

Work and technological innovation in organic agriculture

Tereso, M.J.A.^{a,*}, Abrahão, R.F.^a, Gemma, S.F.B.^b, Montedo, U.B.^c, Menegon, N.L.^d, Guarneti, J.E.^e, Ribeiro, I.A.V.^a

^a Faculty of Agriculture Engineering, Campinas State University, 501 Candido Rondon ave, 13083-875, Campinas, SP, Brazil

^b School of Applied Sciences, Campinas State University, 1300 Pedro Zaccaria st, 13484-350, Limeira, SP, Brazil

^c Polytechnic School, São Paulo University, 380 Prof. Luciano Gaulberto ave, 05508-010, São Paulo, SP, Brazil

^d Center of Exact Sciences and Tecnology, Federal University of São Carlos, km 235 Washington Luis hwy, 13565-905, São Carlos, SP, Brazil

^e Bauru School of Engineering, São Paulo State University, 1401 Eng. Luiz Edmundo Coube ave, 17033-360, Bauru, SP, Brazil

Abstract. Organic agriculture is a sustainable cultivation ecologically, economically and socially. Several researches in organic agriculture have been made from technical perspectives, economic traits or related to ecological aspects. There are practically no investigations into the nature of the technology used in organic agriculture, especially from an ergonomic perspective. From the activity analysis, this study aimed to map the technology used in the production of organic vegetables. Properties producing organic vegetables were selected representing the State of São Paulo. It was applied an instrument (questionnaire and semi-structured interview) with their managers and it was made visual records to identify adaptations, innovations and technological demands that simultaneously minimize the workload and the difficulties in performing the tasks and increase work productivity. For some of the technological innovations a digital scanner was used to generate a virtual solid model to facilitate its redesign and virtual prototyping. The main results show that organic farmers have little technology in product form. The main innovations that enable competitive advantage or allow higher labor productivity occur in the form of processes, organization and marketing.

Keywords: innovation, organic agriculture, horticulture, technological innovation, work productivity

1. Introduction

Organic agriculture is a sustainable cultivation ecologically, economically and socially. Although several studies on organic agriculture have been made from technical perspectives, economic traits and ecological aspects related to practice there are no investigations into the nature of the technology used in this form of cultivation, especially from an ergonomic perspective.

For ABRAHÃO et al. (2008), unlike the heterogeneity typical of conventional agriculture, the majority of organic farms has very similar characteristics: the diversity of production related to their own precepts and certification; predominant family production in small areas; meaningful part of production for export or aimed at specific niches of consumers; wide variety of work systems as a result of the diversity of production. These features require their own technologies, aimed at their specific needs. As the available technology was developed for the conven-

* Corresponding author. e-mail: mauro@feagri.unicamp.br

tional model of agriculture, organic farmers adapt tools and equipment and innovate to increase the productivity of their work.

The organic production units, as any other organization, seek to remain competitive in the market. SCHUMPETER (1984) states that the essential feature of capitalism is its dynamic nature and evolutionary processes linked to innovation that culminate in the creation of new products and processes, opening new markets, developing new sources of supply of raw materials or other inputs and changes in the forms of industrial organization. Organizations would innovate when seeking competitive advantages or to consolidate their competitive position.

BIN (2008) suggests that innovation includes products, processes and new business activities or organizational models. It is not only conceptualized by the progress on the knowledge border, but also as the first time you use or adapt technology to new contexts.

Technological innovation ascribes creating human-related products (artifacts, tools, equipment or machine), technical processes and organizational processes that have proven to be advantageous over traditional practices (CHESBROUGH, 2003; LEDERMAN and SAENZ, 2004).

To understand innovation in organic farming, the typology proposed by the Oslo Manual (OECD, 2005) was adopted:

- **Product innovation:** market introduction of new (or significantly improved) products or services. They include major changes in their technical specifications, components, materials, incorporated software, user interface or other functional characteristics. In organic agriculture we can consider the tools, machinery, equipment and instruments adopted in production practices and in post-harvest;

- **Process innovation:** adoption of new (or significantly improved) processes or logistics of goods or services. In organic agriculture it corresponds to adaptive processes of the cultivars, the techniques used to deal with natural resources, production and property, and the strategies used to control biological agents that compete with the production (fungi, insects, plants);

- **Organizational innovation:** the implementation of new organizational methods in the company's business practices, in the workplace organization or in the external relations. Examples include the adoption of new practices of teamwork, management and coordination, association and cooperative work with others;

- **Marketing innovation:** adoption of new marketing methods, involving significant improvements in

product design or packaging, pricing, distribution and promotion. May be the marketing strategies to win new market niches and linkages with other producers to strengthen the supply to customers.

This study aimed to map the technology innovation that, while minimizing the workload and the difficulties in performing the tasks, increases labor productivity in the organic production properties of vegetables representing the State of São Paulo, Brazil.

2. Methods

It was applied an instrument (questionnaire and semi-structured interview) with the managers of 33 units of organic vegetable production to identify changes, innovation and technological demands.

The instrument was developed to gather the following information: the manager's experience with organic agriculture; the characteristics of the production unit; area devoted to organic planting; the main horticultural crops; work organization strategies and marketing; workforce characteristics of the farm; equipment, tools and instruments used in the different tasks in the work systems; and developed agronomic processes. Technological innovation and its development experiences were explored in the interview. A camcorder was used for visual records of the technological innovation in the production units and a digital scanner was used to generate a virtual solid model of the new tools designed or adapted by the producers.

3. Results and Discussion

The following work systems were identified, with their respective tasks, confirming the observations of GEMMA et al. (2010). Table 1 shows machines, tools and equipment used by producers for the development of horticulture-related tasks in each work system.

The interviewed managers revealed varied experience with organic farming. The range varied from who have been recently certified, to those who have been more than 20 years with this type of production.

Most surveyed production units are familiar with an area of less than 20 ha, although some production units hire employees. All have an environmentally protected area and are characterized by diversity of production, especially for growing lettuce, common to all properties surveyed.

Table 1
Tools, equipment and machines used on the different work systems

Work Systems	Tasks	Tools, equipment and machines
Soil preparation	Preparation of beds	hoe, tractor, rotary hoe and bed-making machine
	Composting	fork, shovel, hoe, wheelbarrow, thermometer, tractor, trailer and shell
	Fertilizer	containers, wheelbarrow, shovel, hoe, fork, backpack pump, tractor, sprayer
	Coverage	shovel, fork, wheelbarrow, hammer, clamps, stakes, tractor, trailer and shell
	Substrate preparation	hoe and wheelbarrow
Seeding production	Seeding	jigs and trays
	Seedlings in cultivation	
	Irrigation	manual watering, hose and sprinklers
	Filling	jigs and trays
	Thinning	
Planting	Planting irrigation	watering cans, hoses and spray
	Sowing	containers, shovels, seed drills and drill
	Transplanting	wheelbarrow and fork
	Tubers/roots planting	hoe, shovel, knife, scissors, and screw to make tractor holes
Crop handling	Inspection	
	Weeding	hoe
	Fertilization	wheelbarrow, shovel, backpack pump, tractor, shell, truck and sprayer
	Pest control	backpack pump, sprayer and tractor
	Irrigation	watering can and hose, spraying and dripping
	Staking and tying tape	knife, pincers, scissors and excavator
Harvest	Vegetable harvest	knife, scissors, baskets and hoes
	Pre-cleaning	knife and scissors
	Transportation	wheelbarrow, boxes and baskets, tractor and truck
	Cleaning	sponge and tanks
Post-Harvest	Selection and classification	knife
	Packaging	cold chamber, sealing film, boxes
	Stocking	wheelbarrow
	Expedition	wheelbarrow

Most workers perform all the tasks that make up the different work systems in organic horticulture. The exceptions are limited to the few tasks that require great strength — done only by men, such as root harvesting — or machinery and equipment operation such as tractors and sprayers. Teamwork is another feature of organic horticulture.

Some marketing innovations were identified, such as delivering baskets of products to consumer's homes through the request made from the internet and the development of own brands and packaging for vegetables, according to the principles of traceability.

All producers surveyed have innovated their processes, especially with regard to agronomic adaptations to introduce new crops. Each situation reveals itself unique, depending on the characteristics of the production unit — microclimate, soil, topography and spatial terrain orientation and water quality.

Most producers sought to develop machinery and tools to increase labor productivity. The adaptations to help manual handling tasks were the most common — wheelbarrows to transport boxes and products harvested — and those aimed at cultural practices, such as hoes adapted to growing in beds.

References

- ABRAHÃO, R. F.; TERESO, M. J. A.; GEMMA, S. F. B.; SNELWAR, L. I.; MASCIA, F. L. Work and Innovation in Organic Agriculture. In: IX International Symposium on Human Factors in Organizational Design and Management –ODAM–2008, Guarujá – SP. **Proceedings...** Santa Monica – CA, USA: IEA Press, v. 1. P.: 297-305, feb., 2008
- BANCO MUNDIAL. **Conhecimento e inovação para competitividade**. Brasília: Confederação Nacional da Indústria, 2008.
- BIN, A. **Planejamento e gestão da pesquisa e da inovação: conceito e instrumentos**. 239p. Tese (Doutorado em Política Científica e Tecnológica) – Instituto de Geociências, Universidade Estadual de Campinas, Campinas, 2008.
- CHESBROUGH, H. **Open innovation: the new imperative for creating and profiting from technology**. Boston: Harvard Business School Press, 2003.
- GEMMA, S. F. B.; TERESO, M. J. A.; ABRAHÃO, R. F. Ergonomia e complexidade: o trabalho do gestor na agricultura orgânica na região de Campinas - SP. **Ciência Rural**, Santa Maria – RS, v.40, n.2, p: 288-294, 2010.
- LEDERMAN, D.; SAENZ, L. Innovation and development around the world. **Policy Research Working Paper**, n. 3774, 2004.
- OECD. **Oslo Manual: guidelines for collecting and interpreting innovation data**, 3ed. Paris: OECD, 2005.
- SCHUMPETER, J. A. **Capitalismo, socialismo e democracia**. Rio de Janeiro: Zahar Editores S.A., 1984.
- WORLD BANK. **World development report 1998/1999: knowledge for development**. New York: Oxford University Press, 1999.

4. Conclusions

Organic farmers have little technology in the form of products (machinery, equipment and tools). The main innovations that enable competitive advantage or allow higher labor productivity occur in the form of processes, organization and marketing.

Most of the equipment and tools developed by producers in the form of trial and error proved to be ineffective and was soon abandoned by farmers. This demonstrates a clear demand for this technological development for the productive sector.

The main innovations are related to processes, work organization and marketing.