow of goods) and in the opposite direction (against the flow of goods),
– technological support: information, depending on the stage of the grain chain, is exchanged through various media and detected by specialized computer systems (ERP-Systems). Therefore, there is a mix of traditional communication and digital media.

Tables 1 and 2 include more specific aspects of information exchange among the individual stages of the chain. The exchanged data are listed in accordance to the stages in table 2 and the used media are presented in Table 1.

The following systems are applied for the data collection at the individual chain stages:

– agricultural trade: paper (examination booklet), IT (accounting systems: „F++", software provider: Comarch),
– mills: paper (examination booklet), IT (accounting systems: „F++", software provider: Comarch),
– bakeries: inventory management system „info Piek" (two modules: production and distribution), software provider: Computer Media Consultants,

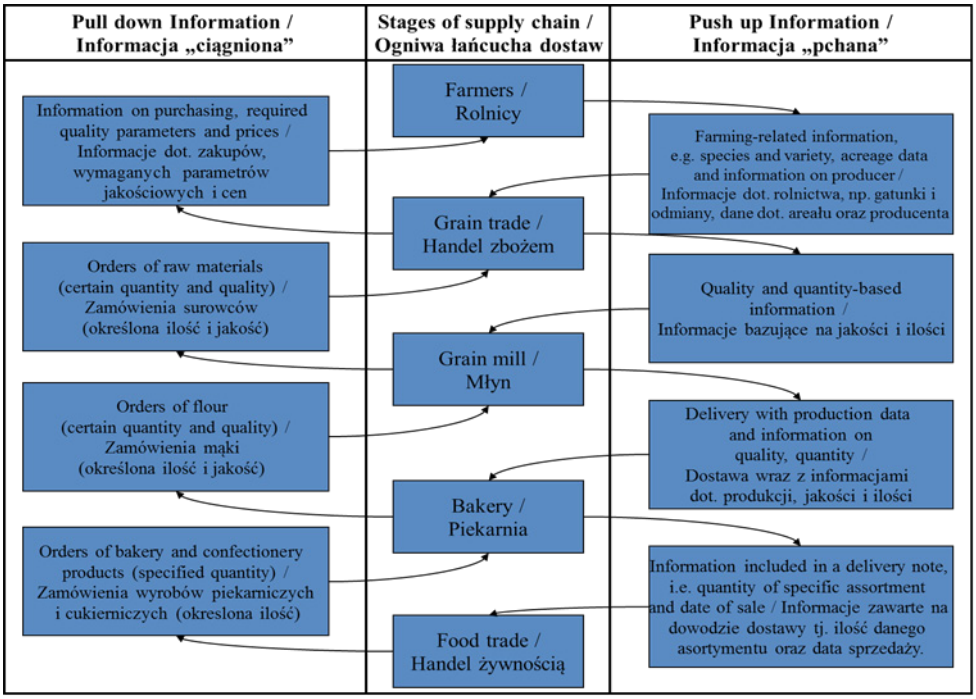

Figure 5. Up- and downstream flows of information
Rysunek 5. Przepływ informacji w górę i w dół łańcucha
Source: own study
Źródło: opracowanie własne

Table 1. Media used for data Exchange
Tabela 1. Media wykorzystywane do wymiany danych

Sender/ *Dostawca* Recipient/ *Odbiorca*	Farmers/*Rolnicy*	External grain trade/ *Zewnętrzny handel zbożem*	Grain storage/ *Magazyn zboża*	Grain mill/*Młyn*	Bakery/*Piekarnia*	Distribution/ *Dystrybucja*
Farmers/ *Rolnicy*			Phone or fax/*Telefon lub fax*			
External grain trade/ *Zewnętrzny handel zbożem*	Phone, personal communication/ *Telefon, komunikacja personalna*	Paper (delivery order with qualities, grain evaluation)/*Papier (zle-cenie dostawy z jakością, ocena zboża)*		Phone or fax/ *Telefon lub fax*		
Grain storage/ *Magazyn zboża*			Phone or fax/*Telefon lub fax*		Phone/*Telefon*	
Grain mill/ *Młyn*				Paper (delivery order)/*Papier (zlecenie dostawy*		Phone/ *Telefon*
Bakery/ *Piekarnia*					Paper (delivery order)/*Papier (zlecenie dostawy)*	
Distribution/ *Dystrybucja*						

Source: own study
Źródło: opracowanie własne

Table 2. Data exchange matrix
Tabela 2. Macierz wymiany danych

Sender/ *Dostawca* Recipient/ *Odbiorca*	Farmers/ *Rolnicy*	External grain trade/ *Zewnętrzny handel zbożem*	Grain storage/ *Magazyn zboża*	Grain mill/ *Młyn*	Bakery/ *Piekarnia*	Distribution/ *Dystrybucja*
Farmers/ *Rolnicy*			Conditions of grain purchase, required quality parameters and prices. Information on individual pattern parameters. Delivery quality on request of farmers (as above). Always: shipping volume and prices/*Warunki zakupu ziarna, wymagane parametry jakości i ceny. Inf. dot. poszcz. parametrów wzorcowych. Jakość dostawy na żądanie rolników (jak wyżej)*			
External grain trade/ *Zewnętrzny handel zbożem*			Grain order: delivery date, quantity and quality (moisture, falling number, sedimentation)/ *Zamówienie zboża: data dostawy, ilość i jakość (wilgotność, liczba opadania, osadzanie)*			
Grain storage/ *Magazyn zboża*	Master data of producer (name, address), product-related informa-tion: type/*Podst. inf. o producencie (nazwa, adres), inf. dot. produktu: typ*	Delivery order: date, quality (as first line), price/*Zlecenie dostawy: data, jakość (w pierwszej kolejności), cena*		Grain order: (requi-red quantity and quality) quality parameters as above/ *Zamówienie zboża: (wymagana ilość i jakość) parametry jakości jak wyżej*		
Grain mill/ *Młyn*			Delivery quantity and quality parameters (as above)/*Wielkość dostawy i parametry jakości (jak wyżej)*		Flour order: quantities of individual flour types with appropriate quality (moisture, protein content, falling number, ash content), delivery date/ *Zam. mąki: ilości poszcz. typów mąki o odp. jakości (wilg., liczba opadania, zaw. popiołu), data dostawy*	
Bakery/ *Piekarnia*				Quality certificate: delivery quantity and quality parameters (such as flour order)/*Cert. jakości: wielk. dostawy i param. jakości (takie jak przy zam. mąki)*		Delivery quantity and delivery date/ *Wielkość i data dostawy*
Distribution/ *Dystrybucja*					Delivery quantity and delivery date/ *Wielkość i data dostawy*	

Source: own study
Źródło: opracowanie własne

Conclusions

For information exchange in the supply chain in an optimal way, the flow of materials has to be monitored in both directions, up and down the chain. The information in the companies should be reviewed and their implications understood and interpreted properly. Information on material flow in the supply chain are critical, because the knowledge of the quantity and quality of goods held by the provider can help to reduce costs. It may also enable the improvement in the areas of planning, purchasing, warehousing, distribution and logistics.

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Streszczenie

Rozporządzenie 178/2002 UE nakłada na wszystkich uczestników łańcucha żywnościowego obowiązek identyfikowalności (traceability), czyli śledzenia pochodzenia produktu. Jest ono trudniejsze w przypadku towarów sypkich niż towarów jednostkowych. Poszczególne partie podlegają procesom mieszania się, z punktu widzenia składu oraz wielkości. W celu zapewnienia identyfikowalności wymagany jest nie tylko właściwy system identyfikacji, ale również zarządzanie partiami. Systemy wspierające identyfikowalność powinny być przystosowane do odpowiedniej systematyki i sposobu kodowania partii towarów wewnątrz przedsiębiorstwa, jak i pomiędzy poszczególnymi ogniwami łańcucha dystrybucji. Wdrożenie systemów wspierających monitorowanie pochodzenia produktów wiąże się z nakładami technologicznymi i organizacyjnymi. W przypadku implementacji międzyorganizacyjnej niezbędne są porozumienia między dostawcami i/lub dostawcami. Wdrożenie odpowiedniego systemu identyfikowalności pozwala na elastyczną wymianę informacji dotyczących jakości, a tym samym na poprawę jakości w całym łańcuchu dostaw.

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