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Management of Date Palm Leaf Waste Consumption in Animal Feeding: The Case of Ranchers in the South of Kerman Province

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Abstract

The present research aimed to use the concept of willingness to use and the ordinal logit model to evaluate the factors influencing the adoption of date palm leaf waste (PLW) by ranchers in the south of Kerman province in 2020. Data were collected by filling in 202 questionnaires by ranchers ran-domly selected at the study site. Based on the results, about 51 percent of the ranchers in the study site are reluctant to use PLW so that only 46 ranchers in the studied sample expressed their willingness to use it. The results of the ordinal logit model show that the willingness to use PLW in animal feeding increases with increasing the rancher's ranching history, providing his/her with information for aware-ness enhancement, decreasing his/her concerns over the feedback of using PLW in animal feeding, and finally, membership in a cooperative. Also, the likelihood of PLW use in animal feeding is higher in large-sized animal farms than in small-sized ones (sheep and goats). Based on the results, to extend the use of PLW in animal feeding, it is necessary to take promoting actions among the ranchers in the study site to ensure them about the health of this feed for their animals. In addition, PLW suppliers can be provided with some facilities to supply their product in the market, and demonstration farms where this product is consumed can be used to reduce the wastage of this commercially capable prod-uct.

Keywords:
Date palm leaf waste; Ordered logit; South of Kerman province; willingness to use

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INTRODUCTION

According to statistics, a great deal of crop residues is annually removed from the production system as waste. Waste management is, therefore, a long-term solution for optimal allocation of resources and environmental conservation and is an approach in national development strategies and economic policy to coping with resource depletion in the agricultural sector (Mahrous et al., 2021). On the other hand, given the shortage of animal feed in the livestock industry, the literature has recently given special attention to the use of new food resources, particularly crop wastes, in animal feeding (Aziz, 2020; Suyitman et al., 2020).

A vast area of arable lands in Iran and most tropical countries is cultivated by date palm trees. Based on FAO's statistics, Iran was the third leading date producer of the world in 2019. Indeed, the Ministry of Agricultural Jahad in Iran has adopted the policy of developing date palm acreage in recent years (Dialami and Givi, 2020). Date palms have several byproducts, including leaves, pods, clusters, trunks, fibers, and seeds, in addition to their main product, i.e., date. Along with their longitudinal growth, date palms produce 10-30 leaves at the end of their trunks every year (Aziz, 2020). Significant amounts of date palm leaf waste (PLW) are produced in Iran, but only less than 5 percent of it is used in handicrafts, and the remaining is left unused or burned, which is even worse for the environment (Jonoobi et al., 2019). Tree twigs are a major source of cellulose for ruminants throughout the world so that forage shortage can partially be met by using them in animal feeding (Kardooni et al., 2013; Ghodusi et al., 2019; Mahrous et al., 2021; Jonoobi et al., 2019; Sharifi et al., 2014). Various studies have supported the applicability of PLW in animal feeding (Aziz, 2020; Febrina et al., 2021). Due to the fact that dates and palm leaf waste are extensively produced in the south of Kerman province, in this study, we seek to investigate the factors that affect the tendency of farmers to use date leaf waste in animal nutrition.

Despite all advantages reported for PLW, results as to the development and adoption of new products in different countries show that the main barriers against the production of these products are small consumption markets and poor acceptance by consumers. Rodríguez et al. (2007) suggest that despite the potential advantages of new products over conventional ones, they are faced with multiple issues and drawbacks in production, distribution, and marketing, which hinder them from finding their way into the consumption basket. PLW has mostly been investigated by animal science researchers from the perspective of its nutritional and physiological significance in recent years, but no research has focused on consumers' willingness and behavior. Similar studies have listed various factors underpinning consumers' willingness to use and pay for new products and technologies. Some researchers have identified personality variables, including age, experience, and gender, to be effective (Etim et al., 2019; Carrer et al., 2017; Bavorová et al., 2020; Michels et al., 2020; Gavindasami and Itlia, 1999; Fakoya et al., 2007; Challa and Tilahum, 2014). Educational level has also been reported to have a significant effect (Vecchio et al., 2020; Thapa et al., 2021; Li et al., 2021; Sharifi et al., 2014; Francis et al., 2008; Challa and Tilahum, 2014). Food safety, confidence in product safety, and the appearance of a new product are also influential of its acceptance positively (Haghjou et al., 2013; Hayati et al., 2017). Previous studies have also considered other important variables, such as awareness of technology advantages (Carrer et al., 2017; Vinholis et al., 2016; Francis et al., 2008), attitudes towards technology, production volume, and gross product income (Angulo et al., 2005; Francis et al., 2008; Challa and Tilahum, 2014; Zhang et al., 2015; Carrer et al., 2017; Li et al., 2021), as well as concerns over the risks of new technology application (Li et al., 2021; Darkwah et al., 2019; Hayati et al., 2017). Membership in agricultural co-

operatives has a proven role in the acceptance of modern technologies and nutritional sources as reported by Ma et al. (2018), Ma and Abdulai (2017), and Zhang et al. (2020). A review of previous studies showed that economic and social factors, awareness of the benefits of new products, and concerns about the risk of using new products are important factors in accepting new products.

The Statistic book of Agriculture Jahad (2019) reports that the south of Kerman province is the fifth in terms of date palm acreage and the second in date palm yield in Iran. Date palm acreage in this region amounts to 3000 ha with 375,000 date palm trees assuming a population rate of 120 trees per ha. Each date palm tree produces 18-24 new date branches every year and the same number of old branches are thinned. If it is assumed that 20 branches are cut from each tree and each branch contains at least 1 kg of palm leaves, the annual leaf waste production in the south of Kerman province reaches 111,498 tons. This huge amount of leaf residues poses a dramatic potential for the regional use of this inexpensive source by animal production systems in animal feeding. A preliminary study in the region and interviews with animal officials of Agriculture Jahad Organization revealed that despite the capacity and potentials for the use of PLW in animal feeding, ranchers in this region rarely use it and consider wheat and barley residues the main source of livestock nutrition. Based on the literature on social acceptance, the first step in producing and supplying a new product (PLW in the present work) is to know consumers' willingness to use as the target community (ranchers in the south of Kerman province in this work). By recognizing ranchers' behaviors and identifying the factors driving and/or hindering their behaviors regarding the willingness to use PLW, a proper instrument can be provided to planners and policymakers of the agricultural sector in the region to adopt strategies for motivating crop production from PLW and promoting the culture of its consumption in animal feeding. In this regard, the present research first assessed ranchers' willingness to use palm leaf residues in animal feeding and then identified the factors influencing their willingness to use it in the south of Kerman.

METHODOLOGY

Research shows that willingness to use is a prerequisite for willingness to pay (Dolnicar et al., 2009; Birol et al., 2010). Accordingly, as long as ranchers have no willingness to use date palm leaf residues, there will be no trade in the market and subsequently, no payment, which is the output of the demand function, will occur.

Assuming a linear relationship between the utility of PLW consumption (D_i) and socioeconomic variables, the function (D_i) will be as follows:

$$D_i = \beta_0 + \sum_{k=1}^{K} \beta_k X_{ik} + \varepsilon_i = \beta_0 + Z_i + \varepsilon_i \quad (1)$$

in which D_i is the utility of the rancher i obtained from PLW consumption in animal feeding, β is the y-intercept, X is a descriptive variable, β_k is the parameter of the descriptive variables, and ε_i is the random noise term.

In Eq. (1), the utility of the individuals (D_i) is not observable and is a latent variable, so it is not estimable. What is observable is the use or non-use of PLW by the ranchers in animal feeding.

Based on the literature, date palm leaves can be included in livestock diets as a suitable alternative to wheat and barley straw (Aziz, 2020). So, in this research approach, the participants were asked about their willingness to use a certain amount of PLW to feed their animals as an alternative to wheat residues.

The dependent variable (use PLW) in this research was defined sequentially and discretely to study factors affecting PLW acceptance using the ordered logit model. The willingness to use PLW in animal feeding was measured discretely on an ordinal scale. The

scale had the following five levels:

$$\begin{aligned}
&WTU = 1 \text{ if } D_i = \mu && \text{None}\\
&WTU = 2 \text{ if } \mu_1 = D_i = \mu_2 && \text{Low}\\
&WTU = 3 \text{ if } \mu_2 = D_i = \mu_3 && \text{Moderate}\\
&WTU = 4 \text{ if } \mu_3 = D_i = \mu_4 && \text{High}\\
&WTU = 5 \text{ if } \mu_4 = D_i && \text{Very high}
\end{aligned} \quad (2)$$

in which μ represents the extreme points. The utility of PLW consumption has one of the above levels.

If it is assumed that the noise term (ε_i) has a logistic distribution, the probability of the acceptance of the *j*th ordinal choice to its non-acceptable by the *i*th rancher can be determined by the following model (Train, 2003).

$$Ln\left[\frac{P_{ij}}{1-p_{ij}}\right] = \mu_j + \beta_k X_{ik} + u_i \quad (3)$$

This model is estimated by the maximum likelihood method and the required probabilities are derived from Eq. (4) as follows (Green, 2005):

$$\begin{aligned}
&\Pr ob(y=0|x) = F(-x'\beta)\\
&\Pr ob(y=1|x) = F(\mu_1 - x'\beta) - F(-x'\beta)\\
&\Pr ob(y=2|x) = F(\mu_2 - x'\beta) - F(\mu_1 - x'\beta)\\
&\Pr ob(y=j|x) = 1 - F(\mu_{j-1} - x'\beta)
\end{aligned} \quad (4)$$

in which F is the cumulative distribution function (CDF) for ε. Expectedly, its functional form can be determined as logit or probit.

For all probabilities to be positive, the following relationship must be established:

$$0 < \mu_1 < \mu_2 < \ldots < \mu_{j-1} \quad (5)$$

In these models, to check the effect of independent variables on the predicted probabilities of the dependent variable and/or to select the order of the alternatives, the marginal effect or the marginal probability is calculated. The β coefficients are not directly related to marginal effects, so the marginal effects of variables on probabilities can be calculated by (Adeli et al., 2017 cited in Green, 2005):

$$\begin{aligned}
&\frac{\partial \Pr ob(y=0|x)}{\partial X_i} = -F(-x'\beta)\beta\\
&\frac{\partial \Pr ob(y=1|x)}{\partial X_i} = [F(-x'\beta) - F(\mu_1 - x'\beta)]\\
&\frac{\partial \Pr ob(y=j|x)}{\partial X_i} = F(\mu_{j-1} - x'\beta)\beta
\end{aligned} \quad (6)$$

Accordingly, the regression model used in this research and its variables were selected based on previous studies is as follows:

$$\begin{aligned}
WTU_i = {} & \alpha + \alpha_1 Age + \alpha_2 Exp + \alpha_3 Gen + \alpha_4 Edu + \alpha_5 Att\\
& + \alpha_6 Know + \alpha_7 Concern + \alpha_8 Hsize + \alpha_9 Inc\\
& + \alpha_{10} Brand + \alpha_{11} Type + u_i
\end{aligned} \quad (7)$$

in which WTU_i is the *i*th rancher's willingness to use PLW in animal feeding, which was designed at five levels. Also, *Age*, *Exp*, *Gen*, *Edu*, *Inc*, *Att*, *Know*, *Concern*, *Hsize*, and *Copp* represent age, experience in animal farming, gender (1 = male, 2 = female), educational level (years), monthly income, attitude towards the use of PLW in animal feeding (7 items), knowledge and awareness of the advantages of PLW use in animal feeding (9 questions), concern over PLW use in animal feeding (4 items), animal count and type (1 = small animals; 2 = big animals), and membership in a cooperative, respectively. The variables of attitude towards, knowledge of, and concern over PLW consumption in animal feeding were measured on the multi-item Likert scale in which the size of each indicator for the respondent was measured from the mean score of his/her responses to all items of a construct. The reliability of these three variables was estimated by Cronbach's alpha on a pretest at 0.79, 0.84, and 0.62, respectively. Also, to confirm the validity of the research instrument, the questionnaire was provided to animal science specialists who confirmed the validity of its different sections after making some revisions.

Study area

Kerman province with an area of 183193

km^2 is located in southeastern Iran between the longitudes 53°26' and 59°29' E. and latitudes 25°55' and 32° N. The average annual rainfall in the study area is 172.7 mm. The minimum and maximum altitudes in the region are 497 and 1326 meters above sea level, respectively. The rainiest month is February and the least rainy month is September. The average annual temperature fluctuates from less than 2°C to more than 26°C. The coldest month of the year in the studied stations is generally January with a range from -1.4 to 15.2°C and the warmest month of the year in most stations is July ranging from 17.6 to 37.1°C.

The research population was composed of all ranchers in the south of Kerman province including the counties of Jiroft, Kahnuj, Manujan, Anbarabad, Qaleh Ganj, Rudbar-e Jonub, and Faryab. Data required were collected by filling a self-design questionnaire by visiting the ranching unit. The sample size was 202 ranchers in the south of Kerman province determined by Cochran's formula. The sample was taken by the stratified randomization technique in which the counties formed the strata. Regarding the number of livestock farms in each of the southern cities of Kerman province, the sample was collected. All calculations and data analysis were performed in the $Limdep_9$ software package.

RESULTS AND DISCUSSION

The studied ranchers were, on average, about 49 years old with 1-40 years of history in ranching. The mean ranching history among the studied people was 17.8 years, showing the high experience of the studied region in ranching. Among the participants, 185 people were male, so less than 17 percent of the studied ranchers were female. The mean of the literacy variable was 11.9 years. In other words, the literacy of the people was, on average, at the high school level. However, 29 percent of the ranchers had an academic degree beyond B.Sc. and about 21 percent were illiterate. This diversity in the literacy level should be considered in the process of promoting and extending modern knowledge and technology. The mean monthly income of the ranchers amounted to 27,500,500 IRR, ranging from 1,780,000 to 564,000,000 IRR. Over 36 percent of the respondents had a monthly income of less than 50,000,000 IRR, reflecting the economic status of the ranchers.

It was found that 42 percent, 36 percent, and 22 percent of the studied ranchers had a negative, neutral, and positive attitude towards PLW use in animal feeding, respectively. This shows the relatively negative attitude towards this alternative feed. Also, the ranchers' responses to the questions about the knowledge and awareness of the significance of using date palm leaf residues revealed that their awareness was very poor so that 87 percent of them gained a score below average. The results showed concerns over PLW use in animal feeding so that about 51 percent of the ranchers were highly concerned and only 23 percent expressed a low level of concern over PLW use. Accordingly, the perceived risk of using this alternative feed is seemingly high among the ranchers, which results in their unwillingness to use it in animal feeding.

Table 1 presents the ranchers' willingness to use PLW in animal feeding. Accordingly, only 23 percent expressed their definite willingness to use PLW, and about half of them have no intention to use it either definite or probably. Data on the ranchers' willingness to use PLW in animal feeding reveal the low level of this variable. This will undoubtedly result in the non-use and inappropriate efficiency of PLW as an inexpensive and suitable alternative for wheat residues. Farmers should be informed through promotional methods that PLW is not a threat to the health and safety of livestock production.

Regarding the ranchers' reasons for their reluctance to use PLW in animal feeding, 63 percent believed that PLW was a threat to the production safety and security of the animal farms, 53 percent expressed the lack of awareness and knowledge about PLW in animal feeding, and 53 percent put their fingers

Table 1
Different Levels of Willingness to Use Date Palm Leaf Waste among the Studied Ranchers

Willingness level	Percentage	Frequency
None	39	79
Low	13	26
Moderate	11	22
High	14	29
Very high	23	46

Table 2
The Ranking of Date Palm Leaf Waste Features

Features	Rank
No side effects for animals	1
Meeting animals' food requirements	2
Price of date palm leaf waste	3
Palatability	4
Easy access	5

on the weakness of agricultural agencies and organizations in properly promoting this alternative feed.

Table 2 presents the ranking of PLW features for use in animal feeding. It is observed that the first priority of the ranchers to use PLW is the lack of any side effects, which is in line with the results as to their concern over the use of this feed. The fact that this feature is ranked higher than the price is important as it shows their concern over the use of PLW. The next ranks are for the supply of animal feed requirement, the price of PLW, palatability, and finally, easy access to PLW in the marketplace, respectively. For easy access to PLW, places can be considered for selling and offering this product in any of the cities.

The factors affecting the adoption of PLW by ranchers in the south of Kerman province were investigated by the ordinal logit model. The log-likelihood statistic revealed the overall significance of the ordinal logit model. Pseudo R^2 confirmed the model's goodness-of-fit and showed that the descriptive variables could partially account for the variance in the probability of selecting different choices of the dependent variable. The accuracy of the prediction of the estimated model was found to be 82 percent, reflecting the model's robustness.

Table 3 presents the results of the model's estimation. Based on the coefficients, the effect of rancher's experience, animal type, animal count, and knowledge of PLW is positive and significant on the probability of PLW adoption, but the effect of concern over PLW use is negative and significant. The variable of knowledge and awareness of the benefits of consuming PLW in livestock nutrition is of the multi-item Likert scale type. The size of this index was obtained for each person from the average score of his/her answers to all items of that index.

To interpret these results, it can be said that when the score of concern over PLW use is increased, the probability for the rancher to be placed at a higher level of willingness to use decreases, whereas as the score of PLW knowledge increases, the rancher is more likely to be placed at a higher level of willing-

ness to use. In other words, people who are more concerned about the use of PLW in animal feeding tend to use less PLW in animal feeding. As well, people with more knowledge are more likely to use PLW in animal feeding.

The coefficients derived for the variables in the ordinal logit model are unable to show how probable it is for an observation to be placed in a target category. So, to derive more results from the model, the marginal effects of the significant descriptive variables were calculated for each level of the ranchers' willingness to use as presented in Table 4. As it is observed, the sum of marginal effects of each variable for different levels is zero. According to Train (2003), the sum of probabilities for different categories of willingness to use PLW is equal to 1, so the sum of changes in these probabilities takes the value 0. Based on the results of marginal effect, if all other conditions are fixed, one unit of increase in the variable of ranching history will increase the probability of PLW adoption for animal feeding by 0.002 units among the ranchers at the fifth level of willingness to adoption (y=4). In other words, with one unit of increase in ranching history, the probability of definite use of PLW will increase by 0.002 units. This means that more experienced people have more willingness to use alternative feed for wheat residues.

According to the marginal effect of the variable of animal type, the presence of cattle at the first two levels (y = 0 and y = 1) reduces the probability of PLW adoption for animal feeding but it increases this probability at the second three levels (y = 2, y = 3, and y = 4). This result can be ascribed to the fact that small animals in the region mostly feed on pastures, so there is less willingness to use PLW and pay for it as a source of food for these animals. In this respect, Mu'azu et al. (2020) argue that the use of a new commercial product will vary among consumers with the type of its use.

Based on the marginal effect of the variable of the animal count, one unit of increase in this variable will have positive effects on the probability of higher levels of willingness to

Table 3

The Results of the Estimated Model for the Factors Affecting the Probability of the Use of PLW in Animal Feeding

Variable	Coefficient	Z-statistic
y-intercept	-11	-11.3
Rancher's experience of ranching	0.35**	2.2
Animal type	0.31***	4.1
Animal count	0.55**	3.1
Knowledge of PLW	1.01*	1.99
Concerns over PLW use	-0.64*	-1.77
Membership in a cooperative	0.77*	1.8
The threshold level of the model		
Threshold 1	0.38	4.2
Threshold 2	1.9	1.6
Threshold 3	2.77	2.7
Threshold 4	4.9	2.4
Number of observations	202	
Percentage of model's correct prediction	82%	
Log-likelihood	-138.7	
Wald X2 statistic	274	
P-value	0.000	

***p<0.01, ** p<0.05, and * p<0.1

pay and negative effects on the probability of its lower levels. Therefore, one unit of increase in the animal count will increase the probability of PLW adoption for animal feeding by 0.018 units among individuals at level 5 of the willingness to use (y=4) if all other conditions are kept constant. In other words, if the animal count is increased by one unit, the probability of definite willingness to use PLW will increase by 0.018 units.

The marginal effect of knowledge of PLW is negative at two first levels of willingness to use and positive at higher levels. This implies that the increase in the rancher's score on PLW knowledge induces a positive change in probabilities at higher levels of willingness to use and a negative change in probabilities at lower levels of willingness to use. The greatest negative change in probability was observed at the indefinite level of willingness to use PLW (level 1), and the greatest positive change was observed at level 4 of willingness to use. These findings are consistent with previous studies (Li et al., 2021; Carrer et al., 2017; Hayati et al., 2017) and support the key role of knowledge on the adoption of technology and modern products by producers in the agricultural sector. Several studies (Benabderrahim et al., 2018; Aziz, 2020; Azizi and Aminifard, 2021) have shown that the use of leaf wastes has not only no adverse impact on the products of animal farms but they can also be a reliable alternative for costly inputs in livestock rations.

Based on the results, when the concern over the use of PLW in animal feeding is increased by one unit, the probability of adoption decreases by 0.005 and 0.025 units at levels 4 and 5 of willingness to use, respectively. Also, one unit of decrease in the variable of concern over PLW use increases the probability of adoption at levels 1, 2, and 3 of willingness to use by 0.015, 0.009, and 0.001 units, respectively. This finding clearly shows the significance of dealing with ranchers' concerns about the use of PLW. As was already mentioned, farmers are mostly concerned about meeting the safety and food requirements of their animals as compared to wheat residues. Dehhaghi et al. (2020) found that confidence in the safety of new innovation had the greatest positive effect on willingness to use treated water in farming among the farmers in Lorestan province, Iran. Also, Shankar et al. (2020) state that the most important factor involved in the adoption of innovation in the trade of new products is users' trust in health and the lack of any consequences. Since previous studies by animal scientists show the lack of concern in this respect (Kardooni et al., 2013; Ghodusi et al., 2019; Benabderrahim et al., 2018; Suyitman et al., 2020), it seems that by reducing the regional ranchers' concern over the health of this food resource, a great step can be taken to encourage the use of date palm leaf residue, which is produced in huge quantities in the region. According to Mancini et

Table 4
The Marginal Effects Calculated for Different Levels of Willingness to Use PLW

Variable	Marginal effects				
	Yj = 0	Yj = 1	Yj = 2	Yj = 3	Yj = 4
Rancher's experience	-0.07	0.02	0.035	0.013	0.002
Animal type	-0.067	-0.02	0.05	0.024	0.013
Animal count	-0.09	-0.03	0.08	0.022	0.018
Knowledge of PLW	-0.15	-0.003	0.12	0.0162	0.0141
Concern over PLW use	0.015	0.009	0.001	-0.005	-0.025
Membership in a cooperative	0.6	0.12	0.17	-0.16	-0.19

al.'s (2019) structured study, recent studies on the use of new food have shown that awareness of food consumption has had a positive effect on people in different nations.

The last variable that influenced the probability of PLW adoption was membership in a ranching cooperative, which is in the last row of Table 4. The marginal effect of this variable indicates that ranchers who are a member of a ranching cooperative are more likely to exhibit higher levels of willingness to use PLW in animal feeding.

CONCLUSIONS AND RECOMMENDATIONS

Based on the literature review and the results of field research, PLW consumption in animal feeding is an approach to using the waste of a large part of date palm orchards in the south of Kerman province in feeding about 2.5 million livestock units in this area. On the other hand, the collection, production, and supply of the food source derived from PLW has a high potential to create employment for the youth, thereby partially alleviating the issue of unemployment. The present research, thus, focused on studying the factors underpinning ranchers' willingness to use PLW in animal feeding in this region using the ordinal logit model. This model can classify the dependent variable into different categories and is employed in surveys in which the respondents' preferences are categorized in an ordinal manner.

The results show the low willingness of the studied ranchers to use PLW in animal feeding. Some main reasons for this reluctance are the lack of confidence in the consumption of this feed source and its effect on animal production and health, the lack of adequate knowledge about the advantages of PLW use, and the weaknesses of public agencies and organizations in promoting PLW. The top priority for the use of PLW is, in the view of ranchers, the security of its consumption and its effect on animal health. The next priorities are confidence in the capability of this product in meeting the food demand of animals, its price, and its availability in the market. Given the positive effect of knowledge of PLW on the likelihood of its use in animal feeding by ranchers and since the security of PLW consumption has been emphasized in the field studies frequently, it is predicted that by informing ranchers in a timely and accurate manner, an important step can be taken to replace expensive food resources, e.g., wheat residues, with this inexpensive food resource in livestock ration. Based on the results of the model, it is recommended to extend information on the advantages of PLW use at farms where small animals, like goats and sheep, are reared. The results reveal the significance of training and promoting the positive aspects of PLW use and the fact that it has no side effect on livestock health among ranchers. Given the significant effect of awareness of PLW benefits, it is suggested to use seasoned and knowledgeable people with rich practical experience in holding training courses for the managers of animal farms to inform them about the benefits of PLW use. Furthermore, a model farm can be selected in the region to show its results and thereby improve ranchers' willingness to adopt PLW.

The results show that more concerned ranchers are less likely to use PLW in animal feeding. In other words, the ranchers perceive the risk of using this alternative feed to be high, which ultimately results in their reluctance to use it. So, it is suggested to enhance ranchers' awareness in fields that they are most concerned about (confidence in PLW's no side effects on animals and its capability to meet the animal's food requirement) so that they can be ensured about the consumption of PLW in animal feeding.

Additionally, the mitigation of the adverse environmental impacts of burning great quantities of date palm residues should be included in the resources used for promoting and recommending the use of its residues in animal feeding. It is recommended to reduce concerns among local ranchers about the use of date palm residues in animal feeding, thereby extending and developing the technology of its use and its conversion to animal

feed, which would greatly contribute to consuming huge volumes of the waste of date palm leaves.

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