*PS1-6 – 6248*

# Impact of integrated pest management (IPM) technology on the organizational attitude of stored grain facilities in Brazil

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## Abstract

In order to improve the control of stored grain pests and to have better grain quality, in 1999, Embrapa Wheat initiated a program to introduce IPM into some important grain storage facilities. The strategy included: (a) changing the behavior of the storage facility personnel through training; (b) improving pest control knowledge in the stored grain unit; (c) maintaining cleanliness of equipment and premises and, after that, application of residual insecticide; (d) identifying the observed stored grain pests; (e) testing pest resistance to pesticide; (f) applying pesticide treatment and / or fumigation; (g) sampling and monitoring stored grain. The IPM program was introduced into nine companies at 13 storage facilities of farm cooperatives. To assess the benefits of this technology regarding the organizational attitude towards the grain and stored grain losses, interviews with the personnel involved in these storage facilities were made, in 2003. Seven storage managers and fifteen storage operators were interviewed and questioned on knowledge of their responsibilities, reciprocal cooperation between operators and the technical team, implementation of new attitude rules for storage personnel, personnel hygiene and safety conditions, work motivation and on the main problems in storing grain. The results showed an improvement in the management of the storage facilities, mainly due to the introduction of worksheets for registering and planning all the tasks needed to run the storage unit. Improved workplace conditions, work satisfaction and motivation, reduced accident risks, better personnel management, greater grain value, guarantee of delivery and customer satisfaction, and a better company market were gained with the IPM technology. It is estimated that storage facilities of these companies, from 2000 to 2004, gained an economic benefit of US$ 11.15 million on commercialized grain.

*Key words:* Organizational attitude impacts; Stored Grain Integrated Pest Management Technology, Adoption; Marketing.

## Introduction

According to the National Stored Grain Units Register, the statistics on Brazilian storage capacity is of approximately 89.6 million tons. Grain storage represents 71.9 % from the country's total storage capacity (Beskow and Deckers, 2002).

Some of the problems caused by inadequate grain storage are: losses caused by stored grain pests; insect fragments in the final product; deterioration of the grain mass; fungus and mycotoxins contamination; effects in human and animal health; and difficulties to export due to its potential risks. The Brazilian Ministry of Agriculture, Livestock and Food Supply and FAO estimate an average physical

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loss of 10 % of the total quantity produced annually in the country. However, quality losses are as important as physical losses.

Expressive insect infestation at storage facilities, resulting in grain quality and physical was the scenery that triggered the development of the IPM program by Embrapa Wheat. In order to improve the control of stored grain pests and to have better grain quality, in 1999, Embrapa started a program introducing IPM into some important grain storage facilities. The IPM program was introduced into nine storage companies at 13 facilities of the following farmers cooperatives: in the state of Paraná, Integrada in the facilities of Londrina, Maringa, Assai, Cornélio Procópio and Ubiratã; Cocari in the facilities of Kaloré; Coopervale in the facilities of Assis Chateaubriand and Cotriguaçu in the facilities of Palotina, and Coopavel in the facilities of Cascavel.; in Mato Grosso do Sul , Copasul in the facilities of Naviraí; in Goiás, Caramuru in the facilities of Rio Verde; and in the state of Rio Grande do Sul , Cotrijal in the facilities of Victor Graeff, and Cotripal in the facilities of Panambi (Figure 1).

The IPM program consists of a set of integrated control methods of stored grain pests (*Rhyzopertha dominica, Sitophilus zeamais, S. oryzae, Plodia interpunctella, Sitotroga cerealella*) which cause damage to the grain and final products by physical and quality losses, as a result of product contamination with insect fragments, fungus and mycotoxins. According to Lorini (2002), the strategy included: (a) changing the behavior of the storage facility personnel through training; (b) improving the pest control knowledge in the stored grain unit; (c) maintaining cleanliness of equipment and premises and, after that, applying residual insecticides; (d) identifying the observed stored grain pests; (e) testing insect resistance to pesticide; (f) applying pesticide treatment and fumigation; (g) sampling and monitoring the grain.

More than 3 million tons/year of grain were monitored by the IPM program. It corresponds to approximately 3.5 % of the total sum of maize, barley, wheat and soybean produced in Brazil. It is estimated that storage facilities of these companies, from 2000 to 2004, gained an economic benefit of US$ 11.15 million on commercialized grain.

The process of improvement of an organization is tied to the objective result and to the organizational attitude. To obtain success in the program implementation, it is necessary to associate the objective result with changes on the organizational

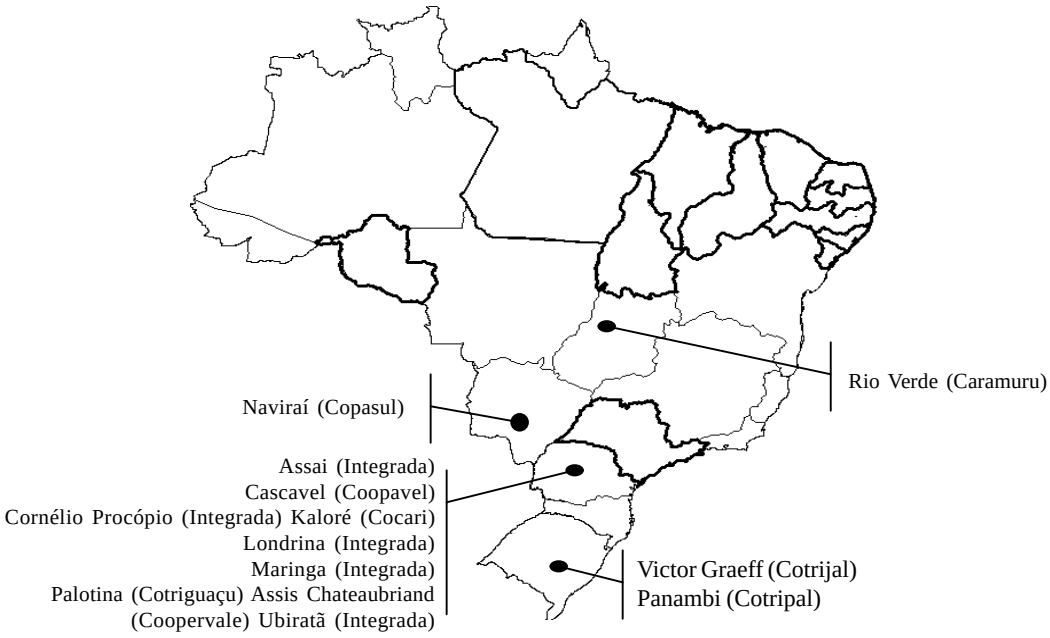


**Figure 1**. Geographical location of the storage facilities that adopted the IPM program.

culture. The IPM program is more than a program to control stored grain pests and grain quality (objective result), it consists on an organizational culture change. The organizational attitude affects the employees' motivation and has a direct impact on the organization productivity.

The aim of this study was to evaluate the impacts of the IPM program in the organizational performance and in the behavior of the storage facilities' personnel where the program was implemented, in terms of knowledge of their tasks, reciprocal cooperation between the operators and the technical team, implementation of new rules for storage personnel, personnel hygiene and safety conditions, work motivation and the main problems in storing grain.

## Material and methods

The present study was described as a study of the organizational environment under a qualitative approach – a case-study. According to Neves (1996), a case-study consists of an environment, a subject or a particular situation analysis, seeking to comprehend the reason why some phenomenon occurs or to comprehend events with reduced control and specific context.

To execute the case-study, a fieldwork for data collection was implemented, the data was processed and frequency analyzed. The fieldwork consisted of an interview technique, and a questionnaire was applied. Interviews were conducted with the personnel involved in these storage facilities in their working environment, with individual characters and in reserved locations to assure the privacy of the interviewee. The aspects approached in the interviews were: (a) the existence of previous control tools; (b) knowledge of the storage facilities' activities; (c) reciprocal cooperation between operators and their technical team; (d) activity intensity; (e) personnel hygiene and safety conditions; (f) work motivation; and (g) the main changes and problems in storing grain. For each aspect, a numeric evaluation scale (1 to 5 or 1 to 10) or a qualitative evaluation scale (very bad - bad - good - very good - excellent; and lower work intensity – normal work intensity - higher work intensity) was established.

Results and discussion

Seven storage managers and fifteen grain operators were interviewed at eight of the 13 storage facilities that adopted the IPM program, in 2003. Regarding the number of years working at storage facilities, 45.5 % of the interviewees had more than 10 years, 22.7 % of them had between 6 to 10 years, and 31.8 % of them had less than 5 years of working experience (Figure 2).

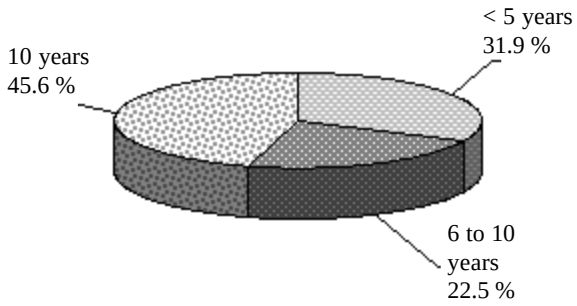


**Figure 2**. Interviewees working time in storage facilities percentage distribution.

Regarding the existent control tools previous to the implementation of IPM program, 95.5 % of the interviewees confirmed the existence of stored grain pests control actions. Fumigation was mentioned by 77.3 % of the interviewees as a previously existent stored grain pests control activity. Cleanliness of equipment and premises (22.7 %), structure pulverization (18.1 %), protectant pesticide treatment (18.1 %) and silos temperature control (4.5 %) were also cited by the interviewees but in lower percentages of previous occurrence.

According to the interviewees, the IPM program improved the pest control knowledge level of the storage facilities. On a scale of 1 to 5, before the program implementation, 72.7% of interviewees asserted that their knowledge level was smaller than 3, obtaining an average of 2.64. After the implementation, 86.4% of interviewees considered their knowledge level higher than 4, obtaining an average of 4.05 (Figure 3). Knowledge increase seems to be related to a better understanding of

stored grain pests' cycle and control, structure cleaning concepts and following other sector activities.

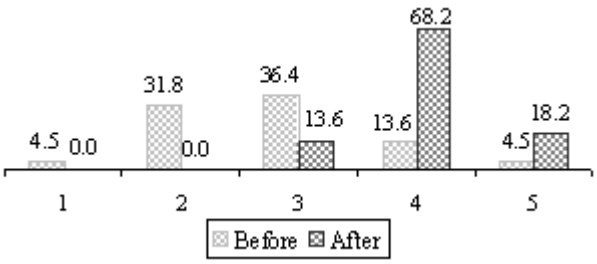


**Figure 3.** Percentage of knowledge levels on the storage facilities' activities, before and after the implementation of the IPM program.

Perceptions on activity intensity, before and after the IPM program implementation, varied according to the functional category (Table 1). Nevertheless, the intensity of the activities increased after the IPM program implementation for all interviewees, in the managers' perception, activity intensity was classified as higher after the implementation. As observed on Table 1, 63.6% of the interviewees classified activity intensity as normal before the implementation. After implementation, 63.6% considered activity intensity higher due to cleaning operations, monitoring and more constant maintenance. At two stored grain facilities, there were new contracted employees. At the units that first adopted IPM, a normalization of activities was registered after the first year of implementation with an increase of the productivity and replacement of activities.

Before the IPM program implementation, only 27.3 % of interviewees attributed a value greater than 8 to reciprocal cooperation between the operators and the technical team in stored grain facilities. After implementation, this percentage increased to 95.4 % of the interviewees (Figure 4). Cooperation increase, according to interviewees, was possible due to the internalization of standard concepts; improvement in the process knowledge, activity divisions, responsibility attribution, behavior changes in relation to cooperation and reduction of pressure at the grain delivery process to the customer. Increased interaction between stored grain facilities and supply chain sectors was observed.

**Table 1.** Activity intensity evaluation, according to the functional categories and total, percentage.

| Functional category / time | | Lower | Normal | Higher |
|---|---|---|---|---|
| Storage Operator | Before | 13.3 | 60.0 | 26.7 |
| | After | 0.0 | 53.3 | 46.7 |
| Manager | Before | 28.6 | 71.4 | 0.0 |
| | After | 0.0 | 0.0 | 100.0 |
| Total | Before | 18.2 | 63.6 | 18.2 |
| | After | 0.0 | 36.4 | 63.6 |

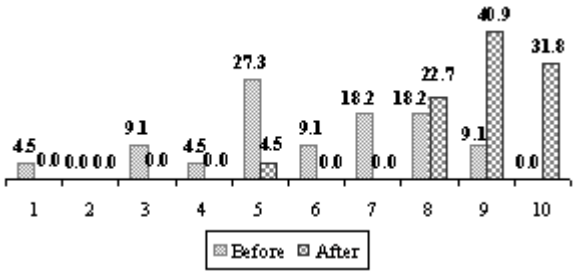


**Figure 4.** Perceptions percentage on reciprocal cooperation between technical team members, before and after the IPM program was implemented.

Regarding the work environment an evaluation scale was used, 72.8 % of the interviewees attributed a value higher than 4 after implementation of the program, the previous value being only 13.6 % (Figure 5). The average attributed value for the work environment varied from 2.5 to 4.2. The managers' perception on work environment improvement was larger than that of the storage operators. Residues elimination in the location, accidents and customer disagreement at the grain delivery process reductions were mentioned as the main work environment improvement factors. Cleanliness of equipment and premises, correct identification of stored grain pests

and their adequate control at grain storage facilities decreased the number of grain movements from one silo to another and insecticide treatments, resulting in the reduction of atmospheric pollution emissions (grains or pesticide particles and odors); accident risks and employees exposure to chemical and biological agents.

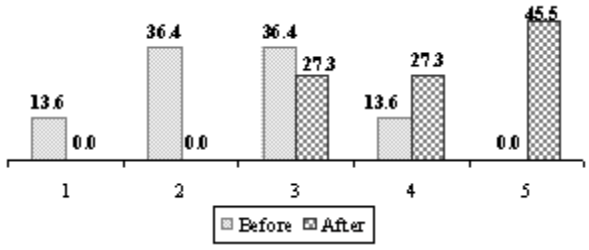


**Figure 5.** Work environment value percentage, before and after the IPM program implementation.

According to the interviewees, the IPM program implementation elevated the employees' satisfaction and motivation levels, increasing this average from 3.3 to 4.0 after implementation. Before the implementation of IPM, 68.1 % of the interviewees attributed a value lower than 3 for their motivation level. After the implementation, 77.2 % of the interviewees assigned a value higher than 4 (Figure 6). Recognition of their participation in the process, several activities and identification of grain storage facilities as a quality bench-mark are cited as motivation factors by the interviewees.

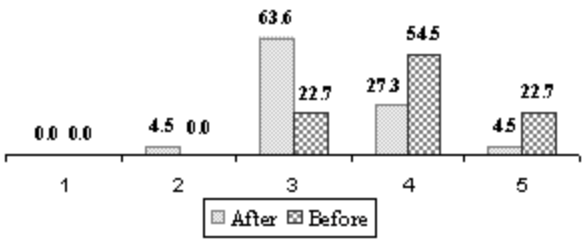


**Figure 6.** Motivation level values percentage, before and after the IPM program implementation.

The main problems and future actions cited by the interviewees as a priority were: grain facility structure improvements; neighboring grain storage facilities with insect infestation problems; grain movements between storage facilities; behavior changes and training continuity; to increase the number of employees; to change the behavior of farmers towards better production practices; product segregation; and establishment of an experience exchange network.

There were expressive alterations in the storage structure with a new concept of constructive model so as to favor cleanliness and to focus on contamination reduction, and, in a preventive process, to increase storage time and to reduce the number of grain movements from one silo to another.

Grain storage facilities with the IPM program gained a positive image in the grain market with a greater grain value and market preference. The trademark MIPGRÃOS, registered by Embrapa Wheat, has been used as a security quality stamp.

Personnel's training is one of the milestones of this technology. More than 1,500 people were directly trained by the project so as to spread and transfer this technology.

The grain value gained as a result of the IPM program implementation is due to grain quality and physical loss reduction; rationalization of insecticide use; duration time increase between the preventive and curative treatments; guarantee of delivery and client satisfaction; and better company marketing. A gain from 1 to 5 % of the grain price is estimated. According to the information given by one of the grain storage facilities, the IPM program implementation resulted in cost reduction of 62 % with corn curative treatment due to the increase of storage time and efficiency improvement in applications by the acquisition of adequate equipment.

Generally, the results of the adoption of the IPM program showed: grain quality and physical loss reduction; rationalization of pesticide use and time increase between the preventive and curative treatments; improvement in storage structures and processes with focus on cleanliness and on preventive control; training people to understand the storage process and stored grain pests; work conditions improvements (pleasant work environment; accident risks reduction; work satisfaction and motivation, etc.); improvements in the management process (introduction of worksheets

for recording and planning all the tasks needed to run the store unit, higher integration and cooperation among employees, resource optimization, etc.); greater grain value, guarantee of delivery, client satisfaction, and better company image.

Considering the economic and organizational benefits obtained by the storage companies which implemented the IPM program, its expectations increased adoption of this technology in the storage system. In December 2005, 20 institutions and companies made a cooperation protocol with Embrapa to implement the IPM program in their grain storage facilities as well as to seek new technologies in this area.

## Acknowledgements

Thanks to Embrapa for the financial support and to the professionals who conceded the interviews.

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