



## Assessment of the constraints in PHM and determinants of losses in grapes (*Vitis vinifera*): An ordered logistic regression analysis

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Received: 16 December 2021; Accepted: 16 June 2022

### ABSTRACT

Grape (*Vitis vinifera* L.) is one of the major fruit crops of India and the largest grape producing states are Maharashtra followed by Karnataka, Tamil Nadu, Mizoram and Andhra Pradesh. The glaring inefficiencies in the supply chain of grapes along with its perishable nature leads to huge losses. The study identified farm size, knowledge level, experience, training received, timely labour availability and distance from farm to market as significant determinants of the losses. Though a lot of research and extension has been done on the technologies for improved production and loss reduction, the adoption of the recommendations by the farmers has been found to be differential. Thus, we need to isolate the factors which hinder the adoption of such recommendations. The present study (2019–21) identified the major constraints as the high initial investment in infrastructure, lack of market intelligence system, unavailability of skilled labour, unavailability of timely chemicals and equipments and thus, chalks out the future strategy accordingly to minimise the losses.

**Keywords:** Constraints, Determinants, Marketing, Ordered logistic regression, Post-harvest losses

Ensuring food and nutritional security of the masses has been a burning issue, given India's position of 101 amongst 116 countries in the Global Hunger Index 2021, faring poorer than neighbouring counterparts like Pakistan, Bangladesh and Nepal (PTI 2021). Each year about 14% of the world's food is lost even before reaching the market and hunger has been on the rise for the past five years (UNEP 2020). The world population is expected to increase to 10 billion by 2050 (United Nations 2019) and feeding such a huge population in a sustainable way will require disruptive changes of the food supply chains during the next 20 years (Kearney 2019). The potential solution for this is to increase the production and/or reduce the losses (Zorya 2011, Hodges 2011). Addressing the issue of food loss and waste can prove beneficial in ensuring food and nutrition security, reducing environmental stress and meeting the climate goals (World Bank 2020). Reducing the wastage of farm produce in the early stages of the supply chain can strongly and positively improve the conditions in countries with high levels of food insecurity (UNEP 2020). The UNEP study reported huge post-harvest losses at the global level due to poor handling practices, inadequate transport

or inefficient storage facilities, lack of cold chain capacity, extreme weather conditions, failure to meet cosmetic standards; with the major wastage reported in the early and middle stages of the supply chain in developing nations (Gustavsson 2011). The losses are reported as 30–40% in fruits and vegetables (Hegazy 2016) to the tune of ₹92,651 crores (Jha *et al.* 2015). Food loss has been considered as an ethical outrage, given the fact that so many people go hungry (UNEP 2020) and thus the issue of food loss and wastage has drawn serious attention as of present, more importantly in the developing nations. India also needs to buckle up to manage the huge quantum of losses reported. To prevent these losses, we need to first delineate the crop and region-specific determinants of the losses and the associated constraints in the post-harvest management (PHM) in the crops. Hence, the present study was undertaken in order to identify the major determinants of losses and the constraints in the grapes (*Vitis vinifera* L.) value chain.

### MATERIALS AND METHODS

An ex-post facto research design was followed for the present study. The study was carried out over the years 2019–2021 in carefully drawn steps, viz. devising the interview schedule, pre-testing the schedule and then collecting the data from purposively selected Pune and Nashik districts of Maharashtra, analysis of the data, interpretation of the results and drawing inferences. The sample included 120 farmers selected through the process of random sampling

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method. The ordinal logistic regression model was used to analyse the determinants of the post-harvest losses in grapes. The losses were categorised into low, medium and high based on the mean and standard deviation of the total losses. The variables like farm size, farming experience, storage duration, quantity harvested and market distance were taken on the ratio level of measurement and the variables like variety grown, knowledge level, training received and labour availability were measured as categorical variables for the proposed econometric model. The value of  $R^2$  will denote the amount of variance explained by the explanatory variables fitted in the model. The constraints were categorised under five broad dimensions, viz. socio-personal, technical, infrastructural, marketing and financial constraints. The scoring pattern followed was 1 (least severe), 2 (not so severe), 3 (moderately severe), 4 (severe) and 5 (most severe). The mean score for each constraint was worked out and the ranking was done in accordance of mean score of each item.

## RESULTS AND DISCUSSION

The losses in grapes were categorised into low, medium and high based on mean and S.D values. The majority of farmers were incurring medium losses (Table 1). The

Table 1 Distribution of respondents (n= 120) based on post-harvest losses

Post-harvest loss (q/ha) in grapes	Frequency (%)
Low (<33.59)	44 (36.67)
Medium (33.59–61.23)	64 (53.31)
High (>61.23)	12 (9.99)
Mean = 47.41; Standard deviation = 13.82	

independent variables used in the econometric model were tested for any presence of multi-collinearity. This was ruled out since the variance inflation factors (VIF) were less than 5 and the tolerance values were greater than 0.2 (Table 2). The statistical significance of the model and non-significant Pearson  $\chi^2$  test statistics indicates that the model fitted the data well. The specified variables explained 42% of the variance in grape losses successfully. The non-significance result of the test of parallel lines indicates that the assumption of *Proportional odds* stands fulfilled and the relationship between the independent variables would hold true across all possible comparisons (Table 2).

With every unit increase in the farm size, there is a predicted increase in the log odds by 0.532 for incurring higher post-harvest losses. As the farm size increases, grape farmers need skilled labour for various operations like training, pruning, girdling, shoot thinning, cluster thinning, bunch thinning, berry thinning, application of plant growth regulators, etc. It was observed that the timely availability of skilled labour was a major problem for the grape farmers in the study location, so higher losses with increasing farm size were imminent.

The knowledge level significantly influenced the post-harvest losses in grapes. Better knowledge of the pre-and post-harvest management practices leads to improved farm and crop management, which is reflected through the reduced post-harvest losses. As hypothesized, the likelihood of reporting higher losses decreases for the farmers with increased experience in grape farming. This was confirmed by the findings of Mebratie *et al.* (2015) and Ummar *et al.* (2015). The grape farmers who didn't attend training were more likely to experience higher post-harvest losses as

Table 2 Multi-collinearity test and Ordered logistic regression results

Independent variable	Estimate	Std. error	p-value	VIF	Tolerance
Farm Size	0.532**	0.757	0.032	1.46	0.68
Knowledge (Low = 1)	0.620***	0.819	0.008	1.66	0.60
Knowledge (Medium = 2)	0.431***	0.456	0.003		
Knowledge (High = 3)	0 <sup>a</sup>	-	-		
Experience	-0.412**	0.349	0.035	1.54	0.65
Training (No training received = 0)	0.860***	0.933	0.006	1.32	0.76
Training (Training received = 1)	0 <sup>a</sup>	-	-		
Variety (Local variety = 0)	0.010	0.058	0.231	1.39	0.72
Variety (Improved variety = 1)	0 <sup>a</sup>	-	-		
Timely Labour availability (No = 0)	0.731***	0.384	0.002	1.48	0.68
Timely Labour availability (Yes = 1)	0 <sup>a</sup>	-	-		
Quantity harvested	0.075	0.363	0.121	1.47	0.68
Storage duration	0.015	0.289	0.113	1.38	0.72
Distance from farm to market	0.234**	0.925	0.044	1.52	0.66
Model fit	$\chi^2(9) = 30.249, p = 0.005$				
Goodness of fit (Pearson)	$\chi^2(198) = 204.353, p = 0.36$				
Pseudo R-square (Nagelkerke)	0.423				
Test of parallel lines	$\chi^2(9) = 16.348, p = 0.854$				

Note: \*\*, \*\*\* means the coefficient is statistically significant at 5% and 1% levels respectively.

compared to those who attended training on post-harvest handling.

Grape farmers who had timely availability of skilled labour had lower levels of post-harvest losses as compared to ones who did not have timely labour availability. The association of the losses with the variables-quantity harvested and storage duration was positive but not significant. This was contradicted by Babalola *et al.* (2010) and Aidoo *et al.* (2014) who found that the larger the quantity of tomatoes harvested, the higher the chances of losses due to poor handling. Mebratie *et al.* (2015) reported the more days the harvested grapes spend before being sold, the higher the grape losses. With a unit increase in market distance, the log of odds of high post-harvest loss increases by 0.234. The farmers who sold the grapes in the local market had no pre-cooling facilities and thus, the losses increased with greater distance to the market. Sharma *et al.* (2018) also reported that more post-harvest losses occur in distant markets than local due to congestion and build-up of heat.

These findings confirmed the results of Kereth *et al.* (2013) who reported that the distance of the market, age of the horticultural produce, the experience of the grower, availability of transportation and road links significantly influence the post-harvest losses. Also, the present findings are in confirmation with the results reported by Affognon *et al.* (2015), Muluken *et al.* (2017) and Sahu *et al.* (2021). The findings were reiterated by Kulwijila (2021) who reported that the age of grape at harvest, the quantity of grapes harvested, experience and distance from the farm to the market positively significantly influenced post-harvest losses of grapes. The skilful management of the farm operations greatly influence the reduction of the losses at various stages of the supply chain (Peter 2010). However, the results were contradicted by Sharma *et al.* (2018) reported variety to be a significant determinant of post-harvest losses in grapes. He argued that all varieties don't express the same shelf-life. Some show shattering if not harvested at particular TSS, while some show rachis browning very fast after harvesting and result in berry shattering and are more prone to post-harvest losses.

The constraints faced in the grape value chain have been represented in Table 3. The lack of mutual cooperation with fellow farmers, distrust and lack of credibility on the scientists was perceived as the most severe socio-personal constraint. Next, they felt constrained as they lacked the basic knowledge of post-harvest management activities. The results find confirmation with the results of Shiralashetti and Hadapad (2016) that illiteracy of the farmers, lack of technical knowledge and cooperative marketing were the major hindering factors. Unavailability of skilled labour was the major technical constraint, as they were heavily needed in various operations like grafting, training, pruning, canopy management (shoot, bunch and berry thinning, girdling), application of plant growth regulators. Varietal specificity was also a constraint for the farmers. In grapes, it is very common that the end output varies based on the rootstock used, even though with the same soil, water,

climatic condition and post-harvest management conditions. So, having the right rootstock with desirable characters of vine vigour, fruit bud differentiation, fruit yield, etc. is an essential pre-requisite, for getting better results from post-harvest management activities. However, the farmers complained of the timely unavailability of the recommended rootstocks. Sharma *et al.* (2018) had also reported findings in the same line.

Study by Gotyal *et al.* (2010) revealed that non-availability of grape experts within the district, shortage of water during summer, high cost of chemicals, irregular and insufficient power supply were the most severe technical constraints. The non-availability of critical inputs like plant growth regulators, sharp secateurs, dual releasing sulphur dioxide pads (Grape guard), bubble pad, sprayers, dusters, etc. on time was regarded as the top most infrastructural constraint by around three-fourth of the respondents. The lack of nearby soil and water testing facilities has been rated as a serious constraint with mean score of 4.07. The farmers did not consider the lack of cool-chain transport facilities as a serious constraint as they mainly sold the produce to the contractors/traders from their fields itself. The findings were in confirmation with the results reported by Aujla *et al.* (2011), Kharade *et al.* (2011), Shiralashetti and Hadapad (2016), Babybowna (2018) that non-availability of skilled labour at proper time, irregular and insufficient power supply, lack of technical knowledge, non-availability of bank loans, high rate of interest, non-availability of true-to-type variety grafts at nearest places, and high cost of inputs were the major constraints in production of grapes. The study also reiterated the findings of Lwelamira *et al.* (2015) and Yusufi (2020) that the core constraining factors identified for the grape farmers were high initial investment in grape farming (75%), unavailability of cold storage facilities (66.6%) and scarcity of water (63.3%).

Due to the absence of an efficient market intelligence system, they were mainly restricted to selling the produce within the state or to the local traders/contractors. Distress sale of the produce was ranked as the second top-most constraint. The farmers opinionated that there was lack of price policy for grapes by the Government, as a result of which there were wide fluctuations in the prices of grapes every year. There was no dedicated policy for produce procurement in grapes, as is existing in case of cereals. Gotyal *et al.* (2010) reported that exorbitant rates of interest, unavailability of timely credit and inadequate credit support for area expansion were the strongly perceived financial constraints.

Too much of market risk and uncertainty was prevalent because of the swinging prices. Equally serious constraints were the lack of facilities like weighing balance, grading machine, cold chambers for temporary storage till the sales in local market. It was found that the farmers did not perceive the 'lack of awareness about the required quality standards and market specifications' as very severe as most of the farmers had some previous knowledge of the required market standards. Because it was mandatory for them to

Table 3 Constraints faced by the grape farmers in adoption of post-harvest management practices (n=120)

Particular	Mean	Standard deviation	Rank	Particular	Mean	Standard deviation	Rank
<i>Socio-personal constraints</i>				Lack of refrigerated transport facilities	1.17	0.38	IV
Lack of basic knowledge about PHM activities	3.80	0.73	II	<i>Financial constraints</i>			
Lack of mass media exposure on this topic	3.72	1.24	V	High cost of inputs & chemicals	4.65	0.55	I
Lack of prior experience	3.78	1.07	III	High cost of skilled labour	4.18	0.77	IV
Resistance to change	2.38	1.05	VIII	High initial investment in infrastructure	4.65	0.55	I
Lack of cosmopolitaness	2.40	1.09	VII	High payback period in investment	4.55	0.59	II
Lack of conviction in these new methods	3.77	1.21	IV	Lack of awareness of credit availability	1.52	0.60	VIII
Lack of willingness to take initiative	3.50	1.14	VI	Lack of access to institutional credit facilities	2.47	0.96	VII
Lack of mutual cooperation with other farmers	3.92	1.01	I	High interest rate for credit	3.50	1.05	VI
Lack of risk-taking ability	3.77	1.21	IV	Lack of Govt support (credit, subsidy)	4.20	0.73	III
Lack of trust & credibility on the scientists	3.92	1.01	I	Unawareness of insurance facilities	3.77	1.21	V
Lack of trust in the distribution chain	1.72	0.72	IX	Inadequate insurance coverage	4.20	0.73	III
Lack of family support	1.17	0.38	X	<i>Marketing constraints</i>			
<i>Technical constraints</i>				Distress sale of produce- need of immediate liquid cash	4.55	0.59	II
Economically unviable operational size	2.47	0.96	VI	Lack of market intelligence (demand, market price, etc.)	4.60	0.64	I
Unavailability of skilled labour	4.53	0.65	I	Lack of grading and packaging facilities	1.72	0.72	VI
Complexity of the recommended practices	4.01	0.70	III	Market risk and uncertainty	4.27	0.86	III
Varietal specificity of the post-harvest technologies	3.80	0.73	IV	Inadequate physical facilities in the market	3.00	0.80	IV
Lack of extension support & guidance	3.50	1.14	V	Lack of regulated market for grapes	3.00	0.80	IV
Lack of training on PHM technologies	4.25	0.70	II	Lack of demand for value added products by local customers	1.17	0.38	VIII
<i>Infrastructural constraints</i>				Low knowledge of marketing strategies	2.02	1.05	V
Shortage of abundant clean water supplies	3.80	0.99	III	Lack of price policy by the government	4.27	0.86	III
Irregular power supply	3.80	0.99	III	Lack of group approach to achieve economies of scale	1.50	0.62	VII
Unavailability of timely chemicals and equipments	4.10	0.92	I	Difficulty in meeting the set quality standards & specifications	2.02	1.05	V
Lack of cold storage facilities	1.17	0.38	IV				
Lack of soil and water testing facilities	4.07	0.90	II				

produce the fruits with some minimum set quality standards to be accepted by the trader/contractor at a profitable price. The findings of the present study were in confirmation with the findings of Gowda (2002), who enlisted some of the marketing constraints in the grape supply chain as no fixed price, low consumer's share in producer rupee, lack of; regulated markets, transportation facilities, cold storage facility, guidance on marketing and exploitation by middle men, non-availability of timely credit. The findings echoed the results reported by Gotyal *et al.* (2010) that the low market price for grapes, domination of middleman, no scientific criteria for price fixation for grapes and lack of regulated or organized market for grapes were the major marketing constraints.

The variables that significantly affected the post-harvest losses in grapes were farm size, knowledge level, experience, training received, timely labour availability and distance from farm to market. These factors explained the variance by 42%. The study delineated the major constraining factors in production and post-harvest management for grape farmers as the expensive inputs and high initial investment in infrastructure (financial constraint), lack of market intelligence system (marketing constraint), unavailability of skilled labour (technical constraint), unavailability of timely chemicals and equipments (infrastructural constraint). The major factors hindering secondary processing of grapes were the insufficient quantity, lack of uniform and desired quality of the raw materials round the year. Thus, anyone

intending to reduce the quantum of losses in the grape value chain needs to focus on these key factors. The Government functionaries should try to improve the value chain of grapes by plugging these loopholes. The first priority area is the skill-building of the farmers, wholesalers and retailers on the recommended post-harvest handling practices through various capacity building interventions. Government should try to establish a strong local market with robust packaging, transportation and storage infrastructure, to reduce the transit and market-level losses and thus reap higher benefits for the farmers in particular and the nation in general. Also, there should be concerted efforts to work in the Public-Private Partnership mode towards enabling and modernising the storage and processing infrastructure into advanced forms, to channelise the surplus produce efficiently, minimise the wastage and benefit from the increased returns from the value-added produce and/or the off-season sales.

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