WORK ORGANIZATION AND TECHNOLOGICAL RESOURCES IN BROILER PRODUCTION - AN ERGONOMICS APPROACH

Carolina Alexandra Marchant Dinten[1]; Roberto Funes Abrahão[2]*; Julieta Teresa Aier de Oliveira[2]

[1]*UNICAMP/FEAGRI - Programa de Pós-Graduação em Engenharia Agrícola.*
[2]*UNICAMP/FEAGRI - Conselho de Infraestrutura Rural, Cidade Universitária "Zeferino Vaz", C.P. 6011 - 13083-875 - Campinas, SP - Brasil.*
**Corresponding author <roberto@agr.unicamp.br>*

ABSTRACT: Ergonomic Work Analysis has made it possible to identify the main factors behind the difficulties encountered by workers in (routinely) performing their tasks. The purpose of this work was studying the relationship between the forms of work organization, the technology used in broiler production, and the impacts of both factors on this type of work from an ergonomics perspective. Both teamwork and cooperation among workers were proven to help minimizing efforts and achieving better results. If on one hand higher technological level adopted could elicit using a smaller number of workers as well as make broiler handling easier and more effective/precise, on the other hand it generated sub-tasks and made equipment operation much more dependent upon close supervision by the workers. So at the same time as the physical stress on the workers was being reduced with lighter load being carried, psychic stress was being increased with the pressure of close supervision. The analysis of production results expressed by the Production Factor (PF) indicator used in an advanced trend analysis using the Technology Utility tool, has shown that properties with a totally or partly familial workforce achieved better production results than those using a patronal workforce, possibly resulting from the fact that workers within a family-based workforce have more autonomy and, therefore, become more motivated to pursue their goals, and that facilitates achieving good results.
Key words: ergonomic work analysis, broiler handling, teamwork, familial workforce

ORGANIZAÇÃO DO TRABALHO E DOS RECURSOS TECNOLÓGICOS EMPREGADOS NA AVICULTURA DE CORTE - UMA ABORDAGEM ERGONÔMICA

RESUMO: O método da Análise Ergonômica do Trabalho permite identificar os principais fatores relacionados às dificuldades na execução das tarefas. Este trabalho teve como objetivo verificar as relações entre as formas de organização do trabalho, a tecnologia empregada na produção e os impactos sobre o trabalho do ponto de vista ergonômico. O trabalho em equipe e a colaboração entre os funcionários ajudam a minimizar esforços e alcançar melhores resultados. Se por um lado o grau de tecnologia adotado permite o emprego de um número menor de trabalhadores e torna o manejo mais fácil e preciso, por outro cria subtarefas e faz com que o bom funcionamento dos equipamentos dependa muito da vigilância dos funcionários, diminuindo constrangimentos físicos como menor transporte de carga, mas criando alguns constrangimentos psíquicos, como a própria vigilância. Propriedades cuja força de trabalho é total ou parcialmente familiar obtiveram melhores resultados de produção que as patronais. Aventa-se a hipótese da maior autonomia que os trabalhadores gozam nas duas primeiras categorias, o que se reflete em maior motivação para que a produção alcance bons resultados.
Palavras-chave: análise ergonômica do trabalho, avicultura de corte, trabalho em equipe, produtor familiar

INTRODUCTION

In the early 1970s, broiler production was highly industrialized. Producers stopped having direct contact with the market (Rizzi, 1993), but still needed to learn about and understand its operative logics and economic agents, and follow progress changes in time. These changes, directly connected to market demands, led to the development of handling procedures, the building of new facilities, and the adoption of biosecurity measures. To adjust to these new requirements, producers were organized in cooperatives which promptly respond to market demands, share product costs, complement the range of products offered, fa-

cilitate the incorporation of technical progress into the production-storage-distribution process, and increase the bargain power with the supply industry, regarding both the wholesale and the consumers market (Bialoskorski, 1998).

Cooperatives were formed by individuals who introduced different forms of work organization, means of production, and investment strategies, all of which caused different impacts on both work and production. Within that context, the general purpose of this study is to determine the relationships between the forms of work organization and the level of technology used in broiler production, and their impacts on this type of work from an ergonomics perspective. To achieve these goals, the methodological tool Ergonomic Work Analysis was used on the farm environment, where workers perform multiple, usually concurring tasks, and operate a great variety of machines, equipments and tools, even though, in most cases, they do not receive appropriate training.

Social and economic relevance of broiler production in Brazil and the fact that technical procedures are common to most properties and integrating companies in which tasks connected to both agricultural and industrial areas are performed, justify this study. In addition, chicken meat is an important source of protein for Brazilian consumers (Bacchi, 2002).

MATERIAL AND METHODS

The study area was a cooperative which integrates 73 producers. Operations were grouped as Patronal (P) Workforce (68.12%), Totally Familial (TF) Workforce (16.44%), and Partly Familial (PF) Workforce (16.44%) (Guanziroli & Cardim, 2000). Operations using contracted labor only in their production process belong to the first category. The TF workforce is represented by operations which use only family members in the production process. Finally, the PF workforce operations use both family members and external and/or temporary labor. The fact that different producers use different technology levels was also analyzed.

The choice of the operations for the sampling universe was based on data supplied by the Cooperative, both regarding the composition of the workforce and the technology level, which determine broiler density per coup (birds per square meter), configuring intentional, non-probabilistic sampling (Costa Neto, 1977). There were two predominant technology levels in the operations, named Level 1 and Level 2, or 'average-to-high technology level' and 'average-to-low technology level', respectively (Table 1). The six chosen operations were grouped in two units with the same

Table 1 - Technology level used in broiler operations integrated with the studied Cooperative.

Technology Level	Equipment and Techniques Employed in the Production												
	Automatic feed bins	Alarm	Circulating fan	Nebulizer	Curtain	Doser	Nipple drinker	Round drinker	Automatic feeder	Chain feeder[1]	Manual heating system	Semi-automaticheating system	Clock equipped with a timer
1	X	X	X	X	X	X	X		X			X	X
2	X		X		X			X		X	X		

[1]Chain feeders, are still used in a smaller scale. They are made of a galvanized sheet featuring a motor/hopper set, curves, a trough and, in some cases, a protection fence. One can choose between hanging feeders and legged feeders, the latter being more frequent in the region where the study was conducted, although in most cases, the legs were found to be no longer functional.

workforce composition (TF_1, TF_2, PF_1, PF_2, P_1, and P_2), one adopting the technology Level 1 and the other the technology Level 2.

Once the sample was defined, the Ergonomic Work Analysis methodology was applied to choose priority work situations to be analyzed. This methodology comprises various steps and is based on *in loco* observation of the workers' behavior in actual work situations, and also on the oral testimony of the workers involved in the production process (Guérin, 2001). A pilot study aimed at acquiring general knowledge of the technical process, and the tasks that would be later observed in the other sampling units, followed. The pilot study, carried from September to December, 2002, consisted of monitoring a complete production cycle in a specific production unit, which included interviewing and applying questionnaires to both owners and workers. Both the daily activity reports and records of oral testimonies were instrumental in promoting familiarization with the steps of the production cycle (Whitaker, 2002): the workers complaints regarding activities they found the most painful, as well as those which they perceived as more harmful to them, the owners, and the Cooperative itself; the equipment, machinery and tools used; physical efforts required and the conduct adopted; the collection of information carried out by workers while they performed their tasks, and the way workers handled this information to decide whether to perform one action or another, i.e., how they organized their activities with the help of the knowledge they acquired in order to achieve goals of the owners, the Cooperative, and their own. Once authors became familiar with these activities, the same methodology was applied to all production units throughout the year 2003, during which a follow up of all the tasks in the production cycle was performed.

RESULTS AND DISCUSSION

The standard production cycle lasts approximately 60 days, and comprises tasks directly connected with the birds' life cycle (bird handling takes approximately 40 to 45 days), cleaning and preparation of broiler houses (approximately 15 days for sanitary depopulation), and other tasks directly connected with management, performed by owners throughout the entire cycle. To better understand these tasks and the relationship between them, each operation was considered a system composed of various subs-systems (Montedo, 2001), each of them comprising tasks performed by both the manager (owner) and the worker (Table 2). These tasks are composed of various subtasks or activities related to a certain step of the cycle (such as depopulation, handling, and managing other activities), and the place where these sub-tasks or activities are performed. Tasks in the sub-systems were considered major ones, both due to their frequency and the fact that they were essential to the production.

Table 2 - Sub-system and tasks of a broiler operation.

Subsystem	Task	
1	Removal of litter and equipment	Sanitary Depopulation
2	Cleaning of the broiler houses and curtains	
3	Desinfection of the house	
4	Assembly of the chick house	
5	Handling of curtains	Broiler handling
6	Broiler feeding	
7	Water supply care measures	
8	Removal of dead birds	
9	Culling	
10	Temperature, humidity, ventilation and light control	
11	Supervision rounds	
12	Equipment maintenance	
13	Family duties	Management of other activities
14	Relationship with third parties	
15	Complemental commercial activities	

The sub-systems were interconnected in different ways or, in other words, performed tasks were concurrent. The composition of the workforce and the level of technology are factors determining this interconnection, the first being much more influential. For instance, in PF or TF operations, sub-systems 13, 14, and 15, which form a task team named 'management of other activities' start concurring with other tasks, since in these forms of work organization, the owner and other family members are directly involved in the production. This is not true for the P workforce, in which both the owner (manager) and the workers perform tasks directly connected with the birds' lifecycle and the property management, respectively. This can be exemplified and illustrated via the daily activity report which shows a relationship between the sub-systems.

The three operations are represented by the acronyms adopted for the form of workforce adopted. Tables 3, 4, and 5, show the daily activity reports for a given period of time for the TF, PF, and P operations. The relationships between the sub-systems are shown in Figures 1, 2, and 3. In the three operations, the daily

Table 3 - Daily activity report during a work period of a Totally Familial (TF) broiler operation.

	Sub-system	Task	Agent	Time	Place
Broiler handling	5	Handling of curtains	3 family members	9:00 am	House 1
				9:45 am	House 2
				10:30 am	House 3
	6	Broiler feeding	3 family members	9:00 am	House 1
				9:45 am	House 2
				10:30 am	House3
	7	Water supply monitoring	3 family members	9:00 am	House 1
				9:45 am	House 2
				10:30 am	House 3
	8	Removal of dead birdss	3 family members	8:30 am	3 Houses
	9	Culling	3 family members	8:30 am	3 Houses
	10	Temperature, humidity, light and ventilation control	3 family members	9:00 am	House 1
				9:45 am	House 2
				10:30 am	House 3
	11	Supervision rounds	2 family members	8:00 am	3 Houses
	12	Equipment maintenance	2 family members	8:00 am	3 Houses
Management of other activities	13	Family duties	1 family member	11:00 am	
	14	Relationship with third parties	-	-	-
	15	Complemental business activities	1 family member	11:00 am	

Table 4 - Daily activity report for a work period at a Partly Familial broiler operation.

	Sub-system	Task	Agents	Time	Place
	5	Handling of curtains	2 workers	9:50 am	House 3
			1 worker	11:20am	House 2
	6	Broiiler feeding	3 workers	8:40 am	House 1
			2 workers	9:50 am	House 3
			1 worker	9:50 am	House 2
	7	Water supply monitoring	3 workers	8:40 am	House 1
Broiler handling			2 workers	9:50 am	House 2
			1 worker	9:50 am	House 3
	8	Removal of dead birds	3 workers	8:40 am	House 1
	9	Culling	-	-	-
	10	Temperature, humidity, light and ventilation control	1 worker	10:55 am	House 1
	11	Rounds	1 worker	10:30 am	3 Houses
	12	Equipment maintenance	3 workers	8:40 am	House 1
			1 worker	10:30 am	Houses 2 and 3
	13	Family duties	-	-	-
Management of other activities	14	Relationship with third parties	-	-	-
	15	Complemental business activities	Owner	Complete Period/Full Shift	-

Table 5 - Daily activity report for a work period at a Patronal (P) broiler operation.

	Sub-system	Task	Agents	Time	Place
Broiler Handling	5	Handling of curtains	3 workers	9:15 am	House 2
	6	Broiler feeding	1 worker	7:50 am	House 1
			3 workers	8:30 am	3 Houses
			3 workers	9:40 am	House 2
	7	Water supply monitoring			
	8	Removal of dead birds	1 worker	7:50 am	House 1
	9	Culling			
	10	Temperature, humidity, light and ventilation control	1 worker	7:50 am	House 1
			3 workers	10:00 am	House 1
	11	Rounds	3 workers	9:15 am	House 2
	12	Equipment maintenance	1 worker	7:50 am	House 1
			1 worker	8:00 am	House 1
			3 workers	10:00 am	House 1
Management of other activities	13	Family duties	-	-	-
	14	Relationship with third parties	-	-	-
	15	Complemental business activities	-	-	-

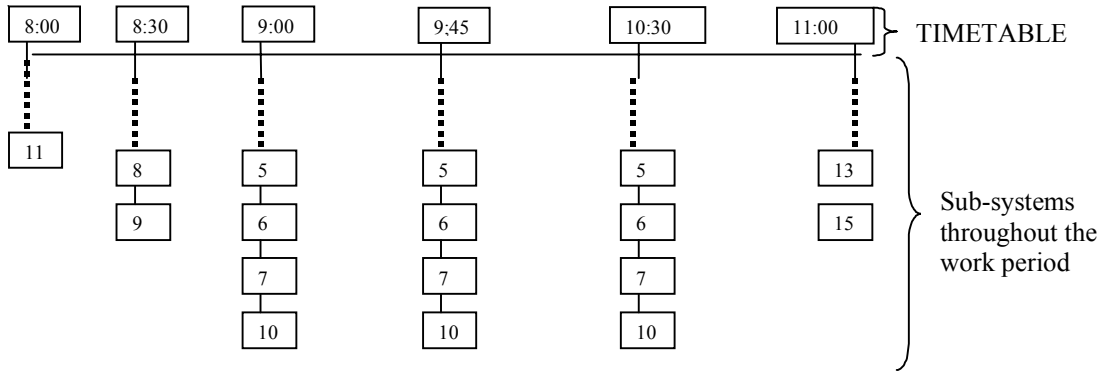


Figure 1 - Daily activity report during a work period in a Totally Familial (TF) broiler operation.

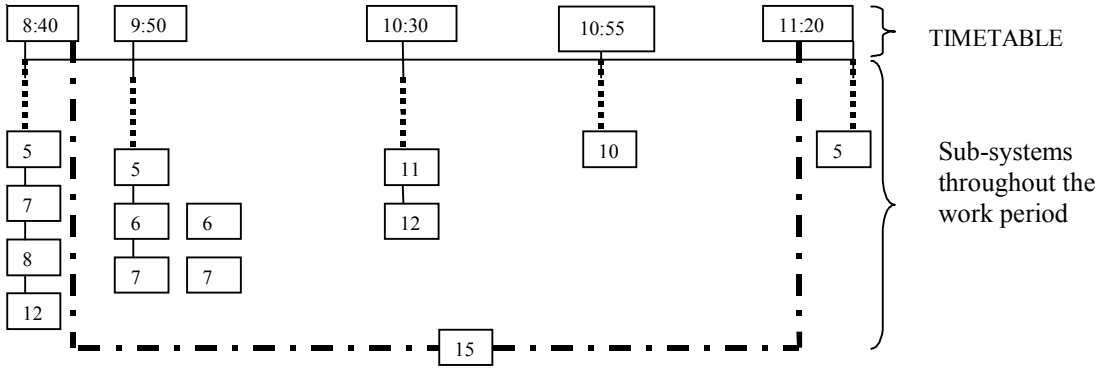


Figure 2 - Daily activity report for a given work period at a Partly Familial (PF) broiler operation.

activity reports correspond to the sub-systems related to both broiler handling and the management of other activities, and illustrate more clearly that tasks concur with one another. In Table 3, for instance, it is possible to show that in house 2, at 09h45, three family members start handling the curtains (sub-system 5) and, at the same time, they feed the broilers (sub-system 6), take care of the water supply (sub-system 7),

and check the humidity and temperature, that is, during this period, sub-systems 5, 6, 7, and 10, are interconnected.

Depending on the technology level adopted, broiler handling could become easier and more accurate, with a reduction in both required body strength and the number of persons engaged in the tasks. On the other hand, various sub-tasks were generated, many accounting for supervision of equipment operation. Even when higher technology level was adopted, adjustment and the development of tools and equipment to minimize stress and possible injuries, and make the job easier, are present in all forms of work organization, although their occurrence is more significant in the two familial categories. The task "feed/ration supply", performed on a daily basis and throughout the whole production cycle, exemplifies both this situation and the fact that different sub-tasks are generated when different technology levels are adopted (Table 6).

During the first 15 days (this period varies from one operation to another), the birds are fed in bins (other containers can be adapted, such as dishes from old feeders or even tubular feeders), spread in the coup to complement the food offer from the automatic feeders, such as the flextube feeder and the chain feeder. Feeding requires great physical strength, is performed twice a day, usually early in the morning and at mid-afternoon, while the maintenance and repair of the feeding equipment may extend to the entire work shift, depending on the daily priorities and work organization.

In the case of both P and PF categories, workers follow owners instructions and establish priorities regarding tasks scheduled for the day, as opposed to the workers in the TF structure, in which the owner sets priorities for the day, even though these priorities may vary as a function of the family´s own needs, which causes the family work shift to be extended.

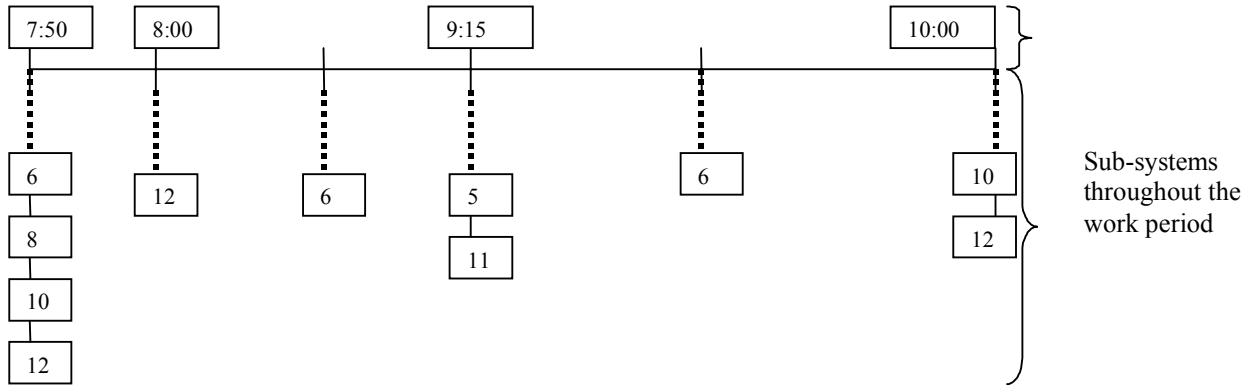


Figure 3 - Daily activity report for a given work shift at Patronal (P) broiler operation.

Table 6 - Sub-tasks derived from the feed supply chore during the broiler production cycle.

Task: Ration feeding	
Sub-tasks as per the technology level	
Medium-to-high technology level	Medium-to-low technology level
Lowering of feeder supply lines,	Assembly and leveling of chain feeders,
Distribution of portable feeders,	Distribution of drip cups,
Manual supply of drip cups,	Manual supply of drip cups,
Manual supply of automatic feeders,	Manual supply of chain feeders,
Start up of automatic feeders,	Feeder start-up (worker stay in the poultry house to check for possible failure/problems),
Removal of drip cups	Removal of a few drip cups,
Feeder cleaning (removal of litter that is mixed with the ration/feed)	Drip cup cleaning and storage,
Drip cup cleaning and storage,	Tray feeding,
Equipment operation check.	Feeder cleaning (removal of litter that is mixed with the ration/feed)
	Equipment operation check.

Many tools and equipment are adapted, or developed, to help performing this task, minimizing the required body strength and the risk of possible injuries, as well as facilitating the job. These adjustments and adaptations are more frequent in the familial categories. In the patronal operations, however, an even greater physical effort is demanded, for there is no adapted equipment available to minimize the physical effort during the performance of this type of task.

Analysis of the Cooperative's documents revealed the existence of parameters for describing production efficiency regarding operations final gains. Among these formal parameters, stand feed conversion and mortality, which form the Production Factor (PF) indicator (equation 1). These values are obtained from data collected daily by the workers at the operation, and plotted on a card named the broiler house report form.

$$PF = \frac{\text{Viability x DWG x 100}}{FC} \quad (1)$$

where: Viability = 100 – Mortality

$$\text{DWG= Daily Weight Gain} = \frac{\text{average weight (kg)}}{\text{age (days)}}$$

$$\text{FC= Food Conversion} = \frac{\text{ration/feed(kg)}}{\text{broiler's liveweight}}$$

This indicator was used, at first, to measure performance of the operations via statistical analysis, such as the calculation of the arithmetic average and the standard deviation of the amounts in the FP report. An other approach proposed in this study is the use of the theory of the technology utility or maturity degree of the technology used in the production units.

Data from the Production Factor report (Figure 4) were provided by the Cooperative for five years interval (2000-2004), and a logistic (S) curve (Lanford, 1972) generated. This curve best represents the improvement in technological knowledge: a succession of different technologies emerging during a given period of time to meet the demand for increasing a certain work performance capacity, and it may be used to estimate the maturity degree of a certain technology, which can be understood as the level of knowledge and application of the technology being adopted, ranging either from 0 to 1 or from 0 to 100%.

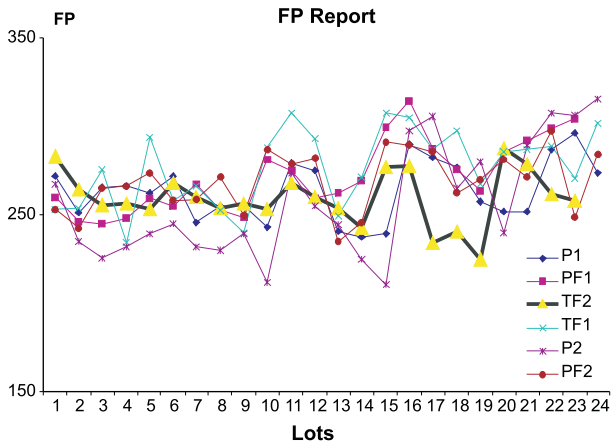


Figure 4 - PF report for all the production units.

A logistic curve was then adjusted for each operation and its respective utility was obtained according to a Production Factor (PF) throughout the time. A distribution of the frequency of occurrence of the PF values was performed to calculate the parameters. The values of a, b, and c were then arbitrated until both the S curve, taken as reference, and the curve actually obtained, were adjusted to one another.

It was then possible to find the logistic curve equation for each operation. Through these equations, which represent the curves shown in Figures 5-7, and which are generated from the PF report, it was possible to calculate the technology utility for each operation being studied (equation 2).

$$u(x) = \frac{1}{a - b \cdot e^{-c \cdot x}} \quad (2)$$

where: u(x) = technology utility; x = attribute being studied – (PF); b = admensional constant; c = constant per attribute unit; $a = 1$.

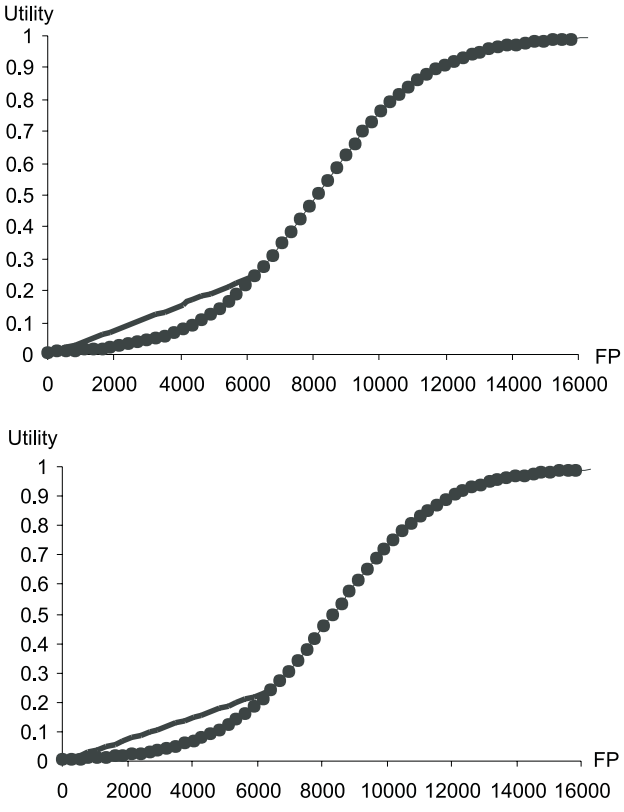
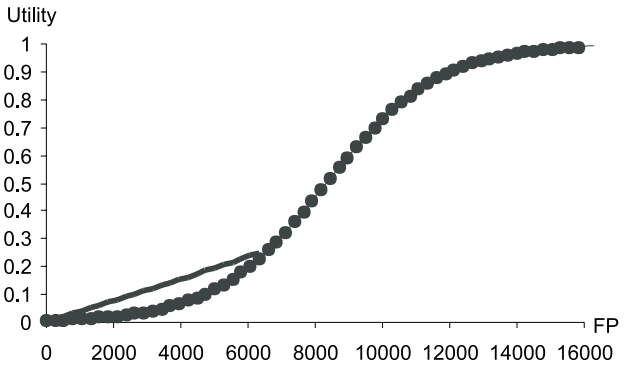


Figure 5 - Technology utility function curves for units TF_1 and TF_2.



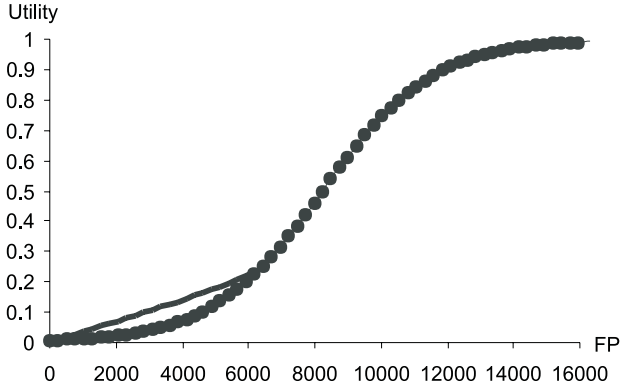
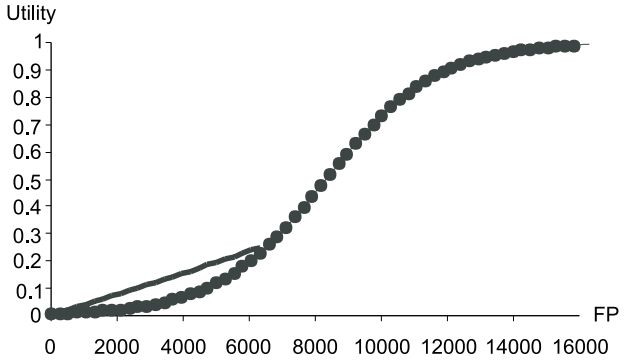


Figure 6 - Technology utility function curves for units PF_1 and PF_2



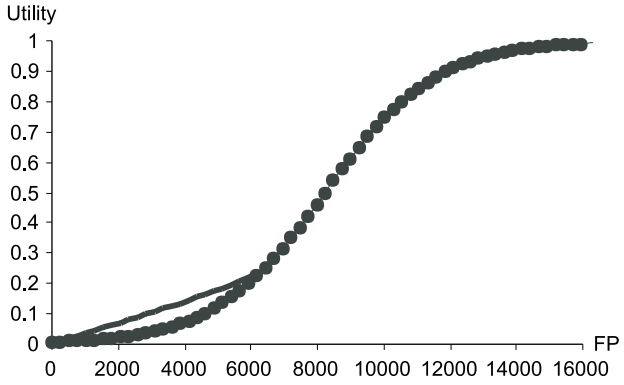


Figure 7 - Technology utility function curves for units P_1 and P_2.

Table 7 - Verbal records from different workforce compositions adopted in broiler operations.

Composition of the workforce	Verbal records
Patronal (P)	*"**The owner said** the lot yield was good, but he hasn't shown us the results yet."*
Partly Familial (PF)	*"Broielers from **my** last lot weighed as much as three kilos. It was a very good lot and the PF (production factor)was high."*
Totally Familial (F)	*"The last lot turned out to be very good. **We** got the first place. The only reason I didn´t get better results was the fact that the slaughter was delayed."*

$$b = \frac{1}{u(0)} - 1 \qquad c = -\log \frac{u(0) - u(0) \cdot u(1)}{u(1) - u(0) \cdot u(1)}$$

These values represent either the technology utility or the maturity degree of the technology. Because we are dealing with operation from the same Cooperative (of which both standards and results are demanded), even when very proximal results are obtained, results obtained by the familial categories are better than those obtained by the patronal categories. In the familial categories, it was observed that the workers' posture e.g., talking in the first person about their work (refer to verbal records shown in Table 7), denotes the undertaking of responsibilities for both decision-making and operational actions, which causes a higher degree of motivation and commitment.

The analysis of PF also shows variations in the obtained results, which could, in some cases, be attributed to climate factors (production decreases, especially during winter) and to the adoption of new technologies, but mainly to labor management, which depends a great deal on the work organization adopted.

Regarding the impact of the tasks comprising the production steps on both the physical and psychological well-being of workers, individuals engaged in sanitary depopulation experience both physical stress (in connection to litter removal) and psychological stress (exposition to the odor exhaled from litter). During broiler handling, both dead bird removal and culling are considered painful from the emotional point of view. Both curtain management and dead bird removal

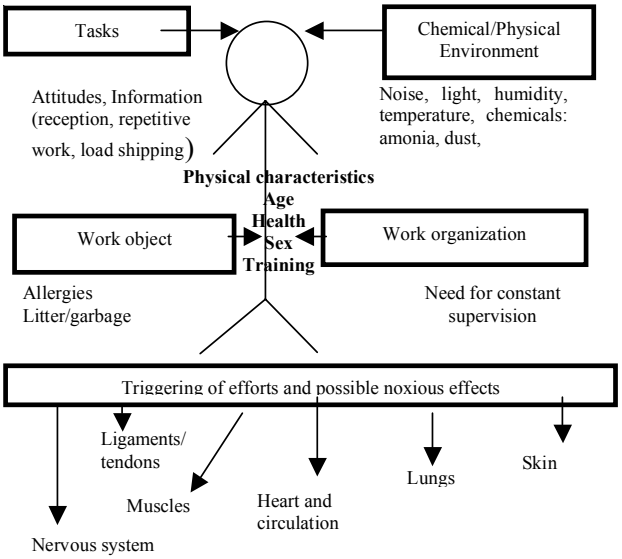


Figure 8 - Factors acting both directly and indirectly on workers engaged in broiler production (adapted from Stoffert, 1988).

were also reported as more painful from the point of view of physical strain.

Verbal records point to the occurrence of work-related physiological disturbances, such as ligament and tendon problems, skin problems and breathing difficulties. Figure 8 gives a clearer view of the situations/conditions to which broiler breeding workers are exposed during the performance of their activities, which can cause stress and other complications that can affect their well being.

According to Alencar et al. (2004), the broiler houses environment is a combination of various physical and physiological factors which generate a complex system of interaction. The growth system, the light, temperature and atmosphere, allied to high densities in the breeding stock and the lack of effective ventilation, may decrease air quality with a high concentration of air pollutants, such as both organic and inorganic dust, pathogens and other microorganisms, fumes such as ammonia, nitrogen monoxide, carbon dioxide, hydrogen sulfide, and methane. Inhalation of organic dust can cause allergic, respiratory reaction in workers, which may evolve into hypersensitive pneumonitis over the years and cause irreversible sequels to the pulmonary function, besides eye, nose and throat irritation.

CONCLUSIONS

Higher level of technology in broiler operations enables the use of fewer workers and makes handling easier and more precise. On the other hand, it generates sub-tasks and causes equipment operation to be too dependent on supervision by workers. The best production results were achieved by operations using familial workforce, a composition in which workers, although having to perform a greater number of tasks, can work more independently from one another, resulting in a greater degree of motivation to perform tasks – even those considered the most painful. The same degree of success is evidenced through the analysis of the maturity degrees of the technologies adopted, which points to familial units using the most consolidated technologies. When new technologies are less frequently adopted, better mastery of technology and adjustments and development of tools which facilitate the work and reduce operating costs are registered. The patronal category, on the other hand, has yielded poorer results, possibly because a more frequent adoption of new technologies, which causes the maturity degree of technology to be lower.

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