HARVEST LABOR QUALITY AND PRODUCTIVITY: CASE STUDY OF CHERRY GROWING IN CHILE[1]

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ABSTRACT - In Chile, the cherry tree has been one of the fastest growing and most profitable crops in the last ten years. However, increasing production costs, the scarcity of hired labor, and unfavorable exchange rates have reduced the productivity and competitiveness of the Chilean fruit sector. The aim of this article is to evaluate the harvest labor quality in cherry growing in Chile through the use of productivity indicators. A harvest labor evaluation system (HLES) was designed and four indicators were measured: *Average Weight of Harvested Box, Average Daily Production per Worker, Percent of Export Fruit, and Percent of Fruit Discarded*. Significant differences were found between the 2010/11 season (with the HLES implementation) and the previous seasons without HLES. The average worker yield, average weight of a filled box, and fruit quality improved, while the amount of discarded fruit decreased. Hired labor management in agriculture is crucial for improving the productivity of the fresh fruit export producers. The use of HLES and the adoption of new technologies could help to solve the competitiveness problem in the Chilean fruit sector.
Index terms: Human resource productivity, Performance indicators, Assessment, agriculture.

QUALIDADE E PRODUTIVIDADE DO TRABALHO NA COLHEITA: ESTUDO DE CASO DE CEREJEIRAS QUE CRESCEM NO CHILE

RESUMO - No Chile, a cerejeira tem sido uma das culturas de mais rápido crescimento e mais rentáveis nos últimos dez anos. No entanto, o aumento dos custos de produção, a escassez de mão de obra contratada, e taxas de câmbio desfavoráveis reduziram a produtividade e competitividade do setor de frutas no Chile. O objetivo deste artigo é avaliar a qualidade do trabalho na colheita em cerejeiras crescendo no Chile através da utilização de indicadores de produtividade. Um sistema de avaliação do trabalho de colheita (HLES) foi projetado e quatro indicadores foram medidos: Peso médio das caixas colhidas, produção diária média por trabalhador, percentagem de exportação de frutas, e percentagem de frutos descartados. Foram encontradas diferenças significativas entre 2010/11 (com a implementação do HLES) e das temporadas anteriores sem HLES. O rendimento médio por trabalhador, peso médio da caixa cheia, e a qualidade dos frutos melhorou, enquanto a quantidade de frutos descartados diminuiu. A administração do trabalho contratado na agricultura é crucial para melhoria da produtividade de produtores exportadores de frutas frescas. O uso do HLES e a adoção de novas tecnologias poderiam ajudar a resolver o problema de competitividade no sector de frutas chileno.
Termos para indexação: produtividade dos recursos humanos, indicadores de desempenho, avaliação, agricultura.

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INTRODUCTION

World cherry production has shown significant growth in the last 20 years, with a total land area of over 380,000 hectares that produces around 2.19 million tons. Major producer countries are mostly in the northern hemisphere: Turkey (428,000 metric tons), United States (412,000 metric tons), Iran (198,000 metric tons), and Italy (125,000 metric tons), which together account for 95.1% of production. The main countries in the southern hemisphere are Chile with 62,000 metric tons, Australia with 19,000 metric tons, and Argentina with 8,000 metric tons, which together represent 4.3% of world cherry production (COMTRADE, 2014). Cherry mostly is consumed as fresh fruit, and it is one of the most widely appreciated fruit for its taste, sweetness and myriad of nutrients (WANI et al., 2014). Also cherries are an important source of antioxidants and nutrients (GABRIELE et al., 2013). Fresh cherries are rich in sugar, anthocyanins, organic acids, tannins and ascorbic acid (YILMAZ et al., 2009). The health benefits of cherry have increased its demand especially in developed countries.

In Chile, the cherry tree has been one of the fastest growing fruit trees. It covers a land area of close to 17,200 hectares, and has an estimated 2015 production of 71, 000 metric tons, of which 52,000 are destined for the foreign market (ODEPA, 2014). Chile is the major producer and exporter of cherries in the southern hemisphere and the second major exporter in the world (ODEPA, 2011a). The increasing interest in cherry tree production is due to several factors: the favorable conditions of soil and climate in Chile, the high profitability of cherry crop, the high international demand, the trade liberalization, and the diversification of new markets (ROJAS et al., 2010). China is the major export destination, receiving 58% of total exports in the 2013/2014 season, followed by the USA with 18.1%, Hong Kong with 15.4%, and Brazil with 4.9% (ODEPA, 2014).

Despite of the bright past of Chilean fruit production, currently the sector is facing competitiveness problems. The agricultural sector currently employs 10% of the total workforce of the country, and the fruit subsector accounts for 9.8% of this section (ODEPA, 2011a). The productivity of agricultural labor during the 2000-2014 period grew at an average rate of 8%; however, agriculture had the lowest increase in labor productivity compared to other sectors of the national economy (ODEPA, 2014). For example, output per person employed in mining is more than 10 times that of farming

activities (ODEPA, 2009). During the 1998-2008 period, the labor force in Chile grew by 28% while the agricultural labor force increased by only 5%. According to Katz and Melo (2009), this situation is related to the importance of the labor item in the cost structure of fruit companies, amounting to approximately 46.5% of total production costs, and in some cases 70 or 80% (for table grapes and avocados, respectively).

The rising costs of energy and the increasing scarcity of labor have drastically reduced profitability and are endangering the viability of a large percentage of fruit orchards in Chile (RETAMALES and SEPÚLVEDA, 2011). Anderson and Valdes (2008) and Katz and Melo (2009) identified two topics that represent a risk for the competitiveness of agriculture: relative exchange rate (or appreciation of the Chilean peso) -which has decreased 26.5% over past ten years (BANCO CENTRAL DE CHILE, 2015) and the rising labor costs in the production of export products. Moreover, competitiveness is also affected by the rising price of inputs. In the last 10 years the price of urea nitrogen fertilizer increased more than 300% (MELO and REBOLLEDO, 2008).

A trend toward increasing rigidity in demand for labor associated with the labor code could represent a risk to the survival of important crops such as berries, seeds, and major fruits. Domínguez et al. (2008) explain that the competitiveness of the fruit sector not only depends on the quality of the products or external factors like the relative exchange rate, but also on the human resources management strategy, worker training, and general work conditions of the employees. The strategies of the Chilean fruits export sector have been aimed at achieving economies of scale and optimizing production and commercial processes in order to lower costs and compete efficiently in the competitive markets (ADASME et al., 2012). However, the growing increase in production costs (labor, energy, and inputs), dollar devaluation, and the decrease of hired labor availability have jeopardized the production of cherries and other fruits, compromising the sustained rise in growth experienced in recent years. This scenario gives rise to the need to research new ways of improving the productivity of the agricultural labor force in this sector. Also, the cherry fruit requires a significant amount of labor (on average 135 workdays per hectare in the season), especially for harvesting in the months of November and December (77 workdays per hectare) (ODEPA, 2011b). The scarcity of the hired labor in this scenario is made more complex by the fact that at the same time as the cherry harvest in Chile there is also a need for labor

for canopy management of table grapes and thinning and green pruning of stone fruits. At the same time, the blueberry harvest and the harvest some early varieties of peaches or nectarines in the central part of the country are also taking place (DOMÍNGUEZ et al., 2008).

In the international literature, human capital productivity has been a widely investigated topic, especially at the aggregate level. Sharma et al. (1990) showed that during the 1975-1980 period, the labor productivity of the agricultural sector was higher in developed countries than in countries in developing. Since the late 1970s, US and European consumers have enjoyed year-round availability of fresh grapes, pears, apples, and peaches in their local supermarkets— fruits that, in the winter months, come disproportionately from Chile (TINSMAN, 2003). The growth of export-oriented fruit production in Chile has increased the demand for labor, although mainly for temporary workers. Usually in the agricultural sector temporary workers are more numerous than permanent workers, and there are less social security benefits and less employment protection for temporary labor (GWYNNE, 1999). Ortiz and Aparicio (2007) pointed out that most new jobs created by the growth in horticultural exports have been unskilled low-wage jobs. This outcome supports the contention of many researchers and managers of successful companies that abundant 'cheap labor' was a necessity. However, 'cheap labor' could decrease competitiveness once the industry has consolidated its position in foreign markets. Schurman (2001) shows that the hyper-competition currently characterizing the agricultural export sector is putting pressure on companies to reduce costs, including labor costs. Chilean workers will have to be more productive; thus, new policies that increase productivity are required. The effects of these policies are influenced by the human capital characteristics of the hired labor.

Given the current scarcity of agricultural labor in Chile it is necessary to found strategies that improve labor performance especially in harvest season where the demand for labor increases notably. The aim of this article is to analyze a method for evaluating the quality of labor in cherry harvest in Chile and to evaluate this method using productivity indicators.

MATERIALS AND METHODS

The study was conducted between October 2010 and January 2011, in an area of the San Francisco de Mostazal in the Cachapoal Province,

Region VI, between 33°59' S and 70°41' W at 503 m.a.s.l. (meters above sea level). We selected two plots within the orchard (see Table 1) and the quality of the hired labor at harvest time was evaluated.

Harvest labor evaluation system (HLES)

The harvest evaluation was performed using 10% of the production achieved by the workers during the day, (e.g. if the worker harvested 20 boxes, two were checked). A complete harvest period was evaluated for four seasons (2007/08; 2008/09; 2009/10 and 2010/11). The harvest period usually begin on November 20-25th until December 15-20th (roughly 20-25 days). Table 3 show a detail of man-days or *Daily Work* (DW) required for each season and for each plot evaluated. Since HLES requires a large number of workers, a quality control procedure for each team of workers was established, and a supervisor was appointed to go through the teams and oversee sampling. The evaluation focused on the quality of the fruit, and the parameters evaluated were chosen to ensure proper harvest of fruit in good condition, taking into account color, splitting, and blemishes, as detailed in Table 2.

The steps for taking harvest evaluation samples were: 1) identifying the plot and harvest team; 2) taking the sample, which entails randomly choosing one box from the pallet containing the boxes harvested by the team, identifying the worker who harvested it, and weighing the box. From the chosen box, 100 fruits (equivalent to 10% of the fruit contained in the box) were randomly selected. These fruits were checked for defects (in accordance with Table 2), any defects founded were recorded in the quality control form, and the results were given to the team supervisor. A tolerance level of 80% of fruits without defects was set, i.e., up to 20 sampled fruits could be defective (ZOFFOLI, 2010). If at the end of the revision of the sample more than 20 fruits had defects, another box was immediately checked. If the result was negative again, the box was deducted from the worker's pay.

Indicators and data analysis

To analyze the effect of the harvest labor quality control described in section 2.1, the productivity indicators described in Table 3 were established. These were subjected to a separate statistical analysis where the 2010/2011 (with HLES season) was compared to the 2009/2010, 2008/2009, and 2007/2008 (without HLES seasons).

With the *Average Weight of Harvested Box* (kg per box) and *Average Daily Harvest per Worker* (kg per DW and boxes per DW) indicators, an

average comparison was done through a single factor analysis of variance (ANOVA, *p*<0.05) and a Tukey test with a confidence interval of 95%. In the case of the *Percent of Export Fruit* and *Percent of Fruit Discarded* indicators, a simple comparison was done using descriptive statistics.

RESULTS AND DISCUSSION

Average Weight of Harvested Box

Table 4 shows significant differences (p<0.05) in the *Average Weight of Harvested Box* in the different seasons both in the comparison of the separate plots and the plots as a whole. For the "Bing 99" plot, the 2010/11 season (HLES) has an average of 9.07 kg per box, and the largest difference was with the 2007/08 season (7.90 kg per box), with 1.17 kg of variance, equivalent to 14.9%. The 2008/09 season had the smallest difference: 0.85 kg, equivalent to 10.3%. Regarding the "Bing 2001" plot, season 2007/08 (7.74 kg per box) was the most different from the HLES season (9.02 kg per box) with 1.27 kg (16.4%), while the 2008/09 season was the less different with 0.90 kg (11.0%). Overall, the HLES season had a positive effect on the *Average Weight of Harvested Box*, with at least 1 kg per box more than the rest of the control seasons. Additionally, increased filling of the boxes has an overall positive impact on the farm, i.e. savings in resources used in harvest labor such as boxes, pallets, and transport (tractor plus tractor workday).

Average Daily Production per Worker (kg per DW and boxes per DW)

Table 5 shows the *Average Daily Production per Worker* measured in kg per DW and boxes per DW. In the case of kg per DW, HLES season shows significant differences with the rest of seasons for both plots. In the case of the "Bing 99" plot, the 2009/10 season (101.31 kg per DW) has the largest difference compared to the HLES season (155.17 kg per DW), with 53.86 kg and 4.58 boxes less than HLES. For the "Bing 2001" plot, the 2008/09 season, with 94.32 kg per DW, was the most different from the HLES season. Relation to the measurement of boxes per DW in the "Bing 2001", there were significant differences in the 2008/09 and 2009/10 seasons relation to the HLES season (4.42 boxes and 2.04 boxes or, respectively). This was not the case with the 2007/08 season. The pooled analysis of both plots show that the 2008/09 season, for both the kg per DW and boxes per DW measurements (42.6 kg and 3.38 boxes, respectively), was most different from the HLES season, while the 2008/09 season

was the less different.

The average output per worker was always higher in the HLES season, where the quality of labor evaluation method was applied to both the kg per DW and boxes per DW measurements. In cases where the difference was minimal or even zero (number of boxes harvested in the 2007/08 season), it was due to the effect of the harvested box average weight indicator, because in the 2007/08 season the content of the boxes (kg per DW) was lower than in the 2010/11 season. This produced a decrease in average number of boxes harvested by workers (boxes per DW) in the 2010/11 season. This was not the case with the average number of kilograms harvested per worker.

Exports and Percent of Fruit Discarded

Table 6 shows the *Percent of Export Fruit* from the HLES season with previous seasons. The overall percent of export fruit for HLES season was 89.9% and it can be observed an increase of 3.7%, 5%, and 7.7% in relation to the 2007/08, 2008/09, and 2009/10 seasons, respectively. Despite the fact that there were no statistical tests for this indicator, the export percentage for the 2010/11 season—in which the quality of labor evaluation was implemented—was always higher than for the previous seasons.

Table 6 also shows the results for the *Percent of Fruit Discarded*. For the "Bing 99" section, there is a slight decrease in this indicator in the most recent season from the 2007/08 season. The decrease from the 2008/09 and 2009/10 seasons to the 2010/2011 season is more pronounced. For the "Bing 2001" section, it is seen that the *Percent of Fruit Discarded* of the most recent season went down significantly from previous seasons. The *Percent of Fruit Discarded* of the HLES season, in which the quality of labor evaluation was implemented, was lower in every case. This improvement can be explained by the change made in the harvest structure: each team of workers had a quality control supervisor. Each worker had a better quality harvest, treating the fruit better and avoiding bruising, blemishes, and low caliber fruit, thus reducing the amount of discarded fruit.

Productivity and quality of hired labor in agriculture is undoubtedly a variable to which cherry producers must pay attention. Hired labor management is a helpful tool to achieve efficiency and productivity on the entire farm (BILLIKOPF, 2002). In this context, our results show improvements, such as: a) improvement in box filling, which positively impacted the use of inputs of the farm; b) the average output of workers improved or at

least stayed constant, given the greater productivity required of them in the harvest; c) improvement in the quality of the fruit sent to processing, observed in the increase in the percent of fruit exports; and d) decrease in the percent of fruit discarded, at the same time as a decrease in the loss of potentially exportable fruit. These improvements are attributable to the implementation of the HLES method.

These results are in line with Billikopf (2002), who argues that the implementation of a labor performance evaluation can help improve labor productivity and enhance existing practices or establish new labor methods. Moreover, the information gained through the evaluations can also be used to create better job descriptions, plan training programs for already hired employees, and create other benefits that help the farm's performance (SALA & SILVA, 2012). Also, training programs and labor programs are shown to have positive effects on the efficiency of hired labor in other sectors, such as the manufacturing and electronic sectors (MASON et al., 2012; YANG et al., 2010). HLES implementation implies a high investment in training (on-work) and its results showed an improvement in labor productivity indicators. The training "on-work" is suitable to acquire skills for a specific job while off-farm training is useful for acquire skills in any area (DEARDEN et al., 2006). Schonewille (2001) reveals that training has a positive effect on labor productivity but it is not clear whether this is mainly due to off-the-work or on-work training. In the industrial sector, Sepulveda (2010) found that training on-work increase productivity while training outside the company has no effect.

Retamales and Sepúlveda (2011) conclude that more investment in research, improvements in fruit quality, different orchard management practices, and higher financial support from the government are needed for the long-term viability of the fruit industry in Chile. Therefore investment in human capital could be a crucial strategy for improving productivity and competitiveness in the fruit sector (MUGERA et al., 2011). According to Martin and Mitra (2001), the lack of specialization could explain low rates of efficiency of the hired labor in the agricultural sector and training programs could help to fill this gap. However, agriculture has lower rates of training implementation than others sectors of the economy (CONTI, 2005); thus, specific "on-work" training programs should be implemented in order to analyze the relationship between productivity of hired labor and farm performance. Agriculture demands high labor-intensive production rather than mechanization or other inputs, and the most important cost item is hired labor. Therefore, gains in hired labor productivity could guarantee the sustainability and competitiveness of agricultural production (KESKIN et al., 2010). Lastly, these management efforts must be complemented by the introduction of new technologies to facilitate work in the orchards and to increase the productivity and competitiveness of the agricultural sector.

TABLE 1- Description of the plots selected for the study.

Plot name	Bing 2001	Bing 99
Plot size (Hectares)	12.98	5.32
Planting year	2001	1999
Variety/rootstock	Bing/Maxma 14	Bing/Maxma 14
Pollinator/rootstock	Rainier/Maxma 14	Rainier/Maxma 14
Planting areas (m)	3 x 5	3 x 5
Number of plants	8,659	3,548
Conduction system	Central axis	Central axis

TABLE 2-Main defects in cherries that influence the quality of the fruit.

Fruit defects	Fruit defects
Low caliber	Spots
Soft	Splitting in stem cavity
Misshapen	Splitting
Dehydrated	Presence of spurs
Lack of color	Presence of fungus
Open wounds	Russet
Bruises	No pedicel

*Prepared with information from Ellena et al. (2006) and Zoffoli (2010).

TABLE 3- Productivity indicators and information sources.

Indicators	Source
Average weight harvested box (kg·per box)	Producer information
Average daily production per worker (kg per DW and boxes per DW)	Producer information
Export percent	Packing information
Percentage of fruit discarded	Producer information

TABLE 4- Average weight of harvested boxes (kg·box^{-1}) sorted by season*.

kg·box^{-1}	Season			
	2007/08	2008/09	2009/10	2010/11
Bing 99 plot	7.90 d ± 0.16	8.23 b ± 0.20	8.17 c ± 0.24	9.07 a ± 0.11
Bing 2001 plot	7.74 c ± 0.09	8.12 b ± 0.31	7.95 c ± 0.28	9.02 a ± 0.09
Both plots	7.79 d ± 0.13	8.16 b ± 0.27	8.01 c ± 0.29	9.03 a ± 0.10
	Overall savings of the farm			
	2007/08	2008/09	2009/10	2010/11
Boxes (units)	1,994	1,907	1,935	1,716
Pallets (48 boxes)	42	40	40	36
Tractor (4 pallets)	10	10	10	9

*Different letters at same line indicate significant differences (Tukey's test, $p< 0.05$). Standard deviation in *italics*. The data did not fulfill the normality and homogeneity assumptions, so a nonparametric Kruskal-Wallis test was performed, and the ranges were calculated and subjected to an analysis of variance (ANOVA, $p < 0.05$) and Tukey and Games-Howell tests, which yielded the same results.

TABLE 5- Average daily production per worker*.

	Season			
Kg per DW	2007/08	2008/09	2009/10	2010/11
Bing 99 plot	121.60 b ±26.79	123.16 b ±31.82	101.31 c ±30.84	155.17 a ± 39.21
Bing 2001 plot	124.68 b ±34.06	94.32 d ±33.07	111.18 c ±28.29	144.59 a ± 38.85
Both plots	123.80 b ±32.17	105.06 c ±35.45	108.49 c ±29.32	147.67 a ± 39.24
	Boxes per DW			
Bing 99 plot	15.40 b ± 3.37	15.24 b ± 3.86	12.52 c ± 3.92	17.10 a ± 4.33
Bing 2001 plot	16.10 a ± 4.35	11.61 c ± 4.18	13.99 b ± 3.50	16.03 a ±4.34
Both plots	15.90 b ± 4.10	12.96 d ± 4.42	13.59 c ±3.68	16.34 a ±4.36
	DW per season			
Bing 99 plot	531	316	270	560
Bing 2001 plot	1317	533	720	1361

*Different letters at same line indicate significant differences (Tukey's test, $p< 0.05$). Standard deviation in *italics*. The data did not fulfill the normality and homogeneity assumptions, so a nonparametric Kruskal-Wallis test was performed, and the ranges were calculated and subjected to an analysis of variance (ANOVA, $p < 0.05$) and Tukey and Games-Howell tests, which yielded the same results.

TABLE 6- Percent of export and fruit discarded in the orchard.

	Season			
% of export fruit	2007/08	2008/09	2009/10	2010/11
Both plots	86.71	85.64	83.47	89.90
% discarded in orchard				
Bing 99 plot	0.90	1.60	2.30	0.75
Bing 2001 plot	2.28	2.21	2.61	1.15
Both plots	1.59	1.91	2.45	0.95

CONCLUSIONS

The results of this study case showed that the HLES for cherry crop improved the efficiency of workers, since significant differences were found between the HLES season (2010/11) and the previous seasons in terms of average worker output, measured in both kg per DW and boxes per DW.

In addition, the *Percent of Export Fruits and Percent of Fruit Discarded* indicators showed improvements in the HLES season, which was achieved with the same number of people as in previous seasons, i.e., fruit quality improved and the discarding of potentially exportable fruit decreased without requiring as many workdays.

Therefore, the implementation of HLES could improve the competitiveness of the export fruit sector, decreasing the labor costs as a result of a higher efficiency of the workers. Nevertheless, this method must be tested on other exports fruits to validate the results of this study case.

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