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The Impact of Wine Grape Harvester on Labour in Western Cape Province of South Africa

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ABSTRACT

Mechanization and technology in agriculture are becoming more and more evident, not only in developed countries, but also in African countries, and more specifically South Africa. The objectives of the study were to identify the factors that impact labourers when wine grape harvesters are used on farms in the Western Cape Province of South Africa by answering the research question of "Which factors affect labour usage on farms that use mechanical harvesters for harvesting grapes?" The study utilized a survey, secondary data, and a binomial logistic regression model. The study shows that increasing hectares used for the production of wine grapes, farmer's age, machine output and average labour output has a significant impact on the reduction of seasonal labour as well as permanent labour on the farms. The study recommends that the government should intervene or introduce legislation to mitigate the effect of mechanical harvesting of grapes on labour. The government should encourage producers to keep farm workers, given technological advances, which discourage the retrenchment of farmers who apply technology advancement, but retain labourers. The government can also provide incentives to producers who apply technological advancement, but retain labourers.

KEYWORDS: Labour; Wine grape harvester; Production; Seasonal labourers; Permanent labour; South Africa

1. Introduction

The substitution of labour and the introduction of machinery on agricultural operations is a general occurrence, which releases labour for employment in other sectors of the economy. Mechanization leads to higher productivity of land and labour, prepares larger areas of land in less time in comparison to manual labour and brings about a larger output. There is also a push for labourers to move to urban areas for job opportunities, because of economic growth and higher wages. Some implements and labour-saving technologies might positively affect the productivity levels of crops if adopted (Hazarika, 2015).

The cost of manual labour has created a need for specialized vineyard equipment where more activities are performed using machinery. A completely mechanized system is likely in the future for all operational activities in any given season. Mechanical operations should not affect the fruit or wine quality negatively. Mechanized vineyard operations include summer pruning and harvesting, dormant pruning as well as fruit thinning. Mechanical harvesters and other mechanical operations have been in use for some time, but there are no appropriate machines for the 12 major trellising systems (Morris, 2000).

The effect of mechanization could impact on labour on wine producing farms in the Stellenbosch and Worcester district municipalities of South Africa. According to Singh (2006), mechanization technologies keep changing with socio-economic advancement and industrial growth within a country. The non-availability of the agricultural labour for field operations and declining interest in agriculture are some of the socio-economic issues in industrialized nations that promote mechanization. In developing countries, labour productivity with dignity and increasing land use drive mechanization in agriculture. Mechanized technological advances are therefore, dynamic and location-specific. Land and labour productivity as well as the quality of inputs of mechanization may differ considerably[4].

Vivarelli (2012, 2013) discussed the compensation and displacement brought about by mechanization at work. Vivarelli (2013) points out that deskilling and the labour-saving effects of capital-intensive technological advances have been a worry since the Luddite movement of the early nineteenth century. However, the author also

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calls into consideration a range of compensatory instruments that may ease such concerns. Labour-saving effects of technology can be advantageous through: (i) higher demand for goods/services; (ii) larger income emanating from redistribution; (iii) additional employment from creating new machines; (iv) additional investments; (v) decrease in wages from price adjustments and (vi) new products created using new technologies.

Busa and Nandi (2014), and Hazarika (2015) mention both the positive and negative effects in employing mechanization on farms. The positive effects refer to the improvement of productivity and that labour can get more output. While mechanization can reduce time and production costs, farmers can have enough time for other operations on the farm. However, the negative impact of mechanization is that it can substitute manual labour (BFAP, 2012). Saayman and Middelberg (2014) assert that it can be costly to implement mechanization, as not all sectors are capable of structural changes. Studies have different perspectives on what mechanization can bring and whether it is to the advantage or disadvantage of farmers.

Wine grape producers are continuously faced with internal and external farming factors such as increasing production costs, rising labour cost, political instability, economic constraints and technological advances, which impact their decision-making and profitability given the competitive international markets. Regions and different district municipalities where wine grapes are produced depend on the topography of the land. Hills, mountains, rivers, lakes, cities, dams, valleys, and production systems determines a farmer's production techniques. This could influence the financial position of a business and the labour needed. A technique like mechanized harvesting of wine grapes could impact significantly on the viability of a farm and labour usage.

Existing studies such as Adu-Baffour et al. (2019), Busa and Nandi (2014), Reddy et al. (2014), Rotz et al. (2019), and Ugur and Mitra (2017) focus on the impact of promoting mechanization; examine the effective and efficient use of labour; assess indices of labour productivity; and how agricultural technology is shaping labour and rural communities. The studies do not determine the factors and the impact that wine grape harvesters have on labour. Therefore, the objectives of the study were to determine the factors that affect labourers when mechanical wine grape harvesters are used on farms of Western Cape Province of South Africa. This study will aid decision-makers and government to develop policies and make efficient modifications to existing policies on the mechanical harvesting of grapes and labour. The findings will also be useful for extension officers, policymakers, and government to understand the context of mechanization within the wine industry to make recommendations or emphasise sustainable production in provinces, but aligned with labour-related issues.

2. Materials and Methods

2.1. Study area

The Western Cape Province of South Africa has five district municipalities, which include Eden, Overberg, Cape Winelands, West Coast, and Central Karoo. The research was carried out in Cape Winelands, the largest wine-producing region in the Western Cape and South Africa. Many of the wine producers, wine cellars, and producer cellars are found in the Cape Wineland district municipality. About 74% of all private wine cellars are situated in the Cape Wineland district, which made it ideal for this research. The Cape Winelands consist of five local municipalities, namely Stellenbosch, Breede Valley, Witzenberg, Drakenstein, and Langeberg (Cape Winelands District Municipality, 2017).

2.2. Sampling technique

A multi-stage sampling technique was used in this study. The first stage was a purposive selection of the Cape Winelands district municipality. The second stage was utilzed purposive sampling to select the three local municipalities' within Cape Wineland's district municipality, namely, Stellenbosch, Drakenstein and Breedevalley local municipalities. The third stage was the selection of specific farms in these local municipalities. The study area was selected, because the largest number of wine grape producers resided in the three local municipalities, as seen in Table 1. The farms were selected randomly in order to represent the three local municipalities (Table 1). As many farmers as possible were interviewed per municipality to get a strong delineation. The population sample illustrated in Table 1 include private cellars, where the sample size was identified from each of the respective towns and surrounding wine grape producing areas. Private cellars produced on average less than 500 tons of grapes per year with their own vineyards and cellars and produce premium quality wine. Producer cellars produced on average more than a 1000 tons of grapes per year, operated as a wine co-operative, had shareholders who produced wine grapes, and processed bulk wine, which was usually of a lower quality than premium wine of private cellars. In this study producer cellars not included. The number of cellars were obtained from the South African Wine Industry Information and Systems (SAWIS) (SAWIS, 2016).

A sample of 91 farmers was chosen from 348 private wine grape producers across the three local municipalities within the Cape Winelands, who were willing to participate in the study. A survey was conducted by the researcher from October 2018 to February 2019 to assess the effect of wine grape harvesters on labour in the Western Cape Province of South Africa. The survey included output per hour per hectare, the cost per hour per hectare for a wine grape harvester, and the cost of labour use per hour per hectare. Data included, but were not limited to, farm size, age, gender, production systems, labour use, the method for harvesting grapes, degree of mechanization, credit, advisory services, and farming income. Income generated from using labour

Table 1: Number of private wine cellars for the Cape Winelands region

Local Municipality	Number of private wine cellars	Number of farmers sampled
Stellenbosch	172	39
Drakenstein	120	30
Breede Valley	56	22
Total	348	91

Source: Author's compilation from SAWIS (2016).

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Table 2: Description of variables for impact on seasonal and permanent labour used in the binomial logistic regression model

Variable	Description
Dependent variable:	
Seasonal labour (LLs) & Permanent labour (LLp) - separately	0 decrease labour and 1 increase labour
Explanatory variables:	
Age (FA)	Age in years
Hectares for production (NHecp)	Hectares under wine production
Seasonal labourers (NSL)	Number of seasonal working during harvest season
Type of harvesting (MethH)	1 if Mechanical harvester, 2 if Labourers, 3 if Both
Type of harvester (TypH)	1 if Self-propelled, 2 if Tractor-drawn and 3 if Both
Length of the harvest season in weeks (DuraH)	Length of the season (weeks)
Machine output in tons per hour (Mchout)	1 if 4 tons/hour or less, 2 if 5 tons/hour, 3 if 6 tons/hour, 4 if 7 tons/hour, 5 if 7 tons/hour, 6 if 9 tons/hour, 7 if 10 tons/hour and 8 if 11 tons/hour or more
Labour output in tons per hour (ALOh)	1 if 4 tons/hour or less, 2 if 5 tons/hour, 3 if 6 tons/hour, 4 if 7 tons/hour, 5 if 7 tons/hour, 6 if 9 tons/hour, 7 if 10 tons/hour and 8 if 11 tons/hour or more
Labourers for 1 ton (LaHar)	How many labourers can harvest 1 ton
Cost of machine harvesting per hour (CostHarM)	1 if R 75.00 per hour or less, 2 if R 120.00 per hour, 3 if R 165.00 per hour and 4 if R 210 per hour or more
Cost of labour harvesting per hour (CostHarH)	1 if R 138.51 or less per hour, 2 if R 169.30, per hour 3 if R 200.08 per hour and 4 if R 230.86 or more per hour
Man-hours per ton (Manhec)	1 if 6 hours per ton or less, 2 if 7 hours per ton, 3 if 8 hours per ton, 4 if 8 hours per ton, 5 if 10 hours per ton and 6 if 11 hours or more per ton
Average machine duration per hour (AvgharMac)	Duration of the machine per hour
Average labour land ratio (Lalahec)	1 if 3 workers:1 ha or less, 2 if 4 workers:1 ha, 3 if 5 workers:1 ha, 4 if 6 workers:1 ha, 5 if 6 workers:1 ha, 6 if 7 workers:1 ha, 7 if 9 workers:1 ha, 8 if 10 workers:1 ha and 9 if 11 workers:1 ha or more

Source: Author Compilation (2019).

and a harvester per hectare was obtained from secondary data sources (man-hours compared to use of a harvester per hectare per hour). The land–labour ratio was also determined per hectare. The collected data were captured in an Excel spreadsheet, cleaned and re-arranged. Jeffreys's Amazing Statistics Program (JASP) and Statistical Package for Social Science (SPSS) were used for the statistical analysis of the data.

In determining the factors that impact labourers as a result of the use of a wine grape harvester, a binomial logistic regression model was used. The binomial logistic regression model was used, because the dependent variables dealt with a binary response variable, multiple explanatory variables and supported categorizing data into discrete classes. The model did not make assumptions about class distribution in featured spaces. Additionally, the output of the binomial logistic regression model was more informative and more significant than other realted models such as probit model. Hence, the dichotomous form of the dependent variable made it possible to determine the significance and influence of selected factors unambiguously. Following the work of Owombo et al. (2012), the logistic regression model is expressed as (Equation 1):

$$LLp/LLs = B0 + B1FA + B2NSL + B3NHecp + B4MethH + B5TypH + B6DuraH + B7Mchout + B8ALOh + B9LaHar + B10CostHarM + B11CostHarH + B12Manhec + B13AvgharMac + B14Lalahec + e \quad (1)$$

Table 2 summarizes the outcome and independent variables of the binomial logistic regression model.

3. Result and Discussion

3.1. Socio-economic characteristic of respondents

Table 3 presents the socio-economic characteristics of wine grape producers. The results showed that 98.9%[5] of the producers are men, where only 1.1% are women. This indicates that wine grape production farms are dominated by men. The results of the research are in line with that of Mariano et al. (2012), where 89% of farmers who adapted to technology such as certified seed technology were men. This implies that male farmers are much more adaptive to new technological advances than female farmers, which will subsequently impact labour use.

Approximately 93.3%[6] of the farmers are married and 6.7% are single, which implies a level of commitment and dedication. A study by Paul et al. (2017) also revealed that marital status is a major factor in technology adoption, which impacts on labour. The respondents are well educated where 19.5% have a secondary education, 5.7% had a higher certificate, 32.2% a diploma and 37.9% held a degree. A total of 4.6% of respondents had a postgraduate qualification (post grade 12 qualifications), which implies the importance of a qualification to manage a farm.

[5] Indicated male producers. Only one, either male or female producers, whether married or not are regarded as farming the land and thus the manager of the farm. It is purely from the perspective of the farmer as an individual and not as partners or shareholders. There is a clear distinction between gender and marital status for quantification and it should not be confused.

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Table 3: Socio-economic characteristics of respondents

Variables	Description	Frequency	%
Gender	Male	90	98.9
	Female	1	1.1
Marital Status	Single	6	6.7
	Married	83	93.3
	Widow	-	
Qualification	Secondary	17	19.5
	Higher certificate	5	5.7
	Diploma	28	32.2
	Degree	33	37.9
	Postgraduate	4	4.6
Source/s of income	Wine	22	25.0
	Wine grapes	17	19.3
	Wine and wine grapes	12	13.6
	Wine and other sources	8	9.1
	Wine grapes and other sources	25	28.4
	Other sources	1	1.1
	Wine, wine grapes and other	3	3.4
Access to credit	Yes, have access	74	89.2
	No, have no access	9	10.8

Source: Author's estimation (2019).

Table 4: Results of mechanical harvest impact on seasonal labour

	Estimate	Standard error	Standardized	Odds ratio	z	p
Hectares for production (NHecp)	0.459	0.181	42.620	1.583	2.544	0.011***
Age (FA)	0.164	0.087	1.895	1.178	1.887	0.059***
Seasonal labourers (NSL)	-0.408	0.157	-11.808	0.665	-2.598	0.009****
Labour output tons per hour (ALOh)	-0.497	0.373	-1.236	0.608	-1.332	0.183**
Type of harvesting (MethH)	-2.583	2.497	-1.295	0.076	-1.034	0.301
Type of harvester (TypH)	-10.017	6.272	-4.774	4.463	-1.597	0.110
Length of the harvest season in weeks (DuraH)	-8.065	6.030	-24.686	3.143	-1.337	0.181
Machine output tons per hour (Mchout)	-0.739	0.750	-1.295	0.478	-0.984	0.325
Labourers for 1 ton (LaHar)	0.156	0.135	1.286	1.169	1.155	0.248
Cost of machine harvesting per hour (CostHarM)	-239.860	15050.990	-145.894	6.763	-0.016	0.987
Cost of labour per hour harvesting (CostHarH)	1.810	1.664	1.704	6.113	1.088	0.277
Man-hours per ton (Manhec)	-1.883	1.333	-3.115	0.152	-1.412	0.158
Average machine duration per hour (AvgharMac)	-3.003	2.853	-2.562	0.050	-1.053	0.293
Average labour land ratio (Lalahec)	3.830	4.326	0.738	46.060	0.885	0.376

***Significant at the 1% level; **significant at the 5% level
Source: Author's estimation (2019).

A quarter (25%) of the respondents had only wine as a source of income. About 19.3% had wine grapes and 13.6% had wine and wine grapes as sources of income. Most of the respondents (28.4%) had wine grapes coupled with other sources of income as income streams. Abbas et al. (2017) found that income raises the probability of acceptance, indicating that incentives for earning income need to be developed. Thus in this research, it is evident that income from the primary production and other income sources within the farming business is significant for technology adaption. It can be noted that most respondents in this study apply a relative level of diversification, which is critical to sustaining a farming business in the long run.

Around 89% of respondents had access to credit. The results of this study are consistent with a study by Mariano et al. (2012) where credit was significant for the adoption of technology. Further, the authors highlighted that sufficient credit is needed for major mechanical investments within agribusinesses. Therefore, most of the respondents maintain a fair amount of viability within their industry and are capable of investing in the mechanical harvesting of grapes.

3.2. Wine grape harvester impact on seasonal labour

Table 4 indicates the impact of a wine grape harvester on seasonal labour. An increase in the number of hectares (NHecp) and farmers' age (FA) significantly affects the impact on seasonal labour. The increase in the number of hectares (NHecp) and the farmer's age (FA) was significant at 1% and positively correlated to an increase in seasonal labour. The results suggested that with an

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Table 5: The effect of mechanical harvesting on permanent labour

	Estimate	Standard error	Standardized	Odds ratio	z	p
Hectares for production (NHecp)	0.218	0.065	20.202****	1.243****	3.362	0.001***
Machine output tons per hour (MHout)	-0.954	0.319	-1.672	0.385	-2.987	0.003***
Type of harvesting (MethH)	-4.580	1.991	-4.580	0.010	-2.301	0.021
Length of the harvest season in weeks (DuraH)	0.063	0.158	0.193	1.065	0.398	0.691
Machine output tons per hour (Mchout)	-0.739	0.750	-1.295	0.478	-0.984	0.325
Labourers for 1 ton (LaHar)	-0.009	0.058	-0.077	0.991	-0.159	0.873
Cost of machine harvesting per hour (CostHarM)	-2.747	1.281	-1.671	0.064	-2.145	0.032
Cost of labour harvesting per hour (CostHarH)	0.758	0.689	0.713	2.133	1.100	0.271
Man-hours per ton (Manhec)	0.467	0.316	0.773	1.595	1.480	0.139
Average machine duration (AvgharMac)	-0.118	1.051	-0.100	0.889	-0.112	0.911
Average labour land ratio (Lalahec)	-6.141	4.899	-1.184	0.002	-1.254	0.210

***Significant at the 1% level
Source: Author's estimation (2019).

increase in the number of hectares (NHecp) and increase in farmer's age (FA) means that seasonal labour will increase. The findings correspond with that of Domingues and Del Aguila (2016), where the cost per hectare of grape mechanical harvesting is lower than the cost per hectare of manual harvesting. Mechanical harvesting is therefore justified when vineyard areas exceed 41.92 ha, and will justify the use of a mechanical collection system of grapes. This is particularly true for wine grape farms exceeding 42 ha. The finding in this study correlates is not supported by similar studies of Reddy et al. (2014) and Adu-Baffour et al. (2019), where they showed the mechanization would increase seasonal labour.

3.3. Wine grape harvester impact on permanent labour

Table 5 shows the results of the effect of mechanical harvesting on permanent labour. The variable hectares for production (NHecp) of wine grapes has a standardized coefficient of 20.202 and an odds ratio of 1.243, which is greater than 1 and suggests a positive relationship with a significance at 1%. The NHecp is a positive predictor of a farm being able to employ fewer permanent labours, which probably indicates the economy of scale in production. This means that the farmer will employ fewer permanent labourers. The finding is consistent with that of Reddy et al. (2014), where there is a positive association between farm mechanization, displacement of family labour, and increased casualization of labour across many crops. Thus, as the number of hectares (NHecp) increases, farmers are more likely to make use of mechanical harvesting, and therefore less permanent labour is used.

The variable machine output tons per hour (MHout) for harvesting grapes has a standardized coefficient of -1.672 and an odds ratio of 0.385, which is negatively correlated and significant at 1%. Type of harvesting (MethH) is also a negative predictor with a standardized coefficient of -4.580 and an odds ratio of 0.010, which is significant at 1%. This may simply reflect that mechanical harvesting is becoming more prevalent and that there might be a change in labour shedding in the responding farms. The finding is consistent with the study of Busa and Nandi (2014) who showed that the use of machinery in agricultural production plays an important role in increasing productivity and reducing the unit cost of production resulting in profitability and making agriculture viable. The finding of the study is also in line with that of Ugur and Mitra (2017) where the impact of technology on jobs is more likely to be favourable where data is linked to skilled-labour employment and product innovation.

4. Summary, Conclusion, and Recommendations

The study revealed that increasing hectares used for the production of wine grapes, farmer's age, machine output, and average labour output has a significant impact on seasonal labourers. The application of mechanized harvesting of grapes enhances the number of hectares for production and fewer permanent labourers will be employed. This implies that there will be a reduction of permanent labourers on the farm. However, it will not reduce the number of seasonal labourers used for harvesting grapes on farms.

The Western Cape and in particular the Cape Winelands is a wine grape production intensive region within South Africa, which has the potential to mechanize and improve technology on farms without impacting the employment within the sector. Hence, the study recommends that the government should intervene or introduce legislation to mitigate the effect on labour because of the mechanical harvesting of grapes. Further, government should encourage producers to keep farm workers on the farm given technological advances, by including policies that discourage the retrenchment of farmers who apply technology advancement, but keep labourers. The government should also formulate a policy that motivates the integration of modern agricultural systems with that of current conventional systems. This will inform about the benefits for both the producers and labourers. The result will ensure profitability, productivity, enhance and maintain employment within the agricultural sector.

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